FA-01 WATER QUALITY MONITORING PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

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PSP

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List of Acronyms and Abbreviations

1-DMax.....1-day maximum temperature
7-DADMax .....7-day average of daily maximum temperature
µg/L.....microgram per liter
cfs.....cubic feet per second
CFU.....colony-forming units
City Light.....Seattle City Light
CoSD.....City of Seattle (Vertical) Datum
CWA .....Clean Water Act
Ecology .....Washington State Department of Ecology
EFH.....Essential Fish Habitat
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
FARWG .....Fish and Aquatics Resource Work Group
FDOM.....fluorescent dissolved organic matter
FERC.....Federal Energy Regulatory Commission
FLA.....Final License Application
FPA .....Federal Power Act
FSA .....Fisheries Settlement Agreement
ILP.....Integrated Licensing Process
ISR .....Initial Study Report
L .....liter
LP.....licensing participant
mg .....milligram
mg/L.....milligram per liter
mL .....milliliter
MPN.....most probable number
mS/cm .....microsiemens per centimeter
NHPA.....National Historic Preservation Act
NMFS.....National Marine Fisheries
NPS .....National Park Service
NTU .....nephelometric turbidity units

PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
QAPP .....Quality Assurance Program Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SOP .....standard operating procedure
TDG .....total dissolved gas
TSS.....total dissolved solids
U.S.C.....United States Code
USFWS .....U.S. Fish and Wildlife Service
USGS .....U.S. Geological Survey
USIT.....Upper Skagit Indian Tribe
USR.....Updated Study Report
WAC .....Washington Administrative Code
WDFW.....Washington Department of Fish and Wildlife
WRIA.....Water Resources Inventory Area

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

The relicensing process includes the timeframes and deadlines specified in FERC's Integrated Licensing Process (ILP), including consultation with interested agencies and Indian tribes related to study plans, study results, and subsequent analysis of results and effects analysis through the filing of the Final License Application (FLA). FERC's process includes steps to satisfy the various statutory authorities identified in the Federal Power Act (FPA) (e.g., Sections 4(e), 10(j), 10(a)). Other related regulatory processes including Washington State Department of Ecology's (Ecology) Section 401 water quality certification process, the U.S. Fish and Wildlife Service's (USFWS) and National Marine Fisheries Service's (NMFS) Section 7 Endangered Species Act (ESA) consultation, NMFS's oversight of Essential Fish Habitat (EFH), as defined by the Magnuson Stevens Fishery Conservation and Management Act, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA) will continue following filing of the FLA. With the filing of the PAD, City Light requested that FERC designate City Light as FERC's non-federal representative for purposes of initiating and conducting day-to-day consultation under ESA Section 7 and NHPA Section 106, which was granted by FERC in its June 26, 2020 Notice of Intent to File License Application for a New License and Commencing Pre-Filing Process.

1.3 Study Plan Development

In 2019-2020, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential Project effects. City Light developed 24 study proposals, including this Water Quality Monitoring study plan.

On April 10, 2020, City Light released the Water Quality Monitoring Draft Study Plan for LP review and comment. On May 5, 2020, the draft study plan was discussed at a Fish and Aquatic Resource Work Group (FARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 16, 2020. The revised draft was discussed on June 24, 2020 at a FARWG meeting. Written comments were received from NPS, Ecology, Washington Department of Fish and Wildlife (WDFW), USFWS, Upper Skagit Indian Tribe, and NMFS and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

This study plan has been modified from the Status Draft version as a result of additional consultation with LPs and addresses, with modifications, elements of the following study requests, as explained in Section 6 of the PSP: Ecology-01 Water Quality Study, NMFS-01 Water Quality, NPS-02 Skagit Project Water Quality Assessment and Modeling, USFWS-03 Skagit Project Water Quality Assessment and Modeling, USIT-07 Water Quality Impacts above and below SCL Project

Infrastructure, and WDFW-17 Water Quality Impacts above and below SCL Project Infrastructure. City Light has addressed specific comments and suggested edits to the study plan that were provided by Ecology.

The study design described in Section 2.6 of this study plan is structured to identify water quality data collection which, along with existing water quality information, will support the license application, including the application to Ecology for certification of the Project under Section 401 of the Clean Water Act (CWA). A licensee must receive a water quality certification, or a waiver thereof, before FERC can issue an operating license. The study will also provide data of value to FERC, other resource agencies, Indian tribes, and other LPs on water quality within the study area (see Section 2.5 of this study plan).

Following completion of relicensing studies, an integrated environmental analysis will specifically address links across resource areas. Data collected as part of the Water Quality Monitoring Study, along with existing water quality information, may also be applicable to other resource areas. Studies that may ultimately be linked, either directly or indirectly, to the findings of this study include the FA-02 Instream Flow Model Development Study (i.e., fish habitat suitability) in the Gorge bypass reach and in the reach below Gorge Powerhouse, and OM-01 Operations Model Study (i.e., effects of flow releases on temperature, dissolved oxygen, and total dissolved gas [TDG]). More needs to be learned within each respective study area before it is clear if and how study results will meaningfully inform comprehensive environmental analysis. City Light will work with LPs to review and integrate information from related studies as part of the ILP process in support of its license application filing.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

As noted above, this study plan has been designed to collect water quality data, which along with existing water quality information, is intended to support Ecology's certification of the Project under Section 401 of the CWA, and the data needs of FERC, while also addressing other data needs of resource agencies, Indian tribes, and other LPs in the context of FERC relicensing. The goal of this study is to monitor water quality parameters for which existing information is insufficient to characterize conditions within the study area. Parameters for which existing data are considered sufficient are identified in Section 2.3 (Table 2.3-1). City Light proposes to direct resources toward the collection of data needed to characterize parameters that are not currently well understood. The water quality parameters listed below will be monitored in the identified waterbodies during the relicensing study period.

Specific objectives of this study are listed below (sampling design and timeframes, which vary by waterbody and parameter, are provided in the Methods section of this plan).

- Provide a summary of all relevant existing water quality information identified in Table 2.3-1.
- Characterize background levels of turbidity and total suspended solids (TSS) in Ross, Diablo, and Gorge lakes.
- Measure fecal coliform levels at targeted locations in Ross Lake.
- Measure temperature, dissolved oxygen, and pH in Diablo and Gorge lakes.
- Continuously monitor temperature, dissolved oxygen, TDG, and turbidity at two locations in the Gorge bypass reach.
- Continuously measure TDG in the Diablo Dam tailrace and Gorge Lake forebay.
- Continuously measure dissolved oxygen, pH, TDG, and turbidity below Gorge Powerhouse. Sample TSS during periods when turbidity levels below Gorge Powerhouse are considered by the RWG to be elevated.[1]
- Continuously measure temperature by installing probes at three U.S. Geological Survey (USGS) stage or discharge gage stations established in the Skagit River downstream of the Gorge Powerhouse for the Instream Flow Model Development Study.
- Sample benthic macroinvertebrates in riffle habitat at the three USGS stage or discharge gage stations in the Skagit River between Gorge Powerhouse and the Sauk River confluence where continuous temperature probes will be installed.

2.2 Resource Management Goals

The study will provide information to help resource agencies and Indian tribes with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

[1] Continuous temperature data below Gorge Powerhouse is currently collected by the USGS at station 12178000.

2.2.1 Applicable Numeric Water Quality Standards and Designated Uses

Numeric water quality criteria for the Project vicinity are shown in Table 2.2-1, some of which differentiate between lakes/reservoirs and stream reaches as defined by Ecology (Washington Administrative Code [WAC] 173-201A-600) as follows: "...reservoirs with a mean detention time greater than fifteen days are to be treated as a lake for use designation..." By this definition, riverine water quality criteria (Table 2.2-1) apply to Diablo (detention time = 9.4 days) and Gorge (detention time = 0.8 days) lakes. Ross Lake, with a detention time of 189.4 days, is subject to the lake criteria identified in Table 2.2-1. Ecology has identified supplemental spawning and incubation criteria for specific reaches within Water Resources Inventory Area (WRIA) 4 (Figure 2.2-1). The Skagit River from Gorge Dam (RM 96.5) downstream to Gorge Powerhouse (i.e., Gorge bypass reach) has a special condition status under State water quality standards (WAC 173-201A-600): water temperatures are not to exceed 21ºC as a result of anthropogenic activities.

Table 2.2-1. Water quality criteria for the Project vicinity (see also Figure 2.2-1).

Parameter	Water Quality Criteria
Fecal Coliform[1]	Not to exceed a geometric mean value of 100 colony-forming units (CFU) or most probable number (MPN)/100 milliliter (mL) with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 CFU or MPN/100 mL.
E. coli	*E. coli* organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL.
Dissolved Oxygen	Lowest 1-Day Minimum: Char Spawning and Rearing: 9.5 milligrams per liter (mg/L) Salmon and trout spawning, core rearing, and migration: 9.5 mg/L
	For lakes/reservoirs, human actions considered cumulatively may not decrease the dissolved oxygen concentration more than 0.2 mg/L below natural conditions.
Temperature	Maximum 7-day average of daily maximum temperature (7-DADMax): Char Spawning and Rearing: 12 degrees Celsius (°C)(53.6°F) Salmon and trout spawning (Sept. 1 to June 15): 13°C (55.4°F) Core summer salmonid habitat: 16°C (60.8°F)
	Skagit River from Gorge Dam to Gorge Powerhouse (Gorge bypass reach). Temperature shall not exceed a 1-day maximum temperature (1-DMax) of 21°C due to human activities. When natural conditions exceed a 1-DMax of 21°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C, nor shall such temperature increases, at any time, exceed $t = 34/(T + 9)$.
	For lakes/reservoirs, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3°C (0.54°F) above natural conditions.
Total Dissolved Gas	Not to exceed 110 percent of saturation at any point of sample collection.
pH	Within 6.5 to 8.5 pH units with human caused variation of: Less than 0.2 units for char and salmon and trout spawning, core rearing, and migration.
Turbidity	Shall not exceed either a 5 nephelometric turbidity unit (NTU) increase over background when the background is 50 NTU or less; or a 10 percent increase in turbidity when the background is more than 50 NTU.

Source: WAC 173-201A-200.

1 The fecal coliform bacterial indicator expires on 12/31/2020.

Designated uses for protection in fresh surface waters that are relevant to the Project are shown in Table 2.2-2.

Table 2.2-2. Designated uses of water in the Skagit River and designated Water Resource Inventory Area (WRIA) 4 tributaries.

	Aquatic Life Uses						Recreational Uses			Water Supply Uses				Misc. Uses				
Water Body	**Char Spawning/Rearing**	**Core Summer Habitat**	**Spawning/Rearing**	**Rearing/Migration Only**	**Redband Trout**	**Warm Water Species**	**Ex Primary Contact**	**Primary Contact**	**Secondary Contact**	**Domestic Water**	**Industrial Water**	**Agricultural Water**	**Stock Water**	**Wildlife Habitat**	**Harvesting**	**Commerce/Navigation**	**Boating**	**Aesthetics**
Skagit River and all tributaries upstream of Skiyou Slough except designated tributaries		✓	✓[2]				✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Designated WRIA 4 tributaries[1]	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓

1 Bacon Cr, Big Beaver Cr, Cascade R, Diobsud Cr, Goodell Cr, Hozomeen Cr, Illabot Cr, Lightning Cr, Little Beaver Cr, Newhalem Cr., Rocky Cr, Ruby Cr, Sauk R, Silver Cr, Stetattle Cr,, Thunder Cr.

2 See supplemental spawning and incubation map (Figure 2.2-1).

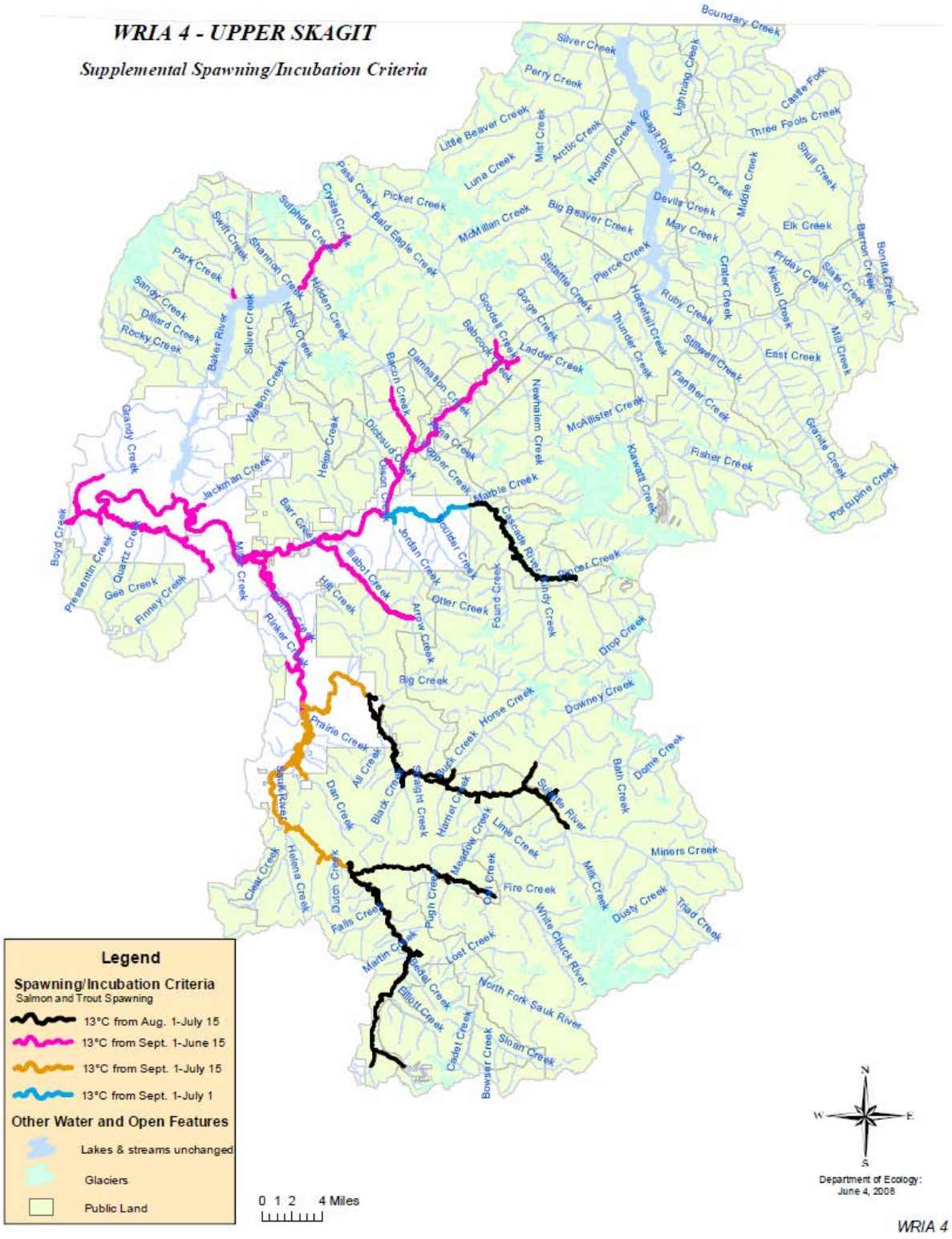

Figure 2.2-1. Supplemental spawning and incubation protection temperature criteria for WRIA 4 Upper Skagit River basin.

2.3 Background and Existing Information

At nearly 23 miles long, Ross Lake is the largest reservoir in western Washington. The reservoir has a surface area of 11,680 acres and storage volume of 1,435,000 acre-feet at the normal maximum water surface elevation of 1,602.5 feet City of Seattle Datum (CoSD).[2] Between 1991 and 2018, the average low water surface elevation ranged from 1,467.1 feet (in April) to 1,584.8 feet (in August). Ross Lake has a detention time of 189.4 days (Connor 2019). Ross Lake is the primary storage reservoir for the Project and is drawn down in winter to capture water from spring runoff and to provide for downstream flood control. City Light typically begins drawing down the reservoir shortly after Labor Day. Spills are infrequent at Ross Dam due to the reservoir's large storage capacity. Spills are typically associated with gate testing, are of short duration, and average only a few cubic feet per second (cfs). From 2014–2018, Ross Dam spilled 20 times. Eleven of these spills occurred in August 2015 during the Goodell Creek Wildfire, which disrupted Project operations and transmission. In 2014, 2016, 2017, and 2018, average spills ranged from <1–5 cfs per day. Average spills were higher (i.e., 1,540 cfs) in 2015 because the fire disrupted operations.

Diablo Lake has a surface area of about 770 acres and gross storage of 50,000 acre-feet at a normal maximum water surface elevation of 1,205 feet. During summer, the reservoir's major tributary, Thunder Creek, carries a heavy load of very fine, suspended glacier-generated sediment, also known as glacial flour, which gives the lake a notable turquoise color. Diablo Lake has a detention time of 9.4 days (Connor 2019). The primary function of the Diablo Development is to reregulate flows between the Ross and Gorge developments. The reservoir typically fluctuates 4–5 feet daily, although drawdowns of 10–12 feet occur occasionally as needed for construction projects or maintenance. Because of its role as a reregulation facility, Diablo Dam spills more frequently than any of the other Project facilities. Spill typically occurs during periods of high runoff, particularly during the spring or early summer. However, Diablo Dam also spills on the rare occasion that units are off-line at the Diablo Powerhouse or when additional water is needed to meet flow requirements downstream of Gorge Powerhouse.

Gorge Lake is 4.5 miles long. At the normal maximum water surface elevation of 875 feet, the reservoir has a surface area of 240 acres and gross storage of 8,500 acre-feet. Gorge Lake has a detention time of 0.8 days (Conner 2019). Because of Gorge Lake's relatively low storage volume, unplanned spills at the dam can occur any time inflow exceeds generation capacity. In addition, because flows from the Gorge Development are critical for fish production and protection in the Skagit River downstream of Gorge Powerhouse, water from Gorge Lake is spilled into the Gorge bypass reach if flows through Gorge Powerhouse are insufficient to meet downstream flow requirements specified under the 2013 Revised Fisheries Settlement Agreement (FSA) for salmon or steelhead spawning or rearing.

The reach of the Skagit River between Gorge Dam and Powerhouse is referred to as the bypass reach and is about 2.5 miles long. Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach (FERC 1995). The flow and non-flow measures incorporated into the FSA were determined by signatories to the settlement to resolve the effects of the absence of flows and obviate any need for flow releases in the bypass reach (City Light 1991). FERC, in its order accepting the settlement agreement, issuing new license and terminating

[2] All water level data currently collected at the Project reservoirs and key water surface elevations cited in the current Project license are reported to City of Seattle Datum (CoSD).

the proceeding (FERC 1995), concurred with the proposed action to continue interim agreement flow measures and add non-flow enhancement measures in the Skagit River below Gorge Powerhouse to address continued habitat loss in the bypass reach since "river flows from the powerhouse are of far more value to the anadromous fishery." Under the current license, flows in the bypass reach are limited to accretion flow, spill-gate seepage, tributary input, and precipitation runoff, except when water is being spilled at Gorge Dam.

From 1991 through 2012, flow releases to the mainstem Skagit River downstream of Gorge Powerhouse were dictated by the current Project license (FERC 1995), which fully incorporates the measures included in the Flow Plan of the FSA (City Light 1991). The primary purpose of the Flow Plan is to minimize the effects of Project operation on salmonids by providing spawning flows and protecting redds, fry, and yearlings. The Project license was amended in 2013 to incorporate a Revised FSA Flow Plan (City Light 2011) that included four measures City Light had been implementing voluntarily since 1995 to further reduce Project effects on steelhead and salmon. The FSA Flow Plan, as amended, is described in Section 3.5.2 of the PAD.

City Light possesses a large number of data files and accompanying data collection descriptions for the Project reservoirs (Table 2.3-1).[3] Table 2.3-1 also includes an account of existing data collected in the mainstem Skagit River downstream of the Project near Marblemount, which is located in the Project vicinity at approximately RM 78. Parameters for which multiple years of recent data have been collected are considered to be adequately represented by existing information. Data collection proposed in this study plan will fill data gaps identified in the body of existing information. A portion of the existing information is presented and discussed in Section 4.4 of the PAD, and a complete presentation of all relevant existing information will be provided in the Water Quality Monitoring Study report filed with FERC (with the Initial Study Report [ISR]). Existing water quality data collected in the Project reservoirs, by any party, will be reviewed for quality and incorporated into the assessment appropriately and summarized in the ISR report. In addition to the information shown in Table 2.3-1, City Light will also obtain and summarize water quality data collected in Ross Lake near the U.S.-Canada border by the USGS, Washington Water Science Center . Temperature, dissolved oxygen, pH, conductivity, and fluorescent dissolved organic matter (FDOM) data are collected continuously at this location; samples for nutrients, major ions, and dissolved and whole metals are collected periodically; bed sediment, algae, snail, and Rainbow Trout liver and fillet metals data are collected annually.

[3] The NPS's study request, NPS-02: Skagit Project Water Quality Assessment and Modeling, Attachment 1, includes a table of existing data, which includes additional data files for the Project reservoirs. City Light will coordinate with the NPS to procure all files and summarize relevant data in the Water Quality Monitoring Study report.

Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project and Skagit River to Marblemount.

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
Ross Lake							
Temperature (°C)	Little Beaver	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	City Light, NPS
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun–Dec	Surface, Middle, & Bottom	X		
		2018	Jun–Nov	Surface, Middle, & Bottom	X		
	Skymo	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun–Dec	Surface, Middle, & Bottom	X		
		2018	Jun–Nov	Surface, Middle, & Bottom	X		
	Pumpkin Mountain	2015	May, Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
		2017	Jun–Dec	Surface, Middle, & Bottom	X		
		2018	May–Dec	Surface, Middle, & Bottom	X		
		2019	Jan–Feb[2]	Surface, Middle, & Bottom	X		
	Log Boom	2000	Sep–Dec	Surface	X		City Light
		2001	Jan–Feb; Sep–Dec	Surface	X		
		2002	Jan–Mar	Surface	X		
		2003	Aug–Dec	Surface	X		
		2004	Jan–Aug; Nov–Dec	Surface	X		
		2005	Jan–Dec	Surface	X		
		2006	Jan–Dec	Surface	X		
		2007	Jan–Oct	Surface	X		
		2008	Sep–Dec	Profile	X		
		2009	Jan–Dec	Profile	X		
		2010	Jan–Feb	Profile	X		
		2014	Nov–Dec	Profile	X		
		2015	Jan–Dec	Profile	X		
		2016	Jan–Mar; Nov–Dec	Profile	X		
		2017	Jan–Sep	Profile	X		
	Hozomeen	2017	Jun–Oct	Surface & Bottom	X		NPS
		2018	Jun–Oct	Surface & Bottom	X		
Dissolved oxygen (mg/L)	Little Beaver	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	City Light

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	NPS
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Skymo	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Pumpkin Mountain	2015	May, Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
pH	Little Beaver	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	City Light, NPS
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Skymo	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Pumpkin Mountain	2015	May, Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
Nutrients	Little Beaver	2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	NPS
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Skymo	2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Pumpkin Mountain	2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
Chlorophyll *a* (µg/L)	Little Beaver	2015	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	NPS
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Skymo	2015	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Pumpkin Mountain	2015	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
Dissolved Organic Carbon (mg/L)	Little Beaver	2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	NPS
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Skymo	2017	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
	Pumpkin Mountain	2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Surface		X	
Turbidity (NTU)	Log Boom	2016	Aug	Profile		X	City Light

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
Specific conductance (mS/cm)	Little Beaver	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	City Light, NPS
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Skymo	2015	Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
			Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
			Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
	Pumpkin Mountain	2015	May, Jun, Jul, Sep, Oct, Nov	Profile		X	
		2016	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Profile		X	
Mercury[3]		2007, 2012, 2015	Summer–Fall	Fish tissue[4]		X	Ecology
PCBs[3]		2007, 2012, 2015	Summer–Fall	Fish tissue		X	Ecology
Copper[3]		2007, 2012, 2015	Summer–Fall	Fish tissue		X	Ecology
Selenium[3]		2007, 2012, 2015	Summer–Fall	Fish tissue		X	Ecology
Zinc[3]		2007, 2012, 2015	Summer–Fall	Fish tissue		X	Ecology
Zooplankton	Little Beaver	2015	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	NPS
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
	Skymo	2015	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal		X	

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
				Tow			
		2016	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2017	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2018	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
	Pumpkin Mountain	2015	Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2016	May, Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2017	May, Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
		2018	May, Jun, Jul, Aug, Sep, Oct, Nov	Horizontal Tow		X	
Diablo Lake							
Temperature (°C)	Log Boom/Forebay	2008	Aug–Dec	Surface	X		City Light, NPS
		2009	Jan–Aug	Surface	X		
		2014	See footnote[2]				
		2015	See footnote[2]				
		2016	Nov–Dec	Profile	X		
		2017	Jan–Sep	Profile	X		
	Thunder Arm	2018	Jun–Dec	1-, 15-, and 28-m depths	X		
		2019	Jan–Aug	1-, 15-, and 28-m depths	X		
	Thunder Arm	2018	Jun, Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct[2]	Profile		X	
	Mid-Lake Buoy	2018	Jul, Aug, Sep	Profile		X	

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
		2019	Jun, Aug, Oct	Profile		X	
	Forebay	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
Dissolved oxygen (mg/L)	Thunder Arm	2018	Jun, Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Mid-Lake Buoy	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Forebay	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
pH	Thunder Arm	2018	Jun, Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Mid-Lake Buoy	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Forebay	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
Specific conductance (mS/cm)	Thunder Arm	2018	Jun, Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Mid-Lake Buoy	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
	Forebay	2018	Jul, Aug, Sep	Profile		X	
		2019	Jun, Aug, Oct	Profile		X	
Gorge Lake							
Temperature (°C)	Log Boom	2014	See footnote[2]				City Light, NPS
		2015	See footnote[2]				
		2016	Nov–Dec	Profile	X		
		2017	Jan–Jul	Profile	X		
		2018	See footnote[2]				

		Timeframe			Data Type		
Parameter	**Collection Location**	**Year Collected**	**Month(s) Collected**	**Sampling Approach**	**Continuous**	**Discrete**	**Entity Collecting Data**
		2019	See footnote[2]				
Skagit River downstream of the Project							
Temperature (°C)[5]	Newhalem	2007–Ongoing	All	Surface	X		USGS
Total dissolved gas (percent saturation)	Below Gorge Powerhouse	1997	Jul	Surface		X	City Light
Skagit River at Marblemount[6]							
Temperature (°C) 7DADMax	Marblemount	2002–2009	Jun–Sep[7]	Surface	X		Ecology
Temperature (°C) Daily grab sample		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Dissolved oxygen (mg/L)		2009–Ongoing	Jan–Dec	Surface		X	Ecology
pH		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Turbidity (NTU)		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Ammonia (mg/L)		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Total phosphorous (mg/L)		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Fecal coliform (CFU/100 mL)		2009–Ongoing	Jan–Dec	Surface		X	Ecology
Metals[8]		1994	May, Jul, Sep, Nov	Surface		X	Ecology
		1995	Jan, Mar	Surface		X	Ecology

1 The period 1991–2019 encapsulates the timeframe beginning with the finalization of the Settlement Agreement and ending with the most recent year.
2 City Light is following up to determine if data (or additional data) are available for the period and timeframe shown in this cell of the table.
3 See Seiders and Deligeannis (2018).
4 Bull Trout, Rainbow Trout, Redside Shiner
5 USGS (2019a) https://waterdata.usgs.gov/usa/nwis/uv?12178000
6 USGS (2019b) https://apps.ecology.wa.gov/eim/search/SMP/RiverStreamSingleStationOverview.aspx?ResultType=RiverStreamOverviewList&StudyMonitoringProgramUserId=RiverStream&StudyMonitoringProgramUserIdSearchType=Equals&LocationUserIds=04A100&LocationUserIdSearchType=Equals.
7 Measurement within this overall timeframe varies by year.
8 Arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc; source Ecology (2019); see URL provided in table footnote number 5.

2.4 Project Operations and Effects on Resources

The Skagit River drains mountainous and, in some cases, glacial areas located mainly within national park and wilderness areas; water flowing through the Project remains clean and cold throughout the year. Existing information indicates that water quality in the Project reservoirs is in compliance with Ecology's relevant numeric criteria. The few 303(d) listings for WRIA 4, which includes the Project and its vicinity, are applicable to reaches that are not affected by the Project, reflecting the good baseline water quality measured within and downstream of the Project Boundary. Moreover, data collected by Ecology indicate that water quality in the Skagit River downstream of the Project (measured at Marblemount and discussed in Section 4.4.5 of the PAD) is in compliance with Ecology's numeric criteria. City Light is aware of no data indicating that the designated uses shown in Table 2.2-2 are adversely affected by the Project's operation.

Although there is a large body of existing water quality information for the Project (see Table 2.3-1), targeted data collection is proposed to address water quality parameters for which existing information is limited. The existing data, combined with that collected during this proposed study, will be used to inform the Section 401 certification process overseen by Ecology as well as FERC's issuance of a new license for the Project.

2.5 Study Area

The study will be conducted in Ross (within the United States), Diablo, and Gorge lakes, the Gorge bypass reach, and in the Skagit River downstream of the Gorge Powerhouse (Figure 2.5-1).[4] Approximate locations of the proposed water quality sampling/measurement sites and the rationale for their locations are discussed in Section 2.6 of this study plan. All sampling locations within the Project reservoirs, Gorge bypass reach, and immediately below the Gorge Powerhouse are affected by Project operations.

[4] A higher resolution map(s) showing the locations of the sampling and measurement sites will be provided in the Water Quality Monitoring Study report included with the ISR.

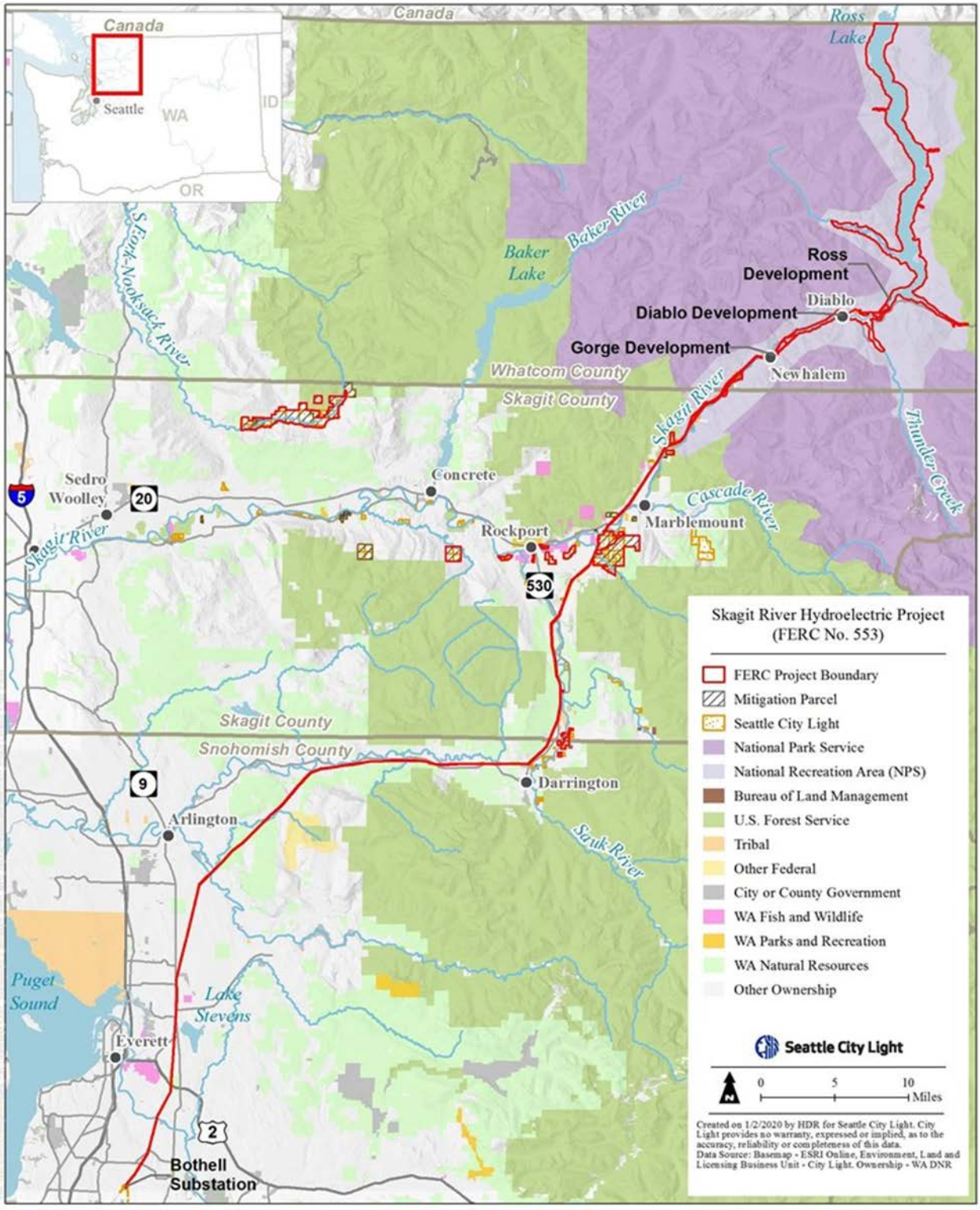

Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

The approach to water quality data collection, by general location and parameter, is outlined below. The proposed parameters and locations were selected after review of the body of existing data summarized in Table 2.3-1 and are intended to augment these data. In addition to new water quality data being collected as part of this study, all existing information identified in Table 2.3-1 will be summarized in the Water Quality Monitoring Study report that will be filed with FERC. A Quality Assurance Program Plan (QAPP) is attached to this study plan. The QAPP details technical elements of field sampling and measurement, laboratory protocols, chain-of-custody procedures, and data management. Table 2.6-1 provides an overview of parameters to be measured or sampled along with proposed sampling locations,[5] sampling timing and durations, and approach to data collection.

Table 2.6-1. Summary of parameters to be measured or sampled along with proposed sampling locations, sampling periods and frequencies, and approach to data collection.

Parameter	Location	Sampling Period	Frequency	Sampling Approach
Ross Lake				
Turbidity (NTU)	Little Beaver	Jun 2021–May 2023	Monthly	Surface and 5 m
	Skymo	Jun 2021–May 2023	Monthly	Surface and 5 m
	Pumpkin Mountain	Jun 2021–May 2023	Monthly	Surface and 5 m
TSS (mg/L)	Little Beaver	Jun 2021–May 2023	Monthly	Surface and 5 m
	Skymo	Jun 2021–May 2023	Monthly	Surface and 5 m
	Pumpkin Mountain	Jun 2021–May 2023	Monthly	Surface and 5 m
Fecal coliform	Hozomeen	Jun–Sep 2021	Monthly	Surface
	Ross Lake Resort	Jun–Sep 2021	Monthly	Surface
	Boat Access Camps (3)	Jun–Sep 2021	Monthly	Surface
Diablo Lake				
Temperature (°C)	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
DO (mg/L)	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
pH	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
Turbidity (NTU)	Upstream End	Jun–Sep 2021	Monthly	Surface and 5 m
	Forebay	Jun–Sep 2021	Monthly	Surface and 5 m
TSS (mg/L)	Upstream End	Jun–Sep 2021	Monthly	Surface and 5 m
	Forebay	Jun–Sep 2021	Monthly	Surface and 5 m
Gorge Lake				
Temperature (°C)	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
DO (mg/L)	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals

[5]As needed, exact sampling locations will be determined in consultation with Ecology and other LPs as part of study implementation planning activities.

Parameter	Location	Sampling Period	Frequency	Sampling Approach
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
pH	Upstream End	Jun–Sep 2021	Monthly	Profile 1-m intervals
	Forebay	Jun–Sep 2021	Monthly	Profile 1-m intervals
Turbidity (NTU)	Upstream End	Jun–Sep 2021	Monthly	Surface and 5 m
	Forebay	Jun–Sep 2021	Monthly	Surface and 5 m
TSS (mg/L)	Upstream End	Jun–Sep 2021	Monthly	Surface and 5 m
	Forebay	Jun–Sep 2021	Monthly	Surface and 5 m
TDG (% saturation)	Below Diablo Dam	Jun 2021–May 2022	Continuous	Below compensation depth
	Gorge Lake Forebay	Jun 2021–May 2022	Continuous	Below compensation depth
Gorge Bypass Reach				
Temperature (°C)	Below Gorge Dam	Jun 2021–May 2022	Continuous	At Depth
	Above Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
DO (mg/L)	Below Gorge Dam	Jun 2021–May 2022	Continuous	At Depth
	Above Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
Turbidity (NTU)	Below Gorge Dam	Jun 2021–May 2022	Continuous	At Depth
	Above Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
TDG (% saturation)	Below Gorge Dam	Jun 2021–May 2022	Continuous	Below compensation depth
	Above Gorge Powerhouse	Jun 2021–May 2022	Continuous	Below compensation depth
Skagit River below Gorge Powerhouse				
DO (mg/L)	Below Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
pH	Below Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
Turbidity (NTU)	Below Gorge Powerhouse	Jun 2021–May 2022	Continuous	At Depth
TDG (% saturation)	Below Gorge Powerhouse	Jun 2021–May 2022	Continuous	Below compensation depth
TSS (mg/L)	Below Gorge Powerhouse	Jun 2021–May 2022	As needed	At Depth
Temperature (°C)	River mile 91.1	Jun 2021–May 2023	Continuous	At Depth
	River mile 85.6	Jun 2021–May 2023	Continuous	At Depth
	River mile 75.1	Jun 2021–May 2023	Continuous	At Depth
Benthos	River mile 91.1	Jul and Sep 2021	Discrete	Streambed
	River mile 85.6	Jul and Sep 2021	Discrete	Streambed
	River mile 75.1	Jul and Sep 2021	Discrete	Streambed

2.6.1 Ross Lake

City Light proposes to collect data from June 2021–May 2023[6] to establish background turbidity (nephelometric turbidity units, NTUs) levels within Ross Lake. Sampling will be conducted once per month, at three general locations in the reservoir: Pumpkin Mountain (48.7904, -121.0496), Skymo (48.8547, -121.0308), and Little Beaver (48.9274, -121.0625). These locations are representative of conditions in the downstream, middle, and upstream ends of the reservoir,

[6] The Updated Study Report [USR] is to be filed by March 2023. City Light recognizes that any data collected beyond December 2022 are not likely to be included in the USR; all data from the June 2012–May 2023 period will be made available to Ecology and other LPs and incorporated to the extent possible into the application for §401 certification of the Project.

respectively, and are used by the NPS in its water quality sampling program. Measurements will be made at the surface and at a depth of 5 m. Samples for the measurement of TSS (milligram/liter [mg/L]) will be collected at the same locations and times as turbidity. TSS samples will be collected according to Ecology's standard operating procedures (SOP) and sent to an accredited laboratory for analysis. The sampling approach is designed to characterize turbidity/TSS during minimum water surface elevation in winter, reservoir refill in spring, normal maximum water surface elevation during summer, and reservoir drawdown in fall.

There are few potential anthropogenic sources of fecal coliform in Ross Lake. City Light proposes to collect samples for the measurement of fecal coliform monthly from June–September 2021 (the period of year when recreational use is heaviest) at the following locations, chosen because they experience relatively high levels of human use: Hozomeen, Ross Lake Resort, and at three boat access camps managed by the NPS (the camps to be sampled will be determined in consultation with Ecology and the NPS). Samples will be collected according to Ecology's SOPs (attached to this study plan) and sent to an accredited laboratory for analysis.

2.6.2 Diablo Lake

Temperature (°C), dissolved oxygen (mg/L and percent saturation),[7] and pH will be measured at 1-m intervals along vertical profiles at the upper end of Diablo Lake and in the Diablo Lake forebay using a Hydrolab® multiparameter sonde with depth probe or equivalent equipment. Sampling will be conducted once per month from June through September 2021 to document conditions during the warmest time of year, i.e., when dissolved oxygen concentrations can be at their lowest. Turbidity (NTU) and TSS (mg/L) will be measured at the same times and locations as the aforementioned parameters, except measurements will be made and samples will be collected at the surface and at a depth of 5 m.

2.6.3 Gorge Lake

Temperature (°C), dissolved oxygen (mg/L), and pH will be measured at 1-m intervals along vertical profiles at the upper end of Gorge Lake and in the Gorge Lake forebay using a Hydrolab® multiparameter sonde with depth probe or equivalent equipment. Sampling will be conducted once per month from June through September 2021 to document conditions during the warmest time of year. Turbidity (NTU) and TSS (mg/L) will be measured at the same times and locations as the aforementioned parameters, except measurements will be made and samples will be collected at the surface and at a depth of 5 m.

Total dissolved gas (TDG) (percent saturation) will be measured during Diablo Dam spill events at two monitoring locations: below Diablo Dam and in the Gorge Lake forebay, using a Hydrolab® TDG sensor or equivalent equipment. TDG will be measured continuously from June 2021–May 2022.

2.6.4 Gorge Bypass Reach

Temperature (°C), dissolved oxygen (mg/L), turbidity (NTU), and TDG (percent saturation) will be measured continuously from June 2021–May 2022 at two locations in the Gorge bypass reach using a Hydrolab® multiparameter sonde or equivalent equipment: i.e., near Gorge Dam and in

[7] Atmospheric pressure will be measured along with all dissolved oxygen.

the reach just upstream of Gorge Powerhouse that stays wet throughout the year. This will allow for the opportunistic measurement of TDG under spill conditions as they arise. Also, during the monitoring period City Light plans to implement controlled flow releases from Gorge Dam of about 50, 500, and 1,200 cfs (i.e., releases made as part of fieldwork needed to develop the Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model).

2.6.5 Skagit River below Gorge Powerhouse

Dissolved oxygen (mg/L), pH, turbidity (NTU), and TDG (percent saturation) will be measured continuously from June 2021–May 2022 in the Gorge Powerhouse tailrace using a Hydrolab® multiparameter sonde or equivalent. TSS (mg/L) will be sampled opportunistically during any periods when turbidity levels are considered by the FARWG to be elevated.

Temperature (°C) will be measured continuously from June 2021–May 2023 with probes installed at three stage/discharge gage stations established in the Skagit River downstream of Gorge Powerhouse for the Instream Flow Model Development Study. Proposed temperature measurement locations include: (1) the proposed stage gage at RM 91.1, (2) the proposed stage and discharge gage at RM 85.6, and (3) the proposed stage gage at RM 75.1.

Benthic macroinvertebrates will be sampled near the three continuous temperature monitoring locations (i.e., RMs 91.1, 85.6, and 75.1) in the Skagit River during two sampling periods: July and September 2021. At each location, benthos will be collected with a D-frame kicknet (with an area of 1 ft^2) over a site length of 2 bankfull widths or more. Eight, 1-ft^2 kicknet samples will be taken in multiple riffles at each location to obtain a single 8-ft^2 composite sample. Kicknet samples will be collected and processed according to the relevant field sampling, preservation, data reporting, records management, and quality assurance and quality control methods described in Ecology's SOPs EAP073 included in the QAPP attached to this study plan.

2.6.6 Analysis and Reporting

An interim monitoring report will be filed in March 2022 (with the ISR), and a final study report will be filed in March 2023 (with the USR) (see Section 2.8 below). As noted in Section 2.6.1, data collected beyond December 2022 are unlikely to be incorporated into the final study report; however, these data will be made available to Ecology and other LPs and incorporated to the extent possible into the application for Section 401 certification of the Project. The final monitoring report will include:

- A description of the study methodology;
- Maps showing all data collection locations;
- An summary of existing data included in Table 2.3-1, and additional data of suitable quality provided by other entities;
- Summary figures and tables of water quality and benthic macroinvertebrate data; and
- Parameter-specific evaluation of available data against Ecology's criteria.

2.7 Consistency with Generally Accepted Scientific Practice

Methods for data collection, handling, and analysis are in accordance with Ecology guidance and associated SOPs as detailed in the QAPP attached to this study plan.

2.8 Schedule

- Field Work – May 2021 to June 2023
- Analysis – August 2021 to August 2023
- ISR – March 2022
- USR – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $316,000.

3.0 REFERENCES

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WATER QUALITY MONITORING PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Ashley Rawhouser (NPS)	05/11/2020	General Comment, Title Page	General Comments NPS: 1) The study plans should stand alone as an independent documents. When referencing the PAD or the original Issue Forms submitted by the LPs a summary of the pertinent information should be provided.	1) City Light agrees that the study plans should be stand-alone documents, but there are limits to what can reasonably be presented in a background or existing information section. The PAD contains much information, which is often detailed and nuanced. A summary in this study plan would not be representative of the material, and reproducing the content of the PAD would make the plan unwieldy. City Light continues to believe that the best approach is for LPs to reference the PAD (Note" any additional information located by City Light but not presented in the PAD will be summarized in the Water Quality Monitoring Study report). 2) City Light has removed references to the issue forms from this study plan (consistent with the approach taken in other study plans). Text has been added to Section 1.3 to better explain the role of the issue forms in contributing to City Light's suite of study proposals. Notwithstanding the restructuring of how issue forms are represented in study plans, City Light acknowledges that not every element of water quality sampling identified in issue forms is addressed in the proposed study design. The principal focus of this study as drafted is to address water quality data gaps needed for 401 water quality certification of the Project. City Light has demonstrated commitment to long-term monitoring of other elements requested in issue forms and will continue to do so through

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					the partnerships we maintain with LPs in ongoing and future monitoring of water quality trends, including such metrics that are not typically conditioned to licenses (e.g., benthos sampling or reservoir phytoplankton), but for which long-term trend monitoring is useful for understanding effects of climate change and other environmental and operational factors at play in the watershed. City Light sees these commitments as largely falling outside of the 401 water quality certification process and best identified and prioritized through a longer term strategic management plan that could be coordinated with LPs and agreed to as part of license conditions beyond the two-year FERC study time frame. Long term strategic sampling, in coordination with City Light's climate resilience strategy, and incorporating a shared data management approach with LPs, is in keeping with City Light's environmental stewardship ethos. City Light would welcome furthering such an approach following license issuance in an independent working group that is expressly focused on strategically prioritized long-term trend monitoring of appropriate water quality metrics.
2.	Monika Kannadaguli (Ecology)	05/13/2020	Section 1.1, General Description of the Project	"The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt ~~powerlines~~power lines that span over 100 miles and end just north of Seattle at the Bothell Substation."	In its documents, including the PAD, City Light consistently uses "powerlines;" the unedited version has been retained in this and other study plans.
3.	Brock Applegate (WDFW)	05/11/2020	Section 1.2, Relicensing Process	"This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the	Section 1.2 and 1.3 were redrafted to better describe the 2019 collaborative process. Formal consultation does not begin until after the PAD

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				Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally." **New comment provided on 06/24/2020:** WDFW does not consider the process as collaborative when the licensee tells the Licensing Participants (LP) to take their issues to FERC. SCL management would not select the collaborative licensing process, the Alternative Licensing Process, which most, if not all, licensing participants preferred. SCL can select the licensing process they prefer, but the ILP operates in consultation, not collaboration when SCL chooses to separate the licensing process from the settlement agreement process. I would agree that we did collaborate during the collection of study issues.	is officially submitted. Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together). **Response to comment provided on 06/24/2020:** City Light appreciates your agency's input and looks forward to working with you to address resource issues during the relicensing proceeding.
4.	Judy Neibauer (USFWS)	05/13/2020	Section 1.2, Relicensing Process	"This study plan reflects the RWG consultation, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally." Mention here that this information will help inform NEPA, the BA for ESA consultation, and the information needed for Section 10j for the Fish and Wildlife Coordination Act....similar to your other study plans....	See revisions to Section 1.3.
5.	Ashley Rawhouser (NPS)	05/11/2020	Section 1.3 Study Plan Development	In general, NPS believes the study plans should standalone as independent documents that contain enough detail so they could be replicated by an uniformed "outside" party.	City Light agrees that study methods must be clearly stated so that the study could be replicated, and such clarity will be provided as the study plan and its associated QAPP are finalized. A draft QAPP will be included in City Light's Proposed Study Plan (PSP), at which

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					time LPs can provide comments on the QAPP. The QAPP will describe the technical aspects of all field, laboratory, and data management aspects of the study, including the frequency of instrument calibrations.
6.	Judy Neibauer (USFWS)	05/13/2020	Section 1.3 Study Plan Development	Yes. My experiences with the Chelan PUD FERC study plans are the if the words are not accurate in the studies, they continually are brought up and argued about what was meant or what was supposed to be studied….Please make studies clear so that FERC and working groups will understand them. (See Comment #5)	See Comment Response #5.
7.	Ashley Rawhouser (NPS)	05/11/2020	Section 1.3 Study Plan Development	"Resource issues to be addressed in part by this study in combination with existing information are identified in the following issue forms: (1) FA10 Reservoir Turbidity; (2) FA14 Water Quality Monitoring; and (3) FA15 Water Quality Data." Please briefly describe or outline the issues to ensure we are all on the same page. Additional NPS issue forms that relate to this study plan but are not listed: FA-08 and FA-05 Current NPS issues include: 1) The proposed development of pumped storage will likely change water temperatures, thermal stratification, dissolved oxygen concentrations, nutrient concentrations, and turbidity in all three reservoirs and downstream in the Skagit River. These changes will have cascading effects on the biological communities and food webs in these waterbodies. In order to assess the impacts associated with this proposed	See Comment Response #1.

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				development, existing water quality conditions need to be established. These data will also be needed to develop a hydrodynamic model that will be used to evaluate changes in reservoir water circulation, stratification, and the water quality characteristics of project's powerhouses outflows. 2) Sustained (maximum 7-day average) water temperatures routinely exceed 20°C in July, August, and September in Ross Reservoir and may inhibit the fall spawning migration of Bull Trout and Dolly Varden and reduce the amount of suitable habitat for foraging and rearing for these species. 3) The primary inflow to Diablo, Gorge, and the Skagit River at Newhalem is from the hypolimnetic releases from the reservoirs above. This is likely depressing water temperatures in these waterbodies reducing invertebrate productivity and the growth of native fish species. 4) Due to impoundment, nutrients are likely sequestered in the reservoirs through biological uptake and deposition into lake sediments rather than flowing downstream. This is potentially reducing invertebrate productivity and the growth of native fish downstream in Diablo, Gorge, and the Skagit River below the Newhalem Powerhouse. 5) The Bypass Reach is currently dewatered due to hydroproject operations an only receives limited inflow from dam leakage and small intermittent tributaries. 6) Increased turbidity during seasonal drawdowns may impair migration and foraging of native Bull Trout, Dolly Varden, and Rainbow Trout.	

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				7) Accumulation of heavy metals in reservoir sediment, primarily Ross, and subsequent uptake into the food web and fish tissue related to historic and active placer mining in the BC portion of the Skagit River and the Ruby Creek watershed.	
8.	Brock Applegate (WDFW)	05/11/2020	Section 1.3 Study Plan Development	I agree with Ashley. SCL should make more specific details on which part of these studies that they will cover in this study. (See Comment #7)	See Comment Response #1.
9.	Judy Neibauer (USFWS)	05/13/2020	Section 1.3 Study Plan Development	"Resource issues to be addressed in part by this study in combination with existing information are identified in the following issue forms: (1) FA10 Reservoir Turbidity; (2) FA14 Water Quality Monitoring; and (3) FA15 Water Quality Data." Describe her the issues, and how this study addressed what data gaps. Link to additional studies like erosion, sedimentation, operational flow models, geomorphology or landforms. You will want to know if some areas are naturally high in turbidity or not. You will want to know if exceedances occur under a range of operational flows. You will want to compare conditions upstream in reservoirs to downstream areas to determine sources of water quality issues. Doing this may help establish additional monitoring locations for data collection. As well, link to the Baker River WQ data to determine how far downstream effect can be observed and for cumulative effects……	See Comment Response #1 regarding issue forms. An integrated environmental analysis will specifically address links across resource areas. The FERC process schedule positions the integrated environmental analysis subsequent to the completion of the study program and prior to the filing of a Project License Application. City Light will work with RWGs to integrate information from related studies as part of the ILP process. City Light has added language to Section 1.3 to better describe potential linkages between studies being implemented during relicensing. City Light plans to collect data over a range of flows, as discussed in the methods section. City Light acknowledges the need to consider data from downstream locations and will assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the relicensing process.

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					This would include not only Baker River data but data from other sources as well.
10.	Monika Kannadaguli (Ecology)	05/13/2020	Section 2.1 Study Goals and Objectives	"City Light proposes to direct resources toward the collection of data needed to characterize parameters that are not currently well understood." I do not see any future proposal or past data for sediment sampling behind Ross Dam. There are known sources of mining and superfund sites upstream of Ross dam. I understand that these sites are not part of SCL project but stormwater discharged from these sites have potential to impact sediment quality downstream. Accumulation of sediments behind Ross dam is a project impact. Was there any data collected in the past to monitor the sediment quality behind Ross dam.	City Light questions whether toxic substances buried in sediment behind Ross Dam are likely to be mobilized during current or potential future Project operations—although the potential for the release of toxics will be explored during the integrated analysis of potential Project effects conducted during the ILP. Rather than sampling sediments that have accumulated at depth, City Light believes that existing/ongoing fish tissue data provide a better indicator of the potential effects of toxics in Ross Lake integrated over time in a biologically meaningful way. Fish tissue samples collected by Ecology in Ross Lake do not indicate toxics-related issues, as explained below. Seiders and Deligeannis (2018) evaluated data from tissue samples taken from 70 Rainbow Trout and native char collected by NPS, which were analyzed for chlorinated pesticides, PCBs, PBDEs, and metals. Concentrations of chlorinated pesticides and PCBs were low "and comparable to levels seen in waterbodies deemed to have little apparent human impact (Johnson et al, 2010, 2013, as cited in Seiders and Deligeannis 2018)." Seiders and Deligeannis (2018) state: "The concentrations of metals in the 2015 samples appear to be typical. Levels of copper were within or slightly above ranges (0.37-2.18

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					mg/kg, respectively) found in other studies in Washington (Energy, 2012; EPA). Concentrations of mercury in 2015 (0.147-0.600 mg/kg) seem typical for the size, age, and trophic level for the native char and rainbow trout that were analyzed. Levels of selenium were detected just above the reporting limit and were within a guideline of 3 mg/kg for the protection of piscivorous wildlife (MacDonald, 1994). Concentrations of zinc were also similar to the median value (8.2 mg/kg) for fish fillets across Washington as reported by Serdar and Johnson (2006)...The 2015 sample results should serve as a good baseline for future comparisons." In addition, City Light has recently become aware of additional toxics data collected in the Skagit River at the US-Canada border (data collected by the USGS, Washington Water Science Center). Dissolved and whole metals are collected periodically, and bed sediment and Rainbow Trout liver and fillet metals are collected annually. These data are not included in Table 2.3-1 because they reflect conditions in an area outside the range of Project impacts (except perhaps fish tissue metals levels given that fish migrate between the reservoir and tributaries). The data will be briefly summarized in the Water Quality Monitoring Study report filed with FERC.
11.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	"The water quality parameters listed below will be monitored in the identified waterbodies during the relicensing study period." Something that is coming to light with climate	Climate change will be addressed as part of the cumulative effects analysis that will be conducted as part of FERC's NEPA process. Under current conditions, however, Ross Lake

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				change is increasing issues with blue green algae. In some bull trout streams, even tho cold, we are seeing changes in type and amounts of algae. In terms of nutrients, this should be part of a long term monitoring program to be able to detect WQ issues related to algae invasions. Climate change will increase these events in some locations…….There are likely key locations both above and below reservoirs, downstream to the mouth, that would provide data some early warning data, to a potentially hazardous problem for both fish, wildlife, and people….	is considered oligotrophic. Nuisance cyanobacteria (aka blue-green algae) issues in a reservoir with such low nutrient concentrations are highly unlikely. Although tributaries upstream of the Project are important, conditions in these tributaries are outside the range of the Project's impacts and the scope of this proposed study. Nevertheless, the Water Quality Monitoring Study report will include a description of algae data collected annually in the Skagit River at the US-Canada border. Regarding the suggested expansion of the spatial scope of this analysis, City Light plans to assess the nature of the Project's contribution to cumulative effects (as required by the NEPA process) downstream of the Sauk River confluence using existing available information. Water quality effects from the Project in the lower reaches of the Skagit River and Puget Sound, given the numerous inflows and complex array of factors contributing to existing environmental conditions in these areas, will be extremely unlikely to be discernible. The proposed study is focused on filling data gaps in our current understanding of water quality conditions in the areas influenced by the Project. An expansion of scope as proposed is not warranted based on the extensive existing information indicating water quality criteria are being met in the reaches directly affected by the Project.

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12.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.1 Study Goals and Objectives	"Specific objectives of this study include the following:" What are the locations for conducting baseline monitoring?	Initial proposed locations for data collection are identified in the Methods section of the study plan. However, locations may be modified/refined in consultation with Ecology and other LPs.
13.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.1 Study Goals and Objectives	"Specific objectives of this study include the following:" A water quality evaluation should evaluate nutrient (N/P) ratios as well to examine evidence for cultural oligotrophication of the systems. Should also be expanded to biological monitoring (phytoplankton, zooplankton, and benthic macroinvertebrates) All 3 reservoirs should be included in this.	City Light understands cultural oligotrophication to be the result of a loss of nutrients, phosphorus in particular, from watersheds. If there is nutrient depletion due to upstream land uses, it does not constitute a Project effect. City Light believes existing information is sufficient to characterize the zooplankton communities of Ross Lake (see PAD and Table 2.3-1 of this study plan). Benthic macroinvertebrates, while critical to a functioning ecosystem, are unlikely to serve as the basis for PMEs, and City Light questions the need for potentially costly and time consuming (mostly due to sample processing) data collection that is unlikely to be used to formulate eventual license conditions. However, sampling macrobenthos could be undertaken as part of long-term monitoring, as explained in Comment Response #1).
14.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	"Specific objectives of this study include the following:" Additional objective: Characterize suspended sediment in tributary inflows, within reservoirs, and downstream of the project.	The objectives and corresponding methods have been revised to include measurement of total suspended solids (TSS) at the locations and times associated with turbidity measurements in Project reservoirs. However, TSS in tributaries reflects watershed conditions of those tributaries, not a Project effect, by which these studies are parameterized.

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15.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.1 Study Goals and Objectives	"Specific objectives of this study include the following:" The PAD and this study plan do not adequatly summarise the existing data and ID data gaps. As such, the list provided below needs to be expanded in terms of geographic and temporal scope and interms of the parameters measured. The current objectives do not address the issues identified by NPS in the previous comment. Revising the objectives is probably better accomplished outside of the bubble format.	Table 2.3-1 has been modified to add more specificity regarding where data were collected and whether parameters are/were continuously or discretely monitored. This more detailed treatment sheds light on data gaps and City Light's data collection objectives to fill those gaps. In addition, City Light is in the process of organizing all its data files, which will be provided to LPs so that they can verify that existing data are suitable for characterizing water quality in the Project Area.
16.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Edits in red text "Specific Objectives of this study include the following: ▪ Characterize background levels of turbidity in the Skagit River, Ross Lake, Diablo Lake, and Gorge Lake at a range of operational flows."	The objective and corresponding methods have been revised to include turbidity measurements in Diablo and Gorge lakes. The study plan already includes turbidity measurements in the Skagit River immediately downstream of Gorge Powerhouse.
17.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Measure fecal coliform levels at targeted locations in Ross Lake." Should include all recreational use facilities in the project boundary. (i.e. Diablo, George, and others)	City Light welcomes LP input regarding specific evidence that suggests a given recreation site should be added to what is proposed under this objective. City Light is aware of no evidence to suggest that bacteria levels are a problem anywhere in the Project area. The sampling proposed in this study plan is meant to screen some of the higher-use areas to see if there are any indications of problems. Sampling at every site would be excessive and not warranted based on the quality of water in the Project area. The bacterial monitoring as proposed takes a risk-based approach wherein

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					sites selected for sampling experience the highest recreational use and hence qualitatively would have the highest likelihood of bacterial contamination.
18.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Measure fecal coliform levels at targeted locations in Ross Lake." Add in sites at additional recreational sites, or future new rec sites (i.e. rafting) along the mainstem Skagit River, or where there are sites in adjacent tribs that could be affecting downstream waters Specifically add in mining sites (Ruby) that could send elevated WQ parameters into reservoirs. Would need to know if issues are within SCL or adjacent/ but cumulative issues.	Bacteria levels in the tributaries upstream of the Project boundary and in the Skagit River downstream of the boundary do not constitute Project effects. Moreover, activities such as rafting are transitory in nature and sampling would be unlikely to capture the effects of such recreation. Also, results of monthly fecal coliform measurements in the Skagit River at Marblemount, 2009-2018, are well below Ecology's criteria, indicating that overall conditions are suitable downstream of the Project. Mining sites in the Ruby Creek drainage are well outside of the Project Boundary, are not affected by Project actions, and have been thoroughly investigated by Ecology for their potential effects on reservoir fish and water quality. See Comment Response #10.
19.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	3rd Bullet – Edits in red text "Specific Objectives of this study include the following: ▪ Measure dissolved oxygen and pH along vertical profiles in Gorge, Diablo, and Ross Lake."	The text has been edited to include Diablo and Gorge Lake in a single objective as requested. City Light believes that existing dissolved oxygen and pH data are sufficient to characterize conditions in Ross Lake.
20.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	4th Bullet – Comment "Measure total dissolved gas below Diablo Dam during spill events."	Spills are infrequent at Ross Dam due to Ross Lake's large storage capacity. Spills at Ross Dam are typically associated with gate testing, are of short duration, and average only a few

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				Does SCL have the total dissolved gas below Ross Dam or a reason not to collect the information? **New comment provided on 06/24/2020:** If you spill, even in small amounts, SCL has a "little" potential for adverse impacts.	cfs. In most years, there is no spill from Ross Lake. As such, there is no potential for adverse impacts due to elevated TDG levels downstream of Ross Dam. **Response to comment provided on 06/24/2020:** Whether sufficient gas is entrained to result in elevated TDG concentrations depends on the volume of water spilled relative to the volume of the receiving water. If spills at Ross Dam are typically only a few cfs, any effect would be diluted in the receiving water and would be very unlikely to translate into potential harmful impacts on fish or other aquatic biota. However, your objection to the use of absolute language is appreciated. Rather than state that "there is no potential for adverse impacts…," City Light provides the following restatement: "As such, adverse impacts are highly unlikely..."
21.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	5th Bullet – Edits in red text and comment "~~Measure dissolved oxygen and pH along vertical profiles in Gorge Lake~~" Just use one bullet for all the lakes, need to have Ross in here, if you already are monitoring that, just say that and discuss how you will add that to new data. Put current data within background or existing information section.	See Comment Responses #1 and #19.
22.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	6th Bullet – Comment "Measure temperature and dissolved oxygen in the Gorge bypass reach." And further downstream until effects of	Temperature (°C) will be measured continuously with probes installed at riverine nodes established in the Skagit River downstream of the Gorge Powerhouse as part of the Operations Model Study.

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				hypolimnetic release are dissipated.	Dissolved oxygen will be collected at two locations in the Gorge Bypass reach and just below Gorge Powerhouse and at Marblemount (also there are historical data at Marblemount). City Light believes these measurements will be sufficient without the need for additional sites downstream of the Project.
23.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	6th Bullet – Comment "Measure temperature and dissolved oxygen in the Gorge bypass reach" It seems that this reach has rarely been studied with it dewatering. I suggest that monitoring of turbidity, and possibly other nutrients should be added to understand its baseline conditions.	Field observations to date show that water clarity is high in the bypass reach nearly all the time, so turbidity measurements do not appear necessary. There are no large tributaries to the bypass reach, so sediment and nutrient loading are minimal. City Light continues to believe that the proposed collection of temperature, dissolved oxygen, and TDG data will provide the information necessary and relevant for assessing Project impacts.
24.	Ashley Rawhouser (NPS)	05/13/2020	Section 2.2 Resource Management Goals	"**2.2 Resource Management Goals**" I think it would be beneficial for SCL and LPs develop a set of RM questions this study will answer. This, as a starting point, would inform the objectives, scope, and methods to be used.	Thank you for your comment. City Light identifies its goals in Section 2.2. The second part of this section is intended to represent agency management goals, and City Light invites LP input. If NPS has specific resource management goals it believes are relevant for inclusion, please provide them to City Light for consideration.
25.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource Management Goals	"**2.2 Resource Management Goals**" According to guidelines for the ILP…this section should also include information about public input considerations…maybe you have this somewhere already… see-https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	Thank you. City Light is aware of these study request guidelines. Also, it is worth noting that the criteria pertain to "public interest," not public "input."
26.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource	"The proposed study will provide information, which in combination with existing data, will be	See Comment Responses #9 and #11.

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			Management Goals	used to characterize water quality within the study area and allow resource agencies with jurisdiction over water or aquatic resources to analyze any Project effects related to water quality." I suggest you extend the scope to the full basin, maybe you have existing data elsewhere, You should discuss it and show how you will add it into the study, and augment with new data. Link to the geopmorphology, landform, and operational studies to understand where addition key areas are from a hyporheic standpoint. That would be important refugia sites for monitoring temperatures over time. Please see our critical habitat rule that has 9 PCEs that need to be maintained. These were developed in 2010. Water quality and temperatures are included. Other PCEs protect key regugia. This study should be designed with these PCEs in mind as well, Describe other agency resource goals here as well	7-DADMax water temperatures in the Skagit River between the Project and the Sauk River are cool year round (rarely >14 °C), so unlike many systems where water becomes warm, thermal refugia between the Project and the Sauk River confluence are not a significant issue.
27.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Between 2009 and 2018, the average low water surface elevation was 1,535 feet." Describe over the course of the current license.	The text was revised as follows: "Between 1991 and 2018, the average low water surface elevation ranged from 1,467.1 feet (in April) to 1,584.8 feet (in August)."
28.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Under normal operations at both the Gorge and Diablo developments there is a short section of free-flowing river between the Diablo tailrace and the upper end of Gorge Lake." This is an unnecessary qualifier. It speaks in contrast to the cultural impact felt by the Upper Skagit Tribe.	The word "short" has been deleted from this sentence.

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29.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.3 Background and Existing Information	"Because of Gorge Lake's relatively low storage volume, unplanned spills at the dam can occur any time inflow exceeds generation capacity. In addition, because flows from the Gorge Development are critical for fish production and protection in the Skagit River, water from Gorge Lake is spilled into the Gorge bypass reach if flows through Gorge Powerhouse are insufficient to meet downstream flow requirements specified under the 2013 Revised Fisheries Settlement Agreement (FSA) for salmon or steelhead spawning or rearing." What flows are you targeting to meet? What is the threshold for spill? Where is this measured in the system?	City Light is required by the existing FSA to release targeted flows to protect and enhance, as possible, spawning, incubation, and rearing of the different life stages and species of salmonids using habitats downstream of the Gorge Powerhouse. Descriptions in the PAD (Section 3.5.2) describe these parameters under the existing license. (These descriptions will also be included in the license application). The "threshold" for spill depends on a number of interacting factors, and a description of operations at this level seems beyond the scope of this section. Instead, the operations model, which is being developed, and eventually will be run, with input from LPs, will provide the operational characterizations needed to complete the integrated effects analysis.
30.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.3 Background and Existing Information	"Because of Gorge Lake's relatively low storage volume, unplanned spills at the dam can occur any time inflow exceeds generation capacity. In addition, because flows from the Gorge Development are critical for fish production and protection in the Skagit River, water from Gorge Lake is spilled into the Gorge bypass reach if flows through Gorge Powerhouse are insufficient to meet downstream flow requirements specified under the 2013 Revised Fisheries Settlement Agreement (FSA) for salmon or steelhead spawning or rearing." Does this mean downstream of the dam or downstream of the gorge powerhouse	The FSA stipulates flow targets for the river downstream of Gorge Powerhouse, per Comment Response #29. Text revised accordingly for clarity.
31.	Jon-Paul Shannahan	05/11/2020	Section 2.3 Background and	"The reach of the Skagit River between Gorge Dam and Powerhouse is referred to as the	Previous documents state that the bypass reach is 2.7 miles long. Current calculations by City

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	(Upper Skagit Indian Tribe)		Existing Information	bypass reach and is about 2.5 miles long." This needs to be measured and standardized in all documents.	Light, made in 2019, reveal the bypass to be 2.5 miles long. This vetted number was used consistently throughout the PAD and study plans.
32.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"The reach of the Skagit River between Gorge Dam and Powerhouse is referred to as the bypass reach and is about 2.5 miles long." Why do we have all this fish passage information in the water quality study? Can we input this fish passage data in the instream flows study where SCL will need to describe which species uses what part of the bypass reach for which habitat? See the Habitat Suitability Curves (HSC) Section of the Instream Flow Study Plan.	Most of this paragraph consists of a general description of the bypass reach, which is relevant. However, City Light agrees that the statement relating to fish passage is not germane to the water quality study plan and has removed the last sentence from the paragraph.
33.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.3 Background and Existing Information	"Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach." Please add specific document reference here (and web link or SharePoint link) Which condition in the previous FERC license says that City light is not required to release any flow into the Gorge bypass reach. ……..	"FERC (1995)" has been added to this statement. See pages 43, 44, 49, and 50 of the FERC Environmental Assessment (1995). Online link: http://www.seattle.gov/light/skagit/Relicensing/default.htm
34.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach." If you are doing studies for safety and recreation. Link to them, and include the monitoring of WQ data at the same time….	See Comment Response #9. Thank you for your suggestion regarding linking studies. In implementing the final approved study plans, City Light will be reviewing all opportunities for efficiencies that do not compromise the objectives or methods of individual studies.

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35.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." We will need to work on this. I am not hearing same conclusion from the other stakeholders.	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan) and #33. This statement is, however, based on a number of sources in the record (see the PAD and FERC (1995)). Nevertheless, City Light understands and appreciates the importance of the questions regarding passage and habitat conditions in the bypass reach, and its potential value as a transit and/or spawning/rearing environment under different flow conditions. The subject of potential passage of salmonids upstream of documented barriers in the bypass reach (Envirosphere 1989) and the options for how best to consider the functional values of the habitat therein will be addressed at length during the ILP. It will constitute a major element of the integrated analysis of potential Project effects and be addressed thoroughly in the License Application and its supporting documentation.
36.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Presumed velocity	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan), #33, and #35.
37.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan), #33, and #35.

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				RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Where in Smith and Anderson is this particular "barrier" described?	
38.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Envirosphere 1989 describes that flows of 1000 cfs create conditions that allow passage of several salmonid species.	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan), #33, and #35.
39.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"The primary purpose of the Flow Plan was to minimize past ~~the~~ effects of Project operations on redd protection and fry stranding on salmon and steelhead." Downstream of the Gorge Powerhouse	City Light feels that the minimizing of Project effects due to flow releases is ongoing, and hesitates to use the word "past." The second proposed text edit has been accepted with modification, i.e., "The primary purpose of the Flow Plan is to minimize the effects of Project operation on salmonids by providing spawning flows and protecting redds, fry, and yearlings."
40.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers at certain flows (partial barriers) to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Delete. Not pertenent for this study plan.	Agreed. Text deleted.

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41.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers at certain flows (partial barriers) to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Many fish, definitely steelhead, routinely make their way over or around this barrier, when the pool depth below the partial barrier becomes so deep. More fish passage will occur if we have more flow within the bypass reach. **New comment provided on 06/24/2020:** Please insert this paragraph into the Fish Passage Study Plan.	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan), #33, and #35. **Response to comment provided on 06/24/2020:** Thank you for your comment. Additional discussions regarding the issue of Project fish passage are anticipated and City Light welcomes discussion of the proposed characterization at that time.
42.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"Much of this reach is upstream of several natural barriers at certain flows (partial barriers) to anadromous fish passage; the most downstream of these barriers is located 0.6 miles upstream of Gorge Powerhouse at about RM 95 (Smith and Anderson 1921; Envirosphere 1989)." Bull trout, lamprey, and other species may be able to manipulate cascades, etc…that allow passage at certain flows. I have surveyed lots of barriers, snorkeled and seen bull trout jump and slither over many obstacles. This seems important for a fish passage study, but WQ should be measured in these areas.	See Comment Responses #32 (this sentence has been deleted from the Water Quality Monitoring Study Plan), #33, and #35.
43.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"The primary purpose of the Flow Plan was to minimize the effects of Project operations on salmon and steelhead."	See Comment Response #35. Bull trout will be considered.

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				We now know lots more about what bull trout do, and they are anadromous here, so when we are developing instream flows, we will need to include bull trout and their prey species. As well consider their Critical Habitat parameters now too	
44.	Monika Kannadaguli (Ecology)	05/13/2020	Section 2.3 Background and Existing Information	**"**Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project.**"** Please elaborate this table to clarify for which parameters there is continuous data available. If a specific parameter is measured only for a few months in any year, please clarify that.	Table 2.3-1 has been modified to add more specificity regarding where and when data were collected and whether they were continuously or discretely monitored. Also, please note that an objective has been added to the study plan that specifies that City Light will provide a complete summary of all pertinent water quality data in the Water Quality Monitoring Study report (City Light has become aware of additional information since the time the PAD was drafted). In addition to the information shown in Table 2.3-1, City Light will also summarize select inflow water quality information, which may be useful for informational purposes. For example, City Light is gaining access to water quality data collected in the Skagit River at the US-Canada border (data collected by USGS, Washington Water Science Center). Temperature, dissolved oxygen, pH, conductivity, and FDOM data are collected continuously at this location; samples for nutrients, major ions, and dissolved and whole metals are collected periodically; bed sediment, algae, snail, and Rainbow Trout liver and fillet metals data are collected annually. These data are not included in Table 2.3-1, however, because they reflect conditions in an area outside the range of Project impacts (except

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					perhaps fish tissue metals levels given that fish migrate between the reservoir and tributaries). The data will be briefly summarized in the Water Quality Monitoring Study report filed with FERC.
45.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	**"Parameters for which multiple years of recent data have been collected are considered to be adequately represented by existing information."** **The specific years should be assessed to describe relevant environmental conditions and project-related actions (e.g. summer drought, 10-year flood event, large spills or drawdowns, etc.), then determine whether additional years of data need to be collected.**	See Comment Response #44. Datasets in many cases are extensive, i.e., collected over a long enough period to account for environmental and operational variability; these variations will be summarized in the final report of the results from the study. In instances where the data collection period is shorter, City Light has proposed to collect additional data to bolster the existing record. City Light believes that the proposed study design, as revised per LP comments, plus existing information should enable characterization of water quality conditions within and downstream of the Project with high confidence and low uncertainty.
46.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	**"**Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project.**"** **Include maps or more detailed descriptions of specific locations (e.g. where in Ross Reservoir has temperature been collected surface at depth, how many locations?), frequency of sampling etc.**	See Comment Response #44.
47.	Ashley Rawhouser (NPS)	05/11/2020	Section 2.3 Background and Existing Information	**"**Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project.**"** For SCL data, NPS will need to review field sampling protocols, that data that were collected, associated metadata, and QAQC	City Light will provide LPs access to all relevant City Light water quality data files. Ecology's data are available at: Freshwater Information Network, Environmental Information Management System. [Online] URL:

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				documentation to determine their usefulness. Assuming that WA DOE and USGS have QAPPs (or similar) in place. Please provide the appropriate citations for data associated with these agencies.	https://apps.ecology.wa.gov/eim/search/SMP/RiverStreamSingleStationOverview.aspx?ResultType=RiverStreamOverviewList&StudyMonitoringProgramUserId=RiverStream&StudyMonitoringProgramUserIdSearchType=Equals&LocationUserIds=04A100&LocationUserIdSearchType=Equals. USGS's data are available at: https://waterdata.usgs.gov/usa/nwis/uv?12178000
48.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	**"**Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project.**"** Thanks for providing. It looks like there are some data gaps, and that with contamination of lakes from acidic rain/snow these days….it seem you might want to collect baseline data in Diablo and Gorge Lakes to understand if conditions are similar downstream. As well, having WQ sampling information from Canada seem important. It would be great to develop a MOU with Canada to share data. Looks like you may need to include additional data or add sampling sites downstream of Marblemount….See my previous comment about sampling turbidity and fecal coliform at key recreational sites.	City Light has developed objectives/methods for the collection of water quality data to fill the gaps identified in the table. Baseline data will be collected from all three reservoirs. Also please See Comment Response #47. City Light agrees; it would be great to access data from sources in Canada. City Light is proposing to collect data on potential bacterial contamination at recreational sites in Ross Lake, at locations within the Project area where recreation is deemed most concentrated. Results of monthly fecal coliform measurements in the Skagit River at Marblemount, 2009-2018 are well below Ecology's criteria. City Light believes data collected at Marblemount are sufficient for understanding potential Project effects on water quality in the river downstream of the Project. Data from sources downstream of the Sauk River will be incorporated into the cumulative effects

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					analysis conducted to satisfy NEPA requirements.
49.	Monika Kannadaguli (Ecology)	05/13/2020	Section 2.3 Background and Existing Information	**"**Table 2.3-1. Summary of existing water quality data collected since 1991[1], Skagit River Hydroelectric Project.**"** Please add baseline monitoring locations to this table. What all parameters were measured and for how long?	Table 2.3-1 has been revised to provide the requested information.
50.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.3 Background and Existing Information	"**Existing Data (years collected)**" Data collection dates provided here does not match with the information provided in the summary tables.	City Light has become aware of additional data since the original "summary table" was provided to Ecology in 2019. Please consider the table contained in this study plan to be the most up-to-date/definitive.
51.	Monika Kannadaguli (Ecology)	05/13/2020	Section 2.3 Background and Existing Information	"2000–2002; 2008; 2010; 2012–2018" Is this all continuous data monitoring?	See Comment Response #44.
52.	Monika Kannadaguli (Ecology)	05/13/2020	Section 2.3 Background and Existing Information	"Zinc (tissue)" Was there any sediment monitoring for Metals by SCL?	See Comment Response #10.
53.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3 Background and Existing Information	Last row of Table 2.3.1 "Metals[3] 1994-1995 Ecology" Macro-invertebrate from NewHalem/gorge Powerhouse and Marblemount	City Light is uncertain how to interpret this comment but presumes that Mr. Shannahan is providing notification that data exist that City Light is unaware of. Please provide a full reference so that we can consider the relevancy of the results. City Light's review of Ecology files from Marblemount revealed no BMI data (see: https://apps.ecology.wa.gov/eim/search/SMP/RiverStreamSingleStationOverview.aspx?

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					ResultType=RiverStreamOverviewList&StudyMonitoringProgramUserId=RiverStream&StudyMonitoringProgramUserIdSearchType=Equals&LocationUserIds=04A100&LocationUserIdSearchType=Equals). Similarly, City Light is unaware of BMI data from Newhalem. City Light will attempt to locate and obtain these BMI data and incorporate them into the Water Quality Monitoring Study report. City Light is aware of BMI data collected by Ecology in six Skagit River basin tributary streams within WRIA 4: Bacon, Diobsud, Finney, Illabot, Jackman, and Presentin creeks, and BMI data collected by the NPS in Stetattle Creek (these data are addressed in the PAD).
54.	Ashley Rawhouser (NPS)	05/11/2020	Section 2.3 Background and Existing Information	"3. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc." Citation needed.	Citation provided.
55.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations have minimal effects on water quality in the Project reservoirs and Skagit River, as shown by the data reported in the PAD. For a summary of available water quality information by water quality parameter and Ecology's water quality criteria, see Section 4.4.5.2, *Existing Water Quality in the Project Vicinity*, of the PAD. The Skagit River drains mountainous and, in some cases, glacial areas located mainly within national park and wilderness areas; water flowing through the Project remains clean and cold throughout the year. The few 303(d) listings for Water Resources Inventory Area (WRIA) 4, which	City Light acknowledges that potential Project effects on water quality will be further assessed in consultation with LPs during the ILP. The license application will provide a summary of such assessments.

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				includes the Project vicinity, are applicable to reaches that are not affected by the Project, reflecting the good baseline water quality measured within and downstream of the Project Boundary. Moreover, water quality data collected by Ecology confirm the high quality of water in the Skagit River downstream of the Project (measured at Marblemount and discussed in Section 4.4.5 of the PAD)." Studies, analyses, and subsequent negotiations will determine the extent to which the project impacts water quality.	
56.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations have minimal effects on water quality in the Project reservoirs and Skagit River, as shown by the data reported in the PAD." PAD summary is insufficient.	See Comment Response #55.
57.	Judy Neibauer (USFWS)	05/13/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations have minimal effects on water quality in the Project reservoirs and Skagit River, as shown by the data reported in the PAD." Need to monitor Turbidity when turbidity is happening during storm events, while reservoirs are drawn down or shorelines intercept key erosional areas…link to erosion, sedimentation, geomorphology study data to identify key locations Also see my comment above where there looks like there have been data gaps in you data described in the table.	See Comment Responses #9 and #44. Following the first year of sampling, City Light will consult with Ecology and other LPs regarding the need for additional fieldwork.
58.	Brock Applegate (WDFW)	05/11/2020	Section 2.4 Project Operations and	"The Skagit River drains mountainous and, in some cases, glacial areas located mainly within national park and wilderness areas; water	City Light has recently become aware of additional water quality data collected in the Skagit River at the US-Canada border (data

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			Effects on Resources	flowing through the Project remains clean and cold throughout the year." Some salmonids may have issues with too cold of water for fish growth. Can SCL look at temperature above the project in the Skagit River? The lack of nutrients in the water can lead to a lack of productivity.	collected by USGS Washington Water Science Center). Temperature has been collected continuously, and sampling for nutrients is conducted periodically. These data will be summarized in the Water Quality Monitoring Study report.
59.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	"The few 303(d) listings for Water Resources Inventory Area (WRIA) 4, which includes the Project vicinity, are applicable to reaches that are not affected by the Project, reflecting the good baseline water quality measured within and downstream of the Project Boundary. Moreover, water quality data collected by Ecology confirm the high quality of water in the Skagit River downstream of the Project (measured at Marblemount and discussed in Section 4.4.5 of the PAD)." Yes many of the water quality metrics meet numeric standards, however water quality must also comply with designated uses narratives. Skagit downstream of Newhalem can potentially have water that is too cold for supporting salmonid productivity prior to thermal mixing of downstream tributaries. Fish use (spawning data and yearling stream use) should be compared to other locations downstream, to measure degree of which this is a problem. Has there been studies measuring macroinvertebrate diversity and abundance to support stream life histories of native fish in section between Marblemount and Gorge Power House? Upper Skagit Indian Tribe would like this metric (macro-invertebrates) measured under this study plan.	Water temperatures in the Skagit River downstream of Newhalem within the FERC Project boundary meet applicable beneficial use standards and City Light is not aware of any evidence that salmonid productivity is adversely affected by temperature in this reach. Macroinvertebrate diversity and abundance data, while interesting, are costly to process, and the results of BMI studies are rarely used to formulate PMEs in the context of relicensing. City Light intends to work with Ecology and other LPs to assess Project impacts based on the parameters identified in this study plan, as revised, and are receptive to considering how macroinvertebrate sampling could be incorporated as a metric for long-term trend monitoring under the new license. See Comment Response #1.

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60.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.4 Project Operations and Effects on Resources	"The existing data, combined with that collected during this proposed study, will be used to inform the Section 401 certification process overseen by Ecology as well as FERC's issuance of a new license for the Project." expanding the water quality sampling to include a full limnological analysis would bolster the strength of the proposed study and allow for additional evaluations to be considered.	City Light believes existing information, in combination with the limnological analyses proposed for the parameters for which we have data gaps, will provide a comprehensive picture of water quality conditions within and downstream of the Project. The collection of limnological data for parameters for which extensive records exist diverts resources.
61.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.5 Study Area	"The study will be conducted in Ross (within the United States), Diablo, and Gorge lakes, the Gorge bypass reach, and in the Skagit River immediately below the Gorge Powerhouse (Figure 2.5-1)." It will be necessary to monitor tributaries flowing into reservoirs to gain a baseline of water quality conditions upstream of the project. Project-related effects extend beyond the area immediately downstream of the Gorge bypass (e.g. cold temperature from hypolimnetic release), in some cases down to Puget Sound (e.g. suspended sediment load), and it will be necessary to extend sampling to these areas to determine when project-related effects become adequately dissipated by tributary inflows or environmental conditions.	Water quality in tributaries is driven by non-Project related causes, primarily land uses and climate, and as a result is beyond the scope of this study and the FERC relicensing process. However, water quality data collected in the Skagit River at the US-Canada border (data collected by USGS Washington Water Science Center) will be summarized in the Water Quality Monitoring Study report. Regarding sampling to Puget Sound, please See Comment Response #11.
62.	Brock Applegate (WDFW)	05/11/2020	Section 2.5 Study Area	"The study will be conducted in Ross (within the United States), Diablo, and Gorge lakes, the Gorge bypass reach, and in the Skagit River immediately below the Gorge Powerhouse (Figure 2.5-1)." Work with Canada to get some information from them or permission to look at temperatures	See Comment Response #48. City Light disagrees that the Project affects water quality upstream of the high-water mark of Ross Lake.

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				in the Skagit River above the project. The true effects area above the Project extends above the Ross Reservoir.	
63.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.5 Study Area	"All sampling locations within the Project reservoirs, Gorge bypass reach, and immediately below the Gorge Powerhouse are affected by Project operations." The geographic scope needs to be expanded. The influence and attenuation of cold water released from the hypolimnion of the reservoirs needs to be evaluated. As does the sequestration of fine sediments and nutrients in the reservoirs. NPS welcomes additional conversations with SCL on these issues.	Temperature data available for the USGS Newhalem gage and Ecology's monitoring station at Marblemount provide a reasonable characterization of temperature trends in the reach directly affected by the Project. Project effects would be difficult to discern in the lower reaches of the Skagit River and Puget Sound given the complex array of factors contributing to existing environmental conditions in these areas. City Light plans to assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the NEPA process. City Light is aware of no evidence indicating that there are nutrient-related adverse effects on biota in the Skagit River downstream of the Project. However, City Light welcomes LP input regarding specific aquatic habitat issues associated with nutrients, and the information upon which LPs base their concerns.
64.	Judy Neibauer (USFWS)	05/13/2020	Section 2.5 Study Area	"All sampling locations within the Project reservoirs, Gorge bypass reach, and immediately below the Gorge Powerhouse are affected by Project operations." I agree, Need to include areas down to the mouth and estuary, and or include data you already have…..There is a need to establish a baseline, determine if key nutrients are lacking due to blockage at dams/in reservoirs and understand what comes in from Canada and or	See Comment Responses #11, #44, #48, and #63.

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				the Baker River system to effect WQ for cumulative effects or aggregated effects analysis…	
65.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6 Methodology	"2.6 Methodology" Measure suspended sediment load in tributaries flowing into reservoirs. The reservoirs sequester suspended sediment, thereby interrupting downstream transport. Suspended sediment is important for delta formation and habitat conditions in Skagit Bay. The large watershed area cut-off by the project is reducing the fine sediment load delivered to Skagit Bay.	Sediment conditions below the Sauk River confluence and delta formation are being addressed in the geomorphology cumulative effects analysis. Also See Comment Response #11.
66.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6 Methodology	"2.6 Methodology" NPS will provide comments on the sample frame and methods when the objectives of the study are finalized.	City Light welcomes any and all input during the established review period for this study plan.
67.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Methodology	"City Light proposes to collect data during one field season to establish background turbidity (nephelometric turbidity units, NTUs) levels within Ross Lake." Will these measurements be near the inlet bays or along the center of the reservoir in line with these inlets? Also, please specify whether these are surface measurement or if they will be water column profiles of turbidity.	City Light proposes to measure turbidity at the reservoir's surface and at a depth of 5 m. Unless otherwise guided by Ecology and other LPs, City Light plans to conduct the measurements at the following coordinates: Pumpkin Mountain (48.7904, -121.0496), Skymo (48.8547, -121.0308), and Little Beaver (48.9274, -121.0625). City Light plans to conduct mid-reservoir sampling at these locations.
68.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.1 Methodology	"City Light proposes to collect data during one field season to establish background turbidity (nephelometric turbidity units, NTUs) levels within Ross Lake." If the events that cause storm turbidity do not happen you may need to expand the	See Comment Response #57.

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				timeline….plan for additional year as necessary to capture these events.	
69.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.1 Methodology	"Sampling will be conducted once per month using a Hydrolab® multiparameter sonde or equivalent, at three general locations in the reservoir: Pumpkin Mountain (48.7904, -121.0496), Skymo (48.8547, -121.0308), and Little Beaver (48.9274, -121.0625)." The sonde should be calibrated before each sampling event, and a proof of calibration log should be provided.	See Comment Response #5.
70.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.1 Methodology	"Sampling will be conducted to characterize turbidity during minimum water surface elevation in winter, reservoir refill in spring, normal maximum water surface elevation during summer, and reservoir drawdown in fall." Is monthly sampling frequency sufficient to capture temporal variability during the drawdown/refill?	City Light believes monthly sampling is suitable to capture temporal variability during drawdown and refill, as these processes take several months in Ross Lake—the primary reservoir where the potential for exposed shorelines to generate turbidity from erosion will be greatest., City Light proposes to consult with Ecology and other LPs to determine if additional turbidity monitoring is warranted after the results from the first year of sampling are shared
71.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.1 Methodology	"City Light proposes to collect fecal coliform data four times during one summer field season at the following locations, chosen because they experience relatively high levels of human use…" All recreation sites should be evaluated for fecal coliform, regardless of use level. Even moderate levels of use can cause fecal coliform commination IF the facilities are not functioning properly.	See Comment Response #17. Sampling at every recreation site is unwarranted for an initial screening to determine if a problem may exist with fecal coliform levels in Ross Lake. Additional sampling can be considered following review of initial results from the sampling at the proposed sites where highest probability for contamination exists. It should be recognized that facility maintenance at these sites is not under the purview of City Light.

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72.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1 Methodology	"City Light proposes to collect fecal coliform data four times during one summer field season during the heaviest use by recreationists at the following locations, chosen because they experience relatively high levels of human use (exact sampling locations will be identified in consultation with Ecology): Hozomeen, Ross Lake Resort, and at three boat access camps managed by the NPS (the camps to be sampled will be determined in consultation with Ecology and the NPS)."	The text has been edited to state: "City Light proposes to collect fecal coliform data four times during one summer field season, when recreational use is heaviest, at the following locations…"
73.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Diablo Lake	**"2.6.2 Diablo Lake"** Sampling should be conducted in the "middle" of the reservoir as well.	Please recall that detention time in Diablo Lake is only 9.4 days, so there is little potential for water quality in the center of the reservoir to be substantially different from that at the inflow and outflow points. Sampling at the upper and lower ends of Diablo Lake will be sufficient to characterize conditions in the reservoir relative to water quality numeric and narrative standards, i.e., City Light believes sampling near the inflow and outflow point will reveal any changes taking place within the waterbody to determine if additional sample sites are needed in the middle of the reservoir or elsewhere.
74.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.2 Diablo Lake	**"2.6.2 Diablo Lake"** Sample turbidity here as well, esp in Storm events; Baseline nutrient levels should be monitored to see if Nutrients are passing between Ross Lake, Diablo Lake, and Gorge Lake. And to see if there are certain operation events that either allow them to pass or not….. Since this license will be long term, and climate change is causing strange elevated levels in	Sampling turbidity in Ross Lake and at the Gorge Powerhouse will suffice to bracket inflow and outflow conditions. City Light is aware of no evidence to suggest that nutrient levels in Diablo Lake are impaired by Project operations, so the sampling proposed in this comment seems excessive. However, City Light welcomes input regarding information LPs have for adverse effects on

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				algae, establish a baseline to help determine if and when this becomes an issue to fish, wildlife, and people. Develop monitoring program for acidity, with pcbs and other contaminants within wilderness lakes, please monitor each of the lake to establish if this is an issue currently, and or may become an issue in the future. This will help with any aggregated / cumulative effects analysis	biota related to nutrient levels in any of the Project reservoirs or downstream. Regarding toxics, please See Comment Response #10. There is no evidence suggesting toxicants, including PCBs, are affecting water quality and/or resources of concern.
75.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Diablo Lake	"Dissolved oxygen (milligram/liter [mg/L]) and pH vertical profile measurements will be made at the upper end of Diablo Lake and in the Diablo Lake forebay using a Hydrolab® multiparameter sonde with depth probe or equivalent equipment." Temperature and other hydrolab capabilities should be collected. Temperature is of particular importance, however. Sonde should be calibrated before each event.	The scope has been revised to include temperature as one of the parameters to be monitored along vertical profiles in Diablo Lake. Regarding calibration, please See Comment Response #5.
76.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.3 Gorge Lake	"**2.6.3 Gorge Lake**" Sampling locations in the "middle" of the reservoir as well. This is needed to gain an understanding of the physical characteristics throughout the entire reservoir.	See Comment Response #73. Also, please recall that detention time in Gorge Lake is only 0.8 days and water is thoroughly mixed
77.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.3 Gorge Lake	"Dissolved oxygen (mg/L) and pH vertical profile measurements will be made at the upper end of Gorge Lake and in the Gorge Lake forebay using a Hydrolab® multiparameter sonde with depth probe or equivalent equipment."	The scope has been revised to include temperature as one of the parameters to be monitored along vertical profiles in Gorge Lake.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Temperature and other hydrolab capabilities should be collected. Temperature is of particular importance, however.	
78.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.3 Gorge Lake	"Sampling will be conducted once per month from June through September during a single field season to document conditions during the warmest time of year." Establish network of temperature monitoring to understand thermal changes that happen in the draw down zones within and adjacent to bull trout spawning streams at a variety of reservoir elevations…similarly, determine if there are tributaries below the dam, where barriers may form at intersections with the mainstem….due to thermal conditions….and include these areas as Temperature sampling sites.	See Comment Response #77. Gorge Lake, is usually kept at or near normal maximum water surface elevation to provide maximum head for Gorge Powerhouse. As a result there is little or no drawdown zone in this waterbody. Moreover, detention time in Gorge Lake is only 0.8 days, so water does not reside long enough in the reservoir to undergo significant changes. Temperatures in Gorge Lake are cool, rarely above 14°C. Based on these characteristics, City Light can see no justification for the requested temperature sampling in Gorge Lake. City Light is unaware of any evidence that there are thermal barriers to tributaries in the reach of the Skagit River downstream of the Project. However, City Light welcomes LP input regarding specific information that indicates that thermal barrier issues occur at the mouths of tributaries. Elevated temperatures within tributaries that affect bull trout stream access are outside the Project's range of effects.
79.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.4 Gorge Bypass Reach	"**2.6.4 Gorge Bypass Reach**" Consider adding in monitoring of WQ during recreational safety study, when water levels are at varying depths in this bypass reach.	City Light will work with LPs and its technical consultants to determine if there is any potential benefit to conducting the Level Three: Multiple Flow Evaluation during the time that water quality parameters are being measured.
80.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.4 Gorge Bypass Reach	"Temperature (°C) and dissolved oxygen (mg/L) will be measured during a single field season at two locations in the Gorge bypass reach….."	See Comment Responses #11 and #65.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Include suspended sediment load. See comment above related to Skagit Bay.	
81.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.4 Gorge Bypass Reach	"Temperature (°C) and dissolved oxygen (mg/L) will be measured during a single field season at two locations in the Gorge bypass reach using a Hydrolab® multiparameter sonde or equivalent equipment: i.e., near Gorge Dam and in the reach downstream ~~of the fish barrier~~ located 0.6 miles upstream of Gorge Powerhouse that stays wet throughout the year." In the plunge pool	Edit accepted.
82.	Monika Kannadaguli (Ecology)	05/01/2020	Section 2.6.4 Gorge Bypass Reach	"Sampling will be conducted once per month from June through September to document conditions during the warmest time of year." Why not continuous data collection? There are other equivalent or even smaller facilities that are collecting continuous Temp data .	City Light has revised the study plan to state that temperature and dissolved oxygen data will be collected continuously from June through September in the Gorge Bypass Reach.
83.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.4 Gorge Bypass Reach	"Sampling will be conducted once per month from June through September to document conditions during the warmest time of year" Sampling should also take place during spill events. Recommend sampling to cover April through end of December	Section 2.6.4, Gorge Bypass Reach, has been revised to include opportunistic temperature, dissolved oxygen, and turbidity monitoring during spill events. Continuous monitoring of turbidity in the bypass reach, outside of spill events, is unwarranted, as base flows through the bypass reach are nominal, water clarity is excellent, and sources of fine sediments that could be suspended to generate turbidity above water quality standards under such base flow conditions are negligible.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
84.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.6 Skagit River below Gorge Powerhouse	"Dissolved oxygen (mg/L), pH, and turbidity (NTU) will be measured continuously for approximately one year in the Gorge Powerhouse tailrace using a Hydrolab® multiparameter sonde or equivalent." Would like to see plan for measuring temperature below project to at least Marblemount.	Temperature (°C) will be measured continuously with probes installed at riverine nodes established in the Skagit River downstream of the Gorge Powerhouse as part of the Operations Model Study.
85.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.8 Schedule	NPS suggests establishing a smaller WQ RWG to develop the sample frame and methods. The schedule should include milestones for consulting with LPs.	The purpose of this study plan review process is to have a dialogue with LPs regarding scope and timeframe of this proposed study; each existing RWG has the ability to decide if additional meetings are needed. City Light sees no need for a separate Water Quality RWG at this time.
86.	Judy Neibauer (USFWS)	05/13/2020	Section 2.8 Schedule	"**2.8 Schedule**" ▪ Consider expanding this to two years of sampling at least esp. if this year is a drought year, or exceptionally cold year….so you can capture key events, ….	See Comment Response #57.
87.	Brock Applegate (WDFW)	05/11/2020	Section 2.8 Schedule	▪ Field Work – January to December 2021 ▪ Analysis – February 2021 to January 2022 ▪ Final Initial Study Report (ISR) – March 2022 ▪ IRS Meeting -- 2022	Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
88.	Monika Kannadaguli (Ecology)	05/13/2020	Section 3.0, References	Please update this list.	References have been updated.
89.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	The listed objectives are actions pursuant to CWA Sec. 401 compliance. We suggest adapting the broad objectives of the CWA and other water quality objectives related to salmonid recovery to fit the context of the study within the Skagit river system. Species specific	As noted in Section 2.1, this study plan is "designed to collect water quality data, which along with existing water quality information, is intended to support [not only] Ecology's certification of the Project under Section 401 of the CWA, and the data needs of FERC,

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				consideration should be made for both lethal and sublethal effects.	[but]…also…other data needs of resource agencies, tribes, and other LPs in the context of FERC relicensing (underline added). Review of the available Project water quality information collected over numerous years indicates water quality within the Project Boundary and downstream of the Project is very good, i.e., in compliance with Ecology's criteria, which have been established to protect beneficial uses, including the suitability of habitat for anadromous and non-anadromous salmonids. Existing information indicates no adverse effects of water quality on fish species within and downstream of the Project Boundary; data collected in this study will be used to further evaluate compliance with Ecology's criteria which City Light believes provide water quality conditions that are conducive to salmonid recovery. In addition, the relicensing process includes opportunities to modify the scope of the Water Quality Monitoring Study if additional information needs are identified. .
90.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Fully describe the linkages to other study plans with sufficient detail to understand the nature of each specific link and how the information will be synthesized to inform relicensing.	City Light has added language to Section 1.3 to address potential linkages between studies being implemented during relicensing. Also, please see Comment Response #9. City Light welcomes further discussion on requested information on study linkages and will consider adding additional information to the PSP filing to expand upon how the information will be synthesized to inform relicensing.
91.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Describe how the study will inform the relicensing process both substantively and procedurally (e.g., how will the information be used to assess alternative management scenario effects on water quality).	Please see Comment Response #9. As noted in the Operations Model Study Plan, simulation of various potential Project operation scenarios considered during the relicensing process (i.e., during the comprehensive resource analysis that

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					will occur after studies are completed in support of license application development) will aid in decision-making regarding the effects of various operating scenarios on water allocation, flood control, fish and wildlife habitat, instream flows, reservoir levels, wetland and floodplain connectivity, recreation, hydropower generation, and other matters [e.g., water quality] affected by flow releases from the Project. City Light will work with all LPs to develop these scenarios and consult during the assessment of potential Project effects associated with each scenario.
92.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Describe in more detail the purpose of conferring with other agencies and tribes.	Please see revisions made to Section 1.2 of this study plan.
93.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Consider combining the study plan with another appropriate study (e.g., Operations Model).	Please see Comment Response #90 and #91. Different technical skills are necessary to implement individual study plans, therefore these study plans and reports will remain separate. Results of studies will be considered comprehensively, along with other available information, to complete a comprehensive resource analysis in support of the license application.
94.	Steve Copps (NMFS)	05/11/2020	Section 2.5 Study Area	The geographic scope should be consistent with project effects on water quality. At a minimum, the study plan should justify the proposed scope.	Project effects on water quality have not been identified; City Light believes that combined with extensive existing information, the scope of the study will fully characterize water quality in the Project area. Please see Comment Response #11. If NMFS has specific water quality data needs that it believes are not included in the current study scope, City Light welcomes additional comment from NMFS.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
95.	Steve Copps (NMFS)	05/11/2020	Section 2.6, Methodology	The proposed sample sample sizes appear to be insufficient. The revised plan should describe in detail the rationale for low sampling rates, it would seem that continuous measurement technology would be more appropriate to understand the influence of water quality on aquatic species throughout multiple life history stages.	Please see revisions to Sections 2.1, 2.3, and 2.6, including revisions to Table 2.3-1.
96.	Steve Copps (NMFS)	05/11/2020	Section 2.8 Schedule	There appears to be an excessive amount of time for analysis given the objective of the draft plan.	Please see the revised study schedule included in Section 2.8. The analysis period extends through the sampling period to acknowledge interim data processing, and the end date only extends two months beyond the end of field data collection.

WATER QUALITY MONITORING PROPOSED STUDY PLAN

ATTACHMENT B

QUALITY ASSURANCE PROGRAM PLAN

QUALITY ASSURANCE PROJECT PLAN

FOR THE WATER QUALITY MONITORING PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020

Quality Assurance Project Plan (QAPP)
Seattle City Light Skagit River Hydroelectric Project

REVISION 0

December 2020

		HDR			Seattle City Light
Rev No.	**Date**	**Preparer**	**Reviewer**	**Approver**	**Reviewer and Approver**
Rev 0	7/27/20	Chad Wiseman	Randall Filbert	Jenna Borovansky	Jeff Fisher
Rev 1					
Rev 2					

Approved by:

_____ _____

Jeff Fisher, Seattle City Light, Technical Lead Date

_____ _____

Jenna Borovansky, HDR, Project Manager Date

_____ _____

Mike Bonoff, Meridian Environmental, Study Lead Date

_____ _____

Chad Wiseman, HDR, QA Officer Date

DISTRIBUTION LIST

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List of Acronyms and Abbreviations

ASTM .....American Society for Testing and Materials
CFR.....Code of Federal Regulations
City Light.....Seattle City Light
C^o.....degrees Celsius
CRT.....Certified Reference Thermometer
CWA .....Clean Water Act
DO.....dissolved oxygen
DQO.....data quality objective
Ecology .....Washington Department of Ecology
ELC.....Environmental Learning Center
EPA.....U.S. Environmental Protection Agency
FERC.....Federal Energy Regulatory Commission
GPS .....Global Positioning System
m .....meter
mg/L.....milligrams per liter
NIST.....National Institute of Standards and Technology
NPS .....National Park Service
NTU .....nephelometric turbidity units
PARCC .....precision, accuracy, representativeness, completeness, and comparability
Project .....Skagit River Hydroelectric Project
QA/QC.....Quality Assurance/Quality Control
QAPP .....Quality Assurance Project Plan
RL .....reporting limit
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RSD.....relative standard deviation
SOP .....Standard Operating Procedure
TDG .....total dissolved gas
TSS.....total suspended solids
U.S.C.....United States Code

1.0 BACKGROUND

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. A licensee must receive a water quality certification before FERC can issue an operating license (or the state regulatory agency can waive certification). A study plan has been designed to collect water quality data, which along with existing water quality information, will support the license application, including the application to Washington Department of Ecology (Ecology) for certification of the Project under Section 401 of the Clean Water Act (CWA). This Quality Assurance Project Plan (QAPP) includes the field data collection methods, laboratory methods, and quality assurance methods to ensure that data collected for this Project are accurate, usable, and repeatable.

The FA-01 Water Quality Monitoring Proposed Study Plan (study plan) provides a summary of existing water quality data collected within the study area and in the mainstem Skagit River downstream of the Project. Parameters for which multiple years of recent data have been collected

are considered to be adequately represented by existing information. This QAPP supports data collection proposed in the study plan that will fill in data gaps identified in the body of existing information.

2.0 PROJECT PLAN

2.1 Project Goal

In most cases, a licensee must receive a water quality certification before FERC can issue an operating license for a hydroelectric project. As noted above, the study plan has been designed to collect water quality data, which along with existing water quality information, will support the license application, including the application to the Washington Department of Ecology (Ecology) for certification of the Project under Section 401 of the CWA.

The proposed study will provide information, which in combination with existing data, will be used to characterize water quality within the study area and allow resource agencies with jurisdiction over water or aquatic resources to analyze Project effects related to water quality.

This QAPP has been developed to provide guidance and quality assurance for water quality sampling and analyses required by the FERC-approved Water Quality Monitoring Study Plan in support of the Project's FERC relicensing.

2.2 Decisions or Outcomes

The collected data will characterize the physical and/or chemical state of surface water in the study area, as defined in the study plan. The data will be filed with FERC in the Initial Study Report and in other subsequent relicensing documents, as needed, and will be suitable to compare to applicable regulatory standards and criteria. Additional information regarding study objectives, methods, and reporting can be found in the study plan.

2.3 Study Area

The study will be conducted in Ross (within the United States), Diablo, and Gorge lakes, the Gorge bypass reach, and in the Skagit River downstream of the Gorge Powerhouse (see Figure 2.5-1 in the study plan). Approximate locations of the proposed water quality sampling/measurement sites are included in Section 5 of this QAPP.

2.4 Project Constraints

Data collection may be constrained by site access during winter snow events. High river flows may also at times affect in situ sampling and sonde maintenance.

3.0 ORGANIZATION AND SCHEDULE

3.1 Involved Parties and Roles

This QAPP has been prepared for the Water Quality Monitoring Study component(s) of the Project's FERC-approved relicensing studies. Within this QAPP are descriptions of methods, procedures, and practices that will be used to assure and control the quality of water quality data.

Key personnel who will be involved in the study are listed in Table 1. City Light's Technical Lead, with assistance from HDR, will be responsible for ensuring that all aspects of the Water Quality Monitoring Study are addressed, including the organization of field staff, scheduling of sampling days, field quality assurance/quality control (QA/QC), coordination with the off-site laboratory, and reporting. Laboratory analytical services will be provided by ALS[1] and EcoAnalysts.[2]

Table 1. List of key personnel on the study team.

Title	Name	Affiliation
Technical Lead	Jeff Fisher	Seattle City Light
Study Lead	George Gilmour	Meridian Environmental, Inc.
Field Coordinator	Robyn Rice	Meridian Environmental, Inc.
QA Officer	Chad Wiseman	HDR, Inc.
Laboratory Manager	TBD	Edge Analytical
Laboratory Manager	Gary Lester	EcoAnalysts

The Study Lead is responsible for monitoring and verifying implementation of the QA/QC procedures found in this QAPP. Key personnel assigned to the Project will have reviewed the QAPP and will be instructed by the Study Lead regarding the requirements of the QA/QC program. The Study Lead will work directly with the Field Coordinator or other designee and Laboratory Manager(s) to ensure that the QAPP objectives are being met.

The Study Lead is also responsible for keeping the QAPP up to date. Modifications may be identified by any member of the study team. Exceptions or modifications to the content of this document will be formalized in the Revision Log following the title page. Revised versions of the QAPP (if they are necessary) will be available to study personnel and attached to subsequent reports. Variances from and non-conformances with the QAPP will be documented in applicable reports.

The QA Officer is familiar with the study, but not involved in day-to-day implementation. The QA Officer is versed in water quality field sampling and laboratory procedures. The QA Officer will review the study's intermediate and final products, and work with the Study Lead to ensure they are of high quality when complete.

3.1.1 Organizational Chart and Responsibilities

The organizational chart for implementation of the Water Quality Monitoring Study is presented in Figure 1.

[1] https://www.alsglobal.com/en/locations/americas/north-america/usa/washington/everett-environmental
[2] https://www.ecoanalysts.com/

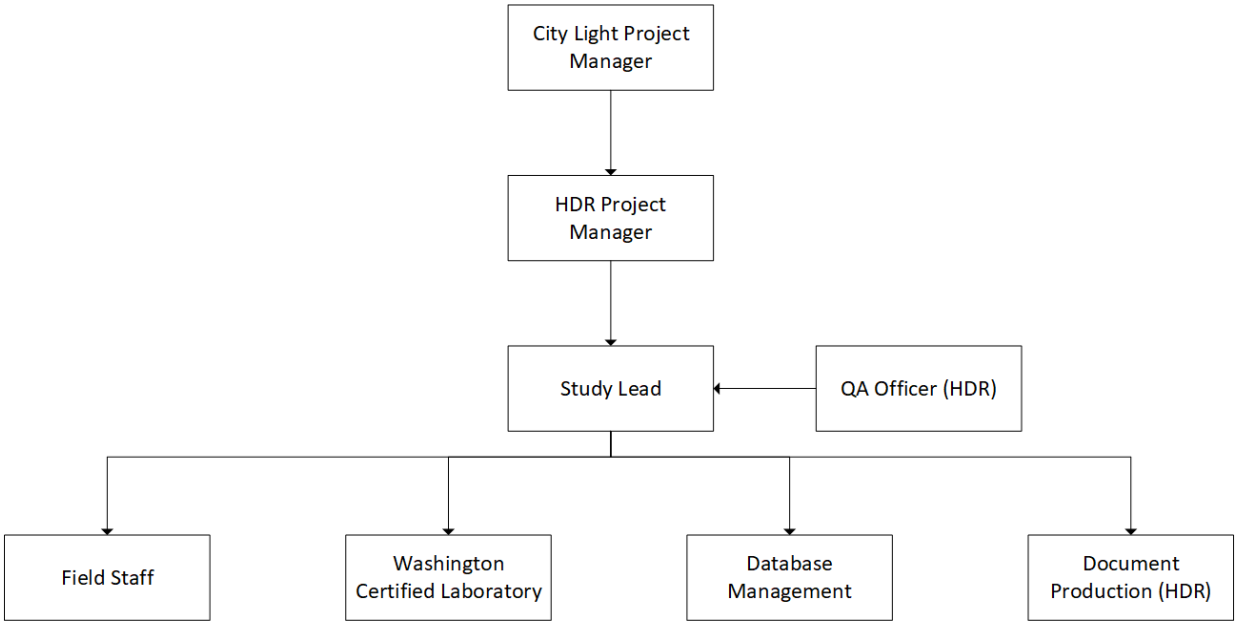

Figure 1. Organizational chart.

3.2 Project Schedule

The following schedule is anticipated, presuming approval of the Water Quality Study Plan by FERC in early 2021[3]:

- Field Work – June 2021 to May 2023
- Analysis – August 2021 to June 2023
- File Initial Study Report – March 2022
- File Updated Study Report – March 2023

4.0 QUALITY OBJECTIVES

Data quality objectives (DQO) are a set of performance or acceptance criteria that the collected data should achieve in order to minimize the possibility of either making a decision error or failing to keep uncertainty in estimates to within acceptable levels. DQOs are defined in terms of five parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC) and differ with different measurement techniques.

DQOs for this Water Quality Monitoring Study are presented in Tables 2 and 3.

[3] The schedule identified herein reflects anticipated dates for a FERC-approved study. However, early data collection is taking place during fall and winter of 2020-2021. The procedures outlined in this QAPP were/will be adhered to for data collection conducted in fall and winter of 2020-2021.

Table 2. DQOs, by measurement type and sampling event.

Precision	Accuracy	Representativeness	Completeness	Comparability
Field Measurements Temperature, pH, dissolved oxygen (DO), turbidity, total dissolved gas (TDG)				
Successive measurements are within precision limits	Within accuracy limits as compared to standards or calibrated meter	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Sensor range includes expected range of conditions in the Study Area
Analytical Laboratory Analyses Fecal Coliform and Total Suspended Solids (TSS)				
Field duplicates within10%; Laboratory QA/QC meets method requirements.	Laboratory QA/QC meets method requirements.	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Meets Reporting Limits.

Table 3. Field measurement methods and quality objectives.

Parameter	Units	Method	Range	Accuracy	Precision
Temperature	Degrees Celsius (°C)	SM2550	0- 50	0.2	0.35
pH	units	SM4500H	0- 14	0.5	0.2
DO	Milligrams per liter (mg/L)	ASTM D888C	0- 60	0.5	0.3
Turbidity	Nephelometric turbidity units (NTU)	SM2130	0- 3,000	5%	5%
TDG	% Saturation	SM 2810B	100 - 140	1%- or 5-mm Hg	1%- or 5-mm Hg

Precision is a measure of the reproducibility of analyses under a given set of conditions. In other words, precision describes how well repeated measurements agree. The precision of field measurements will be evaluated by comparing successive measurements against one another in a controlled environment. The precision of analytical results will be evaluated by comparing duplicate samples and calculating the relative standard deviation (RSD) for those samples. The RSD is the ratio of the standard deviation and the mean, expressed as a percentage.

Precision will be determined through the use of field duplicates, laboratory matrix spike/matrix spike duplicates, and laboratory duplicate quality control samples.

Accuracy is a measure of the bias that exists in a measurement system. In other words, accuracy describes how close an analytical measurement is to its "true" value. For analytical samples, accuracy is typically measured by analyzing a sample of known concentration (prepared using analytical-grade standards) and comparing the analytical result with the known concentration. For bacteria samples, accuracy is evaluated by comparing results to a laboratory reference sample.

Representativeness is the degree that sampling data accurately and precisely depict selected characteristics. The representativeness of the data is mainly dependent on the sample design, such

as locations (spatial), sampling frequency (temporal), and sample collection procedures, as well as analytical constituents and methods. The study plan presents the study design.

Completeness, which is expressed as a percentage, is calculated by subtracting the number of rejected and unreported results from the total planned results and dividing by the total number of planned results. Estimated results do not count against completeness because they are considered usable as long as any limitations are identified. Results rejected because of out-of-control analytical conditions, severe matrix effects, broken or spilled samples, or samples that could not be analyzed for any other reason are subtracted from the total planned number of results to calculate completeness. Although regulations currently do not require a specific percentage of data completeness, it is expected that the measurement techniques selected for use in this study are capable of generating data that is of 90 percent or greater completeness for field and laboratory analyses.

Comparability is the degree of confidence with which one data set can be compared to another. A broad spectrum of field and analytical constituents has been selected to characterize water quality, and the use of approved/documented field and analytical methods will ensure that results adequately represent the true concentrations of constituents within the study area. The comparability of field measurements is ensured by using calibrated water quality meters and sensors that have a measurement range bracketing expected field conditions. The comparability of analytical sample results is ensured by using methods with reporting limits (RL) of adequate sensitivity to generate useful data for the purposes of this study. Selection of appropriate RLs was based on specifications in the U.S. Environmental Protection Agency's (EPA) 40 Code of Federal Regulations (CFR) 136 (EPA 2011), water quality objectives and standards, and the capabilities of commercial laboratories.

5.0 SAMPLING PROCESS DESIGN

The proposed parameters and locations were selected to augment the body of existing data identified in the Water Quality Monitoring Study Plan (*see* Table 2.3-1 in study plan). Sample locations were chosen to be representative of conditions throughout the study area. Table 4 lists the proposed sample locations and analytical parameters for the study.

Table 4. Sample process design.

Location	Sample Identification	Sample Frequency	Sample Type	Temperature (C°)	Dissolved Oxygen (mg/L)	pH (units)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Total Dissolved Gas (% Saturation)	Fecal Coliform (CFU)	Benthic Macroinvertebrates
Ross Lake											
Pumpkin Mountain (48.7904, -121.0496)	ROSS1	Monthly (Jun 2021–May 2023)	Grab				Surface, 5 meters (m)	Surface, 5 m			
Skymo (48.8547, -121.0308)	ROSS2	Monthly (Jun 2021–May 2023)	Grab				Surface, 5 m	Surface, 5 m			
Little Beaver (48.9274, -121.0625)	ROSS3	Monthly (Jun 2021–May 2023)	Grab				Surface, 5 m	Surface, 5 m			
Hozomeen	ROSS4	Four events (Jun 2021–Sep 2021)	Grab							Surface	
Ross Lake Resort	ROSS5	Four events (Jun 2021–Sep 2021)	Grab							Surface	
Boat Access Camps (3 locations)	ROSS6	Four events (Jun 2021–Sep 2021)	Grab							Surface	
Diablo Lake											
Upper End of Diablo Lake	DIABLO1	Monthly (Jun 2021–Sep 2021)	Grab	Vertical Profile (1 m)	Vertical Profile (1 m)	Vertical Profile (1 m)	Surface, 5 m	Surface, 5 m			
Diablo Lake Forebay	DIABLO2	Monthly (Jun 2021–Sep 2021)	Grab	Vertical Profile (1 m)	Vertical Profile (1 m)	Vertical Profile (1 m)	Surface, 5 m	Surface, 5 m			
Gorge Lake[2]											
Upper End of Gorge Lake	GORGE1	Monthly (Jun 2021–Sep 2021)	Grab	Vertical Profile (1 m)	Vertical Profile (1 m)	Vertical Profile (1 m)	Surface, 5 m	Surface, 5 m			
Gorge Lake Forebay	GORGE2	Monthly (Jun 2021–Sep 2021)	Grab	Vertical Profile (1 m)	Vertical Profile (1 m)	Vertical Profile (1 m)	Surface, 5 m	Surface, 5 m			
Below Diablo Dam	GORGE3	Jun 2021–May 2022	Continuous						At Depth		
Gorge Lake Forebay	GORGE4	Jun 2021–May 2022	Continuous						At Depth		
Gorge Bypass Reach											
Below Gorge Dam	BYPASS1	Jun 2021–May 2022	Continuous	At Depth	At Depth		At Depth		At Depth		
Upstream of Gorge Powerhouse	BYPASS2	Jun 2021–May 2022	Continuous	At Depth	At Depth		Surface		Surface		
Below and Downstream of Gorge Powerhouse											
Below Gorge Powerhouse	PHOUSE1	Jun 2021–May 2022	Continuous		At Depth	At Depth	At Depth		At Depth		
Below Gorge Powerhouse	PHOUSE2	Opportunistically Jun 2021–May 2022	Grab					At Depth			
Locations Downstream of Gorge Powerhouse, (3) (RMs 91.1, 85.6, and 75.1)	SKAGIT2–4	Jun 2021–May 2023	Continuous	At depth							
Locations Downstream of Gorge Powerhouse, (3) (RMs 91.1, 85.6, and 75.1)	SKAGIT5–7X	Jul and Sep 2021	Grab								Streambed

6.0 SAMPLING PROCEDURES

Data will be obtained in the field and in the laboratory.

The field sampler will maintain a field notebook and will note relevant conditions during each sampling event on the field data sheet. At a minimum, the following information pertaining to each sample will be recorded: date, time, name(s) of people collecting samples, units of measurements, depth, Global Positioning System (GPS) coordinates for sample site, and river flow.

Gloves and other appropriate personal protective equipment will be worn during sample and data collection activities consistent with the methodologies appropriate for the analyte in question, as summarized in Tables 3 and 5. Observations of any field conditions that could affect sample results will be recorded in the field notebook, such as the concentrated presence of domestic animals or wildlife. Digital photo documentation of sampling conditions may also be performed. All field notes will be clearly written in a format that can be reproduced (i.e., scanned (pdf)) and entered into electronic format (Word or Excel).

Samples will be collected in accordance with Ecology Standard Operating Procedures (SOP) included in Appendix A.

6.1 Data Collections *In Situ*

The field measurement equipment that will be used during this Project includes the following (or a suitable equivalent):

- Multi-parameter water quality sondes (e.g., HydrolabTM DataSonde 5) will be used to measure water temperature, DO, pH, turbidity, and TDG.
- Water temperature data loggers (e.g., Onset Water Temp Pro) will be used to measure continuous water temperature downstream of the Gorge Powerhouse.

Multi-parameter water quality sondes will be calibrated, deployed, and post-checked consistent with Ecology SOP EAP129 and EAP002 (Appendix A). Sondes will be used to measure instantaneous vertical profiles in Diablo and Gorge Lakes, using a long-line data cable. Sondes will also be used for continuous and unattended data collection in the Gorge Bypass Reach and downstream of the Gorge Powerhouse. When used for unattended data collection, the sondes will be deployed in a protective housing that will minimize risk of vandalism or theft. Sondes will be deployed as deep as practical, to best represent river conditions, and to minimize risk of the probes going dry with changing flows. Sondes used to measure TDG will be deployed below the applicable compensation depths. Data will be downloaded and post-processed, consistent with Ecology SOP EAP130 (Appendix A).

Continuous water temperature data loggers will be calibrated, deployed, post-checked, and post-processed consistent with Ecology SOP EAP080 (Appendix A). Data loggers will be used for continuous and unattended water temperature measurements downstream of the Gorge Powerhouse. Water temperature data loggers will be fixed to a structure, such as a bridge piling, boulder, or rebar that has been driven into the river bed.

Prior to each use, the sonde instruments will be calibrated using manufacturer's recommended methods, checked at least monthly for drift, and re-calibrated if not meeting accuracy requirements. Any variances will be noted on the field data sheet and final report. Non-disposable sampling equipment will be thoroughly cleaned between sampling sites.

Any field-collected data that are not already in electronic format (Excel) will be hand entered into an electronic format and checked by a second party.

6.2 Sample Collection for Laboratory-Determined Analytes

Surface water samples will be collected in the field for subsequent TSS and fecal coliform determination in a qualified laboratory. Surface samples will be collected using a grab sampling technique, consistent with the "Stream Side" or "Extension Pole" method in Ecology SOP EAP034 (Appendix A). Surface samples collected from a boat will be collected via the "Extension Pole" method. Each laboratory sample will be collected using laboratory-supplied clean containers. Sample identification will include the site ID and depth interval (e.g. BYPASS-0), date and time collected, and the sampler. The sample bottles will be transported to the sampling location in clean re-sealable plastic bags (e.g. Ziploc®). With the bottles in position for direct filling, the field sampler will don clean nitrile gloves and fill the bottles by directly submerging the sample bottles in the river. The bottles will be returned to the plastic bag, and re-sealed.

6.3 Sample Handling and Custody

A chain-of-custody record will be maintained with the laboratory samples at all times.

A chain-of-custody form that identifies the sample bottles, date and time of sample collection, and analyses requested will be initiated at the time of sample collection and prior to sample shipment or release. Identification information for each sample will be consistent with the information entered in the field notebook. The samples will be transported or shipped to the analytical lab in insulated containers within the appropriate holding time and will be accompanied by the chain-of-custody form. If shipment is needed, the samples will be packaged and shipped in accordance with U.S. Department of Transportation standards. The original chain-of-custody will be given to the lab with the samples and a copy will be retained by the field staff for their records.

Once received by the laboratory, a sample receipt and storage record will be generated. The laboratory will perform all analyses within the constituent- or method-specific holding times.

After analyses, all samples will be disposed of in accordance with federal, state, and local requirements.

6.4 Analytical Methods for TSS and Fecal Coliform

TSS and fecal coliform concentrations will be measured with standard methods by ALS, as specified in Table 5. Containers, preservatives, holding times, and QA/QC requirements are specified in the analytical methods and/or in the laboratory's standard operating procedures. Analytical methods are preferentially EPA or American Society for Testing and Materials (ASTM) methods and are detailed in the laboratory's quality assurance manual.

Samples will be preserved on ice upon sample collection. Fecal coliform samples will have sodium thiosulfate preservative in the containers provided by the laboratory and must not be overfilled. Samples will be transported to the laboratory the same day to meet the fecal coliform holding time.

For each analyte, the laboratory must be able to achieve target reporting limits and method detection limits that will allow consistency with study plan and data quality objectives. Reporting limits are defined to detect small changes in concentration relative to background.

Table 5. Analytical sample container, sample preservation, and holding time requirements.

Analytical Parameter	Units	Method	Reporting Limit	Concentration Range of Interest	Container	Sample Preservation	Holding Time
TSS	mg/L	SM2540-D	1.0	0 - 50	Polyethylene or Glass	Cool, 4°C	7 days
Fecal Coliforms	CFU/100ml	SM9222-D	1	0 - 200	Polyethylene or Glass	Cool, 4°C, 0.008% Na2S2O3	6-24 hours

6.5 Benthic Macroinvertebrates

Benthic macroinvertebrates will be sampled by qualified personnel according to the protocol described in SOP (EAP_073) included in Appendix A. At each sampling location, benthos will be collected in accordance with the SOP (shown in Table 6); see the SOP for more detailed explanation of the monitoring elements shown in Table 6.

Table 6. Sampling protocol for benthic macroinvertebrates.

Monitoring Element	Equipment and Procedural Specifications
Sampling Device	D-frame kicknet
Net Mesh Size	500 µm
Site Length	Two bankfull widths or more
Sample Area	8 ft^2 to create a single composite sample
Station	Multiple riffles
Time to Suspend Sediment	30-120 seconds
Sample	Targeted riffle composite
Sampling Season	July 1–October 15
Subsample Goal	500+ organisms
Taxonomic Resolution	Lowest practical

7.0 QUALITY CONTROL

7.1 *In Situ* Data Collection

Quality control measures for *in situ* water quality meters are described in the SOPs included in Appendix A. Water temperature data loggers will be checked before and after deployment by

comparing the temperature data loggers to a Certified Reference Thermometer (CRT) traceable to the National Institute of Standards and Technology (NIST). Sonde performance will be assessed with calibration checks before and after deployment, according to the manufacturer's specifications. Instrument accuracy is also documented during servicing once a month, by comparing against standard reference materials or a second calibrated meter.

7.2 Sample Collection

QA/QC activities for sampling processes include the collection of field duplicates and field blanks for TSS and fecal coliform testing. The number of duplicates and blanks should be one per field visit.

7.3 Analytical Laboratory

ALS, which has been selected to provide analytical support for the TSS and fecal coliform elements of this study, has appropriate facilities to store, prepare, and process samples and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the study. ALS has a quality assurance plan in place and will adhere to standard protocols for accuracy, precision, instrument bias, and analytical bias.

The laboratory's deliverable (i.e., data package) will include information documenting its ability to conduct the analyses with the required level of data quality. Such information may include results from inter-laboratory calibration studies, control charts, summary data from internal QA/QC checks, and results from analyses of certified reference materials. Additionally, the laboratory will report any inconsistencies or problems associated with any sample run(s) to HDR, who will document the situation as a variance or non-conformance, as appropriate (e.g., contaminated reagents, equipment malfunction, lost or broken sample bottles upon receipt).

7.4 Macroinvertebrates

Quality control measures for benthic macroinvertebrate samples are described in the relevant SOP (EAP_073) included in Appendix A. Benthic macroinvertebrate samples will be processed and analyzed by EcoAnalysts.

8.0 DATA MANAGEMENT PROCEDURES

Field and laboratory data will be entered and maintained in Excel spreadsheets. The contract laboratory will provide an electronic data deliverable and an electronic narrative that includes, at a minimum, Level II documentation.

Throughout the relicensing, the original field notebooks and forms, equipment maintenance and calibration documentation, chain-of-custody forms, laboratory reports, and data verification records will be stored at the HDR office at 905 Plum Street SE, Suite 200, Town Square 3, Olympia, WA 98501-1516. Records will be transferred to City Light upon license receipt or earlier, at City Light's discretion.

9.0 AUDITS AND REPORTS

Periodic assessments will be conducted to ensure that data collection is conducted according to requirements presented in this QAPP. The Study Lead will have the primary responsibility for assessing compliance with the QAPP requirements pertaining to sample collection and handling procedures, field analytical procedures, laboratory analytical procedures, and communicating study status to the QA Officer and Project Manager. The QA Officer or his designee will conduct reviews of field sampling and analysis procedures at the beginning of each field season. The reviews may be performed at a demonstration site or involve accompanying sampling personnel to determine whether sampling activities are being conducted in accordance with the QAPP and study plan. Laboratory analyses will be assessed through evaluating results of QC samples and compliance with DQOs.

If a non-conformance is identified, the QA Officer and/or Study Lead will notify the Project Manager immediately. The Project Manager, QA Officer, and Study Lead will discuss the observed discrepancy with the appropriate person responsible for the activity to determine whether the information collected can still be considered accurate, what the cause(s) were leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The QA Officer and Study Lead will then follow up to ensure that corrective actions have been implemented.

10.0 DATA VERIFICATION AND VALIDATION

Documentation of review, verification, and/or validation will be maintained in the Project file.

All data will be reviewed and verified. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analyses, HDR will subject all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of results to field blank results; and identification of any data that seem inconsistent (Appendix B). If any inconsistencies are found, HDR will consult with the laboratory to identify any potential sources of error before concluding that the data are correct.

All verified chemical detections, including data whose results are "J" qualified, will be used for this assessment. Should the laboratory need to re-extract samples and re-run the sample under different calibration conditions, the data identified by the laboratory as the most certain will be used. If field-sampling conditions, as measured by the field blank, indicate that samples have been corrupted, HDR will identify the data accordingly.

All Onset Water Temp Pro data will be reviewed, and anomalous data may be identified by reviewing a plot of the water temperature results and by comparing any questionable results to ambient monitoring temperature data, flow information, and field notes. Identified data anomalies then may be deleted from the record, provided the reason has been noted.

Handheld multi-parameter meter field data will be processed through a QA/QC procedure as follows. Data from time periods with anomalous patterns or uncharacteristic spikes will be identified and not accepted. Field monitoring data will be compared to the field and laboratory

instrument calibration records. Full documentation of QA/QC procedures and reasons for not accepting any data will be provided in the initial and final study reports.

11.0 DATA QUALITY (USABILITY) ASSESSMENT

It is important that the data collected during this study are accurate, precise, representative, and complete, and can, therefore, be used to characterize water quality within the Project area. These data requirements will be assessed by ensuring that DQOs are met throughout the Project.

After each discrete sampling event, the Study Lead will evaluate if the DQOs have been met. If the impact of the QC failure on data quality is minimal, the data will be flagged and included in the database. If a greater impact is found, the Study Lead will work with the QA Officer to determine the next steps. Data that does not meet the DQOs will be evaluated to determine the cause of the problem and whether corrective actions can be implemented so that DQOs are met in the future.

At the end of the monitoring program, the data generated under this Project will be given to City Light.

12.0 REFERENCES

United States Environmental Protection Agency (EPA). 2011. Guidelines Establishing Test Procedures for the Analysis of Pollutants. Title 40 Code of Federal Regulations, Pt. 136. 2011 ed.

QUALITY ASSURANCE PROJECT PLAN

APPENDIX A

STANDARD OPERATING PROCEDURES

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for Monitoring Total Dissolved Gas in Freshwater

Version 1.0

Author – Paul Pickett
Date -

Reviewer – Karol Erickson, Water Quality Studies Unit Supervisor
Date -

QA Approval – Bill Kammin, Ecology QA Officer
Date -

EAP002

APPROVED: 7/10/2006

Recertified: May 7, 2010

Signatures on File

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
05/7/10	1.0	Recertified	All	Kammin

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Water Quality Studies Unit Standard Operating Procedure (SOP) for Monitoring Total Dissolved Gas (TDG) in Freshwater.

2.0 Applicability

2.1 This SOP should be followed for all monitoring of TDG in freshwater. It includes procedures for spot measurements and long-term continuous monitoring of TDG pressure, and the measurement of barometric pressure data to allow calculations of TDG as percent of saturation.

3.0 Definitions

3.1 Total Dissolved Gas: the amount of gases, typically the constituents of air, dissolved in water. Usually measured as pressure (e.g. mm Hg) or percent of saturation relative to ambient barometric pressure.

3.2 Compensation Depth: the depth in a water column at which the total dissolved gas pressure is equal to the hydrostatic pressure. As a rule of thumb, this corresponds to roughly 1 meter for every 10 percent of saturation above 100%.

3.3 Aerated Zone: the area below a dam's spill, waterfall, or other plunging stream of water where bubbles are entrained in the water column and TDG is crossing the air-water interface of the bubbles either into or out of solution.

4.0 Personnel Qualifications/Responsibilities

4.1 Training in the use of Hydrolab® equipment, including the Standard Operating Procedures for use of Hydrolab® equipment.

4.2 Trained in safety procedures for work on or over the water.

5.0 Equipment, Reagents, and Supplies

5.1 Equipment

5.1.1 A Hydrolab® meter fitted with a TDG sensor.

5.1.2 Spare membrane for TDG sensor

5.1.3 Calibration kit with NIST pressure sensor, bulb hand air pump, fittings and tubes, modified calibration cap, and tools.

5.1.4 Laboratory barometer

5.1.5 Portable digital barometer (optional)

5.2 Supplies

5.2.1 Selzer water (USGS standard is Schweppe's Club Soda)

6.0 Summary of Procedure

6.1 Overview

6.1.1 TDG, simply stated, is air dissolved in water. The dynamics of TDG are governed by gas laws such as Henry's Law and Boyle's Law (Colt, 1984) Supersaturated TDG is most commonly caused by air forced into solution by hydrostatic pressures when a stream of water with entrained air bubbles plunges to depth.

6.1.2 TDG levels can also be affected by a variety of environmental conditions:

6.1.2.1 Primary biological productivity, which changes dissolved oxygen levels, since DO is one component of TDG.

6.1.2.2 Changing water temperatures, which directly change TDG pressures and percent saturation in accordance with gas laws.

6.1.2.3 High winds, and shallow, turbulent flow can increase the rate of gas exchange. Supersaturated TDG is constantly seeking equilibrium with the atmosphere through the air-water interface, but under calm conditions with laminar flow and deep water (such as in reservoir with little wind), that exchange is very slow. A vigorous set of rapids or cascades can allow a rapid return of supersaturated waters to equilibrium.

6.1.2.4 Changes in barometric pressure change TDG levels relative to the standards, since TDG water quality criteria are expressed in terms of percent of saturation relative to ambient barometric pressure. This also means that evaluation of criteria requires measurement or estimation of the absolute barometric pressure at the location being monitored.

6.1.2.5 All TDG monitoring is conducted by field measurements with specialized meters. Various manufacturers provide TDG meters, but all use diffusion membrane methods equivalent to Standard Method 2810 (APHA *et al.*, 1998). Ecology owns several Hydrolab® meters outfitted with TDG sensors. Other meter models are sold by Common Sensing (the original developer of TDG meters) and In-Situ (who bought Alpha Designs, the source of replacement TDG membranes for the Hydrolab® meters). Prior to development of field measurement methods, dissolved gas was measured in the laboratory using a blood gas analyzer, but this method is now rarely used.

Figure 1. TDG sensor and membrane

6.1.2.6 The basic principle behind TDG monitoring is that dissolved gas diffuses through thin silastic tubing wound around a base, and the pressure exerted through the membrane is measured by a pressure sensor. The pressure sensors are quite robust and accuracy is quite stable (they reportedly are the same as those used in automobile engines for emission control). The membrane, however, is delicate and usually the source of any monitoring challenges. Membranes need to be intact, dry inside, and clean. This requires some attention to equipment maintenance and handling.

6.1.2.7 Good TDG measurements require three elements unique to the method: proper meter placement, diligent care of the membrane, and patience:

6.1.2.7.1 For proper functioning of the membrane, meters need to be placed below the compensation depth and outside any aerated zones. Membranes placed in shallow supersaturated water or in bubbly conditions may produce inaccurate readings. Because monitoring often occurs during high flow periods, rapid water velocities, high turbulence, and dynamic water elevations create challenging deployment logistics.

6.1.2.7.2 Periodic cleaning and calibration will help insure membranes are performing properly. During continuous monitoring deployment, maintenance about every two weeks is optimal, but monthly maintenance is adequate.

6.1.2.7.3 Membranes can take 15-20 minutes to equilibrate to changing conditions, so plenty of time needs to be allowed for calibration and for properly equilibrated spot measurements. Bring a book, a laptop to check email, a radio or music player, or just enjoy the scenery!

6.1.2.8 Like all environmental monitoring, a Quality Assurance Project Plan should be developed for TDG monitoring. Examples developed by Ecology are cited in the References (Ecology 2002; 2003; 2004). Ecology's TDG data quality procedures are modeled on the methods developed by the U.S. Geological Survery (Tanner and Johnston, 2001).

6.2 Calibration

6.2.1 Calibration procedures follow the outline provided in Section A.1. of Appendix A. Other parameters measured by the Hydrolab® meter should also be calibrated, especially temperature and dissolved oxygen because of their close relationship to TDG pressure. See the SOPs for Hydrolab® use for instructions on these parameters.

6.2.2 Calibrate the pressure sensor without membrane

6.2.2.1 Take a meter reading with pressure sensor open to ambient air, and compare to the barometric pressure (BP) using the laboratory standard barometer.

6.2.2.2 Attach the fitting to the pressure sensor that connects through tubing and a tee fitting to the NIST pressure gage and the bulb.

6.2.2.3 Pump up the pressure on the bulb until the NIST meter shows 100 mm Hg and record the meter reading and lab BP+100. Repeat for +200 and +300 mm Hg.

6.2.2.4 If any readings are greater than 2 mm Hg different from the lab BP standard, calibrate the meter at ambient BP and ambient BP+200.

6.2.3 Test Hydrolab® meter with dry membrane

6.2.3.1 Attach the dry TDG membrane, then put on a calibration cup with the special cap with tubing.

6.2.3.2 Record a meter reading with the chamber open to ambient BP.

6.2.3.3 Add 200 mm Hg pressure to the chamber (make sure all seals are tight!) and record meter reading. Readings should agree within 2 mm Hg.

6.2.4 Test Hydrolab® meter in Club Soda

6.2.4.1 Remove the calibration cup and put the sensor guard on the meter.

6.2.4.2 Place the probe in a beaker and fill with Club Soda. Watch the readings and record the high reading. TDG should rise from ambient to over 1000 mm Hg (for fresh soda) in about 40 to 60 seconds, and then start to drop.

6.2.4.3 Remove the probe from the Club Soda. Watch the readings and record the low reading. TDG should drop to slightly below ambient BP (effect of evaporation on the membrane) in about 1 to 3 minutes, then begin to rise.

6.2.4.4 If the TDG readings in Club Soda rise or fall too quickly or too slowly, or if the readings don't rise as high as expected or don't fall below ambient, replace the TDG membrane and repeat 6.22 and 6.23. (This is why it's always good to have a spare membrane or two!)

6.2.4.5 The problem membrane can be washed in distilled water, dried thoroughly (at least 24 hours) and then retested. Moisture inside the membrane will cause problems. Membranes can also develop tiny splits or pinholes, in which case they need to be refurbished (rewound with new silastic tubing).

6.2.4.6 If the TDG meter and membrane passes all tests, it is ready to go. Dry the membrane and visually inspect for flaws or internal moisture. Remove the sensor guard and replace calibration cup for transport. TDG membranes are best stored dry when not in use.

6.3 Barometric pressure measurement methods

6.3.1 Obtaining BP measurements that coincide with your TDG pressure readings can be problematic. Ideally a continuous data-logging barometer would be installed adjacent to the deployment location, but Ecology has not found the high cost to be justified by the limited need, and several alternative methods should work adequately.

6.3.2 For spot measurements, the meter itself can work as a barometer. Remove the membrane at the monitoring location and take a reading with only the pressure sensor. The disadvantage of this method is that any handling of the membrane increases the chance of membrane damage.

6.3.3 A hand-held digital barometer of acceptable accuracy serves well for spot readings. (The Quality Assurance Project Plan should specify MQOs for barometer readings.) EAP has some analog (aneroid) barometers, but they have been found to be very sensitive to temperature changes and often provide inaccurate readings in field conditions. Barometer readings can be checked with paired readings with the meter and laboratory barometer during calibration.

6.3.4 For continuous deployment, a meteorological station in the vicinity is needed which records continuous BP. BP tends not to vary on fine spatial scales (within a mile or two), but on regional scales significant differences can occur, especially when BP is dynamic such as during an approaching low front. Ideally you should visit the meteorological station during field surveys and take a spot BP reading on-site for paired comparison. Spot BP readings at the deployment site can then be compared to the meteorological station data, and a regression developed to predict BP at the deployment site from the meteorological station time series. BP varies linearly with altitude, so a first-order linear regression usually works well.

6.4 Spot measurements

6.4.1 The trick to taking spot TDG measurements is to get the meter below the compensation depth and keep it there long enough for a stable reading. The main approaches to accomplish this are:

6.4.1.1 Find a quiet spot where the water is connected to the river but currents are slow, such as an eddy or below an obstruction.

6.4.1.2 Take readings while drifting in a boat.

6.4.1.3 Attach a heavy weight on a short cable with the meter at the end of a rope. Ecology has a cable and weight for this purpose.

6.4.2 Modify the attached form A-3 in Appendix A for the spot readings you plan to collect. When you reach the site, take a BP reading, then lower the meter into the water to an appropriate depth. Monitor the TDG readings until they are stable (less than 1 mm Hg change in 2 minutes). Check the depth to make sure the meter is below the compensation depth (divide the BP by 10, then allow 1 meter for each increment of BP/10 that the TDG reading is above the BP). Record your reading (electronically and in the field book).

6.5 Continuous monitoring deployment

6.5.1 Continuous deployment requires the selection of a location that meets several criteria:

6.5.1.1 Accessible for maintenance;
6.5.1.2 In a representative location;
6.5.1.3 Below the compensation depth for all flows and water surface elevations
6.5.1.4 Will stay in place during high flows; and
6.5.1.5 Protected from damage from debris or movement of the meter itself

Figure 2. TDG continuous monitoring deployment with a PVC pipe mounted from a bulkhead.

6.5.2 A number of approaches have been used around the state. A few are listed here:

6.5.2.1 Install a PVC pipe on a dock, bulkhead, abutment, or other permanent structure, so the meter is 5 meters below low water and the top is accessible from the structure. This is the most ideal kind of deployment for easy access and dependable readings. It is best if the site has secure access.

6.5.2.2 Install a PVC pipe along the river bottom with the end anchored in the channel and the top accessible on the shore. It's challenging to find a location for this kind of deployment where the end is deep enough and won't wash away and the top is in a secure location

6.5.2.3 Put the meter in a protective PVC case and attach to an anchor, which is lowered from a boat or dock. This works best in low velocities, with an anchor heavy enough to stay in place or attached to a structure. An anchor made of a piece of flat steel tends to stay put better than a concrete anchor. At higher velocities you don't want the anchor to move or the meter to bang on the bottom. You could build a custom anchor with a clamp or attached housing for the meter. An alternative to attaching the meter directly to the anchor is to put the meter on a small buoy that is pulled below the surface but keeps the meter off the bottom. The usual security problems exist for buoy deployments in areas with public access.

Figure 3. Anchor and PVC housing deployed from a dock for continuous TDG monitoring.

6.5.2.4 If you have the time, funds, and aptitude to rig a custom deployment, you could rig a cable out to an anchor and then suspend the meter in a housing that hangs from the cable on pulleys. To deploy or retrieve the meter you put tension on the cable and then lower or raise the meter with a second rope.

6.5.3 When you first deploy the meter, take a second meter and take a paired reading before deployment. At intervals of 2-4 weeks, bring a second calibrated meter, take a paired reading, and then swap the meters. If you have another meter for spot readings, a three-way replicate reading is even better. If an extra meter is unavailable, the meter can be retrieved, milked for data, recalibrated, and redeployed in the field. Form A-3 can be adapted to guide this field work and record data.

6.6 Post-calibration and maintenance

6.6.1 Post-calibration follows most of the same steps as calibration (Section 6.2). Form A-2 is provided in Appendix A to guide post-calibration.

6.6.2 After post-calibration, the TDG membrane should be removed, the solid cap placed on the pressure sensor, and the membrane allowed to dry thoroughly. The TDG membrane should then be stored in a sealed container with a moisture absorbent packet.

6.6.3 Damaged TDG membranes can be refurbished for about half the cost of buying an entirely new membrane. Sometimes a membrane that is functioning poorly will work fine after being cleaned and thoroughly dried, so this is worth trying before paying for refurbishment.

7.0 Records Management

7.1 The standardized recording sheets provided in Appendix A should be modified as appropriate for the specific needs of the project and used for calibration and field QA procedures. Care should be taken to record times, barometric pressures, field conditions and other relevant information at frequent intervals.

8.0 Quality Control and Quality Assurance

8.1 QA/QC procedures are described in the procedures above, and will be addressed thoroughly on a project-by-project basis in the QAPP for the project. See References for examples of TDG QAPPs.

9.0 Safety

9.1 All appropriate safety procedures to the installation method employed should be followed for working off of docks, bridges, or boats, and for deploying and retrieving remote moorings with buoy and anchors.

9.2 Installation of mounted tubes or other deployment should follow safety procedures for use of tools and work over water.

9.3 For further field health and safety measures refer to the Environmental Assessment Program (EAP) Safety Manual .

10.0 References

10.1 APHA, AWWA, and WEF, 1998. Standard Methods for the Examination of Waste and Wastewater. 20th Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

10.2 Colt, J., 1984. Computation of Dissolved Gas Concentrations in Water as Functions of Temperature, Salinity, and Pressure. American Fisheries Society Special Publication 14.

10.3 Ecology, 2002. Quality Assurance Project Plan, Mid Columbia and Snake Rivers Total Dissolved Gas Total Maximum Daily Load Field Monitoring. Pub. No. 02-03-067, Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA.

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Appendix A

Laboratory and Field Data Sheets

A.1. HYDROLAB CALIBRATION PROCEDURES (To be done prior to survey)

Hyrolab #_____ Lab barometer ID _____
TDG sensor #_____ Date barometer last calib. _____
Survey location _____ Today's date _____
Survey Date _____ Checked by _____

1. CALIBRATE TDG WITH DIGITAL PRESSURE GAUGE (MEMBRANE OFF).

Lab BP _____ mm Hydrolab ambient pressure _____ mm Time _____
Baro+100mm: expected/measured _____ /_____
Baro+200mm: expected/ measured _____ /_____
Baro+300mm: expected/ measured _____ /_____

If any readings are >2 mm off, do a 2-point calibration at BP and BP+200 mm and note below.
Calibration BP: calibrated/measured _____ /_____
BP+200mm: calibrated/ measured _____ /_____

2. INSTALL DRY MEMBRANE AND TEST HYDROLAB WITH PRESSURE GAGE AND CHAMBER.

Lab BP + 200mm = _____ mm
Before applying 200 mm pressure Hydrolab pressure _____ mm Time _____
After applying pressure Hydrolab pressure _____ mm Time _____

3. INSTALL SENSOR GUARD AND TEST HYDROLAB WITH CLUB SODA.

Before soda test Hydrolab pressure _____ mm * Time _____
High pressure, soda test Hydrolab pressure _____ mm Time _____
Low pressure, after soda test Hydrolab pressure _____ mm Time _____

4. CHECK MEMBRANE FOR INTERNAL MOISTURE AFTER THE OUTSIDE HAS HAD TIME TO DRY.

A.2. HYDROLAB TDG POST-CALIBRATION PROCEDURES (To be done at the conclusion of a survey.)

Today's date _____ Checked by _____

1. TEST LOW CALIBRATION WITH MEMBRANE ATTACHED.

Lab BP _____ mm Hydrolab Pressure _____ mm Time _____

2. TEST HYDROLAB WITH DIGITAL PRESSURE GAGE AND PRESSURE CHAMBER.

Lab BP + 200mm = _____ mm
Before applying 200 mm pressure Hydrolab pressure _____ mm Time _____
After applying pressure Hydrolab pressure _____ mm Time _____

3. TEST HYDROLAB WITH CLUB SODA.

Before soda test Hydrolab pressure _____ mm Time _____
High pressure, soda test Hydrolab pressure _____ mm Time _____
Low pressure, after soda test Hydrolab pressure _____ mm Time _____

(If the unit does not perform well on #1-3 above, re-evaluate the corresponding site record.)

Remove TDG membrane, clean the membrane, air dry, store with desiccator.
Allow TDG sensor to air dry for at least 24 hours.

A.3. HYDROLAB TDG FIELD INSPECTION/CALIBRATION SHEET

Deployment/Retrieval Procedures

Project: _____ Date: _____ Personnel: _____

Weather: _____ Air temperature: _____ ^{o}C

Observed river conditions (flow, spill, etc.): _____

Barometer ID _____ Date last cal._____ Survey meter #:_____

1. Spot reading at:_____**.** Start time:_____; Site conditions:_____

BP:_____; Depth:_____; TDG:_____; DO:____; pH:_____; Cond:_____; Temp:_____;

2. Paired readings at deployment site:_____**.** Site conditions:_____

Start time:_____ Bar Press:_____

Meter #:___; Time:___; Depth:_____; TDG:_____; DO:____; pH:_____; Cond:_____; Temp:_____;

Meter #:___; Time:___; Depth:_____; TDG:_____; DO:____; pH:_____; Cond:_____; Temp:_____;

After a minimum of 15 minutes, if both Hydrolab readings have not changed 1 mm./2 min, or if meters are changing but difference is constant:

_____ mm (DS#____) - _____ mm (DS#____) = _____ mm Time: _____

IF Difference is > 10 mm, do A and B

A. Test both Datasondes with club soda:

DS#____ ; TDG:_____ mm Time: _____

DS#____; TDG:_____ mm Time: _____

B. Test both Datasondes with pressure gage and chamber:

DS#____: ambient_____ mm; plus 200mm_____ mm Time: _____

DS#____: ambient_____ mm; plus 200mm_____ mm Time: _____

IF DATASONDE FAILS EITHER TEST, REPLACE MEMBRANE AND RETEST, OR DO NOT USE.

Old meter retrieval time:_____, new meter deployment time:_____. End time:_____ BP:_____

3. Spot reading at:_____**.** Start time:_____; Site conditions:_____

BP:_____; Depth:_____; TDG:_____; DO:____; pH:_____; Cond:_____; Temp:_____

4. Spot reading at:_____**.** Start time:_____; Site conditions:_____

BP:_____; Depth:_____; TDG:_____; DO:____; pH:_____; Cond:_____; Temp:_____

DEPARTMENT OF
ECOLOGY
State of Washington

Standard Operating Procedure EAP034, Version 1.5

Collection, Processing, and Analysis of Stream Samples

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Purpose of this document

The Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for the Collection, Processing, and Analysis of Stream Samples

Version 1.5

Author - William J. Ward
Date - 11/23/16

Reviewer - Brad Hopkins
Date - 11/23/16

QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date – 7/20/2016

EAP034

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For the internet version, signatures are on file

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
2/9/2007	1.1	Editorial; formatting	All	Bill Ward
3/7/2007		Comments	All	Dave Hallock
5/9/2007	1.2	Edits based on comments	All	Bill Ward
6/19/07		Comments	All	Bill Kammin
8/6/07	1.3	Edits based on comments	All	Bill Ward
9/28/07		Comments	All	Dave Hallock
9/28/07	1.3	Edits based on comments	All	Bill Ward
9/4/12	1.4	Edits based on Dave Hallock and TCT workgroup comments	All	Bill Ward
7/20/2016	1.5	Edits based on needed updates, TCT workgroup comments. Recertified	1,3,4,6,9, &10	Bill Ward

Environmental Assessment Program

Standard Operating Procedure for the Collection and Processing of Stream Samples

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for the collection, preservation, measurement, and analyses of water quality at Freshwater Ambient Monitoring stations.

1.2 It describes the general stream monitoring procedures used for run preparation, sample collection, measurement, processing, preservation, and shipment. The document also addresses quality assurance and quality control procedures.

1.3 The standard set of samples collected, measured, or processed include: temperature, pH, conductivity, dissolved oxygen, turbidity, total suspended solids, fecal coliform bacteria, ammonia, nitrate plus nitrite, total nitrogen, total phosphorus, soluble reactive phosphorus, metals, and stage height. Program SOP methods for Instantaneous Temperature (EAP011), Dissolved Oxygen (EAP023), Metals (EAP029), Fecal Coliform Bacteria (EAP030), pH (EAP031), Conductivity (EAP032), and Invasive Species (EAP070) are also included.

1.4 Other samples that may also be collected and processed on a special study request basis include: alkalinity, dissolved organic carbon (DOC), total organic carbon (TOC), filtered total phosphorus, filtered total nitrogen, Nitrogen Isotope, chlorophyll, and suspended sediment concentration (SSC).

1.5 All Ambient stations are typically monitored once a month and dissolved metals are also monitored every other month at only a few stations.

2.0 Applicability

2.1 This SOP is intended for long term ambient stream monitoring.

3.0 Definitions

3.1 Dissolved Oxygen (DO) – The concentration of dissolved oxygen (mg/L) in a water sample.

3.2 Conductivity –A measure of the ability of water to carry an electrical current. It is dependent upon the concentrations and types of dissolved ions and the water temperature. In general, a greater concentration of ions in the water will lead to a larger conductivity value.

3.3 Ecology – Washington State Department of Ecology.

3.4 EAP – Environmental Assessment Program.

3.5 EIM – Environmental Information Management System. A searchable database developed and maintained by the Washington State Department of Ecology.

3.6 Fecal coliform – A group of bacteria that inhabit the intestinal tract of warm-blooded animals and remain viable in freshwater for a variable period of time. The presence of fecal coliform bacteria in water indicates fecal contamination of the water by a warm-blooded animal; harmful bacteria and viruses associated with fecal contamination may also be present.

3.7 Field Logbook – A weather resistant logbook containing "Rite in the Rain" ® writing paper used to document any and all field activities, sample data, methods and observations for each and all sample sites.

3.8 µmhos – micro mhos (mho = 1/ohm = 1 Siemen) per centimeter

3.9 MEL – Manchester Environmental Laboratory

3.10 MQO's – Measurement Quality Objectives

3.11 MSDS – Material Safety Data Sheets provides both workers and emergency personnel with the proper procedures for handling or working with a particular substance. MSDS's include information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment and spill/leak procedures.

3.12 OC – Operations Center. The location of the program field equipment, boats, walk-in cooler and shop (where technicians repair or fabricate the equipment).

3.13 pH – A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale ranges from 0 to 14.

3.14 Run – Monthly scheduled sampling event (usually lasting 2-4 days).

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified in EAP's Field Safety Manual (Ecology, 2015) such as First Aid, CPR, and Defensive Driving.

4.2 Because the procedure requires the use of hazardous materials, training is required as per the Ecology Chemical Hygiene Plan and Hazardous Material Handling Plan (Section 1) (WA State Department of Ecology 2011), which includes Laboratory Safety Orientation, Job-Specific Orientation and Chemical Safety Procedures. The Standard Operating Procedures in Section 16 of the Chemical Hygiene Plan and Hazardous Material Handling Plan for handling chemicals must also be followed.

5.0 Equipment, Reagents, and Supplies

5.1 Bridge sampler (based on design presented in Figure 4500-0:1 of the 20th Edition of Standard Methods), 1 L Funnel, or Kemmerer/Van Dorn samplers
5.2 Sampling ropes 1 @ 10 ft., 1 @ 35 ft. and 2 @ 55 ft.
5.3 Extension pole with bottle clamp
5.4 1-L funnel with tubing
5.5 Field Logbook or Field Data Report Form
5.6 Meter Calibration Log Form
5.7 Ambient Run Checklist
5.8 Sample tags
5.9 Sample coolers
5.10 Sample bottles
5.11 Cube ice
5.12 Gel-Ice (Blue Ice)
5.13 250 mL 10% HCl
5.14 Bacteria sampler
5.15 Long-line thermistor
5.16 Red-liquid thermometer
5.17 Weighted measuring tape
5.18 USGS gage keys
5.19 Peristaltic pump and filter holder
5.20 Hach PHC electrode
5.21 Hach pH 4, 7, & 10 Buffers.
5.22 Hach pH electrode filling solution.
5.23 pH 7 QC buffer (from another manufacturer - not Hach).
5.24 Hach 4-cell Conductivity electrode

Bridge Sampler W/sample bottles

Bacteria Sampler W/sample bottle

5.25 2 –100 µmhos/cm conductivity standards

5.26 2 – 1 L nutrient grab sample bottles[1] (marked up with black permanent ink and MSDS sticker)

5.27 1 – 1 L pH and conductivity grab sample bottle (marked w/red or green permanent ink)

5.28 DO box that has the following supplies:

5.29 300 mL BOD bottles (enough for the Run plus two spares)

5.30 Glass BOD stoppers

5.31 Plastic BOD bottle caps

5.32 3 mL graduated disposable transfer pipettes (one dedicated to each reagent)

5.33 Manganous sulfate monohydrate reagent bottle with MSDS sticker

5.34 Alkali-iodine-azide reagent bottle with MSDS sticker

5.35 Deionized water (DI water) used to rinse sampling bottles and equipment.

5.36 2-750 mL (or 500mL) plastic DI wash bottles

5.37 Metals sampling supplies:

5.38 Hand vacuum pump with hose and pressure gage

5.39 500mL Teflon FEP bottles pre-filled with de-ionized water by the lab

5.40 125 mL narrow mouth poly bottle containing H2S04 preservative for hardness sample disposable 0.45 micron cellulose acetate filter unit (pre-cleaned)

5.41 Small Teflon vials containing 5 ml concentrated nitric acid preservative

5.42 Powder-free vinyl or nitrile disposable gloves

5.43 Baking Soda

5.44 Eyewash Stations

5.45 Digital Camera

6.0 Summary of Procedure

6.1 Annual Run Preparation. This process typically begins in the winter (several months ahead of the sampling schedule).

6.1.1 The first objective is to work with the regional watershed leads and other Ecology staff to prioritize and select new Basin Stations and metals sample stations[2] (see Attachment A for draft station selection guidance).

[1] These should contain about 200 mL of 10% HCL solution that is replaced every other Run

[2] These are sampled every other month.

6.1.2 The next objective is to complete the "RunOrder" table in the "R&SNewWYPlanning" database. Then, notify the Ambient Database Administrator that the RunOrder table has been updated and he will use the database to generate the following documents: (1) Lab # (assigns lab numbers for each of the run stations), (2) Bottle Order (details the sample bottle needs, delivery, and pickup schedules for each Ambient Monitoring Run).

6.1.3 The administrator will then forward the finalized Lab # and Bottle Order documents to the Manchester Environmental Laboratory (MEL) and post them on the Y drive.

6.1.4 The final objective is to draft and post the following two run documents on the Y drive (Y:\ambient) under the appropriate water year folder (WY__ Docs) and run name by mid-September: (1) Run Times (details the planned daily time schedule) and (2) Run Directions (details driving and sample location directions).

6.2 Monthly Run Preparation. This should begin one week in advance of a run and requires: the completion and posting of a Field Work Plan & Contact Person Form, making sample tags, printing out the Field Data Report Form and the Lab Analyses Required Form (LAR), pre-booking air shipment(s), forward the air shipment confirmation e-mail(s) to the courier, and make hotel reservations.

6.2.1 Samplers should always prepare for a Run through the use of a Run Checklist (see Attachment B) to ensure that all of the necessary tasks, sampling equipment, supplies, sample containers, and safety gear have been dealt with or loaded in the van. *Note: Run sample bottles should have been delivered to the OC bottle storage room (or the designated regional location) by the lab courier the Wednesday before the scheduled run. The lab courier should be contacted if they are not there or the order is incorrect.*

6.2.2 Verify that the conductivity (and if needed DO electrode) soaks in tap or DI water (replace water monthly).

6.2.3 Field Work Plan & Contact Person Form.

6.2.3.1 Samplers must complete and post the Field Work Plan & Contact Person Form on SharePoint, along with links to the Run Directions and Run Times documents before beginning a run.

6.2.3.2 The information on the form enables family and program staff to call a sampler in case of an emergency or conduct a search if there was a mishap.

6.2.3.3 If plans change (lodging, cell phone number, etc.) the sampler must contact a supervisor or the section secretary to have the information revised.

6.2.3.4 If the sampler fails to check in with the contact person, then the contact person needs to notify the supervisor to begin efforts to locate the sampler. *Note: Van cell phones need to be kept on during work hours to allow the lab courier or other staff to get shipment information or to discuss other program related needs.*

6.2.4 Make Sample Tags

6.2.4.1 Use the River and Stream Data Management Database to print the sample tag labels for the Run.

6.2.4.2 Stick the labels to the Rite in the Rain sample tags provided by MEL.

6.2.4.3 Rubber band the labeled tags by station and by the planned sampling order.

6.2.5 Print Out Field Forms.

6.2.5.1 Use the River and Stream Management Database to generate the Field Data Report (FDR) and the Lab Analysis Request (LAR) forms.

6.2.5.2 Check the accuracy of the pre-entered information (run date, sampler…) on the forms before printing them (see Attachment C - Example FDR and LAR Forms).

6.3 Day One Procedures

6.3.1 Refill the DI water containers (2 L bottles and 5 gallon carboy*). Note: this task may also be done at the end of the Run if a DI water source is not available at the satellite office operation center.*

6.3.2 Turn on the cell phone.

6.3.3 Put several scoops of ice into each sample cooler needed for the Run day and set the coolers into the van. If on a multiple day Run that includes an overnight stay, then consolidate the ice needed into a cooler for each day and top the cooler(s) off with several frozen Gel-Ice. If shipping by air cargo, pack one cooler with gel ice.

6.3.4 Calibrate check the van barometer using the OC digital barometer located in the wet lab (or by another means such as a local weather station - but note that weather stations report BP corrected to sea level which must be converted back to absolute pressure). Adjust the van barometer to be within 0.10 in Hg (inches mercury) when needed (and if possible).

6.3.5 Check the calibration of the long-line thermistor to the NIST reference Onset HOBO U14 digital Thermometer, complete the calibration check log to determine if it can be used, and also note the results on the electrode Calibration Log Form.

6.3.6 Empty and refill the dedicated 4, 7, and 10 Hach pH buffer calibration bottles with fresh buffer solution that are the same temperature and at least 15°C.

6.3.7 Replace the pH electrode filling solution, rinse electrode with DI water, carefully re-attach the half-filled electrode soaker bottle, plug the fill hole, and store the electrode upright.

6.3.8 Empty and refill the QC 7 pH buffer and conductivity standard bottles.

6.3.9 Clean the conductivity electrode cells with a Q-Tip, rinse area with DI water, and store electrode in DI or tap water.

6.3.10 Verify that the meter times are in Pacific Standard Time and within 3 minutes to a cell phone or to the Naval Atomic Clock time.

6.3.11 Clean the inside of the filter stand apparatus by removing the hard plastic support from the base and cleaning underneath with a brush, if necessary. Re-assemble and pump (cycle) 10 % HCL through it followed by at least a 10 second flush with DI water from the 2 L storage bottle located in the sink.

6.4 Daily Pre-Departure Procedures

6.4.1 pH Electrode Calibration (Hach PHC electrode).

6.4.1.1 Clear the junction. Remove the filling-hole cap, and slowly pull the attached electrode soaker bottle down the electrode in half-inch increments until there is a noticeable drop in the volume of the electrode filling solution.

6.4.1.2 Remove the electrode storage bottle and top off the electrode fill chamber with filling solution.

6.4.1.3 Calibrate electrode following the electrode instruction manual for a three-point calibration (Note: Hach 4, 7, and 10 buffers must be used).

6.4.1.4 Check the calibration accuracy by reading the QC7 buffer.

6.4.1.5 Record all the calibration information on the calibration sheet. Then reattach the electrode storage bottle and store the electrode upright.

6.4.2 Conductivity Electrode Calibration (Hach CDC electrode).

6.4.2.1 Rinse the electrode with DI water and set it in fresh 100 umhos/cm conductivity standard. *Note: the conductivity standard is easily contaminated. Keep it tightly capped and avoid diluting it with DI or stream sample water. Also note: the accuracy of freshly opened standard can be affected if unused for over 15 days.*

6.4.2.2 Check the meter settings to ensure the meter reads in the non-linear function (nLF) mode for temperature compensation and the reference temperature setting is 25˚C.

6.4.2.3 Measure the 100 standard. If the result is within the acceptable range of ± 2 umhos of the standard (>98 and <102), then record the initial result and cell constant, sample ID number, and skip the following calibration steps. If the result is beyond the acceptable range, then remeasure a freshly opened standard. If this next result is beyond the acceptable range, then follow the calibration steps below.

6.4.2.4 Calibrate the electrode according to the electrode instruction manual.

6.4.2.5 Record the conductivity standard concentration, the electrode ID number, the initial and final cell constants, the sample ID number, and any other required information on the Electrode Calibration Log Form (see Attachment D).

6.4.2.6 Store the conductivity electrode in DI, tap, or stream sample water at all times. (Do not store with the pH electrode).

6.4.3 Pre-Sample Collection Preparations.

6.4.3.1 Insert a new filter into the filter stand and wet the new filter with DI water to help keep it in place. Reassemble the filter apparatus and turn the filter pump on for 10 seconds to further flush the apparatus.

6.4.3.2 Select an empty BOD bottle from the DO box, record its number on the Field Data Report Form, set it in the bridge sampler bucket, and secure the bucket lid.

6.4.3.3 Consolidate the 10% HCl solution from the two dedicated 1 L nutrient grab sample bottles (marked up with black permanent ink) into one of the bottles, triple rinse the empty bottle with DI water, and secure it in a bridge sampler bottle holder location.

6.4.3.4 Rinse a dedicated 1 L pH and conductivity grab sample bottle (marked with red or green permanent ink) with DI water and secure it in another bridge sampler bottle holder location.

6.4.3.5 Secure clean 1 L TSS and 0.5 L general chemistry (mostly used for turbidity analysis) sample bottles in the remaining bridge sampler bottle holder locations.

6.4.3.6 Secure a bacteria sample bottle in the bacteria sampler.

6.5 Sample Collection Procedures.

6.5.1 Deploy the Long-line thermistor (LLT) electrode and if warranted do a stream height reference point (RP) measurement.

6.5.2 Use one of the following three basic sample collection methods: bridge sampler (mostly used to collect samples from bridges), hand dip, and extension pole. *Note: Always survey the sample location for hazards (such as boating traffic or floating woody debris) that must be avoided when using the sampling gear. Also, if necessary, put on a high-visibility safety vest, turn on the amber strobe beacon light or vehicle emergency flashers, and put out the traffic cones and warning signs.*

6.5.3 Bridge Sampler Method. Carry the sampling gear to sample at the station (e.g., bridge sampler, sample bottles, bacteria sampler, sample ropes, and long-line thermistor) onto the bridge to a well-mixed location such as the main part of the channel where representative stream samples may be collected.

6.5.3.1 Lower the thermistor electrode into the water and let it equilibrate for at least two minutes while completing some of the other sampling tasks.

6.5.3.2 If called for, measure the stream stage height[3] and record the result in the Yellow Field Logbook (Flow Book). Also, record the weighted measuring tape correction factor or check bar measurements. *Note: The keys to the gage houses and wire weight gage boxes are located on the key ring stored in the van above the sampling ropes.*

6.5.3.3 Attach the sampling rope to the bridge sampler[4], remove all the bottle caps, and set the caps aside where they can remain clean.

6.5.3.4 Carefully lower the bridge sampler to the water surface, taking care to not dislodge any bridge debris onto it. Allow the bottom of the sampler to touch the water surface, and then raise the sampler off the water for a few moments to allow any debris from the bottom of the sampler to drop off and float away. Then rapidly lower the sampler about 0.5 meters to submerge it. *Note: This minimizes the sampling of surface film and any debris from the bottom of the sampler*.

6.5.3.5 When the bubbles from the bridge sampler bucket vent tube stop (bucket is full), retrieve the sampler taking care not to dislodge bridge debris into it. If a swift current carries the sampler downstream (before it can completely fill), then pull the sampler above the water, allow it to swing upstream, and then drop it back into the water. This action may need to be repeated a few times until the bucket is full.

6.5.3.6 Set the bridge sampler aside and replace the bottle caps.

6.5.3.7 *Note: If alkalinity or other special study grab samples are needed, then collect them using the bridge or bacteria sampler. Also note: A sample bottle may be added to the bridge sampler through the use of a rubber tie down strap.*

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[3] Stream stage height measurements are obtained at some stations from a reference point (RP) by using a weighted measuring tape, a USGS weighted wire gage, or a staff gage.

[4] The bridge sampler with sample bottle holders can simultaneously collect DO, turbidity, total suspended solids, pH, conductivity, and nutrient samples.

6.5.3.8 Memorize or record the water temperature, push the meter hold button to lock the result, retrieve the thermistor electrode, and set the thermistor aside.

6.5.3.9 Attach the sampling rope to the bacteria sampler, remove the aluminum foil-covered stopper or cap from the bacteria bottle, and place the aluminum foil-covered stopper or cap where contamination can be avoided.

6.5.3.10 Move a few feet over from the location where the bridge sampler was retrieved and carefully lower the bacteria sampler to the water surface, taking care to not dislodge bridge debris or the bridge sampler retrieval water onto it. Allow the bottom of the sampler to touch the water surface, and then raise the sampler off the water for a few moments to allow any debris from the bottom of the sampler to drop off and float away. *Note: This minimizes the sampling of any debris from the bottom of the sampler*.

6.5.3.11 Lower the sampler part way into the water but do not submerge the lip of the sample bottle. Allow the current to re-orient the sampler so the sample bottle is on the upstream side of the sampler. Then rapidly lower the sampler about 0.5 meters to completely submerge it. *Note: This minimizes the sampling of surface film and prevents contamination from the bacteria sampler.*

6.5.3.12 Retrieve the bacteria sampler taking care to not dislodge bridge debris onto it.

6.5.3.13 Carefully replace the aluminum foil-covered stopper or cap in a way that avoids contamination to the inside of the bottle.

6.5.3.14 Return to the van with all the sampling gear.

6.5.4 Stream Side (1-L Funnel and hand dip) Method. This method is typically used to collect samples within reach of the water surface when standing in or near the stream.

6.5.4.1 Carry the funnel, thermistor, and any needed sample bottles using vest pockets and an empty bucket to a well-mixed location such as the deepest part of the active channel or another location where a representative sample may be collected. *Note: Do not contaminate the sample location by wading upstream of it or collect a sample from an eddy.*

6.5.4.2 Put the thermistor electrode in the water and let it equilibrate for at least two minutes while completing some of the other sampling tasks.

6.5.4.3 If called for, measure the stream stage height[5] and record the measurement in the Yellow Field Logbook (Flow Book). Also, record the weighted measuring tape correction factor or check bar measurements. *Note: The keys to the gage houses and wire weight gage boxes are located on the key ring stored in the van above the sampling ropes (or within view of driver).*

6.5.4.4 Rinse the funnel in the stream.

6.5.4.5 Invert the funnel or orient the open end of the funnel upstream and slowly submerge it until it and the funnel tubing completely fills avoiding any entrainment of air bubbles. Pinch the end of the funnel tubing and remove the funnel (top end first) from the water.

6.5.4.6 Insert the end of the funnel tubing into the bottom of a BOD bottle, allow the funnel to overfill the bottle until it is nearly empty, and then quickly withdraw the tubing (do not use any samples that were aerated by the final discharge from the funnel). Insert the glass stopper in the BOD bottle and cap it.

6.5.4.7 Hold the base of one of the sample bottles with one hand and remove the bottle cap. Then invert the bottle, reach upstream, and plunge the bottle into the water about 15 cm (6 inches), and then tip the bottle mouth up toward the water surface. Allow the bottle to fill, take it out of the water, replace the cap, and repeat the bottle filling process to fill the remaining sample bottles. *Note: The pH/conductivity bottle should be filled completely; the other bottles should be filled to the shoulder.*

6.5.4.8 Memorize, push the meter hold button, or record the water temperature, and retrieve the thermistor electrode.

6.5.4.9 Return to the van with all the sampling gear.

6.5.5 Extension Pole Method. This method is typically used to reach a more representative or undisturbed sample location from the stream bank or to sample a shallow stream from a bridge.

6.5.5.1 Carry the extension pole, funnel, thermistor, and needed sample bottles using vest pockets and an empty bucket to a well-mixed location such as the deepest part of the active channel or another location where a representative sample may be collected. Do not contaminate the sample location by wading upstream of it.

6.5.5.2 Put the thermistor electrode in the water and let it equilibrate for at least two minutes while completing some of the other sampling tasks.

[5] Stream stage height measurements are obtained at some stations from a reference point (RP) by using a weighted measuring tape, a USGS weighted wire gage, or a staff gage.

6.5.5.3 If called for, measure the stream stage height[6] and record the measurement in the Yellow Field Logbook (Flow Book). Also, record the weighted measuring tape correction factor or check bar measurements. *Note: The keys to the gage houses and wire weight gage boxes are located on the key ring stored in the van above the sampling ropes.*

6.5.5.4 Secure one of the sample bottles in the extension pole clamp (Collect the FC sample last[7]), remove the cap from the bottle, and place the cap where contamination can be avoided.

6.5.5.5 Use the extension pole to position the bottle just over the desired sample location.

6.5.5.6 Invert the bottle and in one quick motion plunge the mouth of the bottle into the water about 15 cm (6 inches) and then tip the bottle mouth toward the water surface. Wait until the bottle has filled, then take it out of the water, replace the cap, and remove the bottle from the clamp.

6.5.5.7 Repeat this bottle filling process to fill the remaining grab samples.

6.5.5.8 The DO sample must be collected following 1L funnel procedure noted in 6.4.2 above or in combination with the extension pole.

6.5.5.9 Memorize, push the meter hold button, or record the water temperature, and retrieve the thermistor electrode.

6.5.5.10 Return to the van with all the sampling gear.

6.6 Field Processing Procedure. Field processing fulfills three essential purposes: to preserve (fix) the DO sample, to prepare the individual samples for shipment to the lab, and to obtain field measurements for conductivity, pH, and barometric pressure. The typical field processing consists of the following procedure:

6.6.1 Put all the sampling gear into the van.

6.6.2 Tag the fecal coliform sample with the appropriate tag and place it in a cooler of ice.

6.6.3 Remove the BOD bottle from the bridge sampler bucket.

[6] Stream stage height measurements are obtained at some stations from a reference point (RP) by using a weighted measuring tape, a USGS weighted wire gage, or a staff gage.

[7] Collect the FC sample first in really slow moving streams. This avoids the potential of having the other sampling gear contaminate the sample location for the bacteria sample.

6.6.4 Remove the bottle stopper and fix the sample by adding two milliliters of manganous sulfate reagent followed by two milliliters of alkaline-azide reagent using the disposable pipettes reserved for each reagent. Add these reagents by dispensing them onto the inside neck of the bottle near the top of the sample (do not immerse the tip of the pipette). This should avoid splashing and entraining air bubbles into the sample and prevent any contamination of the reagents.

6.6.5 If necessary, tap the side of the BOD bottle to dislodge any air bubbles clinging to the inside of the bottle. Then insert a glass stopper in the BOD bottle and tip it to discard the displaced water.

6.6.6 Replace the stopper and invert the bottle a few times to mix the reagents into the sample.

6.6.7 Add a few milliliters of water around the stopper to form a water seal and cover the bottle top with a plastic BOD bottle cap.

6.6.8 Place the fixed sample into the DO box. Note: samples must be analyzed within four days.

6.6.9 Get into the van and record the sample time and the stream temperature on the Field Data Report Form. (Be sure to record exact sample times at Hydrolab stations.)

6.6.10 Remove the pH and conductivity grab sample bottle (marked with red or green permanent ink), rinse the pH and specific conductivity measurement cups and electrodes with sample water, and gently over fill the pH and conductivity measurement cups with the sample water. *Note: excessive agitation of the sample water will affect pH.*

6.6.11 Unplug the pH electrode fill hole and carefully remove the pH electrode soaker bottle, rinse the electrode with DI water, and put it in the pH measurement sample cup. Turn on the meter and gently stir the pH electrode for several seconds every half minute (or so) for three to five minutes while completing some of the other field processing tasks.

6.6.12 Open a 125mL preserved nutrient bottle (contains 0.25 mL of sulfuric acid) and a 125 mL preserved nutrient bottle (contains 0.25 mL of hydrochloric acid) set them in the sink bottle holders[8]. Avoid contact with the acid. Shake the 1 L nutrient sample to ensure it is thoroughly mixed and fill each of the preserved nutrient bottles to the bottle shoulder. Cap the bottles and tip them to mix the acid into the samples and set them aside. Also fill a Hardness sample bottle if Metals samples are to be collected at the station. *Note: special study samples such as dissolved organic carbon (DOC), total organic carbon (TOC), filtered total phosphorus, and filtered total nitrogen samples should also be sub-sampled out of the nutrient grab sample and processed at this time*.

[8] Make sure there are a few drops of acid in each bottle.

6.6.13 Turn on the filter pump and put the intake hose in the remaining 1 L nutrient sample. Allow the filtered sample water to run through the filter apparatus for 10-15 seconds to ensure that the DI water has been purged from it. Then fill a 125-mL amber bottle (no preservative) to the shoulder with filtered sample water, cap it, and set it aside.

6.6.14 Remove the intake hose from the 1 L nutrient sample bottle and rinse hose exterior with DI water. Then put the hose in DI water and let the pump run for 10-15 seconds to flush the interior of the filter apparatus.

6.6.15 Gently stir the pH sample with the pH electrode for several seconds prior to and during the time it takes for the meter to indicate a stable sample measurement. Repeat this process until consecutive stable readings are within 0.02 pH units. Record the result and the sample temperature on the Field Data Report Form. *Note: This process may take several minutes and gradual sample temperature changes may alter the pH or prolong the time it takes to obtain a stable result.*

6.6.16 If a Hach PHC281 electrode initial measurement is < 6.5 pH units, then clear the junction and remeasure the sample (not a current method for other Hach pH electrodes).

6.6.17 If the pH result equals 6.5 or less or 8.5 or higher, then check the calibration of the pH meter using the closest buffer (7 or 10). Record the calibration check result on the Field Data Report Form and if necessary, recalibrate meter, and re-measure the sample[9].

6.6.18 Check the calibration of the pH meter after the first, middle, and last station of the day using the QC 7 pH buffer. Record the check result on the Field Data Report Form and the Calibration Log Form. If necessary, recalibrate meter, and re-measure the sample.

6.6.19 Record the conductivity result on the Field Data Report Form or in the Field Logbook. The meter displays results to the nearest tenth, so round the result to the nearest whole number. If the tenths digit > 0.5, then round up; if it is < 0.5, then round down; and if it is = to 0.5 round to the nearest even number. For example, a conductivity result of 103.5 would be rounded to 104 and a result of 62.5 would be rounded to 62.

6.6.20 Record the barometric pressure, stream stage height, and any other measurements on the Field Data Report Form. Then record any weather or unusual site specific observations, and equipment issues (spend some time on this as these narrative observations can help explain any anomalous data on the form).

[9] If the difference between the pH meter result and the standard is greater than or equal to 0.10 pH units then recalibrate the meter, if the difference between the pH meter result and the standard is greater than or equal to 0.15 pH units, then recalibrate the meter, re-read the sample, and "J" data since last calibration check.

6.6.21 ***Note: if you observe any unusual or suspicious looking colored water in or entering the stream, or other potential environmental hazards (drums, dead animals, or new invasive plants or benthic macro invertebrates), then take some pictures and make notes about the observation and your exact location. If the suspicious looking colored water or potential environmental hazard is dangerous, then do not approach*!**

6.6.22 ***If the suspicious looking colored water is obviously not dangerous, then take some precautions and collect two water samples (500mL bacteria and 1L - TSS) to send to the lab. Also, if warranted, collect any potential new invasive plant samples for later identification. Send to Jenifer Parsons (Program plant specialist) or other agency staff that can do the identification.***

6.6.23 ***In addition, immediately report these observations to the appropriate Ecology contacts (Ecology's Spills Hotline, regional office staff, and/or watershed lead) and indicate that there are samples being sent to the Manchester Lab for potential analysis if it is warranted.***

6.6.24 Label the all sample bottles with the appropriate sample tags, double check the station ID on the tag, and place them in ice in a cooler.

6.6.25 Remove and discard the used filter from the filter apparatus, rinse the inside of the apparatus with DI water, and insert a new filter.

6.6.26 Wet the new filter with DI water to keep it in place, reassemble the filter apparatus, and then turn the filter pump on for 10-15 seconds to flush the apparatus with DI water.

6.6.27 Select an empty BOD bottle from the DO sample box, record its number on the Field Data Report Form, place it in the stainless bridge sampler bucket, and secure the bucket lid.

6.6.28 Rinse the used nutrient sample bottle with DI water and pour the 10% acid solution from the spare bottle into the newly rinsed bottle. Cap it, shake it, and set it aside in the sink to soak until the next station.

6.6.29 Triple rinse the newly emptied nutrient sample bottle with DI water, and secure it in a bridge sampler bottle holder location.

6.6.30 Rinse the dedicated 1 L pH and conductivity grab sample bottle with DI water and secure it in another bridge sampler bottle holder location.

6.6.31 Secure clean 1 L and 0.5 L sample bottles in the remaining bridge sampler bottle.

6.6.32 Rinse electrode with DI water, carefully re-attach the quarter-filled electrode soaker bottle, plug the fill hole, and store the electrode upright.

6.6.33 Decontaminate all field gear and equipment following the "Standard Operating Procedures to Minimize the Spread of Invasive Species" (Parsons, et. al, 2012).

6.6.34 Repeat the Sample Collection and Processing Procedures (see procedures 6.4, and 6.5 above) at the rest of the sampling stations. *Note: the calibration of the pH meter must be checked against a QC 7 pH buffer (not used for calibration purposes) after the first, middle, and last stations of the day. The conductivity meter needs to be checked after the last station of the day. Record the results on the Field Data Report Form and on the Meter Calibration Log Form.*

6.7 Metals Sampling Procedure. If called for, return to the sample location, and collect the metals samples[10] .

6.7.1 This sampling procedure generally follows EPA Method 1669. Samples are collected as single grabs in a 500ml Teflon FEP bottle using the stainless steel metals sampler or by hand. Care must be used at all times when collecting and processing metals samples to avoid contaminating the inside of the sample bottle or cap with debris and to minimize the contact with ambient air.

6.7.2 Metals samples should be processed (filtered, preserved, and placed on ice) within 15 minutes after having been collected. If the metals processing requirement was not met then make a note to the lab on the field sheet (and in the remarks) indicating how long it took to process the sample. The lab may "J" qualify the data. Note: the holding time prior to analysis for all metals, except mercury, is six months and the holding time for mercury is 28 days.

6.7.3 Metals Sampler Method. This method is typically used to collect samples from a bridge or from the stream bank through the use of a rope.

6.7.3.1 Move to a well-mixed location such as the deepest part of the active channel where a representative sample may be collected.

6.7.3.2 Invert the Teflon sample bottle, remove the cap, and rinse the sampler with the "ultra-pure" water that empties out of the bottle.

6.7.3.3 After the bottle empties, set the sampler down and replace the bottle cap.

6.7.3.4 Then fit the sample bottle into the base of the stainless steel metals sampler.

6.7.3.5 Completely loosen the bottle cap while it is kept on the bottle opening. Gently lower the sampler lifting arm hose-clamp over the cap and then tighten the clamp to secure it.

6.7.3.6 Attach the sampling rope.

[10] Metals samples are collected at a few selected stations every other month.

6.7.3.7 Move to a well-mixed location such as the deepest part of the active channel where a representative sample may be collected.

6.7.3.8 Check to make sure the sampler lifting arm can move up freely.

6.7.3.9 Carefully lower the sampler to the water surface, taking care to not dislodge bridge debris onto it. Allow the bottom of the sampler to touch the water surface, and then raise the sampler off the water for a few moments to allow any debris from the bottom of the sampler to drop off and float away. *Note: This minimizes the sampling of any debris from the bottom of the sampler.*

6.7.3.10 Lower the sampler about 15 cm (6 inches) into the water. Allow the current to re-orient the sampler so the sample bottle is on the upstream side of the sampler. Then rapidly lower the sampler about 0.5 meters to completely submerge it. This minimizes the sampling of surface film. *Note: At about 25 cm under the water surface, the sampler should automatically raise the bottle cap and allow the bottle to fill. Also, it may take more than 45 seconds for the bottle to fill.*

6.7.3.11 Retrieve the filled bottle taking care to not dislodge bridge debris onto it or the sampler.

6.7.3.12 Hold the bottle cap down on the bottle opening, carefully loosen the lifting arm hose-clamp, screw on the cap until it is tight, remove and tag the bottle, and place the bottle back in the Ziploc bags that it shipped in.

6.7.3.13 Repeat the procedure to obtain a second metals sample.

6.7.3.14 Put on a pair of gloves from the special Hg metals bottle bag and repeat procedures 6.7.3.1 – 6.7.3.4 to secure the bottle in the sampler.

6.7.3.15 Remove the gloves and follow procedures 6.7.3.5 – 6.7.3.10 to collect the sample.

6.7.3.16 Put on another pair of the gloves, hold the bottle cap down on the bottle opening, carefully loosen the lifting arm hose-clamp, screw on the cap until it is tight, remove and tag the bottle, and place it back in the Ziploc bags that it was shipped in. ***Note: Do not acidify this sample.***

6.7.3.17 Return to the van with the samples and sampling gear.

6.7.4 Hand Dip Method. This method is typically used to collect samples from a small or shallow stream, or near the bank of a large stream.

6.7.4.1 Move to a well-mixed location such as the deepest part of the active channel or another location where a representative sample may be collected. *Note: Do not contaminate the sample location by wading upstream of it or collect a sample from an eddy.*

6.7.4.2 Grab the base of the sample bottle with one hand, invert the Teflon sample bottle, remove the cap, and let the "ultra-pure" water empty out of the bottle.

6.7.4.3 Reach upstream and plunge the bottle into the water about 15 cm (6 inches) and then tip the bottle mouth up toward the water surface.

6.7.4.4 Allow the bottle to fill and then take it out of the water.

6.7.4.5 Replace the cap in a way that avoids contamination to the inside of the bottle and place the bottle in the Ziploc bag it shipped in.

6.7.4.6 Repeat procedure 6.7.4.1 – 6.7.4.6 to obtain a second metals sample.

6.7.4.7 Put on two pair of gloves from the special metals bottle bag, remove the cap, collect the New Hg Metals sample, remove one pair of the gloves, replace the cap, tag the bottle with the new Hg tag, and place it back in the Ziploc bags it shipped in. ***Note: Do not acidify this sample or set the cap down.***

6.7.4.8 Return to the van with the samples and sampling gear.

6.7.5 Extension Pole Method. This method is typically used to reach a more representative or undisturbed sample location from the stream bank or slow moving stream.

6.7.5.1 Secure the metals sample bottle in the extension pole clamp.

6.7.5.2 Move to a well-mixed location where a representative sample may be reached with the pole. Note: Do not contaminate the sample location by wading upstream of it and do not collect a sample from an eddy.

6.7.5.3 Invert the Teflon sample bottle, remove the cap, and let the "ultra-pure" water empty out of the bottle. Also, put the cap into the Ziploc bag the bottle shipped in and put the bag in a location that will prevent contamination to the inside of the cap.

6.7.5.4 Position the bottle over the desired sample location.

6.7.5.5 Invert the bottle and in one quick motion plunge the mouth of the bottle into the water about 15 cm (6 inches). Then slowly move the bottle upstream with the bottle mouth tipped toward the water surface until the bottle has filled.

6.7.5.6 Take the filled bottle out of the water and then replace the bottle cap in a way that avoids contamination to the inside of the cap and bottle.

6.7.5.7 Repeat the procedure to obtain the second metals sample.

6.7.5.8 Put on two pairs of gloves from the special new Hg metals bottle bag, remove the cap, collect the New Hg Metals sample, remove one pair of gloves, replace the cap, tag the bottle with the new Hg tag, and place it back in the Ziploc bags that it shipped in. ***Note: Do not acidify this sample or set the cap down.***

6.7.5.9 Return to the van with the samples and sampling gear.

6.8 Metals Field Processing Procedure.

6.8.1 Total Recoverable Metals and Total Mercury.

6.8.2 Close the vehicle door to minimize drafts

6.8.3 Put on powder-free vinyl or nitrile disposable gloves.

6.8.4 Remove the disposable filter unit from the large Ziploc bag and set the bag and filter unit aside.

6.8.5 Unscrew the cap from the first sample bottle (but leave it on the bottle).

6.8.6 If necessary, gently squeeze the side of the sample bottle to displace about 5 ml of sample to make room for the Nitric acid preservative.

6.8.7 Carefully uncap the small Teflon vial containing 1:1 Nitric acid, lift the cap from the sample bottle and add the acid to the sample. Screw the cap on the sample and then re-cap the empty Nitric acid vial.

6.8.8 Attach the Total Metals and Total Recoverable Mercury sample tag to the sample bottle.

6.8.9 Place the tagged sample in its original Ziploc bag along with the empty (capped) Teflon vial, eliminate air from the Ziploc bag, seal it and then put it in the large Ziploc bag that contained the filter unit.

6.8.10 Dissolved Metals.

6.8.10.1 Attach the hand pump (or peristaltic pump) hose to the metals filter unit.

6.8.10.2 Remove the cap from the second sample bottle; lift up one side of the filter unit lid about 3 cm (1 inch), and pour the sample into the top of the unit. Note: Avoid touching or contaminating the inside of the filter unit.

6.8.10.3 Cap the empty sample bottle and put it into the large Ziploc bag that also contains the tagged total metals sample.

6.8.10.4 Hold onto the filter unit with one hand and use the other hand to squeeze and release the hand pump lever (or turn on the peristaltic pump on the lowest setting) to create a vacuum no greater than 20 PSI[11] to filter the sample.

6.8.10.5 Filter as much of the collected sample as possible (at least half).

6.8.10.6 Empty "ultra-pure" water from an unused Teflon bottle and set the cap on the bottle opening.

6.8.10.7 Unscrew the bottom of the filter apparatus, remove the cap from the top of the unused Teflon sample bottle (do not set the cap down), pour the filtered sample into the Teflon bottle, and set the cap on the bottle opening.

6.8.10.8 Carefully uncap the small Teflon vial containing 1:1 Nitric acid, lift the cap off the bottle containing the filtered sample, and add the acid to the sample. Screw the cap on the sample and then re-cap the Nitric acid vial.

6.8.10.9 Attach the Dissolved Metals sample tag to the sample bottle.

6.8.10.10 Place the tagged sample in its original Ziploc bag along with the empty (capped) Teflon vial.

6.8.10.11 Eliminate air from the Ziploc bag, seal it, and put it in the large Ziploc bag that contains the tagged total metals sample and the empty Teflon bottle.

6.8.10.12 Eliminate air from the large Ziploc bag and place the bagged samples on ice in a cooler.

6.8.11 Field Processing – New Hg Metals

6.8.11.1 Put it in the large Ziploc bag that contains the: tagged total metals sample, dissolved metals sample, and the empty Teflon bottle.

6.9 Quality Assurance / Quality Control Sampling Procedures. Stations for Quality Assurance / Quality Control (QA/QC) samples are assigned at random prior to the water year. A typical Run has two field blank stations and ten field replicate/field split stations per year. One QA sample station is assigned per Run per month. This sampling follows the regular sampling process for the station.

6.9.1 Field Replicate/Field Split Samples[12].

[11]Any peristaltic pumps used for metals filtering must be checked to verify that the lowest setting will not create a vacuum greater than 20PSI.

[12] Replicate samples are collected after the normal set of samples have been collected, processed, and the sampling equipment has been set up to sample another station. The QA_-1 samples are used to assess variability from short-term instream processes and field and lab processing. The QA_-2 samples are used assess variability from only the field and lab processing.

6.9.1.1 Repeat the normal sample collection and processing procedures (See sections 6.4 and 6.5) to collect a second set of field grab samples at the station. Then collect two samples out of the of the same 1 L nutrient grab sample (instead of one set). ***Note: the split samples for the station are usually just nutrient samples, but they may also include non-nutrient samples such as hardness, TOC, and DOC.***

6.9.1.2 Label the first set of collected samples with the QA_-1 (field replicate) tags and label the second samples with the QA_-2 (field split) tags. ***Note: There is no need to split any sample that is collected directly in the bottle and sent to the lab. Also note that the QA_-3 tags is are to be used if any QA samples are collected at a station other than the station associated with the QA_-1 and QA_-2 samples.***

6.9.2 True Process Field Blank Samples. The purpose of this procedure is to subject the blank samples to all the typical sample collection contamination sources.

6.9.2.1 Do not collect fecal coliform or DO samples, or take any pH or temperature measurements.

6.9.2.2 Load the bridge sampler with all the normal plastic sample bottles (TSS, general chemistry, nutrient, and pH/conductivity). Go to the sample site, remove the bottle caps, and set the caps in the typical location you would use at that site (such as on the road or bridging). Lower the bridge sampler to the water surface (do not immerse anything into the stream), retrieve the sampler, and cap the bottles.

6.9.2.3 Return to the van and fill all the containers except the stainless bucket with the Lab provided DI water.

6.9.2.4 Fill the conductivity measurement cup with water from the pH/conductivity grab sample bottle, allow the conductivity electrode to stabilize, and record the measurement.

6.9.2.5 Go through the normal process of obtaining the preserved nutrient bottle samples and filtered nutrient samples from the nutrient grab sample bottle.

6.9.2.6 Label the bottles with the appropriate QA_-1 tags, place them in ice in a cooler, and note the time and conductivity measurement on the Field Data Report Form.

6.9.3 True Process Field Metals Blank Samples[13].

6.9.3.1 Load the sampler with a metals bottle (do not empty the special "ultra-pure" DI water out of the bottle). Go to the sample site, remove the bottle cap, and put the cap in a dry Ziploc bag to avoid any contamination. Lower the Metals Sampler to the water surface (do not immerse anything into the stream), retrieve the sampler, and cap the bottle.

[13] One Metals blank is collected per Run per year.

6.9.3.2 Return to the van and follow the Dissolved Metals processing procedure (see procedure 6.8.10) and filter the ultra-pure de-ionized water from the sample bottle. Then pour the filtered DI water sample back into the same bottle the water came from, cap it, label it with a QA_-1 tag and place it on ice.

6.10 End of Day QC Procedures.

6.10.1 Check the calibration of the pH electrode using the QC 7 pH buffer. Record the result on the Field Data Report Form and the electrode calibration form and if necessary, recalibrate meter, and re-measure the last sample.

6.10.2 Rinse electrode with DI water, carefully re-attach the quarter-filled electrode soaker bottle, plug the fill hole, and store the electrode upright.

6.10.3 Check the calibration of the conductivity electrode. Record the result on the electrode calibration form Form. If the conductivity measurement is not within 5 µmhos/cm of the standard then troubleshoot the meter and if necessary re-measure all of the samples using the general chemistry sample.

6.10.4 Review the information recorded on the Field Data Report Form for completeness.

6.10.5 Use a pen to fill out the Lab Analysis Required Form (LAR). The information required includes: sample times, field contact phone number, relinquished by, relinquish time, relinquished to "Walk in cooler", if necessary, number of coolers, and any helpful comments. Initial and date any changes made to the form in ink.

6.11 OC Walk-in Cooler Shipping Procedures.

6.11.1 Drain the ice water from the sample cooler(s), top the samples off with a couple scoops of ice, and set the cooler(s) in the walk-in cooler. Put a tag on the handle of the cooler indicating it goes to MEL to make identification easier.

6.11.2 Put in the completed LAR in the courier's inbox tray located near the walk-in cooler.

6.12 Greyhound or motor freight (truck) Shipping Procedures. ***Note: If possible, avoid shipping on Greyhound, because this method can delay the receipt of the samples by the lab.***

6.12.1 Fold the completed LAR, put it in a plastic sandwich bag, and tape the bag under the sample cooler lid.

6.12.2 Drain the coolers of ice water, and top them off with some additional ice or frozen Gel-Ice (Blue-Ice). *Note: do not overload the cooler with Gel-Ice because this can freeze the samples. Also, all sample coolers used to ship samples must be in good condition and not leak.*

6.12.3 Tape the cooler drain plug and lid using ¾ or 1 inch reinforced tape. It works best to tape over the drain plug first and then wrap tape twice around that end of the cooler and cooler lid.

6.12.4 Check the sample cooler(s) in at the package service counter of the shipper and provide Ecology's account number along with any other necessary information.

6.12.5 If the shipper indicates any problems with the shipment schedule, then notify the courier.

6.13 Airfreight Shipping Procedures. GoldStreak – Alaska Airlines/Horizon Air Cargo is the current provider of this service for the sample cooler shipments. *Note: The airline may require a 24 hour advance notification procedure. The shipment can be booked online the week before the run.*

6.13.1 Fold the completed LAR, put it in a plastic sandwich bag, and tape the bag under the lid of an empty (dry) sample cooler lid of a cooler that is in good condition and will not leak. Tape the cooler drain plug using ¾ or 1 inch reinforced tape.

6.13.2 Transfer the iced samples into the empty (dry) sample cooler and be sure that the all the sample container lids are tight.

6.13.3 Top off the samples with several frozen Gel-Ice. The amount of Gel-Ice may need to be increased during hot weather to ensure that the samples remain at or below 4° C during shipment. If the Gel-Ice were frozen or kept frozen with dry ice, then use only a few of them to top off the samples[14].

6.13.4 Hold off taping the cooler(s), but take the tape with you so it can be done after check-in and TSA inspection.

6.13.5 Check the sample cooler(s) in at the airline airfreight office or ticket counter. They will need Ecology's Customer ID number, your personal and Ecology ID, and possibly other necessary information. Request that they attach a Keep Cool Sticker to the cooler lid or side and have the officer from the Transportation Security Administration (U.S. Department of Homeland Security) tape the cooler lids down after the cooler contents have been inspected. If possible watch the process to be sure they remember to secure the cooler lids down with tape. *Note: The process allowed to get the cooler lids secured with tape varies at each airport. Some airport staff will let us tape the coolers using our tape, others will tape them using our or their tape (ask if you can watch for chain-of-custody reasons), and sometimes they will tape the lids but not allow you to watch.*

6.13.6 Contact the lab courier with any changes to the planned air shipment and the **air waybill number** (already noted in the forwarded airline confirmation) after the cooler(s) have been shipped.

[14] Dry ice freezes Gel-Ice colder and some samples could be frozen if several of them are used.

6.14 End of Day Procedures

6.14.1 Call the contact person noted on the Field Work Plan & Contact Person Form.

6.14.2 Lift the tube out of the DI water for the filter apparatus, lay the tube across the top of the apparatus, turn on the pump, and pump the filter apparatus dry.

6.14.3 Move the meters, electrodes, a filled DI water wash bottle, pH buffers, and conductivity standard into a heated room (hotel room, regional lab, or operation center).

6.14.4 If the overnight air temperatures will be at or below freezing, then also move the DI water, and DO box containing DO samples into a heated room to prevent freezing or loss to breakage.

6.15 DO Laboratory Analysis - *Note: Save all Winkler chemical waste resulting from any analysis (in a pail or bucket) for treatment (See 6.15.7 Winkler Waste Treatment and Disposal Methods). Also Note: the titration procedures are also documented in a Winkler training video in the Training area of EAP SharePoint.*

6.15.1 Initial Cleaning Procedure:

6.15.1.1 Put on a plastic apron and Nitrile gloves.

6.15.1.2 Thoroughly rinse the flask and stir bar with deionized water.

6.15.1.3 Check and if necessary fill the Potassium bi-iodate dispenser and starch squirt bottle.

6.15.1.4 Fill the Sodium thiosulfate reservoir and loosen the reservoir cap. *Note: it is best to do this a few hours before the titrations, so the solution may reach room temperature and there are no chemical reaction delays during the titration process.*

6.15.1.5 Open the volumetric burette stopcock to a fill position.

6.15.1.6 Raise and lower the sodium thiosulfate storage bottle reservoir above and below the volumetric burette a few times to flush the burette and to mix the sodium thiosulfate in the reservoir.

6.15.1.7 Clamp the reservoir onto the workstation lab-frame above the volumetric burette.

6.15.1.8 Set a small beaker under the burette tip and turn the stopcock to the drain position to dispense the old thiosulfate from the burette but not the burette tip. Refill the burette and then drain it a second time to also rid any old thiosulfate from the tip. Avoid empting the burette tip, because the resulting air bubble is difficult to eliminate.

6.15.2 Titration Procedure:

6.15.2.1 Remove the plastic cap from the BOD bottle.

6.15.2.2 Pour off the water seal and invert the bottle several times to mix the floc.

6.15.2.3 Allow the floc to settle to the lower half of the bottle.

6.15.2.4 Put on the face shield.

6.15.2.5 Remove the bottle-top sulfuric acid dispenser from the acid storage cabinet. The dispenser should already be pre-set to dispense 2 mL of acid.

6.15.2.6 Remove the glass stopper of the BOD bottle. Dispense 2 mL of the acid into the DO sample and put the acid bottle back into the cabinet. ***Note: Concentrated sulfuric acid is a very dangerous chemical and should be handled very carefully. Never add water to it and always immediately rinse and dispose of gloves that get any acid on them.***

6.15.2.7 Re-stopper the BOD bottle and invert it several times over the sink until the precipitate has completely dissolved. The sample should have a clear yellowish color. If some floc remains in BOD bottle, then invert the bottle several times to mix the floc and allow 5-6 minutes for the precipitate to dissolve. If the floc still has not dissolved then add a few drops of sulfuric acid from the sulfuric acid dispenser until floc completely dissolves.

6.15.2.8 Slide a magnetic stir bar into an empty 500 mL Erlenmeyer flask.

6.15.2.9 Fill a 203 mL volumetric flask[15] with the DO sample, transfer the sample to the Erlenmeyer flask, and set the flask in the sink.

6.15.2.10 Refill the volumetric burette with sodium thiosulfate (make sure the sodium thiosulfate escapes from the top nipple).

6.15.2.11 Place the Erlenmeyer flask containing the sample on the magnetic stirrer and turn on the stirrer to the lowest setting.

6.15.2.12 Titrate the sample with the Sodium thiosulfate from the volumetric burette until it turns to a pale yellow color.

6.15.2.13 Squirt 1 to 2 mL of the starch solution into the sample. Note: the addition of the starch solution earlier than this can cause a less distinct titration endpoint or overshooting the end point.

[15] This is a slight modification of azide modification method presented in SM 20th Edition, 1998, which calls for the addition of 1 mL of manganous sulfate and alkali-iodine azide instead of 2 mL. The excess reagents are accounted for by using 203mL volumetric flasks rather than 201mL flasks.

6.15.2.14 Continue the titration process by adding the sodium thiosulfate by quickly twisting the burette stopcock past the discharge point (or by slowly adding individual drops) until the purple color of the sample just disappears. This is the titration end point[16] and it should be sharp and distinct[17]. Care should be taken to avoid an end point overrun.

6.15.2.15 Check the titration end point of any sample that was possibly overrun by adding a drop of bi-iodate from a 3 mL graduated disposable transfer pipette to the titrated sample. If the end point is correct, a faint purple color should reappear. If more than one drop of bi-iodate is required to get a faint purple color, then the end point was overrun and a Back-Titration needs to be done to correct the result (see 6.14.3 – Back-Titration).

6.15.2.16 Record the titration result or corrected titration result in the proper column on the Field Data Report Form or in the field notes as mg/L of DO[18]. If the value is between the 0.1 mL marks on the burette, round the even numbers down and the odd numbers up (e.g., 10.25 to 10.2 and 10.35 to 10.4).

6.15.3 Back-Titration Procedure

6.15.3.1 Back-titrate an overrun end point sample using bi-iodate drops from a 3 mL graduated disposable transfer pipette (1 drop = 0.05 mg/L). Correct the final value[19] if the back-titration requires fewer than or equal to 8 drops and record the result without qualification[20]. If the back-titration requires more than 8 drops but less than or equal to 20, correct the final value and record the result with a "J" qualification (twenty drops are equivalent to 1 mg/L). If the back-titration requires more than 20 drops, do not record a result, but make a comment on the Field Data Report Form indicating the titration error[21].

6.15.3.2 If a graduated burette or pipette is available, then carefully back-titrate to the overrun end point sample using a measured quantity of bi-iodate and subtract the amount used to correct the final result.

[16] The volume of sodium thiosulfate used to titrate 203 mL of a sample equals the DO of the sample in mg/L.
[17] If the end point was not sharp and distinct or the sample contains purple flakes, then replace the starch solution (it may have gone bad – this is rare). Record the result with a "J" qualification to indicate the result is an estimate and note that the starch was bad and was replaced on the Field Data Report Form.
[18] The mL of Sodium thiosulfate used to analyze a 200mL sample with this method is equal to the DO concentration in mg/L.
[19] The corrected final value is the final value - (number of drops used x 0.05 mg/L). For example, if 8 drops were used and the final value was 10.3 mg/L, then the corrected final value is 9.9 mg/L (10.3 mg/L - (8 x 0.05 mg/L or 0.4 mg/L)).
[20] Justification: Our MQOs specify 0.2 mg/L; 8 drops is equivalent to 0.4 mg/L which leaves a generous allowed error of 50% for miscounting, imprecise drop size, etc. to still be within MQOs.
[21] Justification: Results with a potential error of 50% of 1 mg/L, or 0.5 mg/L, should not be recorded at all.

6.15.4 Sodium Thiosulfate Normality Check. The test is done to verify the strength of the Sodium Thiosulfate solution and get a data correction factor. The normality check result should almost always be between 9.95 and 10.05 mL if the Sodium Thiosulfate has been stored properly. The result should also be very similar to those that others have recently recorded in the Titration Log.

6.15.4.1 After the first sample has been titrated to its end point, add exactly 10 mL of the bi-iodate standard using: a 10 mL volumetric burette, w/3-way stopcock, 10 mL bottle-top dispenser, or glass volumetric pipette. Rinse the inside wall of flask with starch solution to ensure that none of the standard is on it and re-titrate.

6.15.4.2 Repeat this procedure mid-way through the batch of samples to be titrated.

6.15.5 Record the volume of the sodium thiosulfate needed for each normality check on the field notebook or worksheet and on the titration log located next to the titration station (The average of the two normality checks is used as a correction factor for the field data). *Note: These normality checks should be very close, within 0.2 mL. If they are not, then do at least two more until you have three consecutive results (within 0.2 mL of each other) to use to calculate a correction factor*.

6.15.5.1 If you get less than a 9.95 mL result, then repeat the normality check on another sample but do the following first:

6.15.5.2 Eliminate air from the tip of the Potassium Biiodate bottle-top dispenser to ensure it dispenses a 10.0 mL.

6.15.5.3 Gently dispense the Potassium Biiodate into the titrated solution in the bottom of the Erlenmeyer flask and avoid getting any on the inside flask wall,

6.15.5.4 Rinse the inside flask wall with starch solution to ensure that all of the Potassium Biiodate is in the titrated solution, and eliminate Sodium Thiosulfate drops/residue from the outside of the refillable burette tip and tube connection.

6.15.6 Correcting Titration End Point Results with Normality Check (NC) Results[22].

6.15.6.1 Note: If using the ambient database, these corrections will be done automatically; simply enter the mL of thiosulfate needed into the database "correction factor" field.

6.15.6.2 Divide the average of the two or more normality check results into 10 to get the correction factor (10/NC avg.), and then multiply the measured result by the correction factor (CF) to get the corrected result (Corrected DO = measured DO × CF).

6.15.6.3 For example, if the average of the normality checks was 9.9 mL and the sample titration result was 11.5 mL, then:

[22] The Ambient database automatically does this.

6.15.6.4 Correction Factor Multiplier = (10/NC avg.) = (10/9.9 mL) = 1.01CF

6.15.6.5 Corrected Result = (measured DO × CF) = (11.5 mL × 1.01CF) = 11.6 mL. *Note: The corrected result is the volume, in mL, of sodium thiosulfate used to titrate a 200mL sample. This volume is equivalent to the concentration of DO in mg/L.*

6.15.7 Waste Treatment Procedures. Follow procedure depicted in Figure 4 below, record final pH on the Winkler Waste Treatment Record (Attachment E), and rinse the treated waste down the drain with copious amounts of tap water.

Figure 4. Winkler Waste Treatment.

6.15.8 Lab Clean Up Procedure

6.15.8.1 Move the sodium thiosulfate reservoir back to its storage area on the counter.

6.15.8.2 Open the volumetric burette stopcock to a fill position (this allows the thiosulfate in the volumetric burette to return to the reservoir).

6.15.8.3 Tighten the reservoir cap, drain thiosulfate from the burette to a level just above the stopcock (leave thiosulfate in the tip), and leave the stopcock in a closed position.

6.15.8.4 Thoroughly rinse the used flasks and stir bar(s), and give them a final rinse them with DI water.

6.16 End of Run Procedures.

6.16.1 Brush and DI rinse the pH and conductivity sample cups and store them upside down.

6.16.2 DI rinse the filter apparatus and pump the lines dry.

6.16.3 Rinse the conductivity electrode with DI water.

6.16.4 Store the meter(s), electrodes, pH buffers, and conductivity standards in a warm and dry area in the regional lab or operation center.

6.16.5 Refill the manganous sulfate monohydrate and alkali-iodine-azide reagent containers in the DO box.

6.16.6 Empty the van of trash and vacuum it out.

6.16.7 Top off the gas tank (tank must be at least ¾ full).

6.16.8 If warranted, get the van oil changed.

6.16.9 Turn any malfunctioning equipment into the Operation Center Technician along with a completed Equipment Problem Report Form for repair at the end of each Run. Malfunctioning equipment may result in unsafe sampling conditions and lost sampling opportunities.

6.16.10 Enter the field data results and comments into our Access-based database, review the entries for accuracy, and turn in the printout of the Run Field Data sheet along with the other documentation to the database manager. *Note: The run isn't considered complete until the field data have been entered and finalized in the database. This means that normally you would do the run, analyze the DO samples, clean up your gear, and enter data before doing any other non-run-related tasks.*

7.0 Records Management

7.1 All hardcopy documentation of the data, such as completed Field Logbook and Field Data Report Forms are kept and maintained by the project lead. These documents are organized in binders or in expanding files. After about six years, hardcopies are boxed and moved to EAP archives.

7.1.1 The data are entered into our Access-based database, reviewed and verified following the Quality Control and Quality Assurance procedures, uploaded into EIM, and posted on our webpage www.ecy.wa.gov/programs/eap/fw_riv/.

8.0 Quality Control and Quality Assurance Section

8.1 The data QA program for field sampling consists of three parts: (1) adherence to the SOP procedures for sample/data collection and periodic evaluation of sampling personnel, (2) consistent instrument calibration methods and schedules, and (3) the collection of a field quality control (QC) sample during each sampling run. Our QA program is described in detail in Hallock and Ehinger (2003) and Hallock (2012).

8.2 The field QC samples are collected as a duplicate (sequential) field sample. This consists of the collection of an additional sample approximately 15-20 minutes after the initial collection at a station. This sample represents the total variability due to short-term, in-stream dynamics, sample collection and processing, and laboratory analysis.

8.3 The annual field QC metals sample is a filtered field blank sample. This sample captures potential contamination from sample processing and laboratory analysis.

8.4 A two-tiered system is used to evaluate data quality of individual results based on field QC. The first tier consists of an automated evaluation of the data. Results exceeding pre-set limits are flagged. The second tier QC evaluation is a manual review of the data flagged in the first tier. Data are then coded from 1 through 9 (1 = data meets all QA requirements, 9 = data are unusable). Criteria for assigning codes are discussed in more detail in Hallock and Ehinger (2003) and Hallock (2012). We do not routinely use or distribute data with quality codes greater than 4.

8.4.1 The overall quality of data collected during the sampling year are evaluated in our annual reports (e.g., Hallock, 2011)

9.0 Safety

9.1 Safety is the primary concern when collecting samples. Since most sample sites are located on highway bridges, road and pass conditions should always be checked before departure (especially in winter). If roadside hazards, weather, accidents, construction, etc. make sample collection dangerous, then skip that station. Note the reason on the Field Data Report Form and notify your supervisor of the hazard when you return to the office. If the hazard is a permanent condition, relocation of the station may be necessary. Review Ecology's Safety Program Manual periodically to assist with these safety determinations.

10.0 References

10.1 APHA (American Public Health Association), 2015. Standard Methods for the Examination of Water and Wastewater-. No: 4500-O C. Winkler Method, Azide Modification, American Public Health Association, 22nd Edition. Washington D.C.

10.2 Ecology, 2015. Environmental Assessment Program Safety Manual. Washington State Department of Ecology. Olympia, WA.

10.3 Ecology, 2011. Chemical hygiene plan and hazardous materials management plan. Washington State Department of Ecology. Olympia, WA

10.4 EPA, 1996. Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. Washington, D.C.

10.5 Hallock, D., 2007. Addendum to Quality Assurance Monitoring Plan: Stream Ambient Water Quality Monitoring: Correction of Objectives, Responsibilities, and Addition of Analytes. Washington State Department of Ecology, Olympia, WA. 11 pp. Publication No. 03-03-200Add2. https://fortress.wa.gov/ecy/publications/summarypages/0303200addendum2.html

10.6 Hallock, D. and W. Ehinger, 2003. Quality Assurance Monitoring Plan: Stream Ambient Water Quality Monitoring. Washington State Department of Ecology, Olympia, WA. 27pp. Publication No. 03-03-200. https://fortress.wa.gov/ecy/publications/summarypages/0303200.html

10.7 Hallock, D., 2010. River and Stream Water Quality Monitoring Report for Water Year 2010. Washington State Department of Ecology, Olympia, WA. 40 pp. + appendices. Publication No. 11-03-037. http://www.ecy.wa.gov/biblio/1103037.html

10.8 Parsons, J., D. Hallock, K. Seiders, W. Ward, C. Coffin, E. Newell, C. Deligeannis, K. Welch. 2012. Standard Operating Procedures to Minimize the Spread of Invasive Species. EAP_SOP - 070.

Attachment A – Draft Station Selection Guidance

Draft Water Year Planning and Basin Station Selection Guidance

We have had problems with final station selection not happening until late September or even into October, after the new Water Year has already begun. As a result, scoping gets neglected, location metadata collection may be sloppy or overlooked, samples may be missed, stations get moved after sampling has begun, and data management is convoluted, which risks data being compromised.

Sometimes there are legitimate reasons for delaying station selection, but too often the reason is that we are all too busy with other things. To help shepherd the station selection process, this document includes some milestones for preparing the ambient runs for a new water year, as well as some guidance for identifying suitable basin stations.

Milestones

Date	Task
June	Ambient regional staff will work with stakeholders (regions, TMDL staff, TMDL effectiveness staff, watershed leads, local governments, etc.) and each other to develop a list of basin stations for the coming water year. (See selection criteria, below.) Identify any supplemental parameters (and funding sources), metals stations, flow-critical stations, etc. to the ambient coordinator. (Some scoping at questionable stations may be required at this time.)
Late July	Ambient regional staff will submit lists of basin stations (final, pending scoping) directly to stakeholders and, via the ambient coordinator to the flow group and EAP managers. Include supplemental parameters, reasons for sampling each station, etc. Also include any proposed stations that were not selected, and the reason they were not selected.
August	Ambient staff will scope basin stations. Look for safe parking and bridge access, safe and representative (e.g., well-mixed) bank sample location. Consider high-flow conditions (and high-tide condition, where applicable). Record cross-section temperatures and conductivities. Take notes for developing run directions (road names, etc.). Take photographs (upstream and downstream) and GPS coordinates (NAD83). The ambient coordinator will provide a sampling schedule for the upcoming water year to MEL and the flow group. The flow group will identify stations where flows may not be available.
Late August	Ambient regional staff will submit the final list of basin stations directly to stakeholders and, via the ambient coordinator to the flow group and EAP managers. Ambient regional staff will indicate the availability of flows at stations where flows are not expected.
Early September	Ambient staff will plan the new water year run. Enter day/order/lab number information, parameters for each station, the coming year's sampling schedule, etc., into a temporary database, complete run directions, etc.
Mid September	Database administrator will submit required reports to MEL.
Late September	Ambient staff must enter September field data on time (the Thursday after the run). After the last run is entered, the database administrator will switch the database over to the new water year's schedule.
October 1	New water year begins.

[*NOTE: Ambient regional staff includes all ambient staff responsible for the Runs in each of the four Ecology regions (currently six Runs) and the database administrator/coordinator.*

Sampling Design

Our standard monitoring design consists of monthly sampling for the constituents listed in the table, below. We are usually willing to collect additional constituents when the analysis is funded by a stakeholder.

Our funding is sufficient to sample a total of 82 stations (plus quality control samples). We have divided these into 62 long-term stations that we monitor every year and 20 basin stations that can change from year to year. If logistics allow, we are usually happy to monitor additional basin stations, provided a stakeholder funds the analyses. (Lab analyses for standard constituents at one station for a year costs $1,320.) We may also establish a series of additional stations in cases where a stakeholder has been able to fund staff time and travel, as well as analyses.

Standard Constituents		
Ammonia	nitrate plus nitrite	phosphorus, total
conductivity	nitrogen, total	suspended solids, total
fecal coliform bacteria	oxygen	temperature
flow (at most stations)	ph	turbidity
metals & hardness (bimonthly, 12 stations)	Phosphorus, soluble reactive	

Basin Station Selection Criteria

Ideally, basin stations will be selected with the consensus of all stakeholders. But if there are too few stations identified by early July, ambient monitoring staff may need to identify additional stations. Conversely, if too many stations are identified, ambient staff will need to prune the list or get commitments from stakeholders to fund the extra stations. Ambient staff will also need to decide if proposed stations meet our basic requirements.

Basin Station Selection Criteria

- Category "5" (303(d) listed. (See www.ecy.wa.gov/programs/wq/303d/.)
- Category "2" (Needs more data. See www.ecy.wa.gov/programs/wq/303d/.)
- Support Ecology's permitting system (See https://fortress.wa.gov/ecy/wqreports/public/f?p=110:300:3631029519474507:::::.)
- Never been there, suspect impairment (See www.ecy.wa.gov/programs/eap/fw_riv/)
- Never been there, need to broaden coverage (especially in supplemental spawning areas)
- Supplement local efforts
- Pre-TMDL
- Contribute to an active TMDL
- Post-TMDL/effectiveness

Basic Requirements

- Safe to park, access bridge/bank, and sample (see EAP Safety Manual, 2012), Working near traffic and from bridges, Working in Rivers and Streams, and Fall Protection, among others; remember, you must be able to park and sample outside the fog line.)
- Stream flows in one direction (i.e., no tidal influence)
- Representative samples can be collected (well-mixed, no upstream tributary or other source)
- Active stream flow gage recommended but not required (see https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp)

Metals Stations

- Permit writers want data *upstream* of their facilities, even if no problems are expected
- Basin stations where we don't have data

Attachment B – Run Checklist

Pre-Run Preparation

___ Hotel Reservations
___ Pre-Booked Air Shipment
___ Field Work Plan in SharePoint
___ Sample Tags
___ Meter Calibration Log Form
___ Lab Analysis Report Forms
___ Field Data Report Forms
___ Waterproof Field Notebook
___ Run Directions Binder
___ Van Binder and keys
___ Cell Phone
___ Gas Van
___ Sample Bottles
___ Submit Timesheet
___

Standards & Sampling Supplies

___ pH 4, 7, & 10 Buffers
___ pH Probe Filling & Storage Solutions
___ Conductivity Standard
___ Filters
___ Pipettes
___ Deionized Water
___ D.O. Reagents
___ 250 mL 10% HCl
___ Disposable Powder Free Gloves
___ Soak Probes in Tap Water
___ Tape
___ Scissors
___ Bags for small bottles
___ Clipboard
___ Baking Soda
___ Flagging

Sampling Equipment

___ Gage & Gate Keys
___ Stainless D.O. Bucket Sampler
___ Fecal Coliform Sampler
___ Metals Sampler
___ Weighted Measuring Tape
___ Ropes
___ D.O. Sample Box
___ Filter Apparatus
___ Hand Vacuum Pump with Hose
___ Map/Gazetteer/Thomas Guide pages
___ Gloves
___ Knee Boots
___ Rain Gear

Van/Safety Equipment

___ Yellow Hazard Beacon
___ Flares or Reflectors
___ Tire Chains
___ Jumper Cables
___ Tool Chest
___ Flashlight
___ Shovel
___ Safety Vests
___ Hardhats
___ First Aid Kit
___ Foil Blanket
___ Emergency Eyewash
___ Hand Towels
___ Hand Truck?
___ Step Ladder?

Personal Gear

___ Sun Glasses
___ Watch
___ Extra Clothing
___ Hat
___ 2 Gallons Drinking Water

Meters/Instruments

___ pH Electrode
___ Conductivity Electrode
___ Long-line Thermistor
___ Barometer
___ Camera (and GPS?)
___ Meter Manuals
___
___

Pre-Departure Preparation

___ Check Road Conditions
___ Acid Wash Filter Apparatus
___ Calibrate Check Barometer[1]
___ Change pH Probe Solution
___ Clean conductivity cells
___ Change pH & Conductivity standards
___ Calibrate Conductivity Electrode[1]
___ Calibrate pH Electrode[1]
___ Check Thermistor Calibration[1]
___ Load Ice Chests, Gel-Ice, and Ice
___
___
___

[1]Enter Observations on Meter Calibration Log Form

Sampler: Bill Ward

SRM FIELD DATA REPORT FORM

Date: 9/17/2012

Station	Station Name	Time	Temp ºC	DO mg/L	DO #	Temp / pH	True / Meter	Cond uS/cm	Press in.Hg	Stage Height	ChkBr/ Corr.	Comments
23A160	Chehalis R @ Dryad											
24B090	Willapa R nr Willapa											
24F070	Naselle R nr Naselle											
25F060	Mill Cr nr mouth											
25E060	Abernathy Cr nr mouth											
25D050	Germany Cr @ mouth											
QAS-1	Quality Control Sample											
QAS-2	Quality Control Sample											

WEATHER, etc:

Bi-Iodate: 10.0/10.0 Thiosulfate: _____/_____

Laboratory Analyses Required

Project Name: **SRM - 1209005**

SIC: **DWF03** Program: **EAP**

Send Results to: **David Hallock** Mail Stop: **47600** ☑ Monitoring Reference QAPP: **0503202 and Addendum**

Date Year 12 mm dd	Time (Military, e.g., 1625)	Field Station ID	Manchester Lab Sample Number	Matrix Code	Source Code	General Chemistry: RUNS parameter group*	Conductivity	Turbidity	Total Suspended Solids	Ammonia	Nitrate-Nitrite	Total Pers. Nitrogen	Total Phosphorus TP8	Orthophosphate Mix 11	TOC	DOC	Chlorophyll	Suspend. Sed. Conc.				Micro: Fecal Coliform (MF)				Metals: Met Amb parameter Tot	Met Amb Parameter Dis	Hardness	Total Mercury Only				
09 17		23A160	- 01	10	12	X	X	X	X	X	X	X	X	X		X						X											Chehalis R @ Dryad
09 17		24B090	- 02	10	12	X	X	X	X	X	X	X	X	X		X						X											Willapa R nr Willapa
09 17		24F070	- 03	10	12	X	X	X	X	X	X	X	X	X		X						X											Naselle R nr Naselle
09 17		25F060	- 04	10	12	X	X	X	X	X	X	X	X	X	X	X		X				X											Mill Cr nr mouth
09 17		25E060	- 05	10	12	X	X	X	X	X	X	X	X	X	X	X		X				X											Abernathy Cr nr mouth
09 17		25D050	- 06	10	12	X	X	X	X	X	X	X	X	X	X	X		X				X											Germany Cr @ mouth
			-		10	12																										
			-		10	12																										
09 17		QAS-1	- 12	10	12	X		X	X	X	X	X	X	X	X	X		X				X											Quality Control Sample
09 17		QAS-2	- 13	10	12					X	X	X	X	X	X	X																	Quality Control Sample

Project Officer

Name: **David Hallock**

Phone: **3604076681**

Sampler

Name: **Bill Ward**

Field Phone #:_____

Chain of Custody Record

Relinquished by	Received by	Date	Hr	Mn	Comments (temp, preserv, No. of coolers, etc.)
		09/17/12			Shipped _____ coolers.

Comments:_____

* RUNS Parameter Group: Turb, TSS, NH3, NO2+NO3, TPN, FCMF.

Attachment D- Electrode Calibration Log Form

Electrode Calibration and QC Checks				Draft version 1.1		
Date (dd/mm/yy)	Time	Run		Sampler(s)		
Thermistor #	a) HOBO Logger/Thermometer (º			Van pressure (Pre-cal.)		
Meter #	b) Thermistor (ºC)			Lab pressure		
pH Elect. #	Correction (a minus b)			LDO Electrode pressure		
Cond Elect. #	Was that corr. expected?	Y/N		Adjusted?	Y/N	
LDO Elect. #	Comments:					

pH Electrode Calibration[a]						Calib. Millivolts (Mv)				
Date/Time	Slope	%	Offset	r2	Temp °C	4	7	10	QC 7 True	QC7 reading

LDO Electrode	Pre calibration[b]			Calibration[c]				Post calibration		
Date/Time	1) Expected mg/L (USGS)	2) Reading mg/L	Diff of 1 & 2d	Slope	Offset	Temp	inHg	1) Expected mg/L (USGS)	2) Reading mg/L	Diff of 1 & 2

Conductivity Electrode Calibration[d]						Temp˚C	Hach pH7	Hach pH10	NIST pH7	NIST pH 10
Date/Time	Initial Cell Constant	Initial Reading	Final Cell Constant	MV W/O temp corr.	Final Standard Reading					
						8	7.08	10.19	7.07	10.21
						10	7.07	10.17	7.06	10.18
						12	7.06	10.14	7.05	10.16
						14	7.05	10.12	7.04	10.13
Daily Electrode QC Check Day #1[e]						16	7.04	10.1	7.03	10.11
Date:	**Sample ID**	**Time**	**True pH**	**Reading**	**Recal?**	18	7.03	10.08	7.02	10.08
pH QC Check #1					Y/N	20	7.02	10.05	7.01	10.06
pH QC Check #2					Y/N	22	7.01	10.03	7.01	10.04
pH QC Check #3					Y/N	24	7	10.01	7	10.02
pH QC Check #4					Y/N	26	7	10	6.99	10.01
End day QC check Cond Stand 100, Reading _____					µS/cm	Comments				
Daily Electrode QC Check Day #2[e]										
Date:	**Sample ID**	**Time**	**True pH**	**Reading**	**Recal?**					
pH QC Check #1					Y/N					
pH QC Check #2					Y/N					
pH QC Check #3					Y/N					
pH QC Check #4					Y/N					
End day QC check Cond Stand 100, Reading _____					µS/cm					
Daily Electrode QC Check Day #3[e]										
Date:	**Sample ID**	**Time**	**True pH**	**Reading**	**Recal?**					
pH QC Check #1					Y/N					
pH QC Check #2					Y/N					
pH QC Check #3					Y/N					
pH QC Check #4					Y/N					
End day QC check Cond Stand 100, Reading _____					µS/cm					

Footnotes

[a] *See bottom right corner for expected ranges.*

[b] *See O_2 Solubility Table below.*

[c] *Recalibrate if difference is ± 0.1 mg/L.*

[d] *If electrode conductivity is >± 5µs/cm, recalibrate, re-read sample, & "J" data since last calibration.*

[e] *If electrode pH is >± 0.10 units, recalibrate; if > ± 0.15 units, recalibrate, re-read sample, & "J" data since last calibration*

LDO Electrode QC Check Post Run								
Date/time	Sample ID	Van Pressure	Meter Pressure	1) Expected mg/L	2) Reading mg/L	Diff of 1 & 2	Slope #: -57.5 to -58.8 (<0.7)	pH4: 165 to 178 (<5)
							Slope %: 98 to 100	pH7: -5 to +6 (<5)
							Slope r^2: >0.9995	pH10: -168 to +179 (<5)
							Offset: -3 to +8 (<4)	Cond: 0.375 to 0.425 (<0.02)

Winkler Waste Treatment Record

Name	Date	Volume	Initial pH	pH after treatment

Measure and record waste volume and initial pH. Then sprinkle in about two tablespoons of Baking Soda per ½ gallon (or one scoop), stir it to mix, wait about five minutes, and then re-measure and record the final pH.

DEPARTMENT OF
ECOLOGY
State of Washington

Standard Operating Procedure EAP073, Version 2.3

Minimum Requirements for the Collection of Freshwater Benthic Macroinvertebrates in Streams and Rivers

April 2019
Publication 19-03-211

Purpose of this document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

Publication Information

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Minimum Requirements for the Collection of Freshwater Benthic Macroinvertebrates in Streams and Rivers

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Approved Date – 10/2/2018

Recertified Date – 10/2/2018

SIGNATURES AVAILABLE UPON REQUEST

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Revision History	Summary of changes	Sections	Reviser(s)
April 2015	2.0	Version has changed because the scope of the SOP has been changed to incorporate more streams. Current version distinguishes between narrow and wide protocols.	throughout	Chad Larson
12/14/2016	2.1	Update cover page and footer; Recertify	all	Bill Kammin
12/28/2017	2.2	Updated Glossary terms, updated formatting, added footers, general edits; Changed ETOH application for clarity	all	Meghan Rosewood-Thurman
10/2/2018	2.3	Minor edits	all	Kaza, Gries
4/16/19	2.3	format and copy edit for web publication	all	J. Ponzetti

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for the collection of freshwater benthic macroinvertebrate (BMI) data. Collection of BMI in wadeable streams and rivers (<25 m average bankfull width) and larger rivers (≥25 m average bankfull width) using narrow and wide protocols, respectively, is discussed.

1.2 This document provides minimum requirements for the standardized methods of collecting and preserving aquatic insects, as well as for the taxonomic identification and reporting of the contents of BMI samples.

1.3 The methods described here are compatible with those used by other federal and state agencies in the Pacific Northwest Region (Hayslip 2007). Data collected using these methods allows us to share data with other agencies, thereby allowing for more efficient use of time in the field and potentially more extensive sampling of the streams and rivers in Washington.

2.0 Applicability

2.1 The procedures outlined here are used by EAP staff when collecting macroinvertebrates during a data collection event (DCE) from rivers and streams in Washington State.

2.2 To allow for comparable results, any data submitted for analysis using Ecology's bioassessment models by outside entities should be conducted in this manner.

2.3 The methods outlined here are employed by several of EAP's programs conducting status and trends monitoring for the state. These include the Watershed Health Monitoring (WHM), Ambient Freshwater Biological Monitoring (BIO), and Sentinel programs (SEN).

2.4 These methods also pertain to biological assessment conducted for potential regulatory purposes, i.e., directed studies (e.g., TMDL studies) or outside entities assessing sites for potential listing on the state's 303(d) list for "biological impairment" (see Ecology's Water Quality Program Policy 1-11: Bioassessment).

3.0 Definitions

3.1 DCE: The *data collection event* is the sampling event for the given protocol. Data for a DCE are indexed using a code that includes the site ID followed by the year, month, day, and the time (military) for the start time of the sampling event. For example: WAM06600-000222-DCE-YYYY-MMDD-HH:MM. One DCE should be completed within one working day, lasting 4 to 6 hours, on average.

3.2 D-frame kicknet (Fig. 1): A lightweight, packable net used for the collection of aquatic macroinvertebrates, composed of a 3- to 4-foot pole with a D-shaped frame attached to the bottom, such that the flat side can be placed against the substrate. The frame is 1 foot wide and 1 foot tall. A 500-micron mesh net is attached to the frame. With the ability to be deployed across most substrate types, this is the required sampling device for status and trends monitoring.

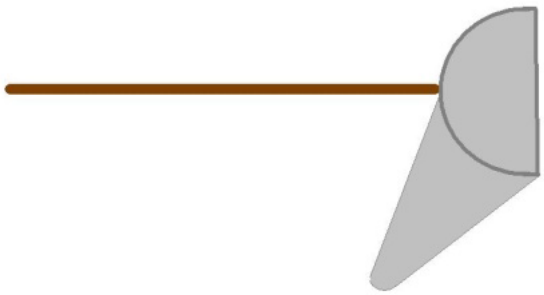

Figure 1: D-frame kicknet.

3.3 EAP: Environmental Assessment Program

3.4 Ecology: Washington State Department of Ecology

3.5 EIM: The Environmental Information Management System is the Department of Ecology's main database for environmental monitoring data. EIM contains records on physical, chemical, and biological analyses and measurements. Supplementary information about the data (metadata) is also stored, including information about environmental studies, monitoring locations, and data quality. The "search by map" feature enables plotting coordinates over orthophotographic imagery.

3.6 Hess sampler: A cylindrical mesh frame that is open on either end to allow access to bottom substrates through the top of the cylinder (Fig. 2). This cylinder has a 500-micron mesh net attached to part of the wall for sample collection. This sampler prevents escape of sample organisms and prevents outside materials and organisms from drifting into the net.

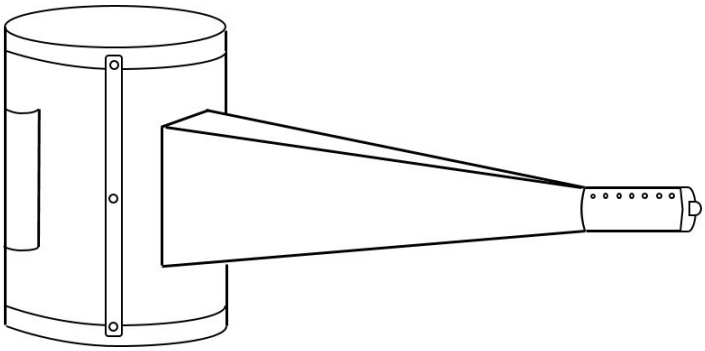

Figure 2. Hess sampler.

3.7 Narrow protocol: The set of Watershed Health Monitoring SOPs that describe data collection at wadeable sites with an average bankfull width of less than 25 m at the index station.

3.8 Narrow protocol sampling stations: Sampling occurs in a zigzag sequence (Table 1) when moving upstream.

Table 1. Pre-determined station locations on each transect of a standard stream site.

Station	% Transect Distance Left to Right
1	25
2	50
3	75
4	50
5	25
6	50
7	75
8	50

3.9 Reach-wide composite sample: The reach-wide sample is composited from eight predefined stations (Table 1). Each station is located on a separate transect and selected without regard to whether it is in a pool, riffle, or other habitat type. Sampling from multiple dispersed locations provides a representative sample.

3.10 SDS: Safety Data Sheets (previously Material Safety Data Sheets or MSDS) provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance. An SDS includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill/leak procedures.

3.11 Station: Any location within the site where an observation is made or part of a sample is collected. For SOP EAP073 and SOP EAP111 (Larson and Collyard 2019), eight out of the eleven transects are randomly selected for periphyton and macroinvertebrate sampling. Table 1 defines the sampling path within the stream or river.

3.12 Substrate: The material that rests on the bottom of the stream.

3.13 Surber sampler – A net used for sampling aquatic insects, composed of a 12 × 12 inch square frame with a 500-micron mesh net attached. It has another 12 × 12 inch square frame that sits on the substrate to border your sampling area (Fig. 3).

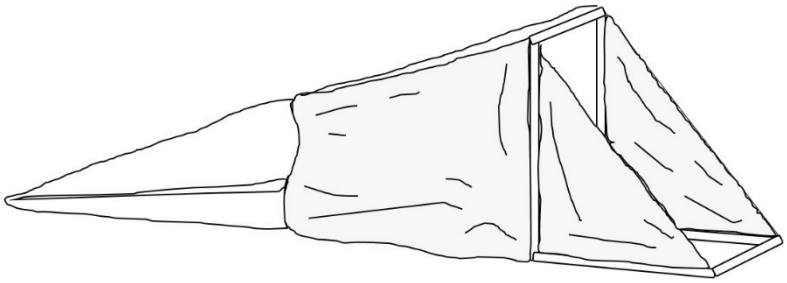

Figure 3. Surber sampler.

3.14 Targeted riffle sampling: A targeted sample represents sampling a single habitat type from a stream reach that extends at least twice its bankfull width. A targeted sample is composed of 8 feet of surface area sampled across multiple riffles or pools. Targeted sampling from a single habitat type can help to reduce the variation in the data and to provide a clear response signal. Individual directed studies may decide on the utility of using targeted riffle sampling; however, projects involved in status and trends monitoring employ only reach-wide composite sampling.

3.15 Transect: A straight line along which observations and/or measurements are made. This line spans the stream channel and is perpendicular to the direction of flow.

3.16 Wide protocol: The set of SOPs for collecting data and samples at non-wadeable sites or sites wider than 25 m bankfull width. It is an abbreviated version of the narrow protocol.

3.17 Wide protocol sampling stations: Sampling at each of the eight transects occurs on the side of the stream or river where habitat is also surveyed. At each of the selected transects, a sample is collected from a representative portion (as much as practical) of a littoral zone extending 10 m into the stream/river from the wetted bank and 10 m upstream and downstream, respectively from the transect. The sample should also be collected in an area shallow enough to deploy the kicknet and in an area away from backwaters, eddies, or other edge habitat.

4.0 Personnel Qualifications/Responsibilities

4.1 For collection of the sample, personnel should at a minimum review the Quality Assurance Monitoring Plans for the status and trends monitoring programs (e.g., Ambient Biological Monitoring (Adams 2010), WHM) and the training tutorial Sampling Macroinvertebrates in Wadeable Streams in Washington State (EAP 2010). Alternatively, they may receive formal training from staff who have themselves been formally trained. EAP has been holding formal training sessions for watershed health monitoring during June of each year. These sessions are open to the public.

4.2 For taxonomic analysis of the sample, the personnel should be certified for identification of Western United States taxa to the genus or species level by the Society for Freshwater Science (http://www.nabstcp.com/). Sample identification and enumeration should be to the lowest practical level as outlined in Quality Assurance Monitoring Plan: Ambient Biological Monitoring in Rivers and Streams: Benthic Macroinvertebrates and Periphyton (Adams 2010).

4.3 All staff must comply with the requirements of the EAP Safety Manual (EAP 2017). A full working knowledge of the procedures in Chapter 1 is expected.

4.4 All staff must be familiar and comply with the requirements of Ecology's Chemical Hygiene Plan and Hazardous Materials Management Plan (EAP 2018).

4.5 Field staff must be trained annually to minimize the spread of invasive species. See SOP EAP070 (Parsons et al. 2018).

4.6 Read this standard operating procedure and discuss any questions with your supervisor or task team leader.

4.7 Read the Safety Data Sheets (SDS) for ethanol before beginning the sorting/taxonomic procedures. The SDSs are available in the Ecology Headquarters benthic laboratory and on the Ecology's internal QA website. Use proper protective clothing and equipment as indicated.

4.8 Immediately report to your supervisor any symptoms or reactions that might be related to ethanol exposure.

5.0 Equipment, Reagents, and Supplies

5.1 Wide-mouth polyethylene jar (128 oz or 3.8 L is a recommended size)

5.2 D-Frame kicknet (pre-cleaned of organisms) with these characteristics:

- Frame mouth that is 1 ft (30.5 cm) wide by 1 ft tall
- 500-µm mesh net

5.3 95% ethanol (3:1 ratio by volume for each part sample)

5.4 Label (waterproof) for jar exterior

5.5 Label (waterproof) for jar interior

5.6 Soft-lead pencil

5.7 Clear tape

5.8 Electrical tape

5.9 Pocket knife

5.10 Wading gear (pre-cleaned of organisms)

6.0 Summary of Procedure

6.1 Details of the procedure are determined by the purpose for monitoring (Table 2).

Table 2. Details of benthic sampling based on monitoring purpose.

Monitoring purpose	Status & Trends (narrow protocols)	Status & Trends (wide protocols)	Regulatory
Device	D-frame kicknet	D-frame kicknet	D-frame kicknet, or Surber, or Hess
Mesh	500 µm	500 µm	500 µm
Site length	20 bankfull widths (150–500 m)	20 bankfull widths (150–2000 m)	2 bankfull widths (or more)
Sample area	8 ft^2	8 ft^2	8 ft^2
Station distribution	8 transects, 4 margins + 4 central	8 transects, littoral zone on side of stream where habitat is surveyed	Multiple riffles or 8 transects
Time to suspend	30 seconds	30 seconds	30–120 seconds
Sample	Reach-wide composite	Reach-wide composite	Reach-wide or targeted-riffle composite
Season	July 1–Oct 15	July 1–Oct 15	July 1–Oct 15
Subsample goal	500+ organisms	500+ organisms	500+ organisms
Taxonomic resolution	lowest practical	lowest practical	lowest practical

6.2 Field Sampling

6.2.1 For status and trends monitoring purposes (e.g., WHM), the sampling season extends from July 1 to October 15. For regulatory monitoring purposes, sampling should be conducted during the same period.

6.2.2 Samples should be collected with a device that uses 500 micron mesh, including D-frame kicknets, Surber samplers, or Hess samplers. Samples collected for status and trends monitoring (i.e., WHM, Ambient Stream Biological Monitoring, and Sentinel programs) should use a D-frame kicknet.

6.2.3 Samples should be collected from 8 square feet of stream bottom surface area and composited in the same jar. These samples should come from multiple locations across the study site.

6.2.4 Samples taken for the purpose of monitoring status and trends of stream health (e.g., WHM) should be composited (regardless of habitat) from 8 randomly selected transects dispersed across a site at least 150 m long. See the WHM SOP for Verification and Layout (in production) or Adams (2010) for a description of the site layout procedures.

6.2.5 Samples taken for the purpose of regulatory assessment should be composited from 8 feet of surface area taken from multiple fast-water habitats in the study reach. Aliquots may be from either turbulent (e.g., riffles) or non-turbulent habitat (e.g., glides), as long as flow is sufficient to carry organisms into the net.

6.3 Fast-water Aliquots

6.3.1 Place the sampling device firmly against the stream bottom, facing the flow of water. Eliminate gaps under the frame with the opening of the collection net.

6.3.2 Identify the surface area to be sampled. Gently scrub large substrate particles (larger than 5 cm in diameter) in front of the sampling device to remove any organisms that cling to the substrates; allow the flow to carry them into the mesh.

6.3.3 After each particle in the sample surface area is cleaned, inspect it for any remaining organisms, and then set it outside of the sample area.

6.3.4 Suspend the substrate into the water column from the specified surface area and allow the flow of the water to carry the BMI into the mesh. This may be accomplished by kicking or using a trowel, for a minimum of 30 seconds, to stir up and suspend the substrate in front of the net.

6.4 Slack-water Aliquots

6.4.1 If flow is unable to carry the BMIs into the mesh, visually inspect the stream bottom for any heavy or large organisms, such as mussels and snails, and place them in the sample jar.

6.4.2 Pick up any loose rocks or large substrate particles and scrub them over the net, allowing the organisms to fall into the mesh, and then set aside.

6.4.3 After scrubbing, vigorously kick the remaining finer substrate within your sampled surface area and drag the net repeatedly (for 30–120 seconds) through the disturbed area just above the bottom.

6.4.4 Move the net all the time so the organisms remain trapped in the net and do not escape; continue kicking.

6.4.5 On completion of sampling, remove the net from the water with a quick upward/upstream motion to wash the organisms to the bottom of the net.

6.4.6 Wash the contents of the net down to the bottom for ease of placing the sample aliquot into a jar. Remove relatively large debris, i.e., pieces of wood or rocks, from the net following inspection for attached invertebrates.

6.4.7 Place the aliquots in the jar.

6.4.8 Carefully inspect the mesh itself and remove any remaining organisms that may be stuck to the net. Adding a small amount of ethanol to the jar prior to sample collection helps to reduce the number of organisms sticking to the net and minimizes sample degradation during the sampling event.

6.4.9 Add 95% non-denatured ethanol to equal 2/3 of the volume of the total sample and add a label printed on waterproof paper to the contents of the jar. Sufficient ethanol is necessary to preserve the contents of the jar until taxonomic enumeration.

6.4.10 Existing water in the jar should not dilute the concentration of ethanol below 70%, so if, for example, approximately 100 mL of water is in the jar, add 300 mL of ethanol (ratio is 3:1).

6.4.11 Seal the jar securely, wrap the lid with electrical tape at the junction with the bottle, and affix a second label printed on waterproof paper to the outside of the jar. Contents are now ready to be delivered to the taxonomist for identification and enumeration.

6.4.12 Minimize the risk of spreading invasive species.

6.4.13 Before sampling in another stream or river, treat boots, boats, and nets according to SOP EAP070 Environmental Assessment Procedure 01-15 (Parsons et al. 2018).

7.0 Data Reporting

7.1 At a minimum, a target of 500 organisms should be identified by the lab for each sample. There are occasional situations that lead to fewer than 500 organisms per sample and do not meet this target. In these cases, the lab should identify the entire sample. Acceptance of smaller count (<500 organisms identified) data into our database for assessment purposes will be allowed at Ecology's discretion.

7.2 Each organism should be identified to the "lowest practical level." Lowest practical level is generally to genus or species, unless the specimen is underdeveloped or has been damaged, preventing identification to this level. Adams (2010) outlined the standard taxonomic effort employed by EAP's status and trends monitoring projects (see appendices G & H in Adams [2010]).

7.3 Lab data reported should include at a minimum:

7.3.1 Lab name/taxonomist

7.3.2 Integrated Taxonomic Information System (ITIS) taxa number

7.3.3 Scientific name of taxa

7.3.4 Collection date

7.3.5 Sampling device

7.3.6 Habitat sampling scheme (reach wide or targeted)

7.3.7 Protocol used (narrow or wide)

7.3.8 Number of organisms identified

7.3.9 Density of taxa per meter square

7.3.10 Number of taxa by life stage

7.3.11 Report number of damaged taxa and indicate if unable to identify to lowest level

7.3.12 Report taxa uniqueness for nonspecific identifications (to estimate diversity)

8.0 Records Management

8.1 List every sample on a chain of custody form submitted to the taxonomist. This form should include location, date, and sampling information.

8.2 The taxonomist will submit data to Ecology's EIM database (ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database) or to Puget Sound Stream Benthos (http://pugetsoundstreambenthos.org/default.aspx). Arrangements should be made with King County DNR to give permissions for the taxonomist to submit data to the Puget Sound Stream Benthos website.

9.0 Quality Control and Quality Assurance Section

9.1 Field Quality Assurance

9.1.1 *Visit precision* measures variability in the sampling method and is related to the variability of collecting a composite sample in a reach. Visit precision is estimated by collecting side-by-side duplicate composite samples of the invertebrate communities within the same reach during the same day at 10% of the reaches sampled annually. Visit precision is calculated using the relative standard deviation (RSD) from two replicate composite samples and should be <20% in reference streams when using the taxa richness metric.

9.1.2 For additional information see the Quality Assurance Monitoring Plan for Ambient Biological Monitoring in Rivers and Streams: Benthic Macroinvertebrates and Periphyton, Appendix C (Adams 2010). https://fortress.wa.gov/ecy/publications/summarypages/1003109.html.

9.1.3 Macroinvertebrate Sorting Efficiency

9.1.4 Quality control procedures for initial sample processing and subsampling involves checking *sorting efficiency*. These checks are conducted on 10% of the samples by independent observers who microscopically re-examine the sorted substrate from each sample.

9.1.5 All organisms that were missed are counted. Sorting efficiency is evaluated by applying the following calculation:

$$SE = n_1 / n_2 \times 100$$

where SE is the sorting efficiency expressed as a percentage, n_1 is the total number of specimens in the first sort, and n_2 is the total number of specimens in the first and second sorts combined.

9.1.6 Sorting efficiency is recorded on each bench sheet by the person or lab enumerating the sample. If 95% sorting efficiency is not achieved for a given sample, a failure is recorded on the bench sheet and in the database.

9.1.7 The sorted portion of that sample is then completely resorted before the sorting efficiency test is repeated for that sample.

9.1.8 Sorting efficiency statistics for each technician and for the entire laboratory are reviewed monthly.

9.1.9 Sorting efficiency for each sample in a project is reported to the client in the technical summary document. Technicians who do not maintain the target sorting efficiency are given remedial training, and larger portions of the samples they process are examined for the sorting efficiency test until they are able to maintain the target sorting efficiency.

9.1.10 A second evaluation of the subsampling process is applied to a small proportion of samples processed in each month; typically, one sample per week is subjected to the following test of *precision of the subsampling process*.

9.1.11 The procedure is only applied to samples where the target number of organisms was achieved in less than half of the Caton grids. A sample is randomly selected, and a second subsample is resorted from the unprocessed sample remnant.

9.1.12 A second technician performs this sort. The resulting subsample is identified, and Bray-Curtis similarity index is calculated for the results of both subsamples.

9.1.13 Results that are less than 90% similar would indicate the need for more thorough distribution of sample materials in the subsampling tray or more special attention given to easily missed taxa when sorting (i.e., increased magnification).

9.2 Taxonomic Accuracy and Precision

9.2.1 Taxonomic misidentification results in inadequate biological characterization of a stream. Errors in identification should be less than 5% of the total taxa in the sample. Re-identification of samples is conducted for 10% of the total number of samples in each year.

9.2.2 Secondary identification is conducted by experienced taxonomists in order to maintain confidence in the data set. Difficult taxa should be sent to museum curators whose specialty includes members of the order in question.

9.2.3 Voucher collections are maintained by the Orma J. Smith Museum of Natural History in Caldwell, Idaho. A voucher collection should be prepared from the set of samples for the year and shipped to the address below:

The Orma J. Smith Museum of Natural History
College of Idaho
2112 Cleveland Blvd.
Caldwell, ID 83605-4432

10.0 Safety

10.1 Field Safety

10.1.1 All field staff must comply with the requirements of the EA Safety Manual (EAP 2019).

10.1.2 Sampling will not take place if the stream is not safe to enter.

10.1.3 Fieldwork should be conducted by a team of two people at a minimum to ensure the safety of the sampler.

10.1.4 If a given sampling location within a study site/reach appears unsafe (e.g., too deep, too steep, or covered with loose material, such as a logjam), it may be shifted to allow sampling in a nearby portion of the same or similar habitat conditions as the one avoided.

10.1.5 Proper field gear should be worn, including shoes with adequate lugging, felting, or studs to allow for traction on slick surfaces.

10.2 Chemical Safety

10.2.1 All employees should read this standard operating procedure and discuss any questions with her/his supervisor or task team leader.

10.2.2 Ethanol should be kept in small quantities in a tightly sealed container out of direct sunlight.

10.2.3 Read all relevant Material Safety Data Sheets (MSDS) before beginning this procedure. The MSDS are available in the Ecology benthic laboratory located at the EAP Operations Center and on Ecology's internal Quality Assurance website.

10.2.4 Report to supervisor immediately any symptoms or reactions that might be related to ethanol exposure.

11.0 References

11.1 Adams, K. 2010. Quality Assurance Monitoring Plan: Ambient Biological Monitoring in Rivers and Streams: Benthic Macroinvertebrates and Periphyton. Publication 10-03-109. Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/summarypages/1003109.html.

11.2 EAP [Environmental Assessment Program]. 2010. Sampling Macroinvertebrates in Wadeable Streams in Washington State. Video, 13 min. 26 sec. Washington State Department of Ecology, Olympia. Posted September 22, 2010. https://www.youtube.com/watch?v=IuNn4VqFtJI.

11.3 EAP [Environmental Assessment Program]. 2019. Environmental Assessment Program Safety Manual. Washington State Department of Ecology, Olympia.

11.4 EAP [Environmental Assessment Program]. 2018. Environmental Assessment Program Chemical Hygiene Plan and Hazardous Materials Management Plan. Washington State Department of Ecology, Olympia.

11.5 Hayslip, Gretchen, editor. 2007. Methods for the collection and analysis of benthic macroinvertebrate assemblages in wadeable streams of the Pacific Northwest. Pacific Northwest Aquatic Monitoring Partnership, Cook, Washington. http://www.pnamp.org/document/1359.

11.6 Larson, C., and S. Collyard. 2019. Standard Operating Procedure EAP111, Version 1.14: Periphyton Sampling, Processing, and Identification in Streams and Rivers. Publication 19-03-207. Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/SummaryPages/1903207.html.

11.7 Parsons, J., D. Hallock, K. Seiders, B. Ward, C. Coffin, E. Newell, C. Deligeannis, and K. Welch. 2018. Standard Operating Procedure EAP070, Version 2.2: Minimize the Spread of Invasive Species. Publication 18-03-201. Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/SummaryPages/1803201.html.

DEPARTMENT OF
ECOLOGY
State of Washington

Standard Operating Procedure EAP080, Version 2.1

Continuous Temperature Monitoring of Freshwater Rivers and Streams

April 2018

Publication No. 18-03-205

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The Activity Tracker Code for this document is 10-196.

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o	Central Regional Office, Union Gap	(509) 575-2490
o	Eastern Regional Office, Spokane	(509) 329-3400

Purpose of this document

The Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for Continuous Temperature Monitoring of Freshwater Rivers and Streams.

Version 2.1

Author – William J. Ward
Date –

Reviewers: Dan Sherratt and Dave Hallock

QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date – 10/26/2011

EAP080

APPROVED: 10/26/2011

Recertified: 2/27/15
Updated and Recertified: 3/25/2015
Updated and Recertified: 3/25/2018

Signatures on File

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

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SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
4/12/10		First draft updating and incorporating existing 2003 Continuous Temperature Protocols with the 2008 TMDL SOP.	All	W. Ward
		Draft addressing Dan Sherratt and Dave Hallock comments	All	W. Ward
		Draft addressing James Kardouni comments	All	W. Ward
	1.0	Final draft		
10/26/2011	1.0	Editorial cleanup	All	B. Kammin
3/25/15	2.0	Minor editorial updates and recertified	All	W. Ward
3/25/2015	2.0	QA approval	All	B. Kammin
3/25/2018	2.1	Minor editorial updates	5, 6, & 10	W. Ward
3/25/2018		Recertified	All	T. Gries

Environmental Assessment Program

Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams.

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) details a methods used by the Department of Ecology (Ecology) to collect continuous temperature monitoring data. It may also contain methods that other entities would find useful for their monitoring work.

The scope of the continuous temperature monitoring program currently focuses on summer (June-September) stream temperatures, but will be expanded to year-round as resources allow.

The intended purpose of the continuous temperature monitoring program is to collect diel stream temperature data that may be used to expand the interpretation of a station's ambient monitoring results and to determine its compliance with state water quality standards. The continuous temperature results are assessed using Ecology's policy for identifying impairments under the federal Clean Water Act (Section 303(d)), which requires stream temperature to be measured on consecutive days in order to apply the criterion.

2.0 Applicability

The Standard Operating Procedures (SOP) will be followed for the installation and maintenance of continuous temperature ambient monitoring stations. These protocols reflect in part those outlined in the TFW Stream Temperature Survey Manual (Schuett-Hames et al., 1999), Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section (https://fortress.wa.gov/ecy/publications/summarypages/0303052.html) (Ward, 2003), Measuring Stream Temperature with Digital Data Loggers (USFS, 2005), and Standard Operating Procedures for continuous temperature monitoring of fresh water rivers and streams conducted in a Total Maximum Daily Load (TMDL) project for stream temperature (Bilhimer and Stohr, 2008).

3.0 Definitions

3.1 7DAD*Max*, 7-day average of the daily maximum temperature
3.2 *EAP*, Ecology's Environmental Assessment Program
3.3 *EIM*, Ecology's Environmental Information Management database for environmental data
3.4 *EPA*, US Environmental Protection Agency
3.5 *GIS*, Geographical Information System

3.6 *GPS*, Global Position System
3.7 *NIST*, National Institute of Standards and Technology
3.8 *PST*, Pacific Standard Time
3.9 *PDT*, Pacific Daylight savings Time
3.10 *QAPP*, Quality Assurance Project Plan

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified in EAP's Field Safety Manual (Ecology, 2016), such as First Aid, CPR, and Defensive Driving.

4.2 Typical Job Class performing SOP: Natural Resource Scientist 1/2/3, Environmental Engineer 1/2/3/4/5, Environmental Specialist 1/2/3/4/5, Administrative Intern 1/2/3.

5.0 Equipment, Reagents, and Supplies

5.1 *General Field Equipment:*

5.1.1 See Attachment A for a list of the typical equipment and supplies that may be used to deploy temperature loggers.

5.2 *Specialized Field Equipment*[1].

5.2.1 Rebar Pounder (see design specifications in Attachment B)
5.2.2 PVC Shade Device (see design specifications in Attachment B)
5.2.3 Onset Tidbit© v2 Temp Logger, (#UTBI-001), +/- 0.2°C
5.2.4 Onset Hobo© Water Temp Pro v2, (#U22-001), -20°C to +50°C, +/- 0.2C
5.2.5 Onset StowAway Tidbits©, -5°C to +37°C model, +/- 0.2°C (no longer available)
5.2.6 Onset StowAway Tidbits©, -20°C to +50°C model, +/- 0.4°C (no longer available)
5.2.7 Spirit-filled thermometer or long-line thermistor with an accuracy of +/-0.2ºC
5.2.8 PC communication cables or optic shuttles specific for each instrument type

6.0 Summary of Procedure

6.1 *Pre-Deployment Run Preparation*

6.1.1 Assemble equipment. Use a checklist to ensure that all of the necessary preparation tasks, equipment, supplies, and safety gear are completed (See Attachment A for the Continuous Temperature Sampling Checklist).

6.1.2 Calibration Checks. All temperature loggers must be calibration checked both pre- and post-study to document instrument accuracy specifications.

[1] The specialized equipment listed does not represent an endorsement by Ecology. Other equipment may be used if it meets the project QA/QC requirements for accuracy and reliability.

6.1.2.1 The calibration checks are done using test-bath temperatures that bracket the intended monitoring range (near 20 and 0ºC). The bath temperatures must be verified with a NIST traceable or calibrated reference thermistor, thermocouple, or thermometer (NIST thermometer)[2]. *Note: This procedure is also used to determine correction factors (if required) for the field thermistor and thermometer measurements.*

6.1.2.2 A calibration-check test-bath method that can maintain a constant temperature is essential to obtain excellent test results. The one described below has worked very well for us. In addition, we have also had great success utilizing a 20-gallon aquarium with a two-bay Hatch Box design and a recirculation pump.

6.1.2.3 Place one open cooler half full of water overnight in a walk-in cooler or room that has a constant air temperature near 0ºC and two coolers (setup similarly) in a room with a temperature near 20ºC. *Note: Test baths done in rooms that have the target temperature ensure stable bath temperatures and the overall quality of the test.*

6.1.2.4 Program the temperature loggers for the test start time and up to a five-minute logging interval (a one- to two-minute interval is preferred). String the loggers together to facilitate their transfer into each water bath.

6.1.2.5 Put the programmed temperature loggers in the near 0 ºC test bath overnight.

6.1.2.6 Twenty minutes before the start of the test, place the NIST thermometer in the water bath oriented to easily view the scale increments. Then, gently stir the water to help ensure a uniform water temperature.

6.1.2.7 Gently stir the water bath again a few minutes before test and just after reading and recording the NIST thermometer temperature.

6.1.2.8 Record 10 relatively constant and consecutive NIST thermometer comparison measurements on the Calibration Check Form (See Attachment C1 for blank form and Attachment C2 for an example of a used form) when the logger records the water bath temperature. If the logger has a two-minute sampling interval, it may take twenty minutes to obtain the 10 NIST measurements.

6.1.2.9 Dewater and transfer the strings of temperature loggers, thermometers, and thermistor probes to one of the room temperature (near 20ºC) water baths. Gently stir the transition water bath and allow the loggers to soak there for several minutes. Then transfer them to the other room temperature water bath for a few minute soak. *Note: this two-step process helps minimize the temperature changes in the final water bath.*

6.1.2.10 Repeat the process noted above to obtain ten relatively constant NIST thermometer comparison measurements the final water bath.

[2] All NIST reference thermistors, thermocouples, and thermometers, used for this test, need to have an annual three-point (near 0, 10, 20°C) calibration check against the Lacey Operations Center NIST or be sent in for an Accredited Calibration Certificate.

6.1.2.11 Download the temperature loggers as soon as possible after the test to shut them off and minimize battery life impacts.

6.1.2.12 Calculate the mean absolute value of the difference between the temperature logger measurements and the NIST thermometer for each water bath with spreadsheet software or by hand. Water-temperature loggers that have a mean difference greater than 0.2°C in one or both water baths have failed the test and cannot be used unless they pass a follow-up test.

6.1.3 Launch temperature loggers. Adjust the computer clock settings to Pacific Standard Time (PST) and also make sure that it will not automatically adjust to Daylight Savings Time (DST). Then adjust the clock time to the atomic clock (e.g., https://www.time.gov). These necessary steps ensure that all the data will be in PST year-round and that all loggers will monitor at exactly the same time.

6.1.4 Program the temperature loggers for a delayed launch that starts at least one hour before the first planned deployment time of the season and at a 30- (or 15-) minute monitoring interval (on the hour and half hour).

6.2 *Stream temperature logger site selection methods*

6.2.1 Deploy temperature loggers in the active and well-mixed part of the stream (or as close as possible to it) to ensure representative temperatures (based on flow volume) are recorded throughout the entire deployment period. The preferred location in these areas is against an instream landmark or other submerged structure that can help hide the logger and minimize the loss to vandalism or high-flow events and also where direct sunlight may be avoided. *Note: avoid deployment locations near popular swimming holes and fishing access points where there is a much higher chance of logger discovery and loss to vandalism.*

6.2.2 Ideal deployment locations are typically at the upstream outside edge or downstream inside edge of the river bends or in the middle of riffles of low flow and wadeable streams (see Figure 1 below).

6.2.3 Temperature logger locations should never be in eddies or pools or locations where these conditions may develop during low flows. In addition, locations just downstream of tributaries, stream-side wetland areas, point-source discharges, and potential hillside groundwater seeps should also be avoided because these conditions may seasonally bias the recorded temperatures. Consider locations either on the opposite side of the stream or upstream of these conditions.

6.2.4 Deployment depth locations should not be on the stream bottom where the loggers may record groundwater inflow, but deep enough that they do not become exposed to air during a low-flow period. The basic deployment location depth goal is six (6) inches (<0.5 ft) off the stream bottom in smaller streams and wadeable locations and, if

possible, at about one half of the water depth in the large streams (Schuett-Hames et al., 1999). *Note: Locating temperature loggers near the stream bottom may be necessary in small streams to ensure that the logger remains submerged during low flows.*

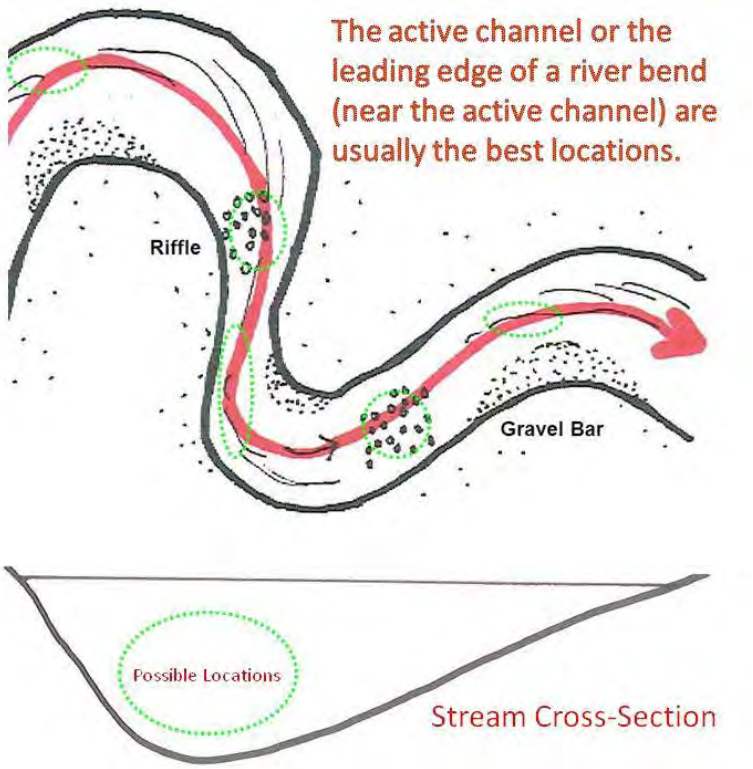


Figure 1. Potential Temperature Logger Deployment Locations

6.2.5 The representativeness of the temperature logger deployment location should be verified by measuring several points in and near the vicinity of the logger and the temperature of the well-mixed part of the stream. If the stream can be easily waded, then a simple cross sectional temperature survey could also be done. Review the survey results, and consider another deployment location, if necessary, to help ensure that the logger will record representative results.

6.3 *Stream temperature logger deployment options*

6.3.1 Record the water-temperature-logger serial numbers on the survey form. (See Attachment D1 for blank form and Attachment D2 for an example).

6.3.2 Pre-assemble the water-temperature logger with a camouflage-painted PVC shade device cover (See fig.2 below and design in Attachment B) that helps hide the logger and prevent any bias from indirect solar radiation.

6.3.3 Avoid low-flow and direct-sunlight temperature logger deployment locations. If the temperature logger needs to be deployed in these locations, then a white PVC shade cover must be used to prevent any solar-biased temperature results (USFS, 2005).

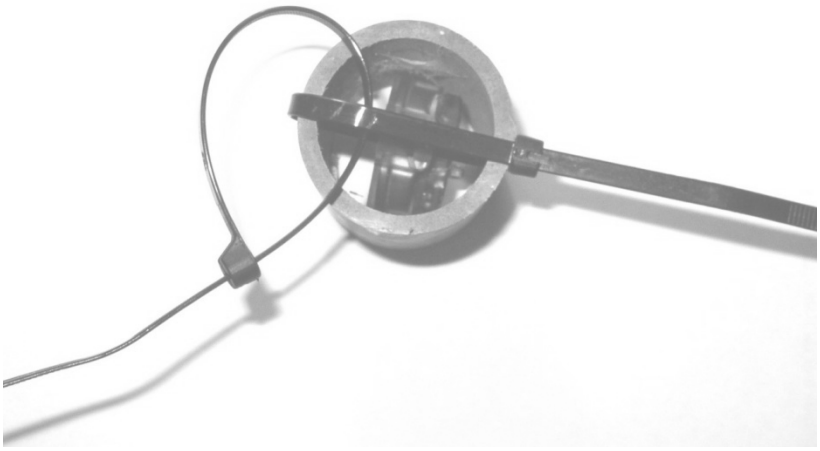


Figure 2. Assembled Temperature Logger and PVC Cover

6.3.4 Place a thermometer or thermistor as close as possible to the identified deployment location and record the measurement after the logger has been deployed. Consider one the use of one of the following deployment methods:

6.3.5 Rebar Deployments. This option is typically used in small- and medium-sized streams to create a suitable temperature logger attachment location in or as near as possible to the active part of the stream. In most cases, this method is best used against the active-part-of-the-stream side of a large landmark rock or log.

6.3.6 Choose a two-to-three-foot length of rebar that can be driven deep enough into the streambed to stay in place during high streamflow events and provide an attachment location that is six inches to one-half of the expected total stream depth during the seasonal low-flow period.

6.3.7 Insert the rebar into the open end of the rebar pounder and use a 4# engineering hammer (or an alternative) to hammer the rebar into the streambed by striking the heavy steel head of the pounder. Hammer all but eight inches of the rebar into the streambed[3].

6.3.8 Leave the rebar pounder on the rebar, and document the water-temperature logger location with photographs.

6.3.9 Remove the rebar pounder and attach the temperature logger assembly to the rebar about 6 inches off the bottom (or mid-water depth) with a cable tie. *Note: In fast-flowing locations an additional cable tie should be attached to the rebar just above the temperature logger assembly attachment point to prevent its loss should the second cable tie loosen on the rebar (or attach the assembly using a small gage wire).*

[3] If a mid-stream depth is desired, then leave more rebar exposed.

6.3.10 Large Rock, Tree Root, or woody debris deployments. This option uses existing instream structures such as large rocks or boulders, woody debris, or roots that are located in or extend into the desired location in the active part of the stream. Attach the water-temperature logger to these structures with cable ties or wire, or to cable or heavy wire that may be used to create the location near the base of these structures.

6.3.11 Photographs of the location using a visual marker (such as the rebar pounder, hammer handle, nearby flagging, or pointing with a finger) are essential to help relocate loggers installed by this method.

6.3.12 Anchor deployments. This option can be used where stable large woody debris is not available or where near-surface bedrock or other consolidated sediments prohibit rebar use. The basic approach is to attach the water-temperature-logger assembly to a heavy weight (i.e., rock, brick, concrete block, wadded up piece of chain, or rebar) that may be set in the desired water-temperature-logger location.

6.3.13 It is also advisable that the heavy object be cabled or chained to something on the nearest bank (or other stable instream structure) to prevent loss during a possible high flow event (*Note: rusty chain use may deter logger loss to vandalism more than a shiny cable*). The heavy weight may be encouraged into the desired deployment location using a stick or boat hook (or similar device). *Note: this is not considered a viable option in locations with a significant groundwater inflow.*

6.3.14 Streamside or pile deployments. A long protective PVC or metal pipe housing may be used to establish a deployment location along deep rivers or at wildly fluctuating streams. The pipe can be fastened to a piling, pier, or anchored to large rocks and trees on the stream bank with the lower end extended into the active part of the stream. The upper end of the pipe should be secured with a threaded or locking cap to discourage casual vandalism. The lower end of the pipe should be perforated to allow streamflow around the logger and also be blocked with a diagonal bolt (or similar device) to prevent logger loss out that end. The logger in a protective cover needs to be kept at the lower pipe end with a weighted cord, length of PVC pipe, or any other method that also allows retrievals and deployments to be made through the upper capped end (see Figure 3 example below).

6.3.15 Buoy or dock deployments. This option may be useful where no pilings are available or where a string of thermistors is desired to monitor stratified conditions. One issue with this type of deployment option is the high vandalism potential. This potential increases dramatically when establishing a new floating structure, so it is best to use existing structures if permission can be obtained.

6.3.16 Aquatic Invasive Species. Clean all field equipment that contacted water following procedures in Parsons, et al., (EAP070) and Ward, et al., (EAP071).

Figure 3. Deployment method using a length of PVC pipe

6.4 *Air temperature logger deployment methods*

6.4.1 Use temperature loggers that can record the maximum expected temperature for the deployment location. If you are locating loggers in an area where the summer air temperatures can exceed 100ºF (37ºC), then use an air thermistor that has the higher temperature range setting.

6.4.2 Record the air-temperature-logger serial numbers on the survey form.

6.4.3 Pre-assemble the air-temperature logger with a PVC shade device cover. The pre-assembly should be done before beginning the process to install the logger (See Figure 2 above).

6.4.4 These temperature loggers need to be located within the same microclimate of the water logger. Ideal locations are one to three meters into the riparian zone (Schuett-Hames et al., 1999) and about four to eight feet above the ground (USFS, 2005). Avoid placing them in areas that are not representative of streamside conditions at your location or where they will be severely impacted from solar radiation. The north side of a shrub or tree trunk should work well in most locations, especially those with limited streamside vegetation choices[4].

6.4.5 One air-temperature logger should be deployed near every water-temperature-logger location. However, if the vegetation and streamside conditions are similar, then one air-temperature logger may be used to cover several nearby water-temperature loggers. *Note: Air loggers deployed for Total Maximum Daily Load studies (*Bilhimer and Stohr, 2008) *must be within approximately 0.5 mile of the most distant water logger.*

[4] Do not use weeping willows, as they can secrete fluid during hot weather and create error in the air temperature results.

6.5 *Documentation Procedures*

6.5.1 Record all the field data and deployment location information on the Continuous Temperature Station Survey Form (See example in Attachment D-1) or by a similar method. Be sure to note the station number and name, temperature logger ID numbers, and air- and water-temperature measurements, and any other useful narrative observations, especially those useful for finding the location (e.g. – "upstream of largest boulder on right bank").

6.5.2 Also, record all observation times in PST (or note when they are DST, so they may be converted to PST later), and use a timepiece that has been calibrated to the atomic clock (or use the cell-phone time).

6.5.3 Further, draw a map and describe the general area, noting the temperature-logger locations, logger installation technique, and any landmark references such as a unique rock, log, root, flagging, or tree (See example in Attachment D-2). *Note: if possible, draw the map with north being toward the page top or denote the direction of north on the drawing*.

6.5.4 Take upstream and downstream photographs of the water-temperature-logger location that includes useful and easily identifiable landmark tree(s), flagging, or boulder. It is also important that the photographs include some visual marker (such as the rebar pounder, hammer handle, or pointing with a finger) to use along with the information on the survey form to help relocate and retrieve it in the future (See Fig 4 below).

6.5.5 Measure and record: the total water depth (water depth), distance from the logger to the streambed (height), distance from water surface to the logger (deployment depth), and the stream temperature on the survey form.

Figure 4. Photo showing the water-temperature-logger deployment location.

6.5.6 Record the temperature logger GPS coordinate location (or note the logger location on an accurate map and determine the coordinates later).

6.6 *Mid-deployment checks*

6.6.1 If possible, periodically visit the temperature-logger location during the deployment period to get mid-deployment temperature-check data and to make sure that it remains submerged and in a representative location. If the logger needs to be moved or is missing and needs to be replaced, then take the appropriate action and enter new remarks and notes on the survey form. *Note: consider taking replacement loggers and deployment equipment along when doing these checks to help expedite to process.*

6.7 *Retrieval Procedures*

6.7.1 Measure and record the stream temperature and surface depth of the water-temperature logger (retrieval depth), and record the results on the field form. Also, measure and record the distance from the streambed up to the logger, and note any differences between the result and what was recorded during deployment.

6.7.2 If the stream may be easily waded, then also consider doing a cross-sectional survey of the stream temperature. The survey results may help determine if the stream-temperature logger measured representative temperatures and show any cross-sectional temperature differences.

6.7.3 Remove all rebar, cement blocks, or other deployed equipment at the end of the study.

6.7.4 Aquatic Invasive Species. Clean all field equipment that contacted water following the procedures in Hallock, et al., 2010 (EAP070).

6.8 *Downloading Procedures*

6.8.1 Gently clean the temperature loggers with a soft wet cloth to remove any biofouling or sediment that may affect its ability to communicate optically during the downloading process. The preferred method is to use water and a soft cloth or soft-bristled brush. Note: avoid using any method that can scratch the logger optic communication area.

6.8.2 Set the computer clock to atomic clock time for the Pacific Time Zone before downloading any temperature loggers. Then follow the manufacturer's downloading procedures, and save the data in text files that may be opened in Excel or another type of spreadsheet software.

7.0 Records Management

7.1 Continuous Temperature Survey Forms are used to document the deployment and retrieval information for a station. Filled-out field forms are organized and stored in binders to use for long-term recordkeeping.

7.2 Use Ecology's FMU Access® Data Logger Database developed by Dave Hallock, to manage, store, export, and upload data summaries to Ecology's Environmental Information Management System (EIM). *Note: the database is available to interested agencies and organizations upon request.*

8. 0 Quality Control and Quality Assurance Section

8.1 *Temperature Logger Post-Deployment Accuracy Check.* Verify the accuracy of the retrieved temperature loggers by conducting a post-deployment calibration check (Refer to Calibration Check procedure, 6.1.2, above).

8.1.1 If the mean absolute value of the temperature difference for a logger in each water bath, compared against the NIST certified thermometer, is equal to or less than the manufacturer stated accuracy (i.e. usually ±0.2°C for a water-temperature logger or ±0.4°C for an air temperature logger), then a second check should be performed.

8.1.2 If a second calibration check result confirms a consistent bias above the stated accuracy, then the raw data should be adjusted by the mean difference of the pre- and post-calibration check results to correct for the logger bias (Schuett-Hames et al., 1999).

8.2 *Data Proofing Procedures.* Data from temperature loggers that met the calibration-check accuracy requirement are proofed and QC checked using *Ecology's FMU Access® Data* Logger Database. This database allows the information recorded on the Continuous Temperature Data Report Form (deployment/retrieval times and temperatures) and available climatic and flow data to be used to proof, edit, run automated QC checks, store, summarize, report, and export the finalized data (to text files, Microsoft® Excel, or to Ecology's Environmental Information Management (EIM) system Excel template).

8.2.1 *Note: all identified anomalous data may be omitted from the data set, provided that the justification remark(s) is inserted on the station Continuous Temperature Station Survey Form and in the electronic record for the data. Similarly, all explainable climatic caused data spikes (i.e. - rain events) should also be noted in these same two records.*

8.2.2 All data will be assigned a measurement accuracy value based on the pre- and post-deployment calibration check results.

9.0 Safety

Safety is the primary concern when deploying temperature loggers. Proper fieldwork safety procedures are outlined in the Environmental Assessment Program Safety Manual (Ecology, 2016). A minimum of two people are required when streams are waded. One can deploy the stream temperature loggers, and the other can assist from shore. If streamside hazards such as high flow, weather, and debris make the temperature logger deployment dangerous, then an alternate location, different deployment method, or different deployment time should be considered.

9.1 Material Safety Data Sheets (MSDSs) for all chemicals used in EAP field sampling or analytical procedures can be found at the following SharePoint link: http://teams/sites/EAP/QualityAssurance/ChemicalSafetyDataSheets/Forms/AllItems.aspx.

Also, binders containing MSDSs can be found in all field vehicles, vessels, Ecology buildings, or other locations where potentially hazardous chemicals may be handled. EAP staff following Ecology SOPs are required to familiarize themselves with these MSDSs and take the appropriate safety measures for these chemicals.

10.0 References

10.1. Bilhimer, D. and Stohr, A., 2008. Standard Operating Procedures for Continuous Temperature Monitoring of Freshwater Rivers and Streams Conducted in a Total Maximum Daily Load (TMDL) Project for Stream Temperature, Version 2.2. Washington State Department of Ecology, SOP Number EAP044. ecology.wa.gov/Quality.

10.2. Dunham J., G. Chandler, B. Rieman, and D. Martin, 2005. Measuring Stream Temperature with Digital Data Loggers: A User's Guide. U.S.D.A. Forest Service Rocky Mountain Research Station. General Technical Report RMRS-GTR-150WWW. 16 p.

10.3. Environmental Assessment Program, 2016. Environmental Assessment Program Safety Manual.

10.4. Hallock, D. 2010. Standard Operating Procedures to Minimize the Spread of Invasive Species from Areas of Extreme Concern. EAP070. https://fortress.wa.gov/ecy/publications/SummaryPages/1803201.html.

10.5. Schuett-Hames, D., A. E. Pleus, E. Rashin, and J. Matthews, 1999. TFW Monitoring Program Method Manual for the Stream Temperature Survey. Washington State Department of Natural Resources and NW Indian Fisheries Commission publication #TFW-AM9-99-005.

10.6. Ward, W., 2003. Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section. Washington State Department of Ecology, Olympia, WA. https://fortress.wa.gov/ecy/publications/summarypages/0303052.html.

Attachment A

This Attachment contains the checklist used to prepare for temperature logger deployments.

Continuous Temperature Sampling Checklist

Pre-Deployment Preparation

_____ Determine Number of Stations
_____ Determine Deployment Equipment Needs
_____ Obtain or Make Deployment Equipment
_____ Check Calibration of:
_____ • Temperature Loggers
_____ • Thermometer
_____ • Thermistor
_____ Plan Deployment Schedule
_____ Schedule Field Assistance
_____ Program Temperature Loggers
_____ Make Motel Reservations
_____ Fill out Field Work Plan and Contact Person Designation Form
_____ Gas Van

Van/Safety Equipment

_____ Tire Chains
_____ Yellow Hazard Beacon
_____ Flashlight
_____ Tool Chest
_____ Jumper Cables
_____ Flares/Reflectors
_____ First Aid Kit
_____ Foil Blanket
_____ Orange Vests
_____ 2 Gallons Drinking Water
_____ Hand Towels
_____
_____

Sampling Equipment and Supplies

_____ Programmed Temperature Loggers
_____ Continuous Temperature Survey Forms
_____ Thermometer
_____ Thermistor
_____ Compass
_____ Maps
_____ Watch
_____ Camouflaged PVC Pipe
_____ Cable Ties
_____ Rebar Pounder
_____ 3/8 inch x 2 – 3 Ft. Rebar Pieces
_____ 4# Hammer
_____ Several lengths of Chain or cable
_____ Pyramid Blocks
_____ Small Wire Cutters
_____ 6’ Pole W/Hook
_____ Knife
_____ Hand Trimmer
_____ Machete
_____ Survey Flagging
_____ Digital Camera
_____ Duct Tape

Personal Gear

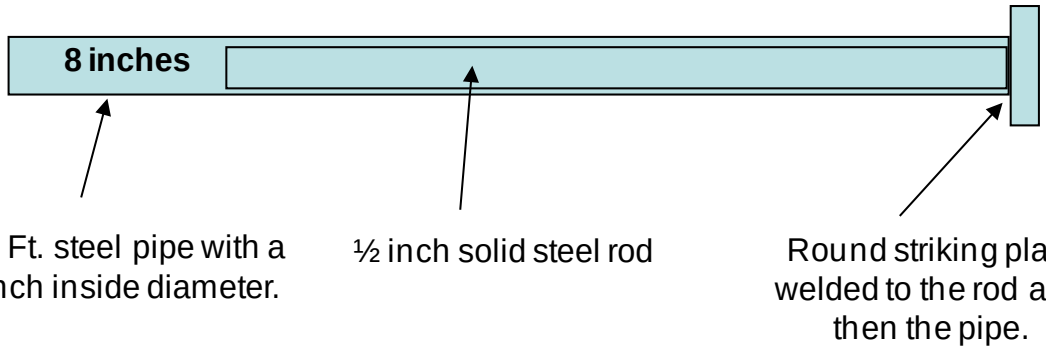
_____ Rain Gear
_____ Knee Boots
_____ Waders
_____ Watch
_____ Gloves
_____ Extra Clothing
_____ Hat
_____
_____
_____

Attachment B

This attachment contains the design specifications for the equipment that is made “in-house.” These designs have been created to meet specific needs for past field studies and can be modified as needed. The equipment to make these includes: power saws, drill press, and other hand tools. The rebar pounder is manufactured by a contracted welder.

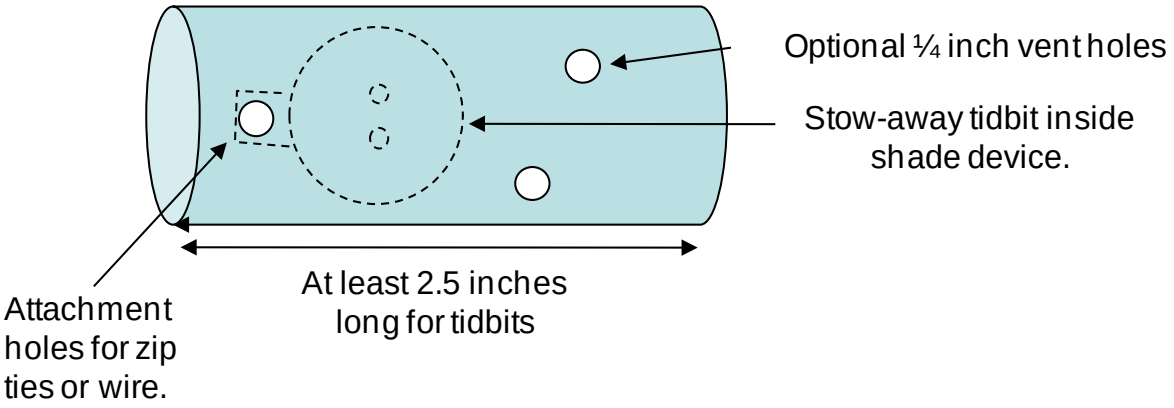
Rebar Pounder Design

Used to drive #4 (½ inch) rebar sections (2-4ft in length) into the streambed to establish an instream thermistor attachment location. The rebar is inserted in the hollow end and a heavy hammer is used to pound on the striking plate.

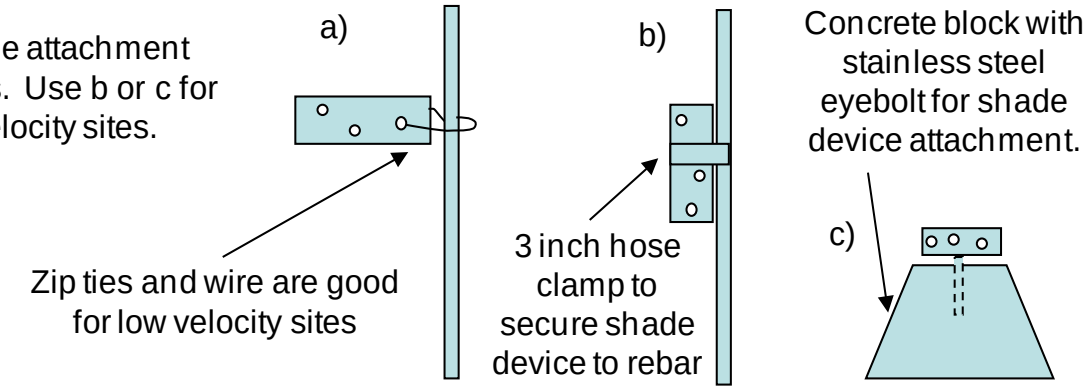


PVC Shade Device

This is typically made from 1.5 inch (inside diameter) PVC pipe. It should completely cover the thermistor to prevent solar radiation absorption. This design may be used for both instream and air thermistors.



Possible attachment options. Use b or c for high velocity sites.



Attachment C.

C-1. Temperature Logger Calibration Check Form – Blank Form.

C-2. Temperature Logger Calibration Check Form – Filled Out Form.

C-1. Temperature Logger Calibration Check Form – Blank Form.

Date: _____

Temperature Logger Calibration Check Form

Technicians:

_____

	Time	NIST SN-	Thermistor #	Red Liquid SN-	SN-	SN-
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

	Time	NIST SN-	Thermistor #	Red Liquid SN-	SN-	SN-
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

C-2. Temperature Logger Calibration Check Form - Filled Out Form.

Date: 5/4/09

Temperature Logger Calibration Check Form

Technicians: WKRD

	Time	NIST SN- 70409	Thermistor # SLLT-1	Red Liquid SN- 8N935	Red Liquid SN- 8N911	SN-
1	08:30	4.3	4.2	4.3	4.3	
2	:32	4.3	4.2	4.3	4.3	
3	:34	4.3	4.2	4.3	4.3	
4	:36	4.3	4.2	4.3	4.3	
5	:38	4.3	4.2	4.3	4.3	
6	:40	4.3	4.2	4.3	4.3	
7	:42	4.3	4.2	4.3	4.3	
8	:44	4.3	4.2	4.3	4.3	
9	:46	4.3	4.2	4.3	4.3	
10	:48	4.3	4.2	4.3	4.3	
11	:50	4.3	4.2	4.3	4.3	
12	:52					
13						
14						
15						

	Time	NIST SN- 70409	Thermistor # SLLT-1	Red Liquid SN- 8N935	Red Liquid SN- 8N911	SN-
1	09:14	21.0	21.0	21.0	20.9	
2	09:16	21.05	21.0	21.1	20.9	
3	:18	21.1	21.1	21.1	21.0	
4	:20	21.1	21.1	21.1	21.0	
5	:22	21.1	21.1	21.1	21.0	
6	:24	21.1	21.1	21.1	21.0	
7	:26	21.1	21.1	21.1	21.0	
8	:28	21.1	21.1	21.1	21.0	
9	:30	21.1	21.1	21.1	21.0	
10	:32	21.1	21.1	21.1	21.0	
11	:34	21.1	21.1	21.1	21.0	
12	:36	21.1	21.1	21.1	21.1	
13						
14						
15						

GOOD

Attachment D

This section contains a blank and filled out example of the Continuous Temperature Survey Form that should be used for Ambient Monitoring - continuous temperature logger deployments. The form must be printed on waterproof paper and all completed ones need to be organized and stored in binders for archival purposes.

D-1. Blank Survey Form

D-2. Filled-out Survey Form

D-1. Blank Survey Form

Continuous Temperature Survey Form

Station #: _____ **Station Name:** _____ **Samplers:** _____

Interval Frequency 00:30

Water Temperature Logger

I.D. # _____

Water Depth _____ **ft** **Deployment Depth** _____ **ft**

Height (Abv Bottom) _____ **ft** **Retrieval Depth** _____ **ft**

Air Temperature Logger

I.D. # _____

Height (Abv Stream) _____ **ft**

Date	Time	Water Temp	Air Temp	Weather/ Comments

Air Temperature Logger Location:

Water Temperature Logger Location:

D-2. Filled-out Survey Form

Continuous Temperature Survey Form

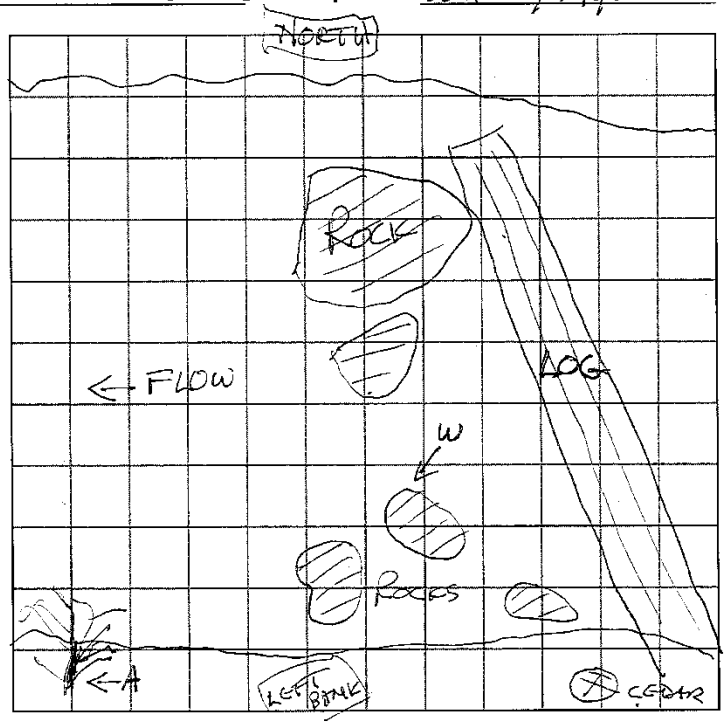
Station #: 08C110 **Station Name:** CEDAR NR LANDSBURG **Samplers:** WARD/MYERS

Interval Frequency 00:30

Water Temperature Logger
I.D. # 457373
Water Depth 1.5 ft **Deployment Depth** 1.0 ft
Height (Abv Bottom) 0.5 ft **Retrieval Depth** 0.7 ft

Air Temperature Logger
I.D. # 457375
Height (Abv Stream) 6 ft

Date	Time	Water Temp	Air Temp	Weather/ Comments
6/25	11:40	11.8	12.5	OVERCAST
9/24	10:20	12.3		PARTLY SUNNY



Air Temperature Logger Location:
ON VINE MAPLE N 3.5' OFF GROUND, TREE IS LOCATED N 15' DOWNSTREAM OF WATER LOGGER LOCATION (ORANGE FLAGGING). LOGGER IS ON BANK SIDE OF TREE.

Water Temperature Logger Location: ON REBAR INSTALLED ON THE STREAM/UPSTREAM CORNER OF THE FIRST OF TWO LARGE ROCKS (>3.5' DIAMETER) BELOW LARGE LOG (N 9' FROM LOG). NEAR LEFT BANK.

DEPARTMENT OF ECOLOGY
State of Washington

Standard Operating Procedure EAP129, Version 1.0

Short-term Continuous Data Collection with a Multiparameter Sonde, Part 1: Field Procedures

December 2019
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[Approved 2019]

Purpose of this Document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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SIGNATURES AVAILABLE UPON REQUEST

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Revision History	Summary of changes	Sections	Reviser(s)
5/30/2018	1.0	Original draft completed	All	Nuri Mathieu
5/31/2018	1.0	Reviewed and contributed	All	Tighe Stuart; Eiko Urmos-Berry

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for short-term (less than 6 months) continuous data collection using a deployed (unattended) multiparameter sonde. This SOP is intended for a variety of types of water quality studies, including Total Maximum Daily Load (TMDL), effectiveness monitoring, toxic loading, and other focused water quality studies.

1.2 Deploying sondes in the aquatic environment requires careful planning, routine dedicated maintenance, and thorough review of data record for usability and quality.

1.3 For long-term (greater than 6 months) or high-flow-conditions sonde deployment, consider requesting the Freshwater Monitoring Unit's assistance with installing a long-term deployment station.

1.4 For deployment in an estuarine or marine environment, consider requesting the Marine Monitoring Unit's assistance with selecting appropriate equipment and installing a deployment station.

1.5 Several of the methods and information presented in this SOP were taken or adapted from the USGS techniques and methods 1D-3: Guidelines and Standard Procedures for Continuous Water Quality Monitors: Station Operation, Record Computation, and Data Reporting (Wagner et al., 2006).

2.0 Applicability

2.1 This document should be used for deploying sondes in freshwater rivers, streams, and other waterbodies for project-level water quality assessments of limited duration.

3.0 Definitions

3.1 ABS — Acrylonitrile butadiene styrene, a type of plastic.

3.2 Fouling — the accumulation of unwanted material on solid surfaces to the detriment of function. The fouling materials can consist of either living organisms (biofouling) or a non-living substance (inorganic and/or organic).

3.3 Sonde — an instrument probe that transmits or logs information about its surroundings underground, under water, in the atmosphere, etc.

3.4 Thalweg — the line that connects the lowest points in a valley or river channel and, thus, the line of fastest flow or deepest water along a river's course.

4.0 Personnel Qualifications/Responsibilities

4.1 In general, field staff should be trained in safety procedures for work in streams. Ecology field staff must undergo annual training and certification for safety, invasive species decontamination, and heat stress.

4.2 Job classifications that typically perform this work: Natural Resource Scientist 1/2/3, Environmental Engineer 1/2/3, Environmental Specialist 1/2/3/4/5, Hydrogeologist 1/2/3/4.

5.0 Equipment, Reagents, and Supplies

5.1 Multiparameter sonde — Currently, EAP staff conducting water quality studies use three different types of sondes:

5.1.1 Hydrolab® Series 4 and 5 Datasondes and Minisondes.

5.1.2 Hydrolab® HL4/HL7 Multiparameter Sonde.

5.1.3 YSI® EXO 1/2/3 Multiparameter sonde.

5.2 Short-term sonde deployment tube. Schedule 40 or 80 PVC with holes drilled at one end for flow (Figure 2).

5.3 ABS bottom plates with large u-bolts and holes for staking (Figure 2).

5.4 Rebar or construction stakes 24 to 48 inches long.

5.5 Galvanized or stainless steel hardware (bolts, nuts, pipe clamps, stops/ferrules).

5.6 ¼-inch (or larger) cable or chain in various lengths (optional).

5.7 Life Vest/Personal floatation device (PFD).

5.8 Hip or Chest Waders.

5.9 Padlocks (optional).

5.10 Galvanized or stainless steel strut channel (optional).

5.11 Heavy duty deployment tube. Galvanized metal pipe with holes drilled at one end for flow (optional).

5.12 Concrete blocks, such as cinder or pier blocks (optional).

5.13 12V Hydrolab external battery in carrying case (if using).

5.14 Ammo box for external battery (if using).

5.15 Hydrolab underwater connection cable (if using external battery).

5.16 “Split” cable for connecting underwater connection cable to external battery (if using).

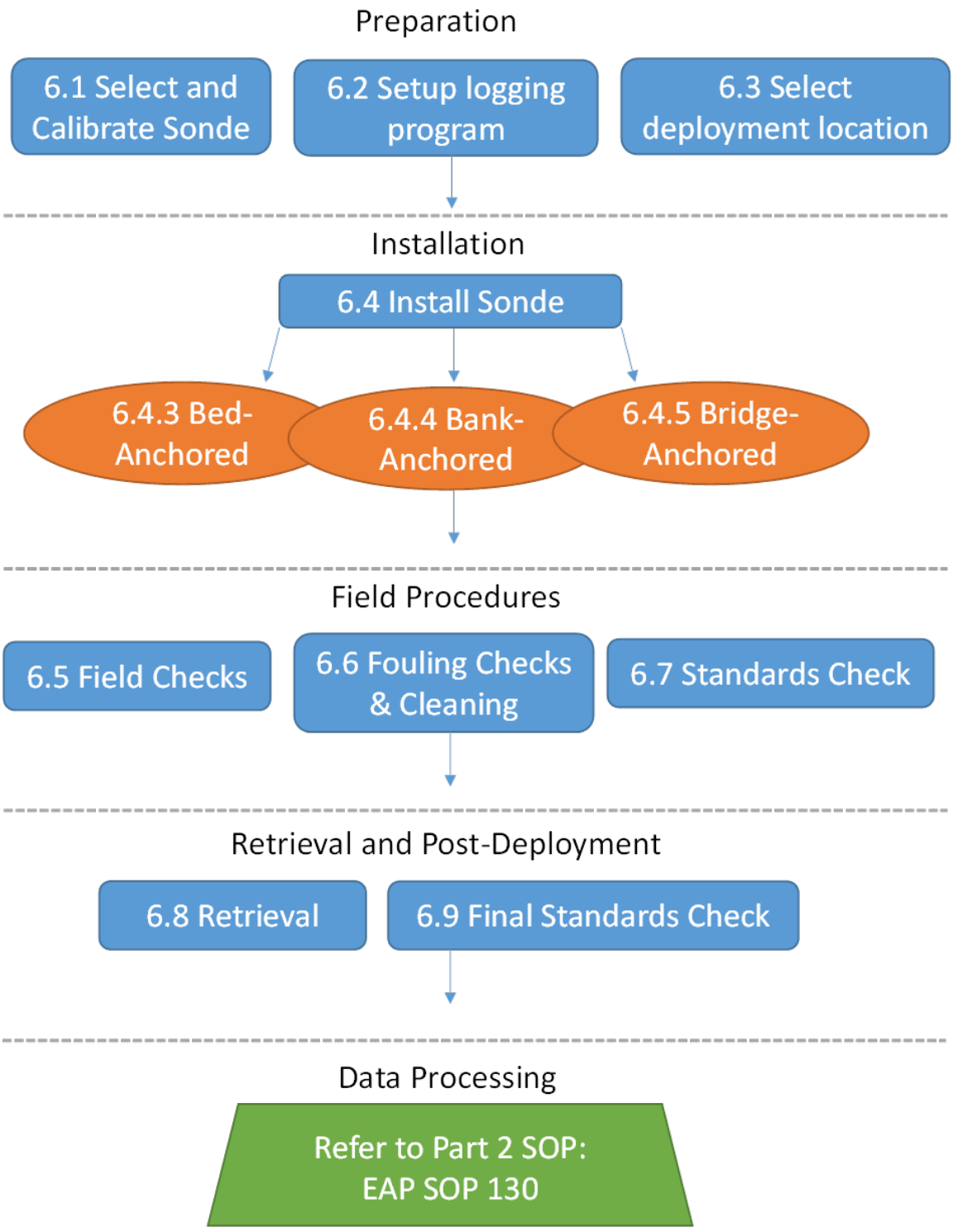

Figure 1. Summary of SOP for Field Procedures

6.0 Summary of Procedure

6.1 Pre-deployment sonde maintenance, calibration, and selection. In general, follow maintenance and calibration procedures outlined in EAP SOP 033 (Anderson, 2016).

6.1.1 Check sonde repair and maintenance history located on the EAP SharePoint site in the "Sonde repair status" spreadsheet in the Hydrolab Reservations SharePoint library. Choose a sonde/s with sensors that are in good repair and equipped with the parameters necessary to meet project objectives.

6.1.2 Designate which sondes will be used for deployment and which will be used to collect instantaneous field checks. For pH and DO in particular, assign sondes with newer sensors to locations that are critical to the study.

6.1.3 For pH, the Hydrolab sondes employ a reference probe that is installed in a separate port from the glass-bulb sensor. These reference probes require dedicated maintenance including routinely replacing the Teflon screw-on junction and replenishing reference electrolyte. For deployments of longer than 5 days, or deployments in low-ionic-strength waters, additional salt crystal pellets can be added to the electrolyte solution.

6.1.4 After replacing electrolyte solution or Teflon junction, it is very important to soak the sensors in tap or clean ambient water BEFORE calibrating the sonde. Ideally, the sonde should be set to log once every 15 minutes over the course of an overnight soak. Alternatively, if short on time or you forget to log overnight, then the sonde should be powered on for at least 15 minutes consecutively in the soaking solution before calibration.

6.2 Pre-deployment sonde setup for unattended logging

6.2.1 Deployments can be setup using either the handheld display unit (handheld) or a computer with the corresponding software installed. The internal logging setup for each of the different multiparameter sondes requires the same basic information including start time, log interval, and site or filename. The manuals for the sondes and handhelds provide more detailed information.

6.2.2 For water quality deployments that include pH and DO measurements, **a logging interval of 15 minutes is recommended**. For all other parameters, a maximum interval of 1 hour is recommended.

6.2.3 To maximize battery and sensor life, it is recommend to start/activate/enable internal logging files in the field immediately prior to deployment. Alternately, if the relative deployment time can be anticipated, the log file may be setup for a delayed start. Another alternative is to activate logging in advance, but leave the sonde disconnected from power until installation in the field. Upon connection to power, logging will commence.

6.2.4 The sondes can also be connected to an external data logger with the appropriate adapters and settings. The sondes can be configured with specific parameters in a specific order (assigned to channels). The parameters and order must match the data logger exactly.

6.2.5 Logging setup information specific to the YSI EXO 1/2/3

6.2.5.1 On the Exo Handheld, the ⚙ (gear) symbol leads to the deployment settings

6.2.5.2 The Exo sondes allow the user to setup the deployment up for a specified time zone. It is recommended that all deployments be setup in Pacific Standard Time (PST), which is always 8 hours behind the Coordinated Universal Time (UTC -0800). It is also acceptable to set the sonde to UTC time and correct to PST when processing the data. Both PST and UTC time avoid data-management issues in the data recorded during daylight savings transitions, such as two duplicate times in a row (in the fall) and skipping ahead 2 hours (in the spring). Record the time zone setting for each sonde after deployment setup is completed. It is also important that field staff record the time zone associated with measurements collected in the field.

6.2.5.3 The Exo sondes allow for an averaging duration to be specified. If pH is being collected for the study, it is important to set an averaging duration other than zero. Two to 3 minutes is suggested. The reason for this is that if the average duration is set to zero (default), only an instantaneous measurement will be collected at each measurement interval. The pH probe will likely not have adequate warmup time to equilibrate, and biased pH data could result. Note that after deployment, it is important to set the averaging duration back to zero for calibration post-checks, to get quick response to each standard/buffer.

6.2.6 Logging setup information specific to the Hydrolab HL4

6.2.6.1 The Hydrolab sondes require that the user enter a sensor warmup time, or how long the sensors will be powered on before collecting a measurement. **A minimum warmup time of 30 seconds is recommended (2-minute warmup if collecting pH)** to allow enough time for sensors to equilibrate to the water without draining battery power excessively. The warmup time must be smaller than the logging interval.

6.2.6.2 An HL4 with a fresh D battery can log for about a week with 15-minute interval and 30-second sensor warmup time; or about 2 days with a 2-minute sensor warmup time.

6.2.7 Logging setup information specific to the Hydrolab Series 4/5

6.2.7.1 As with the HL4, a warmup time of 30 seconds (or 2 minutes if collecting pH) should be used.

6.2.7.2 Similar to HL4, an MS5 with 8 fresh AA batteries can log for about a week with 15-minute interval and 30-second sensor warmup time; or about 2 days with a 2 minute sensor warmup time. This can be significantly extended by using a 12V external battery.

6.2.7.3 ***Important:*** When setting up a log file using HYDRAS3LT, parameters from the "parameters in sonde list" must be selected and added to the "parameters in log file" list, and then "update settings" must be selected. The sonde will NOT automatically log all equipped parameters/sensors.

6.2.7.4 ***Important:*** When setting up a log file using HYDRAS3LT, after configuring logging settings and parameters, **ENABLE** must be selected in order for the deployment to be activated. By default, the log file is disabled until this step is completed.

6.2.7.5 ***Important:*** When setting up log file using terminal mode (via HyperTerminal, Tera Term, or similar), it is important to add all parameters to the scrolling display before creating the log file. The log file will include all parameters displayed at the time the file is created. It is not necessary to do a separate "enable" step when using terminal mode; logging will be armed as soon as file is created.

6.3 Site selection and preparation

6.3.1 The most important step of deployment is selecting a location that is representative, accessible, safe, and relatively private.

6.3.2 To ensure a well-mixed, representative river deployment location, select a spot with adequate but not turbulent velocity (ideally ~1 ft/sec) that is located in the thalweg or main channel of flow and is not influenced by poorly mixed sources.

6.3.3 Good reconnaissance of the deployment location (both in the field and with GIS/aerial photography) is necessary to ensure there are no tributaries, outfalls, or groundwater seepage immediately upstream. As a general rule, equipment should be deployed upstream of bridge crossings to avoid influence from roadside drainage ditches and also upstream of recreational wading/swimming.

6.3.4 A location that is accessible, safe, and private can be difficult to locate and may require obtaining permission from a landowner to access private property.

6.3.5 Section 9.0 and the EAP Safety Manual contain guidelines for assessing site safety.

6.3.6 In some cases, public access with high visibility and recreational activity is the only option for deployment. In this case, make sure to deploy the sonde during a period of low activity such as early morning. Choose a location in the stream that is difficult to access without waders and is not suited to recreation. (Avoid swimming holes, shallow sandy areas, and within a ~50 foot radius of trail or bridge access.)

6.3.7 Deployment may require physical removal of interference and minor alterations of the streambed. Be mindful not to disturb fish and wildlife habitat, keeping impacts on the stream bed and riparian area to a minimum.

6.3.8 Representativeness cross-section surveys

6.3.8.1 If it is unclear whether the deployment location is representative, then a cross-section survey of spot measurements should be taken across the width of the channel. The cross-section should include, at a minimum, measurements at the desired deployment location, within several feet of both banks, and in the thalweg (if different from the deployment location).

6.3.8.2 For deeper or vertically-stratified rivers and streams, vertical profiles of spot measurements should be made at the deployment location and in the thalweg or deepest location nearby. At a minimum, profile measurements should be taken just below the water surface, at the deployment depth and near the streambed, with measurements at other levels to provide a representative profile.

6.3.8.3 For larger rivers or waterbodies, it may be necessary to determine an area-weighted mean for sonde parameters. This can be accomplished by taking equal width and depth increment measurements at the deployment transect. See USGS protocols, including Webb et al. (1999) and Wilde and Radtke (2005) for area-weighted measurements and calculations. Mathieu (2016) provides an example of area-weighted measurement and calculation for salinity.

6.3.8.4 If the sonde cannot be safely deployed in the most representative location, the data may be adjusted for location bias following procedures in Part 2 of this SOP, provided there are at least 3 area-weighted measurements to determine the adjustment factor.

6.4 Installation of sonde

6.4.1 There are three general types of sonde installations: bed-anchored, bank-anchored and bridge anchored, with several modifications within each type. Additional methods for sonde installation (not covered by this SOP) are available including boom-arm and flow-through monitoring installations.

6.4.1.1 Boom-arm installations are possible with assistance from the Freshwater Monitoring Unit's long-term deployment staff. These deployments allow the sonde deployment tube some flexibility of movement in the water column to avoid damage from flood debris.

6.4.1.2 Flow-through monitoring stations are typically the most expensive and require additional housing and justification; installation of these stations should be addressed in a project-specific QAPP, and are generally not applicable to short-term deployments.

6.4.2 Select the installation type that is best for your site and study objectives. Bed-anchored stations are often the best choice for very short deployments (two weeks or less) during stable flow conditions. Bank-anchored installations provide more security for multiple month or wet season deployments. Bridge-anchored installations may be the best choice if the waterbody is deep and the thalweg is limited to the center of the channel. Table 1 provides a list of advantages and disadvantages for each installation type.

Installation Type	Advantages	Disadvantages
Bed-anchored	• Less exposure to vandalism • Easily relocated • More locations suitable • Can be located anywhere across the transect • No/little permitting	• Susceptible to sedimentation. • Susceptible to debris damage • Servicing sensors limited during high water/flooding • Vandalism more likely to result in damage or loss • Not suitable for non-wadeable stream depth or substrate
Bank-anchored	• Sensors can be serviced during all conditions • Less susceptible to debris damage • Vandalism less likely to result in damage or loss* • Suitable for non-wadeable stream depth or substrate	• May require two installations (high and low flow). • More exposure to vandalism • Difficult to relocate • Fewer locations suitable • Must be located near bank • May require additional permitting. • May require private access.
Bridge-anchored	• Can be located anywhere across the transect • Easy to adjust depth • Sensors can be serviced during all conditions • Less susceptible to debris damage • Can be deployed at public access. • Suitable for non-wadeable stream depth or substrate.	• Fewer locations suitable • Requires additional permitting or permissions. • Additional traffic management and safety precautions required.

Table 1. Advantages and disadvantages for bed-, bank-, and bridge-anchored sonde installations

* If deployed in galvanized metal pipe attached to strut channel.

6.4.3 Bed-anchored installations

6.4.3.1 Bed-anchored installations require attachment to stream substrate or an object permanently embedded in the streambed (such as an abandoned piling, large tree, or boulder). Bed installations require wadeable stream access to the deployment location.

6.4.3.2 Bed deployments typically involve placing the sonde inside a deployment tube and attaching to rebar driven into the substrate. Concrete blocks, natural substrate, and large woody debris can be used to keep the sonde suspended above the bed. Pipe clamps, u-bolts, chain, braided steel cable with thimbles and cable clamps, concrete anchors, and heavy duty plastic ties are used to attach and anchor the sonde.

6.4.3.3 Bottom plates made from ABS, with holes drilled for rebar and u-bolts, provide an effective deployment platform. Figure 2 illustrates an example bed deployment configuration and Figure 3 depicts two examples of deployment.

6.4.3.4 The deployment tube may also be attached to abandoned pilings vertically with pipe clamps, cable, chain, rope, or webbing.

6.4.3.5 If changes in flow are expected, installations should be anchored at multiple points.

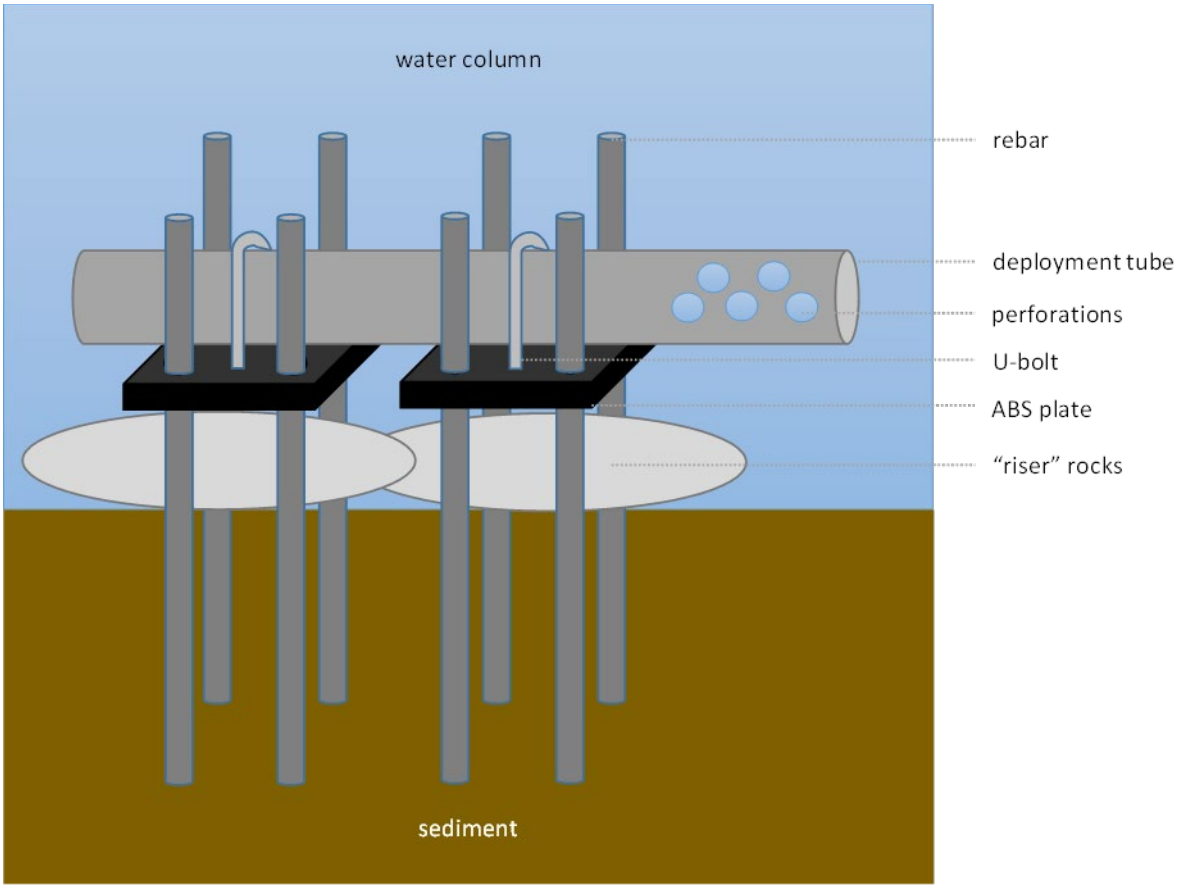

Figure 2. Bed anchored sonde installation using rebar, u-bolts, ABS plates, and PVC deployment tube.

Figure 2. Examples of bed-anchored installations.

6.4.4 Bank-anchored installations

6.4.4.1 Bank-anchored installations range from more involved (such as galvanized metal pipe housing with strut channel anchors: Figure 4) to relatively simple (such as using a chain or cable to anchor a PVC deployment tube to a large tree).

6.4.4.2 Bank-anchored stations provide access during a wide variety of flow conditions and the additional security of being able to anchor to permanent objects on the bank, riparian area, or floodplain.

6.4.4.3 Typically these deployments work best on the outer bank of a river bend where the thalweg, good velocity, and adequate depth are accessible during a wider range of conditions.

6.4.4.4 If possible, the deployment tube should be configured in such a way that the angle or depth can be adjusted as flow conditions change.

Figure 3.Examples of strut-channel (left) and simple rebar (right) bank-anchored installations.

6.4.5 Bridge-anchored installations

6.4.5.1 Bridge-anchored installations may be suspended from bridge railing/barrier or attached to bridge piers/pilings.

6.4.5.2 Bridge deployments should be installed downstream of a bridge piling to protect the sonde from debris damage. The depth of the sonde should be checked and adjusted at least monthly and may need more frequent adjustments during periods of rapidly changing water levels.

6.4.5.3 Before deploying the sonde from a bridge, permission must be obtained from the transportation/engineering department of the jurisdiction responsible for maintaining the bridge.

6.4.6 External battery power

6.4.6.1 Deployments of longer than 2 weeks typically require an external source of power to avoid frequent site visits and protect against data loss.

6.4.6.2 A variety of external power options are available based on the sonde manufacturer and deployment situation.

6.4.6.3 The Hydrolab HL4 and EXO sondes require the sonde be connected to a communications module and external data logger in order to utilize an external power source. Figure 5 shows the external battery options and associated adapters that can be connected to the Series 5 Hydrolab via a field cable.

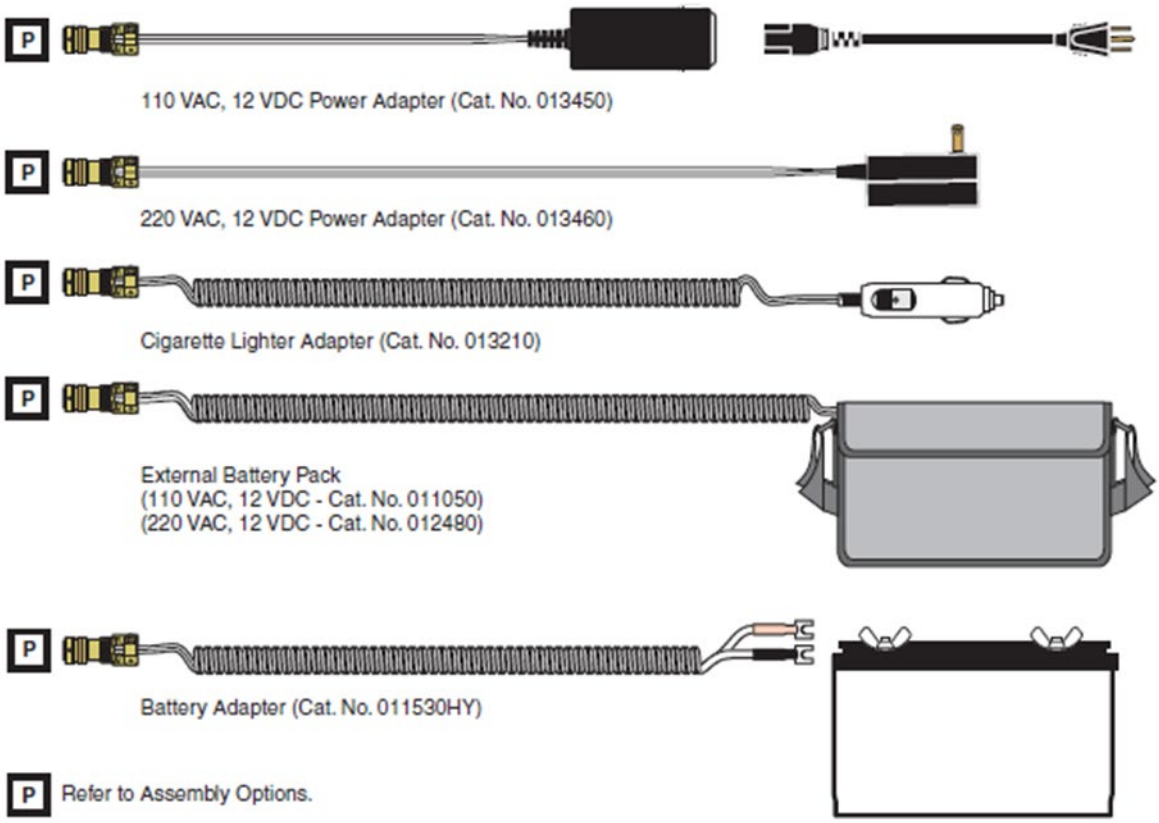

Figure 4. Series 5 Hydrolab external power options (taken from user manual).

6.4.6.4 12-volt DC batteries of varying sizes, stored in waterproof electrical boxes, are typically used to extend the amount of time between site visits.

6.4.7 Rapid deployment module

6.4.7.1 Typically real-time data transmission via telemetry only occurs at long-term-monitoring deployments. However, rapid-deployment telemetry modules can be set up to meet this need for short-term deployments.

6.4.7.2 A small waterproof electrical box is used to house the necessary equipment, including the data logger, data-collection platform radio set (DCPRS), battery, and extra communications cable.

6.4.7.3 PVC is used to cover the cable between the stream and housing. For these short-term deployments, housing can be installed closer to sensor (doesn't need to accommodate as wide of a range of flows).

6.4.7.4 Data is transmitted via the Geostationary Operational Environmental Satellite (GOES) network to Ecology's long-term continuous data management system.

6.5 Performing field checks

6.5.1 Field-check measurements using a separate calibrated sonde or instrument of comparable quality are collected upon deployment, mid-deployment, and at retrieval to help assess the data quality of the deployment measurements.

6.5.2 A list of acceptable field check instruments is maintained in the Programmatic Water Quality Impairment QAPP (McCarthy and Mathieu, 2017).

6.5.3 Upon deployment, the sonde should be allowed at least 5 minutes to equilibrate in the stream. If a logged measurement occurs less than 5 minutes after deployment, then the field check should be collected near the second logged measurement time. For example, if the sonde is deployed at 8:56 and set up to log every 15 minutes starting at 9:00, then the field-check measurement should be collected closer to the 9:15 logged measurement. This initial field check is important for assessing potential drift issues with the sensors.

6.5.4 At least one field check must be collected mid-deployment, unless the deployment is less than 48 hours. The mid-deployment field check can be collected as part of a fouling check (see Section 6.6).

6.5.5 It is recommended to locate the field check sonde as close to the deployed sonde sensors as possible (Figure 6) and to record field checks as close to the logged measurement time on the deployed sonde as possible.

6.5.6 A final field check must always be collected upon retrieval of the deployed instrument. This is the most important field check to collect.

6.5.7 If dissolved oxygen is being measured, a Winkler sample should be collected with each field check as an additional quality check on DO. If a fouling check is being conducted, the Winkler should be collected immediately after the fouling check.

Figure 5. Example of side-by-side field check on a deployed sonde.

6.6 Sonde cleaning and fouling checks

6.6.1 Cleaning of the sonde/sensors and a fouling check should be completed during site visits when a sonde has been left unattended for a period of 1 week or longer and upon instrument retrieval for any deployment of 1 week or longer. More frequent cleaning and fouling checks may be necessary in very eutrophic conditions or during periods of sedimentation.

6.6.2 Fouling check procedure.

6.6.2.1 Conduct site inspection for damage, obstructing debris, sedimentation, and general observations. Record all observations.

6.6.2.2 Upon arriving at the site, immediately place the field-check sonde/instrument in the water near the deployed sonde and power on the handheld. This will allow the field check instrument the appropriate warmup time.

6.6.2.3 **If there is NOT a cable permanently attached to the deployed sonde**, allow the sonde to log one final reading, and then record the pre-cleaning field-check readings at or near the same time.

6.6.2.4 **If there is a cable permanently attached to the sonde**, attach a second handheld to the deployed communications cable and power on the handheld. Allow the appropriate sensor warmup time (2 minutes for pH, 30 seconds for all other parameters), record the deployed sonde readings, and then record the pre-cleaning field check readings at or near the same time.

6.6.2.5 After the pre-cleaning measurements have been completed, immediately remove sonde from the deployment tube, and thoroughly clean sensors following sensor cleaning procedure in 6.6.3. Clean and flush the deployment tube after removing sonde. Figure 7 depicts two examples of sensors with fouling post-deployment.

6.6.2.6 Return the sonde to the same deployment location, allow parameters to stabilize, and record post-cleaning readings and time.

6.6.2.7 At the same time or immediately after, record post-cleaning readings and time from the field check instrument. Take measurement as near to the deployed sonde as possible.

6.6.2.8 Finally, after cleaning is completed collect a Winkler sample (See EAP SOP #023; Ward, 2016) as an additional check on DO.

6.6.2.9 At the end of the fouling check you should have four sets of measurements: 1) deployed sonde pre-cleaning, 2) field check pre-cleaning, 3) deployed sonde post-cleaning, and 4) field check post-cleaning.

6.6.2.10 Make note of any rapid changes in the parameters on the field-check instrument. The pre- and post-cleaning field check readings are used to determine any change in the parameters not associated with fouling. For example, if the stream temperature is warming rapidly.

Figure 6.Sensor fouling due to sedimentation/debris accumulation (top) and eutrophic conditions (bottom).

6.6.3 Sensor cleaning procedure.

6.6.3.1 In general, always follow individual manufacturer's guidelines for cleaning the sonde and attached sensors.

6.6.3.2 After removing the sonde, the deployment tube or apparatus should be flushed with a bucket of water to remove sediment buildup and scrubbed with a hard-bristled brush attached to a long handle or pole.

6.6.3.3 The electrical connector pins of the sonde, cables, and handhelds should be dry and free of debris prior to connecting and powering on. A small container of compressed air is helpful for drying and cleaning connectors.

6.6.3.4 The bodies of the sonde and individual sensors can be carefully scrubbed with a soft-bristled brush or toothbrush and ambient or DI water.

6.6.3.5 The sensor membranes, bulbs, cells, and any other "working parts" should be cleaned with a damp, lint-free cotton swab and DI water, unless otherwise specified by the manufacturer.

6.6.3.6 For turbidity sensors, Wagner et al. (2006) recommends: "the optic lens should be carefully cleaned with alcohol by using a soft cloth to prevent scratching (or as recommended by the manufacturer), rinsed three times with turbidity-free water, and carefully dried. If the readings are unusually high or erratic during the sensor inspection, entrained air bubbles may be present on the optic lens and must be removed."

6.7 Mid-deployment standards check

6.7.1 After cleaning is completed, if the deployed sensors deviate from the field checks by greater than the thresholds identified in Table 2, then the sensors should be checked against NIST-certified standards. A standards check is only necessary for the individual parameters that exceed their respective threshold, not for the entire sonde.

Table 1. Deviation thresholds (field check vs. deployed sonde) which trigger a standards check.

Parameter	Deviation Threshold (Field check vs Deployed sonde)	Bias MQO from Programmatic QAPP
Specific Conductance	± 10%	± 10%
pH	± 0.2	± 0.2
DO	± 0.5 mg/L	± 0.5 mg/L
Turbidity	± 10% or 1 NTU/FNU**	± 10%

** whichever is greater.

6.7.2 If the deployed sensors (except for DO) deviate from the standards by greater than the thresholds identified in Table 3, then the sensors should be recalibrated. Recalibration is only necessary for the individual parameters that exceed their respective thresholds, not for the entire sonde.

6.7.3 For DO, if the difference between the deployed and field check values exceeds 0.5 mg/L (Table 2), then a saturation check should be performed on both the deployed and field check instrument. In general, recalibration of DO is not recommended in the field. The Winkler samples, mid-deployment saturation checks, and post-deployment saturation checks can be used during data processing to assess, and potentially adjust for, bias.

Table 2. Deviation thresholds (standards vs. deployed sonde) which trigger recalibration.

Parameter	Deviation Threshold (Standards vs Deployed sonde)	MQO from Programmatic QAPP
Specific Conductance	± 10%	± 10%
pH	± 0.2	± 0.2
DO	± 0.5 mg/L	± 0.5 mg/L
Turbidity	± 10% or 1 NTU/FNU**	± 10%

** whichever is greater

6.7.4 The temperature of standards/buffers used for calibration can change rapidly in the field due to differences between the ambient, vehicle, and overnight storage temperatures. Pay close attention to temperature readings during calibration and only enter the temperature-adjusted calibration value immediately before calibrating. Note any rapid temperature changes in the buffer on the calibration form or field log book.

6.7.5 If possible, the buffers and sonde should be kept out of direct sunlight during field calibration to avoid temperature changes due to direct solar radiation.

6.7.6 Two options are available for saturation field checks on DO: 1) a small aquarium bubbler can be setup in a small open-top container of water and the sonde placed inside or 2) a bottle of water that has equilibrated to ambient air temperature may be shaken for 40 seconds and then poured into the sonde's calibration cup. See SOP EAP033 (Anderson, 2016) for further detail.

6.7.7 DO saturation field checks require the local barometric pressure. This can be measured in the field with a barometer or can be obtained from a local weather station. The YSI Exo Handheld is equipped with a barometer, and DO saturation can be viewed in %EU mode to obtain readings automatically corrected to the live barometric pressure reading. Most weather stations report the barometric pressure adjusted to sea level. These values must be adjusted for the site elevation using the equation:

$$\text{Pressure at sea level in mmHg} = (\text{Site Elevation} \times 0.0254)$$

6.7.8 During DO saturation field checks, record the DO in mg/L, water temperature, and specific conductance of the water at saturation. The temperature and specific conductance readings can be used to calculate the theoretical DO at saturation in mg/L using the USGS DO saturation tables (https://water.usgs.gov/software/DOTABLES/).

6.7.8.1 The DO tables can be printed out and used in the field for reference.

6.7.8.2 The sonde and theoretical DO values, in mg/L, at saturation can be compared to assess the potential error in mg/L. This information is useful during the data-processing stage.

6.8 Retrieval of sonde and deployment equipment

6.8.1 After collecting the final field, fouling, and Winkler checks, the sonde should be removed from the water and fitted with the sensor storage cup. A small amount of tap or site water should be placed in the storage cup to protect the sensors against damage or drift.

6.8.2 The data should be downloaded, backed-up, and visually checked before leaving the site. Data quality or logging issues may require re-deployment of the same or a different sonde.

6.8.3 Disturbance of the streambed and riparian area should be minimized upon station removal. All materials (rebar, strut channel, concrete blocks, etc.) brought to the site for installation must be removed from the site. The stream and surrounding areas should be restored to their pre-deployment condition, to the extent possible.

6.9 Post deployment reference checks

6.9.1 Both the deployed and field instruments should be checked against reference materials upon retrieval. This is similar to the pre-deployment calibration procedure; however, the sensors should **NOT** actually be calibrated to reference values. This is particularly important for 2- or 3-point calibrations, such as pH, where the second and third readings are affected by the first calibration point.

6.9.2 The purpose of the post-check is to assess the sensors for potential drift or bias issues, NOT to recalibrate the sonde for subsequent data collection.

7.0 Records Management

7.1 Field measurements and observations recorded in a field notebook should be checked for errors and omissions before leaving each site and then entered into the appropriate discharge spreadsheet as soon as possible upon return from the field.

7.2 Electronically recorded measurements should be saved to another device (e.g. usb drive, tablet, or laptop) as soon as possible (preferably in the field) and entered/imported into the project database as soon as possible upon return from the field.

7.3 For Ecology staff, the raw data files should be saved to network drive in order to ensure routine backup of files.

8.0 Quality Control and Quality Assurance

8.1 QA/QC procedures will be addressed thoroughly on a project-by-project basis in the Quality Assurance Project Plan (QAPP) for the project.

8.2 In the absence of a project specific QAPP, QA/QC procedures and objectives should follow those outlined in Section 6 of this SOP, in the Programmatic Water Quality Improvement QAPP (McCarthy and Mathieu, 2017), and in the Part 2 Data Processing SOP.

9.0 Safety

9.1 Wading streams is one of the most dangerous activities undertaken by field staff especially during higher flows. Two people are required at all times when streams are to be waded. Life jackets are to be worn if there is any chance of being pushed downstream or being submerged after falling into the water. Life jackets should also be worn when new sites are being established and when stream conditions to be encountered are unknown.

9.2 Assess whether or not the velocity and depth of the stream are low enough to safely wade across it. As a rule of thumb: **Do NOT wade in flowing water when the product of depth (in feet) and velocity (in feet per second) equals 10 or greater.** For example, if the stream is estimated to be 3 feet deep and have a velocity of 4 ft/s, do **NOT** wade across the stream. This is only a general rule; take extra precautions where the substrate is unstable (slippery or moving), water visibility is impaired (high turbidity or glare), or other challenges are present.

9.3 If there is any chance of the streamflow being strong enough to potentially cause injury (by being swept downstream into rocks or other dangerous settings, drowning, hypothermia, etc.), do not consider wading in the stream. When in doubt, err on the side of safety.

9.4 For further field health and safety measures refer to Environmental Assessment Program's Safety SharePoint site.

10.0 References

10.1 Environmental Assessment Program (EAP), 2019. *Environmental Assessment Program Safety Manual*. Washington State Department of Ecology. Revised 03/19

10.2 Anderson, P. 2016. Standard Operating Procedure EAP033: Hydrolab® DataSonde®, MiniSonde®, and HL4 Multiprobes. Environmental Assessment Program, Washington State Department of Ecology, Olympia.
ecology.wa.gov/quality

10.3 Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 pp. + 8 attachments.
http://pubs.water.usgs.gov/tm1d3

10.4 Ward, W.J, 2016. Standard Operating Procedure EAP023: Collection and Analysis of Dissolved Oxygen (Winkler Method). Environmental Assessment Program, Washington State Department of Ecology, Olympia.
ecology.wa.gov/quality

10.5 Webb, W.E., Radtke, D.B., and Iwatsubo, R.T., 1999. Surface-water sampling: Collection methods at flowing-water and still-water sites: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A6, Section 4.1.
http://pubs.water.usgs.gov/twri9A4

10.6 Wilde, F.D., and Radtke, D.B., 2005. General information and guidelines: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A6, Section 6.0, 36 pp.
http://pubs.water.usgs.gov/twri9A6

DEPARTMENT OF ECOLOGY
State of Washington

Standard Operating Procedure EAP130, Version 1.0

Short-term Continuous Data Collection with a Multiparameter Sonde, Part 2: Data Processing

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Purpose of this Document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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SIGNATURES AVAILABLE UPON REQUEST

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Revision History	Summary of changes	Sections	Reviser(s)
6/12/2018	1.0	Original draft completed	All	Nuri Mathieu
6/30/2018	1.0	Review and major contributions	All	Tighe Stuart;
7/30/2018	1.0	Reviewer	All	Nuri Mathieu
5/14/2019	1.0	Approval	All	Arati Kaza

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for the preparation of technical SOPs.

1.2 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for processing, reviewing, and finalizing short-term (less than 6 months) continuous data sets collected using a deployed multi-parameter sonde. This SOP is intended for a variety of types of water quality studies, including Total Maximum Daily Load (TMDL), effectiveness monitoring, toxic loading, and other focused water quality studies.

1.3 For data collection procedures associated with this SOP see Part 1, SOP EAP129.

1.4 Several of the methods and information presented in this SOP were taken or adapted from the USGS techniques and methods 1D-3: *Guidelines and Standard Procedures for Continuous Water Quality Monitors: Station Operation, Record Computation, and Data Reporting* (Wagner et al., 2006).

2.0 Applicability

2.1 This document should be used for processing data from sondes deployed in freshwater rivers, streams, and other waterbodies for project-level water quality assessments of limited duration (less than 6 months). Deployments of great than 6 months involve a larger dataset and a more dynamic range of deployment conditions. These long-term deployments should be conducted in consultation with EAP's freshwater monitoring unit.

3.0 Definitions

3.1 Data adjustment — raw data values changed based on a factor or equation that accounts for observed bias or drift.

3.2 Fouling — the accumulation of unwanted material on solid surfaces to the detriment of function. The fouling materials can consist of either living organisms (biofouling) or a non-living substance (inorganic and/or organic).

3.3 Instrument Drift — a change in the accuracy of an instrument's measurements over time.

3.4 RMSE — Root Mean Squared Error, the square root of the average of the differences between two measurements.

3.5 Sonde — an instrument probe that transmits or logs information about its surroundings underground, under water, in the atmosphere, etc.

4.0 Personnel Qualifications/Responsibilities

4.1 Staff must be trained in processing, reviewing, and adjusting water quality sensor data.

4.2 Job classifications that typically perform data processing work: Natural Resource Scientist 1/2/3, Environmental Engineer 1/2/3, Environmental Specialist 1/2/3/4/5, Hydrogeologist 1/2/3/4. Entry-level staff should not perform data review or adjustment without oversight from experienced senior staff.

5.0 Equipment, Reagents, and Supplies

5.1 Computer with data processing software such as Microsoft Excel/Access, R, Hydstra, Aquarius, etc.

6.0 Summary of Procedure

6.1 Reviewing and qualifying the field-check instrument data

6.1.1 The first step in processing the continuous data from the deployed sonde is to make sure that the field-collected "check" data used to assess it is of acceptable quality.

6.1.2 For all parameters except dissolved oxygen (DO), the post-check results (see SOP EAP129, Part 1; section 6.9) are used to calculate the difference between the field-check instrument values and reference material values.

6.1.3 The calculated differences are compared to the criteria in table 1 and used to assign a data-quality rating for data collected with each field-check instrument. When multiple reference checks are conducted, the larger of the two differences should be used to assign the rating. For example, if the instrument was 0.15 pH units high, compared to the pH 7 buffer, and 0.22 units high, compared to the pH 10 buffer, then the instrument pH should be assigned a quality rating of "Qualify" based on the 0.22 value.

Table 1. Measurement quality objectives for field-check instruments using post-check data

Measured field parameter	Post-check Reference	Accept	Qualify as Estimate	Reject
Water temperature	NIST-certified Thermometer	≤ ± 0.2°C	> ± 0.2 – 0.8°C	> ± 0.8°C
Specific conductance[a]	NIST-certified Buffer/s	≤ ± 10%	> ± 10 – 20%	> ± 20%
pH	NIST-certified Buffers (2-3pt)	≤ ± 0.2 units	> ± 0.2 – 0.8 units	> ± 0.8 units
Turbidity	NIST-certified Buffer/s	≤ ± 1.0 units or ≤ ± 10% [b]	> ± 1.0 – 2.0 units or > ± 10 – 20% [b]	> ± 2.0 units or > ± 20% [b]

[a] *Except for zero-check*

[b] *Whichever is greater*

6.1.4 For DO, it is recommended that field checks be assessed and, if necessary, adjusted (see section 6.5) based on regression with Winkler samples. Winkler-adjusted DO field checks can be rated based on the degree of agreement between the adjusted values and the Winkler samples (Table 2). In the absence of "accepted" Winkler data, the field-check instrument should be rated based on the percent saturation post-check (Table 2).

6.1.5 For large short-term surveys with many deployed sondes and one field-check sonde, a good approach is to collect a large number (e.g. 10+) of Winklers alongside the check sonde, across a range of values. This provides a strong basis for bias correction of the check sonde. A minimum of 5 Winklers are required to adjust field-check data.

6.1.6 Using the Winkler-adjusted field checks to assess the deployed instruments combines the accuracy and standardization of Winkler samples with the precision of optical DO sensors (Figure 1).

Figure 1. Illustration of accuracy vs. precision, as applied to Winkler and optical DO methods
Additional text describing Figure 1:

Left: The chemical basis of Winkler samples ensures they are generally accurate, but they are not precise, often having up to 0.3 mg/L error.

Middle: Optical DO probe results are very precise, down to a few hundredths of a mg/L. However, they can be inaccurate (biased) up to 1 mg/L off because of inherent problems with saturation calibrations.

Right: Applying a bias correction to optical DO probe results using several Winkler results provides a way to be both precise and accurate.

Table 2. Dissolved Oxygen measurement quality objectives for field-check instruments equipped with optical DO probes, post adjustment.

Measured field parameter	Quality Rating Method Preference	Post-check Reference	Accept	Qualify as Estimate	Reject
Dissolved Oxygen	Primary	Winkler samples	≤ ± 0.5 mg/L	> ± 0.5 – 1.0 mg/L	> ± 1.0 mg/L
Dissolved Oxygen	Secondary	Saturation Check	≤ ± 5%	> ± 5 – 15%	> ± 15%

6.1.7 Winkler data quality is assessed by collecting replicate samples in the field and by performing sodium thiosulfate normality checks with potassium bio-iodate during titration.

6.1.8 If the normality check is off by greater than ±0.2 mg/L, then an attempt will be made to correct the problem (i.e. replace the thiosulfate, check equipment, etc.). A second normality check will then be performed. If the problem is corrected (check now <±0.2 mg/L), then the Winkler samples titrated prior to that normality check may be adjusted by the offset (difference between first and second check). If the second normality check is greater than ±0.2 (problem not corrected), then the Winkler samples will be qualified as estimates. If the second check is greater than ±0.8, the Winkler samples will be rejected.

6.1.9 The programmatic QAPP (McCarthy and Mathieu, 2017) states that the median absolute difference for DO Winkler replicate pairs should be less than 0.2 mg/L.

6.2 Preliminary data rejection and removal

6.2.1 The first step in reviewing a time series raw data file for a deployed sonde is to remove all measurements where the sonde was not deployed in the water column or had not yet equilibrated. If the log file was not enabled/disabled in the field (or power was supplied early), then there may be numerous measurements on either end of the record.

6.2.2 Deployment, retrieval, and site-visit times should be used to remove data points where the sonde was out of water. If field activity time is missing, specific conductance values at or near zero can be used to identify times when the sonde was out of the water. As a general rule, any measurements logged near-in-time to placing the sonde in the water should be removed if they are out of line with other measurements in the record. All removed data should be documented in the project files.

6.2.3 pH may take multiple log intervals to equilibrate. Additional values may be removed from the beginning of the pH time series record based on visual review.

6.2.4 Figure 2 provides an example of data points removed from the raw data file that were collected prior to deployment and after retrieval.

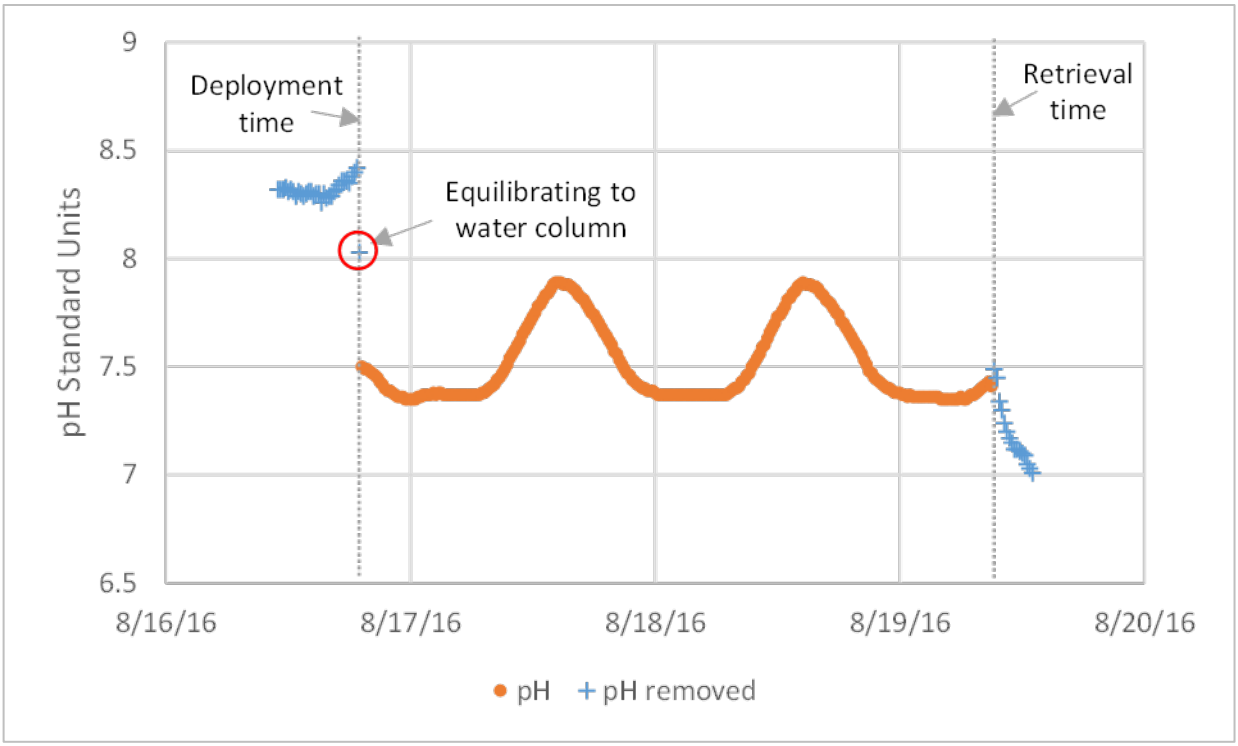

Figure 2. Example of preliminary data removal prior to deployment and after retrieval.

6.2.5 In some cases, temporary interference or fouling may create artificial noise in the data record. Data filters and/or manual review may be used to remove or qualify spurious data points. This level of data processing requires careful review and thorough documentation of any rejected data in the project files.

6.2.6 Figure 3 provides an example of specific-conductance data processing to remove unexplained noise in the data. First, a rate of change filter is applied, and, then, additional noise is removed manually by visual review. The daily signal is retained, and the average of the data changes by 1.1% between raw and processed data.

6.2.7 Removal or rejection of noisy data points should be thought of as a conservative process, whereby data with less certainty associated to it is not reported.

6.2.8 Do not perform data averaging or smoothing to remove noise on continuous sonde data.

6.2.9 Only noise that appears randomly distributed should be removed. Continuous “spikes” in the data should NOT be removed, as they likely represent real discrete changes in water quality due to a temporary discharge or condition. If it is unclear whether the noise is random, qualify, rather than reject the data.

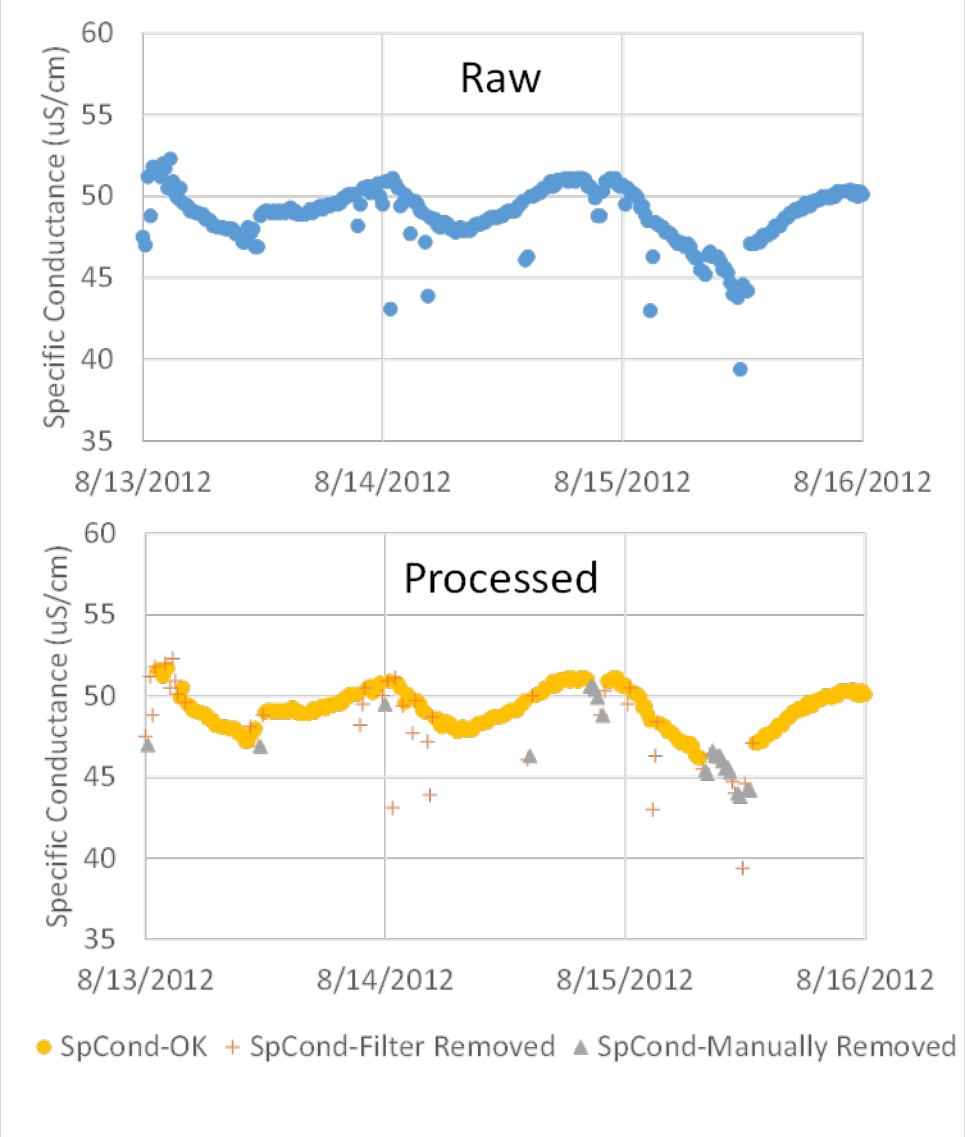

Figure 3. Example of removal of unexplained noise in the data record

6.2.10 When a sonde experiences extreme fouling, sediment burial, or major interference, part of the data file may be salvaged, if a specific fouling or interference event can be identified. Figure 4 provides an example where Sonde A was found buried in sediment following a large storm event. Flow data from a gage in the watershed and water quality data from the nearby unburied Sonde B were used to identify the time of burial. Only results after the identified burial event were removed from the final record.

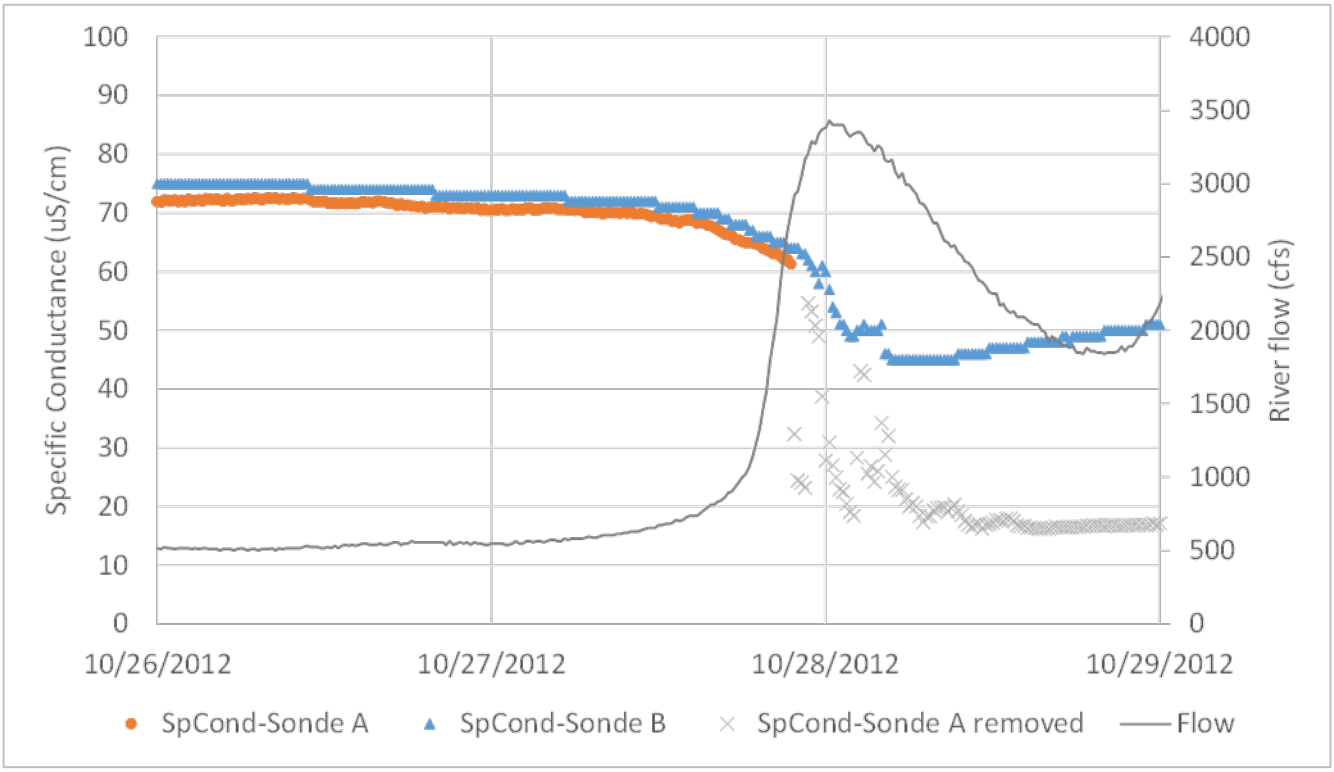

Figure 4. Example of data removed due to sediment deposition during a runoff event.

6.2.11 A log of all removed data (including dates, times, and justification for removal) should be kept with the project files.

6.2.12 In EIM, observations should be entered for data removed/rejected mid-deployment. It is not necessary to enter observations into EIM for data removed from either the beginning or end of the record. See EIM time series data entry guidance for additional detail.

6.3 Fouling adjustments

6.3.1 Fouling adjustments are necessary when fouling checks (see EAP SOP 129, Part 1 section 6.7), collected before and after cleaning, reveal a bias due to sensor fouling. Fouling adjustments should be reviewed and completed before any other type of data adjustment.

6.3.2 Fouling adjustments, while rare, are applied as a drift correction that is a linear interpolation based on the start time, zero, the stop time and the final offset due to fouling.

$$\text{The final fouling offset} = \left(\mathrm{DS}_{\mathrm{post}} - \mathrm{DS}_{\mathrm{pre}}\right) + \left(\mathrm{FC}_{\mathrm{pre}} - \mathrm{FC}_{\mathrm{post}}\right)$$

Where DS= Deployed Sonde Value; FC = Field-check Value; Pre/Post= Before/after cleaning.

6.3.3 Changes in the "clean" field-check instrument values, before and after the deployed sonde cleaning, are used to separate the "true" changes in water chemistry that elapsed while the deployed sonde was being cleaned from the changes in the deployed sonde readings due to removal of fouling.

6.3.4 Figure 5 illustrates a minor drift-fouling adjustment of DO data based on a final fouling offset of 0.15. The fouling offset was calculated as (8.73 - 8.60) + (8.79 – 8.77).

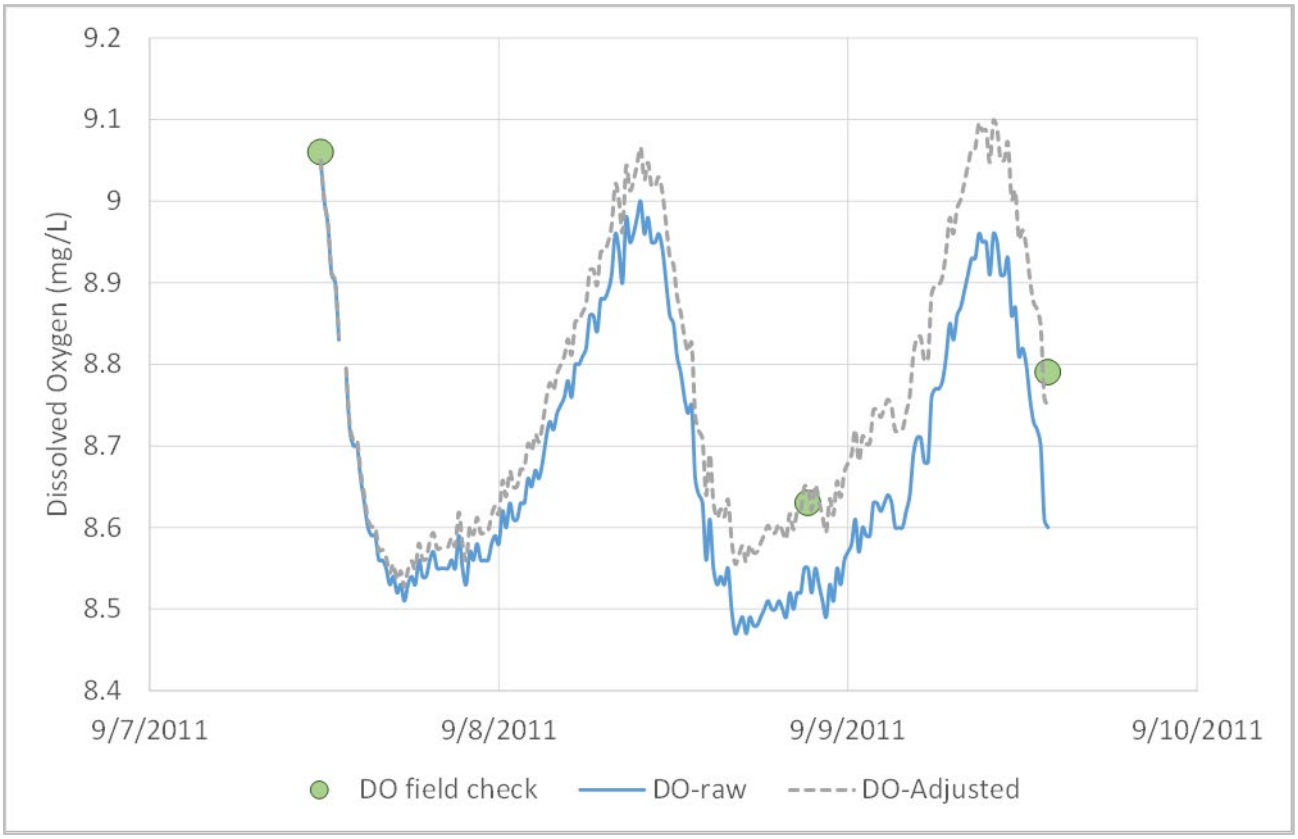

Figure 5. Example of a minor drift-fouling adjustment of DO data based on a final fouling offset

6.4 Determining final adjustment period

6.4.1 The period of adjustment may be different for each parameter. For fouling, the adjustment period will always be limited to in between cleanings. For final adjustments (section 6.5), the period ends when the sonde is recalibrated. This typically coincides with retrieval on short deployments, but not always.

6.4.2 For optical DO sensors, it is recommended to not recalibrate the deployed sensor, if it continues to meet the QAPP specific MQO, until the end of a project. The deployed sensors measurements can then be compared to a larger number of Winkler samples and field-check measurements. Bias or regression adjustments are then made on a larger period of data, based on a larger sample size of quality checks.

6.5 Weight of evidence adjustment based on quality checks

6.5.1 Once the steps of data removal/rejection and fouling review/adjustments have been completed, the final data quality review and adjustment (if applicable) process is started.

6.5.2 All the available information should be used in evaluating whether or not a data adjustment is warranted. A weight-of-evidence approach is used that considers the following information:

- Post-deployment checks against NIST reference.
- Post-deployment checks against other reference (for example air-saturated water).
- Field checks using instrument with "Accept" quality rating (see Table 1 and 2).
- Field checks from Winkler samples with "Accept" quality rating (DO only).
- Deployed measurement values at a nearby location on the same waterbody. *Note: Use caution when considering nearby data; if there are significant inflows, significant biological productivity, or long residence times between the two sites, then this approach is not warranted.*
- Consideration of physical, biological, or chemical processes (for example DO appears supersaturated at all times).
- Field observations (for example, debris accumulated on deployment tube).
- Field-check instruments or DO Winkler samples with a "Qualify" rating are generally not used in the weighing of evidence for adjustments.
- Field-check instruments or DO Winkler samples with a "Reject" rating should never be used in the weighing of evidence for adjustments.

6.5.3 Typically, choose the adjustment that results in the smallest residuals and bias between the adjusted values and QC checks (post and field checks). Best professional judgement and visual review are necessary to confirm the adjustment.

6.5.4 **If the evidence is weak or inconclusive, do not adjust the data**.

6.5.5 There are three primary types of data adjustments:

6.5.5.1 Bias offset: Data are typically adjusted by the average difference between the QC checks and deployed sonde. The majority of QC checks must show bias to use this method. An adjustment for representativeness may also be made, based on the average difference from cross-section surveys or area weighted mean measurements (see SOP EAP129, Part 1).

6.5.5.2 Regression (slope + offset): Data are adjusted using regression, typically linear, between QC checks and deployed sonde. This accounts for both a slope and offset adjustment. The regression must have at least 5 data points and an R^2 value of >0.95 to use for adjustment. Use extreme caution when extrapolating regressions beyond the range of the QC checks.

6.5.5.3 Calibration Sensor Drift: Data are adjusted using linear regression with time from calibration or deployment to post check or retrieval. The majority of QC checks, particularly post checks, must confirm the pattern of drift (the drift-adjusted sonde values should more closely match most of the QC checks). This adjustment is applied in a manner similar to a fouling-drift correction (Figure 4); however in this case, rather than fouling, the drift is due to a sensor degrading, losing power, or not holding a calibration over time.

6.5.6 Table 3 and Figure 6 provide an example of a bias adjustment of 7.1% applied to a specific-conductance deployment based on the average bias from both field and buffer post checks. Table 4 shows the adjusted values and the associated reduction in bias (from 7.1% to -0.4%) and the RMSE (From 7.4% to 2.1%), compared to the QC checks.

Table 3. Example of bias in a deployed sonde, compared to buffer and accepted field checks.

Date & Time	SpCond Deployed	QC type	SpCond QC	Field-check rating	% Difference
9/24/2012 12:40	66.9	Field Check	70.2	Accept	4.7%
9/25/2012 11:00	66.0	Field Check	72.9	Accept	9.5%
9/25/2012 16:40	65.2	Field Check	71.7	Accept	9.1%
9/27/2012 11:40	69.0	Field Check	73.7	Accept	6.4%
9/28/2012 10:00	94.0	Buffer Check (Post)	100		6.0%
Average QC Difference (Bias) =					7.1%
RMSE QC Difference =					7.4%

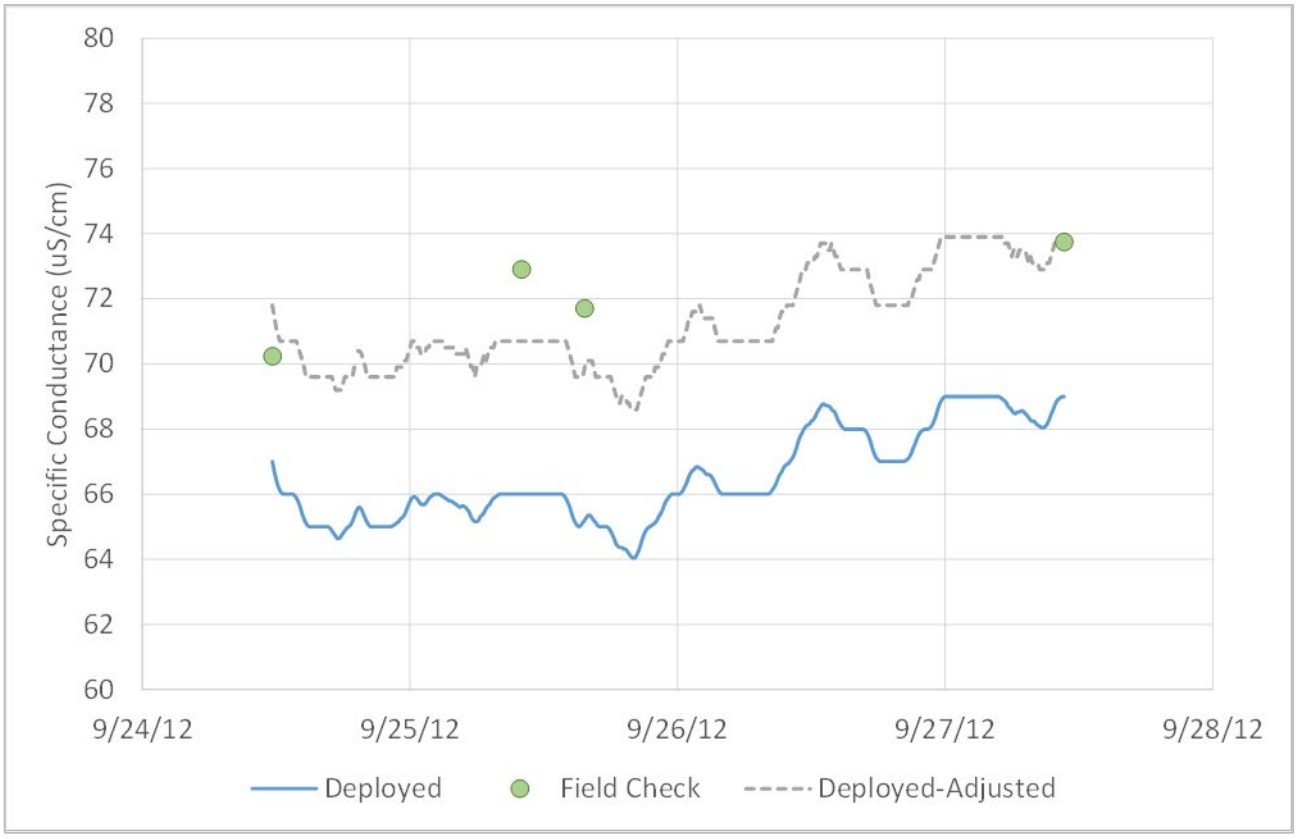

Figure 6. Example of bias adjustment.

Table 4. Adjusted deployment data and residuals/fit with quality checks.

Date & Time	SpCond Adjusted	QC type	SpCond QC	Field-check rating	% Difference
9/24/2012 12:40	71.8	Field Check	70.2	Accept	2.2%
9/25/2012 11:00	70.7	Field Check	72.9	Accept	-3.0%
9/25/2012 16:40	69.9	Field Check	71.7	Accept	-2.5%
9/27/2012 11:40	73.9	Field Check	73.7	Accept	0.2%
9/28/2012 10:00	101.0	Buffer Check (Post)	100		1.0%
				Average QC Difference (Bias) =	-0.4%
				RMSE QC Difference =	2.1%

6.5.7 If any data are adjusted, detailed documentation of the QC data and justification for adjustment must be retained with the project files.

6.6 Final data quality ratings and data qualifiers

6.6.1 The final deployed sonde data, adjusted or not, is assigned a quality rating by comparing the final RMSE QC difference to the criteria in Table 5. For example, the adjusted data from Table 4 would receive an "Accept" quality rating, based on an RMSE of less than 10%, post-adjustment (2.1% RMSE).

6.6.2 The RMSE is the square root of the average of the squared residuals between the final deployed data and the QC check (both field and post check). For specific conductance, the RMSE is calculated with the square of the percent difference, instead of the residual.

Table 5. Final data quality ratings based on the RMSE between quality checks and adjusted/final deployed readings.

Measured field parameter	Accept	Qualify as estimate	Reject
Water temperature	≤ ± 0.2°C	> ± 0.2 – 0.8°C	> ± 0.8°C
Specific conductance	≤ ± 10%	> ± 10 – 20%	> ± 20%
Dissolved Oxygen	≤ ± 0.5 mg/L	> ± 0.5 – 1.0 mg/L	> ± 1.0 mg/L
pH	≤ ± 0.2 units	> ± 0.2 – 0.5 units	> ± 0.8 units
Turbidity	≤ ± 1.0 units or ≤ ± 10%	> ± 1.0 – 2.0 units or > ± 10 – 20%	> ± 2.0 units or > ± 20%

For "or" criteria, use whichever is greater.

6.6.3 Bias adjustments can typically be applied with more confidence, compared to fouling/calibration drift or slope adjustments where the linear relationship cannot be confirmed between quality checks. For this reason, adjusted data where a drift or slope adjustment exceeds the thresholds in Table 6 should be qualified as estimates, regardless of whether or not the final RMSE meets accept criteria.

Table 6. Threshold for when to qualify data based on drift or slope adjustment applied

Measured Field parameter	Drift or slope adjustment threshold for qualifying data
Water temperature	> 0.4°C
Specific conductance	> ± 20%
Dissolved Oxygen	> ± 1.0 mg/L
pH	> ± 0.4 units
Turbidity	> ± 2.0 units or > ± 20% [c]

6.6.4 Adjusted data from a deployed sonde should be designated as adjusted in the EIM database (See section 6.7 data reporting).

6.7 Data Reporting

6.7.1 Table 7 contains names, method codes, units, and digit conventions for continuous deployment data reporting.

Table 7. Reporting units and conventions for continuous data parameters.

EIM Parameter Name or Alias	Reporting Unit/s	EIM Method Code	Reporting Conventions
Temperature, water	°C	TEMPTHERM	To nearest 0.01 °C.
Specific conductance	µS/cm	CONDMETER	<1 to the nearest 0.01 1-100 to the nearest 0.1 > 100 to the nearest whole number
pH	pH	PHMETER	to the nearest 0.01
Dissolved Oxygen	mg/L	DO-OPTICAL DO-CLARK[1]	to the nearest 0.01
Turbidity	FNU/NTU	TURBM	0–10, to nearest 0.1 10–100, to nearest 1 >100, to nearest 10

[1] *Most sensors used by EAP are optical LDO technology (EIM method code = DO-OPTICAL), a few Clark-cell technology sensors are actively maintained (DO-CLARK). Only optical sensors should be used for field-check instruments.*

6.7.2 Dissolved oxygen percent saturation from deployed sondes is generally not reported in EIM. For this data type, temperature, specific conductance, and elevation data are available in EIM. These data can be used to calculate the percent saturation outside of the database.

6.7.3 The EIM help center provides specific guidance on how to enter adjusted time-series data into EIM. Table 8 summarizes this guidance in the context of this SOP. Time-series data is entered into EIM using a specific template and the associated help document.

6.7.4 It is recommended to enter information specific to the data adjustment into EIM Result comment field (see Table 8 comment example).

Table 8. EIM data entry guidelines for adjusted and non-adjusted time-series data from short term deployments.

Final Data Quality Rating	Result Data Qualifier[1]	Result Data Qualifier Description	Comment (Example)[2]
Non- Adjusted Data			
Accept	-	-	-
Qualify	EST	Measurement value reported is estimated. See comment for additional detail.	RMSE >0.5 mg/L based on data quality checks; reported result is an estimate and should be used with caution.
Adjusted Data			
Accept	IA	Instrument result adjusted; reported result meets study objectives	Result Value adjusted for linear instrument drift identified post deployment.
Qualify	EST	Measurement value reported is estimated. See comment for additional detail.	Result Value adjusted; considerable instrument drift during deployment, reported result is an estimate and should be used with caution.

[1] (Column S in Time-Series Result Template)
[2] (Column U in Time-Series Result Template)

7.0 Records Management

7.1 All original data files should be retained in their raw electronic form (.csv, .txt, etc.) in one data folder or database.

7.2 A "final" file or database should be retained for each deployment that includes at a minimum: final data after processing and/or adjustment, any field check or buffer check data associated with the deployed sonde, and any factors or equations used to adjust the data.

7.3 Any information used to review or adjust data should be retained with the project files.

7.4 All files and databases should be stored on a network drive that is routinely automatically backed up.

8.0 Quality Control and Quality Assurance

8.1 The quality control and assurance guidelines are embedded throughout Section 6 in the order that they are encountered during data processing.

8.2 Specific QA/QC criteria are included in tables 1, 2, 5, and 6.

8.3 The Part 1 SOP includes field procedures related to data quality.

8.4 Additional applicable quality assurance guidelines can be found in the programmatic QAPP for water quality impairment studies (McCarthy and Mathieu, 2017)

9.0 Safety

9.1 For further field health and safety measures refer to the EAP Safety Manual (EAP, 2019).

10.0 References

10.1 Environmental Assessment Program (EAP), 2019. Environmental Assessment Program Safety Manual. Washington State Department of Ecology. Revised 03/19.

10.2 McCarthy, S. and N. Mathieu, 2017. Programmatic Quality Assurance Project Plan: Water Quality Impairment Studies. Washington State Department of Ecology, Olympia, WA. https://fortress.wa.gov/ecy/publications/SummaryPages/1703107.html.

10.3 Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; http://pubs.water.usgs.gov/tm1d3.

QUALITY ASSURANCE PROJECT PLAN

APPENDIX B

DATA REVIEW AND VERIFICATION CHECKLIST

This checklist should be used to document data review verification of data generated through implementation of the FERC-approved study plan.

GENERAL

- For each sampling event, samples have been collected and analyzed at all locations and for all analyses specified in the study plan.
- For each sample and analyses, the Project file contains records, field notes, chain-of-custody, and analytical results, including quality assurance documentation (hardcopy and electronic).

FIELD DATA

- Field notes and/or data sheets include date, time of sample collection, field sampling staff, time arrived at site, time left site, site identification, description of site conditions (weather), field parameters, reservoir level or flow information (measured or estimated), sample collection procedures, and call-out quality assurance samples collected. If mistakes are found on the field data sheet, changes can be made by crossing out the mistake and marking the change with a date of change, initials, and reason for change.
- Documentation of field equipment calibration is in the field notes and/or Project records.
- Field data entered into Excel have been checked by a second party.

LABORATORY REPORT

- Field duplicates, blanks, and rinsates were submitted to the laboratory at the frequency specified in the study plan.
- Any constituents found in blanks or rinsates are discussed in the final report.
- Any duplicate concentrations that differ by more than 10 percent are discussed in the final report.
- Samples were received by the laboratory intact and analyzed within method and/or study specified holding times.
- Laboratory reports are accurate with respect to sample IDs, analyses, reporting/detection limits, units, column labels, footnotes, and titles. Have lab re-issue report with corrections if there are inconsistencies.
- Check that non-detects are always reported in the same manner using consistent notation. For example, either “ND” or “<.” Have lab re-issue report with corrections if there are inconsistencies.
- If observed, “J” qualified data and/or elevated detection limits are discussed in the final report.

FA-02 INSTREAM FLOW MODEL DEVELOPMENT PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

ADCP.....acoustic doppler current profiler
AWS.....area weighted suitability
cfs.....cubic feet per second
City Light.....Seattle City Light
Ecology .....Washington State Department of Ecology
EFH.....Essential Fish Habitat
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
ESH.....Effective Spawning Habitat (model)
FARWG.....Fish and Aquatics Resource Work Group
FEMA .....Federal Emergency Management Agency
FERC.....Federal Energy Regulatory Commission
FLA.....Final License Application
FPA .....Federal Power Act
FSA .....Fisheries Settlement Agreement
GIS .....Geographic Information System
HEC-RAS .....Hydrologic Engineering Center River Analysis System
HSC.....Habitat Suitability Criteria
IFIM .....Instream Flow Incremental Method
ILP.....integrated licensing process
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
NHPA.....National Historic Preservation Act
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
PAD.....Pre-Application Document
PHABSIM.....Physical Habitat Simulation
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area

RM .....river mile
RTK.....real-time kinematic
RWG .....Resource Work Group
SR.....State Route
SRSC.....Skagit River System Cooperative
USACE .....U.S. Army Corps of Engineers
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
USGS .....U.S. Geological Survey
USIT.....Upper Skagit Indian Tribe
WDFW.....Washington Department of Fish and Wildlife
WUA .....weighted usable area

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing.

The relicensing process includes the timeframes and deadlines specified in FERC's Integrated Licensing Process (ILP), including consultation with interested agencies and Indian tribes related

to study plans, study results, and subsequent analysis of results and effects analysis through the filing of the Final License Application (FLA). FERC's process includes steps to satisfy the various statutory authorities identified in the Federal Power Act (FPA) (e.g., Sections 4(e), 10(j), 10(a)). Other related regulatory processes including Washington State Department of Ecology's (Ecology) Section 401 water quality certification process, the U.S. Fish and Wildlife Service's (USFWS) and National Marine Fisheries Service's (NMFS) Section 7 Endangered Species Act (ESA) consultation, NMFS's oversight of Essential Fish Habitat (EFH), as defined by the Magnuson Stevens Fishery Conservation and Management Act, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA) will continue following filing of the FLA. With the filing of the PAD, City Light requested that FERC designate City Light as FERC's non-federal representative for purposes of initiating and conducting day-to-day consultation under ESA Section 7 and NHPA Section 106, which was granted by FERC in its June 26, 2020 Notice of Intent to File License Application for a New License and Commencing Pre-Filing Process.

1.3 Study Plan Development

In 2019, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential Project effects. City Light developed 24 study proposals, including this Instream Flow Model Development study plan.

On April 10, 2020, City Light released the Instream Flow Model Development Draft Study Plan for LP review and comment. On May 5, 2020, the draft study plan was discussed at a Fish and Aquatic Resource Work Group (FARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 17, 2020. The revised draft was discussed on June 24, 2020 at a FARWG meeting. Written comments were received from the Upper Skagit Indian Tribe, Washington Department of Fish and Wildlife (WDFW), USFWS, NPS, Skagit River System Cooperative (SRSC), and NMFS and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date.

This study plan addresses, with modifications, elements of the following study requests, as explained in Section 6 of the PSP: Ecology-02 Instream Flow Study, NMFS-02 Geomorphology and Aquatic Habitat, NPS-13 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood and Sediment Below Gorge Dam, USFWS-13 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood, and

Sediment below Gorge Dam, USFWS-15 Geomorphology and Aquatic Habitat Complexity Study Request, USIT-08 Geomorphology and Anadromous Salmonid Habitat, WDFW-05 Geomorphology and Anadromous Salmonid Habitat, and WDFW-08 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood and Sediment Below Gorge Dam. City Light has addressed specific comments and suggested edits to the study plan that were provided by LPs.

Project operations result in the release of flows to the Skagit River at the Gorge Powerhouse and Gorge Dam. Through coordination with the U.S. Army Corps of Engineers (USACE), Project operations reduce downstream flood risk. Through a variety of pathways, and in combination with non-Project related cumulative effects, the Project's flow releases also affect the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids. The development of hydraulic models will provide detailed information on the hydraulic characteristics of flows in the Skagit River (discharge, flow depth and velocity, and their spatial and temporal variations) and be useful when considering potential alternative Project operations, particularly related to effects on fish habitat. This study is intended to describe the development of an instream flow model for the Skagit River in the reach between Gorge Powerhouse and the confluence with the Sauk River. The instream flow model will consist of a numerical hydraulic model that produces hydraulic outputs (i.e., depth and velocity grids) that can be further analyzed or synthesized in a Geographic Information System (GIS) to assess changes in habitat suitability under alternative Project operations. The model may contribute to addressing some of the issues identified in the summary provided in Table 5.3-1 of the PAD (City Light 2020).

The hydraulic model to be developed as described in this study plan will be one of the tools contributing to an integrated analysis of Project effects on environmental resources. Studies that may ultimately be linked, either directly or indirectly, to the findings of this study include: (1) FA-01 Water Quality Monitoring Study (i.e., the relationship between water quality and flows with respect to fish habitat suitability); (2) GE-04 Skagit River Geomorphology between Gorge Dam and the Sauk River Study (e.g., substrate mapping, etc.); (3) OM-01 Operations Model Study (i.e., upstream hydraulic boundary condition); (4) Wetlands Assessment (i.e., in terms of potential river-wetlands connectivity); (5) TR-01 Vegetation Mapping Study (i.e., cover types); (6) FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study; and (7) landform mapping (being conducted by the NPS). More needs to be learned within each respective study area before it is clear if and how study results will meaningfully inform comprehensive environmental analysis. City Light will work with LPs to review and integrate information from related studies as part of the ILP process in support of its license application filing.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Instream Flow Model Development Study is to develop an updated flow-habitat evaluation tool for the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River.

Specific objectives include:

- Develop, calibrate, and validate a numerical hydraulic model of the Skagit River for the reach between the Gorge Powerhouse and the confluence with the Sauk River.
- Integrate hydraulic model outputs and observed characteristics of substrate and cover with biological (species, lifestages, periodicities) and physical (depth and velocity) criteria used in the current flow-habitat evaluation tool, including modifications from additional data sources as appropriate, to develop updated flow-habitat relationships for the reach of the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River.

Once the study is complete (i.e., the model has been developed), the flow-habitat model will be used to investigate and inform the evaluation of flows and habitat in the Gorge Powerhouse to Sauk River reach to continue supporting mainstem Skagit River fish habitat during the new FERC license term and to support additional discussions regarding hydraulic conditions and aquatic habitat, including migration habitat.

2.2 Resource Management Goals

City Light's goal for the proposed study is to develop updated flow-habitat relationships to potentially inform flow management in the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River.

NMFS, USFWS, WDFW, the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, and the Swinomish Indian Tribal Community all have certain management responsibilities for anadromous salmonids and their prey species, wildlife, and plants in the Skagit River basin and its tributaries. Other agencies have responsibilities for adjacent land management.

The flow-habitat model will serve as a tool to analyze current conditions and alternative scenarios during the relicensing process. Additionally, the hydraulic model may be used to support the assessment of alternative scenarios or future proposals involving potential off-channel and floodplain restoration projects to benefit salmonid spawning and rearing in the study reach.

The study will provide information to help resource agencies and Indian tribes with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by licensing participants in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

Detailed information is required on hydraulic conditions and their spatial and temporal variation in the Skagit River between Gorge Powerhouse and the confluence with the Sauk River to support evaluation of flows for the management of Skagit River fish habitat.

Flows downstream from Gorge Powerhouse are managed under the current Project license in accordance with the Revised Fisheries Settlement Agreement (FSA) (City Light 2011) which, amongst other things, provides comprehensive detailed requirements for management of Skagit River releases for the protection of anadromous fish. The Revised FSA provides requirements for protection of Chinook, Pink, and Chum salmon and for steelhead for all lifestages. It includes requirements for flow management for all spawning and incubation periods, restrictions on riverine ramping rates, and specification of minimum flows. Current flow management requirements per the Revised FSA are summarized in Section 3.5.2 of the PAD.

Flow management under the current Project license in accordance with the Revised FSA is supported by City Light's Effective Spawning Habitat (ESH) model. In summer 2015, the ESH model was unable to account for low flows, resulting in the inability to inform, with high reliability, minimum flows for redd incubation during this time period. This model was developed using a small number of river channel cross sections dating from the 1970s to characterize hydraulic conditions. Changes in channel geometry and habitat conditions have occurred over time, and an updated model will reflect both current channel conditions and river hydraulics over a broader range of hydrologic conditions.

Recent hydraulic models are available for portions of the river reach between the Gorge Powerhouse and the Sauk River. Significantly, a detailed two-dimensional hydraulic model was recently developed for an approximately 7-mile reach of the river, extending from just upstream of the confluence with Illabot Creek to a point about 1.5 miles downstream of the confluence with the Sauk River (Natural Systems Design 2019). The model, developed using the RiverFlow2D software (Hydronia LLC 2018), was applied to investigate habitat restoration measures in the Barnaby Reach, which encompasses the mainstem of the Skagit River and its associated floodplain from the confluence with Illabot Creek to the Sauk River. The potential use of this model, and the topographic and bathymetric data on which it is based, is discussed further in Section 2.6 of this study plan.

A two-dimensional hydraulic model was also developed in 2012 for an approximately 4.5-mile reach of the river near the confluence with Illabot Creek for use in the analysis and design of riverbank stabilization measures to protect highway State Route (SR) 20 from erosion (Northwest Hydraulic Consultants 2012). Most of this model is within the domain of the Barnaby Reach model developed in 2019. Additional output provided by the 2012 model, upstream of the Barnaby Reach domain, appears to be based on outdated bathymetric survey data that may not adequately characterize current terrain conditions.

The Seattle District of the USACE recently (circa 2016) developed an updated Hydrologic Engineering Center River Analysis System (HEC-RAS) hydraulic model of the Skagit River from Skagit Bay to Newhalem by combining and recalibrating two pre-existing HEC-RAS models: a two-dimensional model of the Skagit River delta downstream from Sedro-Woolley, and a second one-dimensional model upstream from Sedro-Woolley to Newhalem. The USACE HEC-RAS

model is one component of the Corps Water Management System, which supports decision-making for flood control operations within the Skagit River basin. The one-dimensional model of the upper Skagit, upstream from the Sauk River, is based on outdated channel cross-section data, including data from the Federal Emergency Management Agency (FEMA) surveys of the 1970s. The model calibration focused on high flow events but also attempted to reproduce stage-discharge ratings at key U.S. Geological Survey (USGS) streamflow gages, including that at Marblemount. Poor model calibration at Marblemount was attributed to lack of reliable upstream channel data.

A variety of hydrologic, topographic, and bathymetric data are available to support development of hydraulic models of the study reach, which in turn would provide the hydraulic data needed to update the ESH model, and to potentially inform other related studies:

- Topographic and Bathymetric Data. Light Detection and Ranging (LiDAR) data covering the proposed hydraulic model extents (see Section 2.5 of this study plan) were acquired in 2017 and 2018 (Quantum Spatial 2017; Quantum Spatial 2018). The LiDAR generally provides high quality topographic and bathymetric data; however, there are some gaps or voids in the channel bathymetry data because of limitations imposed by water depth, turbulent aerated water, vegetation cover, and/or channel bed conditions. These voids will need to be filled using ground-based surveys or other techniques as described in more detail in Section 2.6 of this study plan.
- Hydrologic Data. The USGS operates water level and discharge gaging stations on the mainstem Skagit River and several of its larger tributaries. Currently active USGS gages in the area between Gorge Dam and the Sauk River are listed in Table 2.3-1 and locations shown in Figure 2.5-1. Historical data are also available from now-discontinued gages listed in Section 4.4.2 of the PAD. The PAD also provides monthly minimum, average, and maximum outflows from Ross, Diablo, and Gorge lakes for the period 1991–2018.

Table 2.3-1. Active USGS stream gages in the area between Gorge Dam and the Sauk River (see Figure 2.5-1 for gage locations).

Gage ID	Name	Period of Record	Drainage Area (sq. mi.)
12178000	Skagit River at Newhalem, WA	Dec 1908 to May 1914 Oct 1920 to present	1,175
12178100	Newhalem Creek near Newhalem, WA	Feb 1961 to present	27.9
12179900	Bacon Creek below Oakes Creek near Marblemount, WA	Aug 1943 to Sep 1950 Oct 1998 to present	49.7
12181000	Skagit River at Marblemount, WA	Sep 1943 to Jul 1944 Oct 1946 to Sep 1951 May 1976 to present	1,381
12182500	Cascade River at Marblemount, WA	Oct 1928 to Oct 1979 Jun 2006 to present	172
12184700	Skagit River near Rockport, WA[1]	Oct 2015 to present	1,655
12189500	Sauk River near Sauk, WA	Jul 1928 to present	714

1 Gage height only.

2.4 Project Operations and Effects on Resources

The Project's flow releases affect the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids. Information on the hydraulic characteristics of flows in the Skagit River (discharge, depth, and velocity, and their spatial and temporal variations) will describe these influences and may inform alternative scenarios of future Project operations involving flow management, particularly as related to fish habitat.

2.5 Study Area

The study area extends from Gorge Powerhouse at about RM 94 downstream to a suitable location a short distance downstream from the confluence with the Sauk River, at approximately RM 65 (Figure 2.5-1). The total reach length is approximately 29 miles.

The downstream study limit, and downstream limit of the hydraulic modeling, below the confluence with the Sauk River, will be selected to allow the model to correctly account for the influence of the Sauk on conditions on the Skagit upstream from the Sauk, and to ensure a robust downstream boundary for hydraulic modeling. For the purpose of this study plan, it is assumed that the downstream study limit coincides with the downstream extent of the existing RiverFlow2D hydraulic model developed for the Barnaby Reach restoration project discussed further in Section 2.6.1.1 of this study plan.

The focus of the hydraulic model between Gorge Powerhouse and the Sauk River confluence will be on the in-channel portion of the mainstem Skagit River corridor and any side channels identified by the study team as having significant habitat value; however, the model will also include, in lesser detail, the overbank floodplain out to the valley side walls.

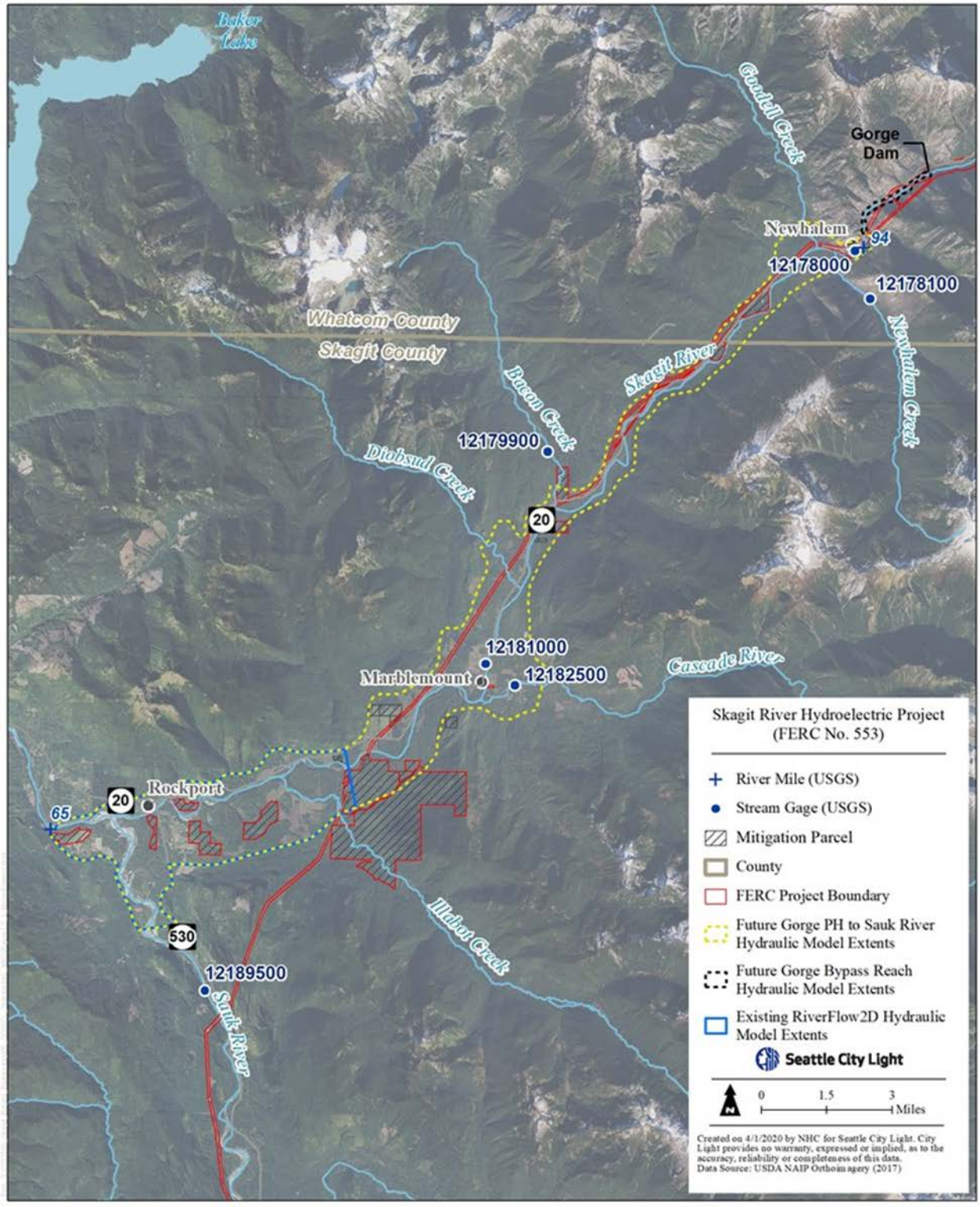

Figure 2.5-1. Overview of study area.

2.6 Methodology

An unsteady flow hydraulic model will be developed for the study area using the USACE HEC-RAS modeling platform (USACE 2016).

2.6.1 Gorge Powerhouse to Sauk River Confluence Model

2.6.1.1 Hydraulic Model Selection and Overview of Model Development

A two-dimensional unsteady flow hydraulic model will be developed for the Gorge Powerhouse to Sauk River reach using the USACE HEC-RAS modeling platform (USACE 2016). The model will extend from the Gorge Powerhouse at RM 94 to just downstream from the confluence with the Sauk River at RM 65, for a total reach length of approximately 29 miles.

Model development will take advantage of previous hydraulic modelling efforts to the extent appropriate. In particular, the proposed model will build on previous model development for the Barnaby Reach restoration project (Natural Systems Design 2019) discussed in Section 2.3 of this study plan.

The Barnaby Reach model is a RiverFlow2D model (Hydronia 2018) covering the approximately 7 lowest miles of the study reach from just upstream of Illabot Creek to the downstream end of the study area, approximately 1.5 miles below the confluence with the Sauk River. The model was developed at a sufficiently fine-scale resolution for investigating restoration measures in the Barnaby Reach. The bathymetry and topography for two-dimensional hydraulic models are described using a mesh or wireframe. The model mesh for the Barnaby Reach RiverFlow2D model comprises approximately 800,000 triangular elements.

In developing this study plan, two hydraulic model options were considered as follows:

(1) Extend the existing Barnaby Reach model upstream to the Gorge Powerhouse using RiverFlow2D.

(2) Develop a new HEC-RAS 2D model of the entire study reach, taking advantage of the bathymetric data and calibration data for the Barnaby Reach from the RiverFlow2D model.

The following factors were considered in selecting a model platform:

- Efficiency of model development (recognizing the availability of the Barnaby Reach RiverFlow2D model);
- Model resolution required to meet study objectives (discussed further in Section 2.6.1.3);
- Speed of model execution;
- Integration with other model platforms (for example, Project operations models);
- Availability of model support and model maintenance;
- Availability of visualization tools and software features for analysis, synthesis and display of model output;
- Efficiency with which metrics of interest for Project flow management can be generated from model output;

- Acceptance by the engineering community and both governmental and non-governmental institutions; and
- Size of user community (which relates to the pool of expertise available for model updates and application).

A qualitative comparison of the RiverFlow2D and HEC-RAS 2D modeling platforms for the above attributes is provide in Table 2.6-1. A two-dimensional HEC-RAS (Version 5) model of the full study reach was determined, after considering the above selection factors, to provide the best tool to meet study objectives, and the best modeling platform for adoption over the term of the next license. Ecology and WDFW approved the use of a two-dimensional HEC-RAS 2D model, as indicated in their August 14, 2020 email correspondence with City Light.[1]

Model development involves the following tasks, described in the following sub-sections:

- Processing of model topographic data
- Development of model geometry
- Analysis of model boundary conditions
- Field monitoring to obtain discharge and water level data to support model calibration and validation
- Model configuration, calibration and validation
- Model application and analysis of model output

Table 2.6-1. Qualitative comparison of RiverFlow2D and HEC-RAS 2D.

Attribute	RiverFlow2D	HEC-RAS 2D
Efficiency of model development (recognizing the availability of the Barnaby Reach RiverFlow2D model).	+	+
Model resolution required to meet study objectives.	+	+
Speed of model execution.	++	+
Integration with other model platforms (for example, Project operation models).	+	+
Availability of model support and model maintenance.	++	+
Availability of visualization tools and software features for analysis, synthesis and display of model output.	+	+++
Efficiency with which metrics of interest for Project flow management can be generated from model output.	+	+
Acceptance by the engineering community and both governmental and non-governmental institutions.	+	++
Size of user community (which relates to the pool of expertise available for model updates and application).	+	+++

[1] August 14, 2020 email from James M. Pacheco (Ecology) to Erin Lowery (City Light).

2.6.1.2 Model Topographic Data

A three-dimensional terrain model of the reach spanning from Gorge Powerhouse to approximately 1.5 miles downstream of the Sauk River confluence (~29 RMs) will be developed from a combination of topobathymetric LiDAR, standard LiDAR, boat-based bathymetric (sonar) surveys, and terrain data from the existing hydraulic model of the Barnaby Reach of the Skagit River.

The following LiDAR sources will be relied on:

- Quantum Spatial topobathymetric LiDAR ("green LiDAR") contracted by City Light; acquired April 25 and 26, 2018 (Quantum Spatial 2018).

Covers ~4,000 acres (~18 RMs) of Skagit River between Gorge Powerhouse and Barnaby Slough reach

- Quantum Spatial topobathymetric LiDAR ("green LiDAR") contracted by the SRSC; acquired April 21, 2017 (Quantum Spatial 2017a).

Covers ~11,000 acres of the Barnaby Slough reach (~10 RMs)

- Quantum Spatial topographic LiDAR contracted by USGS; acquired March 2016 – September 2016 (Quantum Spatial 2017b).

Covers ~3.6 million acres of western Washington

The 2016 LiDAR (Quantum Spatial 2017b) will supplement any floodplain data not acquired in the more limited topobathymetric datasets. A very coarse preliminary hydraulic model of the reach of interest, constructed to test the sensitivity of HEC-RAS model simulation times to cell size, indicates there may be several such floodplain areas (Figure 2.6-1), depending upon the flows simulated. As noted in Section 2.5 of this study plan, while the focus of this study will be on the in-channel portion of the mainstem Skagit River, the model will also include, in lesser detail, the overbank floodplain out to the valley side walls. The lateral extent of the model will be informed by review of data from the landform mapping study.

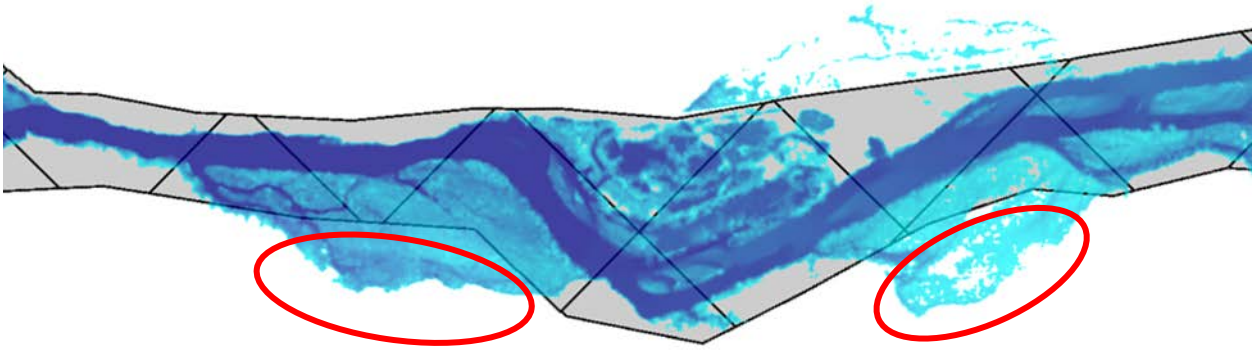

Figure 2.6-1. Coarse HEC-RAS model illustrates floodplain beyond limits of topobathymetric LiDAR (32,000 cfs, corresponding to an approximately 4-year peak flow for the Skagit River at Marblemount).

In addition to areas outside the topobathymetric data extents, areas within the wetted channel exist that are not defined in the topobathymetric rasters. This can occur for reasons such as turbid water, deep water, turbulent aerated water, vegetation cover, and/or a non-reflective channel bottom. These areas, which occur throughout the entire reach and are important to capture for flow conveyance and channel habitat assessment purposes, will be surveyed, subject to safety considerations, using traditional echo-sounding methods from a boat.

A spatial coverage delineating areas where the channel bottom was not measured (examples are shown in Figure 2.6-2) will be loaded onto a laptop running Hypack (hydrographic survey software) linked to a survey grade real-time kinematic (RTK)-GPS and a dual-frequency, single-beam echosounder or an acoustic Doppler current profiler (ADCP). The RTK operation will rely on RTK base stations broadcasting differential corrections. Areas to be surveyed by boat will be somewhat larger than gaps in the topobathymetric LiDAR coverage to provide some degree of overlap between the boat-based bathymetry and LiDAR and to identify and reconcile possible differences between the two data sources.

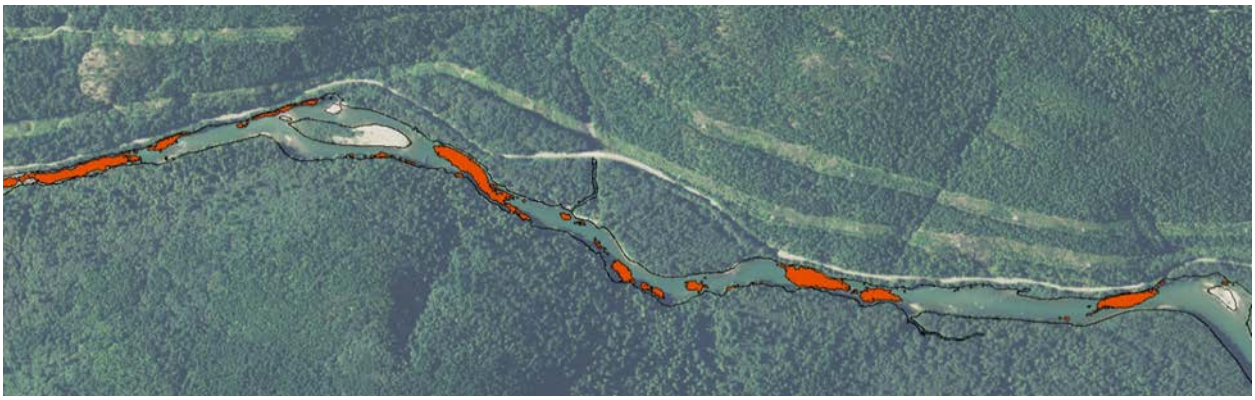

Figure 2.6-2. Red color indicates examples of areas where channel bottom was not mapped with topobathymetric LiDAR.

Where bathymetric surveys cannot be performed safely by boat, most notably in the approximately 1-mile reach known as Shovel Spur rapids, voids will be filled using interpolated terrain data produced by Quantum Spatial (Quantum Spatial 2018).

Boat-based survey bathymetry of voids and interpolated terrain data will be spliced into the topobathymetric LiDAR to create a complete three-dimensional terrain of the modeled reach.

The SRSC recently commissioned studies to evaluate measures to restore habitat conditions for fish and wildlife in the Barnaby Reach of the Skagit River (see also Section 2.3 of this study plan). As part of those efforts, a two-dimensional RiverFlow2D hydraulic model was built of approximately 7 miles of the Skagit River and its floodplain in 2019. The model topographic sources included Quantum Spatial's 2017 topobathymetric LiDAR (Quantum Spatial 2017a) supplemented with channel bathymetry collected via various methods in 2013 and 2014. SRSC's consultant merged the topography datasets and interpolated to fill in remaining data gaps. This developed terrain will be used as-is and joined with the composite terrain to be developed upstream of the Barnaby Slough reach.

The final composite terrain will be imported into HEC-RAS to define the riverbed and surrounding floodplain. The modeled domain will be one reach with boundary conditions as discussed in Section 2.6.2.4.

2.6.1.3 Model Geometry Development

A two-dimensional model mesh will be developed using tools in the HEC-RAS Mapper editor and "draped" over the final composite terrain. The mesh consists of cells, or elements, whose size, shape and orientation are refined as needed to simulate hydraulic conditions. The model cell size will be determined considering simulation run time (fewer cells equates to faster run times), resolution in areas of interest for habitat evaluation (more cells equates to finer resolution and slower run times) and calibration to observed velocities, depths and discharges. A relatively coarse mesh will be used to represent floodplain areas. The final mesh geometry and associated simulation time step will balance achieving good numerical accuracy at the desired resolution while minimizing computation time.

"Breaklines" will be added to the model mesh to ensure geometric features that affect river hydraulics (for example, raised roads) are adequately represented. Skagit River bridge crossings at Marblemount and Rockport will be included in the model.

Hydraulic roughness zones will be delineated representing land use and land surface classes found in the reach such as active riverbed, typically exposed channel bars, forested floodplain, and pasture. The results of the landform mapping study being conducted by the NPS will be reviewed in delineating roughness zones. Initial roughness coefficients will be assigned based on professional judgement and published values (e.g., Barnes 1967) and then refined during model calibration.

2.6.1.4 Model Boundary Conditions

Boundary conditions, representing hydrologic inputs to the proposed model, will be specified by: mainstem flows from the USGS gage Skagit River at Newhalem (as regulated by the Project), tributary inflows to the study reach from both gaged and ungaged tributaries, and flows from the USGS gage Sauk River near Sauk. The currently active gages which will be relied upon to provide these inputs are listed in Table 2.3-1. Active gage locations are shown in Figure 2.5-1. Gaged data will be downloaded from the USGS National Water Information System web site and reviewed for reliability, consistency, and accuracy. Ungaged tributary inflows between the mainstem Newhalem and Marblemount gages, and between the Marblemount gage and the confluence with the Sauk River, will be estimated from the gaged tributary flows using data from both the active gages and historical discontinued gauges. Ungaged tributaries include, for example, Goodell Creek, Diobsud Creek, and Illabot Creek.

City Light staff have observed that the study reach between the USGS Newhalem and Marblemount gages may experience some flow depletion under extreme low flows, as occurred in the summer of 2015. Available hydrologic and groundwater data will be reviewed to develop a better understanding of the significance of channel losses, to the extent possible. If necessary, consideration will be given to accounting for such losses in the hydraulic model by modifying the tributary inflows.

A stage or normal flow condition will be used to specify the model's downstream boundary, downstream from the confluence with the Sauk River.

2.6.1.5 Field Monitoring

A field monitoring program will acquire water level and concurrent discharge data throughout the study reach for use in hydraulic model calibration and validation. Additional detailed monitoring at select transects will also be conducted as described below. The goal of the monitoring program will be to acquire model calibration data at two or three discharges covering the range of discharges and hydraulic conditions of primary interest to fisheries management (discharges assumed to range from about 2,000 cfs to 6,000 cfs at Newhalem), plus one high flow discharge. Given that high flow events are unpredictable, monitoring of a high flow event will be on an opportunistic basis.

Six automatic water level recorders were installed over a six-month period from June through November 2020 at key locations throughout the study reach to supplement stage data available from the three mainstem Skagit River USGS gages at Newhalem, Marblemount, and Rockport and a mainstem stage gage approximately 1 mile upstream from the Sauk River confluence operated by the SRSC. Water levels will be recorded continuously at 15-minute intervals.

The locations for the automatic water level recorders were selected considering hydraulic model requirements, locations of existing mainstem gages, locations of tributary inflows, local hydraulic conditions, and access. The gages will be maintained by the USGS under agreement with City Light. One of the gages was installed at the former location of the USGS gage Skagit River above Alma Creek, with the goal of reestablishing a stage-discharge rating and hence having the ability to obtain continuous stage and discharge data at this location. The installation of these gages was identified by City Light as an early action item to ensure the gages were in place to capture any high flow events in the late spring/early summer 2020 snowmelt runoff period or during fall/early winter rainfall events to support hydraulic model development and calibration starting in spring 2021. The locations of the gages are shown in Figure 2.6-3.

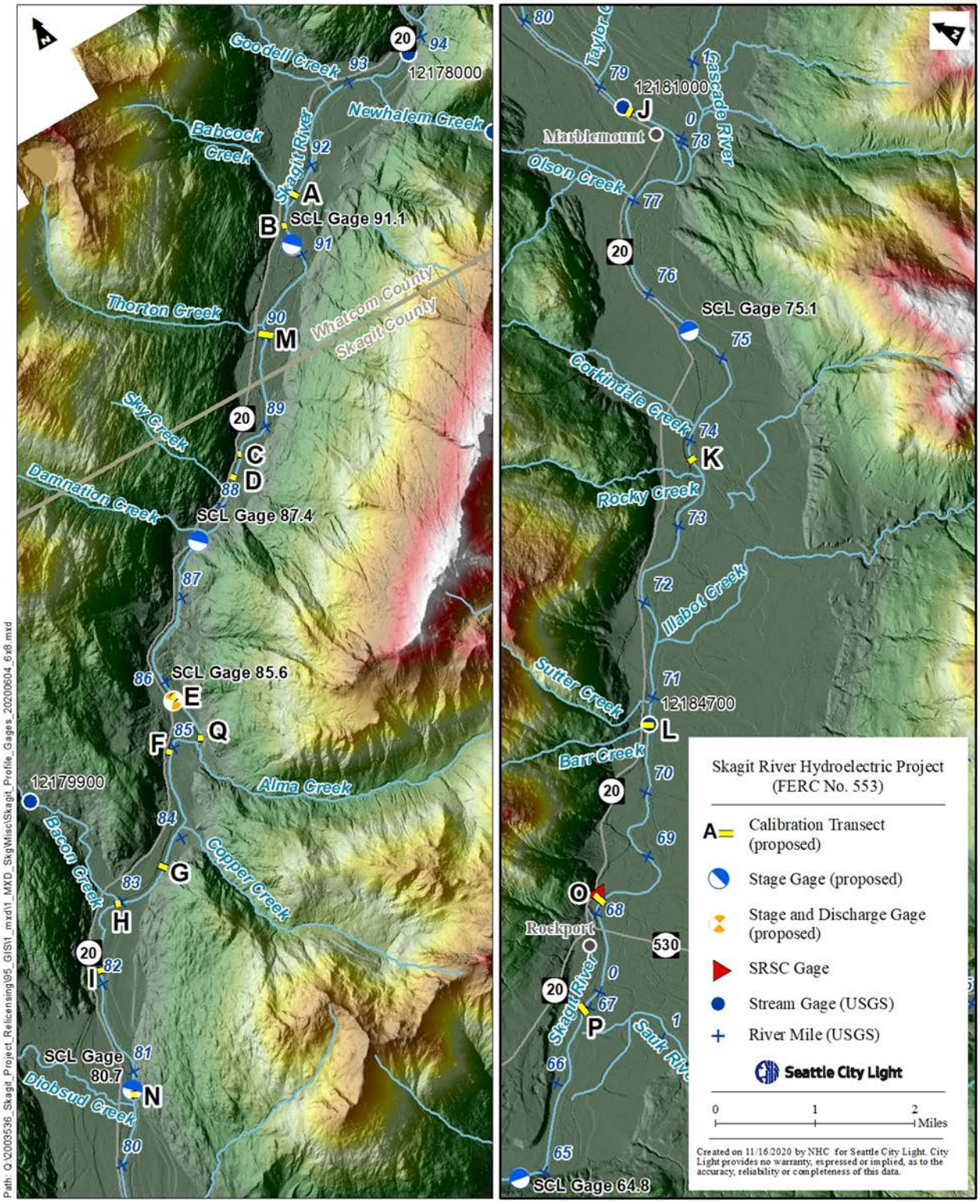

Figure 2.6-3. Stage and discharge gage locations.

In addition to continuous gaging, river water surface profiles for the entire 29-mile reach will be surveyed, subject to safety and access considerations, for discharges of about 2,000, 4,000, and 6,000 cfs at Newhalem. The exact number and magnitude of flows will be determined by hydrologic conditions and scheduled Project releases during the period of the monitoring program. This will be accomplished with the same boat-mounted echosounder or ADCP used to fill voids in the topobathymetric surface, and the key data recorded will consist of water surface elevations. The boat-mounted echosounder will continuously record water surface elevation while the Project discharges at Gorge Powerhouse are held approximately constant. A smoothing filter will be applied to the raw water surface elevation data to produce water surface profiles suitable for use in model calibration (see Section 2.6.1.6 of this study plan). Skagit River discharges will be measured concurrent with the water surface profile surveys at up to four locations along the study reach. Discharges will be determined using an ADCP mounted to a jet boat, augmented by a conventional current meter or handheld acoustic doppler velocimeter in areas too shallow for boat operation. Proposed locations for discharge measurements are: adjacent to the USGS gage Skagit River at Newhalem (gage 12178000), on the Skagit River upstream of the confluence with Alma Creek, adjacent to USGS gage Skagit River at Marblemount (gage 12181000), and adjacent to the USGS gage Skagit River near Rockport (gage 2184700). The need for measuring discharges at the locations of the USGS Newhalem and Marblemount gages will be determined following review of the current stage-discharge ratings developed by the USGS at those locations. If warranted, inflows at ungaged tributaries (for example, Goodell, Diobsud, and Illabot Creeks) will be measured.

Substrate Mapping

The results of substrate mapping will provide input for fish habitat modeling, be used to refine estimates of hydraulic roughness, and aid in hydraulic model calibration. Substrate will be classified visually according to the size codes identified in the WDFW/Ecology Instream Flow Study Guidelines (Beecher et al. 2016) (Table 2.6-2).

Table 2.6-2. Substrate size-classes.

Substrate Code	Type of Substrate
1	Silt, Clay, or Organic
2	Sand
3	Small Gravel (0.1-0.5")
4	Medium Gravel (0.5-1.5")
5	Large Gravel (1.5-3.0")
6	Small Cobble (3.0-6.0")
7	Large Cobble (6.0-12")
8	Boulder (>12")
9	Bedrock

Substrate polygons will be delineated throughout the study reach, with additional effort focused on high-value areas. Substrate mapping will be performed using map tiles developed from high-resolution aerial imagery (Quantum 2018; Skagit County 2015) and loaded into ArcGIS Collector on differential GNSS-enabled iPads. Substrate information will be recorded in Collector by electronically delineating polygons of homogeneous substrate facies (natural breaks) directly onto

the map tiles and assigning each polygon a substrate code. Substrate codes will use the format "ab.c" where "a" is the component code for dominant particle size (particle size will be assigned based on the particle's intermediate axis), "b" is the component code for the subdominant particle size, and "c" is tenths of cell area covered by dominant (50 percent or greater) substrate type. For example, the code 46.8 indicates 80 percent medium gravel and 20 percent small cobble (Beecher et al. 2016).

Field teams will be trained prior to mapping so that substrate coding is accurately and uniformly applied. Initially, crew members will "calibrate" their visual assessments of particle size using a gravelometer or ruler. Regular calibration checks will be conducted as needed, for example, when crews encounter a significant change in substrate conditions or if/when mapping is resumed after breaks in fieldwork.

Cover Mapping

Cover mapping, which will provide input for fish habitat modeling, will be conducted based on the codes identified in the WDFW/Ecology Instream Flow Study Guidelines (Beecher et al. 2016) (Table 2.6-3). The guidelines include nine cover criteria, eight of which (i.e., 00.2–00.9) will be mapped and used for modeling fish habitat. Undercut banks (00.1 in Table 2.6-3) likely constitute a small fraction of the overall rearing cover in a river the size of the Skagit, and exclusion of this cover type will have little influence on the 2D model's output. As a result, undercut banks will be omitted from the cover mapping exercise.

Table 2.6-3. Generic cover/substrate codes and preference values.

Cover Code	Type of Cover	Preference Values		
		Salmon and Trout Rearing	Whitefish Rearing	
		Juvenile and Resident Adult	Juvenile	Adult
00.1	Undercut Bank	1.00	1.00	1.00
00.2	Overhanging Vegetation Near or Touching Water	1.00	1.00	1.00
00.3	Rootwad (Including Partly Undercut	1.00	1.00	1.00
00.4	Log Jam/Submerged Brush Pile	1.00	1.00	1.00
00.5	Log(s) Parallel to Bank	0.80	0.80	0.80
00.6	Aquatic Vegetation	0.80	0.80	0.80
00.7	Short (<1') Terrestrial Grass	0.10	0.10	0.10
00.8	Tall (<3') Dense Grass	0.70	0.70	0.10
00.9	Vegetation > 3 Vertical ft. above SZF	0.20	0.20	0.20

Available remote sensing data packages will be used for initial delineation of cover types, and field mapping will be conducted as needed to supplement the remote sensing analysis. Mapping of overhanging vegetation will be based on available remote sensing data, augmented by a rapid refinement field effort to ensure that results comply with definitions in the Guidelines and reduce the potential for overestimation. Initial delineation of large wood will be based on aerial imagery. However, rootwads, submerged brush piles, and other large wood elements that cannot be delineated from aerial imagery will be mapped in the field. Estimates of aquatic vegetation

abundance and distribution can be derived largely from existing infrared imagery. Although there is likely little aquatic vegetation in the main channel, some targeted mapping will be used to supplement what is derived from infrared imagery. Short (<1 ft) terrestrial grass, tall (<3 ft) dense grass, and vegetation >3 vertical feet above stage at zero flow will be delineated using LiDAR and infrared imagery. Information from multiple remote sensing packages will be combined to produce a map of these terrestrial vegetation cover types.

Data Collection at Transects

Detailed monitoring of depth, velocity, and discharge will be performed at 17 transects distributed throughout the study reach. The transects were selected to represent the range of habitat types (i.e., range of hydraulic conditions) in the study reach: riffles, pools, meander bends, split channels, etc. The number and location of these transects, shown in Figure 2.6-3, were established in consultation with Ecology, WDFW, Upper Skagit Indian Tribe, and SRSC. The detailed monitoring will be conducted for two or three discharges in the range of discharge and hydraulic conditions of primary interest for fisheries management (assumed to range from about 2,000 to 6,000 cfs at Newhalem).

To allow hydraulic model development to be completed early in the relicensing process, City Light proceeded with monitoring of transect data and water surface profiles for low and moderate discharges in the late summer and fall of 2020. Monitoring of low flows was performed during the week of August 24, 2020, with a discharge at Newhalem of about 2,400 cfs. Monitoring under moderate flow conditions was performed during the week of October 19, 2020 with a discharge at Newhalem of about 4,200 cfs.

2.6.1.6 Model Calibration and Validation

The hydraulic model will be calibrated and validated against the discharge, velocity, and water level data acquired during the field monitoring program as well as data collected for the Barnaby Reach project, and data available from the existing USGS gauges at Newhalem, Marblemount and Rockport. Model calibration will be accomplished by first adjusting model coefficients and model mesh to match observed velocities and water levels at about 12 of the 17 transects. Data from the remaining transects will be reserved for use in model validation. The model calibration process will then be extended to match water levels both spatially and temporally at the water level monitoring stations and from the continuous water surface profiles. As part of the calibration process, sensitivity analyses will be conducted by modifying channel roughness coefficients (Manning's "n" values) over a range of conditions and recording how the model results are affected. Similar analyses will be conducted to determine the sensitivity of model results to model mesh size.

2.6.1.7 Development of Habitat Suitability Criteria

Habitat suitability criteria (HSC) define the range of microhabitat variables that are suitable for a species and lifestage of interest. HSC provide the biological criteria input to a habitat model that combines the physical habitat data and the HSC into habitat suitability calculations over a range of simulation flows. Variables typically defined with HSC include depth, velocity, substrate, and instream cover. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively.

Under the current Project license, flows downstream of the Gorge Powerhouse are managed in support of mainstem Skagit River anadromous fish production. The current flow plan is detailed in the Revised FSA (City Light 2011). The approach to managing flows for spawning, incubation, and rearing was initially developed by conducting an Instream Flow Incremental Method (IFIM) analysis using Physical Habitat Simulation (PHABSIM) which modeled nine species and 26 lifestages of sport fishes in the Skagit River. To optimize the model for instream flow planning, LPs agreed to focus on spawning and incubation criteria for Chinook, Pink, and Chum salmon, and steelhead (Crumley and Stober 1984 Vol. I). When the FSA was updated, target flows for stream-type rearing salmonids were also included. The resulting model is referred to as the ESH model. Inputs to the model for these four species were developed using Skagit River specific data where appropriate, which indicated that these species use deeper water, higher velocities, and larger substrate than are reported in the literature. In this way the usable area of the river was adjusted in the model to account for this Skagit specific information as suggested by Bovee (1978). The model produced a range of flows, creating usable spawning habitat and an associated incubation flow for each spawning flow. These mainstem flows incorporate tributary inputs based on observed exceedance flows and are referenced to the USGS gage at Newhalem. The model also incorporates flow program rules (i.e., ramp rates) to protect against fry stranding and trapping.

In practice, the output of the model will provide a season-long, flexible guideline for instream flows and (1) be adjustable based on natural variability of flows; (2) meet biological (spawning, incubation, rearing, and migration) requirements; and (3) protect fry from stranding and trapping, while supporting Project energy generation needs. Post-implementation analysis of the ESH model indicated an increase in mainstem salmon production (i.e., adult escapement) compared to pre-flow plan productivity (Connor and Pflug 2004).

The study proposes to review the existing river-specific habitat information and other flow program rules that support implementation of the current ESH model. ESH model documentation will also be reviewed, and existing species, lifestage, periodicity information and associated HSC, and other rules will be compiled and updated to reassess relationships between fish habitat and flow for the target species[2]. Existing information will be substantiated or updated, and data gaps and/or data issues (e.g., inaccurate, outdated) will be identified. Data gaps or data issues will be addressed using available regional information compiled from literature sources and agency documents (e.g., NMFS Recovery Plan, etc.) appropriate to the study reach. As necessary, updated HSC curves will be developed for each species and lifestage of interest.

HSC curves and periodicity information in combination with a calibrated and validated hydraulic model will allow for detailed analyses of the amount, timing, and location of suitable habitat under a range of discharges for species and lifestages of interest. This could, for example, include development of stage-discharge ratings at locations of interest, analysis of discharge wetted-area relationships, integration of model depth and velocity results with habitat data in an IFIM type of analysis to produce habitat-discharge relationships for species and lifestages of interest. Model results will be output directly from HEC-RAS and analyzed or synthesized further in GIS. For example, HEC-RAS model results will be output as depth and velocity grids. These will be

[2] Initial species and lifestages for HSC development and updates will be those identified in the current ESH model. As part of the model workshops, City Light will consult with LPs regarding additional species and lifestage HSC to be considered as part of the instream flow model.

analyzed in conjunction with substrate/cover grids and HSC curves using GIS scripts to compute usable area. Animation of model results with HEC-RAS RAS Mapper will be used to help visualize spatial and temporal variations in hydraulic and habitat conditions.

2.6.2 Consultation and Report Preparation

A series of five consultation workshops will be held with LPs during model development to solicit input and feedback as follows:

- An initial workshop to discuss the overall program for instream flow model development, including:
  - velocity, stage, and discharge monitoring for hydraulic model calibration;
  - hydraulic model calibration goals and model resolution or mesh size;
  - review/discussion of existing relevant biological and habitat metrics (i.e., the basis for the current ESH model) for model input, potential data gaps, and information sources; and
  - hydraulic model outputs needed to inform the development of guidelines for future fisheries management.
- A second workshop to review and discuss proposed updates to relevant biological and habitat metrics based on discussions and input from the initial workshop;
- A mid-point workshop to present information on hydraulic model construction, including terrain data, model geometry, and model boundary conditions;
- A workshop toward the end of the study to present and discuss the results of hydraulic model calibration and integration with biological/aquatic habitat data; and
- A final workshop to present final model calibration results and to discuss future model application.

The workshops topics identified above are typical model development milestones that benefit from LP consultation. Additional workshops and/or ad hoc discussions to discuss field data collection, model calibration, and other topics of interest to LPs related to the study may be scheduled in consultation with LPs.

A technical report will be prepared documenting instream flow model development, including evaluation of existing information, field data collection, model calibration and validation, and development and integration of biological/physical inputs.

2.7 Consistency with Generally Accepted Scientific Practice

HEC-RAS is widely recognized and accepted throughout the engineering and scientific community for riverine hydraulic modeling. The proposed study methodology for hydraulic model development is consistent with the approach used for similar work.

2.8 Schedule

The schedule for completion of the instream flow model is determined both by the overall schedule for Project relicensing and the needs for hydraulic modeling input by other studies. The schedule

proposed for the Skagit River Geomorphology Between Gorge Dam to Sauk River Study Plan, for example, assumes the availability of a hydraulic model by fall 2021.

The proposed study schedule for hydraulic model development is as follows:

- Planning, permitting, acquisition and installation of stage recorders – April to October 2020
- Opportunistic monitoring of stage and discharge data for high flow events – July 2020 to July 2021
- Monitoring of stage, velocity, and discharge data for controlled flows of primary interest for fisheries management and conducting substrate and cover mapping – August 2020 to July 2021
- Supplementary bathymetric surveys – October[3] to November 2020 and March to April 2021, as flows safely allow
- Review and development of HSC – April to July 2021
- Hydraulic model development and calibration – May to November 2021
- Model Workshops
  - Workshop 1: Instream Flow Model Development Program Overview – April 2021
  - Workshop 2: Biological and Habitat Metrics – July 2021
  - Workshop 3: Hydraulic Model Construction – July/August 2021
  - Workshop 4: Hydraulic Model Calibration and Biological/Habitat Integration – September 2021
  - Workshop 5: Final Calibration and Model Application – November 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $975,000.

[3] Surveys to fill voids in the bathymetric data were initiated in October 2020. Approximately 30 percent of the required data were collected before surveys had to be suspended due to unsafe conditions. The remaining data will be collected in March or April 2021.

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INSTREAM FLOW MODEL DEVELOPMENT
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	General Comments Title Page	Although instructed by SCL staff at the Fish and Aquatics Technical work group on 5/520 that the Utility is no longer accepting scope or scale comments- the discrepancy between tribal resource management goals and study plan draft require additional comments to scope and scale be considered.	Thank you for your comment. Although City Light believes the scope of the study plan is appropriate to develop the information needed to assess potential Project effects, City Light looks forward to continuing discussions on this and other study plans and encourages LPs to submit study plan comments and/or submit additional study requests to FERC as part of the formal relicensing process for issues that remain unresolved through the current consultations and study plan review process. City Light remains committed to continued collaboration with LPs regularly throughout the ILP process.
2.	Brock Applegate (WDFW)	05/05/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG consultation~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally." Please use language from Revised Sedimentation and Operations Model Study Plans. **New comment provided on 06/24/2020:** WDFW does not consider the process as collaborative when the licensee tells the Licensing Participants (LPS) to take their issues to FERC. SCL management would not select the collaborative licensing process, the Alternative Licensing Process, which most, if not all, licensing participants preferred. SCL can select the licensing process they prefer, but the ILP	Section 1.2 and 1.3 were redrafted to better describe the 2019 process. Formal consultation does not begin until after the PAD is officially submitted. Although LP consultation leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together). **Response to comment provided on 06/24/2020:** City Light appreciates your agency's input and looks forward to working with you to address resource issues during the relicensing proceeding.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				operates in consultation, not collaboration when SCL chooses to separate the licensing process from the settlement agreement process. I would agree that we did collaborate during the collection of study issues.	
3.	Judy Neibauer (USFWS)	05/13/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG consultation, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally." Mention here that this information will help inform NEPA, the BA for ESA consultation, and the information needed for Section 10j for the Fish and Wildlife Coordination Act....similar to your other study plans....	Section 1.2 has been edited to identify elements of the relicensing process, such as those noted by USFWS.
4.	Brock Applegate (WDFW)	05/05/2020	Section 1.2 Relicensing Process	"This study will develop numerical hydraulic models of the Skagit River in the reach between Gorge Dam and the confluence with the Sauk River." Flows have effects on aquatic habitat all the way to the estuary.	City Light intends to assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the relicensing process.
5.	Ashley Rawhouser (NPS)	05/13/2020	Section 1.3 Study Plan Development	"This study will develop numerical hydraulic models of the Skagit River in the reach between Gorge Dam and the confluence with the Sauk River." Concur with WDFW and USFWS study area should extend to Puget Sound.	See Comment Response #4.
6.	Judy Neibauer (USFWS)	05/13/2020	Section 1.3 Study Plan Development	"The models may contribute to addressing a variety of issues identified in the issue forms listed in Table 5.3-1 of the PAD (City Light 2020)."	See Comment Response #4. The FERC process schedule positions an integrated environmental analysis subsequent to

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				I agree we will need to understand effects of operations on flow effects down to the estuary for a variety of reasons...aquatic species, riparian habitat, floodplain connectivity, etc. I would also like to understand how operations that alter the reservoirs daily for about 4-5 feet, and then on maintenance or flood flow events that alter the reservoir elevations up to 50 feet might affect downstream resources. Monitoring instream flows to depict what happens all the way downstream, will be important for ESA consultation.	the completion of the study program and prior to the filing of a Project License Application. The integrated environmental analysis will address cross-resource linkages and issues. The information resulting from the study program is intended to inform consultation with LPs including USFWS during future steps within the process. City Light has added language to Section 1.3 to address potential linkages between studies.
7.	Judy Neibauer (USFWS)	05/13/2020	Section 1.3 Study Plan Development	"The models may contribute to addressing a variety of issues identified in the issue forms listed in Table 5.3-1 of the PAD (City Light 2020)." Describe if you will use existing data, other data or links to other study plans here such as geomorphology, operational flows model, etc to help establish timeframes and locations for monitoring stream flow and establishing "instream flows"	Section 1.3 was redrafted to better describe the 2019 process including the rationale supporting City Light's initial draft study plan proposal. See Comment Response #6.
8.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	"**2.1 Study Goals and Objectives**" An Instream Flow Study needs to be as comprehensive as possible and go beyond development of a flow model to be used later in relicense. The study plan needs to identify how the model will be used and what other studies it will be integrated with including the geomorphology study and riparian vegetation study. While many model runs may be developed by an instream flow study group a number of examples should be included in the	See Comment Response #6. The scope of the study is the development, calibration and validation of the model. Subsequent phases of the relicensing process are intended to analyze cross-resource issues and to compare alternative scenarios to existing conditions.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				study plan that goes into the PSP in the ILP process.	
9.	Brock Applegate (WDFW)	05/05/2020	Section 2.1 Study Goals and Objectives	"The primary goal of the Instream Flow Model Development Study is to develop an updated flow/habitat management and evaluation tool for the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River." SCL should extend your geographic scope. The effects of the Project continue downstream in some manner. With a estuary that needs more sediment and a change in timing, a reduction in magnitude and duration of process flows, SCL has cumulatively affected the downstream Skagit River with other users.	See Comment Response #4.
10.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	"The primary goal of the Instream Flow Model Development Study is to develop an updated flow/habitat management and evaluation tool for the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River." There are several flow impacts that extend below the Sauk River confluence that need to be studied including but not limited to middle river spawning and incubation (including timing), flood plain connectivity, habitat flows, downramp rates and amplitudes. Additionally flow impacts combined with geomorphic impacts including disrupted bedload, fine sediment delivery to the Skagit Bay front, LWD disruption to the middle Skagit may be limiting salmonid habitat below the Sauk River.	See Comment Response #4.
11.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1	"The primary goal of the Instream Flow Model Development Study is to develop an updated	See Comment Response #4.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Study Goals and Objectives	flow/habitat management and evaluation tool for the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River." I suggest you extend the scope of the study to include the full basin	
12.	Brock Applegate (WDFW)	05/05/2020	Section 2.1 Study Goals and Objectives	"A second~~ary~~ goal is to describe current hydraulic conditions in the Skagit River between Gorge Dam and the Gorge Powerhouse (i.e., Gorge bypass reach) through the development of a numerical hydraulic model for this reach." **New comment provided on 06/24/2020:** SCL does not understand the request from WDFW. Please see below. WDFW recommended that SCL combine the bypass reach with this instream flow model effort in the downstream reach, not put it in a separate study plan.	City Light understands the requests from WDFW and other LPs for a study plan that focuses on information necessary in the bypass reach and welcomes discussion on the best way to address this in a separate study plan at future RWG meetings. City Light agrees that it may be best to discuss these information needs separate from the existing instream flow study plan, and has removed related text from this study plan. **Response to comment provided on 06/24/2020:** See Comment Responses #12 and #120. Although separate models are proposed for the bypass reach and the Gorge Powerhouse to Sauk River reach, the models will be configured to allow easy interface with outflow from the bypass reach model providing input at the upstream end of the Gorge Powerhouse to Sauk River model. The principal technical reason for developing separate but linkable models is the much finer resolution (and hence longer computational times) required of the bypass reach model given the different physical characteristics of the two reaches.
13.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	"A secondary goal is to describe current hydraulic conditions in the Skagit River between Gorge Dam and the Gorge Powerhouse	See Comment Response #12.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				(i.e., Gorge bypass reach) through the development of a numerical hydraulic model for this reach." Upper Skagit Indian Tribe views this goal as of equal importance to the primary goal stated above.	
14.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	"A secondary goal is to describe current hydraulic conditions in the Skagit River between Gorge Dam and the Gorge Powerhouse (i.e., Gorge bypass reach) through the development of a numerical hydraulic model for this reach." This should include looking at habitat potential in the bypass reach.	See Comment Response #12.
15.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	"Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model of the Skagit River for the reach between the Gorge Dam~~Powerhouse~~ and the confluence with the Sauk River. ▪ Integrate hydraulic model outputs with biological (species, lifestages, periodicities, etc.) and physical (depth, velocity) criteria used in the current flow/habitat management tool to develop updated flow/habitat relationships for the reach between the Gorge Dam~~Powerhouse~~ and the confluence with the Sauk River. ▪ Develop, calibrate, and validate a numerical hydraulic model for the Skagit River for the Gorge bypass reach to describe current hydraulic conditions in this reach." SCL should develop hydraulic models and use fish habitat suitability curves in both reaches. I understand the need to divide the reaches out	See Comment Response #12. This study plan now only refers to the study reach downstream of the Gorge Powerhouse. **Response to comment provided on 06/24/2020:** See Comment Responses #12, #120, and #143.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				because of the water supply, but they should receive equal treatment in the process of obtaining instream flows. **New comment provided on 06/24/2020:** Please see my comment on #12. Combine the study areas, not separate them.	
16.	Curtis Clement (Upper Skagit Indian Tribe)	05/07/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment "Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model of the Skagit River for the reach between the Gorge Powerhouse and the confluence with the Sauk River." The project affects the river all the way to the sound. Why doesn't SCL want to examine what the impacts might be below the Sauk? If mitigation is to be done upstream of the Sauk, that mitigation will always have impacts downstream, it would only be logical to investigate what that impact might be. This model is the perfect time and place to make that investigation. It's only going to help design better mitigation upstream.	See Comment Response #4.
17.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment "Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model of the Skagit River for the reach between the Gorge Powerhouse and the confluence with the Sauk River."	See Comment Response #4.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				As Curtis states, this study needs to cover the entire Skagit River to Puget Sound. See our previous comments for a more thorough justification of this study need (e.g. Wetland and Vegetation Mapping study plans).	
18.	Jon Riedel (NPS)	05/13/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment "Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model of the Skagit River for the reach between the Gorge Powerhouse and the confluence with the Sauk River." Suggest this be integrated with 2 geomorphology mapping projects: landform mapping and habitat characterization. Specifically, model domain should be designed with reach scale geomorphology and landforms in mind.	As part of study planning, existing information such as the referenced landform mapping and habitat characterization will be assessed for utility. The study team is also coordinating with the geomorphology and vegetation mapping study team to ensure that data collection and analyses under that study inform model development.
19.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Specific objectives include: ▪ Integrate hydraulic model outputs with biological (species, lifestages, periodicities, etc.) and physical (depth, velocity) criteria used in the current flow/habitat management tool to develop updated flow/habitat relationships for the reach between the Gorge Powerhouse and the confluence with the Sauk River." Additional criteria should be integrated:	All of these data will be collected as part of the vegetation mapping and geomorphology studies. This study is intended to develop the hydraulic model that will be combined with the results of other studies in order to model fish habitat and potential use. Additional data collection can be discussed during the LP workshops which are a part of this study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				1) Habitat units/types (e.g. pool, riffle, bank, bar, backwater, side-channel, off-channel). 2) Instream cover (e.g. large woody debris, vegetated bars) 3) Substrate composition (e.g. spawning suitability, cover for juveniles) Field studies should document these metrics, if not already collected in other studies.	
20.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	2nd Bullet - Comment "Specific objectives include: ▪ Integrate hydraulic model outputs with biological (species, lifestages, periodicities, etc.) and physical (depth, velocity) criteria used in the current flow/habitat management tool to develop updated flow/habitat relationships for the reach between the Gorge Powerhouse and the confluence with the Sauk River." Including modifications from additional data sources	Text has been revised as suggested.
21.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Specific objectives include: ▪ Integrate hydraulic model outputs with biological (species, lifestages, periodicities, etc.) and physical (depth, velocity) criteria used in the current flow/habitat management tool to develop updated flow/habitat relationships for the reach between the Gorge Powerhouse and the confluence with the Sauk River."	See Comment Responses #4, #6, and #8.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				See second comment in this section (See Comment #10)	
22.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	3rd Bullet – Comment "Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model for the Skagit River for the Gorge bypass reach to describe current hydraulic conditions in this reach." This reach should not be treated separately, or SCL should justify why it is being treated separately. The Gorge bypass reach has the same study needs as the rest of the Skagit River within and below the project boundary.	See Comment Response #12.
23.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	3rd Bullet – Comment "Specific objectives include: ▪ Develop, calibrate, and validate a numerical hydraulic model for the Skagit River for the Gorge bypass reach to describe current hydraulic conditions in this reach." Need to include reference to Unsteady flow model development – see below.	See Comment Response #12. The hydraulic model proposed is an unsteady flow model. The study plan has been edited to indicate this.
24.	Brock Applegate (WDFW)	05/05/2020	Section 2.1 Study Goals and Objectives	"Once the study is complete (i.e., the models have been developed), the flow/habitat models will be used to investigate and inform the evaluation of flows and habitat in the Gorge Dam~~Powerhouse~~ to Sauk River reach to continue supporting ~~mainstem~~Skagit River fish production during the new FERC license term and to support additional discussions regarding	See Comment Response #12. **Response to comment provided on 06/24/2020:** See Comment Responses #12 and #120.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				hydraulic conditions and fish and aquatic habitat, including migration habitat, in the Skagit River in the Gorge bypass reach." **New comment provided on 06/24/2020:** SCL will need to consider the entire fish population, not just the population in the mainstem or below the powerhouse.	
25.	Judy Neibauer (USFWS)	05/13/2020	Section 2.1 Study Goals and Objectives	"Once the study is complete (i.e., the models have been developed), the flow/habitat models will be used to investigate and inform the evaluation of flows and habitat in the Gorge Dam to Sauk River reach to continue supporting Skagit River fish production during the new FERC license term and to support additional discussions regarding hydraulic conditions and fish and aquatic habitat, including migration habitat, in the Skagit River in the Gorge bypass reach." Link to the operational plan, reservoir information, so that when you are sampling downstream and looking at stream flows, you understand what effects are occurring to water levels in the reservoirs...i.e., are tributaries left disconnected or exposed, is there stranding occurring at all, etc...The upstream reservoirs levels and downstream flows information gathered in both areas will need to be combined, to understand the level of risk to both upstream and downstream resources when developing instream flow parameters.	The Instream Flow Model is designed to be operated in tandem with the Operations Model. Post-study analysis of potential Project effects and evaluation of potential alternative operating scenarios using the Instream Flow Model will include linkages to the Operations Model.
26.	Stan Walsh (SRSC)	05/11/2020	Section 2.1 Study Goals and Objectives	"Once the study is complete (i.e., the models have been developed), the flow/habitat models will be used to investigate and inform the evaluation of flows and habitat in the Gorge	Text has been revised as suggested.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Powerhouse to Sauk River reach to continue supporting mainstem Skagit River fish production during the new FERC license term and to support additional discussions regarding hydraulic conditions in the Skagit River in the Gorge bypass reach." Should be fish habitat rather than production	
27.	Stan Walsh (SRSC)	05/11/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop an updated flow/habitat management tool to re-examine flow management in the portion of the Skagit River affected by Project operations between the Gorge Powerhouse and the confluence with the Sauk River to evaluate whether flows as currently regulated by the Project continue to support mainstem Skagit River fish production, and identify where changes may be needed." See second comment section 2.1 (See Comment #10)	See Comment Responses #4, #6, and #8.
28.	Stan Walsh (SRSC)	05/11/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop an updated flow/habitat management tool to re-examine flow management in the portion of the Skagit River affected by Project operations between the Gorge Powerhouse and the confluence with the Sauk River to evaluate whether flows as currently regulated by the Project continue to support mainstem Skagit River fish production, and identify where changes may be needed." This statement suggests the study will be evaluating fish production – which it is not. Suggest rephrasing to "…provide the quantity	Text has been revised as suggested.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				and quality of fish habitat in the mainstem Skagit River necessary to sustain healthy fish populations of key species	
29.	Brock Applegate (WDFW)	05/11/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop an updated flow/habitat management tool to re-examine flow management in the portion of the Skagit River affected by Project operations between the Gorge DamPowerhouse and the estuary confluence withof the Skagitauk River to evaluate whether flows as currently regulated by the Project continue to support mainstem Skagit River fish production, and identify where changes may be needed." SCL should try to identify their partial effects that grow less down the river in SCL's effects analysis.	These edits have not been accepted. See Comment Response #4.
30.	Brock Applegate (WDFW)	05/11/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop an updated flow/habitat management tool to re-examine flow management in the portion of the Skagit River affected by Project operations between the Gorge DamPowerhouse and the estuary confluence withof the Skagitauk River to evaluate whether flows as currently regulated by the Project continue to support mainstem Skagit River fish production, and identify where changes may be needed." WDFW recommends that SCL take migration of fish upstream into and downstream from tributaries into account when the LPs consider instream flows. Tributary fish production should include fish passage in and out of the tributaries as well.	See Comment Response #12. Regarding connectivity of the mainstem Skagit River and associated tributaries (between Gorge Dam and the Sauk River), City Light is not aware of any existing connectivity issues but is interested in exploring these concerns with LPs if there is evidence of issues at such locations. While identification and development of PMEs (i.e., instream flows) for the next license is a phase of relicensing subsequent to the study program, City Light anticipates and is committed to working with LPs during this phase of the ILP to ensure tributary connectivity.
31.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource	"National Marine Fisheries Service (NMFS), US Fish and Wildlife Service,(USFWS),	Edits accepted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Management Goals	Washington Department of Fish and Wildlife (WDFW), the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, and the Swinomish Indian Tribal Community all have management responsibilities for anadromous salmonids and their prey species, wildlife and plants ~~salmon and steelhead~~ in the ~~lower~~ Skagit River basin and its tributaries. Other agencies have responsibilties for adjacent land management." The US Fish and Wildlife Service also has responsibilities for anadromous fish. We would also like you to include other fish species in development of instream flow models for management. Pacific Lamprey, bull trout, Whitefish, cutthroat, etc and other species that may contribute to prey base...per our Critical Habitat PCE 3	The current ESH model incorporates the needs of 9 salmonid species (including cutthroat trout and mountain whitefish) and 26 associated life stages and this biological/habitat information including other rules/constraints to protect fisheries resources (e.g., ramp rates, etc.) will serve as the initial biological inputs for the Instream Flow Model. Additional discussions regarding refinements of biological model inputs is anticipated to occur at model workshops identified in Section 2.6.2.
32.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource Management Goals	"National Marine Fisheries Service (NMFS), US Fish and Wildlife Service,(USFWS), Washington Department of Fish and Wildlife (WDFW), the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, and the Swinomish Indian Tribal Community all have management responsibilities for anadromous salmonids and their prey species, wildlife and plants in the Skagit River basin and its tributaries. Other agencies have responsibilties for adjacent land management. I suggest you extend the scope to the full basin, Please see our critical habitat rule that has 9 PCEs that need to be maintained. These were developed in 2010. Of importance to note is PCE 1 to maintain seeps, springs, ground water, subsurface water like Hyporheic areas; as well	See Comment Responses #4, #6, and #25.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				as the other 8 PCES that are linked to stream flow and reservoir levels in one way or another. If you need to link to other model already completed you can show how you might do that in this model or additional studies. Link to the geomorphology, landform, and operational studies to understand where addition key areas are from a hyporheic standpoint. Understanding where and how these hyporheic areas are, will help identify key refugia within the river channels so that you can accommodate instream flows to protect them. These areas provide for forage, overwintering, cool water refugia, spawning....within the larger water bodies.	
33.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource Management Goals	"National Marine Fisheries Service (NMFS), US Fish and Wildlife Service,(USFWS), Washington Department of Fish and Wildlife (WDFW), the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, and the Swinomish Indian Tribal Community all have management responsibilities for anadromous salmonids and their prey species, wildlife and plants in the Skagit River basin and its tributaries. Other agencies have responsibilties for adjacent land management. You should mention that we now have listed critical habitat and populations since the issuance of the last license and fish settlement agreement. The goal here would be to look at stream flow and develop a new set of instream flows that reduce impacts to species and habitats. You could even list or link to our Critical habitat PCEs for listed species or to the Mag Stevens or other resource management goal for other agencies...such as the USFS	See Comment Response #6.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				standards and guides that address Key watersheds and the Aquatic Conservation Strategy...	
34.	Judy Neibauer (USFWS)	05/13/2020	Section 2.2 Resource Management Goals	National Marine Fisheries Service (NMFS), US Fish and Wildlife Service,(USFWS), Washington Department of Fish and Wildlife (WDFW), the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, and the Swinomish Indian Tribal Community all have management responsibilities for anadromous salmonids and their prey species, wildlife and plants in the Skagit River basin and its tributaries. Other agencies have responsibilties for adjacent land management. not just looking at instream flow for anadromous salmon, will need to include other resources, per my additional language suggestion...	See Comment Response #31.
35.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.2 Resource Management Goals	"The flow/habitat model will serve as a tool to analyze current conditions and alternative scenarios during the relicensing process. Additionally, the hydraulic model may be used to support the assessment, planning and design of potential off-channel and floodplain restoration projects that enhance juvenile salmonid rearing opportunities in this reach." The model should also be capable of handling predicted geomorphic changes under additional potential mitigation alternatives: 1) Process flows to create and sustain fluvial habitats 2) Sediment and wood reintroduced below the dams	See Comment Responses #6 and #8. The primary purpose of the hydraulic model will be to investigate and inform the evaluation of flow/habitat relationships in support of mainstem Skagit River aquatic habitat protection and fish production. The model will have the flexibility that it could be modified or adapted for a range of other applications and interests. The proposed model will not simulate sediment transport or geomorphic change. However basic hydraulic model outputs (discharge, water depth, velocity, shear stress) can be used to support analysis of sediment transport and geomorphic change and will be used to support the geomorphology study.

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36.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.2 Resource Management Goals	"The flow/habitat model will serve as a tool to analyze current conditions and alternative scenarios during the relicensing process." Need the tool to assess Steelhead kelt migration flows, juvenile migration flows and stream life history flows for rearing, growth and survival.	The current model accounts for juvenile migration and rearing. Steelhead kelts were not included in the current model. See Comment Response #31. Additional discussions regarding refinements of biological model inputs is anticipated to occur at model workshops identified in Section 2.6.2.
37.	Stan Walsh (SRSC)	05/11/2020	Section 2.2 Resource Management Goals	"The flow/habitat model will serve as a tool to analyze current conditions and alternative scenarios during the relicensing process." Should include other study linkages (geomorphology, riparian vegetation) and some specifics such as floodplain connectivity and hyporheic flows for riparian vegetation.	See Comment Responses #6, #8, and #35.
38.	Stan Walsh (SRSC)	05/11/2020	Section 2.2 Resource Management Goals	"City Light will confer with resource agencies and tribes that are interested in participating in development of this study proposal, and language identifying specific management goals relevant to this study proposal is anticipated." Will these conferences result in a revised study plan for the PSP?	Consultation on City Light's draft study plans with LPs is intended to result in a revised study plan that would be included in the PSP filing in December 2020. City Light also encourages LPs to submit study plan comments on the PSP and/or submit additional study requests to FERC as part of the formal relicensing process for issues that cannot be resolved prior to PSP submission.
39.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	Detailed information is required on hydraulic conditions and their spatial and temporal variation in the Skagit River between Gorge Dam~~Powerhouse~~ and the estuary ~~confluence with~~ in the Skagit~~auk~~ River to support management of flows for Skagit River fish production.	These edits have not been accepted. See Comment Responses #4 and #12.
40.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"The Revised FSA provides requirements for protection of Chinook, Pink, and Chum salmon and for steelhead for all life stages."	City Light will be assessing Project effects on rearing habitat and geomorphology as part of our effects analysis. In order to assess the effect of the Project on geomorphology, including

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				Perhaps this was the original intent, but subsequent scientific evidence indicates that all life stages are not adequately protected. The Skagit Chinook Recovery Plan identifies juvenile rearing habitat as a key limiting factor basin-wide in the Skagit. An overarching cause is interrupted fluvial habitat forming processes, which includes impacts from hydroelectric projects. The new instream flow study, in combination with the geomorphic study, needs to address interruptions to geomorphic processes that create and sustain rearing habitats for Chinook.	rearing habitat, we will first need to determine the existing conditions. We can then determine how the Project affects the specific metrics which you listed in your comment. It will require that we integrate the results of several other studies in order to conduct this analysis. The hydraulic model and instream flow related habitat metrics are just one piece of that puzzle.
41.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Changes in channel morphology and habitat conditions have occurred over time and an updated model will reflect both current channel conditions and river hydraulics over a broader range of hydrologic conditions." Will the model reflect expected future changes to channel conditions?	See Comment Response #6. The model is intended to describe the existing environmental conditions with regards to flows and aquatic habitat to support fish production. As part of an integrated environmental analysis (subsequent to the relicensing study program) the model will support an analysis of Project effects, assess cross-resource linkages and compare alternative scenarios to the existing condition. Within this analysis framework, the model may be used to inform estimates of potential future changes to channel conditions under alternative operational (flow) scenarios that could be implemented in the future.
42.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Additional data provided by the 2012 model, upstream of the Barnaby Reach domain, is based on outdated bathymetric survey data that may not accurately characterize current terrain conditions." This speaks to the need to incorporate predicted geomorphic changes over the course of the	See Comment Response #41. Note that the proposed 2D HEC-RAS model would be relatively easy to update with new terrain data as they become available.

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				license period, or to develop a model that can be used to adaptively manage over the course of the new license.	
43.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"The one-dimensional model of the upper Skagit, upstream from the Sauk River, is based on outdated channel cross-section data, including data from the Federal Emergency Management Agency (FEMA) surveys of the 1970s." It is also inadequate because it is a 1-D model. A 2-D model is needed to assess complex channel and floodplain habitats.	Agreed.
44.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"The one-dimensional model of the upper Skagit, upstream from the Sauk River, is based on outdated channel cross-section data, including data from the Federal Emergency Management Agency (FEMA) surveys of the 1970s." WDFW assumes that SCL will update the channel cross-section data.	The model geometry will be developed from LiDAR data collected between 2016 and 2018 supplemented by new bathymetric surveys as described in study plan sections 2.6.2.2 and 2.6.2.3. The 1970s era cross-section data will not be used.
45.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3 Background and Existing Information	"There are no existing hydraulic models for the Gorge bypass reach. Under existing conditions, this 2.5-mile-long reach of the Skagit River flows through a steep, confined canyon that is characterized by bedrock and large boulder substrate." Please measure and site consistently across study plans	Previous documents note that the bypass reach is 2.7 miles long. Current calculations by City Light, made in 2019, reveal the bypass to be 2.5 miles long. This vetted number was used consistently throughout the PAD.
46.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Gorge bypass reach is mainly limited by minimal natural flow inputs derived from seepage under Gorge Dam, groundwater accretions, and from four	See Comment Response #12.

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				ephemeral (non-fish bearing) streams, which do not provide a fully wetted channel (Envirosphere 1988)." Incorrect. It is mainly limited by Gorge Dam flow diversions and disrupted sediment and wood transport.	
47.	Curtis Clement (Upper Skagit Indian Tribe)	05/07/2020	Section 2.3 Background and Existing Information	"Development of a hydraulic model will support additional analyses regarding hydraulic conditions in the Gorge bypass." Needs elaboration as to how it will support analysis of a reach that is upstream of where the model will begin.	See Comment Response #12. The sentence quoted refers to development of a hydraulic model of the bypass reach which has now been removed.
48.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Development of a hydraulic model will support additional analyses regarding hydraulic conditions in the Gorge bypass." For below the Sauk, there may be a 2-D model developed for the Skagit River between Day Creek and Sedro-Woolley (project currently being proposed under the RCO Salmon Recovery Funding Board program).	Thank you for the information.
49.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Gorge bypass reach is mainly limited by minimal natural flow inputs derived from seepage under Gorge Dam, groundwater accretions, spill from Gorge Dam, and from four ephemeral (non-fish bearing) streams, which do not provide a fully wetted channel (Envirosphere 1988), when SCL does not spill."	See Comment Response #12.
50.	Stan Walsh (SRSC)	05/11/2020	Section 2.3 Background and Existing Information	"Development of a hydraulic model will support additional analyses regarding hydraulic conditions in the Gorge bypass."	See Comment Response #12.

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				Should include habitat potential in the bypass reach	
51.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Gorge bypass reach is mainly limited by minimal natural flow inputs derived from seepage under Gorge Dam, groundwater accretions, spill from Gorge Dam, and from four ephemeral (non-fish bearing) streams, which do not provide a fully wetted channel (Envirosphere 1988), when SCL does not spill." Linking up to geomorphology, operational modeling, and landform study information may show that there is other ground water, seeps, springs that are important. Please link to that information.	See Comment Responses #6 and #25.
52.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"Development of a hydraulic model will support additional analyses regarding hydraulic conditions in the Gorge bypass." Please think about including a 3-d model development that will greatly assist in showing and helping to develop alternatives for flow management in the future	See Comment Response #12. While a 3-D model would allow detailed examination of hydraulic conditions at certain specific locations (e.g. at a plunge pool), it would not be feasible to apply at the scale of the bypass reach as a whole.
53.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"Topographic and bathymetric data. LiDAR data covering the proposed hydraulic model extents (see Section 2.5 of this study plan) were acquired in 2017 and 2018 (Quantum Spatial 2017; Quantum Spatial 2018). The LiDAR generally provides high quality topographic and bathymetric data, however there are some gaps or voids in the channel bathymetry data because of limitations imposed by water depth and/or channel bed conditions. These voids will need to be filled using ground-based surveys as	See Comment Response #4.

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				described in more detail in Section 2.6 of this study plan." Data needs for below the Sauk must be addressed.	
54.	Judy Neibauer (USFWS)	05/13/2020	Section 2.3 Background and Existing Information	"The PAD also provides monthly minimum, average, and maximum outflows from Ross, Diablo, and Gorge lakes for the period 1991–2018. During the study, opportunistic flows may need to be take during certain times of the year or during changes in operations. Please consider adding some number of opportunistic flow recording sites to capture events that will collect data that represents the range of changes that may occur during operations.	The field monitoring program proposed in study plan section 2.6.2.5 includes installation of automatic water level recorders. These, in conjunction with existing flow gauging stations, will collect data within the study reach which reflects operational changes during the monitoring period.
55.	Jon Riedel (NPS)	05/13/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations regulate flows in the Skagit River downstream from Gorge Dam, reducing downstream flood risk, altering geomorphic processes, and influencing, through a variety of pathways, the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids." And at various spatial and temporal scales. The project has a particularly large impact on the long-duration spring flood, when Ross Lake is being filled with snow melt runoff. This is a geomorphically/habitat key flow event.	Comment acknowledged. The Geomorphology between Gorge Dam and the Sauk River Confluence study will also help to address effects of peak flow events on geomorphology and aquatic habitat including peak flow magnitude, frequency, timing, and duration.
56.	Brock Applegate (WDFW)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations regulate flows in the Skagit River downstream from Gorge Dam, reducing downstream flood risk, altering geomorphic processes, and influencing, through a variety of pathways, the availability and suitability of	See Comment Response #31.

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				spawning, incubation, and rearing habitat for anadromous salmonids." SCL affects many more species than just anadromous salmonid species. The project affects all aquatic habitat and species, including macroinvertebrate populations, resident trout, other fish species, and other organisms.	
57.	Stan Walsh (SRSC)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations regulate flows in the Skagit River downstream from Gorge Dam, reducing downstream flood risk, altering geomorphic processes, and influencing, through a variety of pathways, the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids." And resident	See Comment Response #31.
58.	Judy Neibauer (USFWS)	05/13/2020	Section 2.4 Project Operations and Effects on Resources	"Information on the hydraulic characteristics of flows in the Skagit River (discharge, flow depth and velocity, and their spatial and temporal variations) will describe these influences and inform future Project operations for flow management, particularly as related to fish production." Consider adding a section here about past operations and the effects on stream flows and resources dependent upon stream flow, and describe what the current instream flows are designed to meet, and SCL's overall general management to meet instream flows and a abilities to meet them	The PAD contains much information, which is often detailed and nuanced. A summary in this study plan would not be representative and reproducing the content of the PAD in this study plan would make it cumbersome and lengthy. City Light continues to believe that the best approach is to simply reference the PAD, to which all LPs have access.
59.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.5 Study Area	"The study area, which is defined by the proposed limits of hydraulic modeling, will extend from Gorge Dam at about RM 96.5 downstream to a suitable location a short	See Comment Response #4.

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				distance downstream from the confluence with the Sauk River, at approximately RM 65 (Figure 2.5-1). The total reach length is approximately 31.5 miles." Extend to Puget Sound. See previous comments.	
60.	Brock Applegate (WDFW)	05/11/2020	Section 2.5 Study Area	"The study area, which is defined by the proposed limits of hydraulic modeling, will extend from Gorge Dam at about RM 96.5 downstream to a suitable location a short distance downstream from the confluence with the Sauk River, at approximately RM 65 (Figure 2.5-1)." SCL should consider the effects of the flow model out of the Skagit River and estuary and into the Sound. The Project has population effects on anadromous salmonid populations and those species dependent on them, like orcas.	See Comment Response #4.
61.	Stan Walsh (SRSC)	05/11/2020	Section 2.5 Study Area	"The total reach length is approximately 31.5 miles." See second comment section 2.1 (See Comment #10)	See Comment Responses #4, #6, and #8.
62.	Stan Walsh (SRSC)	05/11/2020	Section 2.5 Study Area	"As discussed further in subsequent sections of this study plan, two separate but linkable hydraulic models will be developed: a model of the Gorge bypass reach; and a model of the reach from Gorge Powerhouse to the confluence with Sauk River (i.e., the reach of primary interest for fisheries production)." Fish habitat within the bypass reach should also be evaluated	See Comment Response #12.

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63.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.5 Study Area	"The focus of the hydraulic model between Gorge Powerhouse and the Sauk River confluence will be on the in-channel portion of the mainstem Skagit River corridor, and any side channels identified by the study team as having significant habitat value; however, the model will also include, in lesser detail, the overbank floodplain out to the valley side walls." This needs to be justified. Are floodplain habitat conditions being more fully addressed in a different study? We have commented on this repeatedly, so I will keep it brief here. Floodplain habitats are key for salmonids. The project impacts floodplain habitats. The study needs to address these impacts adequately.	The primary purpose of the hydraulic model will be to investigate and inform the evaluation of flow/habitat relationships in support of mainstem aquatic habitat protection and fish production. The model will simulate mainstem water surface profiles to evaluate potential for floodplain connectivity and will also simulate floodplain inundation but at a relatively coarse level. The model will however have the flexibility to allow future modification or refinement to analyze floodplain connectivity in more detail.
64.	Stan Walsh (SRSC)	05/11/2020	Section 2.5 Study Area	"The focus of the hydraulic model between Gorge Powerhouse and the Sauk River confluence will be on the in-channel portion of the mainstem Skagit River corridor, and any side channels identified by the study team as having significant habitat value; however, the model will also include, in lesser detail, the overbank floodplain out to the valley side walls. The focus of the bypass reach hydraulic model will be on the in-channel portion of the reach." While LiDAR can provide high quality topographic data, there are "some gaps or voids in the channel bathymetry data because of limitations imposed by water depth and/or channel bed conditions"(Section 2.3). While voids are proposed to be filled by ground-based surveys, the merging of these data sets may be problematic. Validation of the resulting bathymetric data set should be included as a	The process of merging bathymetric data from the Green LiDAR with that from ground-based surveys will include reconciling differences between the two data sources and expanding the area of ground-based surveys where necessary to minimize edge discontinuities. Discontinuities may arise for example because of changes in channel geometry since the 2018 LiDAR flight. While an important consideration, we do not expect this to be a major issue given the relative stability of the channel. The data sources and details of merging data from the various data sources to develop the model terrain will be documented in the study report.

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				study component. The accuracy of wetted channel areas defined by green LiDAR, and areas of data merging between green LiDAR and ground-based surveys should be systematically reported since those areas may describe important aquatic habitat.	
65.	Brock Applegate (WDFW)	05/11/2020	Section 2.5 Study Area	"The focus of the bypass reach hydraulic model will be on the in-channel portion of the reach." The instream flow model should demonstrate the effects of process flows that may envelop the floodplain for consideration during relicensing conditions.	See Comment Response #8. Evaluation of alternative flow scenarios such as process flows is a subsequent step to the study program.
66.	Judy Neibauer (USFWS)	05/13/2020	Section 2.5 Study Area	"The focus of the bypass reach hydraulic model will be on the in-channel portion of the reach." See my previous comment above…but will need to understand how the floodplain, wetlands, seeps, springs also function under different management scenarios. Please include, at the least, the channel migration zone. See our Critical Habitat rules, we will need to understand how SCL impacts elements of critical habitat. Either include data you already have, link to existing data, or add key questions and data collection into this model or a new study. Will need to pull in reservoir levels at periods you are looking at to be able to compare to what is going on upstream above the dams also at similar flows. Will need to understand how operational flow impact adjacent land, tributaries, managed/purchased lands, and transmission	See Comment Responses #6, #12, #32, and #38.

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				corridors…….there may be the need to pull these areas in or have some type of monitoring here to understand impacts to stream flows…. (See Comment #58)	
67.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6 Methodology	"Two separate but linkable hydraulic models will be developed for the study area using the USACE HEC-RAS modeling platform (USACE 2016)." Expand scope and provide details here about how to link to other existing models you mentioned on the phone call. Describe you would incorporate these existing models to tell the story for hydrology and streamflow, and use that to help set instream flow for the whole basin. Describe here how you will pull in reservoir elevation and other information here to help set up instream flows to minimize impacts both above and below dams….	See Comment Responses #6, #12, and #25.
68.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Gorge Bypass Reach Model	"The methodology we adopt for development of the Gorge bypass reach model will be similar in concept to that described in Section 2.6.2 below on development of the hydraulic model from Gorge Powerhouse to the Sauk River confluence, but will differ in detail and will be informed by further development of modeling objectives for the reach." When will LPs be able to review these specifics? How will this DEM developed? Where will discharge, stage heights and water level profiles come from for calibration and validation? If not until sometime during the downstream model,	Section 2.6.1 has been removed from the study plan. See Comment Response #12.

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				will LPs be consulted as details are formulated? This reach needs fish in it, every reach is critical to salmon recovery, more so now than at any other time.	
69.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Gorge Bypass Reach Model	"The methodology we adopt for development of the Gorge bypass reach model will be similar in concept to that described in Section 2.6.2 below on development of the hydraulic model from Gorge Powerhouse to the Sauk River confluence, but will differ in detail and will be informed by further development of modeling objectives for the reach." Curtis is correct, the time has come for SCL to better explain the separate treatment of these river sections.	Section 2.6.1 has been removed from the study plan. See Comment Response #12.
70.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"A model at this resolution is not necessary for reach-wide evaluation of hydraulic conditions to support flow management as proposed under this study plan." Model mesh size for this study needs discussion and needs to be sufficient to evaluate habitat conditions across a wide range of flows and include flood plain connection	This subsection is now 2.6.1.1. The model computational mesh size will be varied as needed to represent spatial variations in both hydraulic and habitat conditions and considering the primary in-channel focus of the model. The sensitivity of model results to mesh size will be tested with selection of mesh size a balance between achieving good numerical accuracy at the relevant scale while minimizing computational time. Mesh size selection will be discussed at a consultation workshop.
71.	Jon Riedel (NPS)	05/13/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"A model at this resolution is not necessary for reach-wide evaluation of hydraulic conditions to support flow management as proposed under this study plan." But wouldn't it be to assess influence of project at habitat scale?	This subsection is now 2.6.1.1. See Comment Response #70.

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72.	Rick Hartson (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"In developing this study plan, two hydraulic model options were considered as follows: (1) Extend the existing Barnaby Reach model upstream to the Gorge Powerhouse using RiverFlow2D. (2) Develop a new HEC-RAS model of the entire study reach, taking advantage of the bathymetric data and calibration data for the Barnaby Reach from the RiverFlow2D model. The following factors were considered in selecting a model platform: ▪ Ease of model development (recognizing the availability of the Barnaby Reach RiverFlow2D model); ▪ Model resolution required to meet study objectives; ▪ Speed of model execution; ▪ Ease of integration with other model platforms (for example, Project operation models); ▪ Availability of model support and model maintenance; ▪ Availability of visualization tools and software features for analysis, synthesis and display of model output; ▪ Ease with which metrics of interest for Project flow management can be generated from model output; ▪ Acceptance by the engineering community and both governmental and non-governmental institutions; and ▪ Size of user community (which relates to the pool of expertise available formodel updates and application)."	This subsection is now 2.6.1.1. A table providing a qualitative comparison of the HEC-RAS and RiverFlow2D platforms has been added.

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				This list is not helpful. Upper Skagit Indian Tribe is requesting a table that describes the relevant characteristics of each model for each of these factors in terms of SCL's determined relicensing needs.	
73.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"The following factors were considered in selecting a model platform: ▪ Model resolution required to meet study objectives;" This has not been adequately discussed. What is the resolution of the Barnaby model and how did SCL determine the relevant resolution for its purposes?	This subsection is now 2.6.1.1. See Comment Response #70. The Barnaby model which extends over a reach length of approximately 8 miles and covers about 7,750 acres uses a model mesh comprised of just under 800,000 triangular elements for an average element area of about 400 square feet with a finer mesh along the main channel and side channels and a coarser mesh elsewhere.
74.	Jon Riedel (NPS)	05/13/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"The following factors were considered in selecting a model platform:" I understand this model platform has a sediment routing function. But is it appropriate for Skagit conditions?	This subsection is now 2.6.1.1. The current 2-D HEC-RAS code proposed for use in this study does not support sediment transport modeling. Sediment transport modeling is available in the 1-D implementation of HEC-RAS and the USACE plans to release a version of the 2-D code with sediment transport modeling in the future. We have not evaluated the suitability of the 1-D HEC-RAS code for sediment transport modeling for Skagit River conditions. We note that suitability of a particular model would depend on multiple factors including scale of modeling, issues to be addressed, etc. We are not proposing to model sediment transport at this time.
75.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of	8th Bullet – Comment	This subsection is now 2.6.1.1. City Light intends to continue consultation on its draft study plans with LPs which includes Ecology.

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			Model Development	"Acceptance by the engineering community and both governmental and non-governmental institutions; and" Did SCL consult with the Department of Ecology on these models? From the RWG meetings, the hydrologist from the Department of Ecology did not seem aware of your model selections. WDFW recommends that you consult with the Department of Ecology. I would highlight this bulleted item until SCL does.	
76.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.1 Hydraulic Model Selection and Overview of Model Development	"A two-dimensional HEC-RAS (Version 5) model of the full study reach was determined, after considering the above selection factors, to provide the best tool to meet study objectives, and the best modeling platform for adoption over the term of the next license." Two -dimensional HEC-RAS is often used to describe reach-level hydraulic conditions. Use of the HEC-RAS model to describe depth and velocities at a scale relevant to HSC should be confirmed before proceeding. Once this occurs, HEC-RAS 2D may be a valuable tool for assessing the relationships between flow and fish habitat. However, it may not be the most efficient tool for assessing the effects of downramping from flow releases at the Gorge Powerhouse. Downramping pulses from Gorge Powerhouse will travel downstream and attenuate as they combine with flows from downstream tributaries. Rather, an unsteady flow model with a time step of 1-hour is recommended to assess	This subsection is now 2.6.1.1. The 2-D HEC-RAS model proposed is an unsteady flow model which will be run at a sub-hour time step. The model will be capable of adequately representing the river's response to downramping. While a 1-D model would certainly be more efficient in terms of computational effort if we were only looking at downramping issues, a single 2-D model (as opposed to parallel 1-D and 2-D models) is believed to be a more efficient approach for the study as a whole. Discharge, depth and velocity monitoring and model calibration will be performed under flow conditions relevant to HSCs. The current license includes requirements for periodic validation of fry stranding mitigation measures. Monitoring data indicates that the fry stranding rate has declined since the rate was first assessed in the '80s. The current flow program/ESH model incorporates stranding and

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				the effects of downramping. Instead of using HEC-RAS 2D, it may be more efficient to develop a parallel HEC-RAS 1D model for routing unsteady flows through the study reach, especially if flows are modeled with a 1-hour time step for multiple years of operation. Downramping may result in stranding and trapping of fry and this study should also assess the potential for this to occur under current and proposed future operations. The areas encompassed by the upper and lower extent of the ramping cycle are termed the varial zone and represent areas most susceptible to stranding and trapping. These areas are found along the channel margins which are frequently used by fry and juvenile fish. The areas are also generally devoid of invertebrate production thereby potentially affecting food availability for younger fish. Areas most likely to be influenced by this should be identified as part of the initial workshop and study methods subsequently defined.	trapping rules. Per Comment Response #31, these biological inputs will be incorporated into the new model to support additional discussions on refining biological inputs and to ensure the new model can support an integrated environmental analysis to address the issue of stranding and trapping under current conditions. The information is intended to further inform potential actions to continue addressing stranding and trapping in the reach between the Gorge Powerhouse and Sauk River under a new license.
77.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.2.2 Model Topographic Data	"A three-dimensional terrain model of the reach spanning from Gorge Powerhouse to approximately 1.5 miles downstream of the Sauk River confluence (~29 RMs) will be developed from a combination of topobathymetric LiDAR, standard LiDAR, boat-based bathymetric (sonar) surveys, and terrain data from the existing hydraulic model of the Barnaby Reach of the Skagit River." Discuss how you might link to landform, geomorphology, and operational flows to help develop the information that may help	This subsection is now 2.6.1.2. See Comment Responses #6 and #25.

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				determine key refugia, wetlands, springs, seeps, and hyporheic areas so that instream flow will maintain these features too.	
78.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.2 Model Topographic Data	"The 2016 LiDAR (Quantum Spatial 2017b) will supplement any floodplain data not acquired in the more limited topobathymetric datasets. A very coarse preliminary hydraulic model of the reach of interest, constructed to test the sensitivity of HEC-RAS model simulation times to cell size, indicates there may be several such floodplain areas (Figure 2.6-1), depending upon the flows simulated. As noted in Section 2.5 of this study plan, while the focus of this study will be on the in-channel portion of the mainstem Skagit River, the model will also include, in lesser detail, the overbank floodplain out to the valley side walls." As commented earlier, the floodplain needs to be assessed in greater detail. These preliminary results indicate the importance of understanding habitat conditions outside of the channels, even in relatively narrow reaches that may be considered to have minimal floodplain habitat.	This subsection is now 2.6.1.2. See Comment Response #63.
79.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.3 Model Geometry Development	"The mesh consists of cells, or elements, whose size, shape and orientation are refined as needed to simulate hydraulic conditions. The model cell size will be determined considering simulation run time (fewer cells equates to faster run times), resolution in areas of interest for habitat evaluation (more cells equates to finer resolution and slower run times) and calibration to observed discharges." Mesh size is a critical component of aquatic habitat evaluation. Larger cells (i.e., coarser	This subsection is now 2.6.1.3. See Comment Response #70.

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				mesh) can be used in overbank areas to reduce run time, but smaller cells (i.e., finer mesh) should be concentrated along shorelines, in-water woody debris, side channels and sloughs. Cell size should be fine enough in areas of important salmonid habitats to depict the velocity gradient, cover distribution, and depth variations described in the HSC. In one-dimensional PHABSIM studies, it is common practice to require a minimum of 20 cells for each transect. This "rule of thumb" originated from the USGS requirement of 20 cells for an accurate flow measurement from wading. This can be used to calculate the cell size needed for habitat modeling. More cells will be needed per river mile at the upstream end of the study reach where the river is narrower. Similarly, fewer cells will be needed per river mile at the downstream end of the study reach where the river is wider.	
80.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.3 Model Geometry Development	"A relatively coarse mesh will be used to represent floodplain areas." This makes sense, assuming there is close coordination with LPs and an iterative approach to allow identification of key floodplain areas where mesh resolution should be made finer.	This subsection is now 2.6.1.3. See Comment Response #63. The primary focus of the study will be the mainstem river. The model will have the flexibility to allow users to refine the mesh for other areas of interest as the need arises in future potential applications.
81.	Jon Riedel (NPS)	05/132020	Section 2.6.2.3 Model Geometry Development	"A relatively coarse mesh will be used to represent floodplain areas." Even if the floodplain has a lot of side channels?	This subsection is now 2.6.1.3. See Comment Responses #63 and #80.

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82.	Jon Riedel (NPS)	05/132020	Section 2.6.2.3 Model Geometry Development	""Breaklines" will be added to the model mesh to ensure geometric features that affect river hydraulics (for example, raised roads) are adequately represented. Skagit River bridge crossings at Marblemount and Rockport will be included in the model." This would be another good place to link with landforms and geomorphic reaches. See comment above.	This subsection is now 2.6.1.3. See Comment Response #18.
83.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.3 Model Geometry Development	"Hydraulic roughness zones will be delineated representing land use and land surface classes found in the reach such as active riverbed, typically exposed channel bars, forested floodplain, and pasture. The results of the landform mapping study being conducted by the NPS will be reviewed in delineating roughness zones. Initial roughness coefficients will be assigned based on professional judgement and then refined during model calibration." Need to address this for below the Sauk, in particular need to consider assumed or potential changes in land use over the course of the license. Alternatively, develop a model that can be used throughout the license term in an adaptive management framework.	This subsection is now 2.6.1.3. See Comment Responses #4 and #41.
84.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.4 Model Boundary Conditions	"Ungaged tributary inflows between the mainstem Newhalem and Marblemount gages, and between the Marblemount gage and the confluence with the Sauk River, will be estimated from the gaged tributary flows using data from both the active gages and historic discontinued gauges. Ungaged tributaries include, for example, Goodell Creek, Diobsud Creek, and Illabot Creek."	This subsection is now 2.6.1.4. Agreed.

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				For unsteady flow modelling of downramping events, tributary inflows should be estimated on an hourly basis. There should be a smooth transition from one day to the next to avoid the creation of artificial downramping from the tributary inflow.	
85.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.4 Model Boundary Conditions	"Ungaged tributary inflows between the mainstem Newhalem and Marblemount gages, and between the Marblemount gage and the confluence with the Sauk River, will be estimated from the gaged tributary flows using data from both the active gages and historic discontinued gauges." Has SCL compiled a list of known sources? This should be included in the study plan.	This subsection is now 2.6.1.4. A list of active and historic discontinued gauges will be compiled at the start of the study along with pertinent information such as period of record, parameters recorded, and drainage area.
86.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.4 Model Boundary Conditions	"Ungaged tributaries include, for example, Goodell Creek, Diobsud Creek, and Illabot Creek." Upper Skagit Indian Tribe has stage data for Goodell and Diobsud but not enough discharge measurements to make a rating curve. We have previously offered to share these data, and the offer stands to support this effort.	This subsection is now 2.6.1.4. Thank you for this information.
87.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.4 Model Boundary Conditions	"Ungaged tributaries include, for example, Goodell Creek, Diobsud Creek, and Illabot Creek." Several years of gage data exist for Illabot that should be incorporated. I believe SRSC is the data steward.	This subsection is now 2.6.1.4. Thank you for this information.
88.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.4 Model Boundary Conditions	"City Light staff have observed that the study reach between the USGS Newhalem and Marblemount gages is apparently affected by	This subsection is now 2.6.1.4. The approach to be considered for simulating

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				channel losses under some conditions. Channel losses were specifically noted following the extreme low flows of summer 2015. Hydrologic and groundwater data will be reviewed to develop a better understanding of the causes and significance of channel losses. If necessary, consideration will be given to accounting for such losses in the hydraulic model by modifying the tributary inflows." While flow gains and losses can be incorporated in to the hydraulic model by modifying tributary inflows, how will the influence of channel gains and losses both in-channel and floodplain groundwater accretion be incorporated in the salmon and steelhead spawning and juvenile rearing habitat modeling components?	losses to groundwater in the mainstem Skagit is by decreasing tributary inflows. We recognize that this does not represent reality; it is simply a means to account for mainstem losses given limited options for simulating such losses in HEC-RAS (and most other riverine hydraulic modeling codes) and ensuring reliable simulation of mainstem low flows. Habitat modeling for this study will rely on traditional habitat suitability curves tied to velocity, depth and substrate. The velocity and depth, as determined by the hydraulic model, are a function of total discharge only and do not consider the source of flow (whether surface or groundwater).
89.	Jon Riedel (NPS)	05/13/2020	Section 2.6.2.4 Model Boundary Conditions	"Channel losses were specifically noted following the extreme low flows of summer 2015." Landform map will help with this. There is a very coarse fill in the valley below Bacon Creek, and particularly from Diobsud Creek to Marblemount.	This subsection is now 2.6.1.4. Thank you for this information.
90.	Curtis Clement (Upper Skagit Indian Tribe)	05/07/2020	Section 2.6.2.4 Model Boundary Conditions	"If necessary, consideration will be given to accounting for such losses in the hydraulic model by modifying the tributary inflows." Are you suggesting that the tributaries will also be losing and will need to be adjusted, or, that you will simulate losses in the Skagit by decreasing flows in the tributaries? If the latter is required, it may suggest other parameters are not properly accounted for and should be revisited rather than forcing the results. For example, hydraulic conductivity of substrate	This subsection is now 2.6.1.4. See Comment Response #88.

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				and floodplain, water withdrawals from ET and domestic use or the modeled area is insufficient causing boundary effects. I don't know all the parameters that are required for HEC-RAS, those are just to illustrate my point.	
91.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.5 Field Monitoring	"The goal of the monitoring program will be to acquire calibration data at two or three discharges covering the range of discharge conditions of primary interest to fisheries management (assumed to range from about 2,000 cfs to 6,000 cfs at Newhalem), plus one high flow discharge." This study plan almost completely overlooks an extremely important aspect of this model development. There needs to be considerable thought put into the flows that will be used for model runs. Modeled flows should consider pre-project hydrology, current license hydrology, and potential mitigation flows. High flow events need to be considered, for instance those that temporarily connect off-channel habitats during the spring Chinook outmigration. This speaks to the need to better incorporate floodplain habitat impacts into this study, and coordinate the selection of flows with model development.	This subsection is now 2.6.1.5. See Comment Responses #6 and #41. FERC's baseline is the existing condition. Modeling potential mitigation flows is a subsequent step to this model development study. The purpose of this study is to develop a new model to support continued protection of fish/aquatic habitat to support healthy fish populations. The proposed range of flows targeted for hydraulic model calibration was determined from a review of current license hydrology. Actual calibration flows will depend on conditions experienced during the monitoring period and may cover a wider range than that currently assumed. High flow events are proposed to be captured opportunistically. Again, the size of high flow events used in model calibration will depend on the conditions experienced in the monitoring period. To the extent possible, flows targeted for use in model calibration will be such as to allow the model to be applied with confidence to potential mitigation flows and other flow scenarios subsequent to model development.
92.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.5 Field Monitoring	"The goal of the monitoring program will be to acquire calibration data at two or three	This subsection is now 2.6.1.5.

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				discharges covering the range of discharge conditions of primary interest to fisheries management (assumed to range from about 2,000 cfs to 6,000 cfs at Newhalem), plus one high flow discharge. Given that high flow events are unpredictable, monitoring of a high flow event will be on an opportunistic basis." Model calibration at a high flow condition will be valuable for analyzing gravel transportation. The Skagit River at Newhalem currently does not receive gravel as a result of gravel storage in the three upstream reservoirs. From 1930 to 1936 (before the construction of Ross Dam), Diablo Reservoir accumulated a total of 358 acre-feet of sediment deposits over this 6-year period (U.S. Soil Conservation Service 1950). The proposed hydraulic model should be used to assess the risk of scour from existing gravel patches and scour from areas where additional gravel may be added.	See Comment Response #35.
93.	Jon Riedel (NPS)	05/13/2020	Section 2.6.2.5 Field Monitoring	"The goal of the monitoring program will be to acquire calibration data at two or three discharges covering the range of discharge conditions of primary interest to fisheries management (assumed to range from about 2,000 cfs to 6,000 cfs at Newhalem), plus one high flow discharge." This ties in with my comment on scale and integration with sediment transport. I would hope that 'geomorpphically significant' flows could also be modeled, such as the spring event with a long duration and a fall peak flow event (100 year) that would examine impact of water storage in Ross Lake.	This subsection is now 2.6.1.5. See Response Comment #8.

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94.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.2.5 Field Monitoring	"Given that high flow events are unpredictable, monitoring of a high flow event will be on an opportunistic basis." Please link the dates and times when monitoring takes place to reservoir elevations to determine how reservoirs change with instream flows. We will need to consider effects in both areas when finalizing any instream flow requirements. Could you have water level recorders in the reservoir?	This subsection is now 2.6.1.5. See Comment Responses #6 and #25.
95.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.5 Field Monitoring	"Up to six automatic water level recorders will be installed at key locations throughout the study reach to supplement stage data available from the three mainstem Skagit River USGS gages at Newhalem, Marblemount, and Rockport and a mainstem stage gage approximately one mile upstream from the Sauk River confluence operated by the SRSC." Locations of the six new water level recorders should be selected in collaboration with the stakeholders. Vertical survey control should be established at all 10 sites using RTK-GPS to ensure that the water surfaces are measured with a datum consistent with the vertical datum used for the hydraulic model (NAVD 88).	This subsection is now 2.6.1.5. Locations for the automatic level recorders have been selected considering hydraulic model requirements, locations of existing mainstem gauges, locations of tributary inflows, local hydraulic conditions, and access. The gauges are being installed and maintained by the USGS under agreement with City Light. Installation is expected to be complete by mid-June. The installation of these gages was identified by City Light as an early action item to ensure that gauges were in place to capture any high flow events in the late spring/early summer 2020 snowmelt freshet necessary to support hydraulic model development and calibration starting in spring 2021. The study plan has been revised to reflect the current status and gauge locations.
96.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.5 Field Monitoring	"The river will be driven with the boat continuously recording water surface elevation while the Project discharges at Gorge Powerhouse are more or less constant. A smoothing filter will be applied to the raw water surface elevation data to produce water surface	This subsection is now 2.6.1.5. The model geometry will reflect split channels, perched side channels etc. However, it is correct that model calibration will be to longitudinal water surface profiles along the main or dominant channel and will in general not

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				profiles suitable for use in model calibration (see Section 2.6.1.6)." It appears that the intent of the boat measurements and smoothing filter are to develop a longitudinal water surface profile. However, water surface elevations vary horizontally across the Skagit River channel. Split channels, multiple channels, perched side channels, and even the inside and outside of a bend can cause significant variations in water surface elevations at a given flow. Those horizontal variations also change in response to changes in mainstem flow. How will those horizontal variations be addressed in the hydraulic and habitat models? Smoothing the horizontal component of water surface elevations can drastically alter the predicted magnitude and frequency of dewatering and inundation of critical shallow water habitats. As described in Section 2.6.2.6, "Model calibration will be accomplished by adjusting model coefficients and model mesh to match water levels both spatially and temporally at the water level monitoring stations and the continuous water surface profiles." This process will address longitudinal water surface profiles but ignore important horizontal variations in water surface elevations.	account for cross-channel variations in water surface elevations. The proposed monitoring program will be expanded to provide more detailed monitoring of selected areas to improve hydraulic/habitat model linkages. Cross-channel variations in water surface elevations in these areas will be monitored and considered in model calibration. See Comment Response #97.
97.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.5 Field Monitoring	"Skagit River discharges will be measured concurrent with the water surface profile surveys at up to four locations along the study reach." Skagit River discharges should be measured at the six locations where water level recorders are	This subsection is now 2.6.1.5. The proposed monitoring program will be expanded to provide more detailed monitoring of selected areas or reference reaches to improve hydraulic/habitat model linkages. Monitoring will include depth, velocity and discharge. The

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				installed when flow releases from Gorge Powerhouse are 2,000, 4,000 and 6,000 cfs.	exact number and location of these reference reaches remain to be determined but are expected to be in reasonable proximity to the automatic water level recorders currently planned for installation. See Comment Response #95.
98.	Curtis Clement (Upper Skagit Indian Tribe)	05/07/2020	Section 2.6.2.5 Field Monitoring	"The need for measuring discharges at the locations of the USGS Newhalem and Marblemount gages will be determined following review of the current stage-discharge ratings developed by the USGS at those locations." Please specify the criteria used to make this decision. Doing so will reveal potential biases in discharge of the other measurements, why would this check be omitted?	This subsection is now 2.6.1.5. The USGS actively maintains the stage-discharge ratings at the Newhalem and Marblemount gage sites. If those ratings are well defined and stable, with little shift over time and with direct discharge measurements close to the rating, then discharges at those sites will be determined from the observed stage and the current stage-discharge rating. This will allow resources to be directed to other monitoring sites.
99.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.6 Model Calibration and Validation	"2.6.2.6 Model Calibration and Validation" What are criteria being used to consider the model validated? Some percentage to the measured flows, smallest possible R^2 achieved for all years of modeled runs, most similar R^2 between the calibration runs and validation runs, other? What is the goal for this?	This subsection is now 2.6.1.6. Various metrics will be used to assess model performance. These will include various statistics of absolute error in simulated water surface profiles (maximum, mean and variance), fit to USGS stage-discharge ratings at the Newhalem and Marblemount gages, absolute and relative error between simulated and observed velocities, and others. Quantitative goals for these metrics have not been set; they will be discussed at a consultation workshop.
100.	Jon Riedel (NPS)	05/13/2020	Section 2.6.2.6 Model Calibration and Validation	"2.6.2.6 Model Calibration and Validation" Will model be calibrated at USGS gages?	This subsection is now 2.6.1.6. Yes, the model will be calibrated to data at the USGS gage sites in addition to other locations.

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101.	Brock Applegate (WDFW)	05/05/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"Habitat Suitability Criteria (HSC) define the range of microhabitat variables that are suitable for a species and life stage of interest." SCL will need to know which species uses which habitat in the bypass reach, hence WDFW's request for a fish barrier survey.	This subsection is now 2.6.1.7. See Comment Response #12.
102.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"Habitat Suitability Criteria (HSC) define the range of microhabitat variables that are suitable for a species and life stage of interest. HSC provide the biological criteria input to a habitat model which combines the physical habitat data and the HSC into habitat suitability calculations over a range of simulation flows. Variables typically defined with HSC may include depth, velocity, and instream cover or substrate. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively. Usable area, also referred to as weighted usable area (WUA) or area weighted suitability (AWS), is defined as the sum of stream surface area within a nodal area model domain or stream reach, weighted by multiplying the area by the index for each habitat suitability parameter." The HEC-RAS 2D model can be used to calculate depth and velocity. However, there is no discussion on how instream cover or substrate will be mapped. The HEC-RAS 2D does not have a module for calculation of weighted usable area. Will a separate model be constructed to perform these calculations?	This subsection is now 2.6.1.7. Substrate mapping will be developed in coordination with the geomorphology study. Substrate data for areas where detailed monitoring is conducted (See Comment Response #97) will be collected in conjunction with that monitoring under the instream flow model study. Cover data will be developed in coordination with the geomorphology study and vegetation mapping study, generally consistent with Ecology guidance on cover types. HEC-RAS model results will be output as depth and velocity grids. These together with substrate and cover grids and habitat suitability curves will be analyzed using GIS scripts to compute weighted usable area. Since the purpose of this study is develop a tool to support flow management to protect habitat, habitat modeling will rely on the traditional determinants of depth, velocity, cover and substrate. While we acknowledge that other factors, including those listed in the comment, may affect habitat quality, it is not clear how they would be used to inform development of and are beyond the scope of the flow management tool.

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				Although depth, mean velocity, and substrate composition have traditionally been considered determinants in habitat selection, different species and life stages of fish may cue on different variables including availability of escape cover, water quality (temperature, dissolved oxygen, pH, turbidity), presence of groundwater upwelling/downwelling, etc. Numerous other habitat components could influence distribution and site selection including competition, predation, feeding behavior, seasonal and diurnal movement, etc. Will this study consider these other elements? If no - why not? If so - how will these be addressed? See additional comment on groundwater below.	
103.	Judy Neibauer (USFWS)	05/13/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"The approach to managing flows for spawning, incubation, and rearing was initially developed by conducting an Instream Flow Incremental Method (IFIM) analysis using Physical Habitat Simulation (PHABSIM) which modeled nine species and 26 lifestages of sport fishes in the Skagit River." Will need to think about critical habitat primary constituent elements…. Need to include bull trout and other anadromous species…i.e., lamprey, cutthroat, whitefish, sculpins…other species considered as preybase too….sc	This subsection is now 2.6.1.7. See Comment Responses #31 and #36.
104.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"To optimize the model for instream flow planning, LPs agreed to focus on spawning and incubation criteria for Chinook, Pink, and Chum salmon, and steelhead (Crumley and Stober 1984 Vol. I)."	This subsection is now 2.6.1.7. Thank you for the comment. We will include this suggestion and other considerations that are developed during the LP workshops.

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				However, the 2020 PAD (page 4-133) states that Coho Salmon are native to the Skagit River and may spawn in side-channel and slough areas along the mainstem channel. These off-channel areas are particularly susceptible to impacts from flow management and should be considered in this study.	
105.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"Inputs to the model for these four species were developed using Skagit River specific data which indicated that these species use deeper water, higher velocities, and larger substrate than is reported in the literature." Additional criteria should be integrated: 1) Habitat units/types (e.g. pool, riffle, bank, bar, backwater, side-channel, off-channel). 2) Instream cover (e.g. large woody debris, vegetated bars) 3) Substrate composition (e.g. spawning suitability, cover for juveniles) Field studies should document these metrics, if not already collected in other studies.	This subsection is now 2.6.1.7. See Comment Response #19. Our response to comment #19 covers most of these items except the habitat units. We will not be delineating habitat units, since delineating these features is subject to professional judgment and are often difficult to quantify using models. However, the proposed approach, which is an update of the current ESH model, does include a suite of HSCs which include depth, velocity, and substrate. By taking this approach, we can infer habitat types and, through post processing in GIS, create spatial analytical tools which will allow professionals in the basin to delineate habitat types. The proposed approach in this study plan aligns with WDFW and Ecology guidance. Any additional work to map or quantify aquatic habitat can be discussed during the LP workshops and during model optimization.
106.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"The resulting model is referred to as the ESH model. Inputs to the model for these four species were developed using Skagit River specific data which indicated that these species use deeper water, higher velocities, and larger substrate than is reported in the literature."	This subsection is now 2.6.1.7. The intent of this study is to develop a new model using as many inputs from the existing ESH model as possible. Our overall goal is to develop a model that is transparent, integrates with operations, and is updateable. The old

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				The Effective Spawning Habitat (ESH) model does not appear to be well documented, other than what is provided in the FSA. Moreover, the model should be made available in a format useable by others so that its' assumptions and algorithms can be tested/verified first, before it is refined with new information and applied in evaluating proposed future operations..	model is none of those things. We can only update the outputs which is why we are taking the proposed approach. Also See Comment Responses #31, #36, and #104.
107.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"The study proposes to utilize the existing site-specific habitat information that supports implementation of the current ESH model." See previous comments regarding the need to incorporate Skagit Chinook Recovery Plan emphasis on juvenile rearing habitat and the importance of fluvial process and habitat forming flows.	This subsection is now 2.6.1.7. Comment acknowledged. See Comment Responses #31 and #106. Development of habitat information will start with the use existing HSC/HSI information from the current ESH model. These data may be updated and/or refined based upon more recent available information as appropriate and will be discussed during model workshops. This would include consideration of the Skagit Chinook Recovery Plan.
108.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"The study proposes to utilize the existing site-specific habitat information that supports implementation of the current ESH model." The proposed study plan proposes to utilize probability-of-use criteria developed as part of the 1975-1984 Skagit River instream flow studies (Crumley and Stober 1984). These criteria were developed using a combination of site-specific data collected through fish sampling, literature sources, and through refinement based on the professional judgment of project biologists. Although the methods used in developing the habitat utilization model (probability of use criteria) appear robust, habitat models that have been adjusted for site-	This subsection is now 2.6.1.7. Comment acknowledged. See Comment Responses #31 and #106. We will be incorporating all the relevant input data that is available from the existing model and as suggested by Ecology and LPs during consultations and workshops. If data gaps exist, we can reduce uncertainty through a well-designed adaptive management program.

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				specific habitat availability (e.g., preference curves) are generally considered to more accurately reflect habitat preference (Bovee 1986).	
109.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"As such, ESH model documentation will be reviewed and existing species, life stage, periodicity information and associated HSC will be compiled to support flow-fish habitat analyses. Existing information will be reviewed for completeness and accuracy." The HSC variables of depth, velocity, instream cover, and substrate define expected fish response to gradations in hydraulic variables. The size of mesh, merging of LiDAR and ground-based measurements, hydraulic model predictions of horizontal (i.e., cross-channel) variations in velocity and water surface elevations do not appear to be accurate enough to depict changes in habitat using HSC. Validation of hydraulic predictions must be conducted in important spawning and rearing habitats. Accurate predictions must be demonstrated early in the process and measures to address any inadequacies identified in the next draft of the study plan. Developing habitat use models based on professional opinion relies on those most knowledgeable to define species habitat needs; however personal, geographical, and knowledge-based biases may influence the accuracy of this approach (Galbraith et al. 2016). In addition to depth, velocity, substrate, and	This subsection is now 2.6.1.7. See Comment Responses #70, #88, #96. #97, and #102. The hydraulic model will be validated against hydraulic data (depth, velocity and discharge) for selected spawning and rearing habitats. Hydraulic model development, calibration and validation will take place as part of the study itself and not as part of study plan process. We agree that surface-groundwater exchange can be important in off-channel areas. Since the purpose of this study is development of a flow management tool to support mainstem fish habitat, surface-groundwater exchange processes will not be evaluated here but would be considered in the evaluation of potential future off-channel mitigation measures.

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				cover, factors such as groundwater inflow – temperature gradients and other water quality parameters, and food availability should be evaluated as potential determinants of habitat suitability. In many river systems, the exchange of groundwater and surface water is part of the natural process in off-channel areas (side channels and sloughs). The surface-groundwater exchange (i.e., upwelling and downwelling) alters thermal and chemical regimes creating unique habitat areas that are often utilized by both spawning and rearing salmonids. For this, consideration should be given to completing a thermal imaging (Forward Looking Infrared -= FLIR) survey of the entire project reach to identify groundwater inputs and areas of thermal refugia.	
110.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"Data gaps and/or data issues (e.g., inaccurate, outdated, etc.), if any, will be identified. Data gaps or data issues will be addressed using available regional information compiled from literature sources and agency documents (e.g., NMFS Recovery Plan, etc.) appropriate to the study reach." This may be OK for most species and life stages but some lifestages (e.g. juvenile rearing) may require additional field data collection to more fully understand temporal and spatial habitat use. For example, recent survey information suggests steelhead juvenile numbers are trending lower than in the past and there is no obvious reason for this. Also – whitefish numbers also seem to be in decline, again with	This subsection is now 2.6.1.7. See Comment Response #97. Part of the instream flow determination process is a step of optimizing flows to meet biological needs based on hydrological conditions. Therefore, it is inherently a process where decisions by natural resources managers are necessary to finalize the seasonal flow ranges. Some of this can be developed during the LP workshops and also in discussions with resources managers. In the current model, there are provisions for Stream-Type juvenile rearing, fry emergence, and fry outmigration. We anticipate that we will refine these flow

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				no apparent reason. Although studies have demonstrated a positive effect of the flow operations on returns of adult Chinook, Pink and Chum salmon (Connor and Pflug 2004), such increases were largely attributed to reductions in redd dewatering and provision of a more stable incubation environment. The rearing lifestage in instream flow studies is often assumed to be provided for as long as habitats for spawning and incubation are provided. This was the case for the current operations of the Skagit Project with the provision of flows focused on protection of salmon and steelhead spawning and incubation habitats. Fry habitats for salmon and steelhead were assumed protected via downramping restrictions, as were those for salmon and steelhead yearlings. Flow operations specifically directed toward provision and protection of juvenile/yearling rearing habitats were largely absent from the FSA and should be evaluated as part of this study. Consideration should be given to establishing 3-4 (or more) Focus Areas located in areas either known to or likely to provide substantial rearing habitats in the river. These will likely include sloughs, side channels and backwater areas with slow moving waters. These areas would be the focus of more detailed study specifically for evaluating flow-rearing habitat relationships that can be used in assessing project effects.	standards during the optimization process. Part of the model development will include identifying reference reaches, or focus areas, for mainstem habitat use. This will include adjacent side channels. We will be selecting these reaches in coordination with natural resources managers familiar with the Skagit River.
111.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and	"HSC curves will be developed for each species and lifestage of interest."	This subsection is now 2.6.1.7. See Comment Response #31.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Aquatic Habitat Information	This should be addressed and discussed during the initial workshop.	City Light agrees. Model inputs will be part of the LP workshops.
112.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.2.7 Development of Biological and Aquatic Habitat Information	"HSC curves and periodicity information in combination with a calibrated and validated hydraulic model will allow for detailed analyses of the amount, time, and location that suitable habitat will be available under a range of discharges for species and lifestages of interest. This could, for example, include development of stage-discharge ratings at locations of interest, analysis of discharge wetted-area relationships, integration of model depth and velocity results with habitat data in an IFIM type of analysis to produce habitat-discharge relationships for species and life stages of interest. Model results can be output directly from HEC-RAS and analyzed or synthesized further in Geographic Information System (GIS). Animation of model results with HEC-RAS RAS Mapper will be used to help visually understand spatial and temporal variations in hydraulic and habitat conditions." Recent climate change has resulted in warmer water temperatures, changing precipitation patterns, and altering stream flows (timing, magnitude, and duration of hydrological event). It is assumed that the periodicity of habitat use (spawning, incubation, migration, etc.) by individual species and life stage in the Skagit River has adapted in response to these changes. Applying result of the habitat modeling to particular time periods will need to be adjusted and account for changes in the timing of habitat use	This subsection is now 2.6.1.7. See Comment Response #31. We are proposing to start with HSC information in the existing ESH model and update with appropriate regional information, as necessary. This will be presented and discussed in the workshops.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
113.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.3 Consultation and Report Preparation	1st Bullet – Comment "An initial workshop to discuss the overall program for hydraulic model development, including stage and discharge monitoring for model calibration, the linkages between hydraulic conditions and relevant biological and habitat metrics, and the hydraulic model outputs required to inform fisheries management decisions;" The initial workshop should focus more than on just the hydraulic model development but also the proposed approach for defining biological data.	This subsection is now 2.6.2. See Comment Responses #31, #111 and #112. Edits have been made to elaborate upon workshop topics.
114.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.3 Consultation and Report Preparation	1st Bullet – Comment "An initial workshop to discuss the overall program for hydraulic model development, including stage and discharge monitoring for model calibration, the linkages between hydraulic conditions and relevant biological and habitat metrics, and the hydraulic model outputs required to inform fisheries management decisions;" This should include an unsteady flow model	This subsection is now 2.6.2. The proposed 2-D HEC-RAS model is an unsteady flow model.
115.	Stan Walsh (SRSC)	05/11/2020	Section 2.6.3 Consultation and Report Preparation	2nd Bullet – Comment A mid-point workshop to present information on hydraulic model construction, including discussion of biological/aquatic habitat information development, terrain data, model geometry, and model boundary conditions; This seem like too much to cover in one	This subsection is now 2.6.2. An additional workshop to discuss biological data will be included in the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				workshop. Suggest a separate workshop to go over the biological data to be collected and the EFH model. This should be preceded by release of a user friendly version of the EFH model, and model documentation	
116.	Stan Walsh (SRSC)	05/11/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	"HEC-RAS is widely recognized and accepted throughout the engineering and scientific community for riverine hydraulic modeling." Revise this section consistent with revisions above	It is not clear what revision is being requested here.
117.	Judy Neibauer (USFWS)	05/13/2020	Section 2.8 Schedule	"The schedule proposed for the Gorge Dam to Sauk River Geomorphology study plan, for example, assumes the availability of a hydraulic model by fall 2021." You may need an additional year if flows don't happen I suggest thinking about a longer study period of 2 years or more.	Thank you for your comment. The ILP provides the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations.
118.	Stan Walsh (SRSC)	05/11/2020	Section 2.8 Schedule	"The proposed study schedule for hydraulic model development is as follows:" Data acquisition and review and ESH refinement should be in the schedule	Additional detail has been added to the study schedule.
119.	Brock Applegate (WDFW)	05/11/2020	Section 2.8 Schedule	▪ Final Initial hydraulic model development report – March 2022 ▪ Study Meeting for the Final Initial Study Report-- 2022	Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
120.	Steve Copps (NMFS)	05/11/2020	Section 1.3 Study Plan Development	This section provides an excellent description of relevant project effects and how the proposed study would inform the relicensing process relative to those effects. It may serve as a model for authors of other study plans to describe the basic rationale for a specific plan.	Thank you for the comment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
121.	Steve Copps (NMFS)	05/11/2020	Section 1.3 Study Plan Development	The section indicates that the proposed study plan will contribute to a variety of issues identified for study in the PAD. Those linkages should be made explicit both within this study plan and in a broader analysis of linkages between all study plans. For example, there are clear linkages to the geomorphology draft study plan that should be drawn out with enough detail to foster a clear understanding of the relationship between the two plans.	City Light has added language to Section 1.3 to address potential linkages between studies being implemented during relicensing. Also, the linkages between instream flow modeling and geomorphology are made in a number of locations in Section 2 of this study plan. Also, please See Comment Responses #6 and #18.
122.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	Similar to the above comment, the objectives are nicely laid out and may serve as a model for authors of other study plans.	Thank you for the comment.
123.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	Section 2.4 cites data collected in the 1970s. An objective should be added to characterize channel changes since that time.	The purpose of this study is the development of a model for existing conditions. The study is not intended to characterize channel changes over time. Use of historic channel geometry data to characterize channel changes over time will be considered in the Skagit River Geomorphology between Gorge Dam and Sauk River study plan. (See Section 2.6.2).
124.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	Additional detail should be provided on how the model will be used to support the relicensing process. Can the models be used in a decision making context to develop and understand impacts associated with alternative management scenarios?	See Comment Responses #6 and #8.
125.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	NMFS is concerned about the abbreviated geographic scope of the proposal.	See Comment Response #4.
126.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Add USFWS to the second paragraph.	Text has been revised as suggested.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
127.	Steve Copps (NMFS)	05/11/2020	Section 2.3 Background and Existing Information	The section includes information that should be linked to the geomorphology study plan. For example, the section describes a recently developed 2-dimensional hydraulic model for the Illabot to Sauk reach that is an appropriate linkage.	The referenced 2-D model of the Illabot to Sauk reach was developed for the Barnaby Reach restoration project. Review of geomorphology studies undertaken for that project is included in the Skagit River Geomorphology between Gorge Dam and Sauk River study plan.
128.	Steve Copps (NMFS)	05/11/2020	Section 2.6 Methodology	This section should better describe the methods for the bypass reach and make clear distinctions from how the other river sections will be modeled. The different approaches should be described in terms of how the model outputs will improve our understanding of project effects on fish and their ecological connections.	See Comment Response #12.
129.	Brock Applegate (WDFW)	06/23/2020	Section 1.3 Study Plan Development	"This study will develop an instream flow model of the Skagit River in the reach between Gorge Powerhouse and the confluence with the Sauk River." Where did the bypass reach go? Will SCL address instream flow in the bypass reach for the proposed study plan document? I can't think of a greater project effect than on the bypass reach.	See Comment Response #12. City Light will develop an effective model for the bypass reach, and will consult with LPs on its development and application. As with the river downstream of the powerhouse, alternative operating scenarios will be evaluated for the Gorge bypass reach during the integrated resource analysis that will be conducted during the ILP.
130.	Brock Applegate (WDFW)	06/23/2020	Section 1.3 Study Plan Development	"This study will develop an instream flow model of the Skagit River in the reach between Gorge Powerhouse and the confluence with the Sauk River." Most LPs asked for an increase in study area from the Dam to the estuary. Why did we get a reduction in study area from the powerhouse to the Sauk confluence?	See Comment Responses #4, #12, and #129.
131.	Brock Applegate (WDFW)	06/23/2020	Section 2.1 Study Goals and Objectives	"The goal of the Instream Flow Model Development Study is to develop an updated flow/habitat management and evaluation tool for the Skagit River between the Gorge	See Comment Responses #4, #12, and #129.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Powerhouse and the confluence with the Sauk River." What will SCL do about the bypass reach? Can we analyze the effects of our selected flows downstream to the estuary?	
132.	Brock Applegate (WDFW)	06/23/2020	Section 2.1 Study Goals and Objectives	"The goal of the Instream Flow Model Development Study is to develop an updated flow/habitat management and evaluation tool for the Skagit River between the Gorge Powerhouse and the confluence with the Sauk River." I think most LPs wanted to combine the bypass reach with the downstream flow model not remove it from the study plan altogether.	See Comment Responses #12 and #129.
133.	Brock Applegate (WDFW)	06/23/2020	Section 2.1 Study Goals and Objectives	"Once the study is complete (i.e., the model has been developed), the flow/habitat models will be used to investigate and inform the evaluation of flows and habitat in the Gorge Powerhouse to Sauk River reach to continue supporting mainstem Skagit River fish habitat during the new FERC license term and to support additional discussions regarding hydraulic conditions and aquatic habitat, including migration habitat." Please include rearing habitat as well.	As noted in Section 2.6.1.7 of the study plan, the study proposes to utilize the existing site-specific habitat information and other flow program rules that support implementation of the current ESH model. The output of the ESH model provides a season long, flexible guideline for instream flows and is adjustable based on natural variation, meets biological (spawning, incubation, rearing, and migration) requirements, protects against fry stranding and trapping, and supports Project generation needs.
134.	Brock Applegate (WDFW)	06/23/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop an updated flow/habitat management tool to re-examine flow management in the portion of the Skagit River affected by Project operations between the Gorge Powerhouse and the confluence with the Sauk River to evaluate whether flows as currently regulated by the Project continue to provide the quantity and	See Comment Response #4.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				quality of fish habitat in the mainstem Skagit River necessary to sustain healthy populations of key species, and identify where changes may be needed." Why not measure the effects all the way down the river?	
135.	Brock Applegate (WDFW)	06/23/2020	Section 2.3 Background and Existing Information	"Detailed information is required on hydraulic conditions and their spatial and temporal variation in the Skagit River between Gorge Powerhouse and the confluence with the Sauk River to support management of flows for Skagit River fish production." Doesn't the rest of the river require detailed information, like the bypass reach?	See Comment Responses #4, #12, and #129.
136.	Brock Applegate (WDFW)	06/23/2020	Section 2.5 Study Area	"The study area, which is defined by the proposed limits of hydraulic modeling, will extend from Gorge Powerhouse at about RM 94 downstream to a suitable location a short distance downstream from the confluence with the Sauk River, at approximately RM 65 (Figure 2.5-1)." WDFW disagrees with the limited study area. Why would SCL not include the bypass reach besides the need to continue down the entire river?	See Comment Responses #4, #12, and #129.
137.	Brock Applegate (WDFW)	06/23/2020	Section 2.5 Study Area	"The focus of the hydraulic model between Gorge Powerhouse and the Sauk River confluence will be on the in-channel portion of the mainstem Skagit River corridor, and any side channels identified by the study team as having significant habitat value; however, the model will also include, in lesser detail, the	Fish habitat will be considered for the in-channel portion of the mainstem Skagit River and for side channels with significant habitat values where hydraulic conditions are determined by mainstem flows and water levels. The Skagit River floodplain will be modeled at a relatively coarse level. Floodplain habitat values will not be considered in this study,

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				overbank floodplain out to the valley side walls." Wouldn't we want to consider these areas for fish habitat?	however the hydraulic model will be capable of refinement to support future assessment of floodplain habitat values as needed. See also Comment Response #63.
138.	Brock Applegate (WDFW)	06/23/2020	Section 2.6 Methodology	"An unsteady flow hydraulic model will be developed for the study area using the USACE HEC-RAS modeling platform (USACE 2016)." The Washington State Instream Flow Study Guidelines does not support HEC-RAS. HEC-RAS has a depth calibrated model without velocity that estimates velocity with a mass balance calculation. HEC-RAS does not refine velocity estimates with data collected on the river, like PHABSIM. DOE and WDFW will continue to consult with SCL to approve HEC-RAS or recommend other flow models.	Thank you for your comment. City Light continues to consult with WDFW and Ecology regarding their concerns and has revised the study plan to include velocity monitoring and calibration to these data.
139.	Brock Applegate (WDFW)	06/24/2020	Section 2.6.1.1 Hydraulic Model Selection and Overview of Model Development	"Field monitoring to obtain discharge and water level data to support model calibration and validation" Model does not collect velocity information during field monitoring like other models.	As noted in Section 2.6.1.5, detailed monitoring of hydraulic conditions will be performed in selected areas (i.e., reference reaches) representative of important habitat in the overall study reach. Monitoring will include depth, velocity and discharge.
140.	Brock Applegate (WDFW)	06/24/2020	Section 2.6.1.1 Hydraulic Model Selection and Overview of Model Development	**Table 2.6-1 Qualitative comparison of RiverFlow2D and HEC-RAS 2D.** "Acceptance by the engineering community and both governmental and non-governmental institutions" Your governmental institution that issues your 401 Certification has not approved your model yet.	Thank you for your comment. City Light looks forward to continued consultation with WDFW and Ecology on the model.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
141.	Brock Applegate (WDFW)	06/24/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	"HEC-RAS is widely recognized and accepted throughout the engineering and scientific community for riverine hydraulic modeling." So far, we have seen HEC-RAS used for hydraulic modeling but not instream flow modeling. DOE has asked for examples of HEC-RAS use in instream flow modeling	Thank you for your comment. City Light looks forward to continued consultation with WDFW and Ecology on the model.

FA-03 RESERVOIR FISH STRANDING AND TRAPPING RISK ASSESSMENT PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

ACS.....adaptive cluster sampling
City Light.....Seattle City Light
CoSD.....City of Seattle (Vertical) Datum
DEM.....digital elevation model
Ecology .....Washington State Department of Ecology
EFH.....Essential Fish Habitat
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
FARWG.....Fish and Aquatics Resource Work Group
FERC.....Federal Energy Regulatory Commission
FLA.....Final License Application
FPA .....Federal Power Act
GIS .....Geographic Information System
ILP.....Integrated Licensing Process
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
NAVD 88.....North American Vertical Datum of 1988
NHPA.....National Historic Preservation Act
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SR.....State Route
UAV.....unmanned aerial vehicle
USFWS .....U.S. Fish and Wildlife Service
USGS .....U.S. Geological Survey

USR.....Updated Study Report

WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

The relicensing process includes the timeframes and deadlines specified in FERC's Integrated Licensing Process (ILP), including consultation with interested agencies and Indian tribes related to study plans, study results, and subsequent analysis of results and effects analysis through the filing of the Final License Application (FLA). FERC's process includes steps to satisfy the various statutory authorities identified in the Federal Power Act (FPA) (e.g., Sections 4(e), 10(j), 10(a)). Other related regulatory processes including Washington Department of Ecology's (Ecology) Section 401 water quality certification process, the U.S. Fish and Wildlife Service's (USFWS) and National Marine Fisheries Service's (NMFS) Section 7 Endangered Species Act (ESA) consultation, NMFS's oversight of Essential Fish Habitat (EFH), as defined by the Magnuson Stevens Fishery Conservation and Management Act, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA) will continue following filing of the FLA. With the filing of the PAD, City Light requested that FERC designate City Light as FERC's non-federal representative for purposes of initiating and conducting day-to-day consultation under ESA Section 7 and NHPA Section 106, which was granted by FERC in its June 26, 2020 Notice of Intent to File License Application for a New License and Commencing Pre-Filing Process.

1.3 Study Plan Development

In 2019-2020, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential Project effects. City Light developed 24 study proposals, including this Reservoir Fish Stranding and Trapping Risk Assessment (Stranding and Trapping Assessment) Study Plan.

On April 10, 2020, City Light released the Stranding and Trapping Assessment Draft Study Plan for LP review and comment. On May 5, 2020, the draft study plan was discussed at a Fish and Aquatic Resource Work Group (FARWG) meeting. City Light reviewed all comments received and is releasing this plan as the revised version of the draft study plan. The revised draft will be discussed at a FARWG meeting. Written comments were received from Upper Skagit Indian Tribe, NPS, Washington Department of Fish and Wildlife (WDFW), USFWS, and NMFS and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date.

No formal study requests related to this study were filed with FERC.

This study plan has been designed to assess the risk of fish stranding and trapping in the study area and inform related littoral and riparian habitat issues raised during the 2019 Study Plan Development Process.

Following completion of relicensing studies, an integrated environmental analysis will specifically address links across resource areas. Data collected as part of the Stranding and Trapping Assessment, along with existing information, may also be applicable to other resource areas. Studies that may ultimately be linked, either directly or indirectly, to the findings of this study include FA-02 Instream Flow Model Development Study, OM-01 Operations Model Study, and sediment deposition and erosion studies. More needs to be learned within each respective study area before it is clear if and how study results will meaningfully inform comprehensive environmental analysis. City Light will work with LPs to review and integrate information from related studies as part of the ILP process in support of its license application filing.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Stranding and Trapping Assessment is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations.[1] Native fish species within Project reservoirs include resident Rainbow Trout (*Oncorhynchus mykiss*), Bull Trout (*Salvelinus confluentus*) and Dolly Varden (*Salvelinus malma*).

Specific objectives include:

- Identify and map focal areas through a desktop Geographic Information System (GIS) analysis of existing elevation and topobathymetric data where stranding and trapping risk to native fish species may occur;
- Undertake field surveys of fish stranding and trapping at select risk areas to confirm or refute the results of the desktop analysis methods; and
- As needed, update the desktop analysis based on field results.

Results and/or tools from this study may be used to evaluate Project effects in the license application.

2.2 Resource Management Goals

The study will provide information to help resource agencies, Indian tribes, and First Nations with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

No stranding or trapping information is available for any of the reservoirs under normal Project operations. Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes due to reservoir drawdowns and/or surface elevation fluctuations. Reservoir drawdowns or fluctuations occur during normal operations to support flood control, fish protection, recreation, and power generation.

Per current licensing requirements, occasional assessments of fish stranding and trapping have occurred in Gorge and Diablo lakes (by City Light and LPs) during scheduled drawdowns outside of normal operations for maintenance activities and infrastructure testing (e.g., spillways, etc.) but no information exists for Ross Lake under these circumstances.

[1] For purposes of this study, "normal operations" are defined as typical operations to support flood control, fish protection, recreation, and power generation and do not include drawdowns for maintenance or infrastructure testing.

In April 2019, drawdown of Gorge Lake to about 830 feet North American Vertical Datum of 1988 (NAVD 88) [2] (823.49 feet City of Seattle Datum (CoSD)) for spill gate testing resulted in stranding and trapping of native fish in the vicinity of the State Route (SR) 20 causeway crossing of Gorge Lake. A report on this stranding and trapping event is currently under preparation by City Light. However, genetic analysis conducted by the WDFW Molecular Genetics Lab confirmed that samples of stranded char appear to be primarily Dolly Varden with a low level (≈ 5 percent) of hybridization with Bull Trout and Brook Trout, and Gorge Lake Brook Trout samples were identified correctly in the field (Small et al. 2020a). Stranded Rainbow Trout were native origin fish (Small et al. 2020b).

Native fish species in the Project reservoirs include Rainbow Trout, Bull Trout, and Dolly Varden. Bull Trout are listed as "threatened" under the ESA. Lifestage information (e.g., fry, juvenile, adult, etc.) of each native species and timing of the presence of those lifestages in reservoirs during periods of Project operations where there is a risk of trapping or stranding are discussed in more detail in Section 2.6.2.4 of this study plan.

2.3.1 Description of Reservoir Operations

All water level data currently collected at the Project reservoirs and key water surface elevations cited in the current Project license are reported to CoSD. All elevations in this and subsequent sections of the study plan are given relative to NAVD 88 and, in most instances, also to CoSD, using the conversions provided below. All Light Detection and Ranging (LiDAR) data discussed in the study plan are reported to NAVD 88.

- Ross Lake: NAVD 88 = CoSD + 6.26 feet
- Diablo Lake: NAVD 88 = CoSD + 6.36 feet
- Gorge Lake: NAVD 88 = CoSD + 6.51 feet

2.3.2 Ross Lake

Under the current Project license, Ross Lake normal maximum water surface elevation and minimum water surface elevation (authorized by current license) are 1,608.76 feet NAVD 88 (1,602.5 feet CoSD) and 1,480.76 feet NAVD 88 (1,474.5 feet CoSD), respectively. Water surface elevations are typically maintained between a normal maximum of 1,608.76 feet NAVD 88 (1,602.5 feet CoSD) during summer and 1,541.26 feet NAVD 88 (1,535 feet CoSD) during fall and winter (a difference of 67 feet). Ross Lake is maintained close to its normal maximum water surface elevation from 31 July through Labor Day and then drawn down for flood control and power generation through the fall and winter months, typically reaching its annual low elevation in mid-April. The reservoir is then refilled during the spring/early summer freshet back to its normal maximum by 31 July. The annual drawdown is typically between about 60 and 80 feet but

[2] City Light is in the process of transitioning over to use of North American Vertical Datum of 1988 (NAVD 88) for representation of vertical datum, which will be completed no later than filing of the license application. A table converting elevation values of key Project features from City of Seattle Datum to NAVD 88 and map of the features is appended to the PSP.

has been as much as 120 feet.[3] A sample of daily water surface elevation data from 2010 through 2018 is shown in Figure 2.3-1.

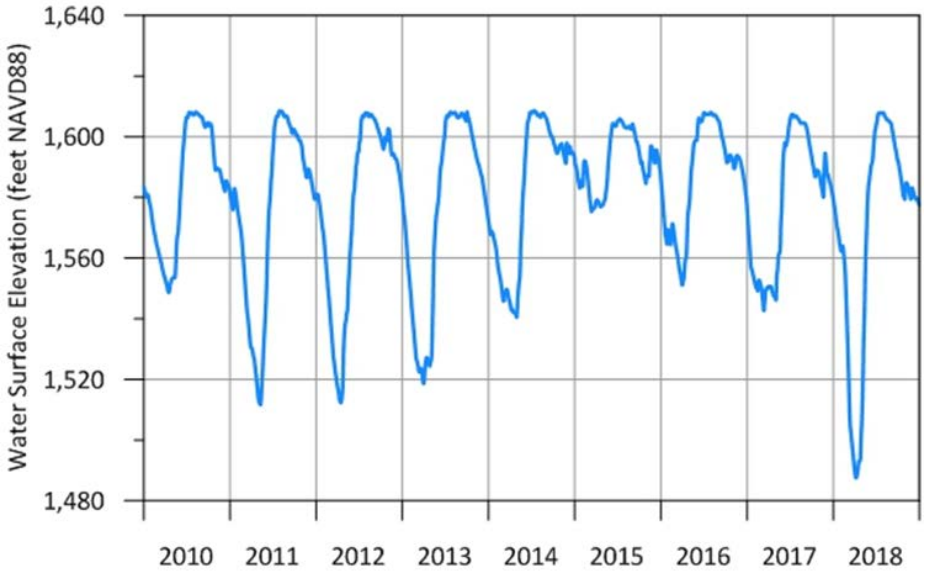

Figure 2.3-1. Ross Lake daily water surface elevations (2010–2018).

2.3.3 Diablo Lake

The primary function of Diablo Lake is to reregulate flows between the Ross and Gorge developments. The lake typically fluctuates 4 to 5 feet daily for a typical operating range between about 1,206 and 1,211 feet NAVD 88 (between about 1,199.64 and 1,204.64 feet CoSD), although under normal operations the lake may be operated as low as elevation 1,203 or 1,204 feet NAVD 88 on occasion, and drawdowns of 10 to 12 feet to about elevation 1,200 feet NAVD 88 occur occasionally as needed for construction projects or maintenance. There is little seasonal variation in water surface elevations. A sample of hourly water surface elevation data for April 2014 through June 2014 is shown in Figure 2.3-2.

[3] The lowest licensed water surface elevation for Ross Lake is 1,480.76 feet NAVD 88 (1,474.5 feet CoSD), 128 feet below normal maximum water surface elevation, which has occurred only once in the current license period (in April 1999). Between 2009 and 2018, the average low water surface elevation was 1,541.26 feet NAVD 88 (1,535 feet CoSD), a difference of 67 feet.

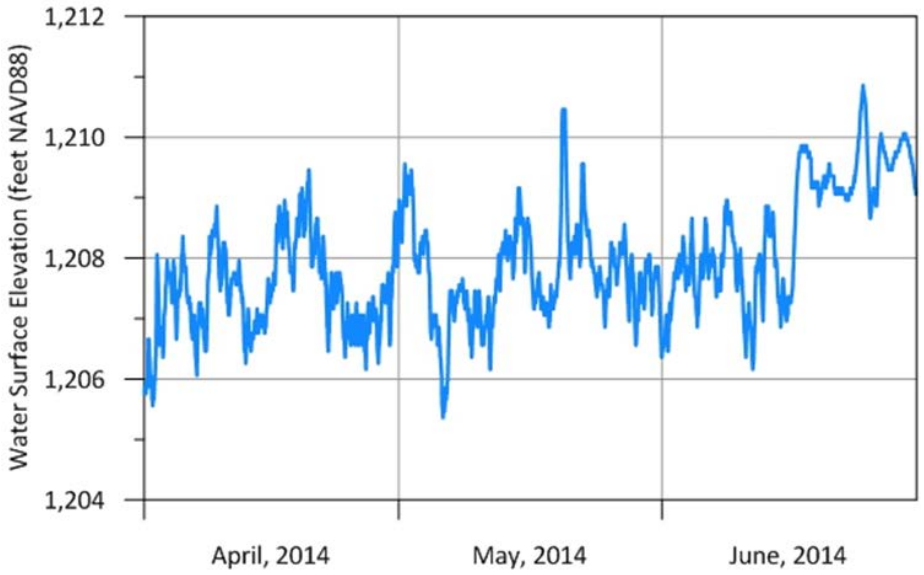

Figure 2.3-2. Diablo Lake hourly water surface elevations (April–June 2014).

2.3.4 Gorge Lake

The primary function of Gorge Lake is to regulate downstream flows for fish protection. Gorge Lake typically fluctuates 3 to 5 feet daily for a typical operating range between about 876 and 880 feet NAVD 88 (between about 869.49 and 873.49 feet CoSD), although under normal operations the lake may be operated as low as 870 feet NAVD 88 on occasion, and drawdowns of 50 feet or more are occasionally needed for spill gate maintenance or inspection. A sample of hourly water surface elevation data for April 2014 through June 2014 is shown in Figure 2.3-3.

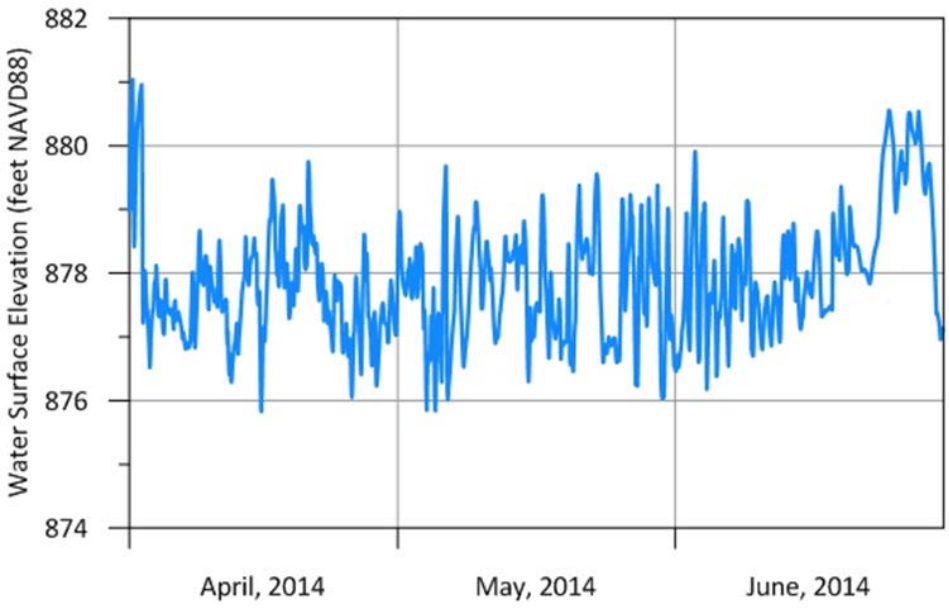

Figure 2.3-3. Gorge Lake hourly water surface elevations (April–June 2014).

City Light's current monthly operations plan states that if the water surface elevation of Gorge Lake is drawn down below 867 feet CoSD (873.51 feet NAVD 88), City Light's Project Fish Biologists will be contacted within 48 hours to conduct a stranding/entrapment assessment at known locations where stranding may occur.

2.3.5 Existing Data

A variety of topographic and bathymetric data are available to support development of digital elevation models (DEM) for use in identifying isolated pools and areas with minimal topographic relief which present the greatest risk for stranding and trapping within the study area. These data comprise:

- Topographic data: Standard LiDAR data were acquired for all three reservoir areas in 2016/2017 (Quantum Spatial 2017) and for Ross Lake in 2018 (Quantum Spatial 2018a). Standard LiDAR data provide topography for shoreline areas above the reservoir water surface elevation at the time of data acquisition. The 2018 Ross Lake LiDAR data were acquired on 25/26 April 2018 at a time when the lake was at a very low water surface elevation (water surface elevation of about 1,494 feet NAVD 88 or 1,487.74 feet CoSD) and hence provides topographic data for almost the entire area of the reservoir presenting a possible stranding/trapping risk. The 2016/2017 data provides no additional information for Ross Lake and limited information on shoreline topography for Gorge and Diablo. The exact extent of shoreline topography from the 2016/2017 LiDAR is discussed further in Section 2.6.2.1 of this study plan.
- Topobathymetric data: Topobathymetric (aka Green) LiDAR data were acquired for portions of Gorge and Diablo lakes on 25/26 April 2018 (Quantum Spatial 2018b). Because of its ability to penetrate water to some (limited) depth, the 2018 Green LiDAR provides somewhat greater coverage of topographic and bathymetric data than the 2016/2017 Standard LiDAR. The exact extent of shoreline topography and bathymetry from the 2018 Green LiDAR is also discussed further in Section 2.6.2.1 of this study plan.

The 2017 and 2018 standard LiDAR data have an absolute Non-vegetated Vertical Accuracy of 0.263 and 0.201 feet respectively with 95 percent confidence. The topobathymetric LiDAR data have a vertical accuracy of 0.366 feet with 95 percent confidence for submerged bathymetric check points. Full details of the LiDAR resolution and accuracy assessments can be found in the LiDAR technical data reports (Quantum Spatial 2017, 2018a, and 2018b).

Reservoir water surface elevation data under current Project operations are available from both the U.S. Geological Survey (USGS) and City Light. The USGS reports daily (end of day) water surface elevations. More detailed hourly data are available from City Light. Given the time scales over which the reservoir water surface elevations vary, daily data are suitable for analysis of Ross Lake water surface elevations, while hourly data are necessary for analysis of Gorge and Diablo lakes water surface elevations. Hourly and daily water surface elevation data from Ross Lake will be reviewed to confirm that the daily data adequately characterize Ross Lake water level fluctuations relevant to the evaluation of stranding and trapping risk. Summaries of monthly and annual maximum, average and minimum water surface elevations for Ross Lake, Diablo Lake, and Gorge Lake are provided in Table 3.5-1, Table 3.5-3 and Table 3.5-6 of the PAD, respectively.

2.4 Project Operations and Effects on Resources

Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes due to reservoir drawdowns and/or surface elevation fluctuations. Reservoir drawdowns or fluctuations occur to support flood control, fish protection, recreation, and power generation. Although reservoir drawdowns are also conducted for maintenance or FERC-required infrastructure testing, these operations occur less frequently, are not anticipated to occur during the study period, and are, therefore, not included in the definition of normal Project operations for the purposes of this study.

2.5 Study Area

The proposed study area includes Ross, Diablo, and Gorge lakes, within the U.S., at elevations below which stranding and trapping risks could be elevated under normal Project operations (Figure 2.5-1). If analysis of existing information and field data collected in the U.S. indicate that information from Ross Lake within Canada is needed to adequately address the objectives of this study, City Light will explore the feasibility of field data collection within Canada (i.e., outside of the FERC Project Boundary).

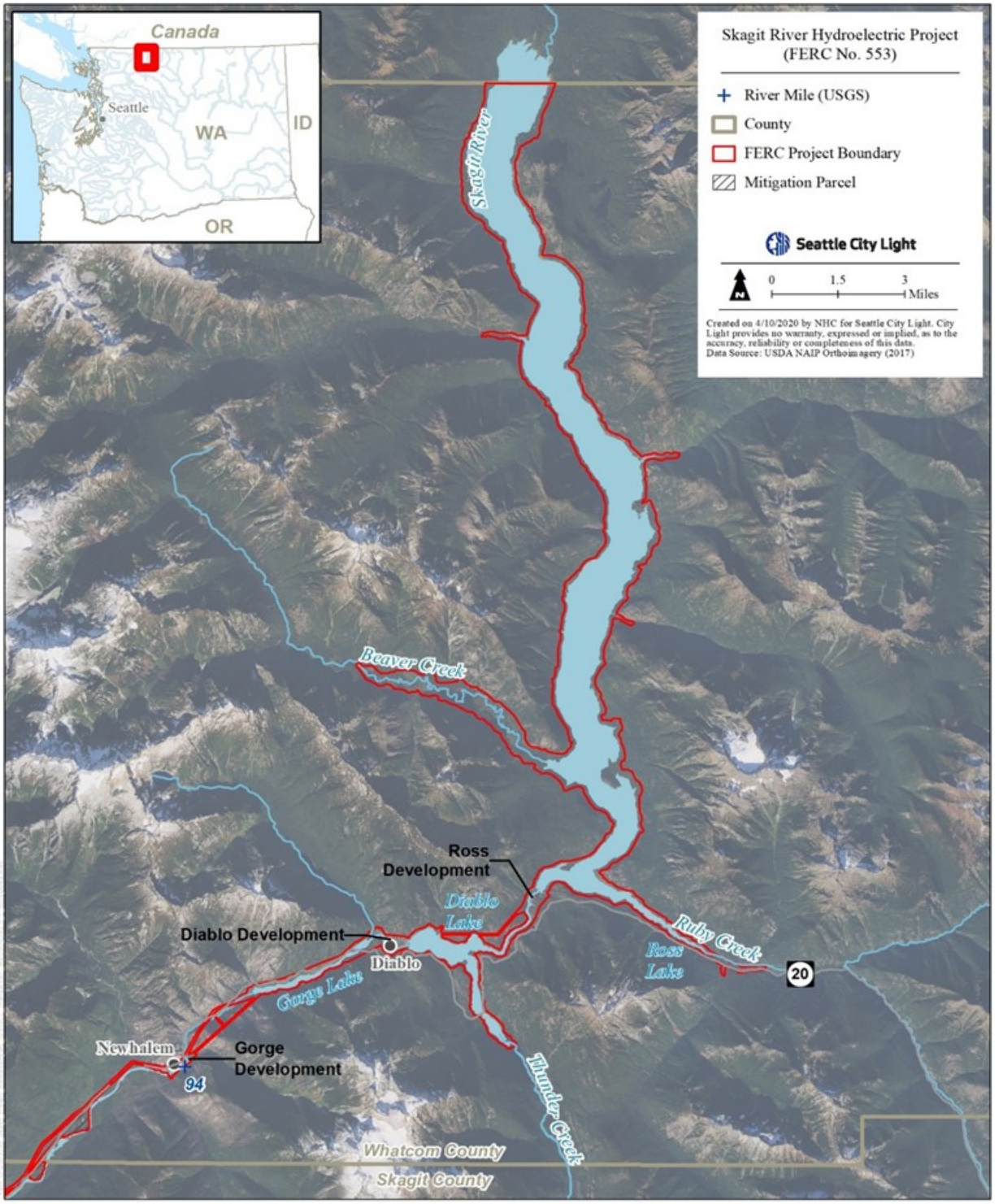

Figure 2.5-1. Overview of proposed study area.[4]

[4] Figure 2.5-1 depicts the Project Boundary encompassing the generation facilities. The study area is the portion of Project reservoirs (i.e., Ross, Diablo and Gorge) at risk of native fish species stranding and trapping under normal

2.6 Methodology

The study includes two phases: (1) field reconnaissance and a desktop analysis of the study area to identify potential areas of fish stranding and trapping risk; and (2) field surveys at selected areas to validate results of the desktop analysis and to update the desktop analysis, as necessary.

2.6.1 2020-2021 Ross Lake Reconnaissance

A total of three reconnaissance level field surveys will be conducted during the 2020/21 Ross Lake drawdown cycle. The reconnaissance effort is intended to provide an initial assessment of entrapment habitat associated with tree stumps (i.e., tree wells) because little is currently known about mechanisms that form this type of habitat in Ross Lake. Information on locations, numbers, and approximate sizes of tree wells, and physical factors (e.g., slope, aspect, or exposure to wave action) associated with the formation of tree wells will be collected. In addition to tree well trapping conditions, reconnaissance will be conducted to examine other low-slope potential stranding zones. If stranding or trapping is observed during reconnaissance, such observations will be useful for refining understanding of the periodicity of reservoir habitat use by lifestage(s) of the primary species' of interest in this study.

Because the DEM model will not have been developed by the time 2020/21 drawdown reconnaissance surveys need to be conducted, existing information will be used to target areas for examination. Specifically, field surveys will focus on areas where stranding and trapping may have been previously observed, where existing information on topographic slope and bathymetry in exposed areas is qualitatively representative of the slope delineations to be refined in the 2021 desktop analysis, and areas—based on best professional judgment and past findings in other systems—that are likely stranding and trapping risk areas (e.g., proximity to a tributary stream or margins of the mainstem influent).[5] These reconnaissance focus areas will represent, in essence, early risk screening "strata." Within these strata, which are expected to represent a significant area of survey within Ross Lake in particular, City Light will test the adaptive cluster sampling approach (defined further in Section 2.6.3 of this study plan) for application later in 2021 and in 2022 after the DEM results can be considered. The results of these surveys will also help to inform the desktop analysis described in Section 2.6.2 below.

2.6.2 Desktop Analysis

The desktop analysis includes (1) assembly and analysis of DEMs of reservoir shoreline and bed topography to inventory potential stranding and trapping areas, (2) an analysis of reservoir water surface elevation data to document the frequency and period of time over which trapping pools are formed and areas of low slope terrain are exposed in drawdown zones, and (3) an analysis of native species lifestage and periodicity information to identify when lifestages susceptible to stranding and trapping risk under normal operations may be present in the study area. The lifestage periodicity analysis may also inform appropriate periods for field sampling.

operations (defined in Section 2.1 of this study plan). If analysis of existing information and field data collected in the U.S. indicate that information from Ross Lake within Canada is needed to adequately address the objectives of this study, City Light will explore the feasibility of field data collection within Canada (i.e., outside of the FERC Project Boundary).

[5] Reconnaissance methods are under development and will be finalized prior to field efforts.

2.6.2.1 Inventory of Areas Presenting Stranding and Trapping Risk

Developing an inventory of areas presenting a stranding and trapping risk will involve assembling a DEM of each of the three reservoirs and then analyzing the DEMs to identify and quantify areas with gradient profiles indicating stranding risk and areas draining to isolated pools indicating trapping risk. The DEMs will be developed from available LiDAR data, supplemented for Gorge Lake and Diablo Lake by bathymetric data to be collected as part of this study.

Ross Lake DEM

The 2018 Standard LiDAR at Ross Lake (Quantum Spatial 2018a) (Figure 2.6-1) was flown at a water surface elevation of 1,494 feet NAVD 88 (1,487.74 feet CoSD), which is substantially lower than the water surface elevation during acquisition of the 2016/2017 Standard LiDAR. Therefore, only the 2018 data will be used when evaluating trapping/stranding issues in Ross Lake. With a typical annual minimum water surface elevation of about 1,541 feet NAVD 88 (1,534.74 CoSD), the 2018 LiDAR will readily quantify the terrain slope and isolated pools with potential for stranding and trapping in Ross Lake.

Diablo Lake DEM

The only available LiDAR data providing complete coverage around Diablo Lake is the 2016/2017 Standard LiDAR, which was flown at a water surface elevation of approximately 1,208 feet NAVD 88 (1,201.64 feet CoSD) (Quantum Spatial 2017). With a minimum water surface elevation under normal operations of about 1,203 feet NAVD 88 (1,196.64 feet CoSD), there will remain a narrow band of shoreline surrounding the lake within the normal operating range whose slope cannot be quantified and where isolated pools cannot be identified from the Standard LiDAR. Green LiDAR was acquired on Thunder Arm, the inundated reach of Thunder Creek that enters Diablo Lake from the south (Quantum Spatial 2018b) (Figure 2.6-2). The Green LiDAR coverage was obtained at a water surface elevation of about 1,208 feet NAVD 88 (1,201.64 feet CoSD), similar to the water surface elevation during acquisition of the 2016/2017 LiDAR. Quantum Spatial reports confidence in underwater laser returns as low as elevation 1,193 feet NAVD 88 (1,186.64 feet CoSD), for a maximum depth underwater of about 15 feet. This allows for quantifying the shoreline terrain slope approximately 35 feet from the lakeshore and quantifying slope and isolated pools in Thunder Arm near the SR 20 crossing where most of the lakebed surface is revealed (Figure 2.6-3). Any areas of the lakebed not colored in dark blue on Figure 2.6-3 are not quantifiable with the available Green LiDAR. As part of the study, additional bathymetric data will be collected in areas within the normal operating range where LiDAR is unavailable to support the desktop analysis. These data will be obtained by boat or autonomous underwater vehicle using traditional echo-sounding methods and will allow for quantifying shoreline terrain down to an elevation of approximately 1,200 feet NAVD 88 (1,193.64 feet CoSD). The Diablo Lake water level has dropped below 1,200 feet NAVD 88 only once since hourly water level records began in 1997; the lake level dropped to approximately 1,199.4 feet NAVD 88 in 2017. Except for the Thunder Arm, the shoreline of Diablo Lake is relatively steep and the potential for stranding and trapping outside Thunder Arm is likely low.

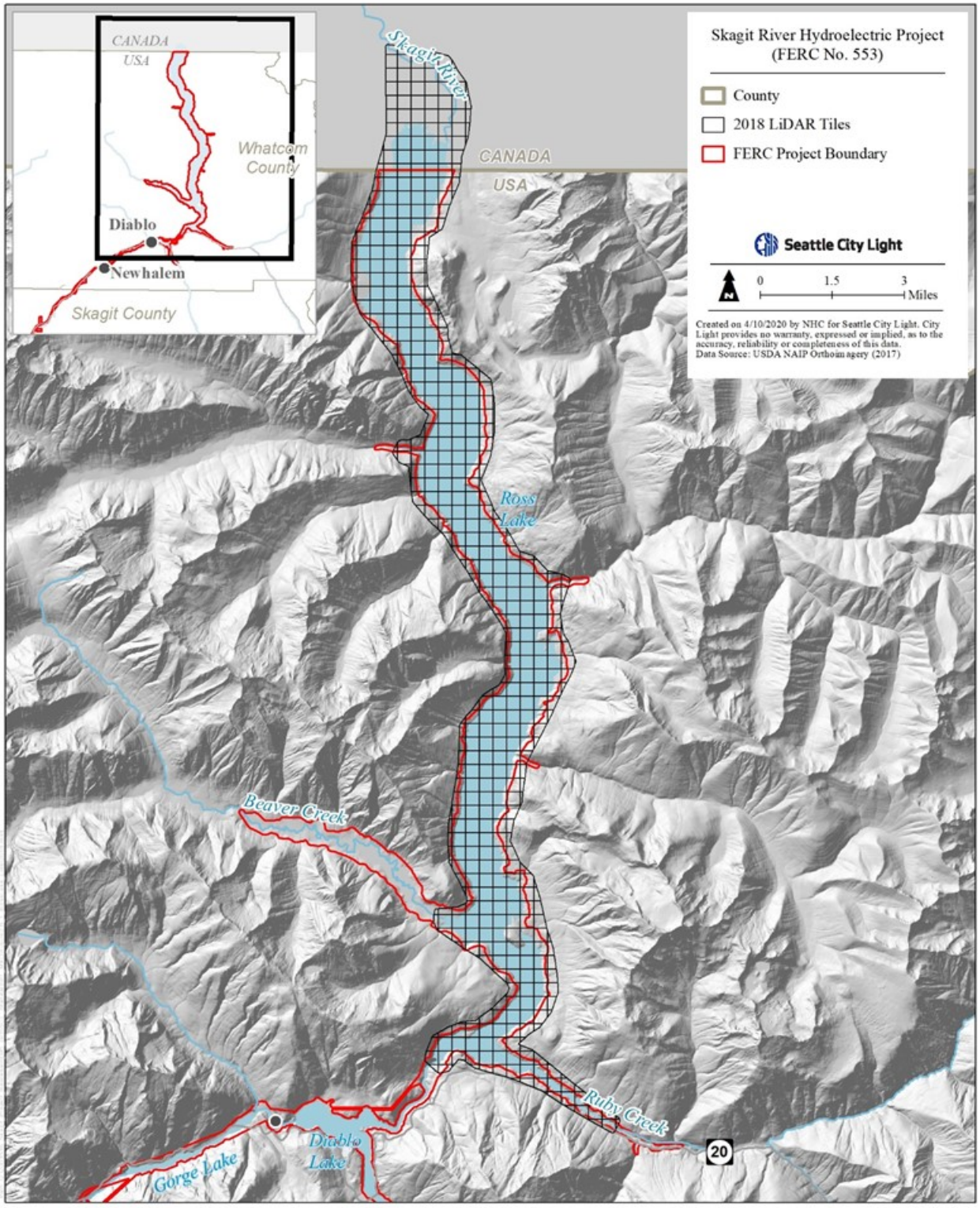

Figure 2.6-1. Extents of 2018 LiDAR of Ross Lake.

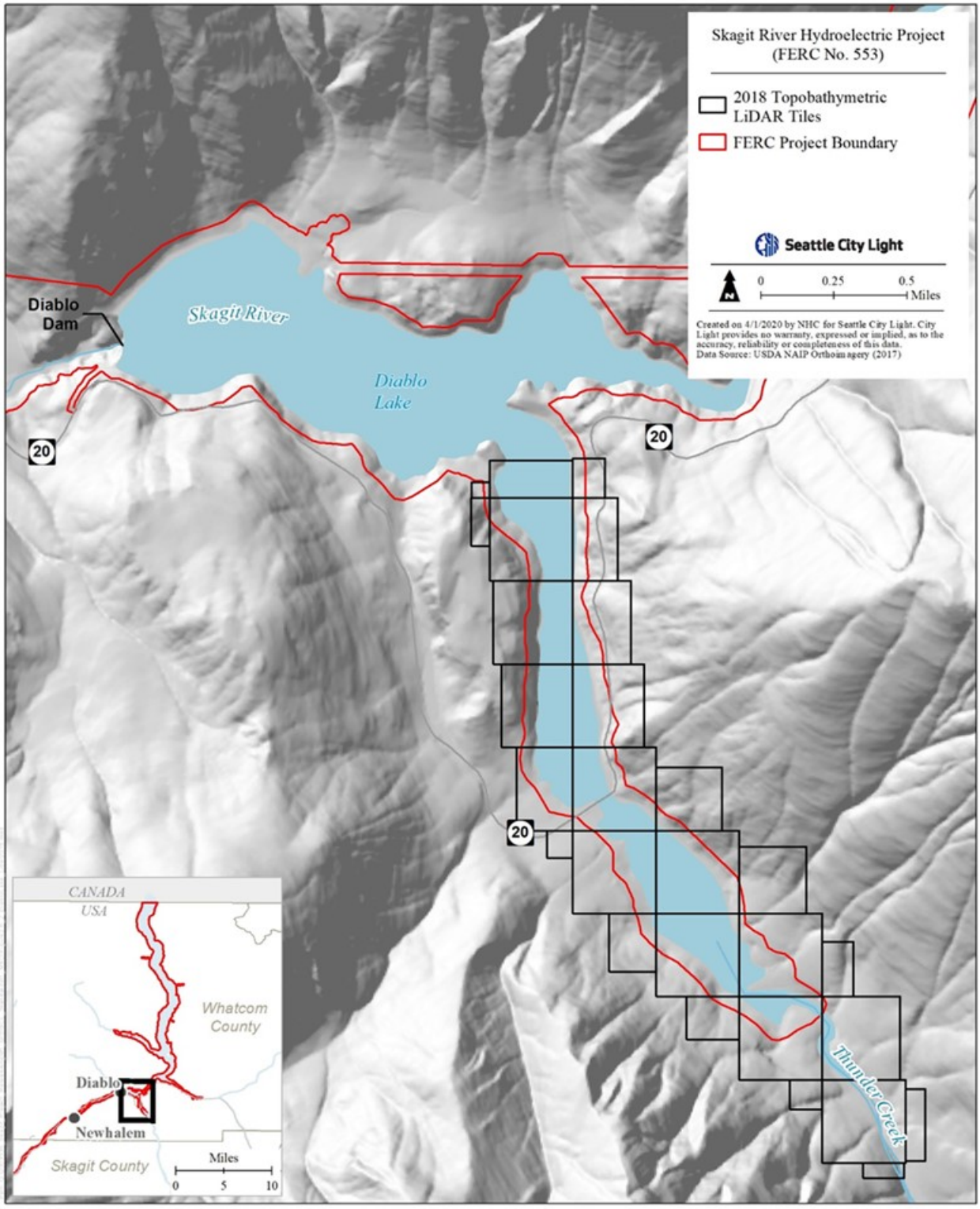

Figure 2.6-2. Extents of 2018 topobathymetric (Green) LiDAR around Diablo Lake.

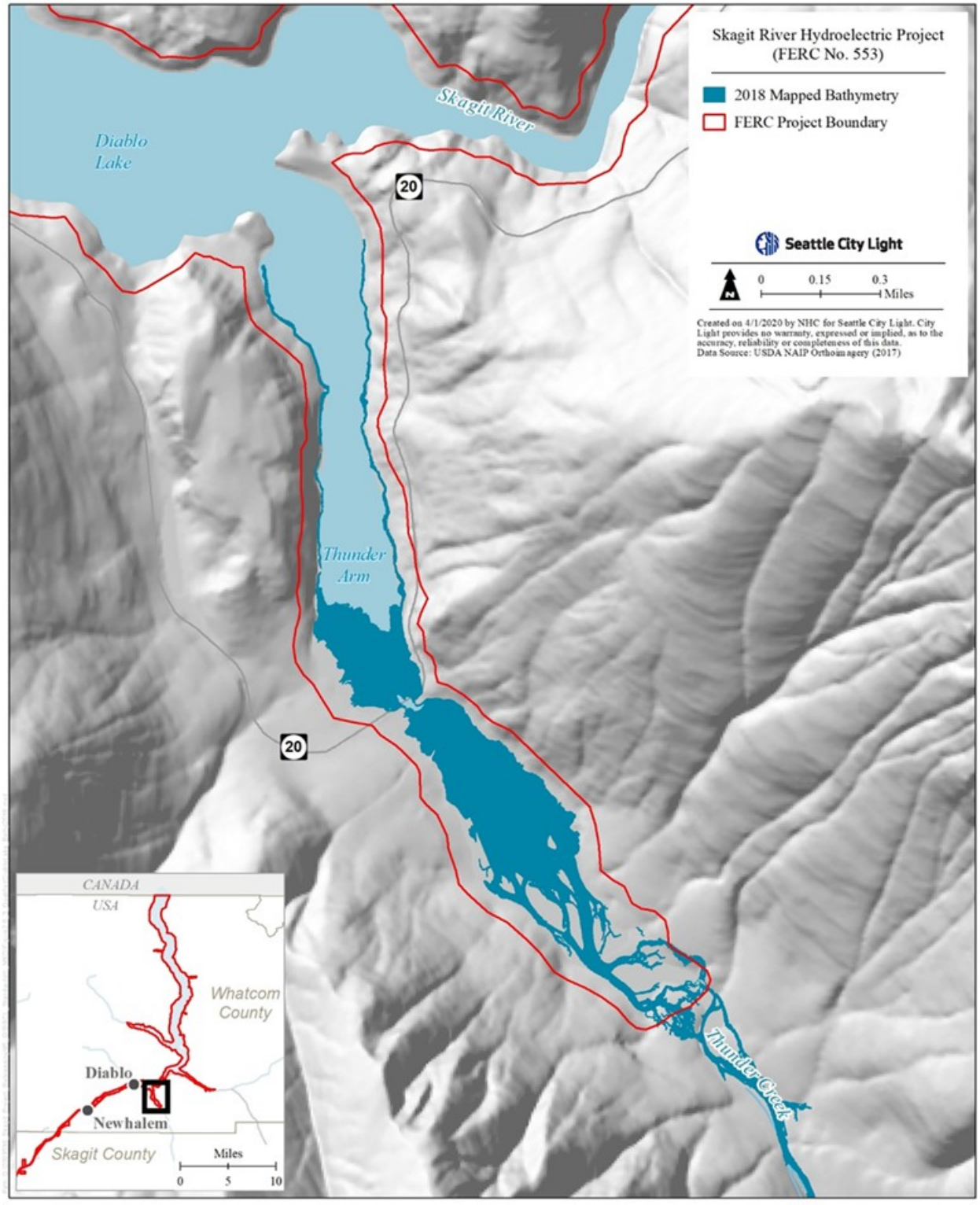

Figure 2.6-3. Dark blue color illustrates shoreline and bed area in Thunder Arm of Diablo Lake that is quantified in the topobathymetric (Green) LiDAR.

Gorge Lake DEM

The only available LiDAR data providing complete coverage around Gorge Lake is the 2016/2017 Standard LiDAR which was flown at a water surface elevation of approximately 876.6 feet NAVD 88 (870.09 feet CoSD) (Quantum Spatial 2017). With a minimum water surface elevation under normal operations of about 870 feet NAVD 88, there will remain a narrow band of shoreline surrounding the lake within the normal operating range whose slope cannot be quantified and where isolated pools cannot be identified from the Standard LiDAR. Green LiDAR was also acquired at the Stetattle Creek confluence with Gorge Lake upstream to Diablo Dam (Quantum Spatial 2018b) (Figure 2.6-4). The Green LiDAR was flown at a water surface elevation of 876 feet NAVD 88 (869.49 feet CoSD), which is similar to the water surface elevation during acquisition of the 2016/2017 Standard LiDAR. Quantum Spatial reports confidence in underwater laser returns as low as elevation 869 feet NAVD 88 (862.49 feet CoSD) near the SR 20 causeway, for a maximum depth underwater of 7 feet. This allows quantifying by LiDAR approximately 10–50 feet of the shoreline lakebed south of the causeway and much of the lakebed slope and isolated pools presenting a trapping risk north of the SR 20 crossing (Figure 2.6-5). Any areas of the riverbed not colored in dark blue on Figure 2.6-5 are not quantifiable with the available LiDAR. As part of the study, the LiDAR data for Gorge Lake will be supplemented by data from a bathymetric survey conducted by boat or autonomous underwater vehicle using traditional echo-sounding methods. The bathymetric survey will map lakebed terrain down to an elevation of approximately 800 feet NAVD 88 (793.49 feet CoSD), which would encompass the lowest water levels seen in the proposed period of analysis since 2011, including those associated with maintenance drawdowns.

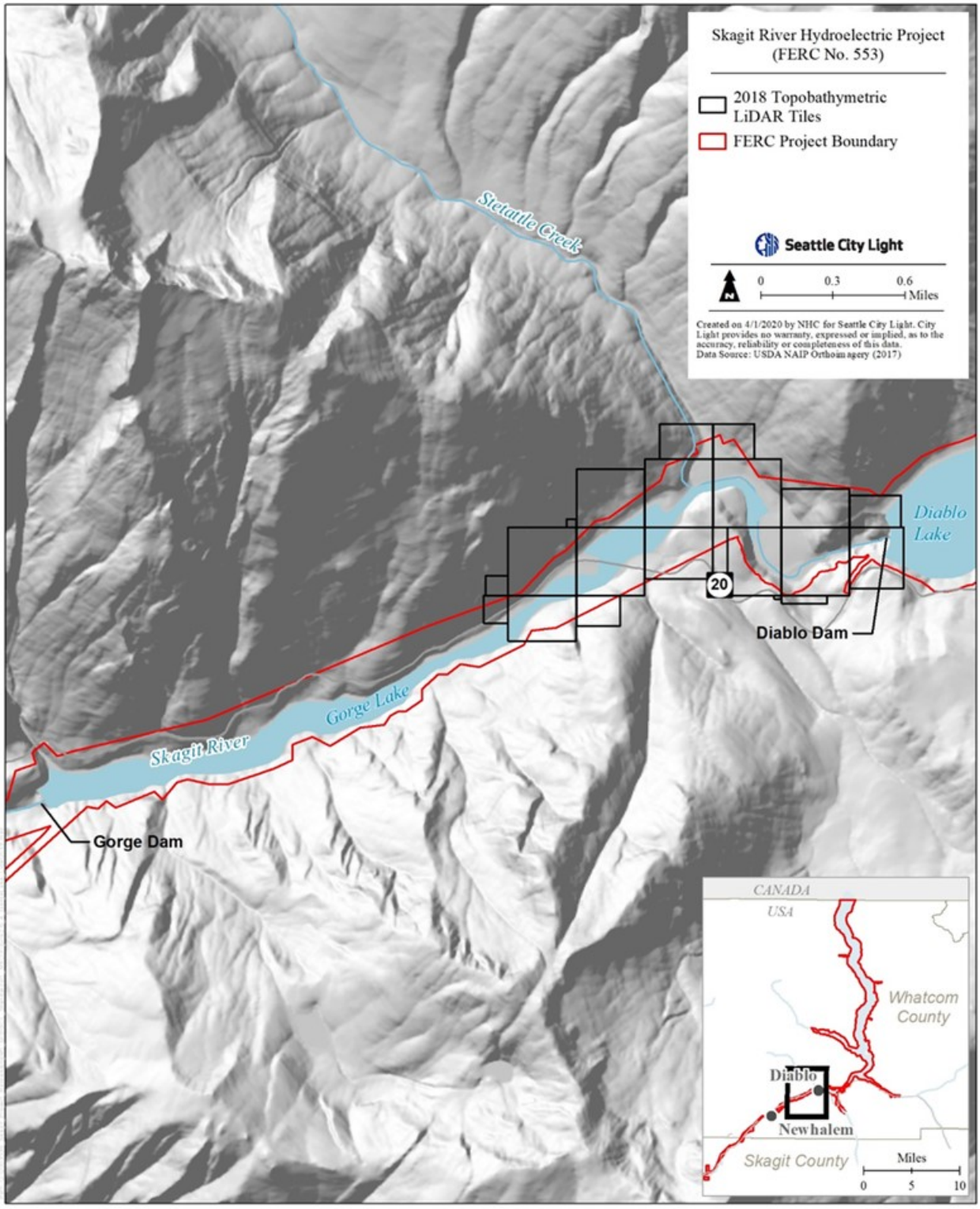

Figure 2.6-4. Extents of 2018 topobathymetric (Green) LiDAR around Gorge Lake.

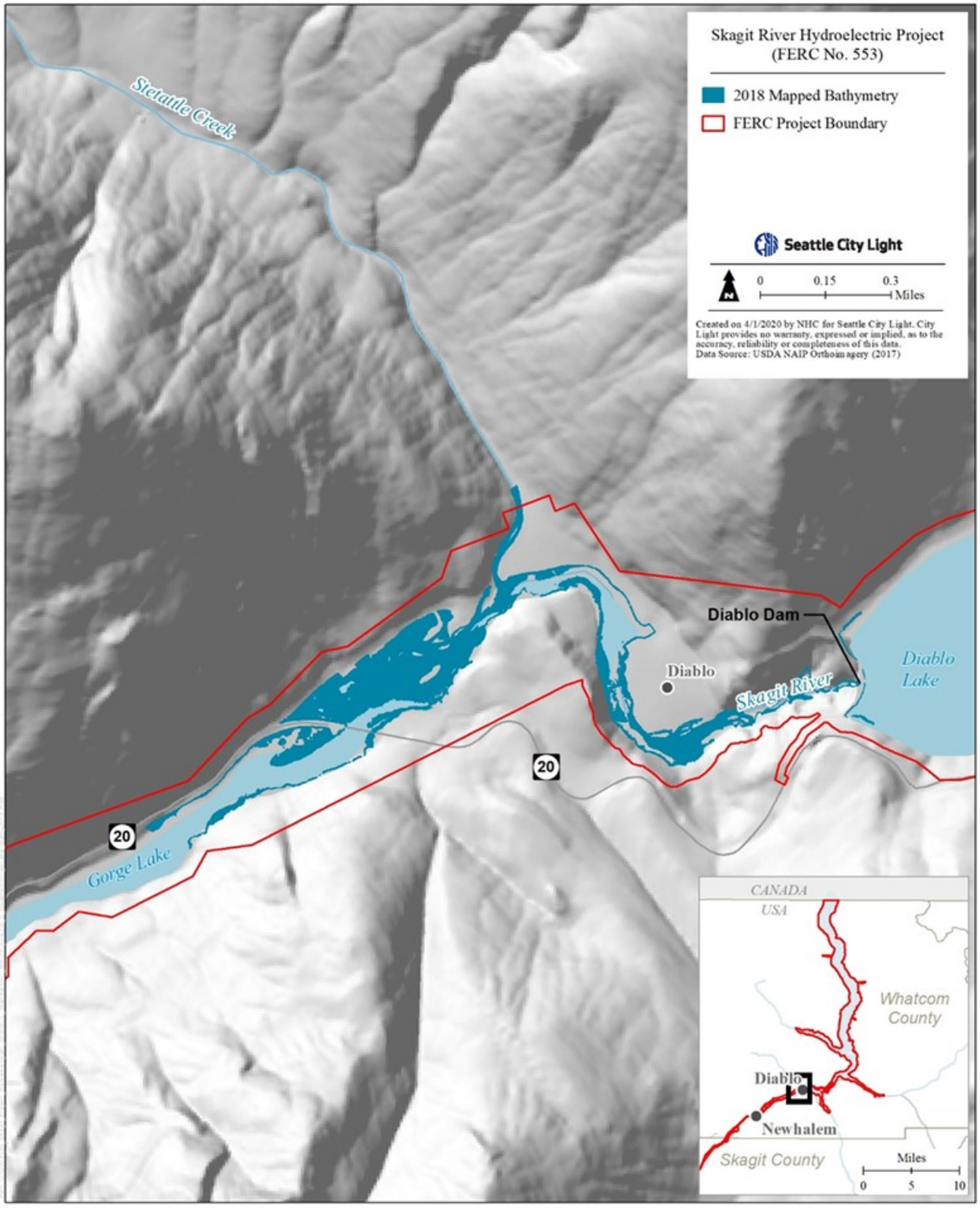

Figure 2.6-5. **Dark blue color illustrates shoreline and bed area of Gorge Lake that is quantified in the topobathymetric (Green) LiDAR.**

2.6.2.2 Analysis of DEMs for Stranding and Trapping Risk

Evaluation of potential stranding and trapping risk in the study area will be performed with standard GIS tools from the ArcGIS Spatial Analyst toolbox supplemented by custom scripts to facilitate analysis. Terrain slopes will be computed for each DEM cell (likely 3-foot square cells) and then labeled as having a slope less than 4 percent, between 4 percent and 6 percent, and greater than 6 percent. These are benchmark slopes previously identified by Bell et al. (2008) as associated with salmonid stranding potential in reservoir environments. These slopes are significantly steeper than the very shallow slopes associated with salmonid fry stranding from boat wakes or stranding in floodplains on unregulated systems on a declining hydrograph (Ackerman et al. 2002; Sommer et al. 2005). However, they are relevant to trapping risks in reservoir systems where stream velocity (rheotactic) cues will be relatively lacking and rapid drawdowns have potential to create ponding. Rheotaxis is useful to orient fish for egress from stranding risk areas when depths decrease gradually, as occurs more often under normative flow regimes. Cells whose slope is inconsistent with a sufficient number of neighboring cells will be aggregated to eliminate overly granular slope classification and remain true to the purpose of this analysis which is to identify areas of low slope presenting a stranding risk. Exposed lakebed slope/area statistics will be summarized by water surface elevation and a map produced illustrating the exposed low gradient areas within the range of water surface elevations for which the DEMs have been developed for each reservoir.

To identify trapping hazards, the lake shoreline and lakebed DEMs will be queried for isolated pools, or "sinks" in GIS terminology. To allow reliable identification of sinks considering the accuracy of the LiDAR data, they will initially be defined as spatially connected cells surrounded by a ring of higher elevation cells that hold water to a minimum depth of 12 inches. Sinks with a minimum depth of less than 12 inches will generally be classified by the DEM analysis as low slope terrain presenting a stranding rather than trapping risk, hence there will likely be some misclassification of stranding and trapping risk. The minimum depth used to identify sinks will be revisited following field verification of the results of the DEM analysis.

Given the resolution of the LiDAR data, a minimum sink area of 108 square feet will be assumed for the purposes of identifying and quantifying sinks. This would represent 12 contiguous 3-foot square cells in the DEM. As with stranding hazards, the number and area of these sinks will be summarized by reservoir water surface elevation and a map produced illustrating the sinks within the range of water surface elevations for which the DEMs have been developed.

The separate maps of low slope terrain and isolated pools or sinks will be overlaid to identify the areas with the highest potential for fish stranding or trapping for a given reservoir water surface elevation.

The 2020/21 drawdown reconnaissance (see Section 2.6.1 of this study plan) also offers an opportunity to verify that areas identified by the DEM analysis as high risk are actually experiencing high stranding or trapping rates, and similarly to determine whether areas where stranding or trapping may have been found during reconnaissance that were *not* identified by the DEM.

2.6.2.3 Analysis of Reservoir Drawdown

Trapping and stranding risk zones will be estimated from the frequency with which isolated trapping pools are formed and the frequency with which low gradient stranding areas become exposed. The reservoir elevation data will also be analyzed to characterize reservoir drawdown rates.

Analysis for Gorge and Diablo lakes will be performed using the record of hourly water surface elevation data since 2011 under current Project operations. As discussed in Section 2.3 of this study plan, water surface elevations in Gorge and Diablo lakes commonly fluctuate within their normal operating ranges daily. The reservoir water surface elevation data will be analyzed in conjunction with the inventory of areas presenting a potential risk to determine the frequency of formation of isolated trapping pools and exposure of low gradient stranding areas by reservoir elevation. Since Gorge and Diablo lakes elevations fluctuate daily, the duration of time that trapping pools remain isolated will be determined. The reservoir elevation data will also be analyzed to characterize reservoir drawdown rates under normal Project operations, classified by time of day and month or season.

Analysis for Ross Lake will be similar to that for Gorge and Diablo, except that the analysis will be performed using the record of daily (end of day) water surface elevation data since 2011. As discussed in Section 2.3 of this study plan, water surface elevations in Ross Lake fluctuate seasonally. Hourly and daily water surface elevation data from Ross Lake will be reviewed to confirm that the daily data adequately characterize Ross Lake water level fluctuations relevant to the evaluation of stranding and trapping risk. As for Gorge and Diablo lakes, the reservoir water surface elevation data will be analyzed in conjunction with the inventory of areas presenting a potential risk to determine the frequency of formation of isolated trapping pools and exposure of low gradient stranding areas by reservoir elevation.

2.6.2.4 Native Species Lifestage and Periodicity Analysis

As referenced above, each of the Project reservoirs support native Bull Trout, Dolly Varden, and Rainbow Trout. While the early life stages of these native species (i.e., emergent fry and young of the year parr) will be physically most susceptible to stranding because of their low velocity tolerance and associated use of shallow and slow waters, defining risks to all life stages of native species under normal operations requires the overlay of temporal operations on reservoir elevations and an understanding of the corresponding phenology of the use of those habitats where trapping and stranding might occur. At present, knowledge at this level of resolution is limited, so predictions of which species and life stage will be most susceptible to stranding or trapping over an annual or seasonal operations cycle will take into account the general life cycles of the native fish to infer their life stage specific temporal susceptibility.

Rainbow Trout are spring spawners, typically spawning from late March through April, but potentially extending well into May or June in systems with cooler water temperatures. Spawning and incubation of the resultant eggs and sac-fry occur over a period of rising water temperatures. Young of the year rainbow trout fry typically emerge from June onwards through July, with susceptible young of the year present through the remainder of the calendar year, with increasing size. Changes in reservoir elevation trapping rearing sub-adult and adult rainbow trout are possible though less likely.

Dolly Varden and Bull Trout, both char species, spawn in the autumn, over a period of declining ambient temperatures, with spawning commencing when water temperatures decline to about 8 ºC, typically in late October and November. Fry of these char species typically emerge from February through March, so stranding and trapping risks for these species are likely highest during this early emergence period through the first few months of early rearing in the spring.

Because none of these native species is known to spawn in the lentic habitats of the Skagit River Project reservoirs—with spawning known to occur in reservoir tributaries—the likelihood of trapping or stranding spawning char is anticipated to be low (as it is with spawning Rainbow Trout). Spawning age fish would be on tributary spawning grounds which would not be susceptible to the effects of reservoir fluctuations or drawdown. In sum, trapping and stranding risks are highest for early emergent fry and young of the year of Rainbow and Bull Trout and Dolly Varden, and the early life stages of these species would be present from February through the summer months. Trapping risks could extend beyond summer months for parr and older sub-adults.

2.6.3 Sampling Design, Field Surveys, and Desktop Analysis Updates

2.6.3.1 2021/22 Sampling Design

Based on field reconnaissance results described in Section 2.6.1, inventory from Section 2.6.2.1, and analysis of reservoir elevation data in Sections 2.6.2.2 and 2.6.2.3 of this study plan, study area zones within each of the three Project reservoirs will be identified for field survey in the 2021/22 field season. Because the areas identified may be substantial, particularly in Ross, subsampling of these study zones for further field survey will be required. A subsample of quadrats corresponding to the resolution of DEM cells will be randomly selected initially from a grid overlay of the key study area zones for initial survey.

An adaptive cluster sampling (ACS) approach will be employed within these study area zones (Thompson 1992). Observations of stranding or trapping, to the extent they may occur, are expected to be highly clustered and not randomly dispersed; therefore, traditional lineal or randomly selected quadrate-based survey has a high likelihood of underestimating observations. That is, traditional randomly selected quadrats will often contain no animals if the habitat use by the species is typically clustered. As such, sampling clusters in a non-random way is needed. Per Thompson (1992), "Adaptive cluster sampling begins in the usual way with an initial sample of quadrats selected by simple random sampling with replacement, or simple random sampling without replacement. When one of the selected quadrats contains the organism of interest, additional quadrats in the vicinity of the original quadrat are added to the sample." The method is akin to hunting for mushrooms--when a forager finds one of a desired species, effort is typically increased in the immediate area of the finding because a higher density of the species is likely.

ACS can result in higher sampling efficiency and higher rates of detecting rare species in comparison to conventional sampling designs, but several assumptions are inherent to its application. First, a quadrat for ACS survey (e.g., quadrat x) is selected only if it contains at least one organism of the study focus (i.e., $y = 1$) (In this case, an observation of a trapped or stranded fish within the quadrat survey area). Next, adjacent quadrats (the 'quadrat neighborhood') are examined for the presence of trapped or stranded fish; these quadrats will have one side in common with quadrat x. Some of these quadrats will contain additional organisms, whereas others will be empty. The empty quadrats do not satisfy the initial selection of a quadrat—these are considered

"edge quadrats." Based on ACS, neighborhoods will expand until there are no further observations in edge quadrats; the collective of adjoining "neighborhoods" is termed a "network," where the random selection of any one of the quadrats in the neighborhood would result in all quadrats being included in the network to be sampled.

In Figure 2.6-6[6], a 400-cell (20 x 20) sample grid is represented. Initially, a random sample of 10 cells was selected for survey. Using ACS, additional adjacent grids are examined, yielding a sample matrix of 37 cells total (in this example), with three sample networks, per the definition above. Simply calculating the mean of all 37 quadrats would result in an estimator that would bias high.

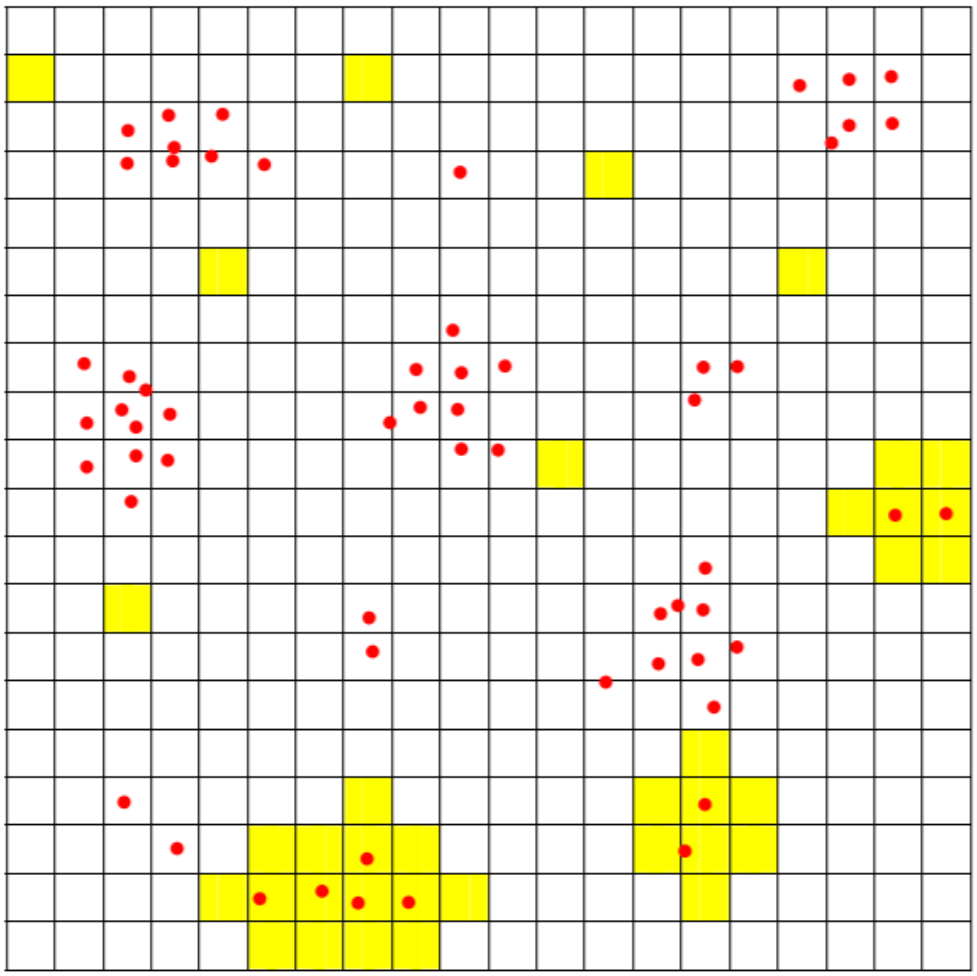

Figure 2.6-6. A 20-by-20 traditional sampling grid, overlaid with representation of subsequently applied adaptive cluster sampling revealing three distinct networks from which abundance estimates can be calculated.

[6] From http://projects.nri.org/ecorat/docs/Adaptive_sampling_protocol.pdf, (no author attribution).

The following sequential procedures are followed to avoid bias and reach estimates of abundance (Thompson 1992).

(1) Calculate the average abundance of each of the networks:

$$w_i = \frac{\sum_k y_k}{m_i}$$

Where

wi = The average abundance of organism y in the *i*-th network
y_k = Abundance of the organism in each of the k-quadrats in the i-th network
mi = Number of quadrats in the *i*-th network.

(2) Calculate the estimator of mean abundance:

$$\bar{x} = \frac{\sum_i w_i}{n}$$

Where

$\bar{x}$ = Unbiased estimate of mean abundance from adaptive cluster sampling
n = Number of initial sampling units selected via random sampling

(3) Calculate the variance of the mean abundance estimate, where samples are selected without replacement[7]:

$$\hat{\text{var}}(\bar{x}) = \frac{(N-n)\sum_{i=1}^{n}(w_i - \bar{x})^2}{Nn(n-1)}$$

In the hypothetical example represented in Figure 2.6-6, 10 quadrats were initially sampled, seven contained no observations of stranded fry, while three did. These three quadrats became three networks from subsequent ACS sampling.

So, the mean estimator (2)

$$\bar{x} = \frac{\sum_i w_i}{n}$$

7 For the reservoir stranding and trapping risk assessment, it is assumed sampling will occur without replacement.

Would be calculated as:

(2/7 + 2/8 + 5/15 + 0/1 +0/1 +0/1 + 0/1 + 0/1 + 0/1 + 0/1)/10, = 0.0869 stranded fry/quadrat.

The variance of the mean (3), would then be calculated as follows:

$$\hat{\text{var}}(\bar{x}) = \frac{(N-n)\sum_{i=1}^{n}(w_i - \bar{x})^2}{Nn(n-1)}$$

$$= \frac{(400-10)\left[\left(\frac{2}{7} - 0.0869\right)^2 + \left(\frac{2}{8} - 0.0869\right)^2 + \ldots.\right]}{(400)(10)(10-1)}$$

$$= 0.0019470$$

Confidence limits for the estimates of the mean are calculated using Equation (4):

$$\bar{x} \pm t_{\alpha}\sqrt{\hat{\text{var}}(\bar{x})} \quad (4)$$

2.6.3.2 Field Data Collection

During each survey, field crews will collect data in pools and low gradient areas where trapping or stranding are observed. Data to be collected from pools where trapping is observed would include:

- Water temperature;
- Dissolved oxygen concentration;
- Turbidity;
- Maximum pool depth and approximate pool surface area;
- Visual characterization of sediment grain size to qualify dominant and subdominant substrates and their relative proportions;
- Number and condition of trapped fish by species and lifestage;[8]
- Distance from instream cover (e.g., large woody debris, boulder scour pool);

[8] Native (i.e., Bull Trout and Dolly Varden) and non-native (Brook Trout) char species are present in the study area. Differentiation between and identification of native char species can be difficult. While rare, hybrids between the two native species and hybrids between Brook Trout and Dolly Varden can also create confusion when attempting to identify or differentiate char species. Brook Trout can be identified by distinct vermiculation on the dorsal surface and dark bands across the dorsal fin. Field differentiation of native char species will be based on size and head morphology, eye orientation, maxilla length, and mouth position features (Cavender 1978, McPhail and Taylor 1995). If native char species cannot be differentiated during field sampling (i.e., Bull Trout versus Dolly Varden), genetic samples will be taken from a subsample of questionable species.

- Presence of canopy cover (y/n); and
- Presence of macroinvertebrates (y/n).

Data collected from low gradient areas where stranding is observed would include:

- Area surveyed over which stranding was observed;
- Field measured slope of area;
- Unusual hydraulic conditions (e.g. unique eddies that concentrate fish);
- Visual characterization of dominant and subdominant substrate;
- Presence of macrophytes;
- Closest distance to instream cover;
- Reservoir drawdown rate at time of field survey, when area became exposed; and
- Number of stranded fish by species and lifestage[9].

Additional actions at each sampling location:

- Photographs and field notes will be taken to document conditions;
- Location will be recorded by GPS;
- Indications of predation will be noted; and
- Common predators present in the area prior to conducting surveys will be noted.

Field surveys for Gorge Lake and Diablo Lake will be conducted quarterly during the study with the reservoirs in their typical operating range. Exact timing will be determined following further consideration of fish species and life stages of primary concern. If conditions allow, one additional field survey for each of the two reservoirs (Gorge and Diablo) may be undertaken on an opportunistic basis if the reservoirs are drawn down below their typical operating range for maintenance or other reasons.

Field surveys for Ross Lake will be conducted three times during the 2021/2022 drawdown cycle. The surveys will cover the full range of drawdown and will take place at the following approximate times:

- October or November 2021, with the water surface elevation drawn down 10 to 20 feet, to elevations of 1,598 to 1,588 feet NAVD 88 (1,591.74 feet to 1,581.74 feet CoSD).
- January or February 2022, with the water surface elevation drawn down 30 to 40 feet, to elevations of 1,578 to 1,568 feet NAVD 88 (1,571.74 feet to 1,561.74 feet CoSD).

[9] In the event of findings of significant stranding and/or trapping, total counts may not be possible or practical, and subsampling would be pursued as appropriate.

- April 2022, with the reservoir elevation close to its minimum and the water surface elevation drawn down 50 feet or more, to an elevation of 1,558 feet NAVD 88 (1,551.74 feet CoSD) or lower.

Each of the surveys in Ross Lake will focus on recently exposed low gradient areas or recently formed pools as Ross Lake is drawn down through the fall and winter months. The exact timing of surveys will depend on actual Project operations and will be adjusted if needed based on the inventory prepared under Section 2.6.2.1 of this study plan.

As appropriate, data collected during field sampling may be used to update the evaluation parameters used in the desktop analysis.

2.6.4 Analysis and Reporting

- A monitoring report will be prepared at the end of the 2021 field program. This will be followed by a final study report at the conclusion of the program (see Section 2.8 of this study plan). Per methods identified in Section 2.6.3 of this study plan, final reporting will estimate mean stranding and trapping within the areas examined in the field over the time periods of study, by species and lifestage (as possible). In addition, the final study report will also include the following:
    - A description of the methodology employed;
    - Field conditions at the time of survey (to include a summary of reservoir elevations and drawdown rates in the periods preceding each field survey);
    - A summary of the empirical data collected in field surveys on fish stranding and trapping;
    - Summary text and figures of the areas presenting a high, medium, and/or low stranding and trapping risk by species and lifestage, as estimated from the DEM and field survey validation;

Data collected will be interrogated to test relevant hypotheses (e.g., H_o: normal operating ranges do not cause an increase in stranding; slopes greater than 6 percent cause no increase in stranding risk; distance from cover has no bearing on trapping risks, etc.). To the degree that multiple factors are recognized as influencing trapping or stranding risks, multiple regression will likely be used to evaluate the relative influence of each factor. A data management plan, including hypotheses to be tested and the statistical methods that will be applied, will be developed in advance of data collections.

2.7 Consistency with Generally Accepted Scientific Practice

The methodology described in Section 2.6 of this study plan considered other investigations of fish stranding and trapping in the western U.S. and western Canada (e.g., Bell et al. 2008; Sykes 2012) and the need to apply an ACS approach to better sample populations of a species for which clustering is likely (Thompson 1992).

2.8 Schedule

The Stranding and Trapping Assessment includes Ross Lake reconnaissance surveys, data collection to address LiDAR data gaps, office assembly and analysis of DEMs derived from LiDAR and other topobathymetric data, GIS-based assessment to identify potential risk areas, a

single season of field validation surveys, and analysis and reporting of field survey results including updates to the GIS-based assessment, as appropriate. The proposed study schedule is as follows:

- Reconnaissance-level field data collection and assembly and analysis of DEMs – Winter 2020/21
- Field surveys (includes both Ross Lake reconnaissance and field validation surveys) – December 2021 to April 2022
- Report Year 1 (Initial Study Report [ISR]) – March 2022
- Post-field analysis – May to June 2022
- Final Study Report (Updated Study Report [USR]) – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $465,000.

3.0 REFERENCES

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RESERVOIR FISH STRANDING AND TRAPPING RISK ASSESSMENT PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	General Comments, Title Page	Although instructed by SCL staff at the Fish and Aquatics Technical work group on 5/520 that the Utility is no longer accepting scope or scale comments- the discrepancy between issue form and study plan draft require additional comments to scope and scale. The 2019 Study Issue Form included downstream of Gorge Dam and Powerhouse, Upper Skagit Indian Tribe is requesting this downstream area (and by-pass) be included in the assessment of stranding and trapping from project operations.	Thank you for your comment. Although the 2019 voluntary process leading up to the development of draft study plans did not result in consensus and inclusion of all LP issues into City Light's proposed draft study plan, City Light believes the scope of the study plan is appropriate to support the relicensing process by providing information to assess potential Project effects. City Light looks forward to continuing discussions on this and other study plans as time allows and also encourages LPs to submit study plan comments and/or submit additional study requests to FERC as part of the formal relicensing process. City Light remains committed to continued collaboration and consultation with LPs regularly throughout the ILP process. City Light acknowledges these issues were raised in 2019. Once complete, hydraulic models (described in other study plans) for the bypass reach and the reach below the Gorge Powerhouse (to the Sauk River) will be able to support additional analysis to assess stranding and trapping resulting from Project flows. This study is focused on stranding and trapping risk related to Project operations in reservoirs.
2.	Ashley Rawhouser (NPS)	05/12/2020	General Comments, Title Page	The NPS requests that Study Plans stand alone as independent documents. When information is cited in the study plan a summary of the pertenent information in the PAD should be provided for the reader. The current document leaves room for too much uncertainty to provide and adequate review.	The PAD contains much information, which is often detailed and nuanced. A summary in this study plan would not be representative and reproducing the content of the PAD in this study plan would make it cumbersome and lengthy. City Light continues to believe that the best

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					approach is to reference the PAD, to which all LPs have access.
3.	Brock Applegate (WDFW)	05/05/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG consultation~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally." I would recommend the language in the two revised studies, the Sediment Deposition and Operation Models Study Plans	Section 1.2 and 1.3 were redrafted to better describe the 2019 process. Formal consultation does not begin until after the PAD is officially submitted. Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together).
4.	Judy Neibauer (USFWS)	05/12/2020	Section 1.3 Study Plan Development	"This study will assess the risk of fish stranding and trapping in the study area and address reservoir stranding and littoral and riparian habitat issues raised during the 2019 Study Plan Development Process." This work will also help inform NEPA and the FWCA…see other language in other study plans (i.e. Operationsl model, sediment study, etc.) for this section….	Section 1.2 was redrafted to identify the regulatory processes addressed during relicensing. The study program and subsequent integrated environmental analysis and NEPA document will provide the information necessary for LPs to execute their statutory responsibilities under the Federal Power Act. The integrated environmental analysis will address cross-resource linkages and issues. The information resulting from the study program will inform an analysis of Project effects, ongoing consultation with LPs, and development of the Project License Application, which will include appropriate Protection, Mitigation and Enhancement measures (PMEs). The FERC process schedule positions the integrated environmental analysis subsequent to the completion of the study program and prior to the filing of a Project License Application.
5.	Judy Neibauer (USFWS)	05/12/2020	Section 1.3 Study Plan Development	"Relevant issue forms include:" Describe if you will use other study data (i.e. from the operational flow study to help look at	City Light has added language to Section 1.3 to address potential linkages between studies being implemented during relicensing. The integrated environmental analysis (See Comment

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				certain stranding/and or entrainment issues, riparian and littoral habitat, and productivity in a variety of flow conditions, from high spring flows to low low flows. Fish stranding, productivity, and riparian/littoral habitat can be affected and changed during a number of events throughout the year.	Response #4) will address cross-resource linkages and issues.
6.	Judy Neibauer (USFWS)	05/12/2020	Section 2.0 Study Plan Elements	"**2.0 STUDY PLAN ELEMENTS**" I found a great source that identifies what Study Guide Criteria should be addressed in these study plans. Maybe you have seen it, but here is the link… https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf …sorry if you already have discussed this.	City Light appreciates the input.
7.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations." The goal should be to quantify the actual harm done to fish, not the risk of harm.	The purpose of the study is not to undertake an investigation of harm to fish due to reservoir water level fluctuations but to assess the risk of stranding and trapping due to such fluctuations at a level of detail appropriate to identify the potential need and scope of future measures to address reservoir stranding and trapping. Stranding and trapping are recognized mechanisms of potential harm at the outset, hence, the intent is to better understand the risks of stranding and trapping.
8.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project	City Light is aware of only one such event and is completing a review of the circumstances and the appropriate BMPs to prevent a repeat. At this time, reservoir operations beyond those defined as "normal operations" in the study plan are not anticipated during the study period. City Light does not support artificially creating reservoir

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				operations[10]." Regarding footnote 1, how will drawdowns for maintenance or infrastructure testing be studied? Previous drawdowns for maintenance or infrastructure testing have resulted in substantial amounts of fish killed during each drawdown event, and these impacts need to be quantified. I personally observed thousands of dead stranded fish during a recent maintenance-related drawdown in Gorge Reservoir.	elevations which simulate larger drawdowns at the scale of maintenance or infrastructure testing given the significant impacts to the Project and the risk for fish mortality. However, the proposed plan has allocated resources to conduct sampling opportunistically should those conditions occur during the study period. Further, the risk assessment results from this study will likely inform efforts for fish recovery for future maintenance actions.
9.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations." NPS requests that either as part of this study or the Amphibian Study the impacts of reservoir drawdowns on amphibian communities be study.	Pools that are formed in drawdown zones will be assessed for special-status amphibians under the Amphibian Study. Incidental observations of amphibians will also be recorded if observed during field surveys under the Reservoir Fish Stranding and Trapping Risk Assessment Study in support of the Amphibian Study.
10.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations." What is the study area? Please describe. The study area should include the Ross in BC as well as the length of the Skagit River in BC that is influenced by Ross Reservoir elevations. McPhail documented char fry in distributary	Please refer to Section 2.5 for a description of the study area. City Light is currently exploring its abilities and obligations within the FERC process regarding any interactions with information sources in Canada.

[10] For purposes of this study, "normal operations" are defined as typical operations to support flood control, fish protection, recreation and power generation and does not include drawdowns for maintenance or infrastructure testing.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				channels of the Skagit during his investigations.	
11.	Brock Applegate (WDFW)	05/05/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations." If you have planned maintenance and infrastructure testing, SCL should have the ability to avoid trapping and stranding or mitigate.	See Comment Response #8.
12.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.1 Study Goals and Objectives	"The goal of the Reservoir Fish Stranding and Trapping Risk Assessment Study is to assess the risk of native fish species stranding and trapping within the study area under normal Project operations." Please quantify what normal project operations are for each reservoir in terms of magnitude/amplitude, frequency, duration (in terms of hours), timing, and rate of change each reservoir drops on an average annual basis during the period of the current license. This should also include future opertational senarios that may be proposed as part o the new license including pumped storage. This peice of info should be included in the study plan. Please do not refer the reader to the PAD.	Please refer to Section 2.3 of the study plan for background information. Reservoir water level variations during the period since 2011 when the revised fisheries settlement agreement was adopted, will be analyzed as part of the study (see Section 2.6.2.3). The range of water levels experienced under normal operation has been clarified in Section 2.3.3 and 2.3.4. Future operational scenarios are unknown at this time. Analysis of potential scenarios is a part of the integrated environmental analysis noted in Comment Responses #4 and #5.
13.	Judy Neibauer (USFWS)	05/12/2020	Section 2.1 Study Goals and Objectives	"Native fish species within Project reservoirs include resident Rainbow Trout (*Oncorhynchus mykiss*), Bull Trout (*Salvelinus confluentus*) and Dolly Varden (*Salvelinus malma*)." Please consider other fish species that may provide a prey base. The study should look at any fish species stranded, including redside	The study is designed to ensure field sampling activities target periods of time when native species (not prey species such as non-native, introduced redside shiner) may be subject to stranding and trapping risk in reservoirs. However, during field sampling, data will be collected on all fish species encountered. There is no evidence indicating that the prey species

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				shiner, sculpin, etc. Expand the scope – Please include alluvial areas of adjacent reservoir tributaries where stranding could also occur during drawdown. What study do you have to look at for stranding downstream of dams. There may be areas downstream of dams that have reduced flow, when you are filling/holding water in reservoirs that affect fish and wildlife, riparian areas, and connectivity/refugia habitat. Please include in this study or add another study downstream.	base (e.g., redside shiner) is being negatively impacted by the Project. The areas of tributary junctions with Project reservoirs at full pool are considered within the study area since these areas can become dewatered during operations and are subject to stranding and trapping risk. Tributary reaches upstream of full pool are not included in this study. Regarding stranding downstream of dams, See Comment Response #1.
14.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.1 Study Goals and Objectives	"Native fish species within Project reservoirs include resident Rainbow Trout (*Oncorhynchus mykiss*), Bull Trout (*Salvelinus confluentus*) and Dolly Varden (*Salvelinus malma*)." We currently lack information about the distribution and timing of fish in the reservoirs. What sources of information will you use to fill this gap?	City Light concurs that periodicity information is currently limited, hence the referral to basic life history information as detailed by Quinn (2004). Sources of spatially and temporally incomplete information include: spawning ground survey, snorkel survey, and temperature monitoring data from tributaries and the Canadian mainstem. These data can be used to infer approximate fry emergence and outmigration timing of juveniles into the reservoirs. In addition, during 2020 reconnaissance, as described in Section 2.6.1, any observations of trapped or stranded fish will further refine periodicity with site specific information.
15.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.1 Study Goals and Objectives	"Specific objectives include:" These study objectives do not address productivity. To address productivity, some sort of primary or secondary productivity analysis needs to be conducted in conjunction with fish surveys.	The overall goal of this study is to estimate trapping and stranding risk due to reservoir operations. Conducting studies which quantify trophic dynamics is beyond the scope of the proposed study; which is looking at trapping and stranding risk. However, the ongoing Food Web study is quantifying trophic dynamics at the population scale which may be informative for

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					assessing productivity. Also See Comment Response #7.
16.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	"Specific objectives include:" The study objectives do not address the population-level impact. The study should consider the fish populations in each reservoir, and the risk to population viability and genetic structure.	See Comment Responses #4, #5, and #7.
17.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.1 Study Goals and Objectives	"Specific objectives include:" The objective below read more like goals. Objectives should have a quanitifable componnet.	City Light believes the terminology used in the Section 2.1 is appropriate. Quantifiable components of the objectives are described later in the study plan, for example under Section 2.6.2 for the desktop analysis.
18.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	I agree with Ashley. SCL should quantify the drawdown rate of the reservoir. SCL has listed a few goals instead of objectives. (See Comment #12 and #17)	Please refer to Section 2.6.1.3 of the study plan. Drawdown rates for each reservoir will be quantified as part of the desktop analysis.
19.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment "Conduct a desktop analysis (using existing data and as needed, additional topobathymetric data) to identify areas where, the frequency with which, and the time periods when (using available fish life-stage periodicity information) there is a risk of stranding and trapping of native fish species in the study area under normal Project operations;" Expanding the desktop analysis to include all Project operations, even ones outside of "normal" is needed to fully understand the impact of the Project on salmonids during drawdowns.	See Comment Response #8 and #12

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
20.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Undertake field surveys of fish stranding and trapping at selected areas within the study area, to field validate results of the desktop analysis; and" The field surveys should do more than validate the existence of stranding risk. Rather, they should quantify the number of fish killed during the various project-related reservoir fluctuations.	Please refer to Section 2.6.3 of the study plan. The number and condition of fish by species and lifestage will be quantified at reservoir stranding and trapping areas sampled during field surveys.
21.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	"Top Objective: Find Reservoir Drawdown rates and minimum reservoir elevations that avoid trapping and stranding of native fish for all three reservoirs" We already know that we have a problem in Gorge Lake, so why not find the drawdown rate in that reservoir. Does SCL have other mitigation proposals for Gorge Reservoir?	These edits have not been accepted. See Comment Responses #4 and #5. Stranding and trapping information collected during the 2019 Gorge Lake maintenance drawdown will be evaluated as part of the integrated environmental analysis (See Comment Response #4) and will support the development of measures to address Project reservoir stranding and trapping in the new FERC license.
22.	Judy Neibauer (USFWS)	05/12/2020	Section 2.1 Study Goals and Objectives	"Top Objective: Find Reservoir Drawdown rates and minimum reservoir elevations that avoid trapping and stranding of native fish for all three reservoirs" Include areas in the study to look at when flows are high, and water levels drop and when water levels are low, and stranding may occur in low rain/snow drought types years…….	Please refer to Section 2.5 for a description of the study area. The ILP provides the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations.

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23.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Red Text Edits and Comment "Undertake field surveys of fish stranding and trapping at selected areas within the study area, to field validate results of the desktop analysis and find a safte drawdown rate; and" Will you validate that you have fish mortality? How will you validate the desktop analysis?	These edits have not been accepted. See Comment Responses #4 and #5. Field sampling will identify and enumerate condition, species (if possible) and life stages of stranded and trapped fish. These data will be used to validate and if necessary, update the desktop analysis tool.
24.	Judy Neibauer (USFWS)	05/12/2020	Section 2.1 Study Goals and Objectives	"Results and/or tools from this study may be used to evaluate Project effects in the license application and arrive at a drawdown rates, and a refill and spill plans, to mitigate those effects." There may be stranding, flooding, due to high or low flows, there may be mitigation needed on both ends.	Thank you for your comment. See Comment Responses #4 and #5.
25.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	"Results and/or tools from this study may be used to evaluate Project effects in the license application and arrive at a drawdown rates, and a refill and spill plans, to mitigate those effects." Why not complete this task while SCL has crews in the field?	These comments have not been accepted. See Comment Responses #4 and #5. Evaluation of Project effects and the development of PMEs to address effects is a subsequent step to the study program.
26.	Judy Neibauer (USFWS)	05/12/2020	Section 2.2 Resource Management Goals	**"2.2 Resource Management Goals"** According to guidelines for the ILP…this section should also include information about public input considerations…maybe you have this somewhere already… see-https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	City Light appreciates the input. Also, it is worth noting that the criteria pertain to "public interest," not public "input."
27.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.2 Resource	**"2.2 Resource Management Goals"**	Thank you for your comment. City Light identifies its goal in Section 2.2. The second part of this section is intended to represent agency

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			Management Goals	BCHydro includes a series of management questions as part of their studies. I think working on a mutually agreed to set of questions would help to clarify the scope and objectives for the study. See: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/environment-sustainability/water-use-planning/southern-interior/clbmon-4-yr2-2018-10-29.pdf	management goals and invites LP input. If NPS has specific resource management goals it believes are relevant for inclusion, please provide them to City Light for consideration.
28.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to improve understanding of the factors influencing fish stranding and trapping risk within the study area under normal Project operations." Goals should include quantifying the actual harm done to fish populations. This should include all operations, including those for maintenance and infrastructure.	See Comment Responses #7 and #8.
29.	Brock Applegate (WDFW)	05/11/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to improve understanding of the factors influencing fish stranding and trapping risk within the study area under normal Project operations." The factors include the rate of drawdown and the elevation of the reservoir and whether SCL observes fish trapping and stranding during the rates and elevation at problem spots identified by the desktop analysis.	Thank you for your comment.
30.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.3 Background and Existing Information	"No stranding or trapping information is available for any of the reservoirs under normal Project operations." Please define what you are considering standing	Please refer to Section 2.6 of this study plan for more information.

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				and trapping. You requested this for the NPS Gorge Stranding report.	
31.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3 Background and Existing Information	"No stranding or trapping information is available for any of the reservoirs under normal Project operations." See my comment above about stranding below dams, Include areas below dams in this study or design an additional study.	See Comment Response #1.
32.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.3 Background and Existing Information	"No stranding or trapping information is available for any of the reservoirs under normal Project operations." Concur. It is unclear if SCL intendeds to conduct stranding and entrapment surveys below Gorge Dam as part of the voluntary collaborative process. If SCL intends to do this noting that here would be appropriate.	See Comment Response #1.
33.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3 Background and Existing Information	"No stranding or trapping information is available for any of the reservoirs under normal Project operations." Describe what are normal operations here.	Please refer to footnote in Section 2.3 for this study's definition of normal Project operations.
34.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes due to reservoir drawdowns and/or surface elevation fluctuations under a variety of flows. Reservoir drawdowns or fluctuations occur during normal operations to support flood control, fish protection, recreation, and power generation." Unless SCL did not operate under normal operating conditions, SCL has already stranded or trapped fish in Gorge Reservoir.	Thank you for your comment. The event described is not considered normal operations as defined in this study plan. See Comment Response #8.

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35.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3 Background and Existing Information	"Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes due to reservoir drawdowns and/or surface elevation fluctuations under a variety of flows." Can you list those reservoir elevations where stranding may occur, from existing information?	Reservoir elevations where stranding or trapping may occur will be determined from analysis of topobathymetric data as described in Section 2.6.2.2 and subject to validation in the field surveys as described in Section 2.6.3. We cannot list the reservoir elevations where stranding and trapping may occur at present, as that is the focus of the study—to define those elevations (and associated reservoir locations) where risks are elevated.
36.	Brock Applegate (WDFW)	05/11/2020	Section 2.3 Background and Existing Information	"Per current licensing requirements, occasional assessments of fish stranding and trapping have occurred in Gorge and Diablo lakes (by City Light and LPs) during scheduled drawdowns outside of normal operations for maintenance activities and infrastructure testing (e.g., spillways, etc.) but no information exists for Ross Lake under these circumstances." WDFW and other LPs will also want to know of stranding and trapping outside of normal operations as well. From an effects analysis, SCL has impacted fish with either scenario, normal or not normal operations.	See Comment Responses #4, #5, and #8.
37.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3 Background and Existing Information	"Per current licensing requirements, occasional assessments of fish stranding and trapping have occurred in Gorge and Diablo lakes (by City Light and LPs) during scheduled drawdowns outside of normal operations for maintenance activities and infrastructure testing (e.g., spillways, etc.) but no information exists for Ross Lake under these circumstances." Agreed. I would also like to know about all species collected and harmed in these events, how many times it happens, and across what flows does this occur.	See Comment Responses #4, #5, #8, and #20.

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				(See Comment #36)	
38.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3 Background and Existing Information	"Per current licensing requirements, occasional assessments of fish stranding and trapping have occurred in Gorge and Diablo lakes (by City Light and LPs) during scheduled drawdowns outside of normal operations for maintenance activities and infrastructure testing (e.g., spillways, etc.) but no information exists for Ross Lake under these circumstances." Lost lake assessments?	Per the white paper prepared with data collected by City Light during 2016 and 2017 it does not appear that fish isolated in Lost Lake are at risk of mortality. Based on the results of that assessment, it is unlikely that additional data collection at Lost Lake would change those results and exposure of Lost Lake is not anticipated during the proposed study period. The NPS also collected data at Lost Lake. These data have not yet been made available to the FCC/NCC and therefore were not included in the white paper.
39.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	"In April 2019, drawdown of Gorge Lake to about 830 feet North American Vertical Datum of 1988 (NAVD 88)[2] (823.49 feet CoSD) for spill gate testing resulted in stranding and trapping of native fish in the vicinity of the State Route (SR) 20 causeway crossing of Gorge Lake. A report on this stranding and trapping event is currently under preparation by City Light." Clarify whether the April 2019 drawdown was for maintenance, and whether the study proposes to examine these types of events.	The April 2019 drawdown of Gorge Lake was for FERC-mandated gate testing. The study proposes to investigate trapping and stranding under "normal Project operations" (see footnote 1, Section 2.1) and which does not include drawdown for testing. Also See Comment Response #8.
40.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3 Background and Existing Information	"Native fish species in the Project reservoirs include Rainbow Trout, Bull Trout, and Dolly Varden. Bull Trout are listed as "threatened" under the Endangered Species Act (ESA)." I am interested in any potential prey species as well…not just the listed ESA species.	See Comment Response #13.

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41.	Ashley Rawhouser (NPS)	05/13/2020	Section 2.3 Background and Existing Information	"Native fish species in the Project reservoirs include Rainbow Trout, Bull Trout, and Dolly Varden. Bull Trout are listed as "threatened" under the Endangered Species Act (ESA)." Concur. All fish species should be included. (See Comment #40)	See Comment Response #13.
42.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.3 Background and Existing Information	"Lifestage information (e.g., fry, juvenile, adult, etc.) of each native species and timing of their presence in reservoirs during periods of Project operations where there is a risk of trapping or stranding are discussed in more detail in Section 2.6.1.4 of this study plan." Could not find this section in the document. Where is section 2.6.1.4?	Section 2.6.2.4 is located on page 2-19 of the study plan.
43.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3.2 Ross Lake	"**Figure 2.3-1 Ross Lake daily water surface elevations (2010-2018).**" Show this data for the entire current license period.	The period 2010-2018 is representative of Ross Lake seasonal water level variations over the current license period and covers the period since adoption of the revised fisheries settlement agreement in 2011 proposed for analysis. Thus, City Light views the period of record proposed as applicable and appropriate because it represents the most current operational regime following the 2011 FSA. The use of earlier data would not be particularly germane to understanding risks of the current operational regime. Water surface elevation data for the full period of record can be readily seen on the USGS NWIS website.
44.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3.3 Diablo Lake	"The lake typically fluctuates 4 to 5 feet daily for a typical operating range between about 1,206 and 1,211 feet NAVD 88 (between about 1,199.64 and 1,204.64 feet CoSD), although drawdowns of 10 to 12 feet occur occasionally	We have not determined the number of times Diablo Lake water levels fell below 1,206 ft NAVD88, but water levels were below 1,206 ft NAVD88 approximately 8% of the time in the period from January 2011 through December

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				as needed for construction projects or maintenance." How often do drawdowns below the typical operating range occur?	2018. In the same period, there were a total of 8 instances where the lake level dropped below 1,202 ft NAVD88 for one hour or more. Also See Comment Response #45.
45.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3.3 Diablo Lake	"A sample of hourly water surface elevation data for April 2014 through June 2014 is shown in Figure 2.3-2." Can you apply bathymetry to these 4-5 feet fluctuations to see if there are certain areas that pop out as key stranding areas? How often does construction and maintenance flows happen? Can you also use bathometry to show where stranding, key productivity issues, and littoral issues may occur with the 10 -12 foot drops. I imagine that during the maintenance flows, there could be stranding downstream once flows stop or are reduced. Similar question as above, can you apply stream bed elevation models to look at where key stranding areas might be below the dams. Please include areas below the dams in this study or another study to look at stranding/ riparian/ and productivity issues down there.	Bathymetric data along the Diablo Lake shoreline will be developed as described in Section 2.6.2.1. Analysis of bathymetric data to identify potential stranding areas will be performed as described in Section 2.6.2.2. Note that because of limited LiDAR coverage of Diablo Lake shoreline, LiDAR data will be supplemented by bathymetric data collected along the shoreline by sonar. Data to be collected will allow analysis of bathymetry down to elevations of 1,200 feet NAVD88 or lower in most places. This would allow analysis of stranding and trapping risk for water level fluctuations of the order of 10 to 12 feet. The Diablo Lake water level has dropped below 1,200 feet NAVD88 only once since records of hourly water levels began in 1997 - the lake level dropped to approximately 1199.4 feet NAVD88 in 2017. Productivity and riparian habitat issues will not be investigated in this study. Regarding stranding below the dams, please See Comment Response #1.
46.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3.4 Gorge Lake	Upper Skagit Indian Tribe would like an assessment of stranding and trapping in by-pass reach under existing conditions. Spill can trap and isolate fish species, the lower 0.6 miles in the by-pass are hydrologically connected to mainstem but daily/hourly ramping is currently unknown- so extent of mortality here is a data	See Comment Response #1.

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				gap.	
47.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3.4 Gorge Lake	"Gorge Lake typically fluctuates 3 to 5 feet daily for a typical operating range between about 876 and 880 feet NAVD 88 (between about 869.49 and 873.49 feet CoSD) , but drawdowns of 50 feet are occasionally needed for spill gate maintenance or inspection." How often do drawdowns below the typical operating range occur?	We have not determined the number of times Gorge Lake water levels fell below 876 ft NAVD88, but water levels were below 876 ft NAVD88 approximately 10% of the time in the period from January 2011 through December 2018. In the same period, there were a total of 6 instances where the lake level dropped below 870 ft NAVD88 for one hour or more. Note that the study plan has been revised to include a complete bathymetric survey of Gorge Lake, down to elevations of approximately 800 ft NAVD88, which would encompass the lowest water levels seen in the proposed period of analysis (2011 – present), including those associated with maintenance drawdowns.
48.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3.4 Gorge Lake	"A sample of hourly water surface elevation data for April 2014 through June 2014 is shown in Figure 2.3-3." Actions are taken to prepare for large flood events what is the typical draw down of Gorge in preparation of these significant storms?	Drawdown of Gorge Lake in anticipation of severe storms varies. The pool level was drawn down to approximately 866.5 ft NAVD88 in anticipation of severe storms in November 2015. More recently such drawdown has been restricted to an elevation of approximately 871.5 ft NAVD88.
49.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3.4 Gorge Lake	"A sample of hourly water surface elevation data for April 2014 through June 2014 is shown in Figure 2.3-3." See comment above about using bathometry to help located sample sites or develop information for key stranding areas, issues with productivity, and littoral habitat.	Shoreline and lake-bed topography will be developed from a combination of standard and Green LiDAR and data from bathymetric surveys to identify areas of stranding and trapping risk as described in Section 2.6.2.1. Productivity and littoral habitat issues will not be investigated in this study.
50.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3.4 Gorge Lake	"City Light's current monthly operations plan states that if the water surface elevation of Gorge Lake is drawn down below 867 feet CoSD (873.51 feet NAVD 88), City Light's Project	Thank you for your comment. Development of future measures to address the potential for stranding and trapping in Project reservoirs is a subsequent phase in the ILP process (See

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				Fish Biologists will be contacted within 48 hours to conduct a stranding/entrapment assessment at known locations where stranding may occur." Seems completely inadequate for monitoring impacts to fishery resources, notification should be made prior to these actions.	Comment Responses #4 and #5). Note also that the monthly operations plan sets the minimum requirement and depending upon seasonal risk and other factors, City Light responds/puts in place preventative measures as circumstances allow. City Light is open to discussion regarding modification of these procedures.
51.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.3.5 Existing Data	"**2.3.5 Existing Data**" Describe the resolutaion and accuracy of these data.	The 2018 standard LiDAR has a reported absolute non-vegetated vertical accuracy of 0.2 feet with 95% confidence and a resolution of 8 pulses/square meter. The 2018 Green LiDAR has a reported absolute accuracy of 0.4 feet with 95% confidence for bathymetric (i.e. submerged) surfaces and a resolution of 6 pulses/square meter. The 2017 standard LiDAR has an absolute non-vegetated vertical accuracy of 0.3 feet with 95% confidence and a resolution of 8 pulses/square meter. Information on vertical accuracy will be included in the text of the study plan.
52.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.3.5 Existing Data	"More detailed hourly data are available from City Light. Given the time scales over which the reservoir water surface elevations vary, daily data are suitable for analysis of Ross Lake water surface elevations, while hourly data are necessary for analysis of Gorge and Diablo lakes water surface elevations." To allow a comparision of the risk among all of the reservoirs hourly data should be used for the entire project. Even though the magnitude of hourly flucuations is likely lower in Ross (than in GOrge or Diablo) Ross has a much larger area of low gradient habitat that is impacted my smaller changes in reservoir elevation changes.	Hourly Ross Lake fluctuations will be checked to ensure that daily elevation data adequately identify stranding and trapping risk. We note also that hourly water level data from Ross often show high variability because of the effects of wind-driven waves. This noise is less evident in the daily record.

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53.	Brock Applegate (WDFW)	05/11/2020	Section 2.3.5 Existing Data	I agree with Ashley. SCL will need hourly rate of change for Ross Reservoir to describe drawdown rates that cause stranding and trapping. Why would SCL want to compare the reservoirs with different units of measurements? (See Comment #52)	See Comment Response #52.
54.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.3.5 Existing Data	"Summaries of monthly and annual maximum, average and minimum water surface elevations for Ross Lake, Diablo Lake, and Gorge Lake are provided in Table 3.5-1, Table 3.5-3 and Table 3.5-6 of the PAD, respectively." The study plans should stand alone. Please include pertenent information in this document.	See Comment Response #2.
55.	Judy Neibauer (USFWS)	05/12/2020	Section 2.3.5 Existing Data	"Summaries of monthly and annual maximum, average and minimum water surface elevations for Ross Lake, Diablo Lake, and Gorge Lake are provided in Table 3.5-1, Table 3.5-3 and Table 3.5-6 of the PAD, respectively." Expand scope-You will need to look at areas downstream for potential stranding/productivity/riparian issues….separate study? Add here? Or do you already have existing information.	See Comment Responses #1, #4, and #5.
56.	Judy Neibauer (USFWS)	05/12/2020	Section 2.4 Project Operations and Effects on Resources	"**2.4 Project Operations and Effects on Resources**" Can you link to issues and how the study goals and objective will address data gaps here.	See Comment Responses #4 and #5.
57.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.4 Project Operations and	"Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes due to reservoir drawdowns and/or surface elevation fluctuations."	Thank you for your comment. For the purposes of this assessment, stranding denotes mortality. Trapping, however, may not result in mortality as other factors may play a role in fish surviving

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			Effects on Resources	Causing mortality	a particular event including but not limited to size and depth of trapping pool and amount of time a pool exists before potentially being reinundated.
58.	Judy Neibauer (USFWS)	05/12/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes and associated alluvial areas of adjacent tributaries due to reservoir drawdowns and/or surface elevation fluctuations." And downstream in riverine areas	See Comment Response #1.
59.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations may strand or trap native fish in Ross, Diablo, or Gorge lakes and associated alluvial areas of adjacent tributaries due to reservoir drawdowns and/or surface elevation fluctuations." See previous copmment.	See Comment Response #1.
60.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	"Reservoir drawdowns or fluctuations occur to support flood control, fish protection, recreation and power generation." Downstream	See Comment Response #1.
61.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.4 Project Operations and Effects on Resources	"While reservoir drawdowns are also made for maintenance or FERC-required infrastructure testing, these operations occur less frequently, are not anticipated to occur during the study period and are, therefore, not included in the definition of normal Project operations for the purposes of this study." These should be included in analysis as they can be an additional source of stranding mortality.	See Comment Response #8.

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62.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.4 Project Operations and Effects on Resources	"While reservoir drawdowns are also made for maintenance or FERC-required infrastructure testing, these operations occur less frequently, are not anticipated to occur during the study period and are, therefore, not included in the definition of normal Project operations for the purposes of this study." This is not adequate reason to exclude from the study. If these operations will occur during the next license period, the impacts need to be understood.	See Comment Response #8.
63.	Brock Applegate (WDFW)	05/05/2020	Section 2.4 Project Operations and Effects on Resources	"While reservoir drawdowns are also made for maintenance or FERC-required infrastructure testing, these operations occur less frequently, are not anticipated to occur during the study period and are, therefore, not included in the definition of normal Project operations for the purposes of this study." SCL should focus on drawdown rate and not why they will drawdown the reservoir. WDFW recommends that SCL find rates change of drawdown and elevations of reservoirs that SCL will strand and trap fish.	Identification of the drawdown rates of the reservoirs, within normal Project operations as defined in the study plan, and the associated reservoir elevations where there is stranding and trapping risk is a component of the study. Please see Section 2.6.2.3. Thank you for the recommendation.
64.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.5 Study Area	"**2.5 Study Area**" Issue Form also requested an evaluation of the current downstream (Below Gorge Dam and Powerhouse) stranding methodology, to better quantify downstream impacts to listed species. Is SCL not considering this area of study? Upper Skagit Indian Tribe is requesting downstream river stranding and trapping be reevaluated as part of this study. See comments about additional request for downstream area and by-	See Comment Response #1.

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				pass reach.	
65.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.5 Study Area	"The study area includes Ross, Diablo, and Gorge lakes at elevations below which stranding and trapping risks could be elevated, under normal Project operations (Figure 2.5-1)." Include all reservoir elevations from full pool to minimum pool. Trapping and stranding risk could be elevated anywhere that project operations affect reservoir elevation.	See Comment Response #8.
66.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.5 Study Area	"The study area includes Ross, Diablo, and Gorge lakes at elevations below which stranding and trapping risks could be elevated, under normal Project operations (Figure 2.5-1)." More detailed description needed. Are you going to assess stranding up Big Beaer Ck? The Canadian portion of the reservoir needs to be included. Early sudy by McPhail documented char in distriburay channels of the Skagit River near Hozomeen. Additionally, this is an area where the frequency of dewatering is likely to be very high given the gradient of the reservoir bed in this location.	Inundated areas of tributary mouths below full pool reservoir elevations are included in the study area. However, upstream portions of tributaries outside of the reservoirs influence on stranding and trapping are not included. Regarding the inclusion of the Canadian portion of the reservoir, See Comment Response #10.
67.	Judy Neibauer (USFWS)	05/12/2020	Section 2.5 Study Area	Agreed. Also see my comments above to include alluvial areas or inundated areas of tributaries where stranding can occur. Some areas that are backed up into tributaries may be outside of the FERC boundary. Link to the geomphology studies to determine where the upper edge of influence is in adjacent tributaries. As well, areas below the dams should be included. (See Comment #66)	See Comment Responses #1, #4, #5, and #66.

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68.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.5 Study Area	"**Figure 2.5-1 Overview of study area**" Have new lidar for Canadian section of Skagit, the interface between Skagit river and Reservoir should be assessed through new or existing trans-boundary management agreements or partnerships.	See Comment Response #10. The 2018 LiDAR coverage of Ross Lake extends into Canada and covers all areas of Ross Lake below its normal maximum water surface elevation. Please see Figure 2.6-1.
69.	Brock Applegate (WDFW)	05/05/2020	Section 2.6 Methodology	"The study includes two phases: (1) a desktop analysis of the study area to identify potential areas of fish stranding and trapping risk; and (2) field surveys at selected areas to validate results of the desktop analysis and to update the desktop analysis, as necessary. (3) Identify drawdown rate for each reservoir that avoids stranding and reservoir elevations that avoid trapping."	See Comment Responses #4 and #5. Please note that analysis of actual drawdown rates under normal Project operations is a component of the desktop analysis. Drawdown rates preceding field surveys will also be determined. Section 2.6.4 will be edited to include reporting of drawdown rates.
70.	Brian Lanouette (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.1 Desktop Analysis	"**2.6.1 Desktop Analysis**" Desktop analysis should also include analysis of passage (ie. Low/no flow passage barriers) to tributary spawning locations, particularly as native char migrate and spawn during the drawdown period. OR covered in reservoir sediment study	City Light currently mitigates for potential effects on fish migration/passage resulting from sediment and woody debris deposition in Project reservoirs, and intends to continue the effort. The 1991 Settlement Agreement stipulates that City Light is to survey for and remove transitory barriers to spawning migration in tributaries to Project reservoirs. City Light has agreed to expand the annual barrier surveys and barrier removal efforts beginning in 2020 following NCC approval.
71.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1 Desktop Analysis	"The desktop analysis includes assembly and analysis of DEMs of reservoir shoreline and bed topography to inventory potential stranding and trapping areas, an analysis of reservoir water surface elevation data to document the frequency and period of time over which trapping pools are formed and areas of low slope terrain are exposed in drawdown zones, and an analysis of native species lifestage and periodicity information to identify when	See Comment Response #14.

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				lifestages susceptible to stranding and trapping risk under normal operations may be present in the study area. The lifestage periodicity analysis may also inform appropriate periods for field sampling." This is a key component of the study and more detail is needed. See previous comment of lack of info on distribution and timing of fish in the reservoirs. Please cite ans summarize the inormation you are planning to use.	
72.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1 Desktop Analysis	I agree with Ashley. SCL may need to conduct other studies to understand fish distribution and timing in the reservoirs. (See Comment #71)	See Comment Response #14.
73.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1 Desktop Analysis	I also agree (See Comment #71)	See Comment Response #14.
74.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1 Desktop Analysis	"The desktop analysis includes assembly and analysis of DEMs of reservoir shoreline and bed topography to inventory potential stranding and trapping areas, an analysis of reservoir water surface elevation data to document the frequency and period of time over which trapping pools are formed and areas of low slope terrain are exposed in drawdown zones, and an analysis of native species lifestage and periodicity information to identify when lifestages susceptible to stranding and trapping risk under normal operations may be present in the study area. The lifestage periodicity analysis may also inform appropriate periods for field sampling." More detail is needed, This should be written so	See Comment Response #14.

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				that the work could be replicated by somebody unfamiliar with project.	
75.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1 Desktop Analysis	I agree, esp. since the license will be for a long term and we may not be around to work on it then… (See Comment #74)	See Comment Response #74.
76.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk" Study should assess the entire drawdown zone. Comments on multiple previous study plans expressed the need for full bathymetric coverage in the three reservoirs. Such data would be relevant here.	See Comment Response #8.
77.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"Developing an inventory of areas presenting a stranding and trapping risk will involve assembling a DEM of each of the three reservoirs and then analyzing the DEMs to identify and quantify areas with gradient profiles (see Section 2.6.1.2 in this study plan) indicating stranding risk and areas draining to isolated pools indicating trapping risk." Section 2 is blank.	Section 2.6.2.2 is located on page 2-18 of the study plan.
78.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"**Figure 2.6-1 Extents of 2018 LiDAR of Ross Lake**" How will the study address tributaries not covered by the 2018 lidar, such as Beaver Creek?	See Comment Response #66. The 2018 LiDAR covers the area where Beaver Creek enters Ross Lake below the Ross Lake normal maximum water surface elevation. The study is intended to assess stranding and trapping in Ross Lake and does not extend to tributaries above the lake's normal maximum water surface elevation.

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79.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"**Diablo Lake DEM**" With the exception of Thunder Arm, the shoreline of Diablo Lake is relatively steep and the potential for stranding and trapping outside Thunder Arm is likely low. This needs to be confirmed with topobathymetric data collection and field verification.	Agreed. Topobathymetric data of the Diablo Lake shoreline will be collected. The description of shoreline bathymetric data collection efforts at Diablo Lake will be revised. See Comment Response #45.
80.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"**Gorge Lake DEM**" "Any areas of the riverbed not colored in dark blue on Figure 2.6-5 are not quantifiable with the available LiDAR." Study should assess the entire drawdown zone. Comments on multiple previous study plans expressed the need for full bathymetric coverage in the three reservoirs. Such data would be relevant here.	See Comment Response #8. The study plan will be revised to include bathymetric survey of Gorge Lake.
81.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.1 Inventory of Areas Presenting Stranding and Trapping Risk	"**Gorge Lake DEM**" "From review of the available Standard and Green LiDAR it appears that topographic data to support the desktop analysis are available for essentially all areas within the normal operating range of Gorge Lake plus additional areas of known trapping risk in the vicinity of the SR 20 crossing." These areas are known to cause fish mortality because they are easily accessible. Within a short walk from SR20 or the Gorge boat ramp, thousands of stranded dead fish have been observed during previous maintenance	Comment acknowledged. The intent of the study is to assess stranding and trapping risk (including mortality where observed during field sampling) in less easily observable locations.

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				drawdowns. The study needs to identify mortality that occurs in less easily observable places within the reservoirs.	
82.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"Evaluation of potential stranding and trapping risk in the study area will be performed with standard GIS tools. Terrain slopes will be computed for each DEM cell (likely 3-foot square cells) and then labeled as having a slope less than 4 percent, between 4 percent and 6 percent, and greater than 6 percent." This is pretty vague. The study plan should provide enought detail for all methods so that an uniformed outside party could replicate and verify the study.	GIS analysis will be conducted primarily using the Spatial Analyst tool set. Text has been added to the study plan.
83.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"Evaluation of potential stranding and trapping risk in the study area will be performed with standard GIS tools. Terrain slopes will be computed for each DEM cell (likely 3-foot square cells) and then labeled as having a slope less than 4 percent, between 4 percent and 6 percent, and greater than 6 percent." This will miss a considerable amount of high risk habitat and greatly underestimate the amount of habitat that poses a risk.	It is not clear why the proposed approach relying on 3-foot square DEM cells to evaluate slope will "miss a considerable amount of high risk habitat". Three foot square DEM cells are actually quite small at the physical scale of the Project reservoirs, and GIS analysis of the DEM should pick up the great majority of low gradient stranding areas and a substantial number of potential trapping area depressions from which to gage risks. It is acknowledged that identification of small depressions such as tree wells via GIS analysis presents a challenge. The significance of tree wells or other small depressions as a trapping risk and the ability to identify those depressions will be assessed during the 2020 reconnaissance described in Section 2.6.1 and the approach to analysis adjusted accordingly as necessary.
84.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1.2 Analysis of DEMs for	Agreed. (See Comment #83)	See Comment Response #83.

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			Stranding and Trapping Risk		
85.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"Cells whose slope is inconsistent with a sufficient number of neighboring cells will be aggregated to eliminate overly granular slope classification and remain true to the purpose of this analysis which is to identify areas of low slope presenting a stranding risk." This needs to be field-verified. The analysis risks missing small isolated stranding pools, which cumulatively may create substantial harm.	The results of the desktop analysis will be field-verified.
86.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"Sinks consist of spatially connected cells surrounded by a ring of higher elevation cells that hold water to a minimum depth of 12 inches." This scale (12") is likely to greatly underestimate "sink" habitat.	The 12-inch minimum depth is a conservative estimate of minimum depth for which sinks could be reliably identified from LiDAR considering LiDAR accuracy (See Comment Response #51) and ground conditions. Field verification of LiDAR analysis will be conducted during the study and may allow use of a smaller minimum depth to identify sinks. Sinks with lower "rims" will generally be classified by the GIS analysis as low slope terrain presenting a stranding rather than trapping risk. There may therefore be some misclassification of trapping and stranding.
87.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"To identify trapping hazards, the lake shoreline and lake bed DEMs will be queried for isolated pools, or "sinks" in GIS terminology. Sinks consist of spatially connected cells surrounded by a ring of higher elevation cells that hold water to a minimum depth of 12 inches." Is this deep enough to ensure stranding mortality will not occur?	See Comment Response #86. Analysis for "sinks" is an approach to identify trapping hazards, not stranding hazards as identified in the comment.

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88.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"To identify trapping hazards, the lake shoreline and lake bed DEMs will be queried for isolated pools, or "sinks" in GIS terminology. Sinks consist of spatially connected cells surrounded by a ring of higher elevation cells that hold water to a minimum depth of 12 inches." Why is there a depth minimum? Small pools with depth less than 12 inches can strand fish, and these may create a substantial cumulative harm.	See Comment Response #86.
89.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"Given the resolution of the underlying LiDAR data, a minimum sink area of 108 square feet will be assumed for the purposes of identifying and quantifying sinks. This would represent 12 contiguous 3-foot square cells in the DEM." This needs to be field-verified. The analysis risks missing small isolated stranding pools, which cumulatively may create substantial harm.	See Comment Response #86.
90.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	"The separate maps of low slope terrain and isolated pools or sinks will be overlaid to identify the areas with the highest potential for fish stranding or trapping for a given reservoir water surface elevation." Please simply and clearly state the minimum surface area and depths of the various stnading habitats you anticipate being able to detect and map with the LiDAR and GIS analysis.	We expect to be able to identify low gradient areas presenting a potential stranding risk as small as 9 square feet (i.e. on the scale of a single 3-foot by 3-foor DEM cell). Considering ground conditions and LiDAR accuracy, we also expect to be able to reliably identify areas representing a trapping risk as small as 108 square feet (representing 12 contiguous DEM cells) and having a minimum depth of 12 inches. Field verification of LiDAR analysis will be conducted during the study and may allow identification of sinks with smaller minimum areas and smaller minimum depths. Please also See Comment Response #86.

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91.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"2.6.1.3 Analysis of Reservoir Drawdown" Please desribe the quantifiable atrributes of the drawdowns you are ascribing risk to.	Drawdown for each reservoir will be quantified by rate of drawdown (inches/hour), classified by time of day and month or season.
92.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"Actual trapping and stranding risk will be determined by the frequency with which isolated trapping pools are formed and the frequency with which low gradient stranding areas become exposed." More detail is needed. How will this be calculated? How will risk be ascribed?	Frequency of formation of trapping pools or exposure of low gradient areas will be determined from analysis of variation in hourly (or daily for Ross Lake) water levels as described in Section 2.6.2.3.
93.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"The reservoir elevation data will also be analyzed to characterize reservoir drawdown rates." Will SCL conduct surveys in the reservoir to confirm the drawdown rates?	Reservoir drawdown rates will be determined from the water level data routinely collected, and validated by the USGS, at Project reservoirs. Field surveys to confirm drawdown rates are not proposed at this time since data verification is already routinely conducted.
94.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"The reservoir elevation data will also be analyzed to characterize reservoir drawdown rates." This will be important to determine accurate drawdown rates to minimize effects. So that we can associate a risk level to the rates.	Agree. Thank you for your comment.
95.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"Analysis for Gorge and Diablo lakes will be performed using the record of hourly water surface elevation data since 2011 under current Project operations" Does that cover typical maintenance and testing that the project has currently under the license provisions. If not would suggest a longer study period to ensure we have variability of flows covered by license.	See Comment Response #8. The period since 2011 adequately describes existing, normal operations. This period is most representative of current Project operations as it reflects operational changes since the 2011 amendment to the Fisheries Settlement Agreement.

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96.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"Analysis for Ross Lake will be similar to that for Gorge and Diablo, except that the analysis will be performed using the record of daily (end of day) water surface elevation data since 2011. As discussed in Section 2.3 of this study plan, water surface elevations in Ross Lake fluctuate seasonally." Unfortunately, SCL may miss drawdown rates of the Ross Reservoir that would strand fish, especially in low slope areas.	See Comment Response #52.
97.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"Analysis for Ross Lake will be similar to that for Gorge and Diablo, except that the analysis will be performed using the record of daily (end of day) water surface elevation data since 2011." Run a subset of hourly fluctuations to ensure that daily elevations adequately identify the stranding risks.	See Comment Response #52.
98.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.3 Analysis of Reservoir Drawdown	"Analysis for Ross Lake will be similar to that for Gorge and Diablo, except that the analysis will be performed using the record of daily (end of day) water surface elevation data since 2011." Also include assessment of pre-2011 water surface elevations.	The period since 2011 was selected for analysis as representative of current normal Project operations. See Comment Response #95.
99.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"2.6.1.4 Native Species Lifestage and Periodicity Analysis" While generally correct, this section, with the exception of the last paragraph, should be bracketed very large error bars. Until we know more about the timing and distribution of fish in the tributaries and littoral habitats of the reservoirs we should assume that fish of all ages, size classes and species are present yearround in	See Comment Response #14.

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				all habitats. As we gather more data we can refine the risk assessment to involve timing. Case in point: the large number of RBT <~40mm killed in the last Gorge Reservoir stranding event.	
100.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	I agree with Ashley. We need the information on fish and the littoral habitats before we can finish this analysis. Otherwise, SCL has a best guess, which leads to possible large errors. (See Comment #99)	See Comment Response #14.
101.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"2.6.1.4 Native Species Lifestage and Periodicity Analysis" Understanding and having a genetic baseline to understand what populations are more succeptible to operational effects, including stranding will be important. We will need to be able to understand what local populations, and life history stages are most susceptible. In some streams bull trout juveniles may outmigrate between one and two…while in other, perhaps cloder tributaries they may migrate later around 3-4 to the reservoir. Also, under standing how they use littoral habitat as juveniles or sub-adults may help determine high risk areas, operational measures, and future restoration need to mitigate impacts. Having a long term pit tag study to monitor a subset of each population through a longer time period than telemetry will assist with long term adaptive management. Having a longer term pit tag study….would help	See Comment Responses #4 and #5. Thank you for this information and these suggestions. We intend to address gaps in periodicity information to inform the study through the exercise outlined in Comment Response #14. Pit tagging is beyond the temporal scope of the study and would require several years of data from which to draw refined conclusions. Lack of refined site-specific periodicity information, over the time period of this study should have limited bearing on the risk assessment results because multiple field checks will be conducted over time in this study, following the desk top analysis, which should capture the periods in which the most vulnerable salmonid life stages could occur in stranding and trapping areas.

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				with understanding what time these fish return to spawning tributaries and use larger bodies of water,…and how they may dip in and out for foraging …over the course of their lifetime…will also help to understand key time periods where bull trout are susceptible to drawdown or long term maintenance flows….	
102.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"While the early life stages of these native species (i.e., emergent fry and young of the year parr) will be physically most susceptible to stranding because of their low velocity tolerance and associated use of shallow and slow waters, defining risks to all life stages of native species under normal operations requires the overlay of temporal operations on reservoir elevations and an understanding of the corresponding phenology of the use of those habitats where trapping and stranding might occur." Need ing information on potentially all fish species, that would serve as a preybase, also non native species, including brook trout, to understand numbers and distributions…	See Comment Response #13.
103.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"At present, knowledge at this level of resolution is limited, so predictions of which species and life stage will be most susceptible to stranding or trapping over an annual or seasonal operations cycle will take into account the general life cycles of the native fish to infer their life stage specific temporal susceptibility." Field studies are warranted.	See Comment Response #14.
104.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"At present, knowledge at this level of resolution is limited, so predictions of which species and life stage will be most susceptible to stranding or trapping over an annual or seasonal operations cycle will take into account the	See Comment Response #14.

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				general life cycles of the native fish to infer their life stage specific temporal susceptibility." Should SCL gather this information instead of guess?	
105.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"Changes in reservoir elevation trapping rearing sub-adult and adult rainbow trout are possible though less likely." The mortality of older fish is likely of greater impact. For instance, older fish have higher survival and fecundity and lower energetic requirements per unit body mass.	Comment acknowledged. We concur that the consequences of trapping or stranding sub-adult and adult fish are greater than younger fish. The text simply references likelihood, not consequences.
106.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"Because none of these native species are known to spawn in the lentic habitats of the Skagit Project reservoirs—with spawning known to occur in reservoir tributaries—the likelihood of trapping or stranding spawning char is extremely low (as it is with spawning rainbow trout)." Access to the tributary spawning locations should be assessed.	See Comment Response #70. Access to tributary spawning locations by native species is routinely assessed as part of the reservoir tributary barrier removal program under the current license.
107.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"Because none of these native species are known to spawn in the lentic habitats of the Skagit Project reservoirs—with spawning known to occur in reservoir tributaries—the likelihood of trapping or stranding spawning char is extremely low (as it is with spawning rainbow trout)." NPS has documented native char spawning in the drawdown zone of Diablo Lake near Colonial Creek.	Thank you for your comment. Please provide this information to City Light to better inform the relicensing process.

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108.	Brock Applegate (WDFW)	05/11/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"Because none of these native species are known to spawn in the lentic habitats of the Skagit Project reservoirs—with spawning known to occur in reservoir tributaries—the likelihood of trapping or stranding spawning char is extremely low (as it is with spawning rainbow trout)." WDFW feels like SCL has some data to collect, with disagreements on fish use. I agree with NPS, SCL has refused to move forward with littoral habitat studies, although they know very little.	City Light looks forward to the documentation of and is unaware of any littoral spawning char occurring in the reservoirs in the decades of operations there. Hence, adverse effects to littoral spawning habitat under existing conditions of reservoir drawdown are equivocal. See also Comment Responses #4 and #5.
109.	Ashley Rawhouser (NPS)	05/08/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	Because none of these native species are known to spawn in the lentic habitats of the Skagit Project reservoirs—with spawning known to occur in reservoir tributaries—the likelihood of trapping or stranding spawning char is extremely low (as it is with spawning rainbow trout). NPS disagrees with statement. An assessment of spawning in littoral habitats has never been completed. What data are SCL using to support this statement?	See Comment Response #108.
110.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.1.4 Native Species Lifestage and Periodicity Analysis	"Spawning age fish would be on tributary spawning grounds which would not be susceptible to the effects of reservoir fluctuations or drawdown." You could end up with inundated redds within affected tributaries, if water is held high during spawning…of visa versa if for some reason you drop it low there could be some dewatered redds…depends on the timing of spawning and operational flow changes.	Operations result in near full pool elevations in the early autumn when native char ascend tributaries to spawn, above the influence of water level elevations in the tributaries. Hence, redd de-watering or inundation in tributaries are not issues affected by the Project.

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111.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"**2.6.2 Field Surveys and Desktop Analysis Updates**" Funding should be provided to interested LPs to collect data and/or indepently verify field data collection. Similiar to current FSA.	City Light will remain in communication with LPs regarding study field programs should they be interested in participating/verifying using their own resources.
112.	Ashley Rawhouser (NPS)	05/13/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"**2.6.2 Field Surveys and Desktop Analysis Updates**" All char should be IDed genetically. All fish mortalities should be preserved and sent to NPS or an agreed to 3rd party for additional analysis that may support other studies.	Char mortalities will be sampled for genetic analysis, guided by a statistically defensible subsampling method whereas analyzing all individuals is impractical or unwarranted. Final sample disposition subject to permit conditions, and/or data sharing for aligned research is negotiable.
113.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Based on the inventory from Section 2.6.1.1 of this study plan and analysis of reservoir elevation data in Sections 2.6.1.2 and 2.6.1.3 of this study plan, key areas of the study area in each of the three Project reservoirs will be identified as candidate sites for field surveys of fish stranding and trapping." Evaluation of study sites should also be made from on the ground evaluations to ensure the desktop analysis did not miss anything. This will also corroborate the desktop analysis.	Thank you for your comment. Field surveys to validate the desktop analysis are planned.
114.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Based on the inventory from Section 2.6.1.1 of this study plan and analysis of reservoir elevation data in Sections 2.6.1.2 and 2.6.1.3 of this study plan, key areas of the study area in each of the three Project reservoirs will be identified as candidate sites for field surveys of fish stranding and trapping." It is unclear how these areas are define/determined.	Field surveys will focus on areas which have been identified from the desktop analysis as presenting a risk of stranding and trapping under normal Project operations. The full suite of areas that may represent conditions where stranding or trapping risks are elevated cannot be known until the digital elevation model is completed. Following which, we anticipate randomly sampling a subset of areas in the field within each strata, per a stratified/random experimental design. Survey areas would be randomly

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					assigned within each strata and field validation would verify or refute stranding and/or trapping conditions, with additional habitat data collected (per Section 2.6.3 of the study plan) to improve our understanding of other physical conditions—beyond elevation and slope, that might influence stranding or trapping. This sampling, to be conducted in 2021, would also be informed by 2020 reconnaissance during Ross Lake drawdown.
115.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"For each reservoir, a number of isolated pools, and areas of low gradient terrain will be selected for sampling." Dewatered areas where stranding mortalities were likely to have occurred should also be assessed.	Assessing stranding areas in addition to trapping areas is also a planned component of the field program.
116.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"For each reservoir, a number of isolated pools, and areas of low gradient terrain will be selected for sampling." What is the method for selecting sample sites? Include systematic transect surveys to validate GIS model and identify stranding in de-watered areas.	See Comment Response #114.
117.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"For each reservoir, a number of isolated pools, and areas of low gradient terrain will be selected for sampling." This is pretty vague. More detail needed as this is critical to verify the desktop analysis. How much area will be surveyed to verify desktop analysis and how will the accuracy and prescision of the desk top analysis be quantified?	See Comment Response #114.

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118.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Selection of sampling locations will consider: accessibility and sampling logistics; safety concerns; frequency of formation of isolated pools or exposure of low gradient areas; and degree to which the pool or low gradient areas are representative of similar features throughout the reservoir drawdown zones." Upper Skagit Indian Tribe would like to consult on location selection, but will recommend inclusion of the life stage and periodicity analysis plus field verification mentioned above.	Thank you for your comment. See Comment Response #14 and #114.
119.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Selection of sampling locations will consider: accessibility and sampling logistics; safety concerns; frequency of formation of isolated pools or exposure of low gradient areas; and degree to which the pool or low gradient areas are representative of similar features throughout the reservoir drawdown zones." Might want to included riffle habitat with pocket water, especially if in rearing habitat for bull trout. In some streams bull trout are stranded within riffle habitat as water levels drop through summer months Check in with WDFWto see if their Large Lakes crews could be available or assistance in survey methods and field help.	Thank you for your comment. Sampling locations will primarily be driven by the desktop analysis which considers slope and other topobathymetric features and may also include additional information resulting from the 2020 reconnaissance effort. This does not preclude the potential for riffle habitat to be captured in this analysis. Although note that Ross Lake is full during summer months to support recreation activities.
120.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Data to be collected at each sampled pool will include:" Data collection should include: • Presence of macroinvertebrates • Collection of all mortalities found.	With regard to collection of all mortalities, please See Comment Response #112. If macroinvertebrates are readily observed, this can be noted in field notes. However, this is not a macroinvertebrate diversity or productivity study.

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121.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	7th Bullet – Comment "Number and condition of trapped fish by species and life stage," Field identification of native char species (i.e. Dolly Varden vs. Bull Trout) should not be considered. This is not an accurate method for differentiating the species. Genetic sampling should be used as the stand alone method for differentiating the two.	Field identification of char species is feasible and recommended. Bull Trout and Dolly Varden have distinct morphologies which makes field identification possible by a properly trained person. The paper which describes the differences between Bull Trout and Dolly Varden was published in 1978. And has since been validated using genetic techniques. Therefore, if field crews are properly trained, they can positively identify char species based on non-invasive observational techniques. The only caveat is hybrids between the two native char species. However, those are rare and would not invalidate a field observation based approach. Also See Comment Response #112.
122.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	7th Bullet – Comment "Number and condition of trapped fish by species and life stage," Conduct repeated visits to infer predation.	While observations of mortalities and trapped live fish will be recorded during field survey, this is not a study to quantify fish mortality *per se*. It's a study to assess risk of operations to strand and trap fish to help manage future mortality as opposed to conducting a detailed accounting of every fish potentially affected by drawdown operations. Per Section 2.6.3, indications of predation during field visits is proposed.
123.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	7th Bullet – Comment "Number and condition of trapped fish by species and life stage[4]," Where is this footnote?	Footnote 4 is located at the bottom of page 2-20 of the study plan.
124.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	14th Bullet – Comment "Presence of macrophytes"	If macrophytes are present on such plots, and fish are also found stranded, if entangled, this would be noted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Survey plots to identify fish entangled in macrophytes.	
125.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	17th Bullet – Comment "Number of stranded fish by species and life stage" All mortalities should be collected and genetic analysis conducted to determine species.	See Comment Response #112.
126.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	20th Bullet – Comment "Indications of predation will be noted." Note common predators in area prior to conducting survey	Thank you for this suggestion, which will be actioned and text has been added to the study plan in Section 2.6.3.
127.	Brian Lanouette (Upper Skagit Indian Tribe)	05/04/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Field surveys for Gorge Lake and Diablo Lake will be conducted quarterly during the study with the reservoirs in their typical operating range." More frequent sampling, and sampling based on lowest drawdown times should occur.	Please See Comment Responses #7 and #122. City Light believes that proposed sampling effort is sufficient to support the risk assessment approach. For Gorge and Diablo lakes, the intent is to sample as close to the lowest point within the normal operating range. The objective of the field surveys is to field validate the desktop analysis. By sampling quarterly, we gain a temporal perspective in addition to the spatial component we are validating. At which point we will have enough information to inform an analysis of effects, potential PME measures, and/or additional studies that may be required.
128.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Field surveys for Gorge Lake and Diablo Lake will be conducted quarterly during the study with the reservoirs in their typical operating range. Exact timing will be determined following further consideration of fish species and life stages of primary concern. The same pools or low gradient areas will be sampled in	As a risk assessment screening study, quarterly sampling as envisioned for Diablo and Gorge allows for an investigation that will capture periodicities of early life stages as well as sub-adult and adult fish of each salmonid species that are the subject of this study. To the extent that night drawdowns occur during these periods

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				each survey. If conditions allow, one additional field survey for each of the two reservoirs (Gorge and Diablo), may be undertaken on an opportunistic basis if the reservoirs are drawn down below their typical operating range for maintenance or other reasons." Since we don't much about the timing and distribution of fish in the littoral habitats and when our migration occurs from tribs quartly sampling is not frequent enough. Timing of surveys should be based on different reservoir elevation and time of day. Right now, we don't know if night drawdowns entrap and kill more fish than daytime draw downs.	of study, we will endeavor to sample at such time to address this gap.
129.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Field surveys for Ross Lake will be conducted three times during the 2021/2022 drawdown cycle. The surveys will cover the full range of drawdown and will take place at the following approximate times: ▪ October or November 2021, with the water surface elevation drawn down 10 to 20 feet, to elevations of 1,598 to 1,588 feet NAVD 88 (1,591.74 feet to 1,581.74 feet CoSD). ▪ January or February 2022, with the water surface elevation drawn down 30 to 40 feet, to elevations of 1,578 to 1,568 feet NAVD 88 (1,571.74 feet to 1,561.74 feet CoSD). ▪ April 2022, with the reservoir elevation close to its minimum and the water surface elevation drawn down 50 feet or more, to an elevation of 1,558 feet NAVD 88 (1,551.74 feet CoSD) or lower."	Analysis of reservoir elevation data is described in Section 2.6.2.3. The desktop analysis will identify entrapment areas such as those described but will not analyze the potential impact on trapping risk of water level variations in the Skagit River at the head of Ross Lake (as opposed to Ross Lake itself) during spring runoff.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				NPS would like to discuss the frequency and timing of Ross surveys. We have observed fish being pushed into entrapment habitats on the rising limb of the Skagit Rivers hydrograph during string runoff. This is also complicated by reservoir level flucuations. Part of this study plan should include an analysis all reservoir levels flucuation rates, amplitude, timing, and duration.	
130.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Field surveys for Ross Lake will be conducted three times during the 2021/2022 drawdown cycle. The surveys will cover the full range of drawdown and will take place at the following approximate times:" You may want to focus on high flows, when areas are at full pool, then water begins to drop…not sure the timing is the same in every reservoir…but it sounds like full pool could vary daily by 5 or more feed in different reservoirs. It would be good to have some survey effort in each reservoir during these types of reservoir level changes also.	Pool elevations for Gorge Lake and Diablo Lake vary daily by from 3 to 5 feet or more, as described in Section 2.4. The pool elevation for Ross Lake varies seasonally, with the daily variation in water level typically less than one foot. The surveys have been designed considering the different operating characteristics of the three reservoirs.
131.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"If conditions allow, one additional field survey for each of the two reservoirs (Gorge and Diablo), may be undertaken on an opportunistic basis if the reservoirs are drawn down below their typical operating range for maintenance or other reasons." This needs to be included, or some other method developed to assess the impact of drawdowns outside the typical operating range.	See Comment Response #8.
132.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Field surveys for Ross Lake will be conducted three times during the 2021/2022 drawdown cycle. The surveys will cover the full range of	See Comment Response #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				drawdown and will take place at the following approximate times: ▪ October or November 2021, with the water surface elevation drawn down 10 to 20 feet, to elevations of 1,598 to 1,588 feet NAVD 88 (1,591.74 feet to 1,581.74 feet CoSD). ▪ January or February 2022, with the water surface elevation drawn down 30 to 40 feet, to elevations of 1,578 to 1,568 feet NAVD 88 (1,571.74 feet to 1,561.74 feet CoSD). ▪ April 2022, with the reservoir elevation close to its minimum and the water surface elevation drawn down 50 feet or more, to an elevation of 1,558 feet NAVD 88 (1,551.74 feet CoSD) or lower." Need to coordinate with BC Canadian fishery agencies to assess upper reservoir stranding and trapping.	
133.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	"Each of the surveys for Ross Lake will focus on low gradient areas recently exposed or pools recently formed as Ross Lake is drawn down through the fall and winter months." The focus on low gradient habitat and exclusion of higher gradient habitat is not warrented at this time. Ross contains a siginifcant amount of entrapment habitat assocaited with stumps on higher gradient habitat.	Analysis of the DEM will identify areas (strata) for subsequent field verification and sampling on the basis of slope. The 2020 reconnaissance will provide an initial assessment of the amount of potential entrapment habitat associated with tree stumps (i.e. tree wells) as a function of slope and may serve to resolve concerns regarding the potential for entrapment in tree wells in higher gradient terrain. Anecdotal experience indicates that the flatter areas in reservoirs appear to generate more tree wells. Findings from the 2020 reconnaissance, discussed in Section 2.6.1, will also inform design of the formal 2021 sampling program.
134.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.3 Analysis and Reporting	"**2.6.3 Analysis and Reporting**" The analysis should quantify the number of fish	See Comment Responses #7 and #122.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				killed during the various project-related reservoir fluctuations. As scoped, it seems to focus on identifying areas of stranding risk. This will not be adequate to assess the risk to reservoir fish populations in terms of abundance, productivity, viability.	
135.	Judy Neibauer (USFWS)	05/12/2020	Section 2.6.3 Analysis and Reporting	"**2.6.3 Analysis and Reporting**" Clearly lay out study questions, methods, analysis, and report format in this section.	The requested details will be developed in the course of the study. Please also See Comment Response #136.
136.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.3 Analysis and Reporting	"A description of the methodology employed," NPS needs this information as part of the study plan in order to support it.	The basic methodology is as described in Section 2.6 of the study plan. The methodology will be further developed in the course of the study, informed in part by the findings of the 2020 reconnaissance.
137.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.6.3 Analysis and Reporting	"Data collected will be interrogated to test relevant hypotheses (e.g., H_o: normal operating ranges do not cause an increase in stranding; slopes greater than 6 percent cause no increase in stranding risk; distance from cover has no bearing on trapping risks, etc.). To the degree that multiple factors are recognized as influencing trapping or stranding risks, multiple regression will likely be used to further our understanding of the relative variation influenced by each factor. A full data management plan, including hypotheses to be tested and the statistical methods that will be applied will be developed in advance of data collections." Proposed analysis methods should be described as part of this study plan.	City Light continues to work on refining the data management and statistical methods to be applied for the study to ensure they are robust and defensible, and will update the study plan with additional details prior to the finalization and filing with FERC as part of the PSP.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
138.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.3 Analysis and Reporting	"A full data management plan, including hypotheses to be tested and the statistical methods that will be applied will be developed in advance of data collections." Include power analysis to ensure adequate sample size for field verification and transect surveys.	A power analysis to ensure adequate sampling to meet study objectives will be a part of the detailed information as described in Comment Response #137.
139.	Ashley Rawhouser (NPS)	05/12/2020	Section 2.8 Schedule	"**2.8 Schedule**" Schedule will need to be revised pending RWG agreement on objectives, scope, and methods.	Comment acknowledged. As appropriate, the schedule will be revised based upon agreements resulting from this 2020 voluntary study plan review process with LPs.
140.	Judy Neibauer (USFWS)	05/12/2020	Section 2.8 Schedule	2nd Bullet – Comment "Field Surveys – January 2021 to April 2022" Allow for opportunistic surveying outside of timeframes when flows allow for key collection of data during both high and low flow events. Might need additional year or two to be able to incorporate flows necessary to do the study…??	Thank you for the comment. The ILP provides the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. Note also that the study allows for opportunistic sampling of Gorge and Diablo reservoirs under conditions outside of normal operations (as defined in the study plan)if they should occur during the study period.
141.	Brock Applegate (WDFW)	05/11/2020	Section 2.8 Schedule	Added 4th bullet "Initial Study Report Meeting-- 2022"	Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
142.	Steve Copps (NMFS)	05/11/2020	Section 1.3 Study Plan Development	Add Fish Passage and Sediment Deposition to the list of linked issues.	Section 1.3 has been revised and linkages to issue forms is no longer included as part of this section. Text has been added to this section to indicate that sediment deposition studies are potentially linked to this study.
143.	Steve Copps (NMFS)	05/11/2020	Section 1.3	Fully describe the linkages to other study plans with sufficient detail to understand the nature of	Please see additional text added to section 1.3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Study Plan Development	each specific link and how the information will be synthesized to inform relicensing.	
144.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	Anadromous fish should be added to the list of species to adequately describe stranding and trapping risks under a new license.	This study is focused on reservoir stranding and trapping upstream of where anadromous fish can access under existing conditions.
145.	Steve Copps (NMFS)	05/11/2020	Section 2.1 Study Goals and Objectives	Additional detail should be provided on how the risk assessment will be used to support the relicensing process. Can the assessment be used in a decision making context to develop and understand impacts associated with alternative management scenarios?	See Comment Response #4. Yes, information from this risk assessment is intended to support a subsequent analysis of Project effects and the development of potential actions to address effects, including alternative management scenarios as appropriate
146.	Steve Copps (NMFS)	05/11/2020	Section 2.2 Resource Management Goals	Define "normal project operations."	Normal Project operations are defined in Section 2.1 (see footnote #1).
147.	Steve Copps (NMFS)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	In the absence of conducting research during drawdowns, the study plan should consider alternative strategies to minimize the risk of trapping and stranding (e.g., rescue).	The study results are intended to inform the development of alternative strategies to mitigate or minimize the risk of stranding and trapping. Rescue, for example, may be one of many strategies evaluated for utility in decreasing risk.
148.	Steve Copps (NMFS)	05/11/2020	Section 2.5 Study Area	Low reservoir stage is a good opportunity to examine the full pool extent in dry conditions to assess problems, especially with tributary junctions. Given the objective of determining when and at what elevations strandings occur, the study area should not be limited to elevations below which strandings would occur.	The study proposes to evaluate stranding and trapping risk under normal operations however allowance is made for opportunistic sampling under larger reservoir drawdowns should those occur during the study period. See also Comment Response #8.
149.	Steve Copps (NMFS)	05/11/2020	Section 2.6.1.1 Diablo Lake DEM	New LiDAR information will be necessary as the 2016/17 data will not provide the level of minimum pool elevation data needed to inform when stranding and blocking would occur.	The 2016/2017 LiDAR data for Diablo Lake will be supplemented by bathymetric data to be collected by boat. Section 2.6.2.1 has been revised.
150.	Steve Copps (NMFS)	05/11/2020	Section 2.6.1.1 Diablo Lake DEM	It would be useful to understand the scale of green LiDAR data to know if the resolution is	See Comment Response #51.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				adequate to detected isolated pools and blockages.	
151.	Steve Copps (NMFS)	05/11/2020	Section 2.6.1.1 Diablo Lake DEM	Please include an image of green LiDAR imagery at Stetattle creek.	Please see Figure 2.6-5. This figure shows the extent of green LiDAR coverage where Stetattle Creek enters Gorge Lake.
152.	Steve Copps (NMFS)	05/11/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	Please expand discussion of slope percentages to ensure the study will not miss sudden changes in gradient. For example, sediment type.	Changes in gradient will be detectable from the LiDAR data. See Comment Response #51 regarding accuracy and resolution of LiDAR.
153.	Steve Copps (NMFS)	05/11/2020	Section 2.6.1.2 Analysis of DEMs for Stranding and Trapping Risk	The study should address the potential for trapping in less than 12-inch depth.	See Comment Response #86.
154.	Steve Copps (NMFS)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	Describe selection criteria.	See Comment Response #114.
155.	Steve Copps (NMFS)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	Add tributary junctions to sampling sites.	See Comment Response #13.
156.	Steve Copps (NMFS)	05/11/2020	Section 2.6.2 Field Surveys and Desktop Analysis Updates	Describe how "distance from cover has no bearing on trapping risks." If true, cover may influence survival of trapped fish.	Whether "distance from cover has no bearing on trapping risks" is one of several hypotheses which may be tested, as described in Section 2.6.4. We agree that cover may influence survival of trapped fish.
157.	Steve Copps (NMFS)	05/11/2020	Section 2.8 Schedule	The schedule should be amended to include foreseeable utility of the risk assessment to inform decision making in the relicensing process.	See Comment Response #147.

FA-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Acronyms and Abbreviations

cfs.....cubic feet per second
City Light.....Seattle City Light
Ecology .....Washington State Department of Ecology
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
FERC.....Federal Energy Regulatory Commission
FTE .....full-time equivalent
HEC-RAS .....Hydrologic Engineering Center River Analysis System
ISR .....Initial Study Report
LP.....licensing participant
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
O&M.....operations and maintenance
OPCC.....Opinions of Probable Construction Costs
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
USIT.....Upper Skagit Indian Tribe
USR.....Updated Study Report
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC by April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

As part of the Study Plan Development Process, LPs expressed concern about the Project's potential effects on fish passage in the mainstem Skagit River, the Gorge bypass reach in particular. To address LP concerns, City Light proposes to conduct the Fish Passage Technical Studies Program (Fish Passage Study).

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. This study plan addresses with modifications, elements of the following study requests, as explained in Section 6 of the PSP: (1) assessment of potential upstream fish passage barriers in the Gorge bypass reach (WDFW-01 Evaluation of Fish Barriers and Fish Species in the Bypass Reach); (2) feasibility analysis of anadromous and resident fish passage facilities (NMFS-04 Feasibility Analysis of Fish Passage, NPS-01 Feasibility Analysis of Anadromous and Resident Fish Passage, USFWS-01 Feasibility Analysis of Fish Passage at the Skagit River Hydroelectric Project, USIT-01 Feasibility Analysis of Fish Passage at the Skagit River Hydroelectric Project, and WDFW-02 Feasibility Analysis of Fish Passage at the Skagit River Hydroelectric Project); and (3) evaluating fish habitat and potential fish productivity upstream of Gorge Dam, with emphasis on ESA-listed salmonids (NMFS-03 Quantifying Habitat and Production Potential of Chinook and Coho Salmon and Steelhead above Ross Dam, NPS-08 Quantifying the Productivity Potential of Reservoir Tributary Habitat, USFWS-02 Quantifying the Habitat and Production Potential of ESA-Listed Salmon, Steelhead, and Bull Trout above Dams, USIT-02 Quantifying Habitat and Production Potential of ESA-listed Chinook Salmon, Steelhead, Bull Trout, Coho Salmon, and Sockeye Salmon above Gorge Dam, and WDFW-03 Quantifying Habitat and Production Potential of ESA-listed Chinook Salmon, Steelhead, Bull Trout, Coho Salmon, and Sockeye Salmon above Gorge Dam). City Light has addressed specific comments and suggested edits to the study plan that were provided by the Washington State Department of Ecology (Ecology).

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The purpose of this study plan is to identify and describe methods to be used to address issues related to fish passage through the Gorge bypass reach and at Gorge Dam, and assess habitat suitability in Stetattle Creek, Gorge Creek, and the riverine reach downstream of Diablo Dam. The study will be conducted in a phased manner. Phase 1 will involve a field investigation to assess whether upstream passage barriers identified by Envirosphere (1989) in the Gorge bypass reach constitute total or partial barriers to upstream passage by anadromous salmonids. If the field investigation concludes that the channel features identified by Envirosphere are partial passage barriers, hydraulic modeling will be conducted to evaluate under what flows they may be passable by anadromous salmonids, and Phase 2 of the study will begin. Phase 2, if required, will involve an assessment of potential fish passage options that could be developed at the Gorge development and an assessment of habitat suitability for anadromous salmonids in select tributaries to Gorge Lake and the riverine reach downstream of Diablo Dam.

Specific objectives of this study include the following:

Phase 1

- Conduct a field investigation to characterize and document the physical structure of channel features in the Gorge bypass reach that were considered by Envirosphere (1989) to represent potential upstream passage barriers to anadromous salmonid species.
- Provide an assessment of whether the channel features identified by Envirosphere constitute total barriers to upstream passage of anadromous salmonids or partial barriers that may be passable under certain flows.
- If the field investigation indicates that barriers may be passable, conduct hydraulic modeling to identify the flow ranges under which steelhead, Chinook Salmon, and Coho Salmon (target species) in the Skagit River could pass the barriers.

Phase 2

- Conduct a fish passage alternatives assessment to identify, develop, and evaluate concept-level upstream and downstream fish passage alternatives for Gorge Dam.
- Evaluate whether habitat in accessible reaches of Stetattle Creek, Gorge Creek, and the riverine reach downstream of Diablo Dam could support various life-history stages of the target anadromous species.

2.2 Resource Management Goals

The study will provide information to help resource agencies and Indian tribes with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

Historical distributions of salmonid species in the Skagit River, particularly in the reach now occupied by the Project, have been influenced by large-scale geological phenomena. Both local and regional drainage patterns in the Skagit River basin have been altered by glaciation (Riedel et al. 2007). The North Cascade Range and Puget Lowlands were inundated by the south-flowing Cordilleran Ice Sheet during the Fraser Glaciation 35 to 11.5 thousand years ago. The Cordilleran Ice Sheet that advanced into the area from the north was greater than one mile thick at Ross Lake and the Puget Lowland (Armstrong et al. 1965; Porter and Swanson 1998). Glacial ice dams blocked the northerly flowing Skagit River and created lakes that drained to the south, forming deep canyons. After the ice sheet retreated, the Skagit River and nearby creeks were redirected to flow south in their current configuration (Riedel et al. 2012). Prior to this redirection, the upper Skagit River is thought to have been a tributary to the Fraser River (Riedel et al. 2007).

Smith (2019) indicated that Bull Trout populations in the Upper Skagit Core area are the result of a founding population from the Fraser River. Smith (2019) based this conclusion on an analysis of mitochondrial haplotypes of Bull Trout from the Fraser and Skagit rivers, and low allelic richness of upper Skagit Bull Trout indicating a founder effect. Smith (2019) suggests that the most likely mechanism for dispersal into the Skagit River above the current location of Gorge Dam is through the upper Skagit River from the Fraser River; the findings of Riedel et al. (2007) corroborate this conclusion regarding the origin of upper Skagit River salmonids. This is consistent with the fact that Bull Trout and Rainbow Trout below Gorge Dam are genetically distinct from those in the upstream reservoirs (Smith 2010; Small et al. 2016), and Dolly Varden only occur upstream of the Skagit River Gorge. Rainbow Trout in Stetattle Creek are also genetically distinct from steelhead in the Skagit River (Kassler and Warheit 2012, as cited in Pflug et al. 2013). These genetic differences coupled with the geologic history of the basin strongly suggest that salmonids in the upper Skagit River basin originated in the Fraser River.

Downen (2014) agrees that compelling evidence exists to support the hypothesis that the upper Skagit River once flowed into the Fraser River and states that native char (Dolly Varden and Bull Trout) and Rainbow Trout in the upper Skagit River basin may have originated in the Fraser River. As described in Downen (2014), a recent analysis conducted by the Washington Department of Fish and Wildlife (WDFW; Kassler and Warheit 2012, as cited in Pflug et al. 2013) found that Rainbow Trout in Ross, Diablo, and Gorge lakes are similar to each other, supporting the agency's management of these fish as a single population. However, they are genetically distinct (cluster separately) from steelhead in the lower Skagit River watershed and other headwater resident Rainbow Trout populations (Pflug et al. 2013). Prior to the construction of Ross Dam, gene flow from the upper Skagit into the lower Skagit was likely only one-way (upstream to downstream) following the redirection of the Skagit River's flow to the south approximately 15,000 years ago (Downen 2014).

The Skagit River Gorge (the gorge) is a narrow section of the Skagit River that begins just upstream of Newhalem, where the river flows through a confined canyon with steep rock walls. Following the geologic connection of the upper and lower Skagit River basins (as described above) after the glacial retreat, the Skagit River flowed south through this gorge through high drops and cascades. Historically, Smith and Anderson (1921) stated that "salmon have been seen [no more than] about one mile above the City of Seattle Camp (i.e., current Town of Newhalem at RM 94).

Also in 1921, the Washington State Fish Commission stated, "no salmon have been observed at any time more than one-half mile above City of Seattle Camp." National Marine Fisheries Service (NMFS; 2012) also concluded that, "Natural barriers blocked the upstream passage of anadromous fish through [what is now] the Project area. These natural barriers include numerous falls, bedrock cascades, and velocity barriers in the 2.5-mile reach located between Gorge Powerhouse and Gorge Dam, and a narrow bedrock constriction and falls located near Diablo Dam." NMFS (2012) further states "While some historical use of areas upstream from the Gorge by steelhead is suggested by anecdotal information gathered at the time of construction [around 1927], the preponderance of evidence indicates limited historical anadromous fish use of the Skagit River watershed upstream from the present location of the Gorge Powerhouse."

The upper extent of salmon access in the Skagit River has been more definitively identified since the Smith and Anderson (1921) report, i.e., there is an apparent passage barrier at approximately 0.6 miles upstream of the Gorge Powerhouse (Envirosphere 1989) within this bypass reach. At this location, a boulder-cascade barrier with a 9-foot vertical drop has been documented where neither the plunge pool depth nor vertical height of the drop were predicted, based on accepted methodologies for assessing fish passage (Powers and Osborne 1985), to allow for upstream passage of any salmonid species except steelhead and perhaps Chinook Salmon under higher flows. A second boulder-cascade series presumed to represent a velocity barrier of less restrictive conditions occurs at approximately 1.3 miles upstream of the powerhouse (Envirosphere 1989). Envirosphere (1989) concluded, "...passage through the Gorge reach would be difficult for fish. Fish migration would only occur during a limited range or 'window' of flows. Discharges below this flow range would prevent the formation of localized plunge pools necessary for leaping. Discharges above this flow range were predicted to result in velocity barriers through narrow canyon sections."

During the previous Project relicensing, City Light conducted an assessment of historical records containing WDFW accounts in the Project vicinity (Envirosphere 1988). From review of the historical records, Envirosphere concluded that, "Some historical evidence suggests that small runs of steelhead trout migrated as far as Stetattle Creek..."

Fish use survey results in the bypass reach (Envirosphere 1989; Upper Skagit Indian Tribe 2016) and Bull Trout genetics studies (Smith 2010; Small et al. 2016) support the conclusion that the lowermost barrier 0.6 miles upstream of the powerhouse historically blocked the upstream movement of salmon and Bull Trout in the Skagit River. In 2016, live steelhead, steelhead redds, and Coho Salmon fry were seen below the lowermost barrier, whereas juvenile Rainbow Trout were found throughout the bypass reach (Upper Skagit Indian Tribe 2016).[1] Further field

[1] Surveys of the bypass reach were conducted on May 9 and June 17, 2016. The May 2016 survey extended from Gorge Powerhouse to about 1.5 miles upstream in the bypass reach. During the survey, snorkelers recorded the number of fish, by species and size-class, and redds in each distinct habitat area. Four adult steelhead and four steelhead redds were observed, all downstream of the barrier located 0.6 miles upstream of the powerhouse. No adult steelhead or redds were observed upstream of the barrier. Numerous Coho Salmon fry were observed in the bypass reach up to about 0.6 miles upstream of the powerhouse; no Coho fry were observed above the [at least partial] barrier located 0.6 miles above the powerhouse. Seven juvenile Rainbow Trout/steelhead were observed in pools below and within the fish passage barrier at 0.6 miles upstream of the Gorge Powerhouse, and five juvenile Rainbow Trout/steelhead were observed in a pool located immediately upstream of the barrier; these fish likely originated in Gorge Lake and were passed downstream during a spill event (Connor 2016). During the June 2016 survey, no steelhead or additional

reconnaissance on October 24, 2019 by a team of City Light, WDFW, Upper Skagit Indian Tribe, and NPS biologists observed no adult steelhead anywhere in the bypass reach (as expected given their spring spawning behavior), but three schools of live Coho Salmon, several Pink Salmon carcasses and redds, and one Chinook Salmon carcass and redd were observed below the first potential barrier. In contrast, several juvenile Rainbow Trout, Brook Trout, and native char were angled or electrofished upstream of the second barrier (located about 1.3 miles upstream of the powerhouse). Under some flow conditions small numbers of steelhead may have historically been able to move upstream of these barriers (Smith and Anderson 1921; Envirosphere 1989; NMFS 2012; NMFS 2018).

Based on review of their study requests, City Light has concluded that licensing participants have not accurately characterized the outcome of 2016 and 2018 field surveys conducted in the Gorge bypass. For example, NMFS cites the Upper Skagit Indian Tribe as having provided and documented "direct observation of adult steelhead in the Gorge Dam plunge pool after a spill event in 2015 (sic), and then again in May of 2018 documented observation of multiple salmonids and life stages upstream within the bypass reach up to Gorge Dam." The NPS, USFWS, and Upper Skagit Indian Tribe use almost identical language to describe having provided documentation of direct observation of adult steelhead in the plunge pool as well as observation of "multiple salmonids" upstream of the Bypass Reach in 2018. WDFW also describes the first event, asserting that "one adult steelhead was observed in the Gorge Dam plunge pool as it chased a lure during the hook and line survey. This fish was estimated to be 28 [inches] in length. This fish was observed by Erin Lowery [City Light] and Hugh Anthony [NPS]. Erin said it was a Steelhead kelt." WDFW also states that "two additional steelhead [also in 2016] were observed in the large pool created by the Butterfly Creek slide [which is above the two potential passage barriers]. These two fish were paired up and were each 30 [inches] in length or greater. A steelhead redd was also observed in the riffle above the dammed pool."

As both NPS and WDFW indicate in their submissions, City Light staff was present for the first cited observation, which occurred on April 25, 2016 (not 2015). City Light disputes the conclusion that adult steelhead were documented in the plunge pool. The observation was of a single fish during angling activities targeting individuals for genetic sampling. The fish struck at a small lure, circled back, and struck again before moving to another part of the plunge pool. While this fish was relatively larger than those being collected on that day, it was similar in size to fishes, including Rainbow Trout, commonly encountered in the Project reservoirs (unpublished NPS data, 2005-2018, provided to E. Lowery (City Light)). At no time during this brief encounter could either of the two people that made the observation, Erin Lowery (City Light) and Hugh Anthony (NPS), determine the species, life history, reproductive status, or an accurate length of that individual fish. To be clear, Erin Lowery has not seen or identified any steelhead, kelts[2] or otherwise, or steelhead redds in the bypass reach upstream of the potential passage barriers at any time.

Moreover, City Light notes that the LPs' reference to a 2018 observation of "multiple salmonids" does not indicate whether these fish were anadromous or resident individuals, and therefore does

steelhead redds were observed; juvenile Rainbow Trout/steelhead and one Eastern Brook Trout were observed above the barrier in June.

[2] A kelt is steelhead that has spawned and is moving back downstream.

not support a conclusion that anadromous fish occur in the bypass reach. It would be imprudent to conclude, based on the 2016 and 2018 events described here, that anadromous fish are able to pass through the bypass reach. In fact, it is possible that the observed fish might have passed downstream with spill.

City Light acknowledges that anadromous fishes use the lower reach of the Gorge bypass, upstream to the lowermost potential passage barrier (as stated in the documentation from May and June 2016 reported above and Envirosphere 1989). However, there have never been any credible, documented observations of anadromous fishes in the bypass reach above the two potential upstream passage barriers. City Light believes that LPs have not accurately represented anecdotal observations of salmonids upstream of the potential passage barriers. These fish were observed from a distance, were neither captured nor handled, and could have been fish that originated upstream of Gorge Dam and displaced downstream during spill. Until someone samples and definitively identifies fish in the bypass reach upstream of the potential passage barriers, it is inappropriate to engage in conjecture about anadromous origins.

2.4 Project Operations and Effects on Resources

With construction of the Project, water in the Skagit River was diverted at Gorge Dam into a tunnel to Gorge Powerhouse, bypassing the Gorge except during spill events. This 2.5-mile section from the dam to the powerhouse is now known as the Gorge bypass reach. Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach (FERC 1995). Flows in the bypass reach are limited to accretion, spill-gate seepage, tributary input, and precipitation runoff, except when water is being spilled at Gorge Dam.

2.5 Study Area

The study will be conducted in the Gorge bypass reach, Gorge Lake, and Stetattle and Gorge creeks and will include Gorge Dam and its appurtenant facilities (Figure 2.5-1).

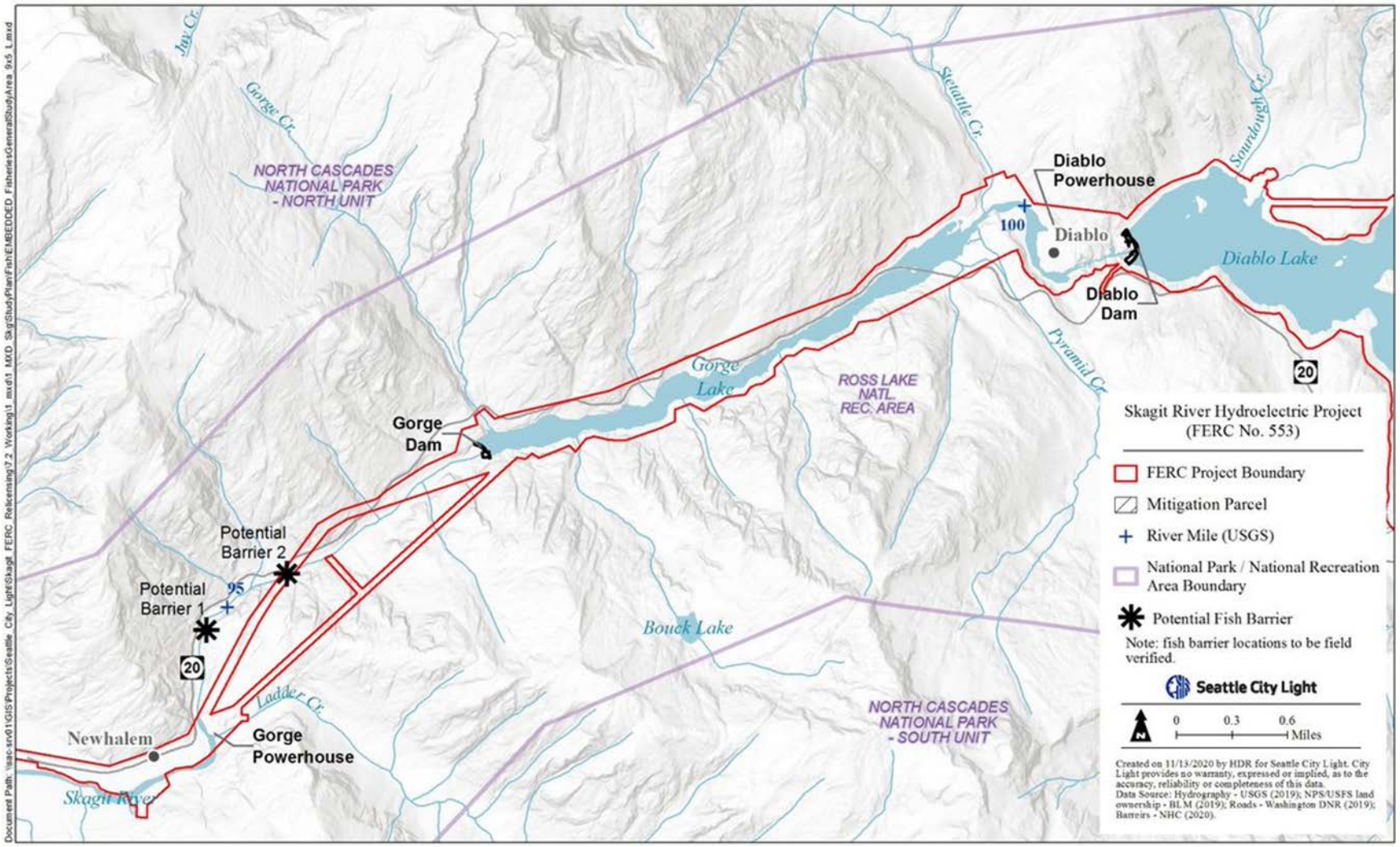

Figure 2.5-1. Study Area for the Fish Passage Technical Studies Program.

2.6 Methodology

As noted in Section 2.1 of this study plan, City Light will conduct this study in a phased manner. Phase 1 will involve a field investigation to assess whether upstream passage barriers identified by Envirosphere (1989) in the Gorge bypass reach constitute total or partial barriers to upstream passage. If the field investigation concludes that the channel features are partial passage barriers, hydraulic modeling will be conducted (see Section 2.6.1.2 of this study plan) to identify the flow ranges under which the barriers may be passable by steelhead and Chinook and Coho Salmon and Phase 2 of the study will begin. Phase 2, if required, would consist of a feasibility assessment of potential upstream and downstream fish passage options that could be developed at Gorge Dam and an assessment of habitat suitability for the target salmonid species in Stetattle Creek, Gorge Creek, and the reach of the mainstem Skagit River immediately below Diablo Dam.

2.6.1 Phase 1

2.6.1.1 Field Investigation of Potential Barriers

A field investigation will be conducted to characterize and document the physical structure of the potential upstream passage barriers identified by Envirosphere (1989) in the Gorge bypass reach. City Light will provide a field-based assessment of whether the barriers may be passable by the target salmonid species.

The following information will be recorded at both barriers identified by Envirosphere (1989) during controlled flow releases from Gorge Dam of about 50, 500, and 1,200 cubic feet per second (cfs) (i.e., calibration flows for the bypass reach hydraulic model).

- GPS coordinate points;
- Effective height of each barrier;
- Gradient/slope of the barrier measured with a range finder and hand level;
- Maximum and average depths of the plunge pool at the base of the barrier;
- A characterization of conditions at the apex of the barrier, which will include velocity measurements at the three flows identified above;
- Maximum and average depth of the landing zone on the upstream side of the barrier;
- Notes describing leap conditions and presence of obstacles; and
- Assessment and documentation of adjacent channel features that might be inundated and provide alternative hydraulic pathways at higher flows.

A fish's potential to successfully ascend a physical feature will be evaluated by comparing the physical characteristics of each feature to the swimming and/or leaping capabilities of each of the target salmonid species. Swimming capabilities for each species will be calculated using mathematical relationships outlined in Bell (1973), Powers and Orsborn (1985), Hunter and Mayor (1986), and Katopodis and Gervais (2016). The maximum leap-height will be estimated using the burst speed resulting from swimming capability data presented in Bell (1973) and Hunter and Mayor (1986) and the leap-height relationships outlined in Powers and Orsborn (1985). Results from these calculations will provide estimated leap heights and leap spans over a range of trajectory angles for each salmonid species. For this evaluation, the anticipated burst speed and

resulting leap height will be adjusted using the dimensionless length factors and condition coefficients presented in Hunter and Mayor (1986) and, as appropriate, updated guidance from WDFW (2019). The evaluation will be based on available information regarding potential size-class distribution and estimated travel time between a fish's entry into the mainstem Skagit River and its arrival at the Gorge bypass reach.

A given channel feature in the bypass reach will be classified as a total barrier to a particular species of adult salmonid if it is judged to have a measured effective barrier height greater than the calculated maximum leap-height for that species under all hydraulic conditions. The threshold for total barriers will be based on the maximum estimated leap-height calculated for a trajectory of 85 degrees.

Features will be classified as partial barriers, rather than total barriers, if they appear to form an impediment to upstream salmonid passage on an intermittent basis. Such a potential barrier would be subject to hydraulic modeling (see below) to provide a more rigorous assessment of the provisional conclusions made during the field investigation and to identify the flows under which the barrier may be passable by the target salmonid species. A feature could exhibit an effective barrier height, a horizontal leap distance, and water velocities that appear negotiable to the target salmonid species but have a low pool depth, obstructions at the leaping or landing zones, or high levels of turbulence that could inhibit passage over some range of flows. Therefore, monitoring cameras will be set up at both barriers, and conditions will be documented under the controlled releases identified in the FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study Plan[3] i.e., 50, 500, and 1,200 cfs, and any operational- or maintenance-related spill releases that may occur during the study period. Water velocities will be measured at the apex of the barriers under the controlled releases identified above, if feasible and safe.

2.6.1.2 Hydraulic Modeling

If results of the field investigation indicate that both of the barriers identified by Envirosphere (1989) are partial barriers to upstream passage of anadromous salmonids, hydraulic modeling would be conducted to estimate the flow range(s) during which fish passage would be possible. The Fish Passage Study report will include a brief description of the hydraulic model along with model output, by species, for each potential passage barrier. Results from the hydraulic model will be used to compare simulated flow depth and velocity and distance to adjacent holding areas with fish species' swimming speeds and anticipated time to exhaustion (endurance). Pathways and corresponding ranges of flow that appear to allow for upstream navigation, and those that do not, will be reported.

2.6.2 Phase 2

If results from Phase 1 indicate that one or more of the target species can pass through the bypass reach, City Light will begin Phase 2, which includes each of the steps outlined below. If the Phase 1 assessment indicates that none of the target species can pass through the bypass reach, City Light would not undertake the Phase 2 assessments described in Sections 2.6.2.1 through 2.6.2.3 of this study plan.

[3] A hydraulic model is being developed per the Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study Plan. The hydraulic model will provide input used in this study, as described in this plan.

2.6.2.1 Fish Passage Facilities Alternatives Assessment

If Phase 1 criteria are met, City Light will identify, develop, and evaluate concept-level upstream and downstream fish passage alternatives for Gorge Dam. The design, function, and performance of any fish passage facilities would need to be consistent with relevant NMFS and WDFW passage facility criteria established for the target salmonid species (WDFW 2019).

To explore passage options for the target species, it will be necessary to evaluate available physical, eco-hydraulic, and operational factors that influence the potential types, configurations, and locations of fish passage facilities. Factors to be considered during development of facilities options will include estimated run sizes, fish species periodicities and life-stage requirements, and anticipated agency-mandated passage efficiency and survival criteria. Based on these inputs, City Light will formulate and develop preliminary facility sizing and functional designs for a set of agreed-upon potential upstream and downstream fish passage alternatives for Gorge Dam. For each potential alternative, City Light will develop rough estimates of probable construction costs and annual operations and maintenance (O&M) costs.

The assessment would likely be conducted for two population levels (low and high) for each of the target species, with the levels identified in consultation with LPs. Target population sizes would also be based on genetics considerations.

Biological and Engineering Design Parameters and Identification of Potential Passage Facility Alternatives

City Light will gather information on facility siting and sizing, general biological and engineering design parameters, and operational considerations in consultation with LPs. Consultation is anticipated to include four workshops and production of technical memoranda to document the outcome of these workshops. Based on this, a common framework will be developed within which potential concept alternatives and appropriate evaluation criteria can be defined. Potential issues and topics to be addressed at the workshops are as follows: (1) establishing concurrence on existing background conditions, identifying assumptions and data gaps, developing a process for formulating and evaluating passage alternatives, and defining feasibility; (2) formulating passage alternatives, including options and specs, and assessing any preliminary findings; (3) reviewing the results of alternatives evaluation, gathering LPs' feedback on those results, and identifying next steps; and (4) reviewing revisions to passage alternatives and receiving feedback and gaining concurrence on final alternatives to be presented in the study report. Information needed to fill gaps will be derived from Project-specific information, values from the fish passage literature, resource agency input, and the professional judgment of City Light's staff and technical consultants.

Base Case flow simulations generated by the Skagit River Project Operations Model will be used to assess the potential frequency, magnitude, and duration of flows and mean daily reservoir surface elevations at potential locations of fish passage facilities. Project area hydrology used in the assessment of potential passage facilities will likely be based on the portion of the historical record that represents current operations, i.e., the period 1991 (i.e., coinciding with the finalization of the Settlement Agreement) through the end of 2020, although City Light and LPs may select a different period of record and/or consider alternative operating scenarios.

Preliminary Functional Layouts and Cost Estimates

City Light will develop functional site layouts, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable costs for select fish passage alternatives. Considerations addressed during the development of preliminary functional layouts for upstream and downstream passage alternatives will include: (1) major facility design elements, (2) O&M procedures; (3) anticipated facility performance; and (4) construction and O&M costs. Results of these tasks will be used to investigate the overall technical feasibility of each potential fish passage facility alternative. Facility performance will be judged in terms of NMFS and WDFW biological and engineering design criteria (NMFS 2011; WDFW 2019).

Order of magnitude Opinions of Probable Construction Costs (OPCC) will be developed for potential upstream and downstream fish passage facility alternatives. Cost estimates will be based on anticipated labor, equipment, and materials required to construct each facility. The overall level of detail will be commensurate with a Class-5 cost estimating classification per AACE International (AACE 2003). OPCC will be based on available vendor cost data from similar projects in the region to the extent they are available. An appropriate percent contingency will be added to cost estimates to account for undefined design items and unforeseen construction challenges that cannot reasonably be anticipated at a conceptual level of design. Taxes, to the extent they can be foreseen, will be accounted for in estimates. Additional cost uncertainty will be addressed by presenting a range of OPCC, i.e., high (+40 percent) and low (-25 percent) estimates for each facility.

O&M costs will include annual costs expected to be incurred continuously over the life of the facility. Operational costs are based on the anticipated annual period of operation, required staffing, and resources and equipment required to operate the facility in a manner that achieves the facility's intended objectives. Maintenance costs are those associated with maintaining the proper function and longevity of the system's components. Maintenance includes painting, lubrication of moving parts, repair of damage, replacement of broken or non-functional parts, and periodic inspection. The annual level of effort required to operate and maintain a facility will be estimated using full-time equivalents (FTE) for required personnel. Non-labor costs, such as electricity or fuel, will be estimated based on calculated usage requirements for specified equipment and vehicles.

2.6.2.2 Habitat Evaluation in Gorge Lake and Tributaries

Concurrent with the fish passage facilities alternatives assessment, City Light will evaluate habitat conditions in reaches of Stetattle and Gorge creeks that would be accessible to anadromous salmonids and the reach of river downstream of Diablo Dam. Existing tributary habitat data will be compiled, reviewed, and summarized to evaluate: (1) the existence and classification of potential impediments to upstream migration of salmonids within tributaries; and (2) tributary habitat survey results. Existing habitat data will then be used to assess the general suitability of conditions in accessible reaches. Assessment of conditions in tributaries will take into consideration the life-history periodicities of the target species. Habitat parameters to be assessed include: (1) hydrology (velocity profiles under different discharges); (2) stream temperature regime; (3) the relative proportions of macrohabitat features; (4) pool areas and depths; (5) channel complexity, including the presence of large woody material; (6) stream length to first impassable barrier; and (7) estimation of total spawning habitat area by species.

If existing information is insufficient to address habitat conditions, targeted field surveys will be conducted to gather additional information on habitat quality. Habitat surveys would be conducted according to standard protocol (e.g., USFS 2012; Bain and Stevenson 1999) as approved, and potentially modified, by City Light and LPs.

2.6.2.3 Feasibility Assessment

Once the fish passage facilities alternatives and habitat assessments are completed, the feasibility of the various passage alternatives will be assessed by working toward establishing a common understanding of what is intended to be achieved within agreed-upon timeframes, what constitutes success, and what performance metrics must be met. For a passage facility to be considered feasible, it must be able to achieve its established objectives and standards of performance.

Each technical option for facilitating fish passage above Gorge Dam will be evaluated in three ways: (1) its ability to be engineered, constructed, and operated in the context of site geology, existing Project and non-Project structures, site hydrology, reservoir and riverine operations, likely benefits to fish populations, and safety requirements; (2) its ability to operate without significantly interfering with existing Project and non-Project uses; and (3) its ability to meet customary performance standards established for similar facilities, such as facility collection efficiency, survival through the passage facility, and overall Project-wide passage effectiveness. Habitat availability and quality, based on the surveys identified in the preceding section, will also influence whether a passage alternative is considered feasible.

Although City Light's proposed assessment would include an evaluation of habitat availability and engineering feasibility, a variety of additional factors that describe the benefits, risks, and constraints of any proposed introduction or reintroduction of anadromous salmonids must be considered (Anderson et al. 2014), and evaluating these is the responsibility of the fish management agencies. These factors include but are not limited to the risk of disease transmission from downstream stocks to those that exist upstream of Gorge Dam, the potential for competition among introduced and resident fish, the possibility of resident species preying on juvenile anadromous fish in Gorge Reservoir and its tributaries, and the potential effects of genetic introgression on resident stocks.

2.7 Consistency with Generally Accepted Scientific Practice

The application of methods outlined in Bell (1973), Powers and Orsborn (1985), Hunter and Mayor (1986), and Katopodis and Gervais (2016), and updated guidance from WDFW (2019), along with the corresponding field measurements and observations proposed in this plan, constitute a standard approach to assessing the degree to which channel features constitute barriers to upstream salmonid migration.

Hydrologic Engineering Center River Analysis System (HEC-RAS) is widely recognized and accepted throughout the engineering and scientific community for riverine hydraulic modeling. The proposed application of HEC-RAS for characterizing the hydraulics of channel features deemed to be partial barriers to upstream migration is consistent with approaches undertaken in similar situations.

Habitat surveys in tributaries will be conducted according to the USFS's Region 6 Stream Inventory Handbook (USFS 2012) or a comparable method. Selection of a vetted and routinely applied survey method constitutes an industry-standard approach.

2.8 Schedule

A provisional, basic schedule for conducting the Fish Passage Study is as follows:

- Phase 1
  - Conduct field investigation to characterize channel features in the Gorge bypass reach considered to be potential upstream fish passage barriers – May to July 2021.
  - Assess whether these channel features constitute total or partial (i.e., passable under certain flow ranges) passage barriers to upstream passage of anadromous salmonids – July 2021.
  - If the field investigation indicates that barriers may be passable, conduct hydraulic modeling (i.e., as part of the Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study) to identify the flow ranges under which steelhead, Chinook Salmon, and Coho Salmon in the Skagit River could pass the barriers – Draft Technical Report – November 2021.
  - Initial Study Report (ISR) – March 2022
- Phase 2 (dependent on outcome of Phase 1)
  - Evaluating whether habitat in accessible reaches of Stetattle Creek, Gorge Creek, and the riverine reach downstream of Diablo Dam could support various life-history stages of the target anadromous species – December 2021 to September 2022.
  - Conducting a fish passage alternatives assessment to identify, develop, and evaluate concept-level upstream and downstream fish passage alternatives for Gorge Dam – December 2021 to December 2022.
    - Workshop 1: December 2021
    - Workshop 2: April 2022
    - Workshop 3: August 2022
    - Workshop 4: October 2022
  - Updated Study Report (USR) – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $375,000. This cost estimate does not include hydraulic modeling of partial barriers to fish passage, which is included in the Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study.

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FA-05 SKAGIT RIVER GORGE BYPASS REACH HYDRAULIC AND INSTREAM FLOW MODEL DEVELOPMENT PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
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List of Acronyms and Abbreviations

cfs.....cubic feet per second
City Light.....Seattle City Light
Ecology .....Washington State Department of Ecology
ELC.....Environmental Learning Center
ESH.....Effective Spawning Habitat (model)
FEMA .....Federal Emergency Management Agency
FERC.....Federal Energy Regulatory Commission
GIS .....Geographic Information System
GNSS .....Global Navigation Satellite System
HEC-RAS .....Hydrologic Engineering Center River Analysis System
HSC.....habitat suitability criteria
IFIM .....Instream Flow Incremental Method
ILP.....Integrated Licensing Process
LiDAR.....Light Detection and Ranging
LP.....licensing participant
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile (USGS)
RWG .....Resource Work Group
UAV.....unmanned aerial vehicle
USACE .....U.S. Army Corps of Engineers
U.S.C.....United States Code
USFWS .....U.S. Fish and Wildlife Service
USGS .....U.S. Geological Survey
WDFW.....Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

As part of the Study Plan Development Process, LPs expressed concern about the Project's potential effects on fish habitat and fish passage in the Gorge bypass reach (defined as the reach between Gorge Dam to Gorge Powerhouse). Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process. Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the interests of LPs, City Light focused its initial draft study plan proposal in the PAD on information gaps that were needed to directly inform license conditions and were focused on potential Project effects.

To address LP concerns about the Project's potential effects on fish habitat and fish passage in the Gorge bypass reach of the Skagit River, City Light proposes to conduct the Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study (Bypass Instream Flow Model Development Study).

This study plan addresses, with modifications, elements of the Evaluation of Fish Barriers and Fish Species in the Bypass Reach Study request submitted by WDFW (WDFW-01) and also addresses with modifications, elements of the Instream Flow Study request submitted by Ecology (Ecology-02), as explained in Section 6 of the Proposed Study Plan (PSP).

Project operations result in the release of flows to the Skagit River at the Gorge Powerhouse and Gorge Dam. Through coordination with the U.S. Army Corps of Engineers (USACE), Project operations reduce downstream flood risk. Through a variety of pathways, the Project's flow releases also affect the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids and long-term geomorphic processes. The development of hydraulic models will provide detailed information on the hydraulic characteristics of flows in the Skagit River (discharge, flow depth and velocity, and their spatial and temporal variations) and be useful when considering potential alternative Project operations, particularly related to effects on fish habitat. This study plan describes the proposed development of an instream flow model for the reach between Gorge Dam and Gorge Powerhouse. The instream flow model will consist of a numerical hydraulic model that produces hydraulic outputs (i.e., depth and velocity grids) that can be further analyzed or synthesized in a Geographic Information System (GIS) to assess changes in habitat suitability under alternative Project operations. Depending on the findings of field investigations to be performed under the FA-04 Fish Passage Technical Studies Program (Fish Passage Study; discussed further in Section 2.6.1.8 of this study plan), the model will provide hydraulic data to support evaluation of potential fish passage barriers in this reach.

Following completion of relicensing studies, an integrated environmental analysis will specifically address links across resource areas. Studies that may ultimately be linked, either directly or indirectly, to the findings of this study include: (1) Fish Passage Study); (2) FA-01 Water Quality Monitoring Study (i.e., the relationship between water quality and flows with respect to fish habitat suitability); (3) GE-04 Skagit River Geomorphology between Gorge Dam and the Sauk River Study (Geomorphology Study)(e.g., substrate mapping, etc.); (4) OM-01 Operations Model Study (i.e., upstream hydraulic boundary condition); (5) FA-02 Instream Flow Model Development (i.e.,

for the reach between Gorge Powerhouse and the Sauk River confluence); (6) RA-02 Gorge Bypass Reach Safety and Whitewater Boating Assessment; and (7) CR-03 Gorge Bypass Reach Cultural Resources Survey. More needs to be learned within each respective study area before it is clear if and how study results will meaningfully inform comprehensive environmental analysis. City Light will work with LPs to review and integrate information from related studies as part of the ILP process in support of its license application filing.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Bypass Instream Flow Model Development Study is to develop a flow/habitat evaluation tool for the Gorge bypass reach (the bypass reach is defined as the reach between Gorge Dam and Gorge Powerhouse) and, if necessary, develop hydraulic data necessary for the evaluation of fish passage at two locations in the bypass reach.

Specific objectives include:

- Develop and calibrate a numerical hydraulic model (or models) of the bypass reach.
- Integrate hydraulic model outputs and observed characteristics of substrate and cover with biological (fish species, lifestages, periodicities) and physical (depth, velocity) criteria to develop flow-habitat relationships for the bypass reach.
- Depending on the findings of field investigations to be performed under the Fish Passage Study, apply the model to provide hydraulic data for evaluation of fish passage, particularly at two previously identified potential upstream passage barriers (Envirosphere 1989) within the bypass reach located approximately 0.6 and 1.3 miles upstream from Gorge Powerhouse[1].

Once the study is complete (i.e., the model has been developed), the flow/habitat model will be used to support additional discussions regarding hydraulic conditions and aquatic habitat within the bypass reach, the potential for fish passage at bypass reach potential barriers and, through integration with results from the Instream Flow Model Development Study,[2] evaluation of instream flows in the mainstem Skagit River between Gorge Dam and the Sauk River.

2.2 Resource Management Goals

The study will provide information to help resource agencies and Indian tribes with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

The bypass reach is the 2.5-mile reach between Gorge Dam and Gorge Powerhouse, which is largely dewatered for much of the time under existing conditions as a result of Skagit River flows being diverted at Gorge Dam into a tunnel for power generation. The river in this reach flows in a steep (average slope approximately 1.6 percent) confined channel with lower gradient run and riffle sections interspersed with higher gradient boulder cascade and plunge pool sections

[1] Hydraulic modeling for evaluation of fish passage will only be conducted if field investigations under the Fish Passage Study conclude that these barriers cannot be considered total upstream passage barriers but may be passable by certain target salmonid species under certain flow conditions. Target species are provisionally identified in the Fish Passage Study as steelhead and Chinook and Coho Salmon.

[2] The Instream Flow Model Development study will develop an instream flow model for the mainstem Skagit River from Gorge Powerhouse to the confluence with the Sauk River.

(Envirosphere 1989). The substrate in the reach is dominated by boulders and cobbles with sand and gravel in pools.

Under existing conditions, flows in the bypass reach are limited to seepage from the spill gates at Gorge Dam, seepage under the dam, groundwater accretion, inflows from four small ephemeral tributaries, and occasional spill from Gorge Dam.

Discharge data for the bypass reach are available from limited measurements of baseflow, including those made in summer and fall 1989 (Envirosphere 1989) discussed further below, and records of spill from Gorge Dam.

Records of spill from Gorge Dam are available starting in January 1997. As reported in Section 4.5.2.4 of the PAD (City Light 2020), under existing conditions, flows of several hundred to over 20,000 cubic feet per second (cfs) occur in the bypass reach during planned and unplanned spill events at Gorge Dam. These spill events are most often the result of inflows to Gorge Lake exceeding Gorge Powerhouse capacity but may also be the result of a load rejection, emergency shutdown of flow diversion, or the release of water during Gorge Powerhouse maintenance periods. During maintenance or emergency shutdown periods, water is routed through the Gorge bypass reach to maintain instream flow requirements in the Skagit River downstream from Newhalem. Between January 1, 1997 and April 16, 2019, there were 634 days (approximately 8 percent of the time) when Gorge Dam was spilling water into the bypass reach, with a daily average spill (for days when spill was occurring) of about 1,900 cfs.

Records of discharge in the bypass reach for pre-Project conditions are available from U.S. Geological Survey (USGS) gage Skagit River at Newhalem (USGS gage 1217800) for the periods December 1908 to May 1914 and October 1920 to September 1924, when diversion of flow for power generation began.

A study of hydraulic conditions, fish habitat characteristics, and fish populations in the bypass reach was conducted in 1989 (Envirosphere 1989). Baseflows were measured in early summer, mid-summer, late summer, and early fall at three locations: at the upper and lower ends of the bypass reach and at an intermediate location. The largest measured baseflows (in late June) were 10 cfs at the upper end of the bypass reach and 15 cfs at the lower end. Low flows of 1.5 cfs and 2 cfs were reported during August and early September for the upper and lower ends of the bypass reach, respectively.

Channel cross-sections were surveyed at a total of 17 transects through the bypass reach. Water surface elevations at those transects were measured during baseflow conditions and for controlled releases from Gorge Dam of 50 cfs, 500 cfs and 1,000 cfs. The channel cross-section data and observed water surface elevation data were used to determine the variation of hydraulic geometry with discharge (including wetted width, depth, and cross-section average velocity) at each transect.

A fish barrier analysis and fish habitat survey were also conducted. Two potential fish barriers were identified, i.e., at 0.6 miles and 1.3 miles upstream from Gorge Powerhouse. Both barriers were classified using the Powers and Orsborn (1985) classification as boulder cascade barriers. The first (at 0.6 miles) and more severe of the two barriers is described (Envirosphere 1989) as a "9-ft vertical drop in elevation over a large granitic block." The 1989 fish barrier analysis indicated

that passage of this barrier by steelhead trout and Chinook Salmon may be possible under a certain range of flow conditions but that other anadromous fish (Pink, Coho and Chum Salmon) "could not negotiate this barrier." The analysis found that fish passage at this barrier would be limited at low flows by plunge pool depth from which to leap, and also concluded that "the presence of velocity barriers at high flows is a definite possibility in the confined bedrock and boulder sections of the bypass reach." The second boulder-cascade series (at 1.3 miles) was characterized as a velocity barrier of less restrictive conditions (Envirosphere 1989).

The 1989 fish habitat survey comprised transect-based quantification of habitat variables (depth and velocity under baseflow conditions, substrate type, and cover) for selected habitat units (shallow pools, deep pools and riffles/runs). The survey found excellent habitat associated with deep pools and large substrate even under existing summer baseflow conditions, noting that "habitat in the Gorge bypass reach is mainly limited by flows which do not provide a fully wetted channel."

Fish survey results in the bypass reach (Envirosphere 1989; Upper Skagit Indian Tribe 2016) and Bull Trout genetics studies (Smith 2010; Small et al. 2016) support the conclusion that the lowermost barrier 0.6 miles upstream of the powerhouse historically blocked the upstream movement of salmon and Bull Trout in the Skagit River. In 2016, live steelhead, steelhead redds, and Coho Salmon fry were seen below the lowermost barrier, whereas juvenile Rainbow Trout were found throughout the bypass reach (Upper Skagit Indian Tribe 2016).[3] Further field reconnaissance on October 24, 2019 by a team of City Light, WDFW, Upper Skagit Indian Tribe, and NPS biologists observed no adult steelhead anywhere in the bypass reach (as expected given their spring spawning behavior), but three schools of live Coho Salmon, several Pink Salmon carcasses and redds, and one Chinook Salmon carcass and redd were observed below the lowermost barrier. In contrast, several juvenile Rainbow Trout, Brook Trout, and native char were angled or electrofished upstream of the second barrier (located about 1.3 miles upstream of the powerhouse). Under some flow conditions small numbers of steelhead may have historically been able to move upstream of these barriers (Smith and Anderson 1921; Envirosphere 1989; NMFS 2012; NMFS 2018). During the previous Project relicensing, City Light assessed historical records containing WDFW accounts in the Project vicinity (Envirosphere 1988). From review of the historical records, Envirosphere concluded that, "Some historical evidence suggests that small runs of steelhead trout migrated as far as Stetattle Creek..."

High quality topographic and bathymetric data (Quantum Spatial 2017, 2018) are available to support development of hydraulic models of the bypass reach, which in turn would provide the

[3] Surveys of the bypass reach were conducted on May 9 and June 17, 2016. The May 2016 survey extended from Gorge Powerhouse to about 1.5 miles upstream in the bypass reach. During the survey, snorkelers recorded the number of fish, by species and size-class, and redds in each distinct habitat area. Four adult steelhead and four steelhead redds were observed, all downstream of the barrier located 0.6 miles upstream of the powerhouse. No adult steelhead or redds were observed upstream of the barrier. Numerous Coho Salmon fry were observed in the bypass reach up to about 0.6 miles upstream of the powerhouse; no Coho fry were observed above the [at least partial] barrier located 0.6 miles above the powerhouse. Seven juvenile Rainbow Trout/steelhead were observed in pools below and within the fish passage barrier at 0.6 miles upstream of the Gorge Powerhouse, and five juvenile Rainbow Trout/steelhead were observed in a pool located immediately upstream of the barrier; these fish likely originated in Gorge Lake and were passed downstream during a spill event (Connor 2016). During the June 2016 survey, no steelhead or additional steelhead redds were observed; juvenile Rainbow Trout/steelhead and one Eastern Brook Trout were observed above the barrier in June.

hydraulic data needed for analysis of instream flows and to support use of the hydraulic model to assess potential fish passage barriers. City Light also has a bathymetric map of the plunge pool below Gorge Dam.

2.4 Project Operations and Effects on Resources

Project operations downstream of Gorge Dam reduce downstream flood risk and affect the availability and suitability of spawning, incubation, and rearing habitat for anadromous salmonids. Project operations may also affect fish passage within the bypass reach for certain species and lifestages. Information on the hydraulic characteristics of flows in the bypass reach (discharge, flow depth and velocity, and their spatial and temporal variations) will be used to assess Project effects and may inform the development of alternative scenarios for future Project operations, including flow releases into the bypass, particularly as they pertain to fish habitat.

2.5 Study Area

The study area extends from Gorge Dam at about RM 96.6 downstream to the USGS Skagit River at Newhalem gage (USGS gage 12178000), approximately 0.5 miles downstream from Gorge Powerhouse at RM 93.7 (Figure 2.5-1). Reach length is approximately 2.9 miles.

The downstream limit of hydraulic modeling, i.e., the USGS Skagit River at Newhalem gage, was selected to allow use of the stage-discharge rating at the gage site as a robust downstream model boundary condition and to overlap with the Gorge Powerhouse to Sauk River hydraulic model proposed under the Instream Flow Model Development study plan.

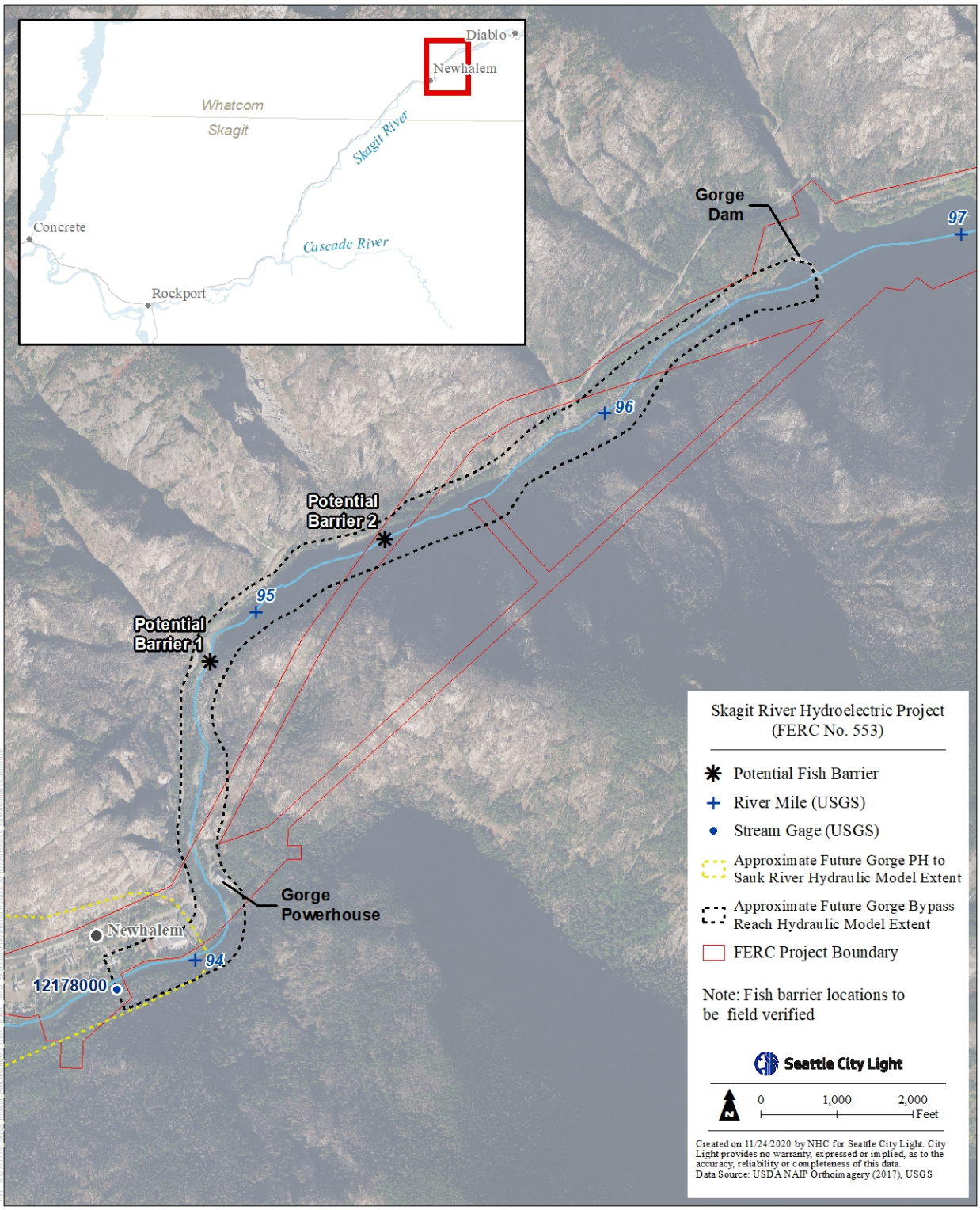

Figure 2.5-1. Overview of study area.

2.6 Methodology

The proposed work will involve the development and calibration of a 2D hydraulic model and application of the model for the analysis of instream flows and, depending on the findings of field investigations to be performed under the Fish Passage Study, to provide hydraulic data for evaluation of fish passage, focusing on the two potential barriers discussed in Section 2.3 and shown in Figure 2.5-1 of this study plan.

2.6.1 Hydraulic Modeling for Instream Flow Analysis and Evaluation of Fish Passage

2.6.1.1 Hydraulic Model Selection and Overview of Model Development

A two-dimensional unsteady flow hydraulic model will be developed for the bypass reach using the U.S. Army Corps of Engineers (USACE) HEC-RAS modeling platform (USACE 2016). The model will extend from Gorge Dam at about RM 96.6 downstream to the USGS Skagit River at Newhalem gage (USGS gage 12178000), approximately 0.5 miles downstream of Gorge Powerhouse at RM 93.7, for a total reach length of approximately 2.9 miles.

The following factors were considered in selecting a model platform:

- Ease of integration with the proposed HEC-RAS 2D model of the downstream reach from Gorge Powerhouse to the Sauk River confluence (see the Instream Flow Model Development Study Plan) and with the operations model (see the Operations Model study plan);
- Efficiency with which metrics of interest for instream flow analysis and evaluation of potential fish passage barriers can be generated by the model;
- Efficiency of model development;
- Model resolution required to meet study objectives;
- Speed of model execution;
- Availability of model support and model maintenance;
- Availability of visualization tools and software features for analysis, synthesis, and display of model output;
- Acceptance by the engineering community and both governmental and non-governmental institutions; and
- Size of user community (which relates to the pool of expertise available for model updates and application).

Model development will involve the following tasks, described in the following sub-sections:

- Processing of model topographic data;
- Development of model geometry;
- Analysis of model boundary conditions;
- Field monitoring to obtain discharge and water level data to support model calibration;
- Mapping of substrate and cover

- Model configuration and calibration; and
- Model application and analysis of model output.

2.6.1.2 Model Topographic Data

A three-dimensional terrain model of the reach from Gorge Dam to the USGS Skagit River at Newhalem gage (USGS gage 12178000) will be developed from a combination of topobathymetric Light Detection and Ranging (LiDAR) and standard LiDAR.

LiDAR data covering the proposed hydraulic model extents were acquired in 2016 and 2018 (Quantum Spatial 2017; Quantum Spatial 2018) as follows:

- Quantum Spatial topobathymetric LiDAR ("green" LiDAR) contracted by City Light; acquired April 25 and 26, 2018 (Quantum Spatial 2018).
- Quantum Spatial topographic LiDAR ("standard" LiDAR) contracted by USGS; acquired March 2016–September 2016 (Quantum Spatial 2017).

The 2018 topobathymetric LiDAR data have an absolute Non-vegetated Vertical Accuracy of 0.182 feet with 95 percent confidence and a vertical accuracy of 0.366 feet with 95 percent confidence for submerged bathymetric check points. The 2016 standard LiDAR data have an absolute Non-vegetated Vertical Accuracy of 0.263 feet with 95 percent confidence. Full details of the LiDAR resolution and accuracy assessments can be found in the LiDAR technical data reports (Quantum Spatial 2017, 2018).

The 2018 topobathymetric LiDAR provides high resolution topographic and bathymetric data and orthophotos for almost the entire study area. There are, however, several locations where topobathymetric voids exist in the data, either because of turbid water, deep water, aerated water, vegetation cover, and/or a non-reflective channel bottom, which prevents adequate laser returns. These voids in the bathymetric data are located at:

- One deep pool approximately 1.4 miles upstream of Gorge Powerhouse;
- The Gorge Powerhouse tailrace; and
- A short stretch of deep water between the Gorge Powerhouse and the USGS Skagit River at Newhalem gage.

Each of these voids will be filled using interpolated terrain data produced by Quantum Spatial (Quantum Spatial 2018).

The topobathymetric LiDAR in the vicinity of the deep pool 1.4 miles upstream from Gorge Powerhouse provides channel bed elevations in water depths up to about 25 feet. The coverage void at this pool (water depth greater than 25 feet under base flow conditions) will not be surveyed due to difficult access. Given the depth of water at this location, use of interpolated terrain data will again have no impact on hydraulic model results or instream flow analysis.

The void in the immediate vicinity of the Gorge Powerhouse tailrace will be not be surveyed because it is unsafe to do so, but it will be filled by interpolation from surrounding bathymetry.

The void in deep water downstream from Gorge Powerhouse will not be surveyed because of difficult access but will be filled by interpolation.

There are several locations where the 2018 LiDAR may not extend far enough to provide complete coverage of the left bank of the bypass reach for modeling high flows. Where this is the case, left bank topographic data coverage will be extended as needed using the 2016 LiDAR data (Quantum Spatial 2017). Use of this less detailed topographic information will have a negligible effect on hydraulic model results and instream flow analysis.

The final composite terrain will be imported into HEC-RAS to define the river channel. The modeled domain will be one reach with boundary conditions as discussed in Section 2.6.1.4 of this study plan.

2.6.1.3 Model Geometry Development

A two-dimensional model mesh will be developed using tools in the HEC-RAS Mapper editor and "draped" over the final composite terrain. The mesh consists of cells, or elements, whose size, shape, and orientation are refined as needed to simulate hydraulic conditions. The model cell size will be determined considering simulation run time (fewer cells equates to faster run times), and resolution in areas of interest for habitat and fish passage evaluation (more cells equates to finer resolution and slower run times). Several meshes will be developed with cells ranging in size from 1 to 5 feet and coupled with a narrow range of appropriate computation time steps. This consistency sensitivity analysis will allow for understanding how cell size and computational time-step affect model results. The final mesh geometry and associated simulation time step will balance achieving numerical accuracy at the desired resolution with minimizing computation time.

Hydraulic roughness zones will be delineated from an initial assessment of channel bed substrate and observed vegetation. Initial roughness coefficients will be assigned based on professional judgement and published values (e.g. Barnes 1967) and then refined during model calibration.

2.6.1.4 Model Boundary Conditions

Hydrologic inputs to the proposed model will be specified by flow releases from Gorge Dam, local tributary inflows between Gorge Dam and the USGS Skagit River at Newhalem gage, and discharge from Gorge Powerhouse. Ungaged tributary inflows between Gorge Dam and the USGS Skagit River at Newhalem gage will be estimated using data from the USGS Newhalem Creek near Newhalem gage (USGS gage 12178100) and data collected during field monitoring (see Section 2.6.1.5 of this study plan).

The published stage-discharge rating for the USGS Skagit River at Newhalem gage will be used to specify the model's downstream boundary.

2.6.1.5 Field Monitoring

A field monitoring program will acquire water level, discharge, and velocity data for use in hydraulic model calibration and, depending on the findings of field investigations to be performed under the Fish Passage Study, to support analysis of fish passage potential[4].

Model calibration for the purposes of instream flow modeling will rely on water surface profile data for the study reach and water surface elevation, velocity, and discharge data at select transects.

Water surface profiles for the 2.9-mile study reach will be acquired, subject to safety considerations, by marking and surveying profiles under existing base flow conditions (with no spill from Gorge Dam) and during controlled releases from Gorge Dam of about 50, 500, and 1,200 cfs. These target flows are similar to those used in the 1989 study of the bypass reach (Envirosphere 1989), but with a somewhat larger flow at the high end. The high-end flow is approximately the 90-percent exceedance flow (i.e. the flow exceeded 90 percent of the time) from analysis of pre-Project discharge data.

Detailed data on water surface elevations, velocities, and discharge will also be collected during baseflow conditions and, subject to safety considerations, at each of the controlled releases, at a maximum of four transects representative of the range of hydraulic conditions in the bypass reach. Transect locations will be determined in consultation with LP natural resource managers familiar with the river.

Additional water surface elevation and velocity data will be collected in the vicinity of the potential fish passage barriers to refine the model calibration at those locations. These data will only be collected if field investigations under the Fish Passage Study conclude that the barriers cannot be considered total upstream passage barriers, and hydraulic modeling for evaluation of potential fish passage is warranted to identify the flow ranges under which target salmonid species in the Skagit River could pass the barriers.

Up to four automatic water level recorders will be installed at key locations throughout the study reach. One of these recorders will be placed in the plunge pool at the base of the lower potential fish barrier (Potential Barrier 1 in Figure 2.5-1). A second instrument will be placed in the tail of the pool above the lower fish barrier. These instruments will provide information on plunge pool depth below the barrier and approach depth above the barrier for the full range of flows experienced during the monitoring period for use in both hydraulic model calibration and to provide data for direct evaluation of fish passage potential. Two additional recorders will be placed in similar locations above and below the upper potential barrier (Potential Barrier 2 in Figure 2.5-1). Exact locations for these instruments will be determined in consultation with LPs and study team fish passage specialists.

Water surface elevation and velocity data will also be collected during baseflow conditions and, subject to safety considerations, at each of the controlled releases at select locations upstream from

[4] The components of the field monitoring program required to support hydraulic modeling for evaluation of fish passage will only be conducted if field investigations under the Fish Passage Study conclude that the barriers cannot be considered total upstream passage barriers and that hydraulic modeling for evaluation of fish passage is warranted.

and within the fish passage barrier sections. Locations for monitoring will be determined in consultation with LPs and study team fish passage specialists.

If possible, documentation of flow conditions within the potential passage barriers will be collected in the form of nadir (i.e., downward facing) and oblique photos from an Unmanned Aerial Vehicle (UAV) to support the fish passage evaluation. These photos will be processed in conjunction with local survey ground control to provide detailed water surface elevation data (water's edge elevation data) through the barrier sections.

Substrate Mapping

The results of substrate mapping will provide input for fish habitat modeling, be used to refine estimates of hydraulic roughness, and aid in hydraulic model calibration. Substrate will be classified visually according to the size codes identified in the WDFW/Ecology Instream Flow Study Guidelines (Beecher et al. 2016) (Table 2.6-1).

Table 2.6-1. Substrate size-classes.

Substrate Code	Type of Substrate
1	Silt, Clay, or Organic
2	Sand
3	Small Gravel (0.1-0.5")
4	Medium Gravel (0.5-1.5")
5	Large Gravel (1.5-3.0")
6	Small Cobble (3.0-6.0")
7	Large Cobble (6.0-12")
8	Boulder (>12")
9	Bedrock

Substrate polygons will be delineated throughout the study reach with additional effort focused on high-value areas. Substrate mapping will be performed using map tiles developed from high-resolution aerial imagery (Quantum 2018; Skagit County 2015) and loaded into ArcGIS Collector on differential Global Navigation Satellite System (GNSS)-enabled iPads. Substrate information will be recorded in Collector by electronically delineating polygons of homogeneous substrate facies (natural breaks) directly onto the map tiles and assigning each polygon a substrate code. Substrate codes will use the format "ab.c" where "a" is the component code for dominant particle size (particle size will be assigned based on the particle's intermediate axis), "b" is the component code for the subdominant particle size, and "c" is tenths of cell area covered by dominant (50 percent or greater) substrate type. For example, the code 46.8 indicates 80 percent medium gravel and 20 percent small cobble (Beecher et al. 2016).

Field teams will be trained prior to mapping so that substrate coding is accurately and uniformly applied. Initially, crew members will "calibrate" their visual assessments of particle size using a gravelometer or ruler. Regular calibration checks will be conducted as needed, for example when crews encounter a significant change in substrate conditions or if/when mapping is resumed after breaks in fieldwork.

Cover Mapping

Cover mapping, which will provide input for fish habitat modeling, will be conducted based on the codes identified in the WDFW/Ecology Instream Flow Study Guidelines (Beecher et al. 2016) (Table 2.6-2). The guidelines include nine cover criteria, eight of which (i.e., 00.2–00.9) will be mapped and used for modeling fish habitat. Undercut banks (00.1 in Table 2.6-2) constitute a small fraction of the overall potential rearing cover in a river the size of the Skagit, particularly in the high-gradient channel in the Gorge, and exclusion of this cover type will have little influence on the 2D model's output. As a result, undercut banks will be omitted from the cover mapping exercise.

Table 2.6-2. Generic cover/substrate codes and preference values.

Cover Code	Type of Cover	Preference Values		
		Salmon and Trout Rearing	Whitefish Rearing	
		Juvenile and Resident Adult	Juvenile	Adult
00.1	Undercut Bank	1.00	1.00	1.00
00.2	Overhanging Vegetation Near or Touching Water	1.00	1.00	1.00
00.3	Rootwad (Including Partly Undercut	1.00	1.00	1.00
00.4	Log Jam/Submerged Brush Pile	1.00	1.00	1.00
00.5	Log(s) Parallel to Bank	0.80	0.80	0.80
00.6	Aquatic Vegetation	0.80	0.80	0.80
00.7	Short (<1') Terrestrial Grass	0.10	0.10	0.10
00.8	Tall (<3') Dense Grass	0.70	0.70	0.10
00.9	Vegetation > 3 Vertical ft. above SZF	0.20	0.20	0.20

Available remote sensing data packages will be used for initial delineation of cover types, and field mapping will be conducted as needed to supplement the remote sensing analysis. Mapping of overhanging vegetation will be based on available remote sensing data, augmented by a rapid refinement field effort to ensure that results comply with definitions in the Guidelines and reduce the potential for overestimation. Initial delineation of large wood will be based on aerial imagery. However, rootwads, submerged brush piles, and other large wood elements that cannot be delineated from aerial imagery will be mapped in the field. Estimates of aquatic vegetation abundance and distribution can be derived largely from existing infrared imagery. Although there is likely little aquatic vegetation in the main channel, some targeted mapping will be used to supplement what is derived from infrared imagery. Short (<1 ft) terrestrial grass, tall (<3 ft) dense grass, and vegetation >3 vertical feet above stage at zero flow will be delineated using LiDAR and infrared imagery. Information from multiple remote sensing packages will be combined to produce a map of these terrestrial vegetation cover types.

2.6.1.6 Hydraulic Model Calibration

The hydraulic model will be calibrated with the discharge, velocity, and water level data acquired during the field monitoring program. Model calibration will be an iterative process in which model parameters are first adjusted to match observed water levels from the continuous water surface

profiles. The model calibration process will then be extended, with further parameter (or possibly, though unlikely, terrain) adjustments as needed, to match observed water levels and velocities at transect locations and, if hydraulic modeling is required to evaluate potential fish passage, at the fish passage barriers. Model visualization tools will be used to compare model results against UAV imagery.

As part of the calibration process, sensitivity analyses will be conducted by modifying channel roughness coefficients (Manning's "n" values) over a range of conditions and recording how the model results are affected.

2.6.1.7 Development of Habitat Suitability Criteria

Habitat suitability criteria (HSC) define the range of microhabitat variables that are suitable for a species and lifestage of interest. HSC provide the biological criteria input to a habitat model that combines the physical habitat data and the HSC into habitat suitability calculations over a range of simulated flows. Variables typically defined with HSC include depth, velocity, substrate, and instream cover. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively. For the species of interest in the bypass reach, HSC curves and periodicity information developed as part of the Instream Flow Model Development Study (see Section 2.6.1.7 of the Instream Flow Model Development Study Plan) may be used[5].

HSC curves and periodicity information in combination with the calibrated hydraulic model will allow for detailed analyses of the amount, timing of availability, and location of suitable habitat under a range of discharges for species and lifestages of interest. Model depth and velocity results will be integrated with habitat data in an IFIM type analysis to produce flow/habitat relationships for species and lifestages of interest. Hydraulic model results will be output directly from HEC-RAS and analyzed or synthesized further in a Geographic Information System (GIS). For example, HEC-RAS model results will be output as depth and velocity grids. These will be analyzed in conjunction with substrate/cover grids and HSC curves using GIS scripts to compute usable area. Animation of hydraulic model results with HEC-RAS RAS Mapper and display of composite usable area in GIS will be used to help visualize spatial and temporal variations in hydraulic and habitat conditions.

2.6.1.8 Hydraulic Data for Fish Passage Analysis

If warranted by the findings of the field investigations conducted under the Fish Passage Study, the calibrated hydraulic model will be run for a range of flows determined in consultation with LPs and study team fish passage specialists to generate hydraulic data to support the fish passage evaluation. The evaluation of fish passage will be conducted as part of the Fish Passage Study.

Hydraulic metrics for fish passage evaluation will be determined in consultation with the fish passage specialists. Basic metrics will include plunge pool depth; difference in water surface elevation between the upstream water surface and plunge pool, and depth and velocity of flow in pathways approaching and through the barriers.

[5]As part of the model workshops, City Light will consult with LPs regarding the species and lifestages HSC for the bypass reach instream flow model.

2.6.2 Consultation and Report Preparation

A series of five consultation workshops will be held to apprise LPs of progress on model development and to solicit feedback and input from LPs as follows:

- An initial workshop to discuss the overall program for instream flow model development and, if required, generation of hydraulic data for fish passage evaluation, including:
  - Velocity, stage, and discharge monitoring for hydraulic model calibration;
  - Hydraulic model calibration goals and model resolution or mesh size;
  - Review/discussion of existing relevant biological and habitat metrics for model input, potential data gaps, and information sources; and
  - Hydraulic model outputs required to develop flow-habitat relationships and to support fish passage analysis.
- A second workshop to review and discuss proposed updates to relevant biological and habitat metrics based on discussions and input from the initial workshop.
- A mid-point workshop to present information on hydraulic model construction, including terrain data, model geometry, and model boundary conditions;
- A workshop toward the end of the study to present and discuss the results of hydraulic model calibration, integration with biological/aquatic habitat data, and the suite of simulation runs proposed to develop flow-habitat relationships and, if required, to generate hydraulic data for fish passage analysis; and
- A final workshop to present final model simulation results.

A technical report will be prepared to document model development and application, including evaluation of existing information, field data collection, model calibration, development and integration of biological/physical inputs, flow-habitat relationships, and a summary of pertinent fish passage hydraulic data.

2.7 Consistency with Generally Accepted Scientific Practice

HEC-RAS is widely recognized and accepted throughout the engineering and scientific community for hydraulic modeling. The proposed study methodology for hydraulic model development and application is consistent with the approach used for similar work.

2.8 Schedule

The proposed study schedule for the Bypass Instream Flow Model Development Study is as follows:

- Planning, permitting, acquisition, and installation of stage recorders – March to May 2021
- Monitoring for controlled releases from Gorge Dam and conducting substrate and cover mapping – June to September 2021
- Hydraulic model development and calibration – May to September 2021

- Hydraulic model application to develop flow-habitat relationships and to generate hydraulic data for fish passage evaluation – October 2021
- Model Workshop Tentative Schedule
  - Workshop 1: Instream Flow Model Development Program Overview – April 2021
  - Workshop 2: Biological and Habitat Metrics – July 2021
  - Workshop 3: Hydraulic Model Construction – July/August 2021
  - Workshop 4: Hydraulic Model Calibration and Biological/Habitat Integration – September 2021
  - Workshop 5: Final Calibration and Model Application – November 2021
- Study Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $477,000.

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GE-01 RESERVOIR SHORELINE EROSION PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A	Draft Reservoir Erosion Field Form
Attachment B	City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

B&W .....black and white
City Light .....Seattle City Light
ELC .....Environmental Learning Center
FEMA .....Federal Emergency Management Agency
FERC.....Federal Energy Regulatory Commission
ft .....feet
GIS .....Geographic Information System
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
NAIP .....National Agriculture Imagery Program
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RTE.....rare, threatened, and endangered
RWG .....Resource Work Group
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USFS.....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted my LPs.

1.3 Study Plan Development

Ongoing shoreline erosion at Project reservoirs (Ross, Diablo, and Gorge lakes) has the potential to affect the following resources: terrestrial vegetation, including rare, threatened, and endangered (RTE) plant communities; wildlife habitat; aquatic resources; cultural resources; and recreation resources along the shoreline. An inventory of shoreline erosion areas was completed in the late 1980s for the current Project license (Riedel 1990), and erosion control measures and shoreline erosion monitoring at selected sites have taken place annually since 1995. This study will: (1) review available information; (2) update the previous shoreline erosion inventory; (3) assess the current status of previously identified areas of shoreline erosion and the effectiveness of existing erosion control measures; (4) identify any new erosion sites; and (5) provide information that will be used to evaluate the effects of Project-related shoreline erosion on resources of concern. At least five issue forms from the 2019 collaborative process are directly or indirectly linked to the results of this study: (1) TE06 Reservoir Erosion; (2) TE07 Shoreline Erosion; (3) FA10 Reservoir Turbidity; (4) CR02 Erosion Monitoring Plan; and possibly (5) CR07 Ross Lake Geomorphology Study and Monitoring. Information from this study will inform the Cultural Resources Survey. Note that reservoir sedimentation at resource areas of concern will be addressed in the Sediment Deposition in Reservoirs Affecting Resources Areas of Concern Study.

On March 13, 2020, City Light released the Reservoir Shoreline Erosion Draft Study Plan for LP review and comment. On March 17, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 29, 2020. The revised draft was discussed on May 6, 2020 at a TRREWG meeting. The revised draft study plan was also provided to the Fish and Aquatics Resource Work Group (FARWG) on June 19, 2020 for review. Written comments were received from Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), NPS, and Upper Skagit Indian Tribe and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of the Reservoir Shoreline Erosion Study are to characterize existing areas of erosion along Project reservoir shorelines and identify any Project-related factors resulting in erosion at each locale. The study results will facilitate City Light's development of erosion control or monitoring measures, as needed where Project-related erosion is affecting resources of concern.

Specific objectives include:

- Update and review each reservoir erosion site identified in the 1990 reservoir erosion inventory to identify ongoing areas of reservoir erosion along the shorelines of Ross Lake, Diablo Lake, and Gorge Lake.
- Identify types of erosion and factors (Project and non-Project) contributing to erosion at each location to help categorize areas with similar erosion patterns and rates.
- Estimate shoreline erosion rates to the extent possible at representative un-monitored sites based on existing measured erosion rates, aerial photographs and Light Detection and Ranging (LiDAR), and on-site evidence to help understand erosion rates and processes.
- Correlate existing erosion rate data collected at monitoring sites during the current Project license term and data collected at previously un-monitored sites (see previous bullet) with erosion site characteristics (e.g., underlying geology, slope, aspect, shoreline height, landform, type of erosion) to help estimate ongoing erosion rates at unmeasured sites.
- Evaluate the condition and effectiveness of existing shoreline erosion control measures.

2.2 Resource Management Goals

City Light's goal is to gain a current understanding of areas of reservoir shoreline erosion and the effectiveness of existing erosion control measures. This information will be used during the relicensing process to assess the potential for Project-related shoreline erosion to affect resources of concern.

The study will provide information to help resource agencies, and Indian tribes and First Nations with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities.

2.3 Background and Existing Information

An inventory of shoreline conditions was completed for the current Project license (Riedel 1990). Shorelines along the three Project reservoirs (Ross, Diablo, and Gorge lakes) are composed of a variety of materials based on the underlying geology and soils materials (Table 2.3-1). The majority of shoreline length on all three reservoirs consists of stable bedrock and talus as well as stable SR 20 road fill along Gorge Lake. Colluvium comprises another large portion of lake shorelines and can be unstable on steep slopes, but is thin, resulting in limited erosion volumes or shoreline retreat if bedrock is encountered. Lodgement till on shorelines in Ross and Diablo lakes is generally consolidated and can be stable, but in some areas till is unconsolidated and erodible.

Less stable deposits (outwash, unconsolidated areas of alluvial fan, alluvium, and landslide deposits) are subject to erosion.

Table 2.3-1. Length (feet [ft]) and percentage of shoreline composed of various materials.

Material	Ross Lake	Diablo Lake	Gorge Lake
Bedrock	95,670 (33%)	38,090 (48%)	19,195 (40%)
Talus	18,440 (6%)	5,250 (7%)	8,365 (17%)
Colluvium	56,675 (20%)	8,990 (11%)	1,970 (4%)
Undifferentiated	0	985 (1%)	655 (1%)
Glacial Till	67,750 (23%)	8,840 (12%)	0
Outwash	8,675 (3%)	0	0
Alluvial Fan	28,740 (10%)	8,775 (11%)	7,710 (16%)
Alluvium	2,295 (<1%)	1,805 (2%)	1,970 (4%)
Landslide	2,625 (<1%)	0	0
Fill	5,415 (2%)	6,238 (8%)	8,040 (17%)
Total	**286,285**	**75,973**	**47,905**

Source: Riedel 1990.

Lake shorelines are subject to erosion from natural processes (e.g., waves, currents, freeze-thaw action, mass movements groundwater, and overland flow), as well as other factors (e.g., recreational use/trampling). Fluctuation of reservoir levels as part of Project operations contribute to lake shoreline erosion by focusing wave energy on different parts of the bank and exposing areas within the drawdown zone to wave action, freeze-thaw, and overland flow and can affect mass movements (Riedel 1990). During reservoir drawdown and filling, previously eroded material is transported downslope and deposited in lower elevations of the reservoirs.

As part of the 1990 shoreline condition inventory (Riedel 1990), information on bank material, bank slope, bluff height, sediment thickness, site aspect, and evidence of slope instability were recorded. Each eroding site was classified based on erosion type and extent based on the following criteria:

- Class I – over 1,000 cubic feet of mass movement had or could occur.
- Class II – less than 1,000 cubic feet of mass movement had or could occur with bluffs over 3-5 feet.
- Class III – less than 1,000 cubic feet of mass movement had or could occur with bluffs less than 3-5 feet.

Shoreline condition at Ross, Diablo, and Gorge lakes varied considerably at the time of the 1990 report (Table 2.3-2). Approximately 26 percent of the Ross Lake shoreline was eroding to some extent, with 2 percent of the shoreline in Class I sites, 14 percent in Class II sites, and 10 percent in Class III sites. Most of the erosion sites were located in the southern 17 miles of the reservoir where colluvium and glacial sediments occur on steep valley slopes. Bluff sites at the Class I areas ranged from 5 to over 50 feet in height. Dominant processes affecting erosion were waves (wind waves and boat waves) undercutting the base of bluffs; at some sites freeze-thaw activity or groundwater seepage contributed to instability.

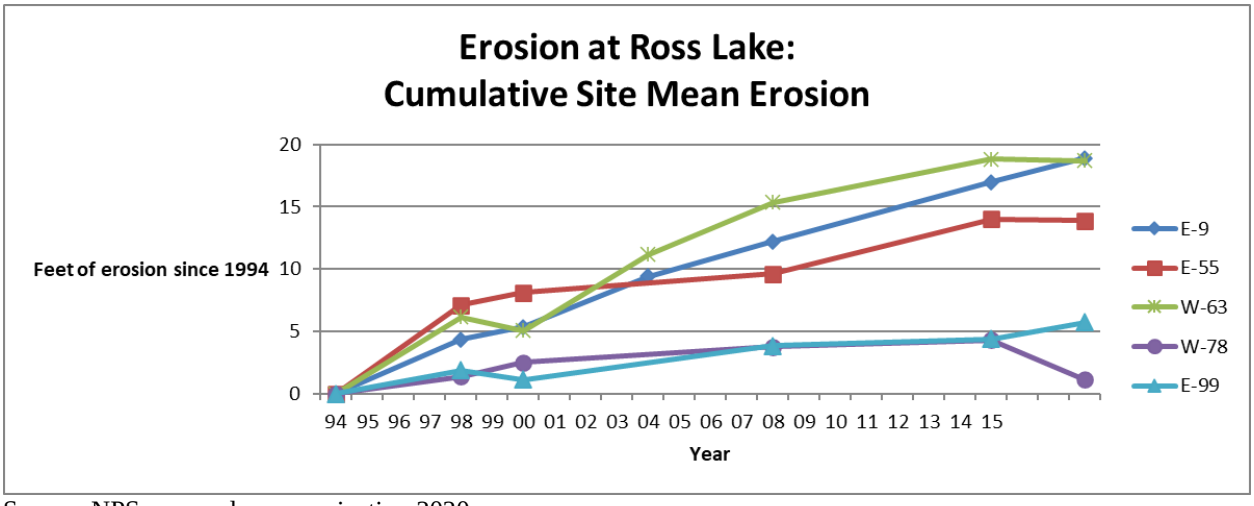
Table 2.3-2. Number of erosion sites and length (ft) and percentage of total shoreline eroding in 1990.

Erosion Class	Ross Lake	Diablo Lake	Gorge Lake
Class I	34 sites; 6,529 ft; 2%	5 sites; 1,801 ft; 2%	3 sites; 312 ft; <1%
Class II	719 sites; 40,072 ft; 14%	17 sites; 2,310 ft; 3%	3 sites; 341 ft; <1%
Class III	390 sites; 29,878 ft; 10%	56 sites; 3,927 ft; 5%	11 sites; 272 ft; <1%
Total	**1,143 sites; 76,479 ft; 26%**	**78 sites; 8,038 ft; 10%**	**17 sites; 925 ft; 2%**

Source: Riedel 1990.

At Diablo Lake, 10 percent of the shoreline was eroding; much of the lake perimeter consists of relatively stable material (e.g., bedrock and talus). The eroding areas were glacial till and colluvium; wave action was the primary cause of erosion. The Gorge Lake shoreline is composed of very stable material; only 2 percent of the shoreline was eroding, primarily mass wasting due to waves undercutting areas of erodible material.

NPS has monitored five bank erosion sites (22 total transects) as part of the Erosion Control Plan (Ebasco Environmental and NPS 1990). The most recent monitoring occurred in 2018. Each of the five sites monitored has a different rate of erosion because of varying bank material, aspect, and slope (NPS personal communication 2020; Figure 2.3-1). The greatest total amount of bank recession is at three sites with thick glacial deposits (E9, E55, and W63), where erosion has claimed an average of 14 to 19feet of the bank in 24 years. Relatively low rates of erosion were observed at the other two sites with an average of less than 6 feet of erosion in 24 years. The majority of the 22 transects had less than 10 feet of erosion over the 24-year monitoring period; the transect with the highest erosion rate had nearly 65 feet of bank retreat. Site E99 is a rocky slope with colluvial soils, while site W78 has a shoreline composed of very dense glacial till.



Source: NPS personal communication 2020.

Figure 2.3-1. Total mean distance of bank recession 1994-2018 at Ross Lake monitoring sites.

2.4 Project Operations and Effects on Resources

The Skagit River Project contains three Project reservoirs: Ross Lake, Diablo Lake, and Gorge Lake. The shorelines of these reservoirs include areas that are subject to erosion that may be

influenced by Project operations. Erosion mechanisms and causes include wind/boat wave action at the water/land interface; rainsplash erosion, overland flow, streamflow, groundwater, and freeze-thaw. Shoreline erosion has the potential to affect terrestrial vegetation including RTE plant communities along the shoreline, wetlands, riparian areas, cultural resources, wildlife or aquatic habitat, and recreation resources (e.g., trails and campgrounds). Erosion monitoring by the NPS has documented up to 0.85 feet/year of bank retreat since 1994, with the maximum rate at one transect of up to 2.5 feet/year (Figure 2.3-1). Erosion control measures have been installed at some of the erosion sites identified during the current Project license and additional erosion control measures, maintenance and modifications to existing measures may be needed during the next license period. Information on the current status of shoreline erosion will be used to inform appropriate shoreline erosion protection measures where resources of concern are affected.

2.5 Study Area

The Reservoir Shoreline Erosion Study area includes shorelines at and near normal maximum water surface elevation of Ross Lake (within waters of the United States), Diablo Lake, and Gorge Lake, and riverine sections between the three lakes (Figure 2.5-1). All of these shorelines are within the FERC Project Boundary.

There are locations along the shorelines, primarily adjacent to Project facilities, where past large rockfall or mass wasting features/hazards exist and have been documented as part of previous dam safety analyses. Rockfall and mass wasting features will be identified as part of the current (reservoir shoreline erosion) study but will be analyzed in more detail as part of the Erosion and Geologic Hazards at Project Facilities and Transmission Line Corridor Study.

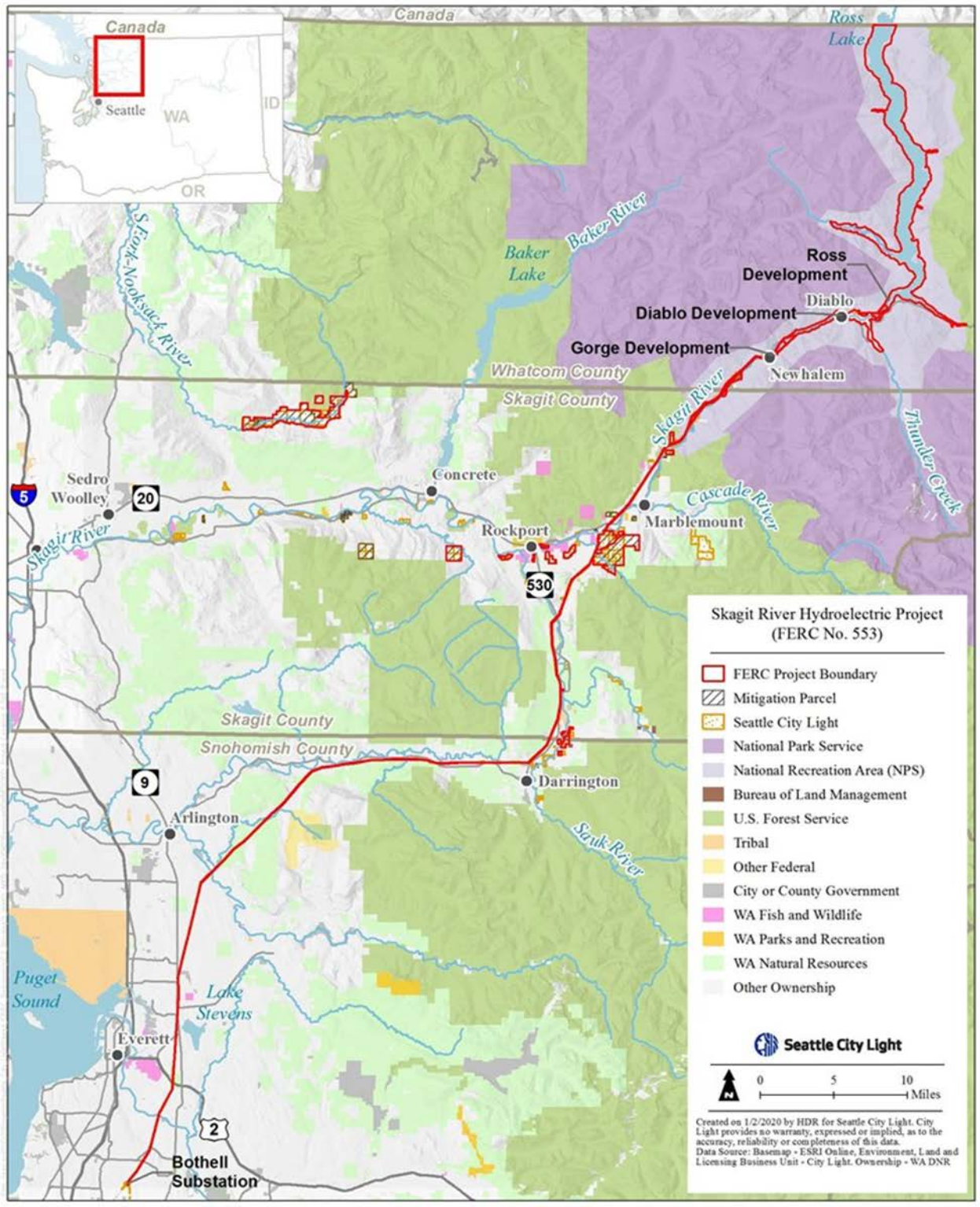


Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

The Reservoir Shoreline Erosion Study will include pre-field analysis of existing information, one season of field work to inventory existing areas of shoreline erosion, and post-field analysis and report writing.

2.6.1 Analysis of Existing Information

Existing reports, maps, aerial photographs, LiDAR data, and NPS erosion data will be compiled and pre-field analyses will be conducted. These analyses include:

- Compile relevant existing reservoir erosion information from NPS, LiDAR, landform mapping, geologic mapping, and aerial photographs for the reservoir erosion study area.
- Digitize erosion areas from the 1990 reservoir erosion inventory to create a Geographic Information System (GIS) database so past sites can be accurately identified during the field inventory and compared to new sites.
- Review existing NPS landform mapping and update landforms along reservoir shorelines if necessary, based on existing LiDAR. Update large shoreline landslide mapping from existing current LiDAR and aerial photographs as needed (see Table 2.6-1 for list of recent LiDAR and aerial photography available).
- If resolution is sufficient, estimate shoreline bank retreat rates using historic and current aerial photographs and/or LiDAR. Relevant aerial photographs of appropriate scale available through the NPS to be considered for the analysis are listed in Table 2.6-1 (Hampton and Griggs 2004). Note that only a few of the aerial photograph years will be selected for the analysis.
- Prepare base maps to use for field inventory (laminated high-resolution prints of aerial photographs with past erosion areas identified).

Table 2.6-1. Available aerial photographs and LiDAR.

Date	Image Type	Scale	Notes
1947	black and white (B&W) stereo photos	1:27,700	U.S. Forest Service (USFS)
1950	B&W stereo photos	1:24,000	USFS
1974	Orthophoto quads	1:24,000	Basis for 7.5-minute topo series
1990	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5-minute series various quads
1992	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5-minute series various quads
1993	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5-minute series various quads
1998	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5-minute series various quads
1998	True color stereo photos	1:12,000	NPS
1999	10” x 10” prints	1:7,200	Walker Wheeler/NPS – working on georeferencing
2006	True Color National Agriculture Imagery Program (NAIP) hi-resolution	1m	Digital
2009	True Color NAIP hi-res.	1m	Digital
2011	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2017	True Color NAIP hi-res.	1m	Digital
2018	4 band RGB-NIR	6 inch	Digital
LiDAR			
2006	LiDAR	Digital	North Puget (USGS) – partial coverage
2016	LiDAR	Digital	3DEP – ff partial coverage
2017	LiDAR	Digital	North Puget
2018	LiDAR	Digital	Seattle City Light – topobathymetry – partial coverage

Source: NPS staff.
Note: additional aerial photograph or LiDAR data may be available and will be used if available.

2.6.2 Field Inventory

A field inventory will be conducted to identify the current status of erosion areas along the shorelines of Ross, Diablo, and Gorge lakes. The inventory will be conducted by boat and foot under near normal maximum water surface elevation conditions. Erosion locations will be mapped on recent aerial photograph base maps; a map showing erosion areas identified during the current Project license inventory (Riedel 1990) will be available for comparison and GPS equipment will be used if feasible to supplement location mapping. CL has found that Trimble GeoXH GPS units are useful in the many parts of the reservoirs.

A unique identifier will be assigned to each erosion site and relevant characteristics will be collected such as eroding length and bank height (or area as appropriate), disturbed and undisturbed bank gradient, bank composition/grain size, geology, type of erosion process, aspect, vegetation presence/absence, factors that appear to be affecting erosion, any evidence of seepage/groundwater, condition, type, and effectiveness of any stabilization measures, and any

evidence of recent erosion (e.g., fresh tree fall, fresh soil at base of bluff). Evidence of total erosion or bank retreat rate since reservoir operations began (e.g., exposed tree stumps, bulkheads, or anchors) will be documented and measured if possible. A photograph will be taken of each erosion site. If possible, photographs will be compared to representative photos from the 1990 inventory. A draft field form is attached to this study plan.

Erosion processes will be determined by field observations and applying site-appropriate geology, geomorphology, and hydrology principles. Field methods for estimating erosion rates will vary depending on site and erosion characteristics, and may include projecting the slope aspect of the original topography, estimating the age and type of vegetation on past failed slopes, and measuring root exposure of tree stumps, or exposure of bulkheads, or anchors (Riedel 1990; City Light 2009; Federal Emergency Management Agency [FEMA] 2018; Hampton and Griggs 2004).

A field inventory and assessment of existing erosion control measures will also be made and will include location, type, condition, effectiveness, and maintenance/repair needs (some of this information may already be available from recent NPS surveys). A photograph will be taken of each erosion control site. These photos will be compared to photos of the erosion control sites taken by the NPS as part of their erosion control program.

2.6.3 Data Analysis and Report Preparation

Field data will be entered into an Excel file or database and erosion locations will be digitized into GIS as line or polygon features as appropriate for each site. Data on erosion site characteristics will be compiled and summarized. Shoreline maps identifying existing erosion sites will be prepared.

A technical report will be prepared describing analysis and field inventory methods and study results. The report will include a narrative describing the geologic, soil, and landform setting relevant to shoreline erosion, an overview of Project-related lake surface elevation fluctuations, and information on areas of reservoir shoreline erosion and erosion control measures.

Specific study and report products include:

- GIS-based map of shoreline erosion areas at Ross, Diablo, and Gorge lakes to allow overlays of erosion sites with resources of concern.
- An Excel database linked to the GIS data with erosion-related characteristics and factors contributing to erosion at each identified erosion site.
- A list of the current condition/effectiveness of existing erosion control measures.
- Compilation of available data about factors contributing to shoreline erosion (for example, reservoir water level fluctuations, wind waves, recreation use).
- An analysis of erosion rates over the term of the current Project license where possible based on existing NPS erosion monitoring results and aerial photograph, LiDAR, and site-based erosion rates using an Excel spreadsheet. Changes in rates through time will be discussed as possible based on data availability.
- The erosion rate data will be used to inform an analysis of associations between relevant site characteristics (e.g., geology, slope, aspect, groundwater, erosion type) and erosion

severity/rate to aid in erosion control planning at sites with resources of concern using Pivot Tables within the Excel database.

- A discussion of Project-related factors contributing to reservoir shoreline erosion.

2.7 Consistency with Generally Accepted Scientific Practice

The methods described above were prepared by a Washington State Licensed Engineering Geologist. Field methods are consistent with those used during the reservoir erosion inventory during the current Project license period. Methods for determining erosion processes and rates in lake settings are similar to those used for analysis of reservoir shoreline erosion during licensing studies at the Boundary Hydroelectric Project (City Light 2009), the Pelton Round Butte Hydroelectric Project (Dubé 2005), and the Cowlitz Hydroelectric Project (Harza Engineering Company 2000) as well as shoreline erosion studies at other lakes (Hampton and Griggs 2004; FEMA 2018).

2.8 Schedule

The Reservoir Shoreline Erosion Study includes pre-field office analysis of existing information, one season of field work on the reservoirs during near normal maximum water surface elevation conditions (summer), post-field data analysis and report preparation. Quarterly progress reports will be prepared.

- Pre-field Analysis – March to June 2021
- Field Work – June to August 2021
- Post-field Analysis – August 2021 to February 2022
- Draft Report (Initial Study Report [ISR]) – March 2022
- Final Report (Updated Study Report [USR] – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $120,000.

3.0 REFERENCES

Dubé, K. 2005. Initial Study Results, Reservoir Shoreline Erosion Study, Pelton Round Butte Hydroelectric Project, Oregon. Report prepared for Portland General Electric, the Warm Springs Power Enterprises, and the Pelton Round Butte Project Shoreline Management Group.

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Hampton, M.A. and G.B. Griggs. 2004. Formation, Evolution, and Stability of Coastal Cliffs – Status and Trends. USGS Professional Paper 1693.

Harza Engineering Company. 2000. Mayfield and Riffe Lakes – Erosion/Deposition Areas within Normal Reservoir Drawdown Zones. Report prepared for Tacoma Power by Harza Engineering Company, Bellevue, WA.

National Park Service (NPS). 2020. personal communication. Excel file e-mailed to Kathy Dubé (Watershed GeoDynamics) by Jon Riedel (NPS) on April 9, 2020.

Riedel, J. 1990. Skagit River Project FERC No. 553 Report on Existing Conditions of Reservoir and Streambank Erosion. Report prepared by USDOI National Park Service, Jon Riedel Project Manager. January 1990.

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RESERVOIR SHORELINE EROSION PROPOSED STUDY PLAN

ATTACHMENT A

DRAFT RESERVOIR EROSION FIELD FORM

Skagit Hydroelectric Project Reservoir Erosion Field Form

DRAFT

Site ID _____

Reservoir _____

Location _____

Date/Time _____

Surveyors _____

Former Site ID _____

Erosion Type
- ❑ Undercut bank
- ❑ Slumping
- ❑ Raveling
- ❑ Rills/gullies
- ❑ Trampling
- ❑ _____

Seepage?
Y / N

Shore Area Affected
- ❑ Shore above high water
- ❑ Drawdown zone
- ❑ _____

Dimensions of eroding area (ft)
- Shoreline length _____
- Bank height _____
- Dist. from shore _____
- Area (sq ft) _____
- Disturbed slope gradient (%) _____
- Undisturbed slope gradient (%) _____

Geology/Soils
- ❑ Bedrock
- ❑ Talus
- ❑ Colluvium
- ❑ Till
- ❑ Outwash
- ❑ Alluvial Fan
- ❑ Alluvium
- ❑ Fill
- ❑ _____

Piping?
Y / N

Gleyed soils?
Y / N

Evidence of erosion rate/activity
- Exposed roots/stump depth (ft) _____
- Fresh tree fall (#, decay class) _____
- Fresh soil _____
- Stabilized (rationale) _____

Vegetation
- Type _____
- Condition _____ Age _____
- % Bare soil _____
- Percent Cover Trees Shrub Herb Other
- Disturbed area _____
- Undisturbed _____

Comments/Sketch

Factors Affecting Erosion
- ❑ Reservoir fluctuations
- ❑ Wave action
- ❑ Recreation use
- ❑ Stream erosion
- ❑ Shoreline Development
- ❑ Road Runoff
- ❑ _____

RESERVOIR SHORELINE EROSION PROPOSED STUDY PLAN

ATTACHMENT B

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	04/17/2020	Section 1.2 Relicensing Process	1st Paragraph – Add: consultation Delete: effort	Change made in different location of sentence and paragraph. Text modified to include discussion and consultation.
2.	Judy Neibauer (USFWS)	04/17/2020	Section 1.3 Study Plan Development	Might want to say somewhere in here or in the Study Plan Development section…that information will be used for ESA consultation and to meet the Fish and Wildlife Coordination Act components of FERC (i.e. Section 10j in the FERC process)	City Light acknowledges the need for consultation with USFWS related to its regulatory responsibilities as required in the FERC process and that the information resulting from the study program is intended to inform consultation with USFWS during future steps within the process. A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of reservoir shoreline erosion, if warranted, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process.
3.	Jon Riedel (NPS)	04/06/2020	Section 1.3 Study Plan Development	Given well-documented erosion, would it not be more accurate to say 'is' affecting these resources? It hasn't stopped.	Thank you for your comment, no changes were made. City Light has summarized existing information on documented erosion in the PAD. The focus of the study is to evaluate ongoing Project-related factors resulting in erosion.
4.	Brock Applegate (WDFW)	04/17/2020	Section 1.3 Study Plan Development	1st Paragraph – Delete: the potential to Add: affected some, if not all, the	Thank you for your comment. No edits made to "the potential to" - See response to Comment #3. No edits made to "affected some, if not all, the"

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Add: wildlife,	Edit made: "Wildlife" City Light welcomes any information that licensing participants may provide that will inform analysis of potential Project-related effects on wildlife due to reservoir shoreline erosion.
5.	Ashley Rawhouser (NPS)	03/17/2020	Section 1.3 Study Plan Development	1st Paragraph – Add: "aquatic resources"	Thank you for your comment. Edit made: "aquatic resources"
6.	Jon Riedel (NPS)	04/06/2020	Section 1.3 Study Plan Development	Will there be a separate study plan for below full pool erosion of CR? If not, this is a major issue because there is clear evidence of continued erosion of intact cultural resource bearing sediments in drawdown.	No edits made. A study plan is not needed to complete this work. Continued erosion of intact cultural resource-bearing sediments below full pool is a known continued Project effect which is already addressed in the Archaeological Mitigation and Management Plan (ARMMP) and other confidential cultural resource documents and is anticipated to continue into the next license period. The ARMMP will be updated, in consultation with cultural resources leads for City Light, the NPS, affected tribes and DAHP, with new strategies for monitoring erosion and identifying viable mitigation measures. In addition, a comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of reservoir shoreline erosion, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) and Section 106 processes.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
7.	Ashley Rawhouser (NPS)	03/17/2020	Section 1.3 Study Plan Development	1st Paragraph – Add: (6) assess cumulative impacts to aquatic reources (E.g. water quality, fish and amphibian habitat, invertebrate communities)	Thank you for the comment. No edits were made. A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of reservoir shoreline erosion, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process.
8.	Jon Riedel (NPS)	04/06/2020	Section 1.3 Study Plan Development	Good to see this was added. Other considerations: shoreline development or lack of (beaches)? no large wood accumulation? no riparian vegetation?	Thank you for the comment. No edits were made. See response to Comment #7. Shoreline and beach development (or lack) will be addressed.
9.	Jon Riedel (NPS)	04/06/2020	Section 1.3 Study Plan Development	One other item to address, and maybe you do in a different SP, is to link erosion and valuable resources listed above.	See response to Comment #7.
10.	Judy Neibauer (USFWS)	04/17/2020	Section 1.3 Study Plan Development	As the reservoirs lower, additional shoreline and stream channels are exposed to air, wind, and water. Please expand the study to include areas within the reservoir bed that may be impacting aquatic and riparian habitats. I supplied comments in the sediment deposition and geomorphology documents about this as well. You should show the linkages to those documents. Because of erosion on shorelines and or exposed bed/banks…there may be key depositional areas from areas of erosion. Also because of the geomorphology, there may be areas that are higher at risk from erosion and deposition that may affect aquatic and riparian habitats.	This study plan addresses reservoir shoreline erosion, at or near full pool levels. See response to Comment #7.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				These erosional areas can affect lake water quality and possibly form barriers to movement and foraging…storm driven erosion create large areas of turbidity out for some distance into reservoirs. Erosion and turbidity at edges of stream banks, that are part of the reservoir bed, when the reservoir is lowered, can also have effects Please include analysis of these areas to be able to understand impacts to critical habitat, bull trout, and their prey species.	
11.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.1 Study Goals and Objectives	Absent conflicting evidence, all shoreline erosion should be assumed caused by project-related factors. Without the project, there would be no reservoir shoreline, hence no shoreline erosion. The location and timing of erosion is driven by reservoir storage and operations. **New comment from Brock Applegate (WDFW) provided on 05/06/2020:** WDFW totally disagrees with this statement. Ongoing operations of the project cause the fluctuation of the reservoir and the erosion. I can't think any more direct impact by ongoing project operations than the fluctuation of the reservoir.	Thank you for your comment, no changes were made. The FERC baseline is existing conditions, and therefore pre-dam conditions are not considered in this study plan. The focus of the study is to evaluate ongoing Project-related factors resulting in erosion. **Response to comment provided on 05/06/2020:** Comment noted.
12.	Judy Neibauer (USFWS)	04/17/2020	Section 2.0 Study Plan Elements	I found a great source that identifies what Study Guide Criteria should be addressed in these study plans. Maybe you have seen it, but here is the link…I think you mention it in the PAD too…	City Light appreciates the input.
13.	Judy Neibauer (USFWS)	04/17/2020	Section 2.1 Study Goals and Objectives	You should show how you will link to the other studies geomorphology, sediment deposition, operational flows, etc, Not sure	See response to Comment #7.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				where you are going to put this. But maybe either in the goals and objectives or back ground information sections. It would help show how you will use old vs new data, and show how these things fit with the issues and questions you are asking.	
14.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Add: and review each site of	Edit made.
15.	Jon Riedel (NPS)	04/06/2020	Section 2.1 Study Goals and Objectives	Will this be site by site review of 1990 conditions?	Yes. Each of the sites identified in the 1990 erosion study will be re-evaluated.
16.	Judy Neibauer (USFWS)	04/17/2020	Section 2.1 Study Goals and Objectives	Include some kind of measurement of storm/wind driven erosion as it can have large effects for quite some distance out into reservoirs (foraging, turbidity barriers, etc) You should study erosion as the reservoir is lowered and filled, for certain flow scenarios. Include erosion study area out into the reservoir bed at junctions of tributaries. Please see my comment in sediment deposition study about potential for the edges of streams to erode or slough as the reservoir draws down, creating turbidity and trapping and stranding fish or other wildlife…	See response to Comment #10.
17.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	Bulleted list – Add: Evaluate the potential impacts of ongoing erosion and erosion control measures to aquatic resources. **New comment from Brock Applegate (WDFW) provided on 05/06/2020:** WDFW disagrees. The fluctuation of the reservoir cause by ongoing operations limits	Thank you for your comment. City Light is unaware of any specific Project-related adverse effects due to reservoir shoreline erosion or erosion control measures that are affecting fish in the reservoirs, i.e., the status of reservoir fish populations does not indicate that there is a habitat-related issue. However, City Light welcomes LP input regarding specific aquatic habitat issues, i.e., issues

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				fish habitat by reducing the amount of littoral vegetation and riparian habitat, which adds structure and food to the water.	identified by LPs regarding erosion or erosion control at a specific location within one of the reservoirs and the associated documentation or anecdotal evidence for a specific adverse effect on a fish species/life-stage. **Response to comment provided on 05/06/2020:** Comment noted.
18.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	Bulleted list – Add: Compare erosion rates in reservoirs to natural lakes of similar size and geomorphology.	Comparison of erosion rates at Skagit River Project reservoirs with other reservoirs would be of academic interest, but is not apparent how this could be used in the FERC process to understand Project effects or to evaluate PME measures.
19.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	I agree with Ashley, SCL should try to understand the effects of the fluctuating reservoir due to ongoing project operations.	See response to Comment #18.
20.	Judy Neibauer (USFWS)	04/17/2020	Section 2.1 Study Goals and Objectives	I agree too.	See response to Comment #18.
21.	Judy Neibauer (USFWS)	04/17/2020	Section 2.2 Resource Management Goals	According to guidelines for the ILP…this section should also include Information about public input/interest considerations…Maybe you have this somewhere else? See this link: https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	See response to Comment #12.
22.	Judy Neibauer (USFWS)	04/17/2020	Section 2.2 Resource Management Goals	Expand this section to include resource management goals that this study could help address. Maybe you can gleen them from the issue forms? Other agencies/ tribes and esp the Park Service may have some resource	City Light appreciates the input. The intent of this section is for agencies to provide feedback on their goals related to the study. Because FERC's jurisdiction is limited to the

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				management goals for this section. Also, is there any kind of transboundary agreement with Canada? Seems like they might have some input here too.	U.S., any transboundary coordination is outside of the scope of this study plan.
23.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	Good information in here already…This section looks like you could link up to key questions and goals and objectives above to show what the existing information will address. Maybe some kind of a summary paragraph? This is where you could possibly use a table to help with that	City Light appreciates the input. No changes were made to the study plan. Feedback on organization will be taken into consideration on development of the study report.
24.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Still worth noting we are losing 1.5 acre of land a year. So it is a big problem.	Thank you for your comment and reference to land loss. This will be evaluated for the new license. This information is included in the PAD, no revision to text necessary.
25.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Or distance of retreat if bedrock encountered.	Thank you for the clarification; text edited for clarity.
26.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.3 Background and Existing Information	Not an appropriate term. The project resulted in creation of reservoirs; there were no natural lentic systems prior to the hydro project.	Thank you for your comment. Text has been edited to remove “Lake”.
27.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.3 Background and Existing Information	Not an appropriate term because the reservoirs are not natural features.	Thank you for your comment. Terminology is used to reflect that natural processes still occur.
28.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.3 Background and Existing Information	Need to add the slope gradient of the landform.	This list was attempting to convey types of erosion processes that result in erosion; slope gradient is an underlying condition that affects rate of erosion and is included in the methods and assessment process (see Section 2.6.2).

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
29.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	This is inaccurate. Lodgement till may be more stable than other bank material but it is eroding, albeit more slowly.	Thank you for the clarification; text will be revised.
30.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	When is this measured, at full pool or low pool? You might want to conduct analysis's at different flow scenarios, including climate change scenarios, so we can determine duration of exposure/erosion… in different flow scenarios.	The shoreline lengths in this table from the 1990 report are at full pool. The objective of this study plan is to evaluate shoreline erosion at near full pool levels.
31.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	I don't think this is uncertain. Look at the literature and the 1990 report! This is what makes the process of bank retreat un-natural. While erosion is natural erosion on a reservoir is different than a natural lake with a more- stable water level.	Text revised to clarify. See also response to Comment #26.
32.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	WDFW agrees with this statement. The fluctuations of reservoirs causes erosion, removes and precludes native vegetation and habitat, and promotes reed canarygrass.	See response to Comment #31.
33.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Movement of eroded sediment (particularly fines) is widespread and significant in volume. I would say ' are', not 'can'.	Text revised to clarify.
34.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	I agree. See my comments in the deposition study…where I mention linking up to this plan, since erosion can lead to deposition. Link to sedimentation study.	See response to Comment #7.
35.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	Sorry, since I am new here…I have some questions and thoughts. Not sure what you all have previously discussed. Sorry if these are repeated questions…. Was this 1990 study done at low pool or only high pool? Was any part of the lake bed included in the study to be able to determine if certain areas of the reservoir erode more than other areas, esp. around edges/mouths of	The 1990 study was done at mid pool elevation based on conversations with Jon Riedel (NPS). A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of reservoir

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				key fish bearing tributaries? Can you overlay with geology to help see how erosion areas line up with land types?	shoreline erosion, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process. This study includes methods that will overlay erosion areas with geology and landforms (See Section 2.6).
36.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	You mean bedrock?	Bedrock and talus; text revised to clarify.
37.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Soils is unstable because it is being undercut by waves.	Text revised to clarify.
38.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.3 Background and Existing Information	What proportion of the known eroding and erodible shoreline is being monitored? This study plan should assess all potentially erodible shorelines, at least remotely, to determine the extent of impact at a project-wide scale.	Twenty five (25) erosion control sites along approximately 0.3 total miles of shoreline are visually monitored by the NPS to determine if erosion control measures are functioning. NPS also monitors erosion at five unprotected locations in Ross Lake with varying bank material, aspect and slope. All areas of shoreline at near full pool levels will be assessed using remote sensing (to the extent possible) and field inventory methods. See Section 2.6
39.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Have data from 2018.	Thank you for providing the updated information; the new graph has been inserted.
40.	Jon Riedel (NPS)	04/06/2020	Section 2.3 Background and Existing Information	Note E9 is average. Erosion at crest is much higher (65 ft. since 1994).	Thank you for clarifying. Text has been revised to clarify
41.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	See comment above. All erosion should be assumed a project impact.	See response to Comment #11. **Response to comment provided on 05/06/2020:**

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				New comment from Brock Applegate (WDFW) provided on 05/06/2020: The ongoing operation of the project causes fluctuations and erosion, the most direct effect of project operations.	Comment noted.
42.	Jon Riedel (NPS)	04/06/2020	Section 2.4 Project Operations and Effects on Resources	Same comment as above. There is no erosion without the project water lapping on the steep mountain slopes covered with unconsolidated glacial drift and colluvium.	See response to Comment #3. No revisions made.
43.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	Fisheries and aquatic resources, including water quality impacts due to turbidity and physical disruptions to littoral and riparian habitats.	See response to Comment #7.
44.	Judy Neibauer (USFWS)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	1st Paragraph - Add: wetlands, riparian areas	Thank you for the clarification. Text added.
45.	Brock Applegate (WDFW)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	1st Paragraph – Add wildlife, aquatic resources and habitat, Add: maintenance and	Thank you for the clarification. Text added.
46.	Jon Riedel (NPS)	04/06/2020	Section 2.4 Project Operations and Effects on Resources	Check this, we have a site with 65 ft in 26 years, or 2.5 ft/year. Using averages minimizes severity of problem. SP should mention loss of 1.5 acres year on Ross.	Thank you for this clarification. Text revised to clarify rates. For the last comment, please see response to Comment #24.
47.	Jon Riedel (NPS)	04/06/2020	Section 2.4 Project Operations and Effects on Resources	And maintenance, specifically of scour protection, but also vegetation and ends of walls.	Thank you for this clarification. Text revised to clarify.
48.	Judy Neibauer (USFWS)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	As I mentioned before…You might include a table that shows how you will answer key questions/issues with new both old and new study information so you can show how you	Many of these will be included in the study results in the study report.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				will analyzing effects of operations. Include erosion at different operation scenarios, by geology/land form type if possible so you can look at risk within certain areas.	A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of reservoir shoreline erosion, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process.
49.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.4 Project Operations and Effects on Resources	Including potential identification of new erosion sites.	Yes, as described in Section 2.6.
50.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.5 Study Area	The entire reservoir shoreline should be assessed for evidence of erosion, at least with remote sensing methods. Erosion should be assessed throughout the entire drawdown zone, not limited to at or near the normal maximum water surface elevation. Fish may be impacted by turbidity at all reservoir elevations. Cultural resources may be present at any elevation. It is necessary to document the extent of erosion to assess potential for resource impacts.	See response to Comments #7, #10 and #38.
51.	Judy Neibauer (USFWS)	04/17/2020	Section 2.5 Study Area	Expand the study to incorporate least moderate and low pool elevations. It seems like you might want to look at erosion at a various number of elevation, not just maximum height. I have seen storms cause erosion at both mid and low pools where more sediments are exposed and where streams intersect with the sediments on the reservoir bottom as they flow across sand/silt to the low pool. Are there any recreation trails, horse, bike, or motorcycle, along reservoir bed that cross	See response to Comment #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				fish bearing tributaries? Not sure if you can do that up there…but if so, you may want to include some of those sites too.	
52.	Brock Applegate (WDFW)	04/17/2020	Section 2.5 Study Area	2nd Paragraph – Add: NPS has Delete: have been Add: these areas Add: SCL should have NPS conduct the study or should include NPS as a required part of the data gathering to maintain consistency.	See response to Comment #53. Edits not accepted.
53.	Jon Riedel (NPS)	04/06/2020	Section 2.5 Study Area	This SCL analysis relied on published NPS data. See upper Skagit landform report, which identified these features. SCL did not contribute to the landform mapping effort. For the sake of consistency and reliability, the NPS should be the party tasked with revisiting the landform map now that Lidar is available.	Thank you for clarifying. City Light will consider the most efficient means to implement the study and is willing to discuss the landform mapping with NPS.
54.	Judy Neibauer (USFWS)	04/17/2020	Section 2.5 Study Area	Thanks for mentioning and linking to the other study here…Will you also at some point summarize upper (above the dams) and lower erosion areas together? You could mention this somewhere in here or link to the downstream erosion information/or new geomorphology study. Tying these two areas together will help understand effects in the basin…maybe mention that here or in the background information also.	The license application will summarize results of all studies related to erosion in the Project Boundary. See response to Comment #48.
55.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1 Analysis of Existing Information	One additional analysis should be added to this list: Coordinate with the CRWG to determine the co-occurrence of erosion sites and cultural resource sites. These data will	See response to Comment #6.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				inform several CRWG studies and needs.	
56.	Jon Riedel (NPS)	04/06/2020	Section 2.6.1 Analysis of Existing Information	Why not other reservoirs in region, as did Riedel 1990? We also have a lot of site measurements, thickness, material type etc. that were not included in the Existing Conditions Report.	See response to Comment #18.
57.	Jon Riedel (NPS)	04/06/2020	Section 2.6.1 Analysis of Existing Information	See earlier comment. NPS should update landforms.	See response to Comment #53.
58.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.1 Analysis of Existing Information	3rd Bullet point – Add: have NPS	Edits removed. See response to Comment #53.
59.	Jon Riedel (NPS)	04/06/2020	Section 2.6.1 Analysis of Existing Information	Unlikely that the airphotos will be of a sufficiently large scale, or offer a clear, un-shaded view of shoreline..	Agree, this is discussed in the methods.
60.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1 Analysis of Existing Information	If lidar analysis is not currently possible, this study should ensure a first time step will be collected so that future monitoring can assess shoreline erosion across the entire project area.	LiDAR data has already been acquired.
61.	Judy Neibauer (USFWS)	04/17/2020	Section 2.6.2 Field Inventory	See my comment above about expanding survey to include multiple operations scenarios, by including moderate and low elevations scenarios, and areas around fish bearing tributaries, especially where silts and sandy banks become exposed at lower flows.	See response to Comment #10.
62.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	Unlikely that it will be accurate enough. NPS has hard copies of site maps on 7.5 minute quads.	Yes, text acknowledges GPS may or may not be helpful.
63.	Judy Neibauer (USFWS)	04/17/2020	Section 2.6.1 Analysis of Existing Information	Is there any existing turbidity information?	See response to Comment #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
64.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	Why not use old numbering system?	Numbering system will be developed during study implementation and will take into account existing numbering.
65.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.2 Field Inventory	I agree. SCL should remain consistent with last study.	See response to Comment #64.
66.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.2 Field Inventory	Will this sych up with the vegeation map? What spatial extent (with 5m, 10m ? of active erosion)	The intent of noting vegetation type in this context is to get a general idea of type and density of any existing vegetation within eroding areas (e.g., trees, shrubs, annual vegetation) to help determine site erosion activity level. See the field form (Appendix) for details. This is not intended to synchronize with vegetation mapping undertaken as part of other studies.
67.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.2 Field Inventory	What kind of vegetation and habitat does the fluctuating reservoirs preclude? **New comment provided on 05/06/2020:** The ongoing operation precludes the establishment of habitat and SCL should consider it an impact.	See response to Comment #10. The current License allows Project reservoirs to fluctuate within set ranges up to normal full pool elevations; quantity and quality of vegetative habitat below normal full pool is considered part of existing conditions and therefore not proposed for study here. **Response to comment provided on 05/06/2020:** Comment noted.
68.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.2 Field Inventory	2nd Paragraph – Add: type Add: potential for and amount of large woody debris recruitment,	An analysis of large woody debris recruitment is not an objective of this study. Edits not accepted.
69.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	You mean distance and then assumed rate based on when waters initially flooded site?	Yes, text revised to clarify.
70.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	Should digitize old photos and compare sites, at a representative many.	If old photos and locations are available, this can be considered for representative

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					locations that can be located during the current field inventory. Text added to clarify.
71.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.2 Field Inventory	2nd Paragraph – Add: existing slope aspect above and below highwater line, Add: and type	Text will be revised to clarify.
72.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	Note table in Riedel (1990) where we also used recession from anchors and dock bulkheads.	Good suggestion, added to methods. Thank you.
73.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.2 Field Inventory	3rd Paragraph – Add: and restoration opportunities to improve conditions for aquatic resources	Any restoration opportunities identified will be discussed in the license application.
74.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	And compared to 1990 photos? The old images need to be digitized.	See response to Comment #70.
75.	Jon Riedel (NPS)	04/06/2020	Section 2.6.2 Field Inventory	One item missing is what the erosion threatens. This should be recorded in field (e.g nesting tree, rare plants/communities, dock bulkheads, trails, etc.).	The analysis of potential effects of shoreline erosion on other resources will be conducted in the license application. If other resource effects are readily visible during the field work, it will be noted on the field form (for example, erosion of a trail or camping area).
76.	Curtis Clement (Upper Skagit Indian Tribe)	04/08/2020	Section 2.6.2 Field Inventory	This study is an opportunity to use photogrammetry or some form of laser scanning to form a new 3D digital data set that can be redone in the future to quantify Slope and volume changes.	Any monitoring methods identified will be discussed in the license application.
77.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.3 Data Analysis and Report Preparation	It was good up in Sec. 1.3 that this plan was linked to CR-02, but the Upper Skagit Indian Tribe would like to see an explicit statement somewhere in the methodology that encourages coordination with the CRWG in cases where erosion and cultural sites co-occur.	See response to Comment #10.
78.	Judy Neibauer (USFWS)	04/17/2020	Section 2.6.3	See my comment above about including a table that can be referenced here to show	See response to Comment #23.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Data Analysis and Report Preparation	what key questions/issues are being answered with existing or new data.	
79.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.3 Data Analysis and Report Preparation	What scale?	The maps in the study report will be prepared from GIS data; this data will be available when the report is finalized so that interested parties can produce maps at any scale they need.
80.	Jon Riedel (NPS)	04/06/2020	Section 2.6.3 Data Analysis and Report Preparation	Need to look at erosion within drawdown, and compare locations of net erosion/deposition with lake level curves. Based on a few measurements, it seems most erosion occurring above 1550 ft. with net deposition below.	This goal of this study is to address reservoir shoreline erosion.
81.	Curtis Clement (Upper Skagit Indian Tribe)	04/08/2020	Section 2.6.3 Data Analysis and Report Preparation	A full pool, low pool and transition erosion rate should be included to really understand project impacts. Expand the timing of the field season to accommodate.	See the response to Comments #9 and #86.
82.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.6.3 Data Analysis and Report Preparation	6th Bullet – Add: , LWD recruitment, shoreline and littoral habitat, water quality	The analysis of potential effects of shoreline erosion on other resources will be conducted in the license application.
83.	Jon Riedel (NPS)	04/06/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	Suggest you use these sites to compare and contrast problems on Skagit reservoirs. Geology of many reservoirs is very similar from northwestern Montanan through Idaho to Washington.	See response to Comment #18.
84.	Jon Riedel (NPS)	04/06/2020	Section 2.8 Schedule	This is too late to start, lake may be at or close to full pool for much of this time. And the survey needs to look at conditions below OHW mark. A big gap in this analysis is looking to see if any kind of beach platform has formed out of eroded materials that could absorb some wave energy.	The intent of this study is to look at shorelines near full pool. Beach platform development should be visible just below the water line, or by utilizing aerial photographs/LiDAR data.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
85.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.8 Schedule	This is an excellent example of the need to coordinate with the CRWG because beach platforms may be covering some parts of cultural resources sites.	See response to Comment #10.
86.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Bulleted list – Add: • Initial Study Report (ISR) – March 2022 • ISR Meeting • Study Plan Modification Request (if needed). For example, SCL may need additional collection of data below OHW mark the following winter and spring. • Field Work -- September 2022 to March 23 (if needed) • Final Report – Summer 2022/2023 **New comment provided on 05/06/2020:** These two ILP milestones will occur. How about adding them to the schedule?	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 05/06/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
87.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 3.0 References	Insert this reference: Schalk, Randall F., with Carolyn D. Dillian, Robert R. Mierendorf, and Beth Blattenberger 2011, Archeological Resources Mitigation and Management Plan for Upper Skagit	Reference not needed; see response to Comment #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				River Valley Archaeological District. Prepared pursuant to Federal Energy Regulatory Commission License 553 for the Skagit River Hydroelectric Project.	
88.	Jon Riedel (NPS)	04/06/2020	Attachment A Draft Reservoir Erosion Field Form	Should use original NPS site numbers for consistency and comparison.	See response to Comment #64.

GE-02 EROSION AND GEOLOGIC HAZARDS AT PROJECT FACILITIES AND TRANSMISSION LINE RIGHT-OF-WAY PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

CFR .....Code of Federal Regulations
City Light .....Seattle City Light
CMZ .....Channel Migration Zone
DNR .....Washington Department of Natural Resources
DOGAMI .....Oregon Department of Geology and Mineral Industries
Ecology .....Washington State Department of Ecology
ELC .....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
GIS .....Geographic Information System
LiDAR.....Light Detection and Ranging
ISR .....Initial Study Report
LP.....licensing participant
NPS .....National Park Service
O&M.....operations and maintenance
PAD.....Pre-Application Document
PME .....protection, mitigation, and enhancement
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RMAP .....Road Maintenance and Abandonment Plan
ROW .....right-of-way
RWG .....Resource Work Group
SSIT .....Sauk-Suiattle Indian Tribe
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USDA.....U.S. Department of Agriculture
USR.....Updated Study Report
WDFW.....Washington Department of Fish and Wildlife
WGS.....Washington Geologic Survey

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

There are a variety of erosion and drainage concerns associated with ongoing Project operations and maintenance (O&M) as well as naturally occurring geologic hazards; these can potentially affect Project facilities, aquatic habitat, terrestrial and riparian habitat, cultural and recreation resources, and water quality. This study will identify and evaluate the interaction of Project facilities and operations with erosion/drainage and geologic hazards. The data from this study will be available to evaluate potential effects on other resources. This study plan directly addresses issues identified in the following issue forms: (1) TE08, Road and Townsite Erosion; (2) TE14; Geologic Hazards; (3) TE15, Roads and Drainage; and (4) FA23, Transmission Line Stream Crossing Habitat.

On June 12, 2020, City Light released the Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-of-Way Draft Study Plan for LP review and comment. On June 23, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and is releasing this plan as the revised version of the draft study plan. The revised draft will be discussed at a TRREWG meeting. Written comments were received from NPS, Washington Department of Fish and Wildlife (WDFW), and the Upper Skagit Indian Tribe and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. The Sauk-Suiattle Indian Tribe (SSIT) submitted the following study request pertaining to aquatic habitat and riparian zone within the transmission line right-of-way (ROW): SSIT-03 Impacts of Transmission Line Right of Way (ROW) on Aquatic Habitat and Riparian Zone for the Skagit River Hydroelectric Project. This study plan addresses some of the elements identified in this study request, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of the Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way Study are two-fold: (1) to characterize where Project O&M activities are affecting erosion, mass wasting, and runoff that could affect terrestrial; aquatic; fisheries; riparian; rare, threatened, and endangered plants; or cultural resources; and (2) to determine where existing erosion, mass wasting, and channel migration/bank erosion have the potential to affect Project facilities. This study plan includes both elements to inform the FERC relicensing process and broader background information that will help inform long-term geologic hazard planning at Project facilities.

Specific objectives include:

- Identify, map, inventory, and characterize areas of erosion, runoff, mass wasting, and culvert conditions that are affected by Project facilities, roads, townsites, and transmission towers. (Goal 1).
- Identify where Project maintenance activities (e.g., road grading, ditch maintenance, vegetation management, streambank protection) along the transmission line ROW and Project roads have the potential to cause erosion or sedimentation or altered hydrologic connectivity to water bodies. (Goal 1).
- Identify the current instream and riparian habitat conditions immediately upstream and downstream of transmission line stream crossings where channel migration, bank erosion, or mass wasting are affected by Project operations. (Goal 1).
- Identify mass wasting (landslide, rockfall) and channel erosion hazards (e.g., channel migration, bank erosion) that could affect Project facilities, roads, or transmission towers. (Goal 2).
- Characterize Project road-stream crossing structures so that hydraulic capacity, erosion, and biological effects (e.g., fish passage) can be assessed. (Goals 1 and 2).

This information will be available to inform license application preparation to evaluate how Project operation and maintenance affects slope stability and erosion, and how water quality, aquatic, riparian, terrestrial, and cultural resources may be affected. The information will be used to inform the relicensing and long-term geologic hazard planning at the Project facilities.

2.2 Resource Management Goals

The study will provide information to help resource agencies, Indian tribes and First Nations with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. The Upper Skagit Indian Tribe included the following resource management goals related to this study plan: goals of the Upper Skagit Indian Tribe include to prevent degradation of aquatic habitat, prevent loss of aquatic, cultural, and fishery resources, and to address fish passage issues.

2.3 Background and Existing Information

2.3.1 Mass Wasting (Landslide and Rockfall)

Steep topography, narrow valleys, and heavy precipitation combine to produce mass wasting hazards within the North Cascades region of the Skagit River Project. In the Puget Lowland region, slopes over-steepened by valley glacier migration coupled with heavy precipitation contribute to mass wasting along southern portion of the alignment corridor. Valley walls produce snow avalanches, rock falls, debris avalanches, shallow-rapid landslides, deep-seated landslides, and debris torrents. Shallow-rapid landslides along steep slopes, slower soil slumps and creep, and large, deep-seated landslides have been mapped and compiled in some areas of the Project Boundary by the National Park Service and Washington Department of Natural Resources (DNR) (Riedel et al. 2012; Washington DNR 2019). Stability assessments have been prepared for some areas near Project facilities (see list of available reports in Section 2.3.4 of this study plan).

2.3.2 Erosion and Drainage at Project-related Roads and Townsites

Erosion and drainage issues at Project-related roads along twelve transmission line access roads between Ross Dam and Bacon Creek and paved roads in Diablo and Newhalem were inventoried for the current license period (Riedel 1990). No erosion issues were identified at that time along paved roads. Several sites were identified where culverts were subject to plugging, small intermittent streams/seeps were causing erosion concerns, or small mass movements were related to roads.

Project-related roads are used to access Project facilities such as dams, powerhouses, mitigation lands, and transmission line towers. While information on road and culvert conditions exists in databases and files of various entities (see Section 2.3.4 of this study plan), this study will provide a comprehensive compilation of data available on the condition of Project-related roads, erosion and runoff issues, or culvert conditions.

2.3.3 Transmission Line Right-Of-Way and Tower Maintenance

City Light performs routine road maintenance and vegetation clearing along the transmission line ROW to ensure access for emergency and scheduled repairs and to meet North American Electric Reliability Corporation reliability standards for clearances of energized conductors and has records of types of procedures and frequency. In addition to routine maintenance, transmission towers have been moved and/or redesigned at five locations to protect against erosion caused by river or stream migration. These include the Boulder River, French Creek, Skagit River near Corkindale Creek (to protect from bank erosion), Diobsud Creek, and the Sauk River. Reports pertaining to the Boulder River and French Creek work are available (see Section 2.3.4 of this study plan). Relocating transmission line towers and installing bank protection measures can result in effects to natural or cultural resources. A Geographic Information System (GIS)-based road inventory recently developed by City Light will be used as basis for assessing O&M activity locations in this study.

2.3.4 Existing Reports, Data, and Resources

City Light will review the following data sources to inform this study:

- Washington Department of Natural Resources. 2019. Landslide Compilation Geodatabase. https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides
- Riedel, J., S. Brady, S. Dorsch, N. Bowerman, and J. Wenger. 2012. Geomorphology of the Upper Skagit watershed: Landform mapping at North Cascades National Park Service Complex, Washington. Natural Resource Technical Report NPS/NCCN/NRTR—2012/568. National Park Service, Fort Collins, Colorado.
- Haugerud, R. and R. Tabor. 2009. Geologic map of the North Cascade Range, Washington. U.S. Geological Survey
- Dragovich et al. 2002. Geologic Map of Washington – Northwest Quadrant. Washington State Department of Natural Resources.
- Dragovich, J. D., L.A. Gilbertson, W.S. Lingley, Jr., M. Polenz, and J. Glenn. 2002. Geologic map of the Darrington 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2002-7, 1 sheet, scale 1:24,000.
- Dragovich, J. D., L.A. Gilbertson, W.S. Lingley, Jr., M. Polenz, and J. Glenn. 2002. Geologic map of the Fortson 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2002-6, 1 sheet, scale 1:24,000.
- Dragovich, J.D., B.W. Stanton, W.S. Lingley, Jr., G.A. Griesel, and M. Polenz. 2003. Geologic map of the Mount Higgins 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2003-12, 1 sheet, scale 1:24,000.
- Dragovich, J.D., B.W. Stanton, W.S. Lingley, Jr., G.A. Griesel, M. Polenz. 2003. Geologic map of the Oso 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2003-11, 1 sheet, scale 1:24,000.
- Minard, J.P. 1985. Geologic map of the Arlington East quadrangle, Snohomish County, Washington: U.S. Geological Survey Miscellaneous Field Studies Map MF-1739, 1 sheet, scale 1:24,000.
- Minard, J.P. 1985. Geologic map of the Lake Stevens quadrangle, Snohomish County, Washington: U.S. Geological Survey Miscellaneous Field Studies Map MF-1742, 1 sheet, scale 1:24,000.
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- Sauk River Migration Analysis (Skagit River System Cooperative)
- Boulder River Channel Migration Analysis (Hererra and Stillwater 2016)
- French Creek Channel Migration Analysis (Stillwater 2014)

- Road Maintenance and Abandonment Plans (RMAP) for mitigation lands and transmission line right-of-way lands under Washington DNR Forest Practice Regulations
- Skagit System Cooperative fish passage database at road culverts (GIS database - in preparation)
- WDFW database on fish passage at road culverts (https://geodataservices.wdfw.wa.gov/hp/fishpassage/index.html)
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2.4 Project Operations and Effects on Resources

Operation and maintenance at Project facilities and Project-related roads could result in potential erosion and drainage issues, particularly if appropriate Best Management Practices are not followed. Erosion, bank armoring, and drainage could potentially affect water quality, aquatic/fish

resources, cultural resources, and terrestrial resources. Additionally, geologic hazards such as mass wasting and channel migration can affect Project facilities and/or be affected by Project operations. Maintenance or measures to protect Project facilities from mass wasting or channel migration can affect fisheries, riparian, cultural, or terrestrial resources.

2.5 Study Area

The Erosion and Geologic Hazards study area will cover land within the Project Boundary from Ross Dam to the Bothell Substation (Figure 2.5-1) including:

- Project dams and powerhouses;
- Project townsites;
- Project-related roads;
- Transmission line ROW; and
- Fish and wildlife mitigation lands.

Note that erosion and mass wasting areas along Project reservoir shorelines (Ross, Diablo, and Gorge lakes) are not included within this study area; they are covered in the Reservoir Shoreline Erosion Study Plan. However, areas around Project-related facilities near Diablo Dam are included in the study area (e.g., Skagit Tour Dock, Ferry Landing, Boat House, City Light Boat Launch, and City Light Dry Dock).

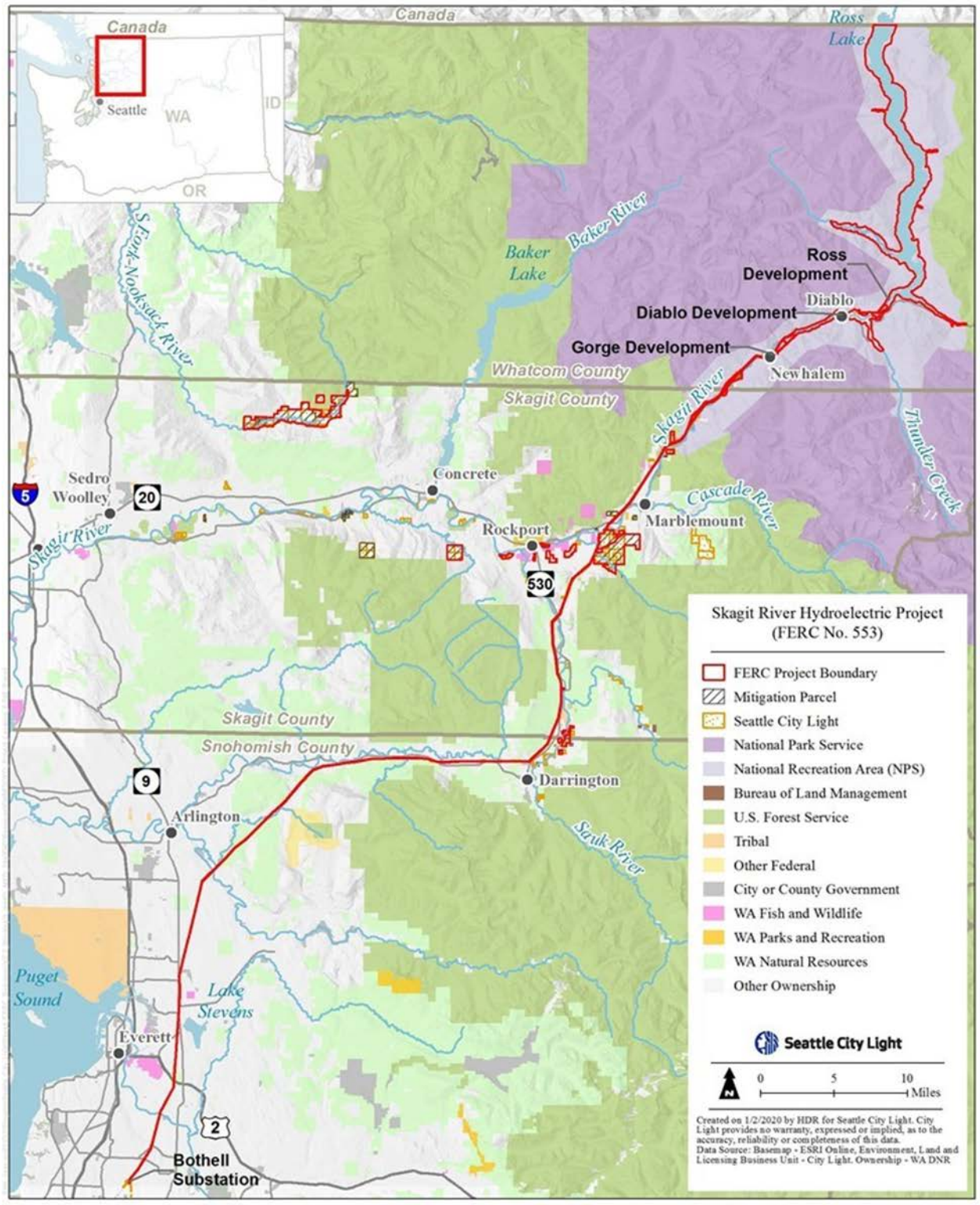

Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

2.6.1 Mass Wasting Hazards

The mass wasting portion of the study will provide: (1) a digital inventory (Inventory) of existing mass wasting features (e.g., landslide and rockfall) within the study area that could affect and/or be affected by City Light facilities and operations; and (2) an initial assessment of susceptibility of slopes to the dominant types of mass wasting within the Project Boundary based primarily on existing mass wasting features, slope characteristics, and local geology. The Inventory focuses on known occurrences of mass wasting, types of mass wasting processes, approximate magnitude of historical landslide/rockfall volumes, and other attributes useful for analyzing areas susceptible to mass wasting. An understanding of the susceptibility of the terrain to specific types of landslides, and their historic magnitudes, is the basis for mapping hazard zones. Hazard zonation will also help provide some regional context for previous site-specific studies.

2.6.1.1 Compile and Review Existing Information

The analysis of mass wasting hazards will include the compilation of reports, published maps, existing geospatial data, and similar studies that are relevant to the identification of unstable slopes in the study area (see existing resources list in Section 2.3.4 of this study plan). The existing information will be useful for establishing data points for regional hazard study and susceptibility analyses. Where appropriate, mass wasting features identified and mapped in the existing studies will be integrated into the Inventory being developed for this study.

Subsurface geotechnical and geologic explorations are useful in mass wasting hazard assessment, however, information on existing explorations will not be reviewed as part of this study. Subsurface information is particularly useful for the study of *individual*, deep-seated landslides, but implementing subsurface information databases for *regional* hazard study is not necessary for this analysis.

2.6.1.2 Identification of Existing Hazards

Mass wasting features in the study area will be mapped and inventoried based on a visual interpretation of LiDAR-derived topographic imagery and aerial photos, and review of existing information. The results of the Inventory will be compiled into a GIS database. The GIS database will be the primary input data for analyzing susceptibility of the terrain to the main types of mass wasting processes.

There are existing, generally accepted protocols from state agencies in Washington and Oregon for compiling mass wasting feature inventories, extending the inventories for susceptibility analysis, and developing hazard maps based on integrating the Inventory with other information in GIS. The Washington Geologic Survey (WGS) of Washington DNR developed a protocol for identification, characterization, mapping, and inventorying recent and historic landslides (Slaughter et al. 2017) by mapping the following geomorphic features:

- Landslide deposits;
- Landslide headscarps, flank scarps, and internal scarps;
- Fan deposits;

- Rockfall deposits and scarps; and
- Recent landslides (typically under 50 years since occurrence).

In addition to mapping the features listed above, information on material, movement type, confidence in identification, and a general relative age of movement (e.g., pre-historic, historic, active) will be interpreted using LiDAR and aerial imagery and added to the Inventory. Several LiDAR datasets exist for the study area (e.g., U.S. Geological Survey 2016/17; City Light 2018) and will be integrated for complete coverage. Geometric parameters for slope angle, headscarp height (used to differentiate shallow and deep-seated landslides), average internal scarp distance, and landslide movement direction will also be measured from a LiDAR elevation model and added to the Inventory; these measurements will be used to calculate landslide failure depth and landslide deposit volume. Observations that do not fit within the existing protocol, such as specific details pertinent to landslide age, will be added as notes in the Inventory. Mass wasting hazards identified in previous studies (Riedel et al. 2012; Whatcom County 2006; Snohomish County 2015; Shannon & Wilson 1999; Golder Associates 2014; Washington DNR 2019; Skagit County 2016; and R2 Resource Consultants, Inc. 2015) will be used to guide mapping and may be integrated into the Inventory as appropriate. Applying the Slaughter et al. (2017) mapping protocol to previously identified mass wasting features will allow those previous efforts to be updated and included in a consistent Inventory.

Landslide Susceptibility Analysis

The Inventory will be used to interpret the types and magnitudes of hazards in the landscape between existing landslides. Landslide susceptibility describes the propensity, or likelihood, of slopes to fail. Susceptibility analysis is effective for mapping mass wasting hazards in terrain that may affect the study area but does not exhibit mappable mass wasting features. The mass wasting inventory mapping protocol (Slaughter et al. 2017) is based on a similar protocol (Burns and Madin 2009) developed by the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI also developed methods for susceptibility analysis (Burns et al. 2012; Burns and Mickelson 2016) that will be used in this study and use the LiDAR-based Inventory as part of the input data.

Landslide susceptibility will be described and quantified using three approaches that vary in detail depending on the type of mass wasting process being analyzed:

- Spatial analysis of landslide/rockfall density from the Inventory;
- Spatial analysis of the slope failure factor of safety; and
- Spatially distributed weighted sums of mapped variables such as geologic units, susceptible geologic contacts, landforms, soil cohesion, slope angle and aspect, and geologic structure.

Shallow and deep-seated landslide susceptibility and rockfall susceptibility will be analyzed using these three approaches. Debris flow susceptibility analysis does not follow these methods and typically focuses on identifying landforms related to debris flow-type processes as described below.

Shallow Landslides

The shallow landslide susceptibility analysis approach (Burns et al. 2012) will integrate the shallow landslides in the Inventory, a simplified factor-of-safety analysis using a LiDAR Digital Elevation Model and geotechnical parameters developed from published information. The work of Strauch et al. (2018, 2019) on hydroclimatological and probabilistic modeling of shallow landslide susceptibility overlaps with and is nearby the study area and is a useful reference.

Deep-Seated Landslides

Deep-seated landslide susceptibility analysis will require more information on geologic conditions such as soil and rock characteristics and geologic structure. Burns and Mickelson (2016) describe a GIS-based weighted sum approach to analyze for deep-seated landslide susceptibility using inputs including:

- The mass wasting feature Inventory;
- Published geologic maps (geologic units, generalized rock and soil characteristics, and orientation measurements of geologic structures);
- Previous rockfall studies where discontinuity mapping was performed; and
- LiDAR-derived slope angle and slope azimuth maps.

Some of the published methods will be adapted for this study; for example, the WGS and Section 16 of the Washington Forest Practices Board Manual (Washington DNR 2016) recommend that deep-seated landslides are defined as those that failed at depths greater than 10 feet, not 15 feet, as indicated by Burns and Mickelson (2016).

Rockfall

The methods for analyzing deep-seated failures will be adapted for analyzing rockfall susceptibility. Rockfall susceptibility analysis will be limited to areas identified from LiDAR and aerial photo observations as being exposed rock faces or relatively unweathered rock with a veneer soil mantle. Areas where known rockfall have occurred will be identified. The application of engineering geologic data in this analysis will emphasize the findings of previous rockfall studies, discontinuity mapping, and kinematic failure analyses.

Debris Flow

Debris flow hazards occur when shallow landslides propagate into steep channelized streams called “chutes.” Debris fans commonly form at the base of chutes and are indicative of episodic debris flow activity. Geomorphologic mapping and landform classifications were performed for parts of the study area (Riedel et al. 2012) and may be useful for identifying debris fans. These geomorphic features that are produced by debris flows will be included in the Inventory for this Project. However, fans can originate from different depositional processes that impart different levels of potential hazard. There are several empirical calculations used to differentiate between alluvial- and debris-flow-dominated fans. WGS (Slaughter et al. 2017) recommends combining the Melton Ratio (Melton 1965) and the Relative Relief Ratio (Wilford et al. 2004) to classify fans in order of increasing hazard: alluvial flow, debris flood, and debris flows. These ratios describe numerical relationships between watershed parameters: the former is the watershed area divided

by the square root of the watershed area, and the latter refines the former by factoring in watershed length.

Quality Control and Compilation of Results

Based on experience of mapping landslides in the region, the landslide features tracked in the inventory are anticipated to contain more deep landslides than shallow. The more severe shallow landslide hazards and risks are more likely related to debris flows. The results of the susceptibility analyses will be classified into three relative hazard classes: high, moderate, and low.

Since multiple data sources will be integrated into the susceptibility analysis, varying levels of data quality could affect the analysis results. As recent, high-quality LiDAR is available for all of the study area and anticipated mapping areas, these data are not considered a significant limiting factor in the analysis.

Field Verification

Field verification may be used at select locations near Project features if additional detail is needed to verify mass wasting hazards.

2.6.1.3 Overlay of Existing Hazards and Project Facilities, Roads and Transmission Towers

The proximity of hazard zones and existing landslides to Project facilities will be used to help understand risks to and from Project features associated with mass wasting processes. While a formal risk assessment is not part of this study, by overlaying the Project facilities on the hazard zonation map, a basic picture of the proximity and severity of hazards to facilities can be drawn and some of the related elements of risk inferred.

Study Results and Deliverables

The study results will be summarized in a report and GIS products and maps, including:

- GIS database (Inventory) of mass wasting features containing polygon and polyline features and associated attribute tables;
- GIS layers containing results of susceptibility analysis in the form of a hazard zonation map: each hazard class will have a unique description related to the type of mass wasting process, and each hazard zone will have a unique symbology in the hazard map;
- A suite of maps that cover the Project ROW and include mass wasting features from the Inventory, previously mapped features from existing studies, and the City Light Project facilities;
- Guidance on the use of the GIS products and maps; and
- Summary of results that indicate areas of special concern, i.e., areas of high hazards or potentially unstable mass wasting features near Project infrastructure.

2.6.2 Project-related Roads and Townsite Erosion and Runoff

The analysis of erosion and runoff from Project-related roads and townsites will include compilation of existing data and GIS layers, a pre-field analysis of roads and stream connectivity, a field inventory of road, culvert, and townsite erosion and runoff conditions, and a post-field summary and analysis.

2.6.2.1 Collect Existing Information

The following existing information and data will be collected to use as part of the analysis:

- Road, townsite, and stream sites identified in 1990 erosion inventory will be re-assessed (Riedel 1990);
- Recent LiDAR data and aerial photographs;
- Geology and soils GIS layers;
- Stream and wetland GIS layers;
- Project-related roads GIS layer (including any available attributes such as width, surfacing, culvert locations);
- RMAP information, where available;
- Townsite road and drainage layer; snow dump locations; and
- Existing culvert fish passage information (https://geodataservices.wdfw.wa.gov/hp/fishpassage/index.html; Skagit System Cooperative fish passage database at road culverts; other available data such as from NPS).

2.6.2.2 Project-related Roads

The analysis of erosion and sedimentation along Project-related roads[1] will consider:

- Erosion (surface erosion, gullying, and mass wasting);
- Hydrologic connectivity; and
- Culvert and drainage structure characteristics and condition, and data to assess fish passage suitability at fish-bearing stream crossings where passage has not been assessed by other entities or passage information is outdated.

A pre-field GIS assessment of potential erosion, fish passage, and hydrologic connectivity will be made based on Project-related roads and stream/wetland crossings. For wildlife mitigation lands, information on road and culvert status will be summarized from existing RMAPs supplemented by field assessments. Locations where roads cross fish-bearing streams (Washington DNR stream designation, SalmonScape) will be identified and cross-referenced with existing culvert fish passage information to determine if additional field data collection is necessary to assess passage.

[1] Project-related roads are currently being inventoried by City Light and will include private roads that are owned and/or maintained by City Light to access Project facilities. Roads maintained by Washington State Department of Transportation are not considered Project-related roads.

A field inventory of Project road and culvert conditions will be made using methods similar to those developed for the Cedar River watershed (Seattle Public Utilities 2005) and the Boundary Hydroelectric Project relicensing as well as WDFW culvert assessment screening data (WDFW 2019) to provide information to initially screen culverts at fish-bearing stream crossings where barrier assessments have not been made by other entities. Information will be collected on:

- Hydrologic connectivity of each road segment/drainage structure (road drainage to streams or wetlands);
- Road condition (tread, cutslope, surfacing, width, gradient, configuration, length hydrologically connected, any erosion or mass wasting issues, fish passage issues, oversteepened sidecast or fillslopes, etc.);
- Culvert condition (diameter, length, plugged, crushed, shotgun, stream crossing or cross-drain culvert, etc.). Fish passage attributes will be collected at Washington DNR designated fish-bearing streams crossings where current passage data is not available to complete a Level A fish passage assessment based on Washington DNR 2019. Each culvert will be assessed in the field to determine if it is a stream crossing, swale, or cross-drain culvert, but fish presence/absence will not be assessed; and
- Bridge condition (length, width); and condition information on any fords or other non-culvert stream crossings.

During fieldwork, City Light will note presence of springs and seeps along the project roads based on evidence of surface water and vegetation that thrive in wet soil conditions (sedges, horsetail, etc.).

Field data will be compiled and analyzed. Surface erosion and hydrologic connectivity will be assessed using the Washington Road Surface Erosion Model (Dubé et al. 2004; https://www.dnr.wa.gov/washington-road-surface-erosion-model). Tables will be developed listing road segments with major erosion issues, gullying or mass wasting issues, or culvert issues. These segments will be flagged to help identify priorities for assessing potential effects to terrestrial, aquatic, and cultural resources as part of relicensing.

Work products will include the following: map and assessment of hydrologic connectivity, erosion issues, and culvert condition/fish passage along Project-related roads; estimate of average annual sediment delivery to streams; table summarizing road/culvert locations with erosion issues or fish passage concerns; and report sections summarizing assessment; GIS database with roads and culvert conditions.

2.6.2.3 Project Townsites

The analysis of Project townsites will consider:

- Runoff and stormwater outfalls
- Erosion (surface erosion, gullying)
- Bank armoring along the Skagit River in Project townsites
- Hollywood levee erosion (along Stetattle Creek)

A pre-field assessment of Project townsites will be made based on mapped townsite facilities (roads, structures, drainage) along with proximity to rivers and streams. The townsites will be visited in the field to visually assess areas of erosion and runoff.

Work products will include the following: map and assessment of runoff or erosion issues at Project townsites; and table listing any issues. The work products will be available during license and protection, mitigation, and enhancement (PME) measure development to assess effects on other resources.

2.6.3 Channel Migration and Stream Crossings

Existing data, reports, and GIS layers pertaining to channel migration at locations where Project roads or the transmission line crosses streams within the study area will be compiled. Existing LiDAR data and aerial photographs of these stream crossings will also be collected.

2.6.3.1 Channel Migration Analysis

Channel migration can occur along streams and rivers located within a wide valley bottom or streams with high erosive power or high bedload (e.g., alluvial fans). Existing topography and the Washington State Department of Ecology (Ecology) Channel Migration Zone (CMZ) Screening Tools (Legg and Olson 2015) were used to determine an initial list of streams and rivers that cross the Project Boundary where channel migration may occur that could affect Project facilities, Project-related roads or transmission towers. These include but are not limited to:

- Ladder Creek
- Goodell Creek
- Thornton Creek
- Damnation Creek
- Bacon Creek
- Diobsud Creek
- Babcock Creek
- Skagit River
- Illabot Creek
- Sauk River
- Stillaguamish River
- Squire Creek
- French Creek (Stillwater 2014)
- Boulder River (Hererra and Stillwater 2016)
- Montague Creek
- Jim Creek
- Siberia Creek

- Snohomish River

This list of streams will be further refined during the study to determine if channel migration may affect Project-related roads, transmission towers, and facilities based on topography and proximity of facilities to the potential CMZ (e.g., if the transmission line crosses a stream but there are no towers within the potential CMZ, channel migration would not affect the facility). Any existing CMZs for these streams will be used as part of this analysis. If existing CMZs for streams on the refined list (streams where facilities may be affected by channel migration) are not available, a CMZ will be delineated within the study area and 500 feet upstream and downstream of the study area boundary using methods in Rapp and Abbe (2003) and/or Washington DNR (2004).

Work products will include the following: CMZ GIS-based map and report sections analyzing potential channel migration effects on Project facilities, roads, and transmission towers.

2.6.3.2 Compilation of Transmission Line Maintenance Procedures near Stream Crossings

Routine maintenance such as vegetation clearing and road maintenance under transmission line ROW has the potential to affect riparian vegetation and streambank stability. A list of maintenance procedures used near each transmission line stream crossing will be compiled to help identify the potential for resource affects. Locations where bank armoring has been installed at transmission line crossings/tower locations will also be identified.

Work products include the following: list of maintenance procedures used near transmission line stream crossings; and a GIS-based map showing affected stream crossing locations.

2.6.3.3 Stream/Riparian/Bank Condition at CMZ and Transmission Line Maintenance Locations

Information on aquatic habitat, bank conditions, and riparian habitat will be collected at streams where:

- The assessment of channel migration (Section 2.6.3.1 of this study plan) indicates that channel migration could affect Project-related roads, facilities, or transmission towers; or
- At stream crossings where maintenance procedures affect aquatic or riparian resources.

Some of these data may be available from the Vegetation Mapping, Wetland Assessment, or Geomorphology between Gorge Dam and Sauk River studies. Collected data can be used during license application and PME development to assist with the analysis of potential risks to and conflicts with these resources and develop appropriate PMEs and management plans.

The following habitat conditions will be collected during a field inventory at the selected locations where existing information is not available. Field data will be collected at the transmission line crossing and for a distance of 10 bankfull channel widths upstream and downstream from the crossing to provide context of local habitat conditions.

- Aquatic habitat (habitat type, dominant/subdominant substrate, large woody debris, stream bank material, bank erosion; bankfull width; any hydromodifications); and

- Riparian habitat (vegetation type, average tree size class, average tree density, understory species, invasive plants).

Work products will include the following: report sections summarizing aquatic habitat and riparian conditions at selected stream crossing locations; and GIS-based map of locations.

2.7 Consistency with Generally Accepted Scientific Practice

The mass wasting and rockfall hazard analysis described above will be performed by or under supervision of a Washington State Licensed Engineering Geologist who specializes in mass wasting assessments. The methods described are similar to those used by geologists within Washington State to identify mass wasting and rockfall hazards. Road erosion and runoff data collection and analyses will use Washington DNR methods (Dubé et al. 2004). Channel migration analysis will be done using published methods developed by Ecology and DNR (Rapp and Abbe 2003; Washington DNR 2004) by or under supervision of a Washington State Licensed Engineering Geologist who specializes in geomorphology.

2.8 Schedule

This study will include pre-field analysis, one year of field work, post field analysis, and a draft and final report.

- Pre-field Analysis – January to June 2021
- Field Work – April to November 2021
- Post-field Analysis – October to December 2021
- Draft Report (Initial Study Report [ISR]) – March 2022
- Final Report (Updated Study Report [USR]) – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $405,000.

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EROSION AND GEOLOGIC HAZARDS AT PROJECT FACILITIES AND TRANSMISSION LINE RIGHT-OF-WAY PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Jon Riedel (NPS)	07/02/2020	Title Page	Good plan is just needs a little clarification.	Thank you for your comment.
2.	Brock Applegate (WDFW)	07/07/2020	Section 2.1 Study Goals and Objectives	2nd paragraph, 3rd bullet – Add: and possible fish passage issues *immediately* in, *upstream*, (italicized language is existing)	No edits made. City Light is not clear how a transmission line crossing could impact fish passage. City Light would appreciate any information on fish passage impacts due to transmission line crossings.
3.	Jon Riedel (NPS)	07/02/2020	Section 2.3 Background and Existing Information	Are there no hazards from over-steepened ice sheet deposits in Puget Lowland?	Text revised to include the following: "In the Puget Lowland region, slopes over-steepened by valley glacier migration coupled with heavy precipitation contribute to mass wasting along southern portion of the alignment corridor."
4.	Brock Applegate (WDFW)	07/07/2020	Section 2.3 Background and Existing Information	Did these streams contain fish?	No formal assessment was completed when the original erosion control plan was prepared. Based on review of SalmonScape, it appears that the stream segments noted in the plan are not known to support salmonids. Presence of resident fish is unknown.
5.	Brock Applegate (WDFW)	07/07/2020	Section 2.3 Background and Existing Information	Please add if the stream contains fish.	This study will not determine fish presence (Washington DNR stream typing will be used for fish/non fish determinations) but will provide information useful for assessing effects of Project operation and maintenance on habitat conditions for fish and identifying PMEs. During PME implementation, some sites might warrant follow-up fish presence surveys.
6.	Jon Riedel (NPS)	07/02/2020	Section 2.3 Background and Existing Information	Will the study examine the impact of certain road maintenance practices? Particularly concerned about side casting and building of fill turnarounds on steep slopes.	Yes, City Light will be examining road management practices. Project-related roads and potential effects will be included; as stated in Section 2.3.2 "…this study will provide a comprehensive compilation of data available on the condition of Project-related roads, erosion and

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					runoff issues, or culvert conditions." Text has been added to Section 2.6.2.2 to clarify.
7.	Brock Applegate (WDFW)	07/07/2020	Section 2.3 Background and Existing Information	4th paragraph – Add: , including fish passage	No edits made. City Light includes fish passage as part of the natural resources category.
8.	Jon Riedel (NPS)	07/02/2020	Section 2.3 Background and Existing Information	Joe also mapped Darrington Quad, but not sure if line crosses it.	Thank you for your comment. City Light has revised to add all relevant geologic maps (10 at 24K and 100K scale for full coverage, retrieved via WGS portal) to Section 2.3.4 and to References section.
9.	Jon Riedel (NPS)	07/02/2020	Section 2.4 Project Operations and Effects on Resources	Mention maintenance of rip-rap along riverbanks in towns?	Agree, edits made in Sections 2.4 and 2.6.2.3.
10.	Brock Applegate (WDFW)	07/07/2020	Section 2.4 Project Operations and Effects on Resources	I agree with Jon. Rip-rap reduces and degrades aquatic habitat and armors the bank.	See response to Comment #9.
11.	Brock Applegate (WDFW)	07/07/2020	Section 2.4 Project Operations and Effects on Resources	1st paragraph – Add: bank armoring,	Agree, edit accepted.
12.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Wouldn't you use that information if you found a deep-seated landside that threatened a project or other facility?	Text revised to the following (italics indicate addition): "*Where appropriate, mass wasting features identified and mapped in the existing studies* will be integrated into the Inventory being developed for this study."
13.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Clarify what you mean by relative? Will you attempt to quantify age of individual landslides when possible using radiocarbon,	The relative age refers to general age of movement (e.g., pre-historic, historic, active), as can be estimated from geomorphic features on LiDAR

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				air photos or volcanic ash?	imagery, freshness of those features and deformation of human-made features such as roads, walls, etc., observed in air photos. Text revised to the following (italics indicate addition): "In addition to mapping the features listed above, information on material, movement type, confidence in identification, and *a general* relative age of movement *(e.g., pre-historic, historic, active)* will be interpreted using LiDAR *and aerial imagery* and added to the Inventory.
14.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Can you give examples of each type? (e.g. debris flows for shallow, and debris avalanches and slumps for deep seated.	Debris flows are addressed subsequently in Section 2.6.
15.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Do you mean debris cones? We distinguish between debris cones and fans and alluvial fans based on several morphometric characteristics, but the most important are basin size, stream gradient, and the slope of the debris accumulation: debris cone >10 degrees, debris fan, 5-10 and alluvial fan <5.	City Light would appreciate more information on the method you reference as it sounds like it might be beneficial to consider adding to the approach. While the methodology and parameters are similar, our method does not account for the debris slope. City Light would like to consider possibly adding this method to the study as it may be useful and a good comparison to the Wilford and Melton methods.
16.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Can you assign probability?	Following the approach we propose, we cannot assign probability but rather a relative likelihood of occurrence. Assigning probability would require more sophisticated modeling and perhaps a site-specific risk assessment study. This is outside the scope for this study.
17.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Which is it?	Text revised to reflect that high-quality LiDAR is available for all of the study area
18.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Note previous comment on rip rap along river in towns.	See response to Comment #9; text revised to include rip rap in Section 2.6.2.3.
19.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Should systematically review conditions at 16 sites identified in current license in RLNRA.	Agree, these will be re-assessed; text revised to include this in Section 2.6.2.1.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
20.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Need to assess threat to SR20 and other roads from mass wasting in NRA. This is an ongoing issue.	Issues stemming from Project-related roads will be assessed, including if Project roads affect SR20. SR20 is a State-operated highway; issues originating from SR20 are not included in this study.
21.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	2nd paragraph; 2nd bullet - Add: and fish migration	The proposed addition is not necessary as the 3rd bullet discusses documenting conditions relating to fish passage. No edits made.
22.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	3rd paragraph - Delete: and Add: fish passage, and	Edit accepted. Pre-field analysis will include review of existing GIS data on fish distribution and culverts to identify which stream segments crossed by Project roads are known to be fish-bearing.
23.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	1st paragraph; 1st bullet - Add: fish passage issues,	Edit accepted.
24.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	These issues can lead to fish passage problems.	Comment noted.
25.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Specifically call out erosion problem along townsites on RB Skagit River	See response to Comment #9; text revised.
26.	Jon Riedel (NPS)	07/02/2020	Section 2.6 Methodology	Note Goodell restoration study looked at towers on RB of creek.	Thank you for the information, we will review that report.
27.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	1st paragraph - Add: fish passage,	See response to Comment #2. City Light would appreciate any information on fish passage impacts due to transmission line crossing.
28.	Brock Applegate (WDFW)	07/07/2020	Section 2.6 Methodology	3rd paragraph; 3rd bullet - Add: Any fish passage problems	See response to Comment #2. City Light would appreciate any information on fish passage impacts due to transmission line crossing.
29.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	New objective: assess impact of bank protection, channel and floodplain fill, and riparian vegetation removal on fluvial geomorphic processes that create and sustain fish habitat. Assess impact to quantity and quality of fish habitat.	Information on bank protection and riparian vegetation removal on fluvial geomorphic processes will be collected in specific locations (see second and third objectives). Assessing impacts is outside the scope of this study plan, but will be included in the DLA.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Channel and floodplain fill cannot be measured due to lack of pre- and post-fill project data.
30.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	The previous paragraph mentions the impacts on fisheries aquatic, and cultural resources, but those are not present in specific objectives. This inconsistency needs to be addressed by including those impacts in specific objectives. I included one such example.	No edits made. The resources are listed in the above goals, which apply to the objectives. The specific objectives relate to the information that will be collected as part of this study. That information will be used in the DLA to assess cumulative effects to resources. Assessment will consist of an overlay of erosion information with any sensitive resource locations in the DLA (cultural, aquatic, fishery, etc.).
31.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	Maintenance activities include road repair needed due to improperly placed fill, altered drainage patterns, and flood damage.	Thank you for your comment. City Light will include all Project maintenance activities that have potential to cause erosion or sedimentation.
32.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	2nd bullet - Add: "that may impact aquatic, fishery, and cultural resources"	See response to Comment #30.
33.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	Assess potential to alter drainage patterns and delivery of surface runoff to streams. Assess potential to alter risk of road damage or failure.	An assessment of the potential for Project-related roads to deliver runoff/sediment and road-related erosion issues will be included in the analysis, and is included in the methods. Text added: "or altered hydrologic connectivity to water bodies"
34.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.1 Study Goals and Objectives	All crossings in fish-bearing waters assessed for passage for all species at all life stages. Quantify fish habitat upstream of all crossings.	Quantifying fish habitat upstream of all crossings is beyond the scope of this study. Level A fish passage at culverts in fish-bearing waters (per Washington DNR stream typing) will be assessed using WDFW 2019 (Washington Department of Fish and Wildlife. 2019. Fish Passage Inventory, Assessment, and Prioritization Manual. Olympia, Washington) at locations where existing culvert assessments are inadequate.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
35.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.2 Resource Management Goals	Prevent degradation of aquatic habitat, prevent loss of aquatic, cultural, and fishery resources. Are examples. Fish passage is another goal that can be addressed.	Thank you for your comment. Text revised to include stated goals.
36.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	*In response to Comment #4* Agree with Brock. Even intermittent streams can be important for fish temporary usage, for example- they can contribute to Bull Trout Foraging, Migrating, and Overwintering (FMO) habitat. Therefore, they should not be discounted.	City Light is not assessing fish usage. City Light will only assess fish passage at streams that have been typed already (per Washington DNR stream typing). Sediment and erosion will be addressed at all crossings. Also see response to Comment #4.
37.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	Field assessment of project culverts, and other crossing types, needs to be conducted. Passage conditions change over time.	We will assess existing data to determine if additional data needs to be collected to appropriately update condition information.
38.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	*In response to Comment #5* Or if fish use the stream even for brief portions of the season/year (see my previous comment).	See response to Comment #5.
39.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	Or protected with bank hardening.	Thank you for your comment. Emergency and/or temporary measures may be necessary to protect infrastructure.
40.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	And installing bank protection measures	Text revised.
41.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.3 Background and Existing Information	Field assessment of project culverts, and other crossing types, needs to be conducted. Data was originally collected over 20 years ago and passage conditions often change over this time period. The purpose of the database cited here is to update past crossing assessments.	Thanks for clarification. We will assess existing data to determine if additional data needs to be collected.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
42.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.4 Project Operations and Effects on Resources	This evaluation is lacking on how Project operational effects on cultural resources, fishery resources, and water quality will be evaluated. More information on evaluating these components needs to be added for this plan to be in a complete state.	Assessment of effects on resources will occur in the DLA.
43.	Curtis Clement (Upper Skagit Indian Tribe)	07/13/2020	Section 2.4 Project Operations and Effects on Resources	Placement of transmission towers and roads in alluvial fans impedes channel migration and other fluvial processes that are beneficial to fish.	Thanks, comment noted. We will evaluate risk to Project-related infrastructure as part of assessment and information will help inform development of a management plan.
44.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.4 Project Operations and Effects on Resources	What components of water quality will be addressed? So far all I see is sediment. I agree erosion and bank armoring can impact water quality beyond sediment- Therefore, other components of water quality such as nutrient spiraling dynamics should be addressed.	Assessing potential water quality problems is beyond the scope of this study. Potential water quality concerns will be addressed as part of the DLA.
45.	Brian Lanouette (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Will the existing data be QA/QC'd? Will its accuracy or applicability be ground truthed with some on the ground observations?	Yes, see QC section below. Field work will be conducted if possibility of mass wasting impacting Project infrastructure if existing information is not available
46.	Curtis Clement (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Kind of an odd statement for this section. Maybe true but don't let this belief bias your results. Deep seated landslide create opportunities for shallow on the toe and head scarps, plus debris flows are not always apparent in LiDAR or in the field, unless a chute is developed but that isn't always the case.	Thank you for your comment.
47.	Curtis Clement (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Please specify how the need for field verification will be determined. Are there criteria or will it be some random subset. My advice is don't just go off of LiDAR, if slope failure can't be verified on aerial imagery, the feature needs verification.	As described in Sections 2.6.1.1 and 2.6.1.2, mass wasting sites will be identified from a combination of existing reports/information and analysis of LiDAR and aerial photography. If mass wasting features are identified that are associated with Project assets, they will be field checked.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
48.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	All crossings in fish-bearing waters should be field assessed for passage condition; recent surveys (e.g. within 10 years) may suffice, but conditions change over time necessitating updated passage assessments.	Please see response to Comments #4 and #5.
49.	Curtis Clement (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Please clarify what this means	Text revised to reflect that "tagged" = "identified".
50.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Include assessment of impacts to fluvial geomorphic process, creation and maintenance of fish habitats, this includes channel and floodplain habitat condition.	Please see response to Comment #29.
51.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	The Project affects channel migration, not the other way around as it's currently written. This may sound like semantics, but it's an important concept to understand USIT's perspective on Project-related impacts.	Comment noted. The flow/geomorphic effects of the Project on channel migration are included in other studies.
52.	Curtis Clement (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	On Goodell alluvial fan	Thank you for your comment.
53.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	And channel migration rate and relic channel locations.	Thank you for your comment.
54.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Where would these come from?	CMZs are sometimes developed for county shoreline management documents or individual projects along streams. NPS has developed a CMZ for the Skagit River.
55.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Hydromodifications (e.g. bank armoring) should be identified, field inventoried, if necessary, for existing and newly developed CMZ's. The impact of hydromodifications on CMZ extent should be assessed, as should the potential for removal or restoration during the term of the license.	Ecology's CMZ delineation methodology includes analysis of hydromodified features. Potential alterations to hydromodifications can be included in PMEs.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
56.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	1st paragraph - Add: "water quality,"	No edits made. Assessing potential water quality problems is beyond the scope of this study. Potential water quality concerns will be addressed as part of the DLA.
57.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	At minimum this should include all fish-bearing streams. Also, develop an approach to determine when maintenance activities along non-fish bearing streams will have the potential to affect downstream conditions in fish-bearing streams.	As stated in the methods, this assessment will take place at locations where maintenance procedures have the potential to affect streams. These may or may not be fish bearing. City Light will address potential impacts of maintenance activities in the DLA. A management plan will include updated treatments to minimize effects of maintenance activities.
58.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Cite the data collection methods that will be used.	Specific data collection methods will be determined based on stream size prior to initiating field work.
59.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	There should also be a comparison to reference reaches, to account for non-Project related impacts to stream habitat condition.	City Light suggests a control/impact type comparison requiring 'reference' reaches is not appropriate for the methodology proposed here.
60.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Measure hydromodifications, including bank armor, channel and floodplain fill. Measure bankfull width and floodplain width.	We can include bankfull and floodplain width, and length of hydromodification, but others cannot be done without additional information would need pre- and post-Project topography to do this. Edits made to reflect this.
61.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	Tree species, or at minimum differentiate between hardwood and conifer.	Thank you for your comment. We will review what information currently exists. We will review standardized existing protocols and how data will be used.
62.	Rick Hartson (Upper Skagit Indian Tribe)	07/13/2020	Section 2.6 Methodology	2nd bulleted list, 4th bullet - Add: "Any water quality problems"	Assessing water quality is beyond the scope of this study.

GE-03 SEDIMENT DEPOSITION IN RESERVOIRS AFFECTING RESOURCE AREAS OF CONCERN PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

City Light .....Seattle City Light
cu yds .....cubic yards
DEM .....digital elevation model
Ecology .....Washington State Department of Ecology
ELC .....Environmental Learning Center
FARWG .....Fish and Aquatics Resource Work Group
FERC.....Federal Energy Regulatory Commission
GPS .....Global Positioning System
ISR .....Initial Study Report
LP.....licensing participant
LiDAR.....Light Detection and Ranging
m .....meter
N/m^2 .....Newton/square meter
NAIP .....National Agriculture Imagery Program
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
sq mi.....square mile
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
USACE .....U.S. Army Corps of Engineers
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife
yr .....year

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing.

1.3 Study Plan Development

In 2019-2020, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential Project effects. City Light developed 24 study proposals, including this Sediment Deposition in Reservoirs Affecting Resource Areas of Concern Study Plan.

On March 13, 2020, City Light released the Sediment Deposition in Reservoirs Affecting Resource Areas of Concern Draft Study Plan for LP review and comment. On March 31, 2020, the draft study plan was discussed at a Fish and Aquatic Resource Work Group (FARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 28, 2020. The revised draft was discussed on May 5, 2020 and June 2, 2020 at FARWG meetings. Written comments were received from National Marine Fisheries Service (NMFS), U.S. Forest Service (USFS), Washington Department of Fish and Wildlife (WDFW), NPS, U.S. Fish and Wildlife Service (USFWS), and the Upper Skagit Indian Tribe and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. Three LPs submitted study requests related to potential backwater effects on tributaries to Project reservoirs: NPS-10 Impact of the Operation of Skagit Hydroelectric Project (#553) Backwater on Major Streams and its Influence on Habitat Quality, USFWS-09 Impact of the Operation of Skagit Hydroelectric Project (#553) Backwater on Major Streams and its Influence on Habitat Quality, and WDFW-11 Impact of the Operation of Skagit Hydroelectric Project (#553) Backwater on Six Major Streams Tributary to Ross Lake and its Influence on Habitat Quality. The LPs requested information on eight tributaries entering Project reservoirs: Big Beaver, Little Beaver, Skagit River, Lightning Creek, Devils Creek, and Ruby Creek that enter Ross Lake; Thunder Creek that enters Diablo Lake; and Stetattle Creek that enters Gorge Lake. The purpose of this study plan is to study sediment accumulations and backwater effects in three of the tributaries requested by the LPs (Skagit River where it enters Ross Lake, Thunder Creek on Diablo Lake, and Stetattle Creek on Gorge Lake), i.e., locations of documented effects on recreation or Project operations due to deposition within reservoir delta deposits. City Light does not believe it is necessary to collect information on the remaining five tributaries for the reasons provided in Section 6 of the PSP.

Ongoing sediment deposition in Project reservoirs is known to affect recreational resources (boat launches and docks), operational facilities (docks and landings), and/or power generation at two locations, and potentially may have similar effects at two additional locations. Deposition is an

ongoing process and will continue over the term of the new license. Information on these four locations is as follows:

- Ross Lake: Hozomeen inlet, formed by the Skagit River flowing into Ross Lake, has affected the Hozomeen Public Boat Launch ("Hozomeen Launch") and Winnebago Flats Dock and Launch ("Winnebago Flats Launch"). NPS performed an environmental assessment (NPS 1999) to improve the recreational facilities at Hozomeen Campground Lower Boat Launch Area ("Government Dock Launch Area" by NPS). Three alternatives were considered; the third alternative to extend "Government Dock" was determined to be not economically feasible due to long-term maintenance needed to properly identify, buoy, and dredge a channel that would access the launch. Though not explicitly stated, it is hypothesized that the depositional environment at the north end of Ross Lake influences access to both boat launches.
- Diablo Lake: Sediment from Sourdough Creek is potentially affecting the City Light Boat Launch, City Light Boat House, West Ferry Landing, and Environmental Learning Center Canoe and Kayak dock. Sediment from a small, unnamed tributary to the east of Sourdough Creek may also be affecting the City Light Dry Dock.
- Diablo Lake: Deposition in Thunder Arm is affecting the ability of boats to launch from Colonial Creek Boat Launch/Dock. City Light in the past has used the beach access area on the north side of the campground adjacent to the existing NPS boathouse for loading and unloading large equipment such as transformers. Access needs to be maintained for equipment that cannot be transported on the Diablo Dam road for future operation of Ross Dam and Powerhouse.
- Gorge Lake: Deposition where Stetattle Creek enters Gorge Lake is reducing power generation by raising the Diablo Powerhouse tailwater elevation and affecting the Gorge Lake Campground Boat Launch and Dock. The delta deposit that has formed at the outlet of Stetattle Creek is used for whitewater training and instruction and long-term effects upon this use should be evaluated.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Sediment Deposition Study is to evaluate the effects of deposition on four specific recreational resources and operations areas within Ross, Diablo, and Gorge lakes. The study will develop an understanding of the physical conditions (rate of deposition, grain size of deposits) under which deposition occurs at the four locations. Specific objectives are as follows:

- Describe and map the location and history of sediment deposition in the:
  - Hozomeen inlet in Ross Lake; i.e., the large arm of upper Ross Lake that has sediment contributed by the Skagit River;
  - Sourdough Creek inlet in Diablo Lake; i.e., the small arm of Diablo Lake into which Sourdough Creek flows;
  - Thunder Arm in Diablo Lake; i.e., the large arm within Diablo Lake into which Thunder Creek, Colonial Creek, and Rhode Creek flow; and
  - Stetattle Creek delta in Gorge Lake (i.e., the sediment deposited at the mouth of Stetattle Creek where it enters Gorge Lake) and the sediment deposited between Stetattle Creek and the State Highway 20 bridge crossing.
- Determine rate and grain size of sediment input, quantify total volume of sediment deposition in the four inlets and deltas, and estimate rate and patterns of deposition.
- Identify likely future zones and patterns of deposition with respect to recreational resources and operational impacts.

2.2 Resource Management Goals

Several agencies and Indian tribes have resource management goals related to sediment conditions in the Project reservoirs and/or the Skagit River. These include USFWS, NMFS, Washington State Department of Ecology (Ecology), NPS, WDFW, Upper Skagit Indian Tribe, Sauk-Suiattle Indian Tribe, and Swinomish Indian Tribal Community.

The study will provide information to help resource agencies, Indian tribes, and First Nations with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

Delta formation and deposition in specific areas of Project reservoirs affect access to/from certain recreational facilities (boat launches and docks), operational facilities (docks and landings), and/or power generation. Studies and potential methods to address concerns have been proposed during the current license period, but specific actions have not been undertaken. This study will build on information from previous studies to develop a better understanding of the impacts of inlet and delta deposition within the four identified areas of concern. Existing information that contributes to the understanding of sediment deposition rates and processes in the areas of concern includes:

- As-built documentation, historical topography and available bathymetry for Sourdough Creek inlet within Diablo Lake, Thunder Arm within Diablo Lake, and the Hozomeen inlet at the north end of Ross Lake.
- LiDAR – LiDAR and green LiDAR are available for areas within the Project Boundary.
- Aerial photographs – Current and historical aerial photos are available to determine changes to the spatial extent of the deposits over time.
- Improvement of Recreational Facilities, Hozomeen Campground Lower Boat Launch Area (NPS 1999).
- Diablo Powerhouse Tailwater Remediation: Stetattle Creek Delta Geomorphology Report – A study is currently being conducted (Watershed GeoDynamics, In Prep) to determine the pattern and rates of deposition of the Stetattle Creek delta. This study will evaluate sediment supply, particle size distribution, and lateral and vertical extent of the deposit. It will also provide suggestions for long-term resolution for both the boat launch ingress and egress and mitigating the effects on Diablo Powerhouse tailrace. The Stetattle Creek Delta results will be incorporated into this study, and methods will be used as a model for other areas of concern.
- Report on Existing Conditions of Reservoir and Streambank Erosion (Riedel 1990).
- Skagit Hydroelectric Project Erosion Control Plan (Riedel et al. 1991).
- Geomorphology of a Cordilleran ice sheet drainage network through breached divides in the North Cascades Mountains of Washington and British Columbia, Geomorphology (Riedel et al. 2007).
- Deposition of Mount Mazama Tephra in a Landslide-Dammed Lake on the Upper Skagit River, Washington, USA. In Volcaniclastic Sedimentation in Lacustrine Settings (Riedel et al. 2009).
- Geomorphology of the Upper Skagit watershed: Landform mapping at North Cascades National Park Service Complex, Washington (Riedel et al. 2012).
- NPS Erosion Control and Revegetation Completion Reports (2016, 2018).
- Regional estimates of watershed sediment input have been developed by the Army Corps of Engineers (USACE 2008). A comprehensive assessment and inventory of sediment sources and yield does not exist for the Skagit River basin (USACE 2008). Annual sediment budgets for ten Skagit River sub-basins were developed by Paulson (1997) but estimates of sediment yield were based on drainages tributary to the Skagit below Gorge Dam (drainages managed for timberland in the Baker River and middle Skagit River areas). An estimate of sediment accumulation of 85 cu yd/sq mi/yr based on comparisons of bathymetry in the reservoir in Gorge Lake was made by the U.S. Soil Conservation Service (1950) for the period 1930-1936. There are glaciated areas (areas covered by glacial ice) within the Thunder Arm drainage area; Nichols (2006) estimated the glaciated areas would produce 2,600 tons/sq mi/yr or around 1,900 cu yd/sq mi/yr. The estimated 0.8–3.8 million tons/yr sediment yield equates to 530–2,500 tons/sq mi/yr from the 1,500 sq mi of the Skagit basin that is not regulated by dams. This Skagit River range is consistent with the regional range of 830–2,500 tons/sq mi/yr of sediment from glacially-fed rivers compiled by R2 Resource Consultants (2004) for Puget Sound Energy. These values have not been adjusted for climate change; literature will be reviewed by City Light as to the effects of climate change on sediment supply.

2.4 Project Operations and Effects on Resources

Sediment supply (non-Project related) from tributaries results in deposition within Project reservoirs. The deposition affects access to/from recreational facilities (boat launches and docks), and operational facilities (docks and landings), access to Ross Dam and Reservoir for ongoing operations and maintenance, and/or power generation associated with the Project. The data obtained with the methods identified below will be used to analyze potential future deposition volumes and patterns to help develop methods to manage sediment deposition at the areas of resource concern through the term of the new license.

2.5 Study Area

This study includes portions of the Skagit River inlet (Ross Lake), Sourdough Creek inlet (Diablo Lake), Thunder Arm (Diablo Lake), and Stetattle Creek delta (Gorge Lake) (Figure 2.5-1). The study area includes inlets/delta at four locations in the Project Boundary:

- Hozomeen inlet at the head of Ross Lake – recreational resource: Hozomeen and Winnebago Flats boat launches;
- Sourdough inlet in Diablo Lake – City Light resources: City Light Boat Launch, City Light Boat House, City Light Dry Dock; recreational resources: West Ferry Landing, Environmental Learning Center Canoe and Kayak Dock;
- Thunder inlet in Diablo Lake – recreational resource: Colonial Creek Boat Launch/Dock; and
- Stetattle Creek delta in Gorge Lake – recreational resource: whitewater training and instruction, Gorge Lake Campground Boat Launch and Dock; operational resource: City Light Diablo Powerhouse Tailrace.

Figures 2.5-2 to 2.5-4 show the extent of the depositional area that will be investigated for three study locations; Figure 2.5-5 is included to show the Stetattle Creek site that is being investigated in an ongoing study (Watershed GeoDynamics, In Prep). Each figure includes the location of the resource(s) of concern. Figure 2.5-2 also includes an area south of the boat launches in case, upon field review, the area has substantially more deposition that could affect the boat launch depositional environment than is visible from the aerials. In addition to the deposition zones shown in the figures, the watersheds of each of the creeks will be included in the study area to help estimate current/future sediment inputs, based on watershed area, geology, and extent of glacial cover.

Note that the Skagit River inlet includes areas within Canada (Figure 2.5-2). The study area within Canada will primarily be evaluated using remote sensing data (LiDAR, aerial photographs); field work will be conducted only if necessary due to the unavailability of adequately representative sampling locations within the U.S.

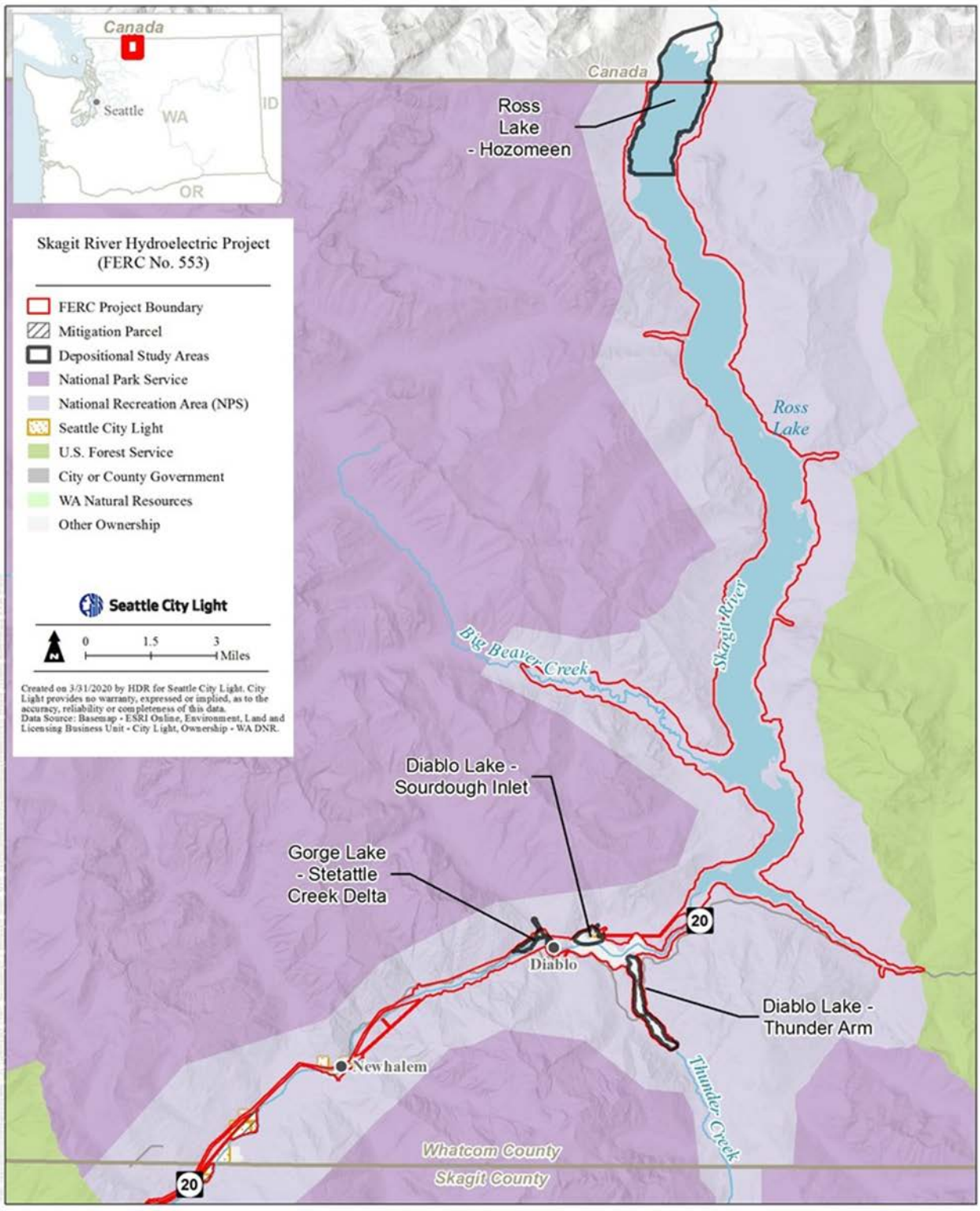

Figure 2.5-1. Overview of study area.

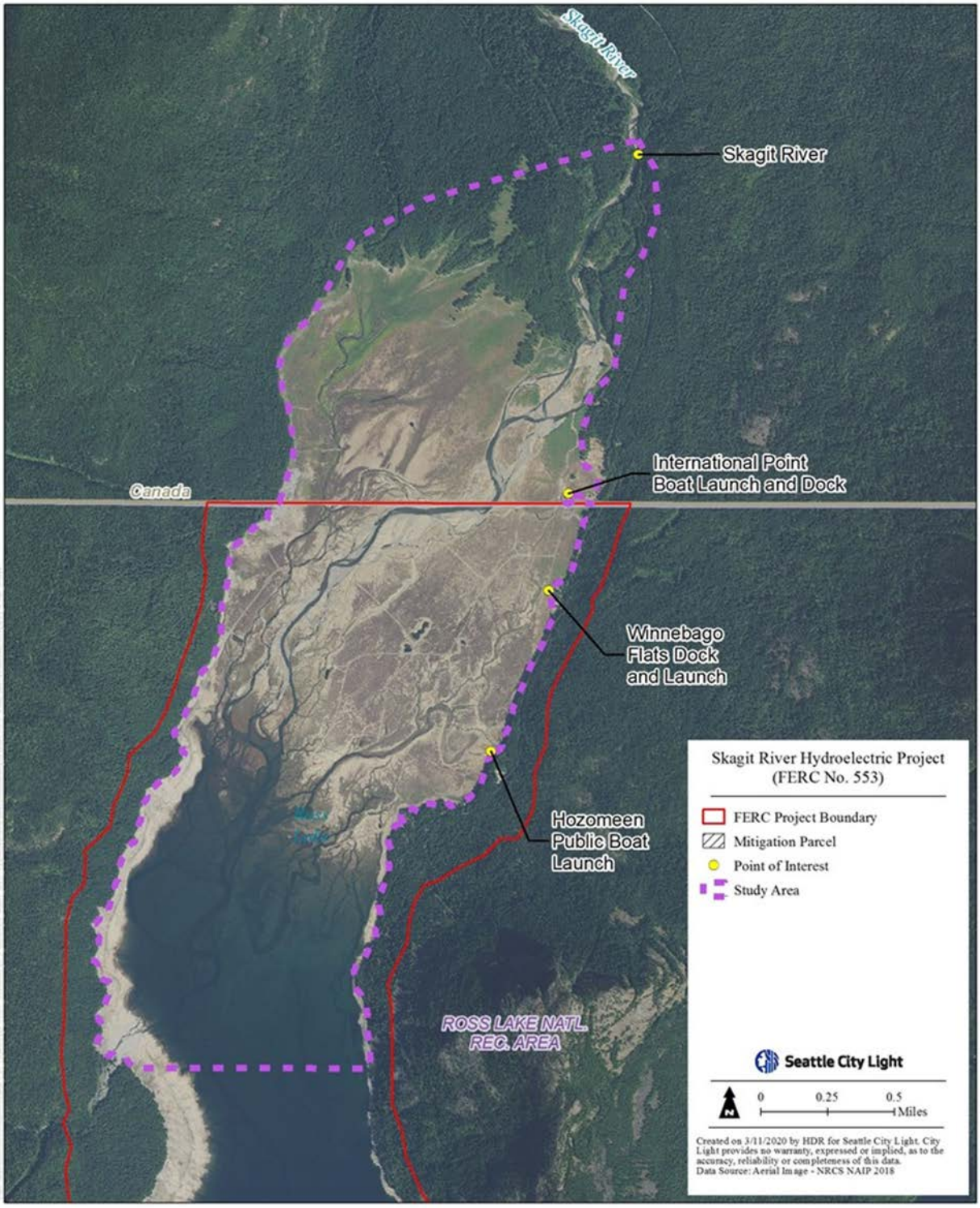

Figure 2.5-2. Study area – Ross Lake - Hozomeen inlet with Winnebago Flats Dock and Launch and Hozomeen Public Boat Launch.[1]

[1] Note: areas within Canada (outside of FERC Project Boundary) will be evaluated primarily using remote sensing methods.

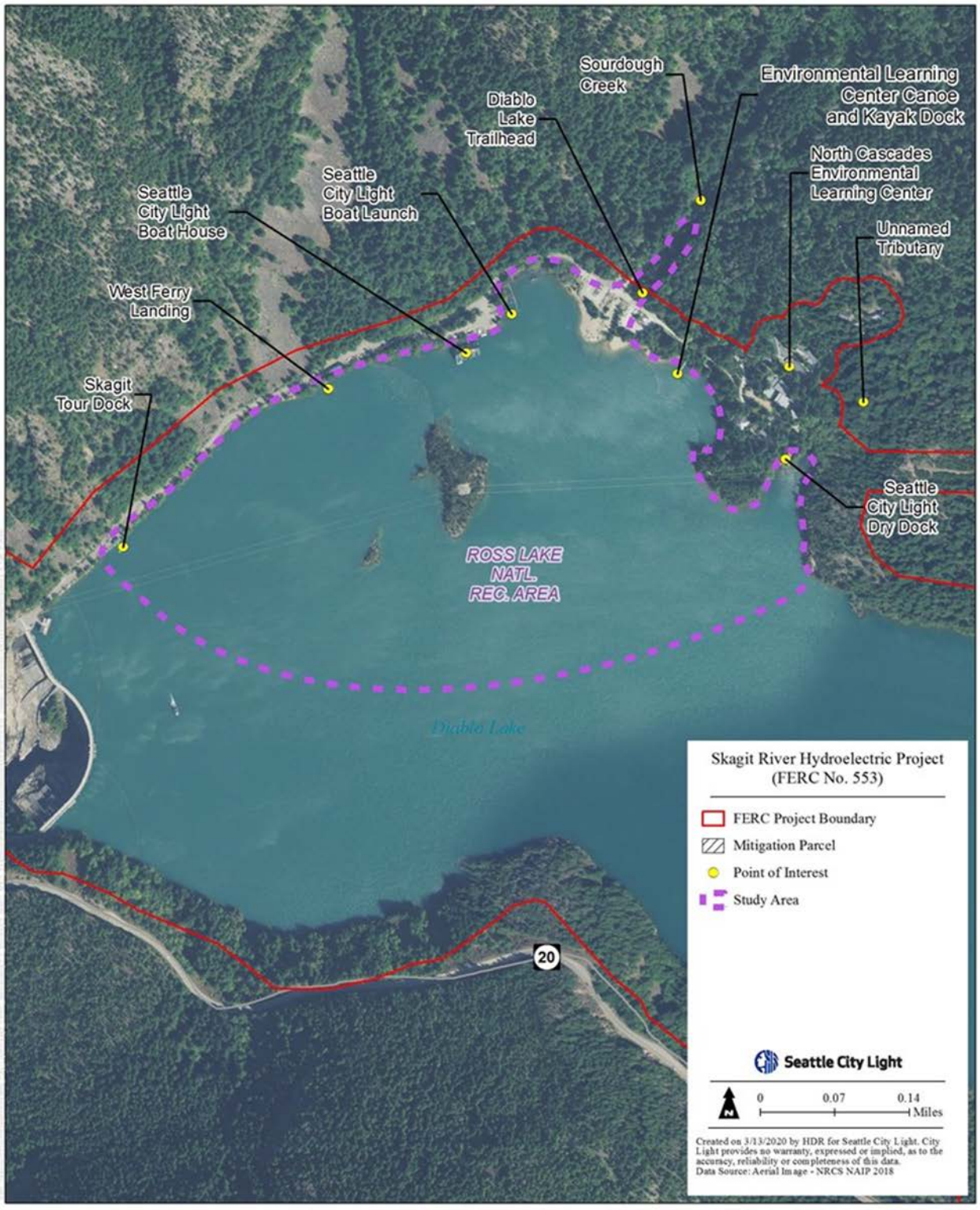

Figure 2.5-3. Study area – Diablo Lake – Sourdough Creek inlet with City Light Boat Launch, City Light Boat House, City Light Dry Dock, West Ferry Landing, Environmental Learning Center Canoe and Kayak Dock and Skagit Tour Dock.

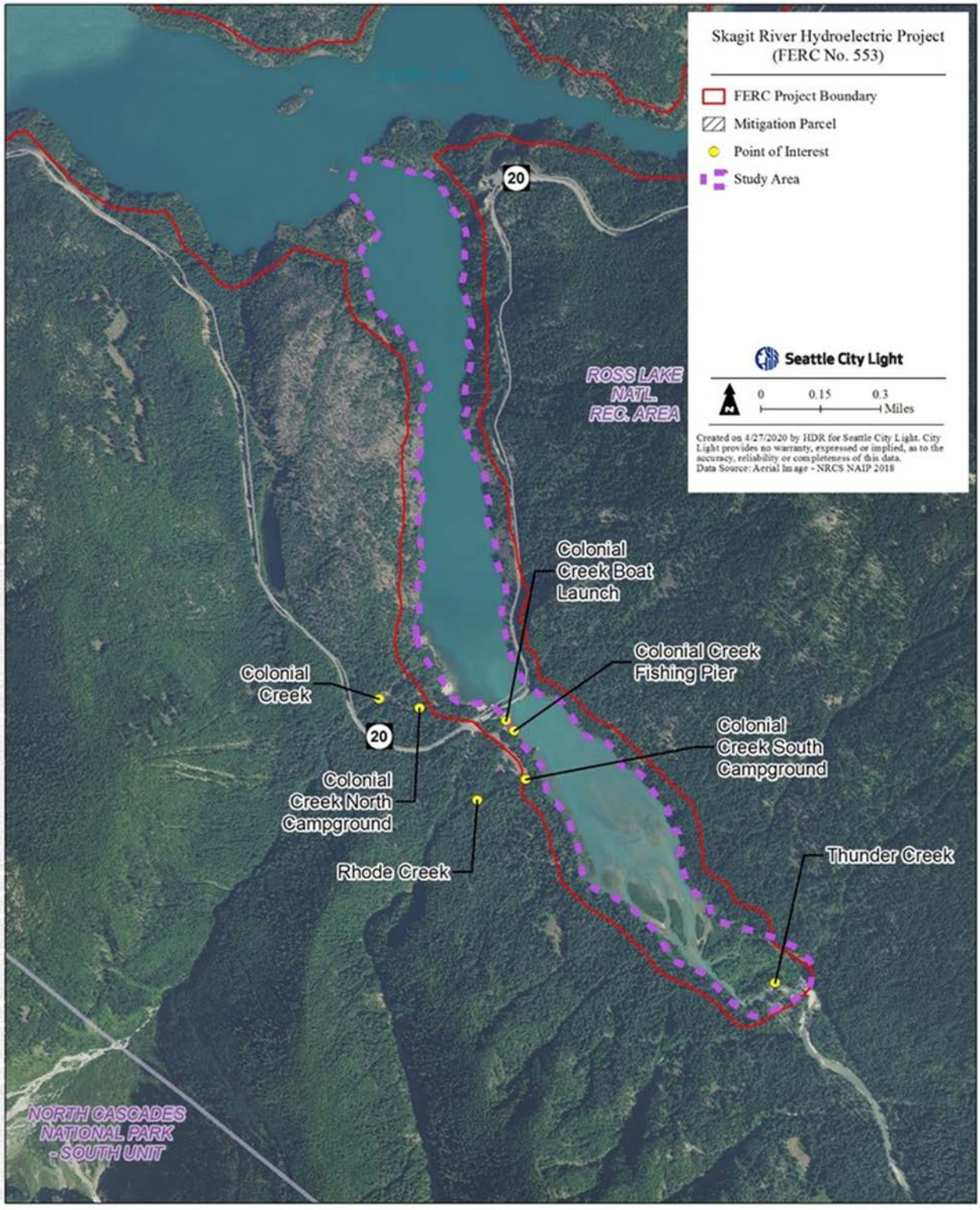

Figure 2.5-4. Study area – Diablo Lake –Thunder Arm inlet, with Colonial Creek Boat Launch/Dock.

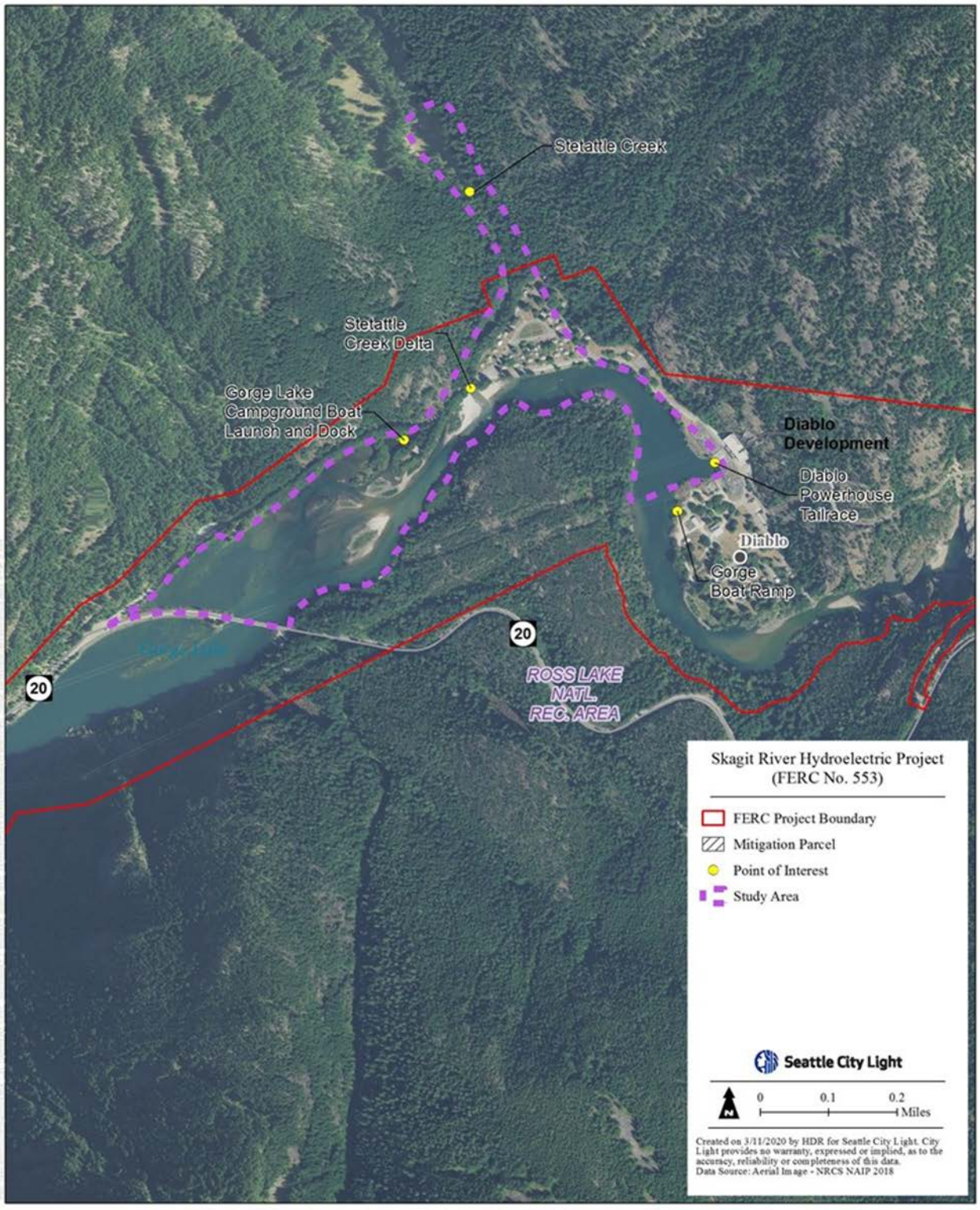

Figure 2.5-5. Study area – Gorge Lake - Stetattle Creek delta, with Gorge Lake Campground Boat Launch and Dock, Stetattle delta deposit, and Diablo Powerhouse tailrace (Watershed GeoDynamics, In Prep)

2.6 Methodology

2.6.1 Compile and Assess Existing Information

Existing information on the study area will be compiled (see Section 2.3 of this study plan). These data will be used to develop initial estimates of sediment input/deposition and rate of inlet/delta sedimentation through time.

- Topography and LiDAR – Historical and recent topography, LiDAR, and green LiDAR will be used to evaluate total deposit volume within each delta study site (Table 2.6-1).
- Aerial photographs – Current and historical aerial photos will be used to supplement the LiDAR data and to determine the changes of the deltas/deposits over time (Table 2.6-1). Historical aerials will be georeferenced as needed. The photos that will be included in the analysis are a subset of those years available using photos that are likely to be complete and of a resolution sufficient for the task. The photos used may change as quality and coverage is evaluated: initially, it is proposed that the years 1950, 1978, 1990, 2006, and most recent 2018/2019 be used to evaluate change over time. Aerial photographs from different years may be substituted or included if higher quality aerial photographs are located.
- Basin sediment yields will be developed using two methods:
    - Average annual sediment budgets for 10 Skagit River sub-basins developed by Paulson (1997), estimates reported in USACE 2008, and any other pertinent references will be used as appropriate based on a comparison of basin geology/geomorphology for the Sourdough, Thunder, and Hozomeen (Skagit River) watershed drainages to develop average annual sediment inputs on a per-acre basis.
    - Estimates for glaciated areas (e.g., Nichols 2006 and any other pertinent references) will be used for glaciated areas (areas covered by glacial ice) of tributary watersheds.
    - The historical aerial photographs used for the delta/deposition analysis will also be used to note and, if possible track through time, any large sediment sources such as landslides, rockslides, or other erosion areas within the Sourdough Creek and Thunder Creek watersheds that should be taken into account for sediment input budgeting purposes.

Table 2.6-1. Project area aerial photograph inventory and remote sensing resources.

Date	Image Type	Scale	Notes
Orthophotos			
1947	Orthophoto quads	1:62:500	
1950	Orthophoto quads	1:62:500	Basis for 15' topo series
1974	Orthophoto quads	1:24,000	Basis for 7.5' topo series
1990	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1992	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1993	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1998	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
Hard Copy Stereoscopic Photographs			
1947	B&W stereo photos	1:27,700	U.S. Forest Service (USFS)
1950s	B&W stereo photos	1:24,000	USFS
8/9-1956	B&W stereo photos	1:24,000	EBK series USFS (NPS incomplete set)
1957	Unclear	1:47,200	VRL series USGS (no NPS set)
1958	Unclear	1:49,000	VSA series USGS (no NPS set)
1963/64	B&W (?) stereo	1:12,000	EMM series USFS (NPS incomplete set)
1973	B&W (?) stereo	?	VCAG series USGS (no NPS set)
1978	True color stereo photos	1:24,000	NPS
1998	True color stereo photos	1:12,000	NPS
Hard Copy Stereoscopic Photographs - Pairs			
1984	Color, Hi- res. CIR min. overlap	1:10,000	NPS prints 3 ft x 3 ft
1990	Hi -res. B&W min. overlap	1:10,000	NPS prints 3 ft x 3 ft
National Agriculture Imagery Program (NAIP) Orthorectified Digital Imagery			
2006	True Color NAIP hi-resolution	1m	Digital
2009	True Color NAIP hi-res.	1m	Digital
2011	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2017	True Color NAIP hi-res.	1m	https://viewer.nationalmap.gov/basic
LiDAR			
2018	Ross Lake	0.5m or 1ft	USGS QL1 standards
2018	Gorge and Diablo Lake Green LiDAR	0.5m or 1ft	USGS QL1 standards
2017	Skagit Topobathy	0.5m or 1ft	USGS QL1 standards
Digital Elevation Models/topographic maps			
2017	Western Washington	0.5m or 1ft	3DEP North

2.6.2 Field Data Collection

New data to be collected in the field for the areas of concern (within the U.S.) include bathymetry and distribution and grain size of inlet and delta deposits. Field data are not currently proposed to

be collected within Canada. If analysis of available information and proposed fieldwork in the U.S. identify data gaps that must be filled to meet the objectives of the study, City Light will explore the feasibility of field data collection within Canada (outside the Project Boundary).

2.6.2.1 Bathymetry

Bathymetry data will be collected in inlets in Ross and Diablo lakes during high water level in the areas generally defined within Figures 2.5-2 to 2.2-4, excluding riverine environment and areas too shallow for bathymetry. Bathymetry data will be collected during high water level for Ross Lake; June through September is generally maximum water level. Diablo Lake normally has only a 4- to 5-foot variation in water level but every attempt will be made to accomplish the bathymetry within the Sourdough Creek and Thunder Arm study areas at the highest water level. Some bathymetry data have been collected for part of the Thunder Arm inlet; these data will be supplemented to cover the entire study area. The area for the bathymetry and sediment deposition analysis has been extended upstream and downstream of the recreational issue of concern (e.g., boat launch) because it is important to understand upstream and downstream controls. For example, the Colonial Creek delta may influence deposition at the Colonial Creek Boat Launch/Dock in the Thunder Arm of Diablo Lake. Data have already been collected for the Stetattle Creek delta in Gorge Lake (Figure 2.5-5) (Watershed Dynamics, In Prep).

2.6.2.2 Sediment Transport and Deposition Zones

The reservoir can act as a base level that influences inlet and delta deposition and riverine sediment transport. Upstream of the reservoirs, there is a point where the reservoir level does not affect riverine transport of sediments. This location will be established by evaluating LiDAR and field evidence such as an inflection point where the gradient changes from flat and depositional to steeper with more transport-dominated processes. Evaluation of the change in slope can be used to evaluate changes in transport processes (Richards 1982).

An estimate of flow competence within and above the zone of reservoir influence will be made by measuring a cross section, particle size, and slope within the lower gradient depositional zone between the reservoir and the inflection point, and above the inflection point. Flow competence (the point at which the particle of interest, e.g., median particle is just mobile, or "incipient motion") will be estimated using river gradient, particle size (Wolman pebble count; Wolman 1954), and hydraulic radius of a cross section. These variables will be measured both above and below the inflection point. Incipient motion occurs when critical shear stress on a particle exceeds bed shear stress. Bed shear stress (function of the hydraulic radius-slope product) will be obtained as output from WinSXPRO, a cross section analyzer (Hardy et al. 2005). Bed shear stress (τ) is expressed as an average force (Newton/square meter [N/m^2]) over the transect width and will be averaged for the entire cross section at bankfull and flood-prone (elevation of water at twice the maximum bankfull depth) elevations. The shear stress required to initiate motion for a given particle size will be established using the Shield's relationship that defines the critical shear stress (τ^*_{ci}, the shear stress threshold at which incipient motion occurs). Shield's relationship for critical shear stress is defined as $\tau^*_{ci} = \beta (\gamma_s - \gamma) D_x$, where β = Shield's parameter (dimensionless critical

shear stress), γ = specific weight of the fluid, γ_s = specific weight of the sediment[2], and D_x = particle diameter of interest (i.e., D_{16}, D_{50}, and D_{84}, in mm). Recent research has shown the parameter to range between 0.033 and 0.21 (Bunte et al. 2013). A matrix of the flow at which the D_{50} (median particle) and D_{84} (particle distribution of which 84 percent are finer) are mobile will be presented, using different estimates of Shield's parameter.

This information will be used to inform long-term input and influence from upstream and non-Project sediment upon sediment management in the areas of concern.

2.6.2.3 Mapping of Inlet Area Deposits

Laminated aerial photographs pertinent to the study area or a field computer loaded with aerial photographs will be used to map polygons around distinct units within the inlet areas of like-sized particles or "facies", while in the field.

Exposed Sediments

For the area exposed during drawdown (usually March–April minimum pool level) for the U.S. portion of the Hozomeen inlet in Ross Lake, it will be possible to directly assess the particles and establish particle size. Within exposed deposits, surficial particle size estimates will be evaluated by compiling a facies map. Facies are groupings of like particles that reflect the conditions and environment of deposition and serve to distinguish sections of deposits. A facies may consist of, for example, a mixture of poorly sorted grains that is consistent over the entire patch. Facies maps are useful as descriptors of current conditions to capture reach-wide variations in surface size (Kondolf and Piègay 2003). Delineation of the surface bed texture will be separated into distinct units by dominant and sub-dominant grain-size classes (Level I, Buffington and Montgomery 1999). Each patch that represents a facies must have a minimum size of 1,000 ft^2 to be considered a separate facies (approximately 10 meter [m] x 10 m as suggested in Pasternack 2012). Polygons will be drawn around the facies on laminated aerial photographs or a Global Positioning System (GPS)-enabled tablet to provide a visual representation of the variability and distribution of particles.

It is expected that the alluvial fan at the mouth of Sourdough Creek can be walked and sampled (i.e., the steep delta-shaped deposit external to the mean high water mark of Diablo Lake), along with the shallow inundated sections at the upper end of Thunder Arm and in the U.S. portions of the Hozomeen inlet, and within the riverine zone of Sourdough Creek, Thunder Creek, and the Skagit River upstream of Ross Lake. The small tributary that may be affecting the City Light Dry Dock will also be assessed for sediment supply and type of sediment transported to the reservoir. There may be shallow inundated areas that are too fine-grained and saturated to walk but not deep enough to use a shallow-draft boat; these areas may need to be estimated using aerial imagery.

Sub-Aqueous Sediments

For those areas that are perennially inundated, there are two methods of particle size determination. For the areas over 1.5 feet deep, an inflatable kayak or Johnboat will be used to deploy a petit

[2] Specific weight of water is based on water temperature (e.g., a water temperature of 7.2C has a specific weight of 9,732 N/m^3; specific weight of sediment is based on the particle size (e.g., a D_{90} of 128 mm has a specific weight of 19,322 N/m^3 [Vanoni 1975 p. 40]

PONAR grab sampler. This device can be used to sample particles that cannot be reached by wading. An estimate of the dominant particle size from each sample will be documented. If the site can be waded, visual or tactile estimations of particle size will be documented. Polygons will again be drawn around like-particles.

2.6.3 Analysis

Deliverables will include:

- The in-progress sediment study report for the Stetattle Creek delta in Gorge Lake (Watershed Dynamics, In Prep).

For the three study areas where new data will be collected (e.g., Sourdough Creek, Thunder Arm, inlet, and Hozomeen inlet):

- Summary report that sets out methods, results, and conclusions.
- Current bathymetry with data tied to mean high-water elevation.
- A digital elevation model (DEM) of study areas developed from bathymetry and existing topography below and outside of mean high-water level.
- Shaded relief map of accumulation of sediments within the study areas below the mean high-water level. Increments of relief will be determined based on the variability and resolution of the data.
- Estimate of total volume of sediment accumulated within the areas of concern.
- Calculated sediment volume/year deposit within study areas based on 1952 Ross Dam construction and 1936 Diablo Dam construction or the latest bathymetry/topographic data available for comparison.
- Estimate of sediment input to the areas of concern by grain size category.
- Qualitative assessment of future deposition and patterns.
- Facies maps of three areas of concern: Sourdough Creek inlet, Thunder Arm, and Hozomeen inlet.
- Location where riverine processes become affected by reservoir level.
- Estimate of sediment mobility in the tributary below and above the inflection point where transport processes change from transport-dominated to deposition affected by the reservoir level in Sourdough Creek, Thunder Creek, and the Skagit River above the Hozomeen inlet.

2.7 Consistency with Generally Accepted Scientific Practice

Comparison of the earliest known original and current topographies to determine changes in sediment deposition location and character is a common component of relicensing studies. Methods vary depending on available data, but estimating changes in sediment deposits is critical to management of Project facilities; methods used herein are similar to those used in other reservoir studies (e.g., Dendy et al. 1973; Kondolf and Piegay 2003; studies summarized in Minear and Kondolf 2009) and relicensing efforts (e.g., Stillwater Sciences 2001; Merced Irrigation District 2011).

Particle size analysis, i.e., facies mapping of deposits and channel morphology studies are common assessments used in relicensing studies (e.g., Yuba County Water Agency 2012; 2013; Nevada Irrigation District 2011; Merced Irrigation District 2011).

2.8 Schedule

- Pre-field analysis – March 2020 to March 2021
- Fieldwork – March to September 2021
- Post-field analysis – April to December 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $140,000.

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SEDIMENT DEPOSITION IN RESERVOIRS AFFECTING RESOURCE AREAS OF CONCERN
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	Each plan suffers from an abbreviated scope and lack of clarity in guiding hypotheses and the questions the studies are designed to answer. From NMFS' perspective, the study plans should clearly state the anticipated utility of the proposed research in understanding the past, current, and future effects of the project on ESA-listed salmonids, Critical Habitat, Essential Fish Habitat, and Treaty Trust Responsibilities. Fish habitat includes a diverse assemblage of aquatic and terrestrial species that are affected in time and space by the operations at the dams. Further, the study plans should clearly state the anticipated utility of proposed research in understanding the status quo, assessing ongoing project effects, and predicting the effects of future management plan scenarios under a new license, including climate change scenarios.	City Light acknowledges the need for consultation with NMFS related to its regulatory responsibilities as required in the FERC process and that the information resulting from the study program is intended to inform consultation with NMFS during future steps within the process. The FERC process schedule positions the integrated environmental analysis subsequent to the completion of the study program and prior to the filing of a Project License Application. City Light currently manages and investigates existing depositional features and over the course of the relicensing will identify appropriate PME measures in consultation with LPs.
2.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The study plans should describe in detail how they will inform our collective understanding of fish and aquatic habitat and ecology. To that end, the study plans should be forward thinking in connecting the anticipated results between these and other study plans. The connections between study plans should be made explicit now to ensure researchers are thinking ahead about the utility of their data from both technical and analytical perspectives and so that plans and associated cost estimates fully reflect foreseeable tasks. Explicitly making these connections will also assist NMFS and other LPs understand exactly how our data needs will be met through multiple study plans.	The integrated environmental analysis referred to in Comment #1 will specifically address links across resource areas. City Light will work with the RWGs to integrate information from related studies as part of the ILP process.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
3.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The geographic and temporal scopes of the draft Geomorph and Operations Model study plans are insufficient. The Geomorph study should be extended to include the full extent of project effects on geomorphic processes. That includes at a minimum, downstream to Puget Sound and upstream through the bypass reach and Stetattle Creek where the project precludes a known population of ESA-listed steelhead from migrating and spawning. The Geomorph and Operations Model draft study plans should be developed to improve our collective understanding of historical processes (including pre-dam conditions) so that they can be compared to the status quo and future management scenarios. **New comments from Brock Applegate (WDFW) provided on 05/05/2020:** SCL current operation of the project does not allow fish passage between the reservoirs or upstream to Stetattle Creek. In addition, SCL refused to study fish barriers in the bypass reach or acknowledge that at the very least, steelhead can migrate to the plunge pool below Gorge Dam. With additional flow, WDFW expects more upstream fish passage to Gorge Dam, through the partial fish barriers described in the Envirosphere report. SCL would not write a study plan, but only looked at the possibility of fish in the bypass reach with only limited amounts of surveys and no study plan.	Please refer to the Geomorphology and Operations Model study plans for City Light's respective responses for those studies. The FERC baseline is existing conditions, and therefore pre-dam conditions are not considered in this study plan. Project effects would more than likely be indiscernible in the lower reaches of the Skagit River and Puget Sound given the complex array of factors contributing to existing environmental conditions in the lower reaches of the Skagit River. City Light plans to assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the relicensing process. **Response to comments provided on 05/05/2020:** Thank you for your comment. Additional discussions regarding the issue of Project fish passage are anticipated and City Light welcomes discussion of this issue with LPs in the future.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
4.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The draft Sediments Deposition study plan should consider the effects of project operations on biological processes including fish movement between the reservoir and tributaries. **New comment from Brock Applegate (WDFW) provided on 05/05/2020:** SCL did not answer the question of fish passage to Stetattle Creek or between the reservoirs.	City Light currently mitigates for potential effects on fish migration/passage resulting from sediment and woody debris deposition in Project reservoirs, and intends to continue the effort. The 1991 Settlement Agreement stipulates that City Light is to survey for and remove transitory barriers to spawning migration in tributaries to Project reservoirs. City Light has agreed to expand the annual barrier surveys and barrier removal efforts beginning in 2020 following NCC approval. **Response to comment provided on 05/05/2020:** See response to Comment #3.
5.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The draft study plans would benefit from collaboration within the FA Group to harmonize LP comments and explore opportunities for improving efficiency and utility of the anticipated results in meeting the needs of all License Participants. **New comment from Brock Applegate (WDFW) provided on 05/05/2020:** SCL informs LPs that if they want fish passage and other study plans that the other 99% of the LPs want, "Go to FERC with your study plan request." This response does not equal collaboration. Although the identification of study issues forms felt collaborative, the process to bin and prioritize did not. The LPs have consulted on the creation of the current study plans. WDFW respects and appreciates the consultation on study plans and SCL's prerogative to do so, but the LPs would not call the current study plan creation as collaborative.	The requested collaboration is underway, as evidenced by the 2019-2020 voluntary study identification process, including this study plan and associated comment-response effort. Moreover, City Light will continue collaboration with LPs regularly throughout the ILP process. **Response to comment provided on 05/05/2020:** City Light appreciates your agency's input and looks forward to working with you to address resource issues during the relicensing proceeding.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				SCL did not choose the collaborative licensing process, the Alternative Licensing Process (ALP). WDFW remains fine with the status of study plan consultation, but SCL has chose something different than 100% collaboration.	
6.	USFS	04/14/2020	General Comments	It is not stated in the draft study plan how the methods and measures for analysis will result in a better understanding of project effects on sediment depositional dynamics, and more importantly on aquatic habitats. **New comment from Brock Applegate (WDFW) provided on 05/05/2020:** Sediment deposition in the reservoirs and below the project has affected upstream fish migration. WDFW does not need population effects for SCL to violate State law. If you have fish passage blockage, SCL has violated State law. With that said, WDFW looks forward to working with SCL to find solutions to fish passage problems.	The data collected as part of this study plan will be used, in conjunction with data on Project reservoir elevation fluctuations, to help understand Project effects on sediment deposition in the areas identified in the study plan. Regarding aquatic habitat, City Light is unaware of any Project-related adverse effects due to sediment deposition that are affecting fish in the reservoirs, i.e., the status of reservoir fish populations does not indicate that there is a habitat-related issue. However, City Light welcomes LP input regarding specific aquatic habitat issues associated with sediment deposition in the reservoirs, and the associated information for such adverse effects on any fish species/life-stage. **Response to comment provided on 05/05/2020:** City Light appreciates your agency's input and looks forward to working with you to address resource issues during the relicensing proceeding.
7.	USFS	04/14/2020	General Comments	The draft study plan cites FA44 and FA45 as issues the study will address but there is no specific goal/objective for evaluating project effects on sediment deposition dynamics and consequent impacts to aquatic habitat, no methods to evaluate those impacts, and no	References to these issue forms have been deleted from this study plan, and text has been added to Section 1.3 to better explain the role of the issue forms in contributing to City Light's suite of study proposals.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				measures for analysis that will develop conclusions on those likely impacts.	With regard to effects of sediment deposition at tributary mouths on fish passage/migration or aquatic habitat, see responses to Comments #4 and #6 and #10.
8.	USFS	04/14/2020	General Comments	This study plan appears to address the data gap and resource impacts identified in RA01 Recreation and Visitor Use.	Yes, this study is intended to address a data gap which was first brought forward in the Recreation and Aesthetics RWG. Subsequent discussions among the geomorphology subgroup did not identify additional locations at that time where sediment deposition was identified as an impact to biological resources. Per comment response #4 and #10, City Light sees an opportunity to address potential sediment deposition issues in other areas through direct management action by expanding the current reservoir tributary barrier removal program.
9.	Brock Applegate (WDFW)	04/13/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans….." **New comment provided on 05/05/2020:** When Seattle City Light constantly tells the LPs to "take their study plan request to FERC," the LP does not feel like they have collaborated. WDFW agrees to disagree, but also realizes that SCL have every right to pick their licensing and consultation process.	Section 1.2 and 1.3 were redrafted to better describe the 2019 process. Formal consultation does not begin until after the PAD is officially submitted. Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together). **Response to comment provided on 05/05/2020:** Thank you for your comment.
10.	Jon Riedel (NPS)	03/27/2020	Section 1.3 Study Plan Development	What about Big Beaver. There is a massive sand delta there that is a major source of fine sediment. Is it being transported to dam? Affecting turbidity? Prone to collapse? Filling river channel when lake down?	Understanding tributary delta sediment deposits that may impact natural resources is a shared interest of City Light. We see opportunity to incorporate information gathering into the current tributary delta barrier removal program and possibly identify a management PM&E

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				New comment from Brock Applegate (WDFW) provided on 05/05/2020: LPs have also brought up sedimentation concerns for natural resources as well, but SCL has only moved forward with these particular spots that have recreation and facility concerns.	measure in subsequent consultation associated with relicensing. The focal areas of this proposed study are based on the issues identified by LPs from sediment deposition concerns around specific recreational resource assets. Turbidity is being addressed as part of the Water Quality Study as part of actions to fill data gaps on existing conditions in Ross Lake. **Response to comment provided on 05/05/2020:** Thank you for your comment. Please refer to specific comments in this table related to natural resource concerns from LPs and City Light has provided responses to specific issues identified; if WDFW has specific resource issues it believes are not captured, City Light welcomes further discussion.
11.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	WDFW feels like SCL should focus on the Big Beaver Creek and wetlands. Although the sediment may or may not affect reed canarygrass population in the area, sediment aggradation could affect fish habitat and passage. SCL should make this area, an area of focus for aquatic restoration activities and wetland mitigation. SCL should address sediment issues in other area besides those listed in this study plan. SCL should do a sediment budget model to describe how much sediment the Project cuts off, does not transport downstream, and stores.	City Light believes that quantifying the rates of sediment by the Project is not necessary to mitigate for potential Project impacts on downstream resources. Rather, during relicensing, City Light plans to work with LPs to gather information and develop tools to support current and future environmental resource objectives in the Skagit River downstream of the Project (i.e., Gorge Dam to Sauk River). This will include addressing limiting factors to fish populations by continuing, and possibly modifying, City Light's instream flow program and identifying and implementing active habitat restoration and effectiveness monitoring. City Light hopes to collaborate with LPs to take a resource-benefit

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					approach, e.g., identifying locations in the Skagit River below the Project and then targeting eventual PME measures to improve ecological function at those locations. Ongoing wood management activities will also provide information on wood inputs to the reservoirs. With regard to effects of sediment deposition at tributary mouths on fish passage/migration or aquatic habitat, see responses to Comments #4 and #6 and #10. Regarding the comment on reed canarygrass, the Invasive Plant Inventory will address reed canarygrass distribution.
12.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	SCL should also address aggradation of sediment at the tributaries to all the reservoirs with fish. SCL should evaluate fish passage in the spring for spawning resident trout and the fall for spawning char. Fish barriers often occur when the reservoir elevation drops. Sediment often drops out of the creek when it flows into the reservoir or backwater caused by it, which increases the aggradation and possible fish passage blockages. **New comment provided on 05/05/2020:** See my response to your response on # six.	See responses to Comments #4 and #6 and #10. **Response to comment provided on 05/05/2020:** See response to Comment #10.
13.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Ongoing sediment deposition in Project reservoirs is known to affect recreational resources (boat launches and docks), fish and wildlife resources, operational facilities (docks and landings), and/or power generation at two locations, and potentially may have similar effects at two additional locations."	See responses to Comments #4, #6, and #10. With regard to wildlife, City Light is proposing to conduct studies to assess potential Project effects on wildlife. City Light is also providing baseline information on vegetation throughout the Project area, i.e., Vegetation Mapping, Wetlands Assessment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Please include more locations and additional objectives in this study. You may need to link to the geomorphology, and operation studies for additional information to inform sediment deposition in reservoirs. Also see my comments in the Geomorphology study where I mentioned to add geomorphology assessments above the dams. Understanding if there are naturally higher sediments coming down from tributaries will help to in determining operational effects. Sedimentation in reservoirs are known to cause effects to aquatic and wildlife species and habitats. Sediments deposit at most of the larger tributaries, where they connect with reservoirs. This may occur at multiple reservoir elevations bands, creating sediment deposition where ever the mouth of the stream has intersected with the reservoir. Additionally, aggradation of substrates/sediments can occur in many of the reservoir tributaries due to the effect of the reservoir slowing down the energy of the stream and causing aggradation of larger and smaller substrate upstream from the reservoir some distance upstream. Turbidity and sediment deposition in the reservoirs also happens due to wind/rain action lapping at the exposed shorelines/sediments on the reservoir beds, and can be extreme. Turbidity can extend many yards out into the reservoir. This can cause effects to foraging/migrating fish, depending on the time	City Light welcomes any information that licensing participants may provide that will inform Project related effects on wildlife due to sedimentation. **Response to comment provided on 05/05/2020:** Thank you for your comment. Please see responses to Comments #10 and #13.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				of year, but especially during juvenile out migration and adult spawning migrations. **New comment from Brock Applegate (WDFW) provided on 05/05/2020:** SCL has other areas to address sedimentation than just recreation facilities.	
14.	Jon Riedel (NPS)	03/27/2020	Section 1.3 Study Plan Development	1st Bullet – Comment "Hozomeen inlet" Never heard this term before.	This term was used to better describe the location.
15.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	4th Bullet – Add red text "The delta deposit that has formed at the outlet of Stetattle Creek is used for whitewater training and instruction and long-term effects upon this use should be evaluated, along with containing spawning habitat for rainbow trout."	Effects on recreational resources will be included in recreation resource studies and the license application. Rainbow trout continue to have access to spawning habitat in Stetattle Creek and City Light is not aware of any information on impediments to passage or habitat use of the Stetattle Creek delta area by rainbow trout. See responses to Comments #4 and #6.
16.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 1.3 Study Plan Development	1st Paragraph – Comment The study should consider sediment deposition across the entire reservoir system. The project has been in place for over a century, over which time sediment deposition may have reduced reservoir storage capacity. It is important to determine if, and to what extent, this may be impacting operational flexibility, including instream flows, fisheries and aquatic resources. Additionally, measuring total sediment deposition would provide important information for the geomorphic assessment, for example the ability to estimate average annual sediment input.	See responses to Comments #1, #6, and #11.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
17.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 1.3 Study Plan Development	Bullets 1 through 4 – Comment Additional locations should include all fish-bearing tributaries to determine impacts to fish passage that have already occurred and that are expected to continue, increase, or manifest over the course of the next license term. Passage may be interrupted due to sedimentation patterns associated with reservoir operations. Specific impacts may include lack of channel definition resulting in diffuse flows with water too shallow to allow normal fish passage, loss of surface flow as water infiltrates depositional features, or physical blockages created by wood and other debris that gets deposited as reservoirs are drawn down.	See response to Comment #4.
18.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/13/2020	Section 1.3 Study Plan Development	1st Bullet – Comment The Hozomeen inlet is archaeologically and culturally significant to the Upper Skagit Indian Tribe, which is concerned that sedimentation may be affecting some in the cluster of archaeological sites documented in this area (see 2011 Archaeological Resources Mitigation and Management Plan).	Effects on cultural resources are being addressed in the Historic Properties Management Plan.
19.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 1.3 Study Plan Development	Last Paragraph - Comment Geomorphology study needs could be addressed related to average annual sediment input rate. Reservoir fishery study needs could be addressed by understanding fish passage impacts into tributaries. See above comments.	See responses to Comments #4 and #10 and #11.
20.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Issues to be addressed by this study are identified in the following issue forms: (1) FA44 Sediment Deposition within Reservoirs that Affect Resources of Concern; (2) FA45	See responses to Comments #6 and #13.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Bathymetry and Sediment Deposition within Reservoirs; and (3) RA01 Recreation and Visitor Use." Include additional objectives to identify other Resources of Concern. At the least it should also include fish and wildlife, and I also added it above.	
21.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Issues to be addressed by this study are identified in the following issue forms: (1) FA44 Sediment Deposition within Reservoirs that Affect Resources of Concern; (2) FA45 Bathymetry and Sediment Deposition within Reservoirs; and (3) RA01 Recreation and Visitor Use." Link bathymetry to operations modeling to determine if there are shallow areas or areas of potential barriers that develop within the reservoirs during drawdown. This can also inform the future fish passage study.	See response to Comment #4.
22.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	Issues to be addressed by this study are identified in the following issue forms: (1) FA44 Sediment Deposition within Reservoirs that Affect Resources of Concern; (2) FA45 Bathymetry and Sediment Deposition within Reservoirs; and (3) RA01 Recreation and Visitor Use. This study should also be used to help inform the Fish and Wildlife Coordination Act components of FERC (i.e. Section 10j in the FERC process).	See response to Comment #7. The study program and subsequent integrated effects analysis and NEPA document will provide the information necessary for LPs to execute their statutory responsibilities under the Federal Power Act.
23.	USFS	04/14/2020	Section 1.3 Study Plan Development	***The FS recommends*** only including those issues, and referencing those issue forms, that are explicit goals and/or objectives of this study	See responses to Comments #4, #6, and #7.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				plan. If methods are not designed to study the specific data gaps identified in the issue forms, then issues should not be included here. Alternatively, describe in sufficient detail how conclusions drawn from this study plan will inform project effects on the issues brought forward in this paragraph. In particular, there is no mention of aquatic habitat impacts from sediment deposition, yet that measure seems a priority in both FA issue forms (as described by LP comments). ***The FS recommends*** including study design methods, or include an interpretation of the data collected from proposed methods, that is specific to project effects on aquatic habitat as described in the issue forms for FA44 and FA45. Alternatively, focus on solely issues of RA01 Recreation and Visitor Use.	
24.	Judy Neibauer (USFWS)	04/13/2020	Section 2.0 Study Plan Elements	I found a great source that identifies what Study Guide Criteria should be addressed in these study plans. Maybe you have seen it, but here is the link… https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	City Light appreciates the input.
25.	Ashley Rawhouser (NPS)	04/13/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comments In general, the scope of this study is too limited in both geographic extent and in terms of the resources that are potentially impacted. This appears to initiate a piece meal approach to dealing with sedimentation issues related to the dams and this will likely create confusion for	See response to Comment #11.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				LP's, FERC, and SCL down the road. NPS identified the need to develop updated bathymetric maps covering all the reservoir as a baseline piece of information needed early in the process. And that these maps will be needed to address multiple issues. As such, the limited scope of the study is problematic and needs to be expanded. Why aren't the forebays of the dams and the confluences of a tributaries with the reservoirs part of the scope?	
26.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	I agree the goal and objectives seems limited. Either expand this study or add a new study to look at fish and wildlife habitat issues related to sedimentation, deposition, and turbidity, related effects from operations. You may also want to link to the geomorphology study data you will be collecting.	See responses to Comments #4, #6, #10, and #13.
27.	Jon Riedel (NPS)	03/27/2020	Section 2.1 Study Goals and Objectives	4th Bullet – Comment Note problems with deposition by 3 streams; Thunder Colonial and Rhode. Rhode cr primary source of sediment to boat launch.	All three tributaries will be analyzed as part of this study.
28.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	5th Bullet – Comment "Stetattle Creek delta in Gorge Lake (i.e., the sediment deposited at the mouth of Stetattle Creek where it enters Gorge Lake) and the sediment deposited between Stetattle Creek and the State Highway 20 bridge crossing." I am guessing that there is a much larger list of tributaries that contribute to migratory and resident fish spawning, rearing, and foraging, that are in need of assessment. Please add key	See responses to Comments #4 and #6. Also see responses to comments in the Geomorphology Study Plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				fish bearing tributaries, their intersections with the reservoir at multiple locations, and some distance upstream where aggradation/deposition may occur. See my comments in the geomorphology study to add areas above the dams and in tributaries. This will help to determine if depositions are partly natural or caused by the lowering and raising of the reservoirs. You will likely want to link to the geomorphology study.	
29.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	Added 7th Bullet "Identify where there are likely aggradation and depositional areas are within tributaries that are and will continue to be connectivity issues for aquatic and wildlife species and or are problem areas in need of restoration."	See responses to Comments #4, #6, and #13.
30.	Brock Applegate (WDFW)	04/13/2020	Section 2.1 Study Goals and Objectives	8th Bullet – Add red text "Identify likely future zones and patterns of deposition with respect to natural resources, recreational resources, and operational impacts."	City Light chose not to adopt this edit, because the focus of this study is to address recreational resources and operations areas. Assessment of potential Project impacts on other resources will be reviewed with LPs during the ILP and in some cases addressed through management measures. Please see responses to Comments #4, #6, #10 and #13.
31.	Brock Applegate (WDFW)	04/13/2020	Section 2.1 Study Goals and Objectives	8th Bullet – Comment The manipulation of this sediment may cause fish and wildlife impacts. Please explain the environmental effects as the NEPA documentation will require.	As required by the ILP schedule, the NEPA analysis, follows the study phase of the process. FERC's NEPA document will address Project effects and effects associated with implementing potential PMEs. If PMEs are identified that involve the manipulation of sediment, an environmental analysis of that action would occur at that time.

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32.	Rick Hartson (Upper Skagit Indian Tribe)	04/12/2020	Section 2.1 Study Goals and Objectives	1st Paragraph – Comment "The goal of the Reservoir Deposition Affecting Resource Areas of Concern Study is to evaluate the effects of deposition on four specific recreational resources and operations areas within Ross, Diablo, and Gorge lakes." See previous comments regarding need to expand study scope to entire reservoir system, and aquatic resources.	See responses to Comments #4 and #6 and #10. Also, recreation impacts resulting from sedimentation deposition are not occurring universally, so this study is focused on areas of known impact.
33.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment This study will be using some existing sediment budgets as a starting point to understand potential sediment input. SCL should use the data they collect at these sites and develop new sediment budgets for each of these basins for comparisons. The budgets described were developed in areas within entirely different geologic domains and different forest practices. Additionally, the sub-basins listed here are not that similar in size, overall aspect or level of glaciation; even if they are at least in the same geologic domain. This study should include development of new sediment budgets based on collected data for each of these basins.	Data from previous sediment input budgets in the Skagit River basin will be used as just one tool to help evaluate sediment input from the listed watersheds. Data collected from each basin and delta deposit will also be used to evaluate sediment input at each location.
34.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	6th Bullet – Comment The study should differentiate between natural pre-project depositional features and sediment deposits that started occurring as a result of the project.	Traces of submerged natural depositional features will likely be difficult to detect and measure in a meaningful way. The goal of this study is to estimate depositional rates in the recreational resource areas of concern under existing conditions rather than address specific pre-Project features. See response to Comment #1.

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35.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.1 Study Goals and Objectives	7th Bullet – Comment "Identify likely future zones and patterns of deposition with respect to recreational resources and operational impacts." And fishery and aquatic resources.	See responses to Comments #4 and #6.
36.	USFS	04/14/2020	Section 2.1 Study Goals and Objectives	***The FS recommends*** modifying the goal of the study plan to include some measure of project effect on aquatic habitats as a result of reservoir sediment deposition. Aquatic habitats are a resource of concern, and are identified in issue forms FA44 and FA45. ***The FS recommends*** clarifying the goal statement to ensure the study plan is to *"…evaluate* ***project effects*** *of* ***sediment deposition****…"* The results of the study should provide SCL and LPs an ability to distinguish the naturally occurring depositional patterns versus those created by project operations. ***The FS recommends*** including an evaluation of all tributary confluences that have known benefit to aquatic organisms and their habitats. This evaluation could possibly be extrapolated from the data being collected as part of the proposed study design given that the proposed study area is quite large. Effects of project operation on tributary/reservoir confluence habitat is a data gap and could be addressed in this study design.	See responses to Comments #1, #6, and #34.
37.	Brock Applegate (WDFW)	04/13/2020	Section 2.2 Resource Management Goals	Add red text "City Light will confer with resource agencies and tribes that are interested in participating in	See responses to Comments #1 and #2.

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				development of this study proposal, and language identifying specific management goals and possible environmental effects relevant to this study proposal is anticipated."	
38.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	According to guidelines for the ILP…this section should also include Information about public input considerations…Maybe you have this somewhere else? See this link: https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	See response to Comment #24. Also, it is worth noting that the criteria pertain to "public interest," not public "input".
39.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.2 Resource Management Goals	1st Paragraph – Comment Upper Skagit Indian Tribe is interested in evaluating sediment deposition across the entire reservoir system, and the associated impacts on cultural, fishery, and aquatic resources.	See responses to Comments #4, #6, and #18.
40.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	"City Light is interested in evaluating the effects of deposition in the four identified areas of concern in order to inform the relicensing process." This should be expanded to include other goals and objectives… see above comments	See responses to Comments #6, #10, #11, #13, and #18.
41.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.2 Resource Management Goals	2nd Paragraph – Comment As currently scoped, it appears the study is not adequate to address Upper Skagit Indian Tribe's specific management goals. The study scope should include the entire reservoir system so that system-wide impacts can be understood and addressed. For example, see earlier comments related to average annual sediment input rate, tributary fish passage, and reservoir storage capacity.	Although addressing specific, relevant management goals is at times an objective of resource studies, not all agency and Tribal management goals pertain to the FERC relicensing study program. As the ILP unfolds, City Light will work with LPs to identify and address management goals that intersect with relicensing. See responses to Comments #4 and #11.

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42.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	Add in any other agency resource management goals? NPS? WDFW? See your other study plans, you mention there might be other agency resource management goals. You could list them here too…	Edits have been made so that the content of the referenced section is consistent with that of other City Light study plans.
43.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Delta formation and deposition in specific areas of Project lakes affects access to/from certain recreational facilities (boat launches, docks), operational facilities (docks and landings), aquatic and wildlife species and habitats, and/or power generation." This is a section where maybe you add a paragraph showing how previous issues, and current information/data will be used in the assessments and effects analysis of aquatic habitats…you could put that in a table that links the office data with the field data, issues, and key questions. See my comments in this section in the geomorphology study too Link to the shoreline erosion study, the geomorphology study, and operational model study…there are likely overlaps with these studies where data from each could inform the other.	See responses to Comments #2, #6, and #13.
44.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Existing information that contributes to the understanding of sediment deposition rates and processes in the areas of concern includes:" Include major tributaries and deposits within the reservoir beds in these assessments. You will need to that identify fish passage issues, upstream tributary habitat conditions, and	See responses to Comments #4, #6, and #10. Thank you for the interesting reference to another reservoir system, likely with different dynamic processes affecting the transport of sediment and fish behavior. City Light is not aware of evidence that salmonids are being

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				aggradation of substrates/sediments. Information about depositions (i.e. in rivers/tributaries and in reservoirs) and including areas of wind driven turbidity and deposition; will be needed to assess current and future operational effects from the lowering and raising reservoirs. There is evidence that shows operational effects occur within the reservoir beds to bull trout from such things as predation and poor habitat. As reservoirs lower, and migratory bull trout are located within the small river channels/braided channels while migrating to and from spawning tributaries. Predation occurs due to the lack of cover and sediments that form stream banks in the reservoir bed. Edges of the stream banks (i.e. within the reservoir bed) can collapse and bury migratory bull trout that may be hiding or holding in the reservoir portion of the stream. An example of this occurred in an Idaho BOR reservoir in the N. Fork Boise system, where they found a dead bull trout that had a radio tag and was buried in 20 cm of the collapsed sandy stream banks within the reservoir bed. I am not sure where this effect falls out yet (passage, habitat, sediment deposition?)…but it was a combination of sediment deposition in the reservoir beds and the operational drawdowns that likely caused this effect. The study was conducted by USBOR. And here is the reference. Salow and Hostettler 2004. There are also studies in the Yakima basin, within bull trout spawning habitat associated with reservoirs where sediment deposition at stream junctions, within tributaries, and within	buried in sediments near the mouths of tributaries in the Skagit system, nor that predation on bull trout is linked to Project effects on sedimentation in the reservoirs. City Light and LPs will be able to explore potential impacts on fish and aquatic resources to a greater degree during the ILP (Please also see the response to Comment #6.). Habitat conditions in the tributaries, above the influence of the reservoirs' high-water marks, are outside the range of the Project's effects.

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				reservoir beds, impact passage and aquatic habitats and as well…facilitates predation.	
45.	Brock Applegate (WDFW)	04/13/2020	Section 2.3 Background and Existing Information	5th Bullet – Add red text "It will also provide suggestions for long term resolution for both the boat launch ingress and egress, and mitigating the effects upon Diablo Powerhouse tailrace and fish habitat."	See response to Comment #6 If future sediment manipulation is identified as a mitigation measure, effects of that measure on fish habitat will be evaluated as part of the planning process.
46.	Jon Riedel (NPS)	03/27/2020	Section 2.3 Background and Existing Information	12th Bullet – Comment "Regional estimates of watershed sediment input have been developed by Army Corps of Engineers (USACE 2008)" There is more: Chilliwack, Goodell, Newhalem (?) 1039 1936 estimate of sediment volume for Diablo Reservoir (SCL study).	Thank you for the additional references. Text has been revised.
47.	Jon Riedel (NPS)	03/27/2020	Section 2.3 Background and Existing Information	12th Bullet – Comment "Annual sediment budgets for ten Skagit River sub-basins were developed by Paulson (1997)….." On heavily managed timberlands.	Agreed. The conditions in different watersheds will be considered as part of this analysis to aid in determining if referenced studies are applicable. Text has been revised.
48.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.3 Background and Existing Information	1st Paragraph – Comment "Delta formation and deposition in specific areas of Project lakes affects access to/from certain recreational facilities (boat launches, docks), operational facilities (docks and landings), and/or power generation." Reservoirs is appropriate term. Lentic systems did not exist here prior to the project.	Agreed, text edited accordingly.

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49.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.3 Background and Existing Information	1st Paragraph – Comment "Delta formation and deposition in specific areas of Project lakes affects access to/from certain recreational facilities (boat launches, docks), operational facilities (docks and landings), and/or power generation." Reiterating need to broaden scope of study and assessment of resource impacts. See previous comments.	See responses to Comments #4, #6, and #13.
50.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.3 Background and Existing Information	1st Bullet – Comment "As-built documentation, historical topography and available bathymetry for Sourdough Creek inlet within Diablo Lake, Thunder Arm within Diablo Lake, and the Hozomeen inlet at the north end of Ross Lake." Has access to these as-built documents been granted to LPs? If not, Upper Skagit Indian Tribe requests access to the documents to foster a shared understanding between SCL and LPs.	As-built documents may be subject to confidentiality requirements. City Light will share materials related to as-built documents to the extent permitted by law.
51.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 2.3 Background and Existing Information	5th Bullet – Comment "This study will evaluate sediment supply, particle size distribution, and lateral and vertical extent of the deposit." The study should also assess what restoration of the historic alluvial fan would do for project operations and fishery resources as relating to passage and access to Stetattle Creek to the Skagit River inside Gorge reservoir- as this is the only free flowing section of the Skagit in the project area. Study should assess historical	See response to Comment #1.

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				extend of gravel and sediment bar as compared to rate of change from project operations.	
52.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.3 Background and Existing Information	12th Bullet – Comment "Annual sediment budgets for ten Skagit River sub-basins were developed by Paulson (1997)…" These results were from active industrial forests at a time when current forest practices were just being put into place. Expect that these budgets will be different than they are now for the same basins, certainly different than basins upstream of Gorge powerhouse.	See response to Comment #47.
53.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.3 Background and Existing Information	12th Bullet – Comment "…Nichols (2006) estimated the glaciated areas would produce 2,600 tons/square…." Is this personal communication based on the USACE 2008 regional study? This is very unclear where this comes from and how it fits in with the numbers below. It gives a number that is close to the high range of the regional estimate, but there is no information for where it falls within a range for glaciated areas. Is 2,600 the mean, the low end or the high end of what is produced from glaciated areas?	Yes. This reference is reported in the USACE (2008) regional study; the reference has been edited to clarify the source. A more detailed description and analysis of various sediment supply rates reported for appropriate watersheds in the vicinity of the study area will be provided in the study report.
54.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.3 Background and Existing Information	12th Bullet – Comment "….R2 Resources (2004) for Puget Sound Energy." The Baker area and middle Skagit are substantially different geology than what exists	See response to Comment #47.

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				upstream of Gorge powerhouse, as are the forest practices.	
55.	USFS	04/14/2020	Section 2.3 Background and Existing Information	Existing information provided in this section does not include information about project operation effects on sediment deposition in aquatic habitats in the three reservoirs. This study is a good opportunity to resolve that data gap.	See responses to Comments #4 and #6.
56.	Judy Neibauer (USFWS)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	This is a section described in the study plan guidelines I shared earlier…Here you can talk about how the results from the Project will affect the resources. This section could link up to the goals and objectives above and share how the information will be used to assess effects. You can describe here where the data gaps are that this study will address. This section just seems like it lacks description, and looks more like a general statement/paragraph, without the details of how the data will be used to address the effects…Maybe add information showing how data will be used in the effects analysis…you could put that in a table too.	See responses to Comments #1 and #24.
57.	Judy Neibauer (USFWS)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	"Sediment supply (non-Project related) from tributaries results in deposition within Project reservoirs. The deposition affects access to/from recreational facilities (boat launches, docks); aquatic and wildlife habitat; and operational facilities (docks and landings);" Effects likely occur to aquatic and wildlife populations and habitat, as previously mentioned. Need to add this here. Or show how you are addressing fish and wildlife issues elsewhere.	See responses to Comments #4, #6, and #13.

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58.	Brock Applegate (WDFW)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	"The data obtained with the methods identified below will be used to analyze potential future deposition volumes and patterns to help develop methods to manage sediment deposition at the areas of resource concern and develop mitigation for any fish and wildlife impacts through the term of the new license."	See responses to Comments #6 and #13.
59.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.4 Project Operations and Effects on Resources	"The deposition affects access to/from recreational facilities (boat launches, docks), and operational facilities (docks and landings); access to Ross Dam and Reservoir for ongoing operations and maintenance; and/or power generation associated with the Project." The deposition affects cultural, fisheries, and aquatic resources. See previous comments.	See responses to Comments #4, #6, and #18.
60.	USFS	04/14/2020	Section 2.4 Project Operations and Effects on Resources	***The FS recommends*** a clear statement of **project effect** on sediment deposition dynamics and their subsequent impact on aquatic/recreational resources. Identify the clear project effect of operations management on depositional patterns, and include the "potential" impacts to aquatic habitats that this study will address. Alternatively, remove FA44 and FA45 as issues to be addressed and focus solely on recreation impacts. ***The FS recommends*** modifying the following statement "…The data obtained with the methods identified below will be used to analyze future deposition volumes and patterns to help develop methods to manage sediment deposition at the areas of resource concern…" I'm hoping that we all agree that sediment transport and deposition from tributaries will not cease to occur in the future!	See responses to Comments #6 and #7.

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61.	Brock Applegate (WDFW)	04/13/2020	Section 2.5 Study Area	SCL should include Big Beaver Creek and all other tributaries that may have fish passage blockages due to sedimentation when the tributary flow arrives at the reservoir or the backwater cause by it.	See responses to Comment #4.
62.	Judy Neibauer (USFWS)	04/13/2020	Section 2.5 Study Area	Agreed. Also see my previous comments about expanding this study to include tributaries and reservoir beds. Rationale: Deposition likely occurs at multiple locations along the lower reaches of tributaries. This may depend where the reservoir elevation levels intersect along the stream. Deposition also can occur long distances out into the reservoir from the tributary mouths and from erosion of exposed reservoir shorelines/beds by wind and rain storm events. Also, aggradation and deposition of larger substrate and smaller sediments have likely occurred some distance upstream from the location of the reservoir bed to some type of reach break or point of inflection in the tributary stream channels. These distances upstream might be unique to geomorphology and land types.	Comment acknowledged. All elements of deposition will be addressed to assess potential Project impacts on the target resources identified in the study plan.
63.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.5 Study Area	Upper Skagit Indian Tribe believes the study area should encompass the entire reservoir system. See previous comments.	See response to Comment #11.
64.	USFS	04/14/2020	Section 2.5 Study Area	***The FS recommends*** including all of the tributary/reservoir confluences where aquatic habitat impacts are likely to occur from project effects. This could be completed in the same fashion as the study area in Canada with remote sensing data. Field work could be limited to those areas where remote sensing data is insufficient.	See responses to Comments #4 and #6.

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65.	Jon Riedel (NPS)	03/27/2020	Figure 2.5-4	"Study area – Diablo Lake –Thunder Arm inlet, with Colonial Creek Boat Launch/Dock." Show Rhode Creek, a major source of sediment for boat launch.	Map revised to show Rhode Creek.
66.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6 Methodology	Given expectations about collaboration and cross-resource coordination, this Methodology needs to explicitly include a statement about consultation with other working groups, particularly the CRWG.	City Light will work with RWGs so that information from all related studies will be integrated in the context of the ILP process.
67.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.1 Compile and Assess Existing Information	Compile geomorphology, geology land types to assist in determining natural levels of deposition within tributaries and at mouths of tributaries. .See my comments about adding in areas above. Possibly assign a high, moderate, low risk to tributaries for their natural levels of deposition, while using geology/ landform to help sort them. You can use that condition risk as a base to start from to help determine operational effects. I am just thinking out loud here, but you will need to determine levels of natural deposition and baseline conditions to be able to show operational effects at points of deposition. This will also inform any type of maintenance or restoration needed in the future.	See response to Comment #1.
68.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Compile and Assess Existing Information	4th Bullet – Comment "Average annual sediment budgets for ten Skagit River sub-basins developed by Paulson (1997; USACE 2008)…." These will be good sanity checks and initial starting point but SCL is going through a lot of	The conditions in different watersheds will be considered as part of this analysis to aid in determining if referenced studies are applicable. One objective of the study is to determine sediment inputs from each watershed; a variety of methods are described to do this. Text revised to clarify.

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				trouble just to use these two already developed budgets anyway. Why not develop a sediment budget based on all the data being collected in each specific basin, each of which can more directly apply to other basins in the project?	
69.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Compile and Assess Existing Information	4th Bullet – Comment "Estimates for glaciated areas (Nichols 2006) will be used for glaciated areas of tributary watersheds." It was only 1 estimate.	Agreed. Thank you for the clarification. Text revised.
70.	Curtis Clement (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Compile and Assess Existing Information	4th Bullet – Comment "Estimates for glaciated areas (Nichols 2006) will be used for glaciated areas of tributary watersheds." Again, where did this estimate come from? It is also unclear how this will be used. Thunder creek is glacially fed but not all of it is a "glaciated area." How will this study define glaciated area? How will the yield/acre for glaciated areas be incorporated?	The area of a specific watershed that is covered by glacial ice will be used to help estimate the amount of sediment coming from that erosional process (this is what is meant by "glaciated area"). Estimates of sediment production from other glaciated areas in the Pacific Northwest may also be used as appropriate. Text revised for clarity.
71.	USFS	04/14/2020	Section 2.6.1 Compile and Assess Existing Information	***The FS requests*** review of the methods in Nichols 2006 that will be used for glaciated areas of tributary watersheds. We were unsuccessful finding it in the archived materials on the HDR sharepointe site.	References will be made available to LPs.
72.	Jon Riedel (NPS)	03/27/2020	Section 2.6.2.1 Bathymetry	How will you measure? At spots, continuous swath?	The specifics of the bathymetry analysis will be selected based on the most appropriate technology to obtain the needed data at each site.

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73.	Curtis Clement (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.2.1 Bathymetry	"Bathymetry data…." Multibeam, singlebeam, vessel mounted with IMU or handheld unit, or a wading rod? LiDAR? What method to be used?	See response to Comment #72
74.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.2.1 Bathymetry	"Some bathymetry data have been collected for part of the Thunder Arm inlet; these data will be supplemented to cover the entire study area." What is the source and year of data collection? Is there need to consider whether additional deposition has occurred since this data was collected?	Green LiDAR was flown in April of 2018 for Diablo Lake by Quantum Spatial. These data should be recent enough to support the study.
75.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2.1 Bathymetry	Why not cover other areas of Gorge Lake? It seems that should be looked as well. Besides in tributaries, you will need to understand if there are any in-reservoir passage barriers at certain operational flows. Does current bathymetry cover the whole lake?	There is no evidence of in-reservoir passage barriers in Gorge Lake. See response to Comment #4.
76.	USFS	04/14/2020	Section 2.6.2.1 Bathymetry	***The FS recommends*** a description of how the bathymetry will be collected. There was mention of using existing bathymetry for a part of Thunder Arm inlet. To avoid discrepancies in volumetric estimates across time, all bathymetric data should be collected at the same time.	The specifics of the bathymetry analysis will be selected based on the most appropriate technology to obtain data at each site. The date that each set of bathymetric data was collected will be accounted for during data analysis.
77.	Jon Riedel (NPS)	03/27/2020	Section 2.6.2.2 Sediment Transport and Deposition	"Evaluation of the change in slope can be used to evaluate changes in transport processes (Richards 1982)." At Lake Chelan we developed a 1-D backwater model to quantify this, and it went >0.25 miles upstream..	City Light agrees that changes in slope can be due to numerous factors; these will be assessed during the analysis. Text revised for clarity.

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				Change in slope may be due to underlying geology and reach scale geomorphology. See glacial lake Skagit in Riedel 2017.	
78.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.2.2 Sediment Transport and Deposition	I agree with Jon. Other things can affect a change in slope besides the end of sediment transport. SCL should explain how they will address this possible problem.	See response to Comment #77.
79.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2.2 Sediment Transport and Deposition	"Evaluation of the change in slope can be used to evaluate changes in transport processes (Richards 1982)." Slope might be a good first cut, but there may be other geomorphic / terrain features or flow processes (glacial dominated vs spring fed systems) that cause reservoir effect to go further upstream. Utilize geomorphic study and geology or land type data to help determine distances of influence upstream in tributaries. You will likely need to use landform, geomorphology, aerial photo interpretation to assist in depicting distances upstream where operational effects dissipate. Separately, you may need to do some reservoir bed surveys along key tributaries to look for connectivity issues.	See response to Comment #77.
80.	Curtis Clement (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.2.2 Sediment Transport and Deposition Zones	3rd Paragraph – Comment "This information will be used to inform long-term input and influence from upstream and non-project sediment upon sediment management in the areas of concern." Also to inform downstream geomorphology study and potential management goals, such as sediment enrichment.	See response to Comment #11.

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81.	USFS	04/14/2020	Section 2.6.2.2 Sediment Transport and Deposition	***The FS recommends*** evaluating other mechanisms of slope change like underlying geology or reach scale geomorphic controls. How these natural controls modify the geographic scope of project effects will be important to address either quantitatively or qualitatively in the results.	See response to Comment #77.
82.	Curtis Clement (Upper Skagit Indian Tribe)	04/10/2020	Section 2.6.2.3 Mapping of Inlet Area Deposits, Exposed Sediments	1st Paragraph – Comment "….1000 ft^2 to be considered a separate facies (approximately 10 meter [m] x 10 m…" Did you mean 100 square feet or 1000 square feet?	1,000 square feet as stated in the methods.
83.	Curtis Clement (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.2.3 Mapping of Inlet Area Deposits, Exposed Sediments	2nd Paragraph – Comment "There may be shallow inundated areas that are too fine-grained and saturated to walk nor deep enough to use a shallow-draft boat so these areas may need to be estimated using aerial imagery." This would be a good opportunity to use green lidar, which has been discussed for use in other study plans.	Thank you for the comment. City Light agrees and would use existing green LiDAR as available.
84.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2.3 Mapping of Inlet Area Deposits, Exposed Sediments	Wind driven erosion, turbidity, an deposition can occur in a number of locations. Examine wind patterns from storms and runoff patterns of tributaries, to help assess effects within reservoirs. I have seen wind and rain driven muddy waters, several hundred yards off of reservoir shorelines many times. There may be a depositional area some distance out where the accumulations from these wind/rain events occur.	See response to Comment #10. However, there is no plan to attempt to map out turbidity plumes associated with individual depositional features, plumes that are likely of short duration and localized, and therefore unlikely to have significant effects on aquatic resources over time.

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				The turbidity caused from shoreline/reservoir bed sediments, can affect foraging and swimming abilities, contribute to predation, degrade refugia habitat… among other issues….especially, if events occur near key holding/forage habitat and at mouths of tributaries and during juvenile outmigration or adult spawning migration.	
85.	USFS	04/14/2020	Section 2.6.2.3 Mapping of Inlet Area Deposits, Exposed Sediments	***The FS recommends*** including bedload core sampling as part of the field data collection effort as a measure of project effect on fine sediment volume in suitable spawning habitat for individual fish species. A random sub-sample across tributary/reservoir confluences can be collected during other field reconnaissance.	See response to Comment #6.
86.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.3 Analysis	"For the three study areas where new data will be collected (e.g., Sourdough Creek Thunder Arm, inlet, and Hozomeen inlet):" May need to include other areas per previous comments	See responses to Comments #6, #11, and #13 and parts of #1.
87.	Jon Riedel (NPS)	03/27/2020	Section 2.6.3 Analysis	3rd Bullet – Comment "Current bathymetry with data tied to mean high water elevation." What will error be in the estimate?	Error estimates will be developed as part of data analysis during the study.
88.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.3 Analysis	4th Bullet – Comment DEM of study areas developed from bathymetry and existing topography below and outside of mean high water level. Aerial photo analysis, may help identify	The locations to be studied have been identified with specificity. City Light does not intend to expand the analysis to characterize conditions at a large number of tributary mouths. See responses to Comments #6, #11, and #13 and parts of #1.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				locations of key tributaries with sediment deposition, and determining wind and bank erosion, turbidity, and deposition risk areas?	
89.	Jon Riedel (NPS)	03/27/2020	Section 2.6.3 Analysis	7th Bullet – Comment "Calculated sediment volume/year deposit within study areas based on 1952 Ross Dam construction and 1936 Diablo Dam construction or the latest bathymetry/topographic data available for comparison." These are 25 ft contour maps, so the estimate would have a large error.	See response to Comment #87.
90.	Jon Riedel (NPS)	03/27/2020	Section 2.6.3 Analysis	12th Bullet – Comment "Estimate of sediment mobility in the tributary below and above the inflection point where transport processes change from transport-dominated to deposition affected by the reservoir level in Sourdough Creek, Thunder Creek, and the Skagit River above the Hozomeen inlet." Why just these tributaries? There are many other large ones influenced by reservoir backwater – e.f. Devils. Ruby, Lightning, L. Beaver.	These tributaries were identified due to specific, known recreation and operations related concerns, i.e., to obtain information required to complete a specific effects assessment.
91.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.3 Analysis	12th Bullet – Comment I agree with Jon. SCL should develop a sediment budget for the entire Project area, but at the very least address and study those areas that may have fish and wildlife impacts due to sediment aggradation. How will SCL address possible fish passage barriers and loss and degradation of aquatic habitat in those areas?	See responses to Comments #4, #6, and #13.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
92.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.3 Analysis	13th Bullet - Added a new bullet "Description of habitat of fish and wildlife described by type, quality, and quantity and possible impacts by any recommended projects or management generated by this study plan."	See responses to Comments #6 and #13. Potential impacts associated with any proposed projects or management actions will be assessed as part of the planning process for those actions.
93.	Curtis Clement (Upper Skagit Indian Tribe)	04/10/2020	Section 2.6.3 Analysis	7th Bullet – Comment "Calculated sediment volume/year deposit within study areas based on 1952 Ross Dam construction and 1936 Diablo Dam construction or the latest bathymetry/topographic data available for comparison." The intention here is not clear. If you are talking about using contours from those times I am skeptical that you will be able to capture the changes in volume simply because of the resolution of surveys from that time. More recent data needs to be included to support whether certain depositional features did or did not already exist.	See response to Comment #89.
94.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.3 Analysis	8th Bullet – Comment "Estimate of sediment input to the areas of concern." Reported by size class?	Total sediment input will be estimated; estimates by size class will be made, if possible, from data collected as part of the study. Text revised to clarify.
95.	USFS	04/14/2020	Section 2.6.3 Analysis	***The FS recommends*** a review of the goals and objectives of this study plan, the issues identified to be addressed, and whether the analysis will result in conclusions of how project operations effects sediment deposition and consequent aquatic habitat impacts.	See responses to Comments #4, #6, and #7.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				The FS did not identify a clear study goal (section 2.1) specific to sediment depositional impacts to aquatic habitat, nor was an explicit design feature in the methods (section 2.6) meant to address aquatic habitats impacts, and there appears to be no specific measure of aquatic habitat degradation due to project effect (section 2.6.3). ***The FS recommends*** this study plan focus on recreation impacts as it does not appear to be directed at aquatic habitat concerns as described in FA44 and FA45.	
96.	USFS	04/14/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	***The FS recommends*** review of Nichols 2006.	Thank you for your comment.
97.	Brock Applegate (WDFW)	04/13/2020	Section 2.8 Schedule	Edited or added the following bullets: ▪ Initial Study ~~Final~~ Report (ISR)– March 2022 ▪ ISR Study Meeting ▪ Requests for study plan modification (if needed) ▪ Second Season of Field Work and studies (if needed) ▪ Post-field analysis (if needed)– April to December 2022 ▪ Final Study Report (if needed)—March 2023 **New comment provided on 05/05/2020:** I agree with the reasoning of SCL other than SCL will conduct a study meeting. How about adding below? - Final report of the Initial Study Report (ISR)	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP provides the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have information from the studies available as soon as possible to

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				- ISR Study Meeting - Request for study plan modification (if needed) SCL will have a study meeting. Why not list the meeting?	inform development of management proposals and cross resource analysis. **Response to comment provided on 05/05/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
98.	USFS	04/14/2020	Section 2.9 Level of Effort and Cost	***The FS recommends*** a breakdown of likely costs for each phase (described in section 2.8).	City Light is open to discussions with LPs regarding the need for the additional information that is being requested. Costs will be updated through subsequent drafts of the study plan.

GE-04 SKAGIT RIVER GEOMORPHOLOGY BETWEEN GORGE DAM AND THE SAUK RIVER PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Acronyms and Abbreviations

CFR.....Code of Federal Regulations
City Light.....Seattle City Light
dbh.....diameter at breast height
Ecology .....Washington State Department of Ecology
EFH.....Essential Fish Habitat
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
FARWG .....Fish and Aquatics Resource Work Group
FERC.....Federal Energy Regulatory Commission
FLA.....Final License Application
FPA .....Federal Power Act
GIS .....Geographic Information System
ILP.....integrated licensing process
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
LRMP.....Land and Resource Management Plan
LWD .....large woody debris
NAIP .....National Agriculture Imagery Program
NHPA.....National Historic Preservation Act
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
USACE .....U.S. Army Corps of Engineers
U.S.C.....United States Code
USFS.....U.S. Forest Service

USFWS .....U.S. Fish and Wildlife Service

USGS .....U.S. Geological Survey

USIT.....Upper Skagit Indian Tribe

WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project vicinity resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

The relicensing process includes the timeframes and deadlines specified in FERC's integrated licensing process (ILP), including consultation with interested agencies and Indian tribes related to study plans, study results, and subsequent analysis of results and effects analysis through the filing of the Final License Application (FLA). FERC's process includes steps to satisfy the various statutory authorities identified in the Federal Power Act (FPA) (e.g., Sections 4(e), 10(j), 10(a)). Other related regulatory processes including Washington State Department of Ecology's (Ecology) Section 401 water quality certification process, the U.S. Fish and Wildlife Service's (USFWS) and National Marine Fisheries Service's (NMFS) Section 7 Endangered Species Act (ESA) consultation, NMFS's oversight of Essential Fish Habitat (EFH), as defined by the Magnuson Stevens Fishery Conservation and Management Act, and consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA) will continue following filing of the FLA. With the filing of the PAD, City Light requested that FERC designate City Light as FERC's non-federal representative for purposes of initiating and conducting day-to-day consultation under ESA Section 7 and NHPA Section 106, which was granted by FERC in its June 26, 2020 Notice of Intent to File License Application for a New License and Commencing Pre-Filing Process.

1.3 Study Plan Development

In 2019-2020, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential Project effects. City Light developed 24 study proposals, including this Geomorphology between Gorge Dam and the Sauk River Study Plan.

On March 13, 2020, City Light released the Skagit River Geomorphology Between Gorge Dam and the Sauk River Draft Study Plan for LP review and comment. On March 31, 2020, the draft study plan was discussed at a Fish and Aquatic Resource Work Group (FARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 16, 2020. The revised draft was discussed on June 24, 2020 at a FARWG meeting. Written comments were received from NMFS, U.S. Forest Service (USFS), NPS, USFWS, Washington Department of Fish and Wildlife (WDFW), Upper Skagit Indian Tribe, Skagit River Systems Cooperative, and Sauk-Suiattle Indian Tribe and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date.

Five LPs submitted a total of 13 study requests related to geomorphology and aquatic habitat in the Skagit River and Project effects on sediment, instream large wood, channel forming flows, and/or floodplain connectivity/off-channel aquatic habitat: NMFS-02 Geomorphology and Aquatic Habitat, NPS-11 Impact of Operations of Skagit Hydroelectric Project (#553) on Sediment Capture Within Reservoirs and Sediment Recovery Below Gorge Dam and Its Influence on Endangered Species Habitat, NPS-12 Impact of the Operations of Skagit Hydroelectric Project (#553) on Sediment Storage, Stability and Transport on Skagit River and its Influence on Endangered Species Habitat, NPS-13 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood and Sediment Below Gorge Dam, USFWS-11 Impact of Operations of Skagit Hydroelectric Project (#553) on Sediment Capture Within Reservoirs and Sediment Recovery Below Gorge Dam and Its Influence on Endangered Species Habitat, USFWS-12 Impact of the Operations of Skagit Hydroelectric Project (#553) on Sediment Storage, Stability and Transport on Skagit River and its Influence on Endangered Species Habitat, USFWS-13 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood, and Sediment below Gorge Dam, USFWS-15 Geomorphology and Aquatic Habitat Complexity Study Request, USIT-08 Geomorphology and Anadromous Salmonid Habitat, WDFW-05 Geomorphology and Anadromous Salmonid Habitat, WDFW-08 Impact of the Operations of Skagit Hydroelectric Project (#553) on Process Flows of Water, Wood and Sediment Below Gorge Dam, WDFW-09 Wood Budget, Inventory and Assessment, and WDFW-10 Impact of Operations of Skagit Hydroelectric Project (#553) on Sediment Capture Within Reservoirs and Sediment Recovery Below Gorge Dam and Its Influence on Endangered Species Habitat.

This Skagit River Geomorphology between Gorge Dam and the Sauk River Study Plan addresses, with modifications, many of the elements identified in the study requests listed above, as explained in Section 6 of the PSP. City Light has addressed LPs' specific comments and suggested edits to this study plan.

Project operations alter peak flow magnitude, duration, and timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat and cultural resources through the alteration in flow, sediment, and large woody debris (LWD). Geomorphic processes affect aquatic habitat by influencing substrate size and quality, large wood dynamics, main channel and side channel habitat abundance and diversity, and side channel, wetland, and floodplain connectivity. Information on geomorphic processes, aquatic habitat for a number of fish species including anadromous, migratory, and resident salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence is needed to improve the understanding of how Project operations influence aquatic species and their habitat and cultural resources over the next license term.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River Study (Geomorphology Study) are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes, which will be used to evaluate the Project's contribution to cumulative effects in the reach.

Specific objectives include:

- Use aerial photograph and LiDAR data and collect field data to document current conditions and changes to document:
  - Baseline channel configuration and migration patterns;
  - Distribution of aquatic habitat types, characteristics, and availability;
  - Side channels and off-channel habitat, including hydraulically connected wetlands;
  - Substrate size and distribution; sediment sources and delivery mechanisms; and
  - Large wood input, transport, and retention.
- Determine flow rates that result in redd scour to help guide management of peak flow releases from Gorge Dam and Powerhouse.

2.2 Resource Management Goals

The study will provide information to help resource agencies and Indian tribes with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Resource management goals were provided by LPs in their study requests identified in Section 1.3 of this study plan.

2.3 Background and Existing Information

Aquatic habitat in the Skagit River supports numerous anadromous, migratory, and resident fish species as well as other aquatic organisms. Geomorphic processes affect components of aquatic and riparian habitat, including substrate size, quantity and quality; large wood dynamics, and main channel and side channel habitat diversity. Floodplain connectivity—both hydraulic and geomorphic—is also important for aquatic and terrestrial biota and riparian ecosystem dynamics. Information on floodplain and riparian vegetation, wetlands, and landform mapping being conducted in other Skagit licensing studies will provide baseline information helpful to the analysis of geomorphic and aquatic habitat conditions considered in this study plan.

Detailed information on aquatic habitats downstream of Gorge Dam is needed to improve the understanding of current spawning and rearing capacity for all salmonid species using the habitat, and how these factors could be predicted to change over the next license term. Additional information is also needed to establish gravel quantities and quality on a spatial scale, gravel mobilization and redd scour flows in primary spawning areas, and changes to river geometry that may occur through time. Data on existing river conditions downstream of Gorge Dam are needed to enable tracking changes to:

- Channel configuration and migration patterns;
- Aquatic habitat types, characteristics, and availability;
- Side channels (existing channels, formation and maintenance processes);
- Substrate size and distribution; and
- Large wood (existing; potential input, transport, and retention processes).

Other land use practices such as timber harvest, road construction, and bank protection downstream of Gorge Dam also influence geomorphic processes and the suitability of aquatic habitat. Evaluating the relative influence of different natural and human-induced processes will aid in the understanding of existing river conditions.

City Light surveys anadromous fish spawning locations throughout the year and records location, water depth, and species. These data can provide information on preferred spawning locations and habitat to help guide gravel scour monitoring. Flow data in the reach is available at several U.S. Geological Survey (USGS) gage locations to help analyze the interaction between peak flows and geomorphic processes. Historic and recent aerial photographs and recent LiDAR data are available to aid in mapping channel configuration, large wood, and sediment dynamics.

Existing information that provides a basis for understanding geomorphic processes in the Skagit River includes:

- A baseline fluvial geomorphology report was prepared for the Skagit River basin (Gorge Powerhouse to estuary) by the U.S. Army Corps of Engineers (USACE) that includes an estimated sediment input budget based on basin sediment budgets and suspended load data and a description of fluvial geomorphic reaches (USACE 2008).
- Channel incision was identified as a potential issue during the Skagit River Project's last relicensing in the early 1990s. Analysis of USGS gage records at that time showed incision at the Alma gage (no longer in service) and little variation to 0.4 feet of aggradation at the Newhalem gage (Riedel 1990).
- The WRIA Limiting Factors Assessment for the Skagit River (Smith 2003) identifies types of habitat/conditions that are limiting fish production in the river. Information on substrate quality, streambed stability and LWD are listed as data gaps in the upper Skagit River (Newhalem to Sauk River confluence).
- The Skagit Watershed Council produced Geographic Information System (GIS)-based analyses of relative sediment input, riparian conditions, and bank hardening areas in the Skagit River system (Beamer et. al 2000). This information was used for a reach assessment of the Middle Skagit River (Sauk River confluence to Sedro-Woolley) that analyzed potential areas to target habitat restoration based on habitat, geomorphology, and land uses (Smith et al. 2011).
- A sediment budget of the Middle Skagit River (Rockport to Sedro-Woolley) was developed by Rothleutner (2017) and included an analysis of historical channel migration rates and sediment input from river meandering. GIS-based methods used for this analysis could be used in other river reaches to estimate sediment input from bank erosion and channel migration.

- The Skagit Watershed Council commissioned a report on LWD in the Skagit River system (Natural Systems Design 2017) that identified LWD as a potential limiting factor in the Skagit Chinook Recovery Plan. The report also included a summary of existing factors affecting LWD recruitment and potential methods to analyze/inventory LWD in the watershed.
- Geomorphology, hydrology, and hydraulics studies undertaken for the Barnaby Reach restoration project provide detailed information on the Skagit River channel, off-channel areas, and floodplain in the area just upstream of the Sauk River confluence (Skagit River System Cooperative and Natural Systems Design 2019).
- Suspended sediment monitoring by the USGS on the lower Skagit River (Curran et al. 2016) and Sauk River (Jaeger et al. 2017).

2.4 Project Operations and Effects on Resources

Project operations alter peak flow magnitude, duration, and timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat through the alteration in flow, sediments, and LWD. Geomorphic processes affect aquatic habitat by influencing key habitat forming elements, such as: substrate size, amount, and quality; key pools, large wood dynamics, main channel and side channel habitat diversity, streambank condition, riparian vegetation, tributary and floodplain connectivity, including side channel and hydraulically connected wetlands.

2.5 Study Area

The primary study area includes areas where new information collection will occur in the Skagit River and tributary deltas between Gorge Dam and the Sauk River confluence (Figures 2.5-1 through 2.5-3). This study will also compile existing relevant geomorphic information on the Skagit River downstream from the Sauk River confluence, which will be used to evaluate the Project's contribution to cumulative effects in that reach, but will not collect any new information downstream from the Sauk River confluence.

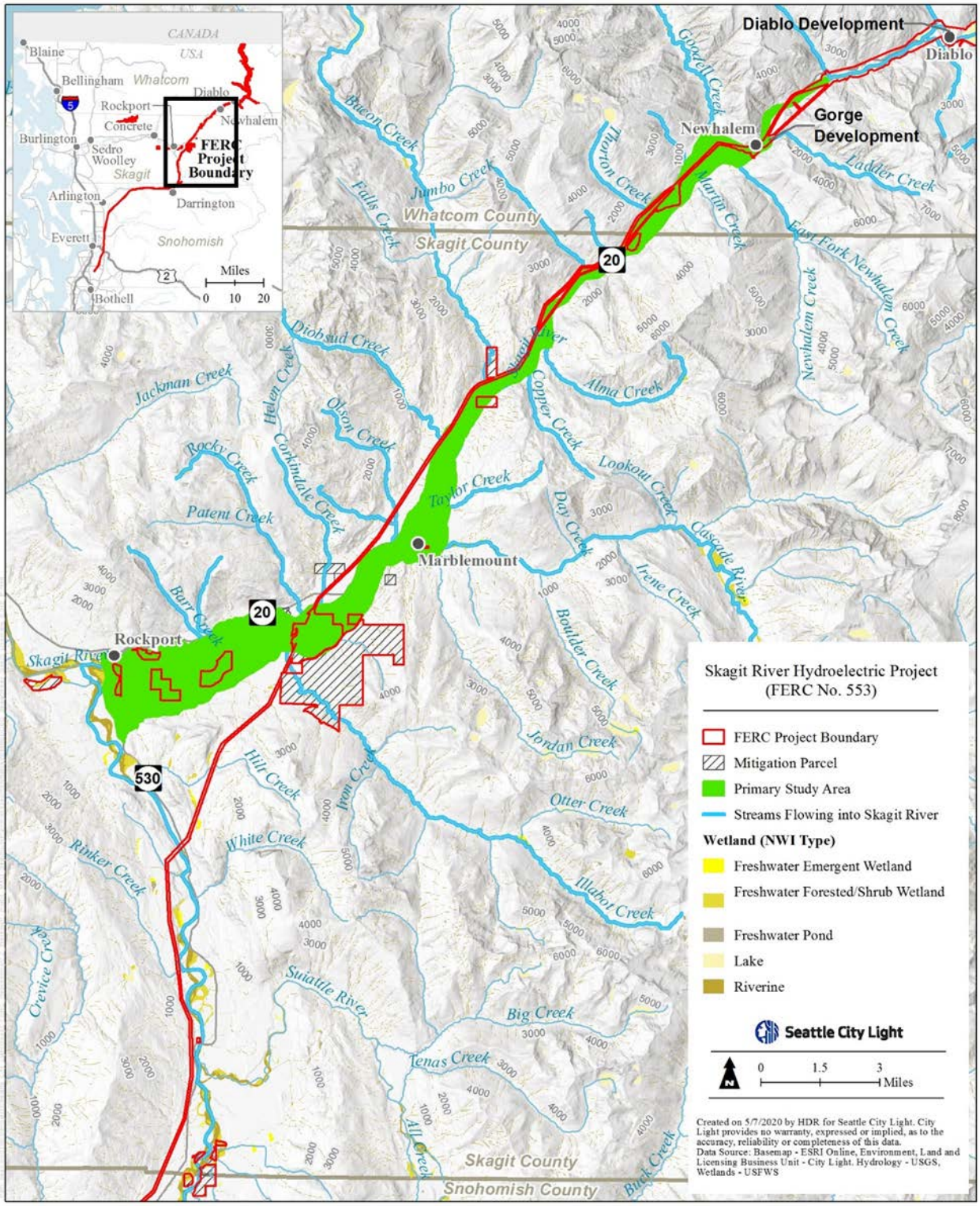

Figure 2.5-1. Overview of study area: Gorge Dam to Sauk River confluence.

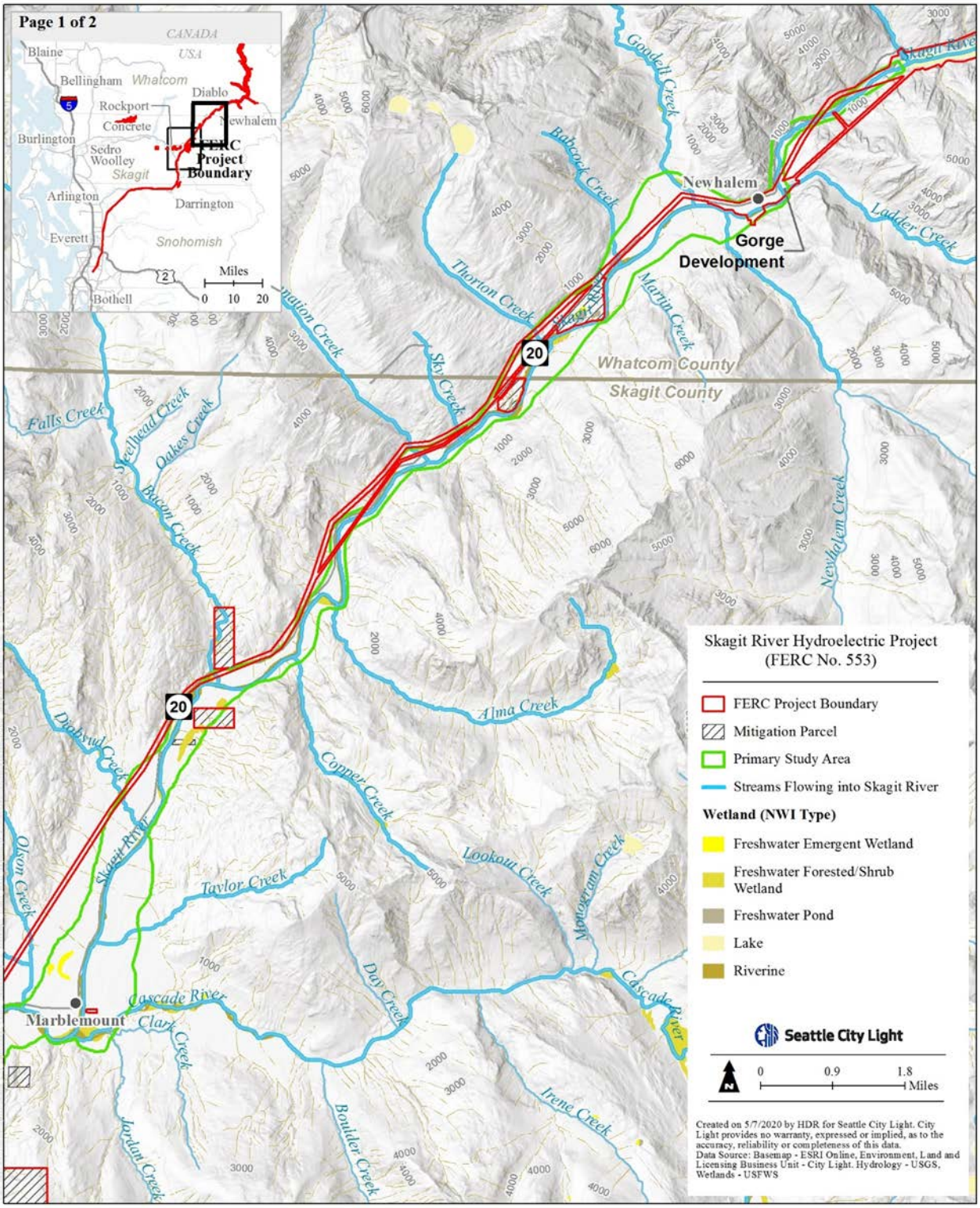

Figure 2.5-2. Northern portion of study area: Gorge Dam to Marblemount.

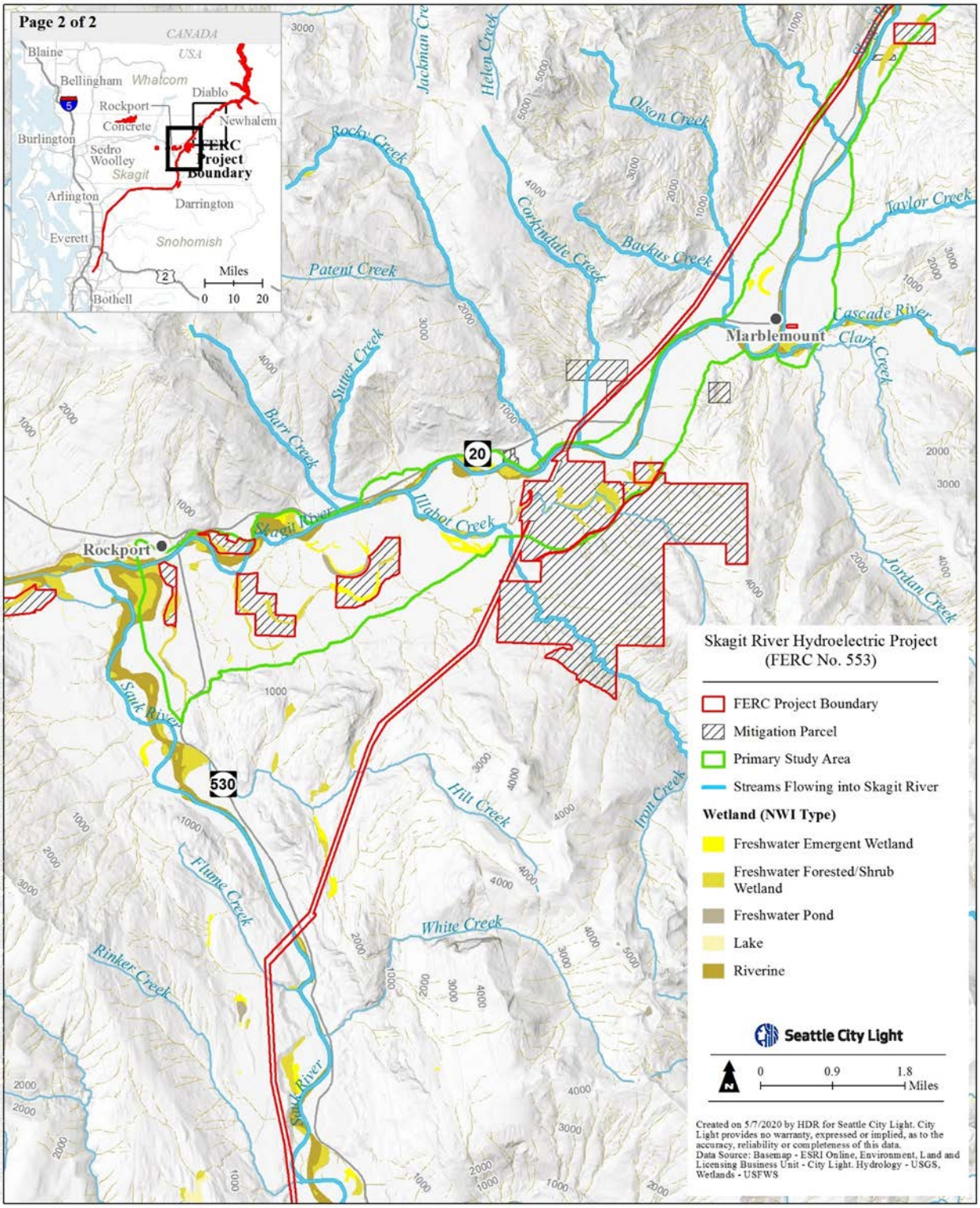

Figure 2.5-3. Southern portion of study area: Marblemount to Sauk River confluence.

2.6 Methodology

The Skagit River Geomorphology from Gorge Dam to the Sauk River Study will include pre-field analysis of existing information, one season of field work to inventory current geomorphic conditions in the Skagit River, three years of scour monitoring[1], and post-field analysis and report writing. Work below is described by geomorphic/habitat topic, but information on multiple topics will be collected during a single field effort for efficiency, and the analysis and reporting will include a synthesis of geomorphic processes among the different topics.

2.6.1 Collect Existing Information

Existing reports, maps, aerial photographs, LiDAR data, peak flow data, and habitat/redd survey data will be compiled (see Table 2.6-1 for available aerial and LiDAR data sets). Up to seven sets of aerial photographs will be chosen from available coverage at approximately decadal scale for use in analysis of planimetric geomorphic changes under existing flow conditions. These will be related to topographic changes determined by evaluation of geomorphic change between LiDAR surfaces. Pre-field analyses will be conducted using this data as described by topic in the following sections. A comprehensive set of base maps will be prepared to use for field inventory between Gorge Dam and the Sauk River confluence (a set of laminated high-resolution copies of aerial photographs and a set of laminated copies of visualization detrended LiDAR topography data). Geomorphic reaches will be delineated based on consideration of several factors such as gradient, confinement, tributary junctions, and landform mapping (being conducted by NPS). These reaches will be used to help group and analyze geomorphic data.

Available reports on Skagit River geomorphology downstream from the Sauk River confluence will be summarized. An annotated bibliography will be prepared, and a summary of geomorphic conditions will be written for inclusion in the study report.

[1] A pilot scour monitoring study started in September 2019; it is anticipated the scour monitoring study will be expanded to include new areas and continue through September 2022.

Table 2.6-1. Available aerial photograph and LiDAR Data.

Date	Image Type	Scale	Notes
Orthophotos			
1947	Orthophoto quads	1:62:500	
1950	Orthophoto quads	1:62:500	Basis for 15' topo series
1974	Orthophoto quads	1:24,000	Basis for 7.5' topo series
1990	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1992	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1993	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
1998	Orthophoto quads, 1-2m res.	1:24,000	Update to 7.5 minute series various quads
Hard Copy Stereoscopic Photographs			
1947	Black B&W stereo photos	1:27,700	USFS
1950s	B&W stereo photos	1:24,000	USFS
8/9-1956	B&W stereo photos	1:24,000	EBK series USFS (NPS incomplete set)
1957	Unclear	1:47,200	VRL series USGS (no NPS set)
1958	Unclear	1:49,000	VSA series USGS (no NPS set)
1963/64	B&W (?) stereo	1:12,000	EMM series USFS (NPS incomplete set)
1973	B&W (?) stereo	?	VCAG series USGS (no NPS set)
1978	True color stereo photos	1:24,000	NPS
1998	True color stereo photos	1:12,000	NPS
Hard Copy Stereoscopic Photographs - Pairs			
1984	Color, Hi- res. CIR min. overlap	1:10,000	NPS prints 3 feet x 3 feet
1990	Hi -res. B&W min. overlap	1:10,000	NPS prints 3 feet x 3 feet
2006	True Color National Agriculture Imagery Program (NAIP) hi-resolution	1m	Digital
2009	True Color NAIP hi-res.	1m	Digital
2011	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2015	True Color NAIP hi-res.	1m	Digital
2017	True Color NAIP hi-res.	1m	https://viewer.nationalmap.gov/basic
2006	True Color NAIP hi-resolution	1m	Digital
2009	True Color NAIP hi-res.	1m	Digital
2011	True Color NAIP hi-res.	1m	Digital
LiDAR			
2005	LiDAR	digital	Puget Lowlands – partial coverage
2006	LiDAR	digital	North Puget (USGS)
2009	LiDAR	digital	North Cascades – partial coverage
2017	LiDAR	digital	Skagit River topobathymetry – partial coverage
2017	LiDAR	digital	North Puget
2018	LiDAR	digital	Seattle City Light topobathymetry

2.6.2 Geomorphic Change

The analysis of geomorphic change includes two primary metrics: channel migration and channel incision. Changes in active channel width, sinuosity, and braiding intensity will also be analyzed. Tasks will include the following:

Mapping will be conducted of active channel areas as polygons on current (2019) and up to six historical geo-referenced aerial photographs (seven total sets of aerials). Active channels include areas within the river where the combination of sediment transport intensity and hydroperiod prevent establishment of vegetation. Wetted areas will be digitized separately from unvegetated areas (bars) and each polygon will be coded as wetted or unvegetated bar.

Channel migration rates will be calculated by summing the difference in new channel planform area between aerial photograph years and dividing by reach length. Migration rates will be calculated for each bank of the river separately. Channel migration rates will be compared to peak flow conditions and changes to sediment inputs and large wood loading to determine conditions which contribute to bank erosion and channel migration. Channel migration history over the existing license period will be visualized by calculating historic channel occupancy maps and maps illustrating historic channel positions. Bank protection will be taken into account when analyzing channel migration.

Sediment input from channel migration will be estimated based on the methods used by Rothleutner (2017) in the middle Skagit River to allow direct comparison and, for the more recent period with available LiDAR data, by comparing geomorphic change between LiDAR surfaces. This task will be coordinated with the bank material sampling undertaken as part of the landform mapping study to assess grain size of eroded bank material.

Locations and character of bank protection will be mapped between Gorge Dam and the Sauk River to update information in Beamer et al. (2000). This will be coordinated with other field efforts (e.g., landform mapping study or aquatic habitat mapping) and any other updated hydromodification data from other sources.

Active channel width, sinuosity, and braiding intensity will be calculated for appropriate geomorphic reaches (reaches with similar confinement characteristics) based on the active channel mapping. Changes through time will be tracked.

An analysis of USGS gage rating curve changes during the term of the current license (from 1990 to present) will be made at the Skagit River at Newhalem (USGS 12178000), Skagit River at Marblemount (USGS 12181000), Skagit River near Rockport (USGS 12184700) gages to evaluate potential channel incision or aggradation. These data will be combined with rating curve change analysis from the previous licensing studies (Riedel 1990). If feasible, historic cross-section data at other locations between the Gorge Dam and the Sauk River will be compared with available Green LiDAR data to evaluate channel changes at locations between gages.

The Relative Elevation Map based on current LiDAR data (developed as part of landform mapping study being conducted by the National Park Service) will be used to analyze channel evolution stage between Gorge Dam and the Sauk River based on the Stream Evolution Model in Cluer and Thorne (2013).

2.6.3 Aquatic Habitat

An inventory of the current status of aquatic habitat in the Skagit River between the Gorge Dam and the Sauk River will be made using both remote sensing and field methods. This work will be coordinated with data collected in the FA-02 Instream Flow Model Development Study and the FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study (Bypass Hydraulic Model Development Study).

An initial map of aquatic habitat types will be made based on recent (2019) georeferenced aerial photographs and green LiDAR (e.g., riffle, pool, glide, cascade, side channels as visible – see Section 2.6.4 of this study plan for more detail on side channels). Habitat units will be digitized from 2019 aerial/LiDAR data to obtain a GIS layer. Data fields obtained from the GIS analysis will include habitat type, average depth (from green LiDAR), and average wetted width. Estimates of average bankfull width and depth will be made based on the green LiDAR and results from the 2D hydraulic model (Instream Flow Model Development Study). Pool depths that were not able to be determined from the green LiDAR data will be field verified as part of the Instream Flow Model Development Study and the Bypass Hydraulic Model Development Study as described in those study plans. Field information on cover and dominant/subdominant substrate size will also be collected as part of the Instream Flow Model Development Study and the Bypass Hydraulic Model Development Study for the reach between Gorge Dam and the Sauk River and will be used to characterize each aquatic habitat unit using GIS.

Summary tables showing the amount (square feet) and characteristics of aquatic habitat will be prepared and synthesized with substrate, large wood, and side channel data collected as described in the following sections.

2.6.4 Side Channels and Off-Channel Habitat

An inventory will be taken of the current status of side channels and off-channel habitat in the Skagit River floodplain between Gorge Dam and the Sauk River. The inventory will be made using a combination of remote sensing and field methods.

An initial map of side channels and off-channel habitat will be made based on recent (2019) georeferenced aerial photographs and green LiDAR in coordination with the NPS landform mapping project currently underway and the Wetland Assessment Study. Side channels will be digitized from 2019 aerial/LiDAR data to obtain a GIS layer. Data fields obtained from the GIS analysis will include side channel type (overflow side channel [perennial and seasonal] wall-based channel, groundwater-fed channel) and area. A Relative Elevation Map, which shows relative elevations above/below river water surface, will be used to help delineate side channels and off-channel areas.

The initial map of side channels having significant habitat value (as defined in the Instream Flow Model Development Study) will be refined and field-checked during low-flow conditions as part of the Instream Flow Model Development Study. The field inventory will include collecting information on side channel characteristics not available from aerial photographs, such as inlet and outlet characteristics, dominant/subdominant substrate, and cover.

Information on off-channel habitat will be collected from aerial photographs/LiDAR and field data collected as part of the Wetland Assessment. In addition, the 2D hydraulic model being developed as part of the Instream Flow Model Development Study will be used to help assess side channel/off-channel connectivity under selected flows (flows will be determined based on a peak flow frequency analysis).

If possible (depending upon visibility of side channels on aerial photographs), side channel formation and changes through time over the period of the current license will be mapped and correlated with peak flow conditions (magnitude and duration) between aerial photographs chosen for the geomorphic change analysis to help determine how side channels form and/or are maintained under existing peak flow conditions.

A summary of the amount and quality of side channel habitat will be made. Information on side channel formation and changes over time will be used to evaluate the ability of existing peak flow conditions to create and maintain side channels.

2.6.5 Substrate/Sediment

An inventory of the current status of substrate in the Skagit River, side channels, tributary deltas, and unvegetated bars between the Gorge Dam and the Sauk River will be made. The inventory will be made using both remote sensing and field methods and will be coordinated with the landform mapping project currently underway.

Field data on dominant/subdominant substrate size between Gorge Dam and the Sauk River will be collected as part of the Instream Flow Model Development Study and the Bypass Hydraulic Model Development Study.

Wolman pebble counts (100 surficial particles) and sub-surface samples (Church et al. 1987) will be collected at locations representative of bedload transport (e.g., top end of point bars or upper end of mid-channel bars) during low flow conditions. Sample spacing will depend upon the availability of appropriate bars and will be stratified by geomorphic reach, with the aim of one sample per river mile. Pebble counts will also be made on tributary deltas to characterize the grain size of current sediment contributed from tributaries. Data from the landform mapping study currently underway will be used to assess the grain size of sediment sourced from riverbank erosion. Surface and sub-surface substrate size will be compared at sample locations to help determine the extent of any armoring.

Tributary deltas and unvegetated bars will be mapped on a series of up to seven historical to recent aerial photographs to enable tracking of their sizes and conditions over time and assess the ability of current peak flow regimes to distribute incoming sediment (see Section 2.6.2 of this study plan).

An analysis of initiation of gravel transport at key/representative spawning locations using scour monitors and accelerometers will be made to help determine the flow rate that initiates movement or results in substrate scour to redd depth. A pilot redd scour monitoring project was initiated at three locations during August 2019 to help determine the feasibility of using various scour monitor/accelerometer techniques in the Skagit River. Details of the field methods are attached to this study plan. Scour monitoring was expanded to include a total of 10 other critical spawning

areas and will be continued through the fall of 2022 to allow monitoring of several high flow seasons since high flow events are not predictable.

Summary tables and graphs showing area of different substrate sizes, median surface and sub-surface grain size (from sample locations), and proportion of bedrock, boulder, cobble, gravel, sand, and fines longitudinally along the length of the study reach will be prepared. Summary tables of these same parameters for tributary inputs will also be made. Maps showing the changes in gravel bar/tributary deltas through time will be prepared to help correlate any changes in gravel bar or delta growth/movement with peak flows. An analysis of flow levels that initiate substrate movement and scour depths in spawning areas will be made using the representative scour data. The scour data will be used along with the hydraulic modeling (see Instream Flow Model Development Study) to extrapolate the results to other areas of the study reach based on substrate size and modeled hydraulic conditions.

2.6.6 Large Wood

An inventory of the current status of large wood in the Skagit River between Gorge Dam and the Sauk River, including tributary mouths, will be conducted using both remote sensing and field methods. The inventory will be coordinated with the cover mapping conducted for the Instream Flow Model Development Study and the Bypass Hydraulic Model Development Study.

An initial inventory of large wood will be made using current (2019) filtered LiDAR cross referenced to concurrent aerial photographs (similar to methods described in Abalharth et al. 2015). LiDAR will be used to delineate large wood and jams. Delineated wood and jams will be cross referenced with aerial photographs to verify features and collect additional information such as root wad (Y/N), function, and member of log jam (Y/N). Data will be entered into the GIS coverage and volume of wood will be calculated if possible.

Current large wood will be field inventoried during low flow conditions by boat or foot in coordination with the aquatic habitat inventory. Pieces of large wood over 25 feet in length and 12 inches in diameter will be tallied in each aquatic habitat unit (see Section 2.6.3 of this study plan) in binned categories. In addition, more detailed information on large wood (over 25 feet in length and 12 inches diameter) within ten 0.5-mile-long representative detailed wood inventory reaches will be collected. In these detailed wood inventory reaches, a GPS point will be taken on each large wood piece and information on length, diameter at breast height (dbh), orientation, root wad (Y/N), single log (Y/N), jam (Y/N), source, decay class; species, mobility, habitat/geomorphic function will be collected for use in determining wood dynamics.

An inventory of large wood on up to seven sets of historical aerial photographs (assuming resolution is appropriate) over the term of the last license will be made, with wood digitized as line features to help determine large wood mobility and loading to correlate with peak flows between aerial photograph series.

Work products will include:

- Summary tables/graphs showing existing large wood loading metrics along the river;
- Summary of any changes to large wood loading and sources over the term of the current license based on historical aerial photographs correlated with peak flow conditions; and

- Evaluation of the potential for future large wood loading from tributaries and bank erosion based on tributary inputs, bank erosion rates, and riparian vegetation type and size (linked to channel migration analysis in Section 2.6.2, the Vegetation Mapping Study and Landform Mapping Study in floodplain).

2.6.7 Data Analysis and Report Preparation

A technical report will be prepared describing analysis and field inventory methods and study results. The report will include a narrative describing each of the aquatic habitat/geomorphic topic areas and results listed in the previous sections as well as a synthesis of the interactions between these processes and conditions.

Specific study and report products include:

- A description of the geomorphic setting and brief summary of relevant previous geomorphic studies conducted in the Skagit River between Gorge Dam and the Skagit River estuary including a summary of relevant information from the landform mapping study (NPS in progress).
- A summary of geomorphic change (planform change, channel migration, and channel elevation change) over the term of the current license and correlation with peak flows/geomorphic disturbances.
- GIS-based maps, summary tables and analyses of aquatic habitat, side channels, substrate, and large wood as described in previous sections.
- An analysis of initiation of substrate movement and redd scour in monitored areas (adjacent to redds) with peak flow conditions. Use the 2-D Hydraulic Model (Instream Flow Model Development Study) to extrapolate measured substrate movement with mapped grain size and computed shear stress to other critical spawning locations.
- An analysis of current side channel conditions and side channel formation/maintenance processes.
- An analysis to evaluate current amount and quality of spawning and rearing habitat for all salmonid species within the study area.
- Estimate potential future loading of large wood and gravel/cobble in the Skagit River between Gorge Dam and the Sauk River confluence.
- Synthesis of the interaction among flow, sediment loading, large wood input, channel migration/side channel formation, floodplain connectivity and aquatic habitat.

2.7 Consistency with Generally Accepted Scientific Practice

The methods described above were prepared by a Washington State Licensed Engineering Geologist and are consistent with remote sensing and field inventory methods used in other parts of the Skagit River and in other large river systems (Abalharth et al. 2015; Church et al. 1987; Cluer and Thorne 2013; Rothleutner 2017; Skagit River System Cooperative and Natural Systems Design 2019; Smith et al. 2011; USACE 2008).

2.8 Schedule

The Geomorphology Study includes pre-field office analysis of existing information, one season of field work in the river during the late summer low-flow period (summer), post-field data analysis and report preparation.

- Scour monitoring – August 2019 to July 2022
- Pre-field Analysis – January to June 2021
- Field Work – January to September 2021 (depending on flows)
- Post-field Analysis – Summer 2021 to Winter 2021–2022
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $400,000.

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SKAGIT RIVER GEOMORPHOLOGY BETWEEN GORGE DAM AND THE SAUK RIVER PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Steve Copps, Jim Meyers, and David Price (NMFS)	04/13/2020	General Comments	Each plan suffers from an abbreviated scope and lack of clarity in guiding hypotheses and the questions the studies are designed to answer. From NMFS' perspective, the study plans should clearly state the anticipated utility of the proposed research in understanding the past, current, and future effects of the project on ESA-listed salmonids, Critical Habitat, Essential Fish Habitat, and Treaty Trust Responsibilities. Fish habitat includes a diverse assemblage of aquatic and terrestrial species that are affected in time and space by the operations at the dams. Further, the study plans should clearly state the anticipated utility of proposed research in understanding the status quo, assessing ongoing project effects, and predicting the effects of future management plan scenarios under a new license, including climate change scenarios.	City Light acknowledges the need for consultation with NMFS related to its regulatory responsibilities as required in the FERC process and that the information resulting from the study program is intended to inform consultation with NMFS during future steps within the process. The FERC process schedule positions an integrated environmental analysis subsequent to the completion of the study program and prior to the filing of a License Application. City Light currently manages and investigates many aspects of aquatic species conditions in the study area and over the course of the relicensing will identify appropriate PME measures in consultation with LPs.
2.	Steve Copps, Jim Meyers, and David Price (NMFS)	04/13/2020	General Comments	The study plans should describe in detail how they will inform our collective understanding of fish and aquatic habitat and ecology. To that end, the study plans should be forward thinking in connecting the anticipated results between these and other study plans. The connections between study plans should be made explicit now to ensure researchers are thinking ahead about the utility of their data from both technical and analytical perspectives and so that plans and associated cost estimates fully reflect foreseeable tasks. Explicitly making these connections will also assist NMFS and other LPs understand exactly how our data needs will be met through multiple study plans.	The integrated environmental analysis referred to in Comment #1 will specifically address links across resource areas. City Light will work with the RWGs to integrate information from related studies as part of the ILP process.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
3.	Steve Copps, Jim Meyers, and David Price (NMFS)	04/13/2020	General Comments	The geographic and temporal scopes of the draft Geomorph and Operations Model study plans are insufficient. The Geomorph study should be extended to include the full extent of project effects on geomorphic processes. That includes at a minimum, downstream to Puget Sound and upstream through the bypass reach and Stetattle Creek where the project precludes a known population of ESA-listed steelhead from migrating and spawning. The Geomorph and Operations Model draft study plans should be developed to improve our collective understanding of historical processes (including pre-dam conditions) so that they can be compared to the status quo and future management scenarios.	Please refer to the Operations Model study plan for City Light's responses for that study. The FERC baseline is existing conditions, and therefore pre-dam conditions are not considered in this study plan. As noted in Section 2.1, the upper end of the Study Area is bounded by Gorge Dam, i.e., the Gorge bypass reach is included in the study area. Note that the few steelhead that occasionally made it to Stetattle Creek did not constitute a population but rather an intermittent spawning aggregation. Project effects would more than likely be indiscernible in the lower reaches of the Skagit River and Puget Sound given the complex array of factors contributing to existing environmental conditions in the lower reaches of the Skagit River, and the extremely limited time available to these studies. City Light plans to assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the relicensing process, and nonetheless remains open to discussion of evidence of effects that should be evaluated herein. Note that to support this assessment, existing information downstream of the Sauk River confluence will be compiled and analyzed as part of this study.
4.	Steve Copps, Jim Meyers, and David Price (NMFS)	04/13/2020	General Comments	The draft study plans would benefit from collaboration within the FA Group to harmonize LP comments and explore opportunities for improving efficiency and	The requested collaboration is underway, as evidenced by the 2019-2020 voluntary study identification process, including this study plan and associated comment-response effort.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				utility of the anticipated results in meeting the needs of all License Participants.	Moreover, City Light will continue collaboration with LPs regularly throughout the ILP process.
5.	USFS	04/13/2020	General Comments	Quantification of sediment (bedload) and wood arrest by project operation and consequent downstream resource impacts. This is a significant omission and is a clear project effect on downstream resources now and into the new license.	City Light believes that quantifying the rates of sediment and wood retention by the Project is not necessary to mitigate for potential Project effects on downstream resources. Rather, during relicensing, City Light will work with LPs to gather information and develop tools to inform our understanding of existing conditions that may or may not support current and future environmental resource objectives in the Skagit River downstream of the Project (i.e., Gorge Dam to Sauk River.) These studies should expand our understanding of the limiting factors to fish populations that could be further addressed through the implementation of the current (or modified) instream flow program, through identifying and implementing active restoration projects that address these limiting factors in a strategic manner (e.g., reflective of Skagit River Chinook, steelhead and bull trout recovery plans), and through effectiveness monitoring from which appropriate adaptive management measures can be identified and actioned upon. City Light, favors this type of resource benefit management approach (i.e., identifying locations in the Skagit River below the Project and then targeting eventual PME measures to improve ecological function at those locations) and looks forward to further discussions with all LPs for means to explore this approach in concert with meeting their resource management objectives.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Also note that the reservoir sedimentation study at reservoir locations with specific resource related concerns, and the shoreline erosion study will provide some information of relevance to the stated concern. Ongoing wood management activities will also provide information on wood inputs to the reservoirs.
6.	USFS	04/13/2020	General Comments	Evaluation of geomorphic change as a result of project effect. The study plan attempts to study the existing condition without isolating the project effect on the resource of concern.	See Comment Responses #1 and #5.
7.	USFS	04/13/2020	General Comments	Address the geomorphic change downstream as a consequence of the range of flows released by the project not just peak flows. It seems imprudent to omit nearly the entire range of flow conditions from analysis when attempting to study project effects on downstream resources.	High flows (rather than moderate or low flows) are the driver of geomorphic processes; text was revised to clarify that the magnitude and duration of high flows will be considered during the analysis.
8.	USFS	04/13/2020	General Comments	**The FS recommends** the title be modified to include the remainder of the Skagit River to the terminus or delta (including the bypass reach). This will enable SCL to sufficiently capture all of the fluvial geomorphic direct, indirect, and cumulative effects from project operations on physical habitats in the Skagit River. Including all areas of likely effects will inform the development of license requirements and assist the Forest Service (FS) analysis of Forest Plan consistency1,2 and Wild and Scenic River Act (WSRA) section 7 determination 3 needed during the relicense process.	See Comment Response #3.
9.	Jon Riedel (NPS)	03/31/20201	Section 1.1 General Description of the Project	"The Project also includes two City Light-owned towns, an Environmental Learning Center, several recreation facilities, and several parcels of fish and wildlife mitigation lands."	Roads associated with the Project are included in the Project Area; issues related to roads will be included in the Erosion and Geologic Hazards study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Mention all of the roads associated with the project?	
10.	Judy Neibauer (USFWS)	04/13/2020	Section 1.2 Relicensing Process	"The PAD also includes an outline of the goals and objectives of this study." You should mention that this data will help to collect data for other analysis such as: NEPA, ESA, and the Fish and Wildlife Coordination Act (see Section 10j of the FERC regulations). The FWCA process is combined in the ILP process and comes into play later.	Section 1.2 has been edited to identify elements of the relicensing process, such as those noted by USFWS.
11.	Brock Applegate (WDFW)	04/12/2020	Section 1.2 Relicensing Process	"This study plan reflects consultation from the RWG effort,…."	Section 1.2 and 1.3 were redrafted to better describe the 2019 process. Formal consultation does not begin until after the PAD is officially submitted. Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together).
12.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG effort, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans…" This study plan might reflect the RWG effort, but falls critically short of addressing the need identified by the RWG on scope (spatial scale), and complexity of the issues across resources of concern.	See Comment Response #3. City Light acknowledges that the proposed study plan does not incorporate all issues discussed during the 2019 RWG effort (i.e., study elements where consensus could not be achieved were not included). The proposal reflects City Lights view of geomorphology issues that may warrant study under the Project FERC relicensing process. During subsequent stages of the ILP, City Light and LPs will be able to explore potential effects on resources to a greater degree and will work with the RWGs to integrate information from related studies. See also Comment Responses #1 and #2.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
13.	Brock Applegate (WDFW)	04/12/2020	Section 1.3 Study Plan Development	"Project operations reduce ~~alter~~ peak flows by magnitude and duration and alter the flow period timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat and cultural resources through the reduction in flow, sediment, and LWD. Geomorphic processes affect aquatic habitat by influencing substrate size and quality; large wood dynamics, main channel and side channel habitat abundance and diversity, and side channel, wetland, and floodplain connectivity. Information on geomorphic processes, aquatic habitat for a number of fish species including anadromous, migratory, and resident salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence and downstream to the estuary is needed to improve the understanding of how Project operations may influence aquatic species and their habitat and cultural resources over the next license term."	See Comment Response #7 regarding flows and #3 regarding spatial scope of analysis. Text accepted with minor modification (i.e., "alter" was retained).
14.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 1.3 Study Plan Development	"Project operations alter ~~peak~~ flows in the Skagit River downstream" The continued use of Peak flows creates an appearance that aquatic resources are only impacted via lack of peak flow. However, smaller events or the duration of these events also need to be evaluated for impacts to aquatic resources of concern. Basic operations have also disrupted sediment, bedload, and LWD from downstream habitats and processes.	See Comment Response #7 regarding flows and #5 and #6 regarding quantification of sediment and LWD retention by the reservoirs.
15.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 1.3 Study Plan Development	"Project operations alter peak flows in the Skagit River Downstream"	See Comment Response #7 regarding flows and #5 and #6 regarding quantification of sediment and LWD retention by the reservoirs.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Also disrupt sediment and LWD transport by storing in reservoirs. Understanding the project impacts on geomorphology requires accounting for the interaction between sediment, LWD, and habitat-forming flows. A wide range of flows, not just peak flows and the duration of these flows, affect connectivity to floodplain habitats (e.g. wetlands, relic channels, side channel) and wetted area of channel habitats (e.g. bank, bar, backwater, side channel).	
16.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 1.3 Study Plan Development	"Geomorphic processes affect aquatic habitat by influencing substrate size and quality; large wood dynamics, main channel and side channel habitat abundance and diversity, and floodplain connectivity." Functioning PNW rivers provide spawning habitats that are protected from scour during high flow events (e.g. side channels, groundwater fed floodplain channels, meander bends). Need to consider interaction between sediment mobility and hydraulics of simplified channels, where the project may be simplifying channel geomorphology and increasing redd scour.	A synthesis discussion integrating the flow, sediment, large wood, aquatic habitat, channel migration, and side channel dynamics based on existing information as well as data gathered as part of this study will be included in the study report (see Section 2.6.7). City Light will use this information in a forward-looking manner, by evaluating potential future scenarios relative to existing conditions, to help develop appropriate PMEs.
17.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 1.3 Study Plan Development	"Geomorphic processes affect aquatic habitat by influencing substrate size and quality; large wood dynamics, main channel and side channel habitat abundance and diversity, and floodplain connectivity." High flows interact with LWD in habitat-forming processes. The project impacts both high flow and the abundance of LWD	See Comment Response #16 for synthesis discussion.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				downstream of the dams, thus the study needs to account for this interaction to understand the extent of impacts.	
18.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 1.3 Study Plan Development	"Geomorphic processes affect aquatic habitat by influencing substrate size and quality; large wood dynamics, main channel and side channel habitat abundance and diversity, and floodplain connectivity." Also affect channel migration and formation of floodplain habitats. The study needs to explicitly consider habitat forming processes, not simply presence of habitats during a given snapshot in time.	See Comment Response #16 for synthesis discussion.
19.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for anadromous salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence is needed to improve the understanding of how Project operations ~~may~~ influence aquatic habitat for anadromous salmon and cultural resources over the next license term." Essential fish Habitat, as defined by the Magnuson Stevens Fishery Conservation and Management Act.	See Comment Response #10. EFH is included with other statutory authorities in Section 1.2.
20.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for anadromous salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence is needed to improve the understanding of how Project operations influence aquatic habitat for anadromous salmon and cultural resources over the next license term." This term will limit collaborative opportunities	See Comment Responses #3 and #5. City Light currently transports woody debris from Project reservoirs to the lower Skagit River to benefit aquatic habitat. As summarized in Section 5.0 of the PAD, a management plan will be developed over the course of the relicensing process to outline wood management and will include

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				if it does not include materials affected by the reservoirs. The lack of an operation is relevant here. Namely, the lack of a program to transport LWD and sediment downstream of the dams. Also, reservoir storage inundates Skagit River and tributary floodplains, thereby preventing the growth of forests and a source of LWD recruitment.	information on the process for transporting trapped wood downstream.
21.	USFS	04/13/2020	Section 1.3 Study Plan Development	**The FS recommends** modify the following statement to clearly identify project effects on the full range of natural flow conditions, sediment transport, and large wood recruitment and transport. Statement: **Project operations reduce peak flows by magnitude and duration and alter the flow period timing in the Skagit River downstream of Gorge Dam.** **The FS recommends** only including those issues, and referencing those issue forms, that are explicit goals and/or objectives of this study plan. If methods are not designed to study the specific data gaps identified in the issue forms, then issues should not be included here. Alternatively, describe in sufficient detail how conclusions drawn from this study plan will inform project effects on the issues brought forward in this paragraph.	See Comment Response #7 regarding flows and #11 regarding references to issue forms.
22.	Jon Riedel (NPS)	03/31/2020	Section 1.3 Study Plan Development	"Project operations reduce peak flows by magnitude and duration and alter the flow period timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes…." Really should mention major project impact of eliminating sediment (bed load) and LWD,	See Comment Response #7 regarding flows. See Comment Responses #5, #6, and #20.

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				which along with flow period alteration have major geomorphic impacts. Further it is not just peak flow but duration, particularly for spring flood.	
23.	Judy Neibauer (NPS)	04/13/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for…." I wasn't involved in the early development of this study…but I am thinking that understanding where the key upwelling/hyporheic areas are, would be important to add. Overlaying geomorphology with temperatures can help indicate/find key hyporheic areas and pools that are used for refugia, forage, spawning etc. If there is any FLIR data out there to utilize, it would be worth finding. You can overlay that with Lidar/geomorphology information to help show the upwelling/cool water location that are indicative of hyporheic areas. The effects from project operations to these refugia areas would be important to know. It seems that this would be the place for collecting that type of information.	This study does not include water temperature. However, temperature data are collected at the Newhalem USGS gage, and Ecology has and continues to collect temperature data at Marblemount. As discussed in the PAD, available data indicate that water temperature is in compliance with Ecology criteria in the reach downstream of the Project. 7-DADMax water temperatures in the Skagit River between the Project and the Sauk River are cool year round (rarely >14 °C).
24.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for ~~anadromous salmonids~~ a number of fish species including anadromous, migratory, and resident salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence and downstream to the estuary is needed to improve the understanding of how Project operations may influence aquatic species and their habitat ~~for anadromous salmon~~ and cultural resources over the next license term."	Edits accepted.

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25.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for a number of fish species including anadromous, migratory, and resident salmonids…." Should include other fish species in this statement as well. We will need to think about bull trout and their prey species, and other resident fish.	See Comment Response #24.
26.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	I agree with Judy, we should consider all aquatic species. (See Comment #17)	See Comment Response #24.
27.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Information on geomorphic processes, aquatic habitat for a number of fish species including anadromous, migratory, and resident salmonids, large wood, and sediment in the Skagit River between Gorge Dam and the Sauk River confluence and downstream to the estuary is needed to improve the understanding of how Project operations may influence aquatic species and their habitat…" I would imagine you are thinking about applying the information gained by this geomorphic study to aquatic species…not just anadromous salmon…hence the addition here. At some point you may need to make a distinction between habitat types…and we also have "listed critical habitat" under the ESA Critical habitat rules. If this information will help qualify conditions of critical habitat, you may want to point that out somewhere.	See Comment Response #24.
28.	Brock Applegate (WDFW)	04/13/2020	Section 1.3, Study Plan Development	"….(8) FA35, Process Flows,…" Many LPs question whether this study will identify the process flows, which SCL will	See Comment Responses #1 and #11.

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				need for the flow model. If we can't identify the process flows, please remove FA35 and FA 36 from the list.	
29.	Jon Riedel (NPS)	03/31/2020	Section 1.3 Study Plan Development	"….(13) FA47, Sediment Budget and Storage, Stability, and Transport in Skagit River Downstream of Gorge Dam." Glad to see you at least acknowledge these issue statements, even if this SP does not address them. This remains a large issue with a huge data gap. NPS will want to know how SCL will address.	Thank you for your comments. See Comment Responses #5, #6, and #11.
30.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	I agree with John. This study plan will not address sediment budget or storage in and transport around the reservoirs. Why include this Study Issue Identification Form in the list when it does not address it in the Study Plan? (See Comment #21)	See Comment Responses #5, #6, and #11.
31.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.1 Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are…." Can SCL provide the rationale (written) for why the study doesn't include 1) the Bypass Reach and 2) the Skagit River below the Sauk confluence. If possible please provide citations to support the proposed study area.	See Comment Response #3.
32.	Brock Applegate (WDFW)	04/12/2020	Section 2.1 Study Goals and Objectives	WDFW would like to see an explanation why SCL did not include downstream of the Sauk confluence in this study plan beyond the collection of literature. Most LPs realize a reduction in effects below the Sauk confluence, but SCL should make some attempt to understand their impacts below the Sauk. No other LP accepts the explanation by SCL of no	See Comment Response #3.

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				effects or too complicated to calculate the effects. SCL has some sort of effect downstream of the Sauk confluence. (Response to Comment #23)	
33.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	Include areas upstream of the dam as well as downstream to the mouth/estuary, and also include some distance upstream into fish bearing tributaries that are connected to both the river and to the reservoir (at least key tributaries used for spawning and foraging)… There is likely some distance upstream in the tributaries where effects are observed. Rational: Actions associated with operations such as releasing flows, cause streams/ rivers/ and reservoir movements up and down, and these flow changes or reservoir elevation changes generally change tributary processes (i.e., they slow or hasten the rate of flow in the tributary itself, and change the point at which the waterways connect to the main Skagit River or reservoirs. Hence, affecting the geomorphology at intersection of the mouths of the tributaries…can be a big deal for connectivity. Adding these areas and assessing the geology/gradients/ flow regimes, etc… can help inform what is natural processes vs operational effects.	See Comment Response #3. Regarding reservoir connectivity, habitat conditions in the reservoir tributaries, above the influence of the reservoirs' high-water marks, or in tributaries that flow into the Skagit River, are outside the range of the Project's effects. City Light currently mitigates for potential effects on fish migration/passage (i.e., connectivity) resulting from sediment and woody debris deposition in Project reservoirs, and intends to continue the effort. The 1991 Settlement Agreement stipulates that City Light is to survey for and remove transitory barriers to spawning migration in tributaries to Project reservoirs. City Light has agreed to expand the annual barrier surveys and barrier removal efforts beginning in 2020 following NCC approval. Regarding tributary connectivity between Gorge Dam and the Sauk River, City Light is not aware of any connectivity issues due to geomorphic processes downstream of Gorge Dam. However, the Relative Elevation Model (REM) that is being developed for this reach will help address this concern as part of the license application process.
34.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to	See Comment Response #3.

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				characterize how Project-related changes in peak flows affect geomorphic processes in the reach." See Upper Skagit Indian Tribe comments on Vegetation Mapping and Wetland Mapping studies from TR&RE RWG. These were detailed comments that present evidence of project impacts below the Sauk confluence and the importance of understanding this in terms of EFH for salmonids, including for ESA-listed species.	
35.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes in the reach." CC: Suggesting mitigation for effects upstream without having a better understanding of what is downstream is dangerous because everything downstream has adjusted to previous conditions before mitigation.	See Comment Responses #1, #2, and #3.
36.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1, Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes in the reach." CC: Understanding the current condition is important but is SCL intention to keep things as they are for the future license or to improve	Subsequent to completion of the study program, there are steps in the relicensing process intended to determine what PMEs will be formulated, including how the Project will be operated during the next license term (See Comment Responses #1 and #2). City Light is proud of its stewardship of the river and the current flow regime, i.e., as required by the FSA, has been beneficial to anadromous and resident salmonids in the Skagit River. City Light's goal is to continue to benefit aquatic

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				things during the future license? If the goal is to bring salmon back we need to be studying how to reverse project impacts; not keep them status quo.	resources, which may involve the reshaping of the flow release schedule (among other things). However, City Light respectfully requests that LPs recognize that City Light's obligation in the context of the FERC process is to mitigate for ongoing Project effects.
37.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes in the reach." Also, disrupted LWD and sediment transport. And disrupted formation of floodplain forests under reservoirs (see earlier comment).	See Comment Responses #5 and #6.
38.	Brock Applegate (WDFW)	04/12/2020	Section 2.1 Study Goals and Objectives	"Project-related changes in peak flows affect geomorphic processes in the reach." How will SCL accomplish this statement without the use of a sediment budget?	See Comment Responses #5 and #6.
39.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.1 Study Goals and Objectives	"Specific objectives include:" New objective: Determine peak flow magnitudes and duration curves that support natural fluvial processes and habitat-formation to help guide management of peak flow releases from Gorge Dam and Powerhouse, and to help determine potential issues related to floodplain development.	See Comment Responses #1, #2, and #6. City Light is not addressing this with the objectives of this study plan but acknowledges that evaluating appropriate peak flow releases for the next license term will be a topic addressed during later stages of the formal ILP. Note also that evaluating floodplain development and associated regulations are beyond the scope of the relicensing process and study program.
40.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Comment "Use aerial photograph and LiDAR data and collect field data to document current	See Comment Responses #3 and #6. Edits made to use sub-set of all available historical aerial photographs/maps.

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				conditions and changes over the period of the current license to document:" Not adequate to understand disruption to fluvial process. Impacts were likely already in place at start of current license. Need to have historic condition as a reference against which to estimate the ongoing disruption to fluvial and habitat-forming processes. Then, account for non-project interacting factors that impact fluvial process, then we can isolate and identify the impacts caused by the project.	
41.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Baseline channel configuration and migration patterns;" CC: How far back is SCL planning to look? Why not include older topo maps? There is valuable information back to 1899 that could be used to track changes to the rate of migration that would be indicative of project effects since the beginning.	See Comment Responses #3 and #6.
42.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.1 Study Goals and Objectives	2nd Bullet – Comment "Baseline channel configuration and migration patterns;" Pre-project. GLO maps may provide a resource.	See Comment Responses #3 and #6.
43.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.1 Study Goals and Objectives	4th Bullet - Comment "Side channels and off-channel habitat;" Wetlands and other floodplain habitats that only have surface connectivity to channels during high flows.	The *Study Goals and Objectives* include side channels and off-channel habitat. Wetlands are being addressed in a separate study plan in TRREWG; information from that study will be integrated with information from this geomorphology study after the relicensing

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					study program is completed and described in the license application.
44.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	6th Bullet – Comment Large wood input, transport, and retention. Wood budget for system?	An analysis of wood loading and mobility for current conditions will be developed based on an analysis of wood on aerial photographs as described in Section 2.6.6.
45.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.1 Study Goals and Objectives	7th Bullet – Comment "Determine flow rates that result in redd scour to help guide management of peak flow releases from Gorge Dam and Powerhouse." Spatially explicit scour risk to account for hydraulic heterogeneity (e.g. refuge in side channels and groundwater fed floodplain channels).	The combination of the redd scour measurements and the hydraulic model developed for the Instream Flow Study can be used to extrapolate measured scour to other areas of the modeled channel.
46.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.1 Study Goals and Objectives	7th Bullet – Comment "Determine flow rates that result in redd scour to help guide management of peak flow releases from Gorge Dam and Powerhouse." The first issue should be to understand what flows currently result in redd scour, across the current available habitat and for all native salmonids downstream of project area. Scour to pink redds is fundamently different than scour to Steelhead redds based on species specific spawning locations (depth, substrate size, channel location etc.) and timing. Upper Skagit Indian Tribe is requesting scour assessments specific to each anadromous salmonid species present in the Skagit. As noted multiple times project operations have not passed wood, sediments nor bed load which may bias these	The pilot Redd scour monitor locations cover Pink, Chum, Chinook, and steelhead spawning locations; the expanded monitoring locations will cover all mainstem spawning species. See Comment Responses #5, #6, and #20. Future instream flow recommendations will be developed as part of the license application and include consideration of many resources.

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				results. Managing flows from the project require a much deeper and wider dive than redd scour to assess future recommendations for downstream flows, suggest removing this reference.	
47.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	"Project-related changes in peak flows affect geomorphic processes in the reach." Include gathering of data for locations of key hyporheic/upwelling areas. This can lead to finding out about potential spawning, foraging, and rearing habitat. I would like to suggest you add a component to the objectives that looks at geology and temperature patterns (glacial till deposits or where fault lines of land forms are that could be overlaid with temperature data like FLIR or other data)… These types of data linked together may provide knowledge for effects to aquatic refugia…such as key locations for spawning, foraging, overwintering, or key holding habitat that might be cooler than surrounding waters. Understanding key hyporheic or upwelling areas, will help with understanding how operational flows affect these types of refugia.	See Comment Response #23.
48.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	Specific objectives include: These objectives seem a bit limited. You might think about putting in the key questions you are going to answer. If you are collecting aquatic habitat data there are generally more objectives that you have listed here…i.e., Are there enough key pools? Is there enough key wood for cover and forming pools, stabilizing channel? Are there too many sediments mixed	See Comment Responses #1, #2, and #6.

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				with the spawning substrates? Also, show how you will be using data gathered in the office vs the field, and link the data to the questions you will be answering. In the Existing Information section below, you can show the data you already have and the questions it answers. Doing something like this… might help partners understand what this study will pulling together in the office vs that field and how it links to the issues.	
49.	Brock Applegate (WDFW)	04/12/2020	Section 2.1 Study Goals and Objectives	5th Bullet – Add red text "Side channels and off-channel habitat, including hydraulically connected wetlands;"	Thank you. These edits have been incorporated.
50.	Jon Riedel (NPS)	03/31/2020	Section 2.1 Study Goals and Objectives	6th Bullet - Comment "Substrate size and distribution; sediment sources and delivery mechanisms; and…" You mean, specifically, tributaries? I thought Issue Statement was for 'sediment budget'?	The intention is to look at substrate size, distribution, existing sediment sources and delivery mechanisms in the mainstem Skagit and at the mouths of tributaries.
51.	Jon Riedel (NPS)	03/31/2020	Section 2.1 Study Goals and Objectives	7th Bullet - Comment "Determine flow rates that result in redd scour to help guide management of peak flow releases from Gorge Dam and Powerhouse." Isn't it flow peak discharge as well as rate (ramping)? And duration is also critical for geomorphology. Lack of sustained peak flow is allowing tributary deposits to accumulate in main channel and narrow Skagit River.	Agree discharge and duration are important – See Comment Response #7. Changes to the Skagit River at tributary junctions will be assessed as part of this study (See Section 2.6.2).
52.	USFS	04/13/2020	Section 2.1	The first paragraph on pg 2-1 does not identify a clear resource issue and associated project	See Comment Responses #1, #2, #5, #6, and #20.

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			Study Goals and Objectives	effect. The Goal of the study should be "**Evaluate the <u>project effects</u> on geomorphic conditions between Gorge Dam and the Skagit River terminus or delta (including the bypass reach)".** This will enable SCL to sufficiently capture all of the fluvial geomorphic direct, indirect, and cumulative effects from project operations on physical habitats in the Skagit River. Including all areas of likely effects will inform the development of license requirements and assist the Forest Service (FS) analysis of Forest Plan consistency1,2 and Wild and Scenic River Act (WSRA) section 7 determination 3 needed during the relicense process. Objectives of the study would be to measure those effects (quantitatively or qualitatively) on specific issues identified in the issue forms described in Section 1.3. **The FS recommends** including two quantifiable measures of downstream effects on the geomorphic condition of the Skagit River that appear to be missing from the objectives. 1) Quantify anticipated wood loading above Gorge Dam for the period of the new license, based on methods described in the study plan but applied to the upper basin above Gorge Dam, as a measure of wood transport loss to downstream habitat due to project effects. 2) Quantify anticipated bedload volume above Gorge Dam for the period of the new license, based on methods described in the study plan but applied to the upper basin above Gorge	

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				Dam as a measure of sediment transport loss to downstream habitat due to project effects. The loss of both large wood and bedload volume over the period of the new license is an indirect project effect on all downstream Skagit River geomorphic condition and subsequent physical habitat formation for aquatic species. Objectives identified in this section provide a thorough description of the existing condition, and snapshots of the period of the current license, but it is unclear how the product from this study plan will be tied to project effects during the new license period. **The FS recommends** adding a summary at the end of Section 2.1 of how each objective will meet the stated goal.	
53.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	According to guidelines for the ILP…this section should also include Information about public input considerations…Maybe you have this somewhere else? See this link: https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	City Light appreciates the input. Also, it is worth noting that the criteria pertain to "public interest," not public "input."
54.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	"This information will be used during the licensing process to inform Project effects on the geomorphic conditions through this reach of the Skagit River and identify potential protection, mitigation and enhancement measures, as appropriate." Think about rewording this to say you are not just looking at effects to the geomorphic conditions…but setting a baseline to establish how the changes to geomorphic	See Comment Response #6.

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				conditions/processes effect the fish, aquatic, and riparian resources.	
55.	Jon Riedel (NPS)	03/31/2020	Section 2.2 Resource Management Goals	"This information will be used during the licensing process to inform Project effects on the geomorphic conditions through this reach of the Skagit River and identify potential protection, mitigation and enhancement measures, as appropriate." How will SCL know how to design mitigation for loss of bed load if there is no idea how much is being cut-off by dams? How would SCL understand dynamic nature of bed load transport and storage without basic modeling? The lack of gravel from the upper basin has many effects below the project, including influence on channel stability, bank erosion, and introduction of gravel from these sources. It also would influence floodplain connectivity.	See Comment Responses #5 and #6.
56.	Brock Applegate (WDFW)	04/12/2020	Section 2.2 Resource Management Goals	I agree with and cannot describe it better than Jon. I would only add that the reach in question does not operate in a vacuum. SCL has effects above the Project from the lack of transport of sediment and large woody debris. SCL has effects below the Project like disconnected channels and wetlands and a shrinking estuary. I agree that the SCL has a smaller effect the farther we go downstream, but the Project still have some effect. How does SCL intend on answering salmonid population questions or mitigation for such when it won't collect the information for the entire river? (See Comment #35)	See Comment Responses #3, #5, #6, and #20.
57.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource	I also agree see my other comment above about study area. It is highly likely that there are some	See Comment Response #3 and #33.

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			Management Goals	effects out into the estuary…as well as effects above the dams. In general, in most systems where there are dams, the tributaries are also affected some distance upstream (i.e., from operational flows, reservoir levels). (See Comments #35 and #25?)	Habitat conditions in tributaries upstream of the dams are not within the scope of this study but are addressed in the Reservoir Deposition study plan. City Light is unaware of any Project-related adverse effects on aquatic habitat in the lowest reaches of tributaries to the Skagit River downstream of the Project. However, City Light welcomes LP input regarding specific aquatic habitat issues associated with geomorphic alteration, and the associated site-specific information that serves as the basis for raising the issues.
58.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.2 Resource Management Goals	Suggestion for Goal Statement that may help bridge difference of LPs approach and Utilities approach: The Shared resource management goals are to understand how Project past's and current operations have affected existing Essential Fish Habitat, and geomorphic processes through and below project area. If the goal is to just know what existing aquatic habitat conditions currently exists then we bias that understanding by not identifying what the projects impacts are to those resources.	The FERC baseline is existing conditions, and therefore ongoing effects, not past effects, are the focus of this study plan (see also comment response #6). In addition, this study plan addresses conditions from Gorge Dam to the Sauk River. Other study plans are currently aimed at assessing conditions in the Project reservoirs. Also, it is important to emphasize that this study constitutes the first phase of investigation, and studies and LP consultation will continue during the ILP process.
59.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.2 Resource Management Goals	"This information will be used during the licensing process to inform Project effects on the geomorphic conditions through this reach of the Skagit River and identify potential protection, mitigation and enhancement measures, as appropriate." CC: What is the metric for this and when does this come into play? How will the need to enhance or mitigate be determined if current conditions between Gorge and Sauk are all that	See Comment Responses #1, #2, #5, and #6.

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				are assessed? Why is there no study currently being planned for to address mitigation or enhancement based on quantifying how much sediment and LWD is being cut-off by the dams?	
60.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.2 Resource Management Goals	"City Light will confer with resource agencies and tribes that are interested in participating in development of this study proposal, and language identifying specific management goals relevant to this study proposal is anticipated." When and how? The current path on this study plan was for LP's to ask clarifying questions, which directly stymied a robust dialogue of scientific inquiry to tease out Projects impacts on current existing habitats and processes. The statement also implies the utility has created the study plan without input, but a more accurate statement would acknowledge the contributions to date, and limited use and interpretation by the utlity, with additional work to move towards an agreed to study plan. Suggest the creation and facilitated support of hydro-geomorph sub group.	Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together). See Comment Responses #1, #2, #11, and #12.
61.	USFS	04/13/2020	Section 2.2 Resource Management Goals	**The FS recommends** changing the goal statement "City Light's resource management goals are to gain a current understanding of existing aquatic habitat conditions related to geomorphic processes in the Skagit River between Gorge Dam and the Sauk River confluence." to better align with federal, state, and tribal resource management goals. An appropriate change would be **"City Light's resource management goals are to gain an understanding of project effects on**	See Comment Response #3 regarding spatial scope. Section 2.2, Resource Management Goals, was modified to include the USFS management documents.

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				geomorphic conditions between Gorge Dam and the Skagit River terminus or delta (including the bypass reach)". This will enable SCL to sufficiently capture all of the fluvial geomorphic direct, indirect, and cumulative effects from project operations on physical habitats in the Skagit River. Including all areas of likely effects will inform the development of license requirements and assist the Forest Service (FS) analysis of Forest Plan consistency1,2 and Wild and Scenic River Act (WSRA) section 7 determination 3 needed during the relicense process. **The FS recommends** maintaining consistency throughout the suite of study plans by referencing the following FS management planning documents: 1990 Mt. Baker Snoqualmie National Forest Land and Resource Management Plan (LRMP) 1994 Record of Decision - Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl - Attachment A to the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. 1983 Skagit River Management Plan Volume II.	

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62.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Skagit River supports numerous anadromous, migratory, and resident fish species as well as other aquatic organisms. Geomorphic processes affect components of aquatic and riparian habitat, including substrate size, quantity and quality; large wood dynamics, and main channel and side channel habitat diversity." The term "resident" can take many forms….in the FERC world and policy world…"resident" may mean all fish but salmon. In the biological world resident means fish that stay in their stream they were born in. In the Skagit we have bull trout that exhibit all life history forms (anadromous, adfluvial, riverine, and resident). If you add the word migratory here (i.e., fish that are staying in freshwater and moving between lakes/reservoirs/rivers/streams), that may insure you are covering and discussing these forms of fish more appropriately. Today, with all the new telemetry and PIT tag data, we know there are more life forms that act differently and use different habitat than a true "resident" fish. In the bull trout world, we may have anadromous bull trout spawning with riverine migrants, or even resident sized fish. This Project might be an opportunity to begin discussing native fish assemblages and insuring that when we talk about anadromous fish, we also mean bull trout. And that when we talk about steelhead, we talk about resident or riverine forms….Not sure how to do this yet, but it could start with definitions and or usage of the terms salmon, steelhead, bull trout when	Edits accepted.

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				we talk about habitat they exist in.	
63.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Skagit River supports numerous anadromous, migratory, and resident fish species as well as other aquatic organisms. Geomorphic processes affect components of aquatic and riparian habitat, including substrate size, quantity and quality; large wood dynamics, and main channel and side channel habitat diversity." Geomorphic studies can be used to look at a large array of aquatic and riparian habitat information, all generally important to addressing the effects of operations. Thus, I add riparian habitat here, because changes to channels, effect riparian vegetation, that in turn effects macroinvertebrates, overhanging cover, LWD, undercut bank cover, and energy dispersion of the channel… and these are all important to assess aquatic habitat. I am guessing, that perhaps the vegetation mapping can link up to the geomorphology study data, to help determine changes in riparian vegetation types?... Overall, this seems like a good section of the document to describe the linkages to other studies where you will use additional data from this study to identify effects?	Edits accepted.
64.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.3 Background and Existing Information	"Aquatic habitat in the Skagit River supports numerous anadromous and resident fish species as well as other aquatic organisms." And habitats that may be considered terrestrial. For example, floodplain terraces and wetlands that may only have surface connections to main	See Comment Response #63.

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				channels during high flows. Wetlands can support direct use by juvenile salmonids. Inundation of forested floodplain terraces supports aquatic productivity via terrestrial subsidies. There must be thorough coordination among this geomorphic study and the Wetland and Vegetation Mapping studies in the TR&RE RWG.	
65.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.3 Background and Existing Information	Essential Fish Habitat, might capture the complexity of habitat types fish biologist are concerned with- which includes both aquatic and terrestrial, plus seasonal habitat types across the floodplain.	EFH is included with other statutory authorities in Section 1.2.
66.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.3 Background and Existing Information	"Additional information is also needed to establish gravel quantities and quality on a spatial scale, gravel mobilization and redd scour…" Spatially-explicit redd scour. Use of 2-D model would help identify hydraulic refuges, such as those associated with side channels, meander bends, vegetated islands, and log jams.	The purpose of the study is to collect information to understand the existing environment and identify potential limiting factors associated with hydro-operations. This information in combination with information from other studies including the hydraulic model can be used to support the development of PMEs to address Project effects.
67.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	"Additional information is also needed to establish gravel quantities and quality on a spatial scale, gravel mobilization and redd scour flows in primary spawning areas, and changes to river geometry that may occur through time." Is there a basin-wide scale? Or, just tributaries?	The Study Area includes the mainstem and tributary mouths.
68.	Brock Applegate (WDFW)	04/12/2020	Section 2.3 Background and Existing Information	"Additional information is also needed to establish gravel quantities and quality on a spatial scale, gravel mobilization and redd scour flows in primary spawning areas, and	See Comment Responses #1 and 6.

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				changes to river geometry that may occur through time." Do primary spawning areas change from year to year? If so, we many need to develop an adaptive management plan, when we finish this study to monitor scour, if the spawning areas move in the river.	
69.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.3 Background and Existing Information	▪ Channel configuration and migration patterns; ▪ Aquatic habitat types, characteristics, and availability; ▪ Side channels (existing channels, formation and maintenance processes); ▪ Substrate size and distribution; and ▪ Large wood (existing; potential input, transport, and retention processes). See previous comments to ensure these are adequately understood.	Thank you. Comment noted.
70.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.3 Background and Existing Information	"These data can provide information on preferred spawning locations and habitat to help guide gravel scour monitoring." Scour monitoring should allow comparison to a reference river system or reconstruction of historic conditions to help understand whether the current system has adequate heterogeneity and hydraulic refuge to provide natural redd protection under a variety of flows. Depending on the timing, there may be a conflict between habitat-forming flows and redd protection. The geomorphology study should help determine whether this conflict may arise, and, if so, how we can accommodate both redd protection and	See Comment Responses #1, #3, #6, and #36.

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				habitat-forming flows (i.e. we need understand how we can best mimic a natural PNW river that supports all necessary salmonid life-stages and species).	
71.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.3 Background and Existing Information	"Existing information that provides a basis for understanding geomorphic processes in the middle and lower Skagit River includes:" These will be valuable resources, but the geomorphic study needs to be comprehensive from Gorge Dam downstream to the Skagit delta/estuary (other comments in this study plan as well as in Vegetation and Wetland Mapping plans in TR&RE RWG).	See Comment Response #3.
72.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	3rd Bullet - Comment "Side channels (existing channels, formation and maintenance processes);" Need to link this, and other data, with landform maps. There is some overlap here, making it critical that we work together on the side channels.	Yes, the intention is to use landform mapping the NPS is preparing. Text revised to clarify.
73.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	Other land use practices such as timber harvest, road construction, and bank protection downstream of Gorge Dam also influence geomorphic processes and the suitability of aquatic habitat. Note there are few of these impacts above Bacon Creek. Should add other hydro projects to list of land use?	Thank you for your comment. Other hydro projects will be included in the cumulative effects analysis.

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74.	Brock Applegate (WDFW)	04/12/2020	Section 2.3 Background and Existing Information	Thanks Jon, SCL has another hydroelectric project at Newhalem Creek. (See Comment #44)	See Comment Response #73.
75.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	If there are existing SCL facilities/projects or other types of issues/ongoing actions, they should be included in the background, including any habitat conditions that may be altered as a result.. (i.e., Newhalem Dam, storage areas/access roads, transmission corridors, conservation lands, hatcheries, road/culvert issues). The background information will help develop baseline conditions and capture the past and current conditions and show why you might need to study. Collecting the information in these areas becomes important, and helps USFWS, NMFS, and FERC/ SCL to compare any ongoing or new effects to the baseline and may help out SCL to determine their levels of effects. (See Comment #44)	See Comment Response #73.
76.	Brock Applegate (WDFW)	04/12/2020	Section 2.3 Background and Existing Information	"Evaluating the relative influence of different natural and human-induced processes will aid in the understanding of existing river conditions." These kind of evaluation would help with your effects analysis below the Sauk confluence as well.	Thank you for your suggestion.
77.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Evaluating the relative influence of different natural and human-induced processes will aid in the understanding of existing river conditions." Do you have locations of key refugia for bull trout already? You should mention that in here	See Comment Response #1. Also, City Light will work with USFWS in the context of the Section 7 Consultation associated with the relicensing to address effects on Bull Trout.

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				somewhere. Understanding how key refugia and populations change with operations will be important for the effects analysis. We will be looking at effect to bull trout and bull trout critical habitat both above the dams, in tributaries, within SCL owned lands, transmission corridors, and below the dam out into the estuary.	
78.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	Understanding how SCL's portion of the impacts (i.e. dam operations, and management, of other areas including transmission line corridors) is a key goal and should be described in effects assessments. Gathering data to help parse this out will be important. You might include a description of other land management issues…dredging, land use, forest practices, irrigation, fishing, to name a few… (See Comment #48)	See Comment Response #73.
79.	Brock Applegate (WDFW)	04/12/2020	Section 2.3 Background and Existing Information	"City Light surveys anadromous fish spawning locations throughout the year and records location, water depth, and species." Will this continue into the next license? I assume we will have a good grasp on the location of excellent spawning areas and possible spawning area changes to look at redd scour flows throughout the life of the license, if necessary.	While the identification and development of PMEs for the next license is a phase of relicensing subsequent to the study program, City Light anticipates and is committed to working with LPs during the ILP to identify monitoring and protective flow releases for the new license term.
80.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	"Historic and recent aerial photographs and recent LiDAR data are available to aid in mapping channel configuration, large wood, and sediment dynamics." Since you are not modeling, how will you address sediment dynamics? At specific points with instruments? Here again, the data	See Comment Response #6. Links to landform mapping and geomorphic reach breaks have been added to the text throughout the study plan.

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				collection and analyses need to be linked to specific geomorphic reaches identified in the landform mapping. SCL has an early version of the reach breaks, but they are being revised as we map.	
81.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	"Existing information that provides a basis for understanding geomorphic processes in the middle and lower Skagit River includes:" Should mention landform mapping at 1:6000 scale currently being conducted?	See Comment Response #72.
82.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Existing information that provides a basis for understanding geomorphic processes in the middle and lower Skagit River includes:" See my previous comment on expanding study area. Here I don't see you are gathering information in tributaries below or above the dams to determine areas affected. Effects likely travels some distance upstream of the influence of the Skagit River or Reservoirs. This might be unique in certain tributaries based on land types. We will need information in these areas above and below the dams, within reservoirs, and some distance upstream in the tributaries to assess effects from operational flows. There may also be different levels of effects in reservoir tributaries, from where they enter the reservoir at the highest flows, to where they enter the reservoir at average flows, to where they enter the reservoir at lowest flows.	See Comment Responses #3 and #57.
83.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	5th Paragraph, 1st Bullet – Comment "A baseline fluvial geomorphology report was prepared for the Skagit River basin (Gorge Powerhouse to estuary) by the U.S. Army	Agree – this will be appropriate for some of the small watersheds we are looking at. The geology, topography, land use, etc. conditions in each watershed will be taken into account

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				Corps of Engineers (USACE) that includes an estimated sediment input budget based on basin sediment budgets and suspended load data and a description of fluvial geomorphic reaches (USACE 2008). This report relies largely on the work of Paulson, which is focused on logged areas in NF.	when using data from sediment budgets prepared for other areas.
84.	Jon Riedel (NPS)	03/31/2020	Section 2.3 Background and Existing Information	5th Paragraph, 2nd Bullet – Comment "Channel incision was identified as a potential issue during the Skagit Project's last relicensing in the early 1990s. Analysis of USGS gage records at that time showed incision at the Alma gage (no longer in service) and little variation to 0.4 feet of aggradation at the Newhalem gage (Riedel 1990)." Hasn't USGS (Anderson) recently revisited this?	The USGS provided a draft analysis at a geomorphology workgroup meeting; a finalized analysis will be prepared as part of this study.
85.	Brock Applegate (WDFW)	04/12/2020	Section 2.3 Background and Existing Information	5th Paragraph, 8th Bullet – Comment "Suspended sediment monitoring by the USGS on the lower Skagit River (Curran et al. 2016) and Sauk River (Jaeger et al. 2017)." SCL should think about a reproduction of this study in the study reach with the same protocol.	There will be turbidity monitoring just below the Gorge Powerhouse, which should reveal the times when system-wide water clarity issues are occurring. If the suggestion to conduct suspended sediment monitoring is for sediment budgeting purposes, See Comment Response #6.
86.	USFS	04/13/2020	Section 2.3 Background and Existing Information	***The FS recommends*** modify this section to include a clear statement of what the data gap is that the study plan is to address. The below problem statement address the data gap need, but it is unclear in the study plan methods how this study plan will address this issue.	See Comment Responses #1 and #2.

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				"Detailed information on aquatic habitats downstream of Gorge Dam is needed to improve the understanding of current spawning and rearing capacity for all salmonid species using the habitat, and how these factors could be predicted to change over the next license term." ***The FS recommends*** that this section describe the background and existing information on each issue described in section 1.3. Providing the background and existing information of each issue will draw out where data gaps are and how this study plan can best be developed to address them. This section may be a good place to link other study plans intended to provide additional information on issues that may inform conclusions of this study plan.	
87.	Jon Riedel (NPS)	03/31/2020	Section 2.4 Project Operations and Effects on Resources	"Project Operations and Effects on Resources" And sediment? Gravel? LWD? Duration?	See Comment Response #88.
88.	Brock Applegate (WDFW)	04/12/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations ~~alter~~ reduce peak flows in duration and magnitude and alter flow period timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat through the reduction in flow, sediment, and LWD. Geomorphic processes affect aquatic habitat by influencing key habitat forming elements, such as: substrate size, amount, and quality; key pools, large wood dynamics, main channel and side channel habitat diversity, streambank condition, riparian vegetation, tributary and floodplain connectivity, including	The term "reduce" was rejected because the term alter provides for a wider and more varied scope of changes. Other edits accepted.

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				side channel and hydraulically connected wetlands."	
89.	Judy Neibauer (USFWS)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations reduce peak flows in duration and magnitude and alter flow period timing in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat through the reduction in flow, sediment, and LWD. Geomorphic processes affect aquatic habitat by influencing key habitat forming elements, such as: substrate size, amount, and quality; key pools, large wood dynamics, main channel and side channel habitat diversity, streambank condition, riparian vegetation, tributary and floodplain connectivity, including side channel and hydraulically connected wetlands."	Edits accepted.
90.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations alter peak flows in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat." See other comments. The transport of LWD and sediment is impacted, as is the recruitment of LWD above the dams.	See Comment Responses #5 and #6.
91.	Judy Neibauer (USFWS)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	This is a section described in the study plan guidelines which I shared earlier…It mentions this is where you get to talk about how the results from the Project will affect the resources. This section could link up to the goals and objectives above and show how the information will be used to assess effects. Currently, this just seems like a general statement/paragraph, without the details of how the data will be used.	See Comment Responses #1 and #2.

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92.	USFS	04/13/2020	Section 2.4 Project Operations and Effects on Resources	**The FS recommends** modifying this section to include the project effects on the complete range of natural flow conditions, sediment transport, and large wood recruitment and transport both above the dams and downstream to the Skagit River delta (as described above).	See Comment Responses #3, #6, and #20.
93.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.5 Study Area	See previous related comment. (See Comment #23)	See Comment Response #23.
94.	Brock Applegate (WDFW)	04/12/2020	Section 2.5 Study Area	Please explain why SCL will not pursue the collection of new information below the Sauk River confluence to the estuary.	See Comment Responses #3.
95.	Judy Neibauer (USFWS)	04/13/2020	Section 2.5 Study Area	Please see my comment above, I agree with folks about expanding the study both above and below the dams, and also I think it should gather information in affected tributaries for some distance upstream …as well as your conservation land areas, and across your transmission lines/roads, see my previous comments. (See Comment #25)	See Comment Responses #3 and #57. Please see the Sediment Deposition in Reservoirs study plan for City Light's responses regarding tributaries to the Project reservoirs.
96.	Brock Applegate (WDFW)	04/12/2020	Section 2.5 Study Area	In consideration of the historic fish passage to Stetattle Creek, SCL should consider the geomorphology currently and historically from Diablo Canyon and downstream.	See Comment Response #3.
97.	Rick Hartson (Upper Skagit Indian Tribe)	03/30/2020	Section 2.5 Study Area	Need to continue the full study downstream to the Skagit delta/estuary. Also, study area needs clarification regarding lateral boundaries. The study area should encompass the FEMA 100-year floodplain (see FEMA NFIP BiOp for Puget Sound, 2008). The FEMA 100-year floodplain should be determined in the absence of project-related flood control (see Upper Skagit Indian Tribe's Regulatory Floodplain Issue Form). This approach for mapping the floodplain attempts to directly relate	See Comment Responses #3, #5, and #20. Lateral boundaries to study area have been adjusted. The study area includes the NPS-mapped channel migration zone along the Skagit River upstream from the Sauk River. The study area was extended upstream from the NPS-mapped channel migration zone to Gorge Dam and includes the entire valley bottom in the extended portion of the study area.

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				information requests to ongoing project operations. The study area should be expanded beyond the 100-year floodplain where geomorphic assessment suggests a possibility for bank erosion and channel meandering over the course of the relicense period (see earlier comment for justification, including reference to comments in Vegetation Mapping and Wetland Mapping studies from TR&RE RWG). See previous comments regarding lost floodplain forests and LWD recruitment due to reservoir operations that prevent tree growth in Skagit River and tributary floodplains upstream of the dams. The study area should include all floodplains between low pool and high pool in the reservoirs. The area between low pool and high pool should also consider landslide-prone areas that may provide sediment and LWD to the floodplain via mass-wasting events. Also, agree with Ashley that Gorge bypass should be included in this study. There is potential for well over a mile of high quality rearing habitat (e.g. see Additional Information Request #4 from current license). The geomorphic study will also help assess fish passage. Though it is clear that anadromous fish can reach Gorge Dam, understanding how LWD and sediment retention impact hydraulic roughness will help determine the range of flows under which passage is possible, as well as species-specific requirements (e.g. can Chum salmon, with the poorest jumping ability	Fish passage issues related to the Gorge bypass reach are being discussed as part of continuing discussions and will be addressed during later phases of the ILP, when a synthesis of information across resource areas is conducted to evaluate Project effects and appropriate PMEs.

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				of anadromous Skagit salmonids, reach Gorge Dam?).	
98.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.5 Study Area	Note the Upper Skagit Indian Tribe dissatisfaction of project area and scope. With that as our primary concern, a secondary comment is will the study acknowledge if there are data gaps from this compilation, and once compiled will the reports/data be analyzed for project ongoing impacts to aquatic resources and the processes that maintain and sustain them?	See Comment Response #3. Data gaps relevant to a cumulative effects analysis will be identified for geomorphic information downstream from the Sauk River. The compiled information will be used for a cumulative effects analysis that will consider effects to geomorphic processes and aquatic habitat.
99.	USFS	04/13/2020	Section 2.5 Study Area	**The FS recommends** modifying the geographic scope to encompass all potential direct, indirect, and cumulative project effects on natural resources. This would include the bypass reach and the Skagit River down to the terminus or delta. The FS recommends modifying the second statement regarding compiling information below the Sauk to "…This study will also compile **historically** relevant geomorphic information on the Skagit River downstream from the Sauk River confluence but will not collect any new **field data** downstream from the Sauk River confluence".	See Comment Response #3. The FERC baseline is existing conditions, and therefore historical conditions are not being addressed in this study plan.
100.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section, 2.6 Methodology	"Figure 2.5-1 Overview of study area: Gorge Dam to Sauk River confluence." Upper Skagit Indian Tribe questions why the entire by pass reach is not in project boundary. Could SCL explain the odd delineation from their perspective or records?	See Comment Response #3.
101.	Jon Riedel (NPS)	03/31/2020	Section, 2.6 Methodology	"The Skagit River Geomorphology from Gorge Dam to the Sauk River Study will include pre-	Comment is acknowledged. City Light is confident it has the resources to ensure that the

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				field analysis of existing information, one season of field work…" Concerned that this is too short of a time, particularly since it overlaps with the reservoir erosion field data collection in summer 2021.	study program can be executed successfully within the identified period of time. Note however, that the ILP includes steps for LPs, City Light and FERC to assess the need for additional study information during the 2 year relicensing study window.
102.	Brock Applegate (WDFW)	04/12/2020	Section, 2.6 Methodology	I agree with Jon. SCL will also depend on one season to collect information at specific flows. SCL may not receive those specific flows. SCL may rely too heavily on the green Lidar and aerial photographs to get some information, like pool depth. SCL may need additional field work to retrieve information not obtainable by green Lidar and aerial photographs. (See Comment #67)	See Comment Response #101. In areas where pool depth is not reliable using green LiDAR, depth data will be collected as part of the Instream Flow Model Development Study. Text revised to clarify in more detailed methods - Section 2.6.3.
103.	Judy Neibauer (NPS)	04/13/2020	Section, 2.6 Methodology	Collection of data: Do you mean you are collecting data on existing conditions? If yes, you would likely need to do some additional sampling to understand the layers of sediments/bedload deposited from prior to and during project operations to be able to see what has been changing,. Collecting this information would help you to be able to see how processes will change into the future with continued or changed operations.	Surficial sediment gradation and subsurface sampling methods are described in Sections 2.6.3 and 2.6.5.
104.	Brock Applegate (WDFW)	04/12/2020	Section, 2.6 Methodology	"The Skagit River Geomorphology from Gorge Dam to the Sauk River Study will include pre-field analysis of existing information, one season of field work to inventory current geomorphic conditions in the Skagit River, three years of scour monitoring[2], and post-field analysis and report writing."	See Comment Response #68.

[2] A pilot scour monitoring study started in September 2019; it is anticipated the scour monitoring study will be expanded to include new areas and continue through September 2022.

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				If the greatest concentration of redds change over the decades, SCL will need to continue this scour monitoring throughout the license.	
105.	Judy Neibauer (USFWS)	04/13/2020	Section, 2.6 Methodology	Agreed. This may be a long term management plan type of monitoring need. (See Comment #70)	See Comment Response #68.
106.	USFS	04/13/2020	Section, 2.6 Methodology	**The FS recommends** identifying contingencies or adaptive management in field schedule duration and intensity. Field schedule in draft study plan does not account for field data collection efforts needed above the dams to study sediment and large wood budgets, and does not include data collection effort in the bypass reach.	See Comment Responses #3, #5, and #20.
107.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.1 Collect Existing Information	Is there FLIR data analysis conducted in the Skagit? Please add this or another type of temperature information to your study…. this type of information overlaid with geomorphology /Lidar data could help to depict hyporheic areas within the channels. Finding these areas could be key to finding refugia…areas that fish and their prey may use for refuge, foraging, and spawning. Long term temperature monitoring may be needed and might be part of a long term management plan.	See Comment Response #23.
108.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.1 Collect Existing Information	See my comment above about expanding geomorphic analysis upstream and into adjacent tributaries to be able to depict how operations are/will affect sediment/bedload transport…This will inform operational effects to passage, habitat quality, quantity, flows, and refugia in these areas of intersection between tributaries and the river or reservoirs.	See Comment Responses #3 and #57. Please see the Sediment Deposition in Reservoirs study plan for City Light's responses regarding tributaries to the Project reservoirs.

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109.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Collect Existing Information	"An annotated bibliography will be prepared, and a summary of geomorphic conditions will be written for inclusion in the study report." Primary concern study does not match Upper Skagit Indian Tribe expectations for geographic scope. Secondarily need to ensure study report does not simply describe what is there as a baseline. Upper Skagit Indian Tribe has been requesting an understanding of how project operations affect EFH and processes that create and maintain salmonid productivity.	See Comment Responses #3 and #6. EFH is included with other statutory authorities in Section 1.2.
110.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.2 Geomorphic Change	"The analysis of geomorphic change includes two primary metrics: channel migration and channel incision." Bank armoring may retard or stop channel incision and migration. Please take bank armoring into account during the analysis or change the analysis area.	Bank armoring will be taken into account during the analysis of channel migration. Text revised to clarify.
111.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2 Geomorphic Change	"This analysis will consider change in these metrics over the term of the existing license to inform likely changes over the term of the new license." You should include a measurement that helps look at bedload movement, to determine the average sized particles moving…or not moving. This will help inform what particles are moving through the system, and where they are causing changes in key habitat (i.e. spawning, refugia, pools, etc.). This would also help inform future restoration needs.	See Comment Responses #1, #2, #5, and #6. The scour monitoring in conjunction with the 2-D hydraulic model developed as part of the instream flow study will provide information on bedload movement.
112.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2 Geomorphic Change	"Channel migration rates will be compared to peak flow conditions and changes to sediment inputs and large wood loading to determine	See Comment Responses #1, #2, and #3.

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				conditions which contribute to bank erosion and channel migration." Need to establish a number of flow scenarios to look at how the channel has changed. For the effects analysis you will need to think about climate change scenarios and how operational flows change in the future. Including scenarios with climate effects added. I would expect you would need to stablish a baseline of flows from the earliest years of data collection and look to find the number of peak, base, and low flows and their duration…over time so that you can use the information to help define their intervals….. This will help SCL figure out at what flows channels seem to change to develop habitat, maintain habitat, and degrade habitat and how often this may occur. Link this study to the Land type/Geological mapping: Because of the geomorphic processes and land types, channels will react differently depending where you are in the landscape. Summarizing data by reach type or some type of a method that makes sense based on location is a normal part of looking at geomorphology data. You might look at some of the Forest Practices watershed analysis tools used in years past to delineate data. You may choose to delineate it by water bodies… tributary/river/reservoir….and by something similar to Source, Transport, and Depositional reaches. By doing this categorizing of data, you can adequately combine data and tally the data in a way so that you are not mixing apples and oranges…	Please see the Sediment Deposition in Reservoirs At Areas of Resource Concern study plan for City Light's responses regarding tributaries to the Project reservoirs. Geomorphic reaches will be developed early in the study as a way to group and analyze data collected. Text added to clarify in Section 2.6.1.

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				Expand the study to include the areas I have mentioned previously (above the dams, in to tributaries, and out to the estuary/mouth)…	
113.	Jon Riedel (NPS)	03/31/2020	Section 2.6.2 Geomorphic Change	"Active channel width, …." Will be measured, not calculated?	Active channel width will be calculated based on mapping/digitizing of active channels on the referenced series of aerial photographs.
114.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.2 Geomorphic Change	"Changes through time will be tracked." See my previous comments. Include areas of tributaries that are affected by river and reservoir flows/levels. As mentioned earlier…. The stream channels within tributaries are altered some distance upstream of the mouths…by flows in mainstem rivers. Tributary channels that enter in reservoirs are also altered some distance upstream as reservoir levels are raised and lowered. We visually can see this at the mouths of streams, but depending upon the geomorphology of the tributaries and the operations that alter the flow and water levels….you can walk some distance up these tributaries to see the changes that can travel upstream. These changes in processes can cause either aggrading or degrading the channels that may contribute to degrading aquatic habitat and vegetation, and fish populations. Some stream channels can go subsurface causing a disconnection in the surface water. What do you mean when you say changes will be tracked through time….annually, periodically, etc.?	This study area includes the Skagit River downstream of Gorge Dam (to Sauk River), so analysis of tributaries entering reservoirs is outside of this study area. Tributary mouths that enter the Skagit River from Gorge Dam to the Sauk River are part of the study area for this study. The junction of tributaries and mainstem rivers are very dynamic environments. City Light is not aware of locations in this study area where tributaries go subsurface or result in passage barriers, but is interested in exploring these concerns with LPs if there is evidence of such locations. Changes will be tracked through time at intervals determined by the sets of historic aerial photographs chosen for the analysis (see second paragraph in Section 2.6.2).

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115.	Jon Riedel (NPS)	03/31/2020	Section 2.6.2 Geomorphic Change	"An analysis of USGS gage rating curve changes during the term of the current license (from 1990 to present) will be made at the Skagit River at Newhalem (USGS 12178000), Skagit River at Marblemount (USGS 12181000), Skagit River near Rockport (USGS 12184700) gages to evaluate potential channel incision or aggradation." Duration and timing of events also key impact and not just peaks.	Agree.
116.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.2 Geomorphic Change	I agree with Jon. Please consider timing, magnitude, and duration of the flows. (See Comment #80)	See Comment Response #115.
117.	Jon Riedel (NPS)	03/31/2020	Section 2.6.2 Geomorphic Change	If feasible, historic cross-section data at other locations between the Gorge Dam and the Sauk River will be compared with available Green LiDAR data to evaluate channel changes at locations between gages. FEMA floodplain study and cross sections below Bacon Creek.	Thank you for the suggestion.
118.	Jon Riedel (NPS)	03/31/2020	Section 2.6.2 Geomorphic Change	"The Relative Elevation Map based on current LiDAR data….." We are developing these by reach in landform mapping, and using them more as a tool than an end-product (i.e. changing vertical scale makes a big difference).	Thank you for the clarification.
119.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"The analysis of geomorphic change includes two primary metrics: channel migration and channel incision." Will channel incision include a stream bed armoring assessment? Concern here is has the	Streambed armoring will be assessed by comparing surface and sub-surface grain size. See Comment Response #33.

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				longevity of lack of sediment and bed load transport locked the Skagit to a perpetual incised state? How will floodplain, side channel and tributary seasonal connectedness be measured? Concern is a potential loss of connectivity given incised channel forms along the mainstem?	
120.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"Map active channel areas as polygons on current (2019) and up to five historical geo-referenced aerial photographs." How will tributary junctions be addressed? What tributaries and how far up will these be mapped? Floodplain reach mapped or defined by?	All tributaries with channels visible on aerial photographs will be mapped within the study area.
121.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"Channel migration rates will be calculated by summing the difference in new channel planform area between aerial photograph years and dividing by reach length." CC: How will you identify sites to perform the calculation? LP's need to be able to weigh in on this.	The intention is to calculate migration rates by geomorphic reach and analyze all areas of river (not just a few specific sites). Geomorphic reaches will be developed as part of the study using channel metrics and landform mapping (NPS).
122.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"Channel migration rates will be calculated by summing the difference in new channel planform area between aerial photograph years and dividing by reach length." CC: This reach average method can be misleading if meanders aren't growing but rather just translating downstream or if an active channel moves because the planform area can actually stay steady even though there has been significant migration. The motion of individual meanders need to be taken into account.	The migration analysis will be performed for each bank of the river to help differentiate movement of meanders. Text revised to clarify.

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123.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"Channel migration history over the existing license period will be visualized by calculating historic channel occupancy maps and maps illustrating historic channel positions." CC Will you take into consideration whether channel migration occurred over time by continual bank erosion or whether it occurred due to some event causing avulsion? The average rate over time might calculate the same but the mechanics and impacts are very different.	If it is apparent from the aerial photograph record that migration is progressing via avulsion that will be noted.
124.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"Locations and character of bank protection will be mapped between the Gorge Dam and the Sauk River to update information in Beamer et al. (2000)." Upper Skagit Indian Tribe has a data set on all chinook bearing tributaries and along the Skagit. The methodology used a rapid watershed visual mapping assessment. Please contact Rick h for data and reports.	Thank you for the information; it will be very helpful and included in the analysis.
125.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"An analysis of USGS gage rating curve changes during the term of the current license (from 1990 to present) will be made at the Skagit River at Newhalem (USGS 12178000), Skagit River at Marblemount (USGS 12181000), Skagit River near Rockport (USGS 12184700) gages to evaluate potential channel incision or aggradation." The impact of sediment and wood began as early as the 1918/19 with the building of the first dam at gorge, using a truncated data set may obscure project ongoing impacts.	See Comment Responses #1, #3, #5, and #6.

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126.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Geomorphic Change	"The Relative Elevation Map based on current LiDAR data (developed as part of landform mapping study being conducted by the National Park Service) will be used to analyze channel evolution stage between Gorge Dam and the Sauk River based on the Stream Evolution Model in Cluer and Thorne (2013)." CC By this do you mean the river stage at which channels evolve?	The Cluer and Thorne (2013) paper identifies an idealized progression that occurs along some river channels in response to disturbance. The paper is available in the reference section on SharePoint.
127.	USFS	04/13/2020	Section 2.6.2 (Geomorphic Change) through 2.6.6 (Large Wood)	**The FS recommends** that the two primary metrics to be used for evaluating project effects on downstream geomorphology be the quantification of sediment (bedload) and large wood arrested by the project. Using this analysis, develop a range of scenarios of effects to geomorphic condition downstream of the project under a range of flow conditions from the USGS historical record. The mapping of channel migration zone (CMZ) across the range of historical aerial photos is useful for evaluating human-induced and natural effects to CMZ migration rates for the area of interest, but is too coarse to isolate those effects from only the project. The purpose of the study plan should address data gaps in how project operation contributes to downstream resource impacts. It is unclear how this mapping exercise achieves that objective. The analysis of USGS rating curve changes is useful but shouldn't be limited to the period of the existing license but include the entire period of record. As mentioned above, depending on which USGS station is analyzed the ability to	See Comment Responses #3 and #5. Channel migration is influenced by a number of Project and non-Project factors. It may not be possible to differentiate among these, but the analysis is still useful to identify rates of channel migration.

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				detect (and isolate) project effects will be extremely difficult to immeasurable.	
128.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.3 Aquatic Habitat	"An inventory of the current status of aquatic habitat in the Skagit River between the Gorge Dam and the Sauk River will be made using both remote sensing and field methods." I am excited you will be using LiDAR to help make assessments. Think about adding a summary of current and new information in a table ….to show what data you are pulling from existing sources, how you will use it and what additional data you will be collecting. Show the key questions it will answer and issues it addresses. Habitat affected by the Project operations would include habitat in streams not just in this study area …but in the rivers/ tributaries, reservoirs, and in streams along the transmission corridors/access roads or conservation lands. Will you be surveying side channels similarly? Aquatic data can also be grouped by reach types, depending on geology…a pool in one reach may not be similar to a pool in another reach. See my previous comments about this. Using geomorphology/geology and precipitation zones can help design your reach breaks, this will help you look at how you will organize your data so that you can compare it correctly. If you already have data for these areas mention	Thank you for your suggestions on study plan formatting but the format of study plans is standardized for the Project. Streams along the transmission corridor are addressed in a separate study plan. Side channel methods are discussed in Section 2.6.4. Geomorphic reach breaks will be determined as part of study implementation based on a number of factors as discussed in Section 2.6.1.

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				it in the section above where you previously talked about existing data, if its aquatic habitat related, bring it forward here to show how you will use it in combination with field data.	
129.	Jon Riedel (NPS)	03/31/2020	Section 2.6.3, Aquatic Habitat	"An initial map of aquatic habitat type will be made based on recent (2019) georeferenced aerial photographs and green LiDAR…" This data is poor in pools and deep cutbanks. Pool depths will have to be measured in field.	See Comment Response #102.
130.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.3 Aquatic Habitat	Yes, SCL may need more than one season of study because of the extra field work that SCL may need to conduct due to the decrease in accuracy of data for cutbanks and pool depths. WDFW and NPS have found several problems that might occur to trigger a fieldwork season in 2022 and SCL should remain open to the possibility. (See Comment #86)	See Comment Response #101.
131.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.3 Aquatic Habitat	"Data fields obtained from the GIS analysis will include habitat type, average depth (from green LiDAR),…" SCL may want to set aside more time for fieldwork. SCL may need more time to acquire information for pool depths.	See Comment Response #101.
132.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.3 Aquatic Habitat	"The initial map will be refined and field-checked during a walk/float of the river from Gorge Dam to Gorge Powerhouse (foot survey) and between Gorge Powerhouse to the Sauk River confluence (foot/boat survey as appropriate) during low flow conditions." Study proposed limited field time, and how will floodplain and side channels be addressed given difficulty mapping from aerial photographs and limited time for field	See Comment Response #101. LiDAR will be very useful for mapping side channels on the floodplain.

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				verification?	
133.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.3, Aquatic Habitat	"The field inventory will use standard methods…" What type of standard methods or habitat survey will be done? Describe here if it will be detailed like a Hankin –Reeves type survey the USFS uses, or if it will be more of a geomorphic reach assessment. Identify details here so that people know what the data can be used for in terms of assessing affects to aquatic species. If you collect only geomorphic reach scale data, you might miss some of the important information (wood, pools, temperatures, depth, substrate type, undercut banks, riparian vegetation, etc.) which are key indicators used to assess effects… Additional field methods might need to be applied, such as more pebble counts, McNeil core sediment sampling, deploying thermographs, etc. to determine quality of pools and key habitats….	Details of specific aquatic habitat inventory methods will be discussed with LPs to determine appropriate methods for use in a large non-wadable river like the Skagit. McNeil cores are not proposed to conduct the sub-surface sampling because the sample size would be too small considering the size of substrate in the Skagit River. This study does not include water temperature. However, temperature data are collected by USGS at Newhalem, and Ecology has and continues to collect temperature data at Marblemount. As discussed in the PAD, data indicate that water temperature is in compliance with Ecology criteria in the reach downstream of the Project.
134.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.3 Aquatic Habitat	The field inventory will use standard methods to field verify habitat typing and collect information not available from aerial photographs. Please provide reference to standard methods	See Comment Response #133.
135.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.3 Aquatic Habitat	"Field data will include average bankfull width, cover, and if visible (dependent upon turbidity and water depth) dominant/subdominant substrate particle size (e.g., bedrock, boulder, cobble, gravel, sand, fines), and embeddedness."	The same types of data will be collected in all side channels. Chum channel locations are known and can be assessed separately if needed.

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				How will the "Chum channels" man made mitigation sites- be measured or identified against natural aquatic systems?	
136.	Jon Riedel (NPS)	03/31/2020	Section 2.6.4, Side Channels	"The inventory will be made using both remote sensing and field methods." Landform mapping is also addressing this. Need to coordinate to reduce duplication and make products comparable.	Agree – text revised to clarify.
137.	Jon Riedel (NPS)	03/31/2020	Section 2.6.4 Side Channels	"Data fields obtained from the GIS analysis will include side channel type (overflow side channel, [perennial and seasonal], wall-based channel, groundwater-fed channel) and area." These are not the units, or at least descriptions, you shared previously and which the landform mapping is using.	City Light will continue to coordinate on side channel typing.
138.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.4 Side Channels	"If possible (depending upon visibility of side channels on aerial photographs), side channel formation and changes through time over the period of the current license will be mapped and correlated with peak flow conditions between aerial photographs to help determine how side channels form and/or are maintained under existing peak flow conditions." What does peak mean here – do we need that detail or correlated with flow conditions…	City Light has revised text to clarify (magnitude and duration of high flows).
139.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.4 Side Channels	"A summary of the amount and quality of side channel habitat will be made." Glad to see that the quality of side channels will be reviewed. Will you be conducting the same aquatic habitat surveys in the side channels as in the mainstem?	Habitat methods for side channels will be similar to aquatic habitat methods as described in the study plan. Effects of hyporheic flows are not addressed in this study plan. See Comment Response #23.

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				Is seems that type of information in side channels would be needed to assess the operational effects on the type of habitat within the side channels. Some side channel habitat is similar to the mainstem habitat…and should be treated as aquatic habitat in aquatic surveys….and some side channels could become the mainstem in some years…You may need to determine they types of side channels you will gather aquatic information on, Maybe aerial photos could help with this. Assessing and understanding the hyporheic areas associated with these channels is important and can help determine if they are key forage, rearing, refugia type areas. The effects of operational flows in these areas will be important to know.	Effects of operation and PME measures would be addressed as part of the license application. This is a subsequent step to the study program.
140.	Jon Riedel (NPS)	03/31/2020	Section 2.6.5 Substrate / Sediment	"An initial map of dominant/subdominant substrate size will be made if visible on recent (2019) georeferenced aerial photographs." Doubt you can do this with scale of aerial phots – and not just historic small scale ones but also recent large scale NAIP images with a 1m resolution. This is another product that should be linked to landform mapping, which is just noting whether or not bars are gravel vs. sand.	Agree – the methods acknowledge it may not be possible. Links to landform mapping are included in this section of the methods.
141.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.5 Substrate / Sediment	"An initial map of dominant/subdominant substrate size will be made if visible on recent (2019) georeferenced aerial photographs." SCL should tell us how they will accomplish these tasks as it sounds like the photographs lack the detail to detect substrate size.	See Comment Response #140.

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142.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.5 Substrate / Sediment	"The initial substrate map will be refined and field-checked during a walk/float of the river from Gorge Dam to Gorge Powerhouse (foot survey) and between Gorge Powerhouse to the Sauk River confluence (foot/boat survey as appropriate) during low flow conditions." Will SCL have enough time in one season to collect, verify, and proof other information gathered from Green lidar and aerial photographs?	See Comment Response #101.
143.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.5 Substrate / Sediment	"An inventory of the current status of substrate in the Skagit River, side channels, tributary deltas, and unvegetated bars between the Gorge Dam and the Sauk River will be made. The inventory will be made using both remote sensing and field methods and will be coordinated with the landform mapping project currently underway. An initial map of dominant/subdominant substrate size will be made if visible on recent (2019) georeferenced aerial photographs. Substrate size categories include bedrock, boulder, cobble, gravel, sand, and fines. Substrate polygons will be digitized to produce a GIS layer. Minimum polygon size will be 1,000 square feet. The initial substrate map will be refined and field-checked during a walk/float of the river from Gorge Dam to Gorge Powerhouse (foot survey) and between Gorge Powerhouse to the Sauk River confluence (foot/boat survey as appropriate) during low flow conditions."	An analysis of armoring will be made based on results of sediment armor/sub-armor sampling.

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				Will an assessment of armoring be conducted with these data?	
144.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.5 Substrate / Sediment	"Wolman pebble counts (100 surficial particles) and sub-surface samples (Church et al. 1987) will be collected at locations representative of bedload transport (e.g., top end of point bars or upper end of mid-channel bars) during low flow conditions." Could identify in each of these methods sections, the questions you will be answering? That might help understand what it is you are measuring, and how the information will answer the questions for future assessments. It is not clear here in the substrate/sediment section everything you will be answering. Pebble counts are a great first cut way of seeing red flags and areas of deposition. However, using pebble counts across habitat types and not just at bars would help to also determine the quality of a range of habitat types. See the Hankin-Reeves type surveys the USFS uses as an example tool to use to assess sedimentation across all habitat types and by reach type. This section seems like you are limiting the collection of substrate/sediment data. Will you do different pebble counts or combine additional counts from the Aquatic survey? If you will want to determine how impacted spawning areas are…you might utilize some other tool like the McNeil core sampler transects.	See Comment Responses #1 and #2 regarding the integration of information in the ILP process. As described in Section 2.6.3, dominant and sub-dominant substrate will be collected within habitat units. McNeil cores are too small to use to sample the large substrate in the Skagit River.
145.	Jon Riedel (NPS)	03/31/2020	Section 2.6.5 Substrate / Sediment	"Sample spacing will depend upon the availability of appropriate bars, with the aim of one sample per river mile."	Gravel sampling will be stratified by geomorphic reach, which will take into account landform mapping, tributaries, and other channel metrics– text will be revised to clarify.

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				This seems very coarse based on initial landform mapping results (i.e more than one gravel bar per mile). There is also a lot of variability with tributary inflows and changes in reach scale geomorphology. Sampling frequency should be linked to reaches identified in landform mapping.	The 1 sample/river mile is based on an initial look at gravel bars on aerial photographs; this can be adjusted if needed based on the results of the initial mapping and landform mapping.
146.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.5 Substrate / Sediment	I agree with Jon. Sampling spacing should depend on landform changes. We should have another sample for each change in geomorphological landform, instead of set on a specific distance. (See Comment #97)	See Comment Response #145.
147.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.5 Substrate / Sediment	I agree. If not appropriate reaches you may be comparing data not representative of the different land types…which could skew data (i.e. if in a sandstone reach vs a bedrock vs a glacial till type reach); and it would be like comparing apples and oranges. (See Comment #97)	See Comment Response #145.
148.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.5 Substrate / Sediment	"Sample spacing will depend upon the availability of appropriate bars, with the aim of one sample per river mile." Sampling appears limited in scope.	See Comment Response #145.
149.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.5 Substrate / Sediment	"Tributary deltas and unvegetated bars will be mapped on a series of up to five historical to recent aerial photographs to enable tracking their size and condition over time and assess ability of the current peak flow regimes to distribute incoming sediment (see Section 2.6.2 above)." How far up tributaries and which ones will be surveyed? If sediment appears unchanged between time series then that might imply no	Tributaries visible on aerial photographs will be mapped within the study area. It is true that unchanging sediment between aerial photograph series could imply that they were deposited, transported, and re-deposited, but it is unlikely that this sequence would result in deposits that are totally similar between the two periods. The sequence of high flows between aerial photograph periods will help to analyze the potential for this occurring.

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				sediment inputs but what if they were dropped, washed away and filled between photo periods, seems like this might need a change in approach?	
150.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.5 Substrate / Sediment	"An analysis of initiation of gravel transport at key/representative spawning locations using scour monitors and accelerometers will be made to help determine the flow rate that initiates movement or results in substrate scour to redd depth." See comments above about species specific spawning sites and risk from scour.	See Comment Response #46.
151.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.6 Large Wood	An inventory of the current status of large wood in the Skagit River between the Gorge Dam and the Sauk River including tributary mouths will be made using both remote sensing and field methods. Why not consider remote sensing down to the estuary?	See Comment Response #145.
152.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.6 Large Wood	Since the Project is in the headwaters of the Skagit, effects to instream and riparian area LWD have likely occurred through time and will continue with the new license. Looking at operational effects across the Project seems like something needed. If you have other data, you should describe it in the existing information section above, and bring it forward here to show how you will be linking any new data collected in the field work. If no existing data is available, this study should include those areas lacking information. The Project occurs both above and below dams, affect some areas upstream in adjacent tributaries, affect streams in transmission	See Comment Response #20.

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				corridors, and on conservation lands. These areas should be included in this study to see how aquatic and riparian habitat is changed through time, how habitat is altered at high/low flows, and how riparian areas may be affected during low flows, especially for extended low flow periods or low reservoir levels. You should include an analysis for operational effects to existing in-channel wood, and future wood in riparian areas, and including climate change scenarios. Understanding how much wood is out there, how wood is interacting with the channel at certain flow levels, and what the future recruitment is like, is key to understanding aquatic habitat effects. Maybe you are already doing this type of wood assessment. But this updated information could be used to help with new restoration designs on reservoir shorelines, in tributaries, or in rivers in the Project area. A restoration goal may be to collect woody debris to be used at certain locations where data shows operations may have impacted in-channel or future wood.	
153.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.6 Large Wood	"An inventory of the current status of large wood in the Skagit River between the Gorge Dam and the Sauk River including tributary mouths will be made using both remote sensing and field methods." CC: Please include an inventory of LWD that has been intentionally passed or moved into the river as per the LWD management plan.	See Comment Response #20.

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154.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.6 Large Wood	"An initial inventory of large wood will be made using current (2019) filtered LiDAR cross referenced to concurrent aerial photographs (similar to methods described in Abalharth et al. 2015). LiDAR will be used to delineate large wood and jams. Delineated wood and jams will be cross referenced with aerial photographs to verify features and collect additional information such as root wad (Y/N), function, and member of log jam (Y/N). Data will be entered into the GIS coverage and volume of wood will be calculated if possible." Yearling Phase one report has method and results of large wood jams, and should be utilized for rate of change or inventory assessments. Includes Newhalem down to hyw 9 Bridge in Sedro-Wolley.	Thank you for the additional information.
155.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.6 Large Wood	"LiDAR will be used to delineate large wood and jams. Delineated wood and jams will be cross referenced with aerial photographs to verify features and collect additional information such as root wad (Y/N), function, and member of log jam (Y/N)." CC: Persistence of single LWD or log jams should also be determinable and useful information. How many years has any particular log jam been in place?	Yes, it is intended to look at this type of data if possible depending upon the resolution of the aerial photographs.
156.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.6 Large Wood	"Work products will include:" Wood budget for below Diablo dam? Also a table describing the quantity of LWD passed at New Halem Ponds over last license, it should include timeframe of events. Another estimate should be made for amount released through Gorge dam as part of maintenance operations.	See Comment Response #153.

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157.	Jon Riedel (NPS)	03/31/2020	Section 2.6.7 Data Analysis and Report Preparation	1st Bullet – Comment "A description of the geomorphic setting and brief summary of relevant previous geomorphic studies conducted in the Skagit River between Gorge Dam and the Skagit River estuary." Link with landform mapping, which should be available in draft form by the time you are starting this study.	Agree, text revised to clarify.
158.	Jon Riedel (NPS)	03/31/2020	Section 2.6.7 Data Analysis and Report Preparation	4th Bullet – Comment "An analysis of initiation of substrate movement and redd scour in monitored areas (adjacent to redds) with peak flow conditions." This will be a Swiss cheese approach. With no continuous modeling you will conduct spot measures of sediment entrainment, but what about deposition and storage? Some of the gravel bars, spawning beds may be transitory features.	See Comment Responses #5 and #6.
159.	Brock Applegate (WDFW)	04/12/2020	Section 2.6.7 Data Analysis and Report Preparation	4th Bullet – Comment I agree with Jon. If SCL doesn't complete the sediment budget model, they cannot predict future spawning habitat where they needs to measure redd scour. Without a prediction tool, you will need to measure redd scour throughout the license, hence SCL should have a monitoring and adaptive management plan for the license that addresses redd scour. (See Comment #103)	See Comment Responses #5 and #6.
160.	Jon-Paul Shannahan	04/13/2020	Section 2.6.7 Data Analysis	6th Bullet – Comment	Text revised to add "quality".

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
	(Upper Skagit Indian Tribe)		and Report Preparation	"An analysis to evaluate current amount of spawning and rearing habitat for all salmonid species within the study area." CC: and Quality	
161.	USFS	04/13/2020	Section 2.6.7 Data Analysis and Report Preparation	The FS recommends that final report conclusions provide a clear nexus between project effects and downstream resource impacts (if any). The current products identified in the draft study plan describe work products that summarize existing condition, due in large part to effects of all human-induced impacts and natural processes. The report should focus on the project effects on downstream geomorphic conditions. The FS recommends having a table in this section describing remaining data gaps not addressed, issues identified for resolution but unable to resolve, and preliminary next steps.	See Comment Responses #1, #2, and #6.
162.	Jon Riedel (NPS)	03/31/2020	Section 2.8 Schedule	3rd Bullet – Comment "Field Work – January to September 2021 (depending on flows)" This is ambitious, You have a large field area, and limited low flow periods for field work. The summer part of this field season also overlaps with reservoir erosion field season. Will you have multiple crews?	See Comment Response #101.
163.	Brock Applegate (WDFW)	04/12/2020	Section 2.8 Schedule	3rd Bullet – Comment and Schedule Comments I agree with Jon. See additions to the schedule.(See Comment #106) Initial Study ~~Final~~ Report (ISR) – March 2022	See Comment Response #101. Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP provides the opportunity for comment on the final report submitted in the ISR and

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				ISR Meeting Request for study plan modification (if needed) Next season of Field Work and Studies (if needed)—January to September 2022 Post-field Analysis (if needed) – Summer 2022 to Winter 2022–2023 Final Study Report (if needed)- March 2023	discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year. City Light believes that it will be beneficial to all parties to have information from the studies available as soon as possible to inform development of management proposals and cross resource analysis. The schedule reflects the timeline for this study only, not the larger ILP process.
164.	USFS	04/13/2020	Section 2.8 Schedule	The FS Recommends modifying the intensity of field work necessitated by including field data collection above the dams and in the bypass reach. If infeasible to increase data collection effort, then request omitting much of the evaluation of existing condition and focus on quantifying known project effects (sediment and wood) arrested by project operation.	See Comment Responses #3, #5, and #6.
165.	Stan Walsh (SRSC)	03/30/2020	Section 2.1 Study Goals and Objectives	"**2.1 Study Goals and Objectives**" The study plan does not address disruption of bedload and LWD by the project which is an area of study identified by multiple agencies and tribes. SRSC request the study proposal be modified to include a) An estimate of bedload and LWD annually disrupted by the project b) Model routing of the estimated	See Comment Response #5. Regarding "modeling multiple levels of bedload augmentation", this would be a subsequent step to this study. See Comment Response #2.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				bedload through the Skagit River under multiple flow regimes in conjunction with the instream flow study c) Model estimated LWD distribution through the Skagit River under multiple flow regimes in conjunction with the instream flow study d) Model multiple levels of bedload augmentation under multiple flow regimes in conjunction with the instream flow study	
166.	Stan Walsh (SRSC)	04/13/2020	Section 2.1, Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes in the reach." The Scope of the study needs to be extended to below the Sauk River. Specific project impacts that need analysis below the Sauk are disruption of fine sediment delivery to the estuary and bay front and disruption of LWD transport to the middle Skagit River	See Comment Response #3.
167.	Stan Walsh (SRSC)	03/19/2020	Section 2.1, Study Goals and Objectives	"The study goals of the Skagit River Geomorphology between Gorge Dam and the Sauk River study are to characterize the current condition of aquatic habitat in the reach, and to characterize how Project-related changes in peak flows affect geomorphic processes in the reach." It is likely not just peak flows that influence geomorphology but the entire flow regime and	See Comment Response #7. Text has been revised.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				specifically duration of high flow events, numerous flow regimes need to be evaluated for their effect on geomorphology in conjunction with the flow model	
168.	Stan Walsh (SRSC)	03/19/2020	Section 2.1, Study Goals and Objectives	1st Bullet - Comment "Use aerial photograph and LiDAR data and collect field data to document current conditions and changes over the period of the current license to document:" The study needs to look over longer period than the current license. The flow conditions of the current license may be maintaining an already adverse condition that is a direct effect of the ongoing operation of the project.	See Comment Response #3.
169.	Stan Walsh (SRSC)	03/19/2020	Section 2.1, Study Goals and Objectives	Suggested New Bullet A specific objective of the flow study should be to implement a-d listed in the first comment in this section.	See Comment Response #5.
170.	Stan Walsh (SRSC)	03/19/2020	Section 2.3 Background and Existing Information	"City Light surveys anadromous fish spawning locations throughout the year and records location, water depth, and species." Only steelhead are recorded for all redds, for salmon species only the shallowest redds at risk of dewater at minimum flows are marked comprehensively	Thank you for the clarification.
171.	Stan Walsh (SRSC)	04/13/2020	Section 2.3 Background and Existing Information	"This information was used for a reach assessment of the Middle Skagit River (Sauk River confluence to Sedro-Woolley) that analyzed potential areas to target habitat restoration based on habitat, geomorphology, and land uses (Smith et al. 2011)."	Thank you for your comment. The Upper Skagit Indian Tribe 2010 bank hardening data will be collected and used in the analysis if available.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				For the Middle Skagit River Assessment an updated inventory of bank hardening was conducted by the Upper Skagit Indian Tribe in 2010.	
172.	Stan Walsh (SRSC)	04/13/2020	Section 2.3 Background and Existing Information	"Geomorphology, hydrology, and hydraulics studies undertaken for the Barnaby Reach restoration project provide detailed information on the Skagit River channel, off-channel areas, and floodplain in the area just upstream of the Sauk River confluence (Skagit River System Cooperative and Natural Systems Design 2019)." This document seems out of place in this section as the Barnaby Reach is above the Sauk River.	You are correct. Text revised.
173.	Stan Walsh (SRSC)	03/19/2020	Section 2.4 Project Operations and Effects on Resources	"Project operations alter peak flows in the Skagit River downstream of Gorge Dam, thereby altering geomorphic processes that may affect aquatic habitat." See comment on range of flows in Sec 2.1	See Comment Response #7.
174.	Stan Walsh (SRSC)	03/19/2020	Section 2.5 Study Area	"This study will also compile existing relevant geomorphic information on the Skagit River downstream from the Sauk River confluence but will not collect any new information downstream from the Sauk River confluence." See comment on study below the Sauk River confluence in Sec 2.1	See Comment Response #3.
175.	Stan Walsh (SRSC)	03/24/2020	Section 2.6.2 Geomorphic Change	"This analysis will consider change in these metrics over the term of the existing license to inform likely changes over the term of the new license."	See Comment Response #3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Geomorphic changes likely occurred as a result of ongoing project operations prior to 1995 that the current license continues to maintain or exasperate. Continued disruption of bedload needs to be analyzed as requested in Sec 2.1	
176.	Stan Walsh (SRSC)	03/24/2020	Section 2.6.2 Geomorphic Change	"Channel migration history over the existing license period will be visualized by calculating historic channel occupancy maps and maps illustrating historic channel positions." See comment on study period in Sec. 2.1	See Comment Response #3.
177.	Stan Walsh (SRSC)	03/24/2020	Section 2.6.2 Geomorphic Change	"Locations and character of bank protection will be mapped between the Gorge Dam and the Sauk River to update information in Beamer et al. (2000)." Also include Upper Skagit Indian Tribe inventory of bank armor 2013	Thank you for your comment; Upper Skagit Indian Tribe bank protection inventory will be obtained and used in the analysis if available.
178.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.2 Geomorphic Change	"An analysis of USGS gage rating curve changes during the term of the current license (from 1990 to present) will be made at the Skagit River at Newhalem (USGS 12178000), Skagit River at Marblemount (USGS 12181000), Skagit River near Rockport (USGS 12184700) gages to evaluate potential channel incision or aggradation." Gage locations are chosen for their stability and are not generally representative of the reaches where they are located. Translation of incision/aggradation at the gage sites to other areas of the Skagit would seem to be too tenuous to be useful.	Comment noted and will be included in study report discussion of channel change analysis. Other non-USGS cross sections will also be used if possible.
179.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.4 Side Channels	"Data fields obtained from the GIS analysis will include side channel type (overflow side	Backwater side channels are included as overflow side channels; the classification of

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				channel, [perennial and seasonal], wall-based channel, groundwater-fed channel) and area." This inventory should include backwater channels.	side channel types is worthwhile of continued discussion as there are several different classification schemes available.
180.	Stan Walsh (SRSC)	04/13/2020	Section 2.6.4 Side Channels	"If possible (depending upon visibility of side channels on aerial photographs), side channel formation and changes through time over the period of the current license will be mapped and correlated with peak flow conditions between aerial photographs to help determine how side channels form and/or are maintained under existing peak flow conditions." Side channel connectivity is often difficult to ascertain from aerial photos. Connectivity needs to be look at over a wide range of flows in conjunction with the flow study. Connectivity also needs to be modeled with bedload disruption analysis and bedload augmentation scenarios.	Connectivity on historic aerials is difficult and is acknowledged in the methods statement. Use of the instream flow study model to analyze side channel connectivity may be explored as part of the integrated environmental analysis noted in Comment Response #2.
181.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.5 Substrate/Sediment1	"Sample spacing will depend upon the availability of appropriate bars, with the aim of one sample per river mile." Spacing should be determined by reach but one-mile spacing seems sparse	See Comment Response #145.
182.	Stan Walsh (SRSC)	04/13/2020	Section 2.6.5 Substrate/Sediment1	"Tributary deltas and unvegetated bars will be mapped on a series of up to five historical to recent aerial photographs to enable tracking their size and condition over time and assess ability of the current peak flow regimes to distribute incoming sediment (see Section 2.6.2 above)." If aerial photos are used to estimate quantity, it	Agree, this will be included as part of the analysis of data.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				will be important to investigate the flow conditions at the time of each photo and use that information to "normalize" the measurements so comparisons can be made.	
183.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.5 Substrate / Sediment	"If scour monitoring devices deployed are successful at measuring scour in the river, scour monitoring will be expanded to other critical spawning areas and continued through the fall of 2022 to allow monitoring of several high flow seasons since high flow events are not predictable." How will this be addressed if scour flows do not occur in the two-year study window?	Scour monitors were deployed at several locations in fall 2019 and will be continued through fall 2022, allowing for 3 high flow seasons. A high flow occurred after the 2019 deployment that we anticipate will provide some data for the analysis.
184.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.6 Large Wood	"**2.6.6 Large Wood**" See comment in Sec. 2.1 on LWD transport disruption by the project.	See Comment Response #5.
185.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.6 Large Wood	"In these detailed wood inventory reaches, a GPS point will be taken on each large wood piece and information on length, diameter at breast height (dbh), orientation, root wad (Y/N), single log (Y/N), jam (Y/N), source, decay class; species, mobility, habitat/geomorphic function will be collected for use in determining wood dynamics." Consider a couple categories of jams to get at stability	Thank you for your comment. Additional details on jams will be collected.
186.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.6 Large Wood	"An inventory of large wood on up to five additional sets of historical aerial photographs (assuming resolution is appropriate) over the term of the last license will be made, with wood digitized as line features to help determine large wood mobility and loading to correlate	See Comment Response #3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				with peak flows between aerial photograph series." See comment on study period in Sec. 2.1	
187.	Stan Walsh (SRSC)	04/13/2020	Section 2.6.6 Large Wood	"An inventory of large wood on up to five additional sets of historical aerial photographs (assuming resolution is appropriate) over the term of the last license will be made, with wood digitized as line features to help determine large wood mobility and loading to correlate with peak flows between aerial photograph series." Resolutions of older photographs may make comparisons with current conditions difficult. How will this be addressed? More modern color photos may over-represent current conditions compared to past photo resolution.	Yes, the difficulty in resolution on older aerial photographs is acknowledged in the text. This will be discussed in the report based on the actual resolution of chosen photo sets.
188.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.7 Data Analysis and Report Preparation	2nd Bullet – Comment A summary of geomorphic change (planform change, channel migration, and channel elevation change) over the term of the current license and correlation with peak flows/geomorphic disturbances. See comment on time period of analysis in Sec. 2.1	See Comment Response #3.
189.	Stan Walsh (SRSC)	03/30/2020	Section 2.6.7 Data Analysis and Report Preparation See comment on geographic scope in Sec. 2.1	7th Bullet – Comment Estimate potential future loading of large wood and gravel/cobble in the Skagit River between Gorge Dam and the Sauk River confluence. See comment on geographic scope in Sec. 2.1	See Comment Response #3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
190.	Sauk-Suiattle	06/22/2020	Section 2.1 Study Goals and Objectives	"Use aerial photograph and LiDAR data and collect field data to document current conditions and changes to document:" It might be good to stress which data are corroborated by ground-truthing, or indeed which data are collected in the field (vs only through labwork via Lidar). If the method of collecting data is mostly remote sensing, then the hypothesis may need amending to suggest that, say, "distribution of aquatic types" as perceived remotely. Or perhaps just agree on definitions that are used, which may be interesting as an exercise, anyway. (this following up on the 6/22 CRWG conversation with Kathie Dube et al.) -slobo	Thank you for your comment. The detailed methods sections specify remote sensing and field verification for each component.
191.	Brock Applegate (WDFW)	06/24/2020	Section 2.5 Study Area	SCL has effects downstream of the Sauk confluence. The biggest impact would include hydrology and the change of timing, duration, and magnitude of process flows and the reduction in flood plain. The loss of flood plain has led to less connectivity of fish habitat. Additionally, the river suffers from a reduction in sediment and wood, which has reduced the size of the estuary. The Project holds back large amount of sediment at the upstream end Ross Lake dam and other tributaries that feed into the reservoir system. Please expand your study area to analyze effects by the project for the entire river. Fish populations and orcas will need this more ecosystem approach to effects analysis, along with information collected downstream of the Sauk confluence to address it.	See Comment Responses #3 and #5.

SKAGIT RIVER GEOMORPHOLOGY BETWEEN GORGE DAM AND THE SAUK RIVER
PROPOSED STUDY PLAN

ATTACHMENT B

SCOUR MONITOR PILOT PROJECT – INSTALLATION NOTES MEMO

Memo

Date:	October 7, 2019
Project:	Skagit River Project FERC Relicensing
To:	Erin Lowery, Seattle City Light
From:	Kathy Dubé, Watershed GeoDynamics
Subject:	Scour Monitor Pilot Project – Installation Notes

Scour monitors were installed at three locations in the Skagit River between RM 77.5 and 82.5 on August 22 and 23, 2019. The purpose of the installation was to test scour monitor and accelerometer equipment to determine:

- Which types of equipment are most suitable in the mainstem Skagit River;
- Best methods for installation (e.g., equipment, locations, crew size, time required) as well as any limitations of equipment or installation methods;
- Flows that initiate substrate movement in areas near Chinook redds; and
- Flows that scour substrate to Chinook redd depth.

1.0 EQUIPMENT

Three types of scour monitors/accelerometers were constructed for use: sliding bead and golf ball scour monitors as described in Shuett-Hames et al. (1999); and 2-array accelerometers as described in Gendazak et al (2013).

1.1 Sliding Bead Scour Monitors

Sliding bead scour monitors are the smallest monitors constructed and use ¾ inch steelhead Corkies strung on 3/32 inch stainless steel aircraft cable (Figure 1). The advantages of these monitors are ease of installation and the ability to measure finer scale scour since each bead is ¾ inches in diameter. The main disadvantage is that the Corkies are not as durable as the larger plastic balls used in the golf ball monitors.

1.2 Golf Ball Scour Monitors

Golf ball monitors are similar in design to the sliding bead monitors but use plastic perforated heavy-duty golf balls in place of the Corkies (Figure 2). Drill a small pilot hole into the wooden anchor dowel to insert the thin metal rod during installation. The golf balls are approximately 1.7 inches in diameter, so they record scour at a coarser scale than the Corkies. The golf ball monitors require use of a larger diameter installation pipe which is more difficult to pound into the substrate than the smaller diameter sliding bead inserter.

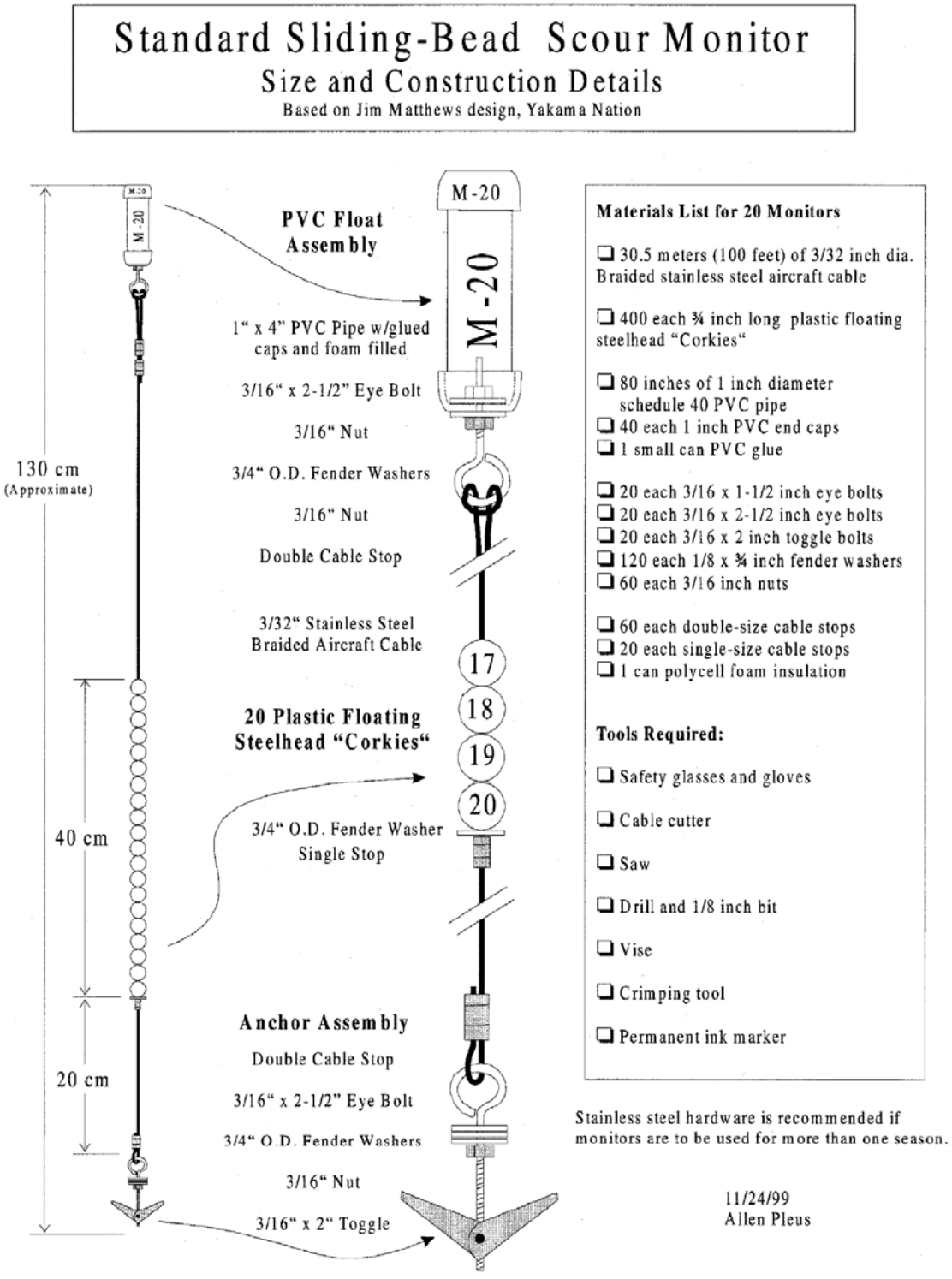

Figure 1. Sliding bead scour monitor design. Source: Schuett-Hames et al. 1999.

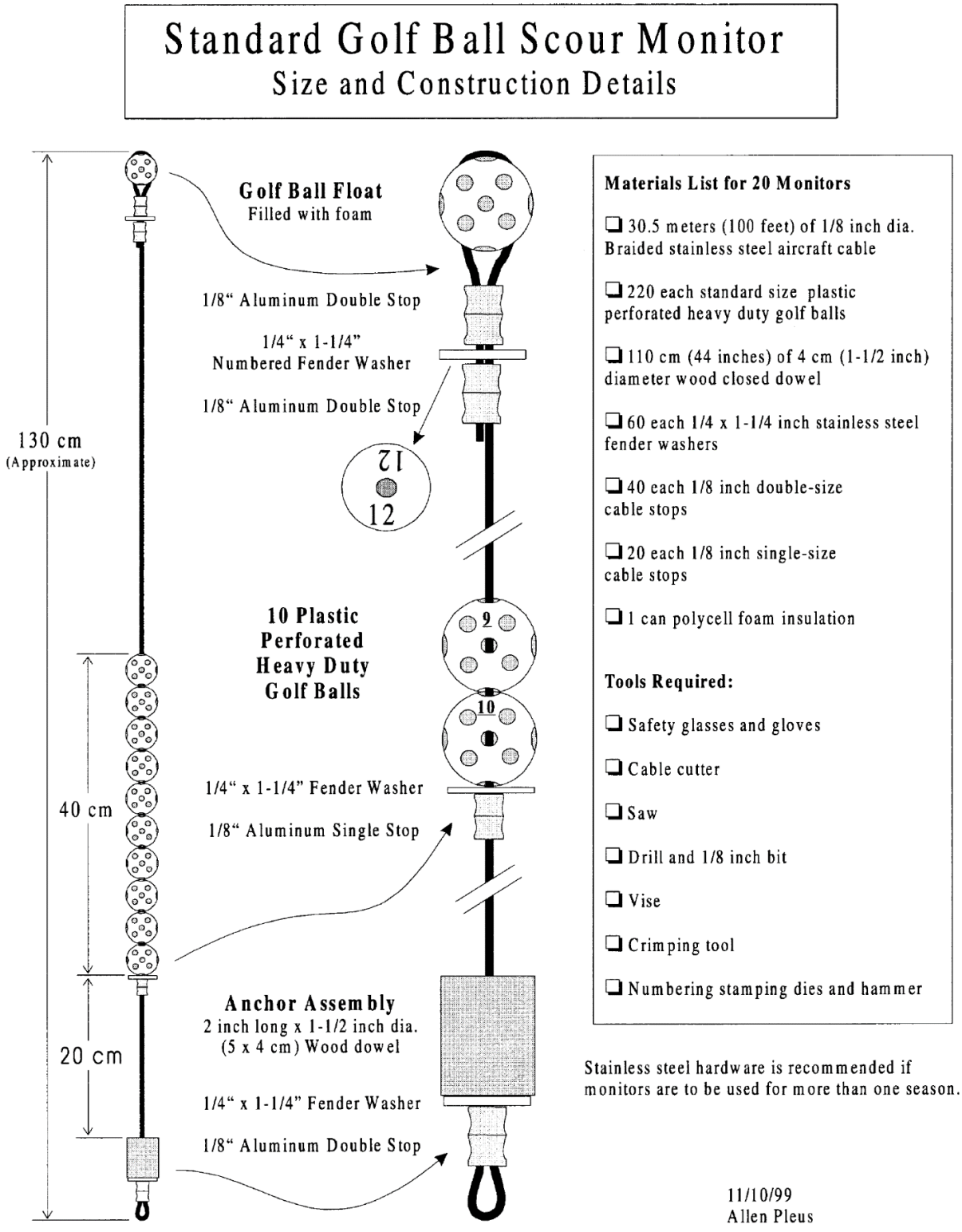

Figure 2. Golf ball scour monitor design. Source: Schuett-Hames et al. 1999.

1.3 Accelerometer Arrays

Arrays of two accelerometers were constructed using a design modified from Gendazak et al. 2013 (Figure 3). Accelerometers measure x-y-z orientation at given time steps and thus record the time when movement takes place (which can be correlated with flow at that time), but they do not record precise scour depths. Hobo Pendant G® accelerometers were inserted into 4-inch lengths of 1.5-inch diameter PVC pipe. A piece of 1/8 inch stainless steel aircraft cable was threaded through a hole drilled through the PVC pipe, through the eye on the accelerometer, and then crimped in place with a double cable stop. The other end of the airline cable was threaded through a piece of wooden dowel anchor similar to that used for the golf ball scour monitors. Drill a small pilot hole into the wooden anchor dowel to insert the thin metal rod during installation. Each accelerometer was wrapped in plastic wrap prior to inserting into the pipe, and spray foam was sprayed into each pipe so that the accelerometer would not move unless the entire pipe assembly moved. Two accelerometer pipe set ups were threaded through each dowel, with one set at 10 inches from the dowel and the other set at 17 inches from the dowel. The result was two independent cables with accelerometers set 7 inches apart from each other. This allowed for the accelerometers to be inserted into the gravel with the top accelerometer measuring movement of surface substrate (initiation of movement) and the bottom accelerometer measuring movement of material 7 inches below the surface (average Chinook redd depth). The accelerometers were set to begin recording on September 1, 2019 at 30-minute intervals (at timestamp GMT-8). This allows for 1.2 years of record to be stored before the onboard memory fills. Accelerometers require the use of the larger-diameter installation pipe. An inserter for the Golf Ball Monitors and Accelerometer Arrays was fabricated based on Figure 4, provided by Andy Gendazak. This inserter is available for use on future scour monitor installations.

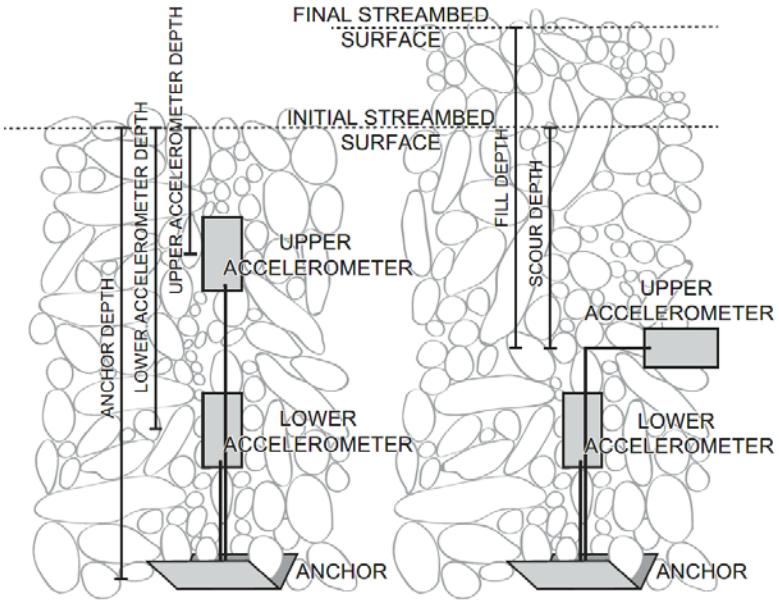

Figure 3. Gendazak Accelerometer Array general design (the anchor was modified for the present project – similar to golf ball anchor). Source: Gendazak et. al 2013.

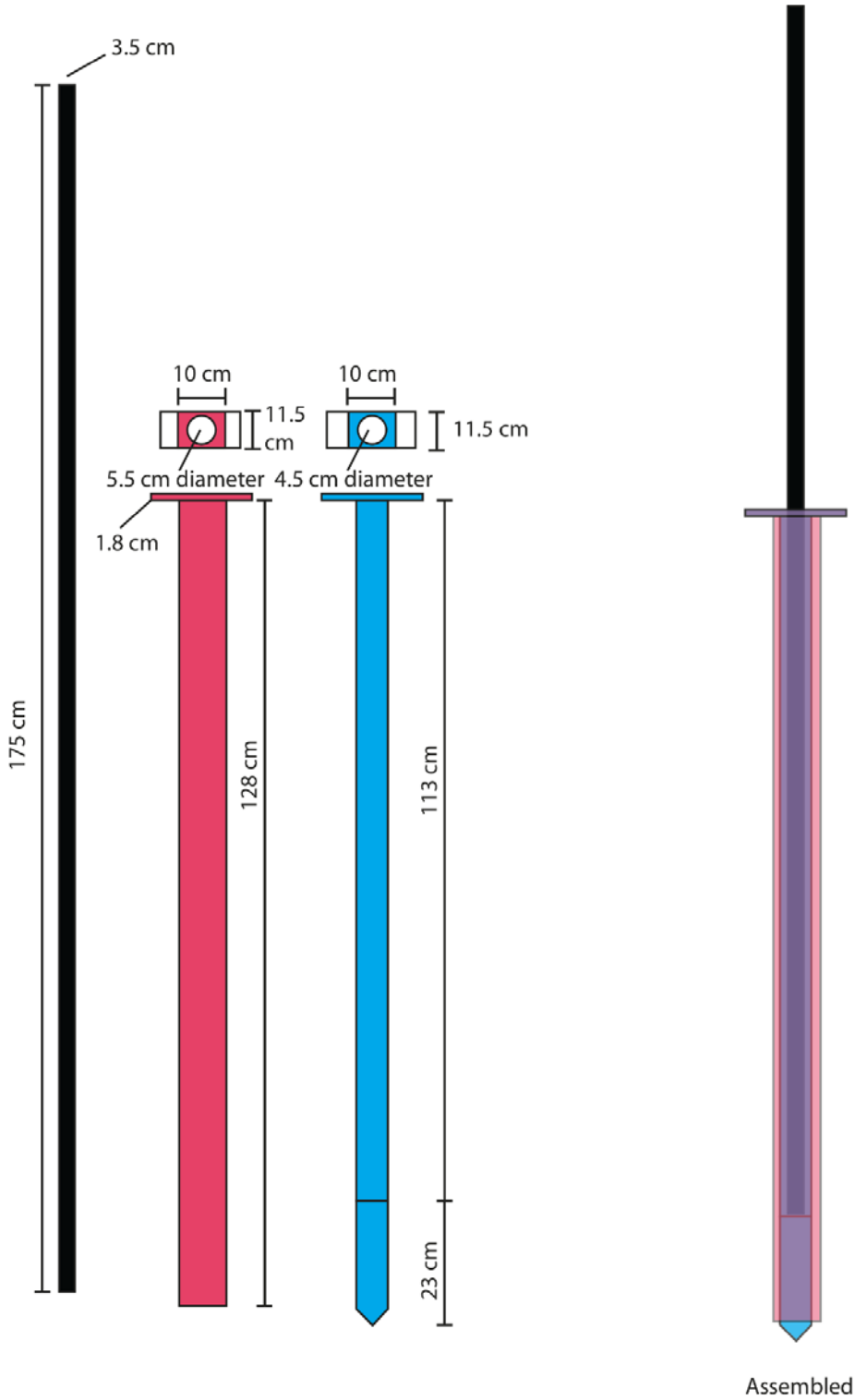

Figure 4. **Golf Ball and Accelerometer Inserter Design – stainless steel pipe, mild steel pounding rod. Source; Gendazak, personal communication.**

2.0 INSTALLATION METHODS

The following equipment is needed to install the monitors:

- Scour monitors and accelerometer arrays (2 of each type were installed at each site in 2019); 5-gallon buckets work great to keep them semi-organized
- Large inserter (fabricated 2 pipe inserter with steel pounding rod) – check for damage to outside pipe and determine if repairs are needed or a second outside pipe should be brought in case of damage from large cobbles. Mark pipe with insertion depth prior to pounding into substrate.
- Small inserter pipe and straight joints (bring several of each, see if Newhalem shop can repair threads if needed)
- Thin metal rods for inserting (bring 2-3)
- Long wooden dowels with small pilot hole drilled to fit thin metal rod for inserting
- Alligator clips on a 2 ft line with flagging so they don't get lost (bring several – for small inserter)
- Small hinge clips on 2 ft line with flagging so they don't get lost (bring several – for large inserter)
- Small and large sledgehammers
- 100-foot fiberglass tape marked in tenths of a foot; compass
- Trimble GPS, handheld GPS as backup
- Waterproof Camera
- Gravelometer
- Field book and pebble count data sheets
- Pencils, large Sharpies
- Copies of permits
- Personal Safety Gear: PFD, safety glasses, hearing protection, work gloves, waders, rain gear, sunscreen, food, water, hats, extra clothes

At each site, determine locations to install monitors. Keep in mind locations where Chinook are known to spawn, substrate size, water depth, and space different types of monitors/accelerometers to cover area.

To install monitors, make sure inserter is marked with installation depth prior to starting (use a Sharpie when inserter is dry). Place inserter at desired location and pound into gravel to marked depth. With large inserter, make sure to take turns. Hold inserter in a vertical position until it can stand upright without support. Sometimes inserters will tilt as they work their way around large cobbles. Try to pull the inserter vertical after it has worked around cobbles. If inserter "bounces" for many hits and does not go into substrate it is likely that it has hit a boulder and a new location will be needed.

After the inserter is pounded in to the marked depth, remove the pounder and center pipe leaving the outside pipe in the substrate. Test depth of hole inside pipe with the long wooden dowel to make sure that fine sediment/sand is not blocking the bottom of the pipe – pound inserter in farther if necessary. Prepare the scour monitor or accelerometer – put a clip on the sliding bead/golf ball cable to keep balls from sliding up cable when it is inserted. Tie thin string onto accelerometer pipes to keep vertical. Place end of thin metal rod into pilot hole in dowel or toggle and insert into pipe, making sure to hold onto string attached to clip or accelerometers. When the metal rod is all the way into the pipe, put the long wooden dowel onto the end (in pilot hole) and push in as far as possible. Once monitor is pushed all the way into pipe, hold the dowel and string steady and have another person slowly and carefully remove the pipe while pushing down on the dowel. Note that this can be tricky, go slow and push or pound gently on the rod/dowel if needed (pounding too hard will push metal rod through dowel – a bad thing). After pipe is removed, check on beads/balls/accelerometers to make sure they are the appropriate depth below riverbed. Fill in top of hole with gravel/fines as needed so beads don't pop up. Record burial depth for each monitor. Attach float if using.

Take a GPS Point with the Trimble at each monitor location and label with monitor designation in notes field.

Measure distance between each monitor and all other monitors as well as any distinctive locations on shore (trees, large boulders, bridge piers, etc.). Draw a sketch with distances in field book.

Take photographs of each site looking upstream, downstream, and at monitors.

Do a Wolman pebble count of 100 particles (use gravelometer) making sure to cover area representative of substrate where monitors are located.

Check inserters after each installation to make sure ends (top and bottom) are not too mangled so that scour monitor/accelerometers will fit through; replace or repair as needed.

Double check before leaving each site to make sure you've got all equipment

3.0 INSTALLATION LOCATIONS

Sites were chosen for the pilot project installation based on areas where Chinook are known to spawn, and where permits could be obtained given the time constraints in 2019. Scour monitors were installed at three locations in the Skagit River: downstream of Bacon Creek, upstream, and just downstream of the Cascade River confluence (Figure 5). Flows during installation were 2,470-2,540 cfs at the Marblemount gage.

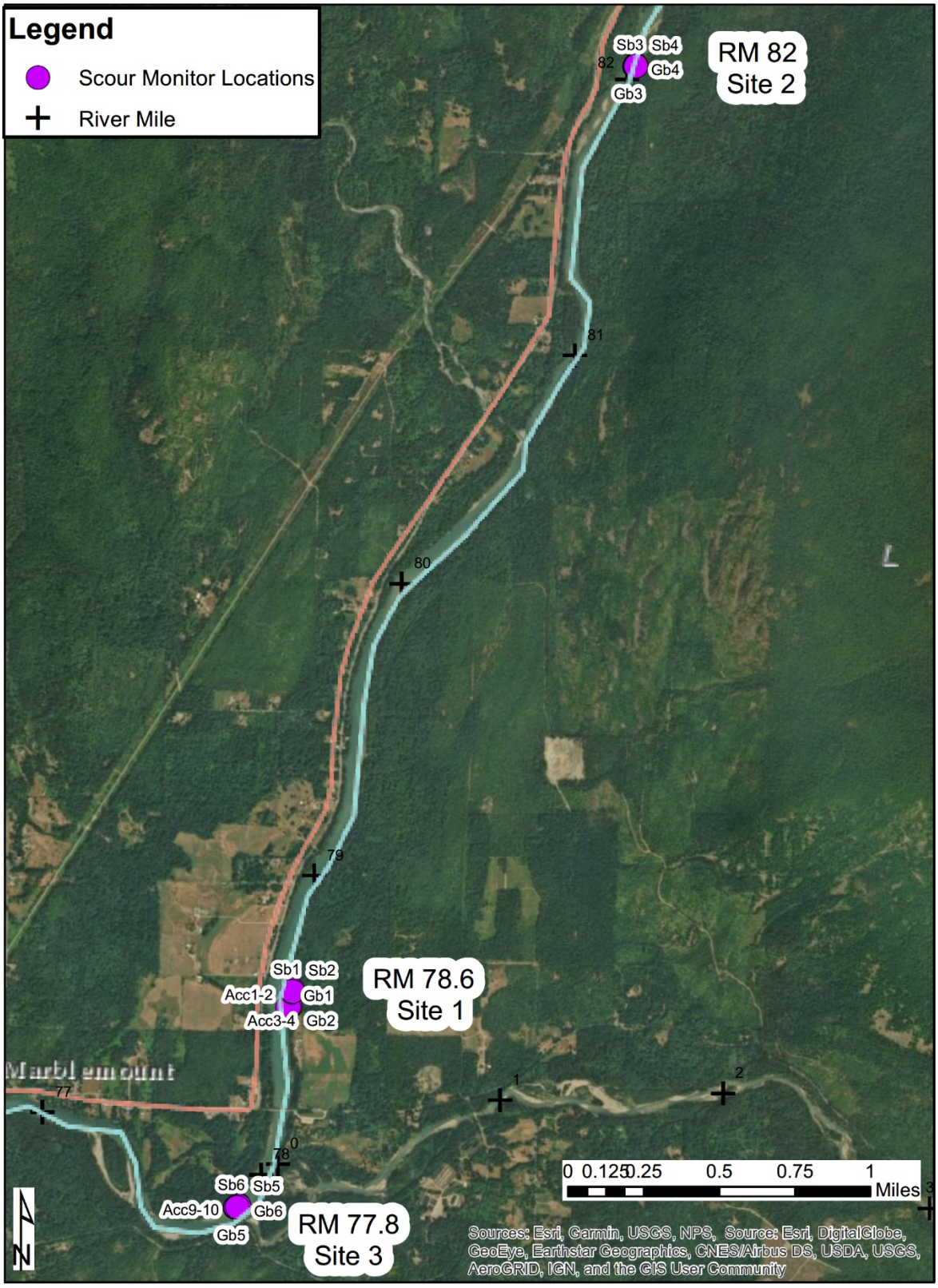

Figure 5. 2019 scour monitor installation locations.

3.1 RM 82 Left Bank Moses Bar Site 2

The site at RM 82 is the downstream end of a left bank bar. This bar is disconnected from the bank at the downstream end by a channel that flows at high discharge levels but was a backwater channel during placement. Monitor placement is summarized in Table 1 and shown in Figure 6.

Table 1. RM 82 Moses Bar monitors.

Monitor Designation	Initial Burial Depth
GB 3 (Golf Ball)	3 inches (one cobble depth)
GB 4 (Golf Ball)	3 inches (one cobble depth)
SB 3 (Sliding Bead)	4 beads floating
SB 4 (Sliding Bead)	3 inches (one cobble depth)
Acc 5-6 (Accelerometer)	4 inches
Acc 7-8 (Accelerometer)	3 inches (one cobble depth)

RM 82 site looking downstream (left) and upstream (right).

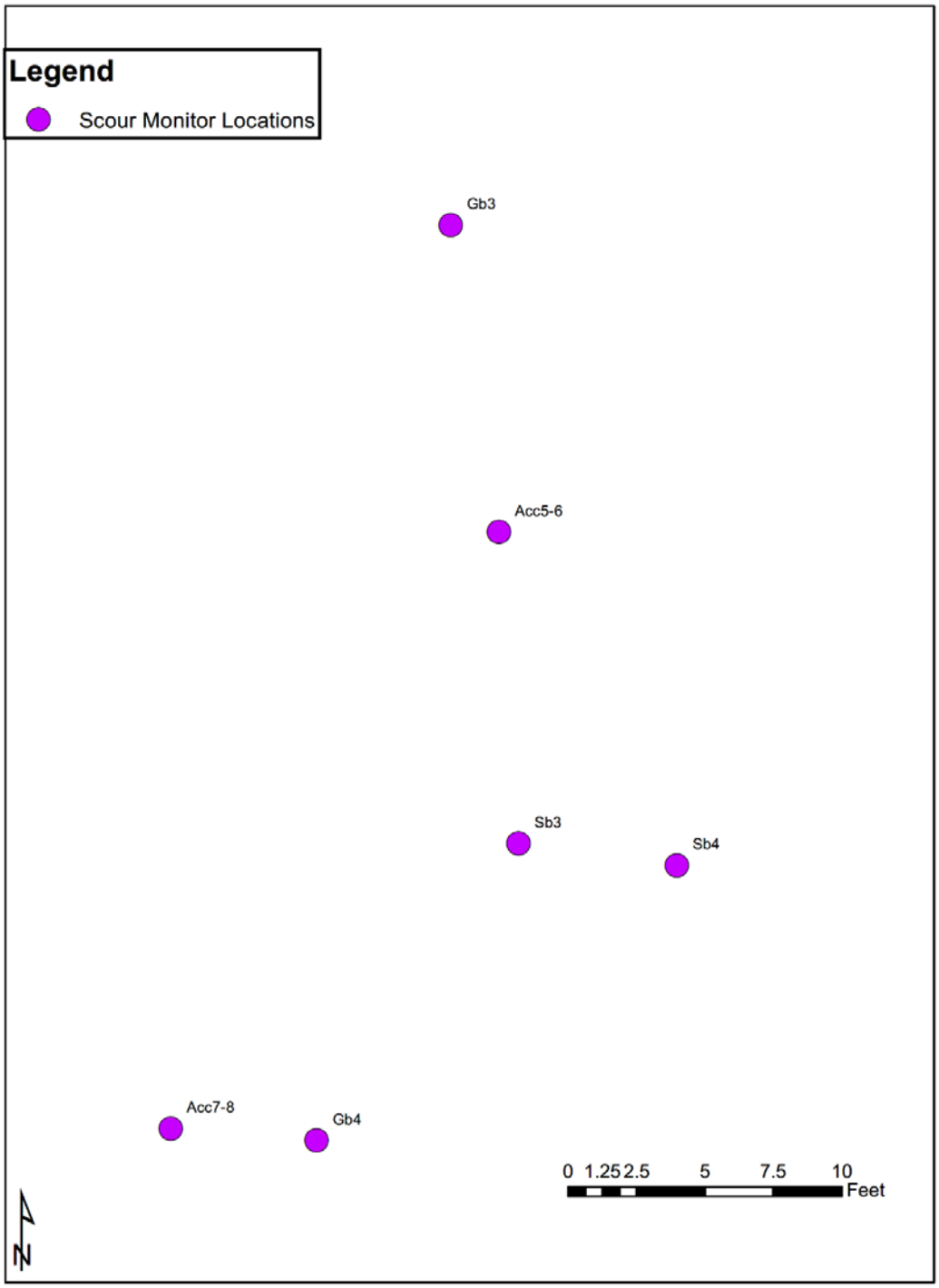

Figure 6. RM 82 Left Bank Moses Bar Site 2 – 2019 scour monitor locations.

3.2 RM 78.6 Left Bank Channel Upstream of Cascade River Road Bridge Site 1

The RM 78.6 location is upstream from the Cascade River boat launch and bridge in a left bank low flow channel. The channel was separated from the main flow by a bar during monitor placement but is part of the main channel during higher flows. A lower (downstream) and an upper (upstream) grouping of monitors was placed at this location. Monitor placement is summarized in Table 2 and shown in Figure 7.

Table 2. RM 78.6 Upstream of Cascade Road Bridge monitors.

Monitor Designation	Initial Burial Depth
GB 1 (Golf Ball)	1 inch
GB 2 (Golf Ball)	5 inches
SB 1 (Sliding Bead)	1 inch
SB 2 (Sliding Bead)	2 inches
Acc 1-2 (Accelerometer)	3 inches (one cobble depth)
Acc 3-4 (Accelerometer)	5 inches

RM 78.6 lower site looking downstream (left) and upstream (right).

RM 78.6 upper site looking downstream (left) and toward main channel (right).

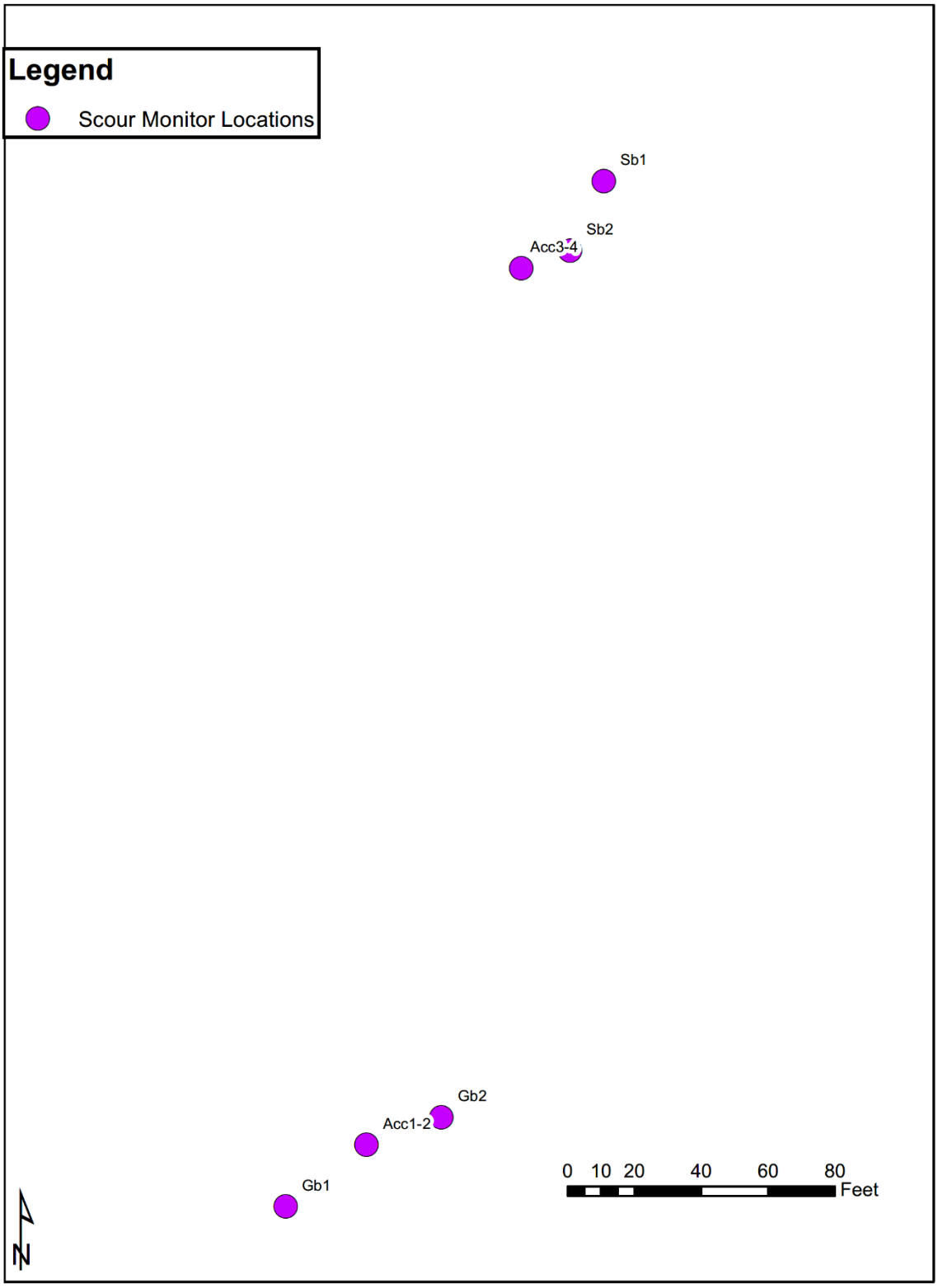

Figure 7. RM 78.6 Left Bank Bar upstream of Cascade River Road Bridge Site 1 – 2019 scour monitor locations.

3.3 RM 77.8 Right Bank Bar at Cascade River Confluence Site 3

The RM 77.8 site is on a right bank bar across the mainstem Skagit River from the mouth of the Cascade River. The site likely is influenced by the sediment input from the Cascade River; the substrate was much looser and easier to install monitors than the two upstream sites. Monitor placement is summarized in Table 3 and shown in Figure 8.

Table 3. RM 77.8 Cascade Confluence Bar monitors.

Monitor Designation	Initial Burial Depth
GB 5 (Golf Ball)	4 inches
GB 6 (Golf Ball)	3 inches (one cobble depth)
SB 5 (Sliding Bead)	3 inches (one cobble depth)
SB 6 (Sliding Bead)	3 inches (one cobble depth)
Acc 9-10 (Accelerometer)	3 inches (one cobble depth)
Acc 11-12 (Accelerometer)	3 inches (one cobble depth)

RM 77.8 lower site looking downstream (left) and upstream (right).

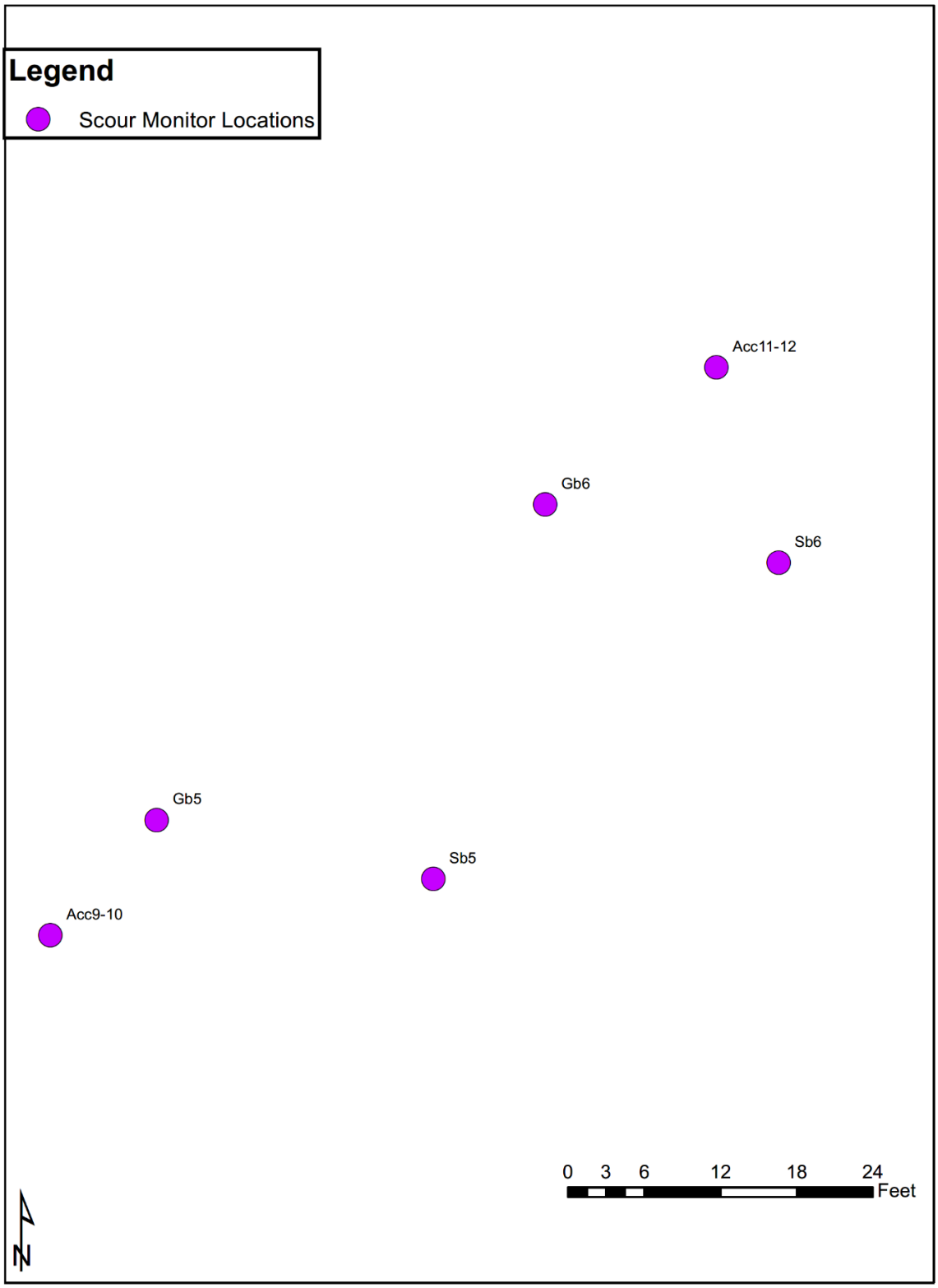

Figure 8. RM 77.8 Right Bank Bar at Cascade River Confluence Site 3 - 2019 Scour Monitor Locations.

3.4 Substrate Texture at 2019 Scour Sites

Surficial substrate texture for each of the scour monitor sites is shown in Figures 9 and 10. All sites were dominated by coarse gravel and cobble particles, with the two sites just upstream and downstream of the Cascade River confluence having a finer texture than the upstream-most site.

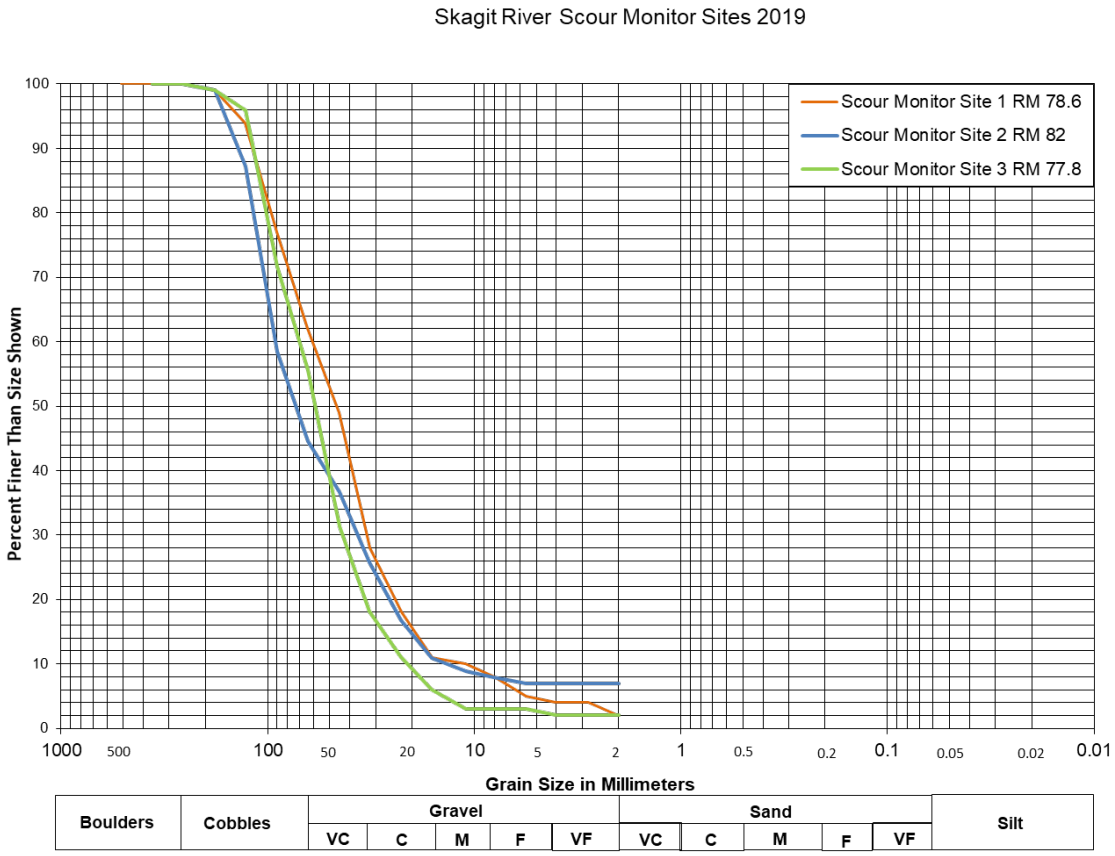

Figure 9. Substrate texture, percent finer, at 2019 scour monitor locations.

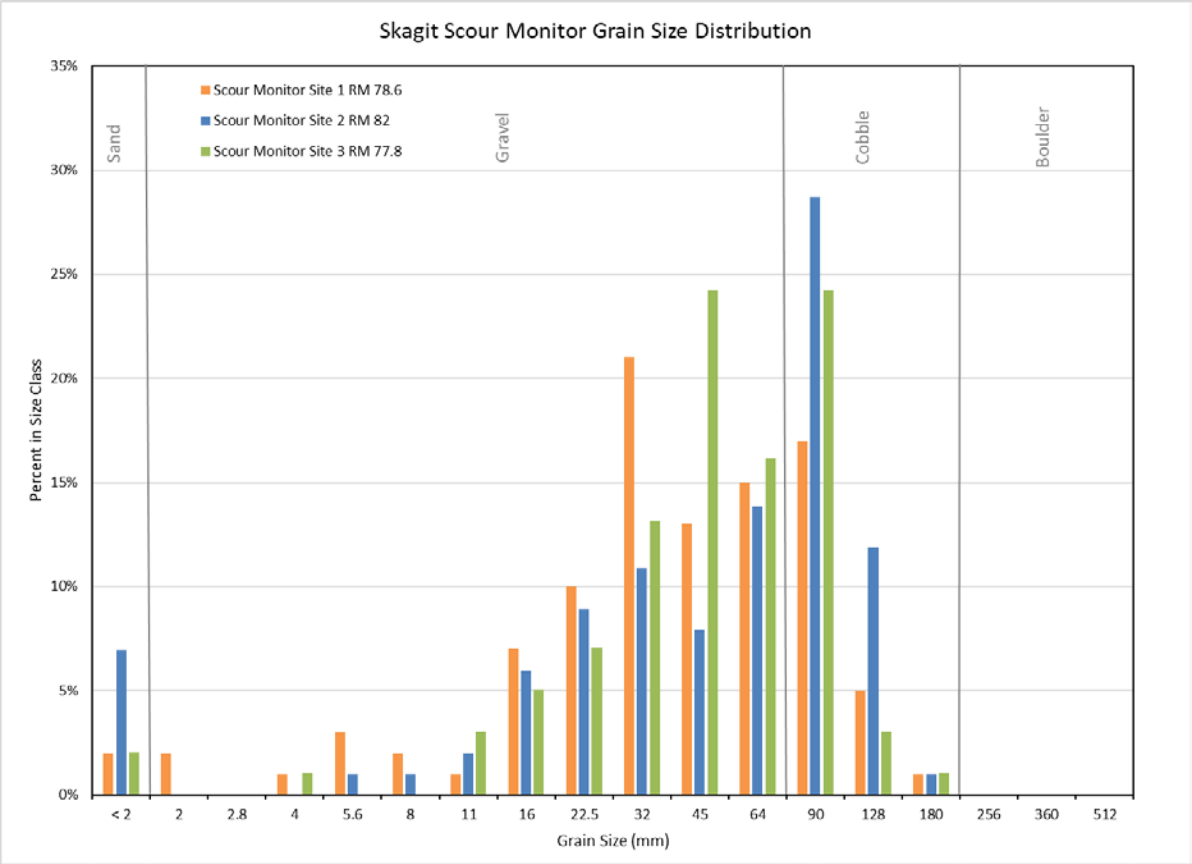

Figure 10. Substrate texture, grain size distribution, at 2019 scour monitor locations.

4.0 PLANS FOR DATA COLLECTION

If flow and water clarity is suitable, the scour monitor and accelerometer installations will be visually checked by Erin Lowery during weekly spawner surveys to determine if monitors appear to be in place and if any beads/golf balls appear to have moved.

Scour monitors and accelerometers will be relocated as soon as flows are low enough during the summer/fall of 2020. If scour monitors are buried, the depth of fill on top of the monitor will be recorded; if beads have moved from the vertical position, the number of beads/golf balls will be recorded to determine scour depth. Scour monitors can be left in place if there has been little scour or can be pulled and reset. Accelerometer arrays will need to be removed from the gravel and cut out of the pipe to allow data to be downloaded using the HOBO software. The accelerometers can be re-deployed after data is downloaded, and re-inserted into the pipes and re-installed, or inserted into new pipe arrays if the old arrays are damaged or rusted.

Data on any scour/fill and timing will be compiled and correlated to flow recorded at the Newhalem and Marblemount gages.

5.0 RECOMMENDATIONS FOR FUTURE INSTALLATIONS

Based on the fall 2019 installation trip, we have the following recommendations:

- Allow time to obtain the necessary permits or waivers depending upon installation locations chosen
- Bring extra installation equipment if available, particularly clips and small inserter pipes to allow for damage
- Install during the lowest flows possible
- A four-person crew is optimal to allow 3 people to pound the inserters into the ground while a fourth person gets the monitors set up
- Allow 3-4 hours per site for installation and travel time between sites; staying on site is recommended instead of driving to and from Seattle each day
- Some installation locations may be accessible by foot but consider that heavy equipment needs to be carried to each site
- Use Trimble to locate each monitor accurately to aid in recovery and locating during spawner surveys
- Triangulate between each monitor and, if possible, shore locations such as trees to aid in recovery
- Decide if floats should be used for scour monitors (golf ball or sliding bead) based on any loss of equipment (vandalism)

6.0 REFERENCES

Gendaszek, A.S., C.S. Magirl, C.P. Konrad, C.R. Czuba, and C.P. Konrad. 2013. The Timing of Scour and Fill in a Gravel-bedded River Measured with Buried Accelerometers. Journal of Hydrology Vol. 495 pp. 186-196.

Schuett-Hames, D., R. Conrad, A. Pleus, and K. Lautz, 1999. TFW Monitoring Program Method Manual for the Salmonid Spawning Gravel Scour Survey. Prepared for the Washington State Department of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-008; DNR #110. December. Available at: http://file.dnr.wa.gov/publications/fp_tfw_am9_99_008.pdf.

OM-01 OPERATIONS MODEL
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

CFR .....Code of Federal Regulations
CHEOPS .....Computer Hydro Electric Operations and Planning Software
City Light .....Seattle City Light
CWA .....Clean Water Act
Ecology .....Washington State Department of Ecology
EIM .....Energy Imbalance Market
ESA .....Endangered Species Act
FARWG .....Fish and Aquatics Resource Work Group
FERC.....Federal Energy Regulatory Commission
ISR .....Initial Study Report
LP.....licensing participant
NEPA .....National Environmental Policy Act
NMFS.....National Marine Fisheries Service
NPS .....National Park Service
O&M .....operations and maintenance
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA .....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SDIDC.....Skagit County Drainage and Irrigation District Consortium LLC
USACE .....U.S. Army Corps of Engineers
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife
WSRA .....Wild and Scenic River Act

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

1.3 Study Plan Development

In 2019-2020, City Light convened a number of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in a Study Plan Development Process, which provided LPs and City Light the opportunity to submit forms that identified potential resource issues, their potential connection to the Project, information or studies requested, a rationale for studying the issues, and how the information collected by the study could be used to support relicensing. Table 5.1-2 of the PAD provides a summary of all the issue forms submitted during this 2019 process.

Section 5 of the PAD lists the resource studies and management plans proposed by City Light to address select (but not all) issues identified as part of the Study Plan Development Process. While acknowledging the broad interests of LPs, City Light focused its initial draft study plans contained in the PAD on information gaps that were most likely to inform license conditions by a study of potential project effects. City Light developed 24 study proposals, including this Operations Model study plan.

On March 13, 2020, City Light released the Operations Model Draft Study Plan for LP review and comment. On March 31, 2020, the draft study plan was discussed at a Fish and Aquatics Resource Work Group (FARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 28, 2020. The revised draft was discussed on May 5, 2020 and June 2, 2020 at FARWG meetings. Written comments were received from National Marine Fisheries Service (NMFS), U.S. Forest Service (USFS), Washington Department of Fish and Wildlife (WDFW), Upper Skagit Indian Tribe, U.S. Fish and Wildlife Service (USFWS), and NPS and responded to in an attachment to this this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. The Skagit County Drainage and Irrigation Special Purpose Districts represented by the Skagit County Drainage and Irrigation District Consortium LLC (SDIDC) and the Skagit County Dike and Drainage District Flood Control Partnership, submitted the study request SDIDC-01 Flood Storage Timing: Study Plan Seattle City Light Skagit River Hydroelectric Project FERC No. 553. SDIDC also submitted the study request SDIDC-02 Irrigation Water Supply: Study Plan Seattle City Light Skagit River Hydroelectric Project FERC No. 553. SDIDC-01 and SDIDC-02 request the simulation of alternative operating scenarios under varying hydrologic conditions. City Light recognizes the need to model a range of alternative operating scenarios for the Project as part of relicensing, many of which will be identified by LPs. However, the OM-01 Operations Model Study Plan is aimed at describing how the model will be developed and applied. Identifying and evaluating specific alternative operating scenarios, such as those identified by SDIDC, will take place later in the relicensing process. Although this study plan was not revised to address these study requests, the requests will be accommodated by the overall process, as further explained in Section 6 of the PSP.

City Light operation and maintenance of the Project affect Ross, Diablo, and Gorge lakes' storage levels, reservoir releases, and the rates of change of each. Any modifications to current operations may affect reservoir storage/surface elevations (which may affect tributaries flowing into reservoirs), flood control, streamflows (including the Skagit River downstream of the Project), fish

and wildlife habitat, riparian habitat, wetland and floodplain connectivity, recreation, and hydroelectric power generation. This study will develop a calibrated and validated Operations Model of the Project, with linkages to the Instream Flow Model, to support the evaluation of alternative operating scenarios considered during the relicensing process.

The modeling results would also provide information needed to drive discussion of scenarios with LPs and conduct review under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Clean Water Act (CWA) Section 401, Fish and Wildlife Coordination Act, and Wild and Scenic River Act (WSRA). Modeling would also inform future power generation alternatives (for example, the California Energy Imbalance Market [EIM]) and City Light's Integrated Resource Plans (as established by WA State law ESHB 1010). Operations modeling may also consider potential future hydrologic regimes due to climate change and the effects such changes may have on Project operations and environmental resources. Separate from the study, the Operations Model will be utilized to simulate alternative operations scenarios identified by City Light and LPs through the relicensing process

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Operations Model Study is to develop a Base Case scenario representation of Project operations. For purposes of Operations Model development, the Base Case represents the Project's operations under the current FERC license. The objective of this study is to develop an Operations Model that represents existing Project operations with reasonable accuracy for purposes of relicensing, and which can be used to simulate potential future operations under a variety of operating scenarios. Simulation of various potential Project operation scenarios considered during the relicensing process will aid in decision-making regarding the effects of various operating scenarios on water allocation, flood control, fish and wildlife habitat, instream flows, reservoir levels, wetland and floodplain connectivity, recreation, hydropower generation, and other matters affected by flow releases from the Project. The Base Case has specific relevance in FERC relicensing proceedings as it represents the baseline conditions to which other scenarios of potential future operations are compared. In addition to the Base Case, defined by current FERC license requirements, a Current Operation Baseline scenario will be developed to simulate the voluntary fish-protection flows released from the Project.

2.2 Resource Management Goals

City Light's goal for the proposed study is to develop a tool to simulate Project operations for the evaluation of the effects of numerous, and potentially competing, alternative future operating scenarios for and with consultation by LPs. The Operations Model will be capable of providing direct or supporting analysis to inform decision-making related to the following potential issues:

- Reservoir storage/refill/outflows/flood control;
- Reservoir water surface level fluctuations (aquatic and wildlife habitat, riparian vegetation, recreation, navigation, cultural site protection);
- Seasonal targets for reservoir levels under a range of hydrologic conditions;
- Instream flows in the Skagit River downstream of the Project and within the bypass reach;
- Connectivity of wetlands, floodplains, and tributaries to river and reservoirs;
- Power generation and its timing; and
- Aquatic habitat particularly with salmonid spawning, incubating, and rearing flows.

Several agencies and Indian tribes have resource management goals related to reservoir water levels and Skagit River flows. These include the U.S. Army Corps of Engineers (USACE) for flood management; USFWS, NPS, NMFS, Washington State Department of Ecology (Ecology), NPS, WDFW, USFS, Upper Skagit Indian Tribe, Sauk-Suiattle Indian Tribe, and Swinomish Indian Tribal Community. The study will provide information to help resource agencies, Indian tribes and First Nations with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities.

2.3 Background and Existing Information

Adequate information currently exists to develop the Operations Model that meets the above objectives. A summary of the data available is provided in the PAD and includes reservoir area-storage-elevation information for each reservoirs' historical operations data on reservoir water levels, reservoir releases, power generation, and flows downstream of the Project (City Light 2020). The Project's existing FERC license specifies the minimum required fishery releases, flows downstream of the Project and flood control requirements. Current Project operations and flow management requirements are summarized in Section 3.5 of the PAD (City Light 2020).

Additional data searches and literature reviews will be completed to identify and evaluate available and relevant hydrologic data and other information related to historical and projected water quantity within the Project's watershed and affected downstream reaches. As part of this data compilation, City Light will request input from LPs to make sure all relevant hydrologic information is considered. For example, the data and literature will include the recent study entitled Hydrology, Stream Temperature, and Sediment Impacts of Climate Change in the Sauk River basin (Bandaragoda et al. 2020), which includes the hydrology, stream temperature and sediment effects of climate change in the Skagit River basin. The hydrologic modeling work associated with this report includes analyses of naturalized streamflow at Project reservoir locations (Ross, Diablo, and Gorge) and at sixteen tributaries using future climate change scenarios (Bandaragoda et al. 2020). Additional information related to river hydraulic characteristics and water quantity at and below the Project is proposed to be developed as part of the Instream Flow Model Development Study. The Operations Model study will be closely coordinated with the Instream Flow Model Development Study to ensure the two models are fully integrated. Such integration will include relationships between releases from Gorge Development and flows/elevations at points of interest (nodes) along the Skagit River downstream of the Gorge Development.

2.4 Project Operations and Effects on Resources

The Operations Model developed under this study plan will document and define the Base Case, Current Operations Baseline, and be capable of projecting the effects of alternative operating scenarios on available water storage, flow releases and release rates, lake levels and fluctuations, and relevant issues associated with or dependent upon water availability under different water year types and hydrologic regimes. The Operations Model will inform the continuation or development of new operations and maintenance (O&M) measures that may become license terms under a new FERC license. As outlined in detail in Section 3.5 of the PAD, the three Skagit River developments are hydraulically coordinated to operate as a single project for purposes of flood control, downstream instream flows for resource protection, recreation opportunity, and power generation (City Light 2020).

2.5 Study Area

The scope of the Operations Model Study is the geographic region of the Skagit River from the upper end of Ross Lake to the Gorge Powerhouse tailrace. The Operations Model will include Ross Lake, Ross Dam and Powerhouse, Diablo Lake, Diablo Dam and Powerhouse, Gorge Lake, Gorge Dam, Gorge bypass reach, Gorge Powerhouse, and tailrace. Additionally, within the study area limits of the Instream Flow Model, the Operations Model will be integrated with the Instream Flow Model to evaluate the potential effects of alternative flow/stage measures and timing along

the Skagit River. This integration will be simulated within the Operations Model as either flow or stage requirements at riverine nodes within the Operations Model. Dynamic hydraulic modeling to simulate the timing and flow attenuation relationship between nodes along the Skagit River and discharge from Gorge dam will be simulated with the Instream Flow Model. These relationships will then be entered into the Operations Model to allow for the simulation of Project operations to support flow or stage requirements at riverine node locations along the Skagit River.

2.6 Methodology

City Light proposes to develop an Operations Model using the Computer Hydro Electric Operations and Planning Software (CHEOPS™) model. CHEOPS is a flexible, reliable, and easy-to-use tool created more than two decades ago specifically to evaluate a wide range of factors considered during FERC relicensing that may affect natural resources and project operations, including reservoir levels, water uses and generation. One of the many capabilities of CHEOPS modeling platform is the degree to which the Operations Model architecture provides a customized platform to investigate river- and project-specific characteristics, water demands, and constraints of the particular plant and river system being evaluated. Additionally, CHEOPS is designed to be user-friendly, it can be run from PC or personal laptop through an easy-to-use graphical interface and utilizes Microsoft Excel as the output data analysis platform, this allows the Operations Model to be used by LPs with minimal amount of training and computer know-how.

CHEOPS utilizes daily flows (or hourly if essential to a particular variable), plant generating characteristics, flood control parameters, and reservoir/plant operating criteria to simulate project operation. CHEOPS simulates operations of a plant to meet user-specified goals (e.g., instream flow requirements while meeting other regulatory constraints and power production with the available flow). The Operations Model is fully capable of determining reservoir elevation, headlosses, net head, turbine discharge and spill, power generation, and other user-specified variables in hourly (or higher resolution) increments. The proposed Operations Model will encompass an inflow dataset including streamflows into Ross Lake, incremental inflows to Diablo and Gorge lakes, as well as incremental flows to nodes along the Skagit River downstream of the Gorge Development. The Operations Model will allow for the evaluation of variables and constraints including inflows, reservoir operations, unit performance and generation capacity, operating characteristics and constraints, time-of-day generation, minimum flows, water level fluctuation constraints, and other user-specified variables. The Operations Model will include characteristics of the three Project reservoirs powerhouses, and water conveyance structures; as well as incremental tributary flows and hydraulic relationships at select nodes along the Skagit River. The Operations and Instream Flow Model (i.e., instream flow model from Gorge Powerhouse to just below the Sauk River) will be designed to work in tandem, where the Operations Model simulates Project operations, and the Instream Flow Model simulates the riverine flow hydraulics (depth, velocity, water surface elevation, etc.) downstream of Gorge Development. The Instream Flow Model will define stage discharge rating curve relationships at key node locations (to be defined as part of the Instream Flow Model Development Study) along the Skagit River downstream of the Gorge Development. These stage discharge relationships will be incorporated into the Operations Model, enabling the Operations Model to simulate Project operations in support of specific stage or flow objectives at these key node locations. Figure 2.6-1 shows a conceptual schematic of the linkages between the Operations Model and the Instream Flow Model.

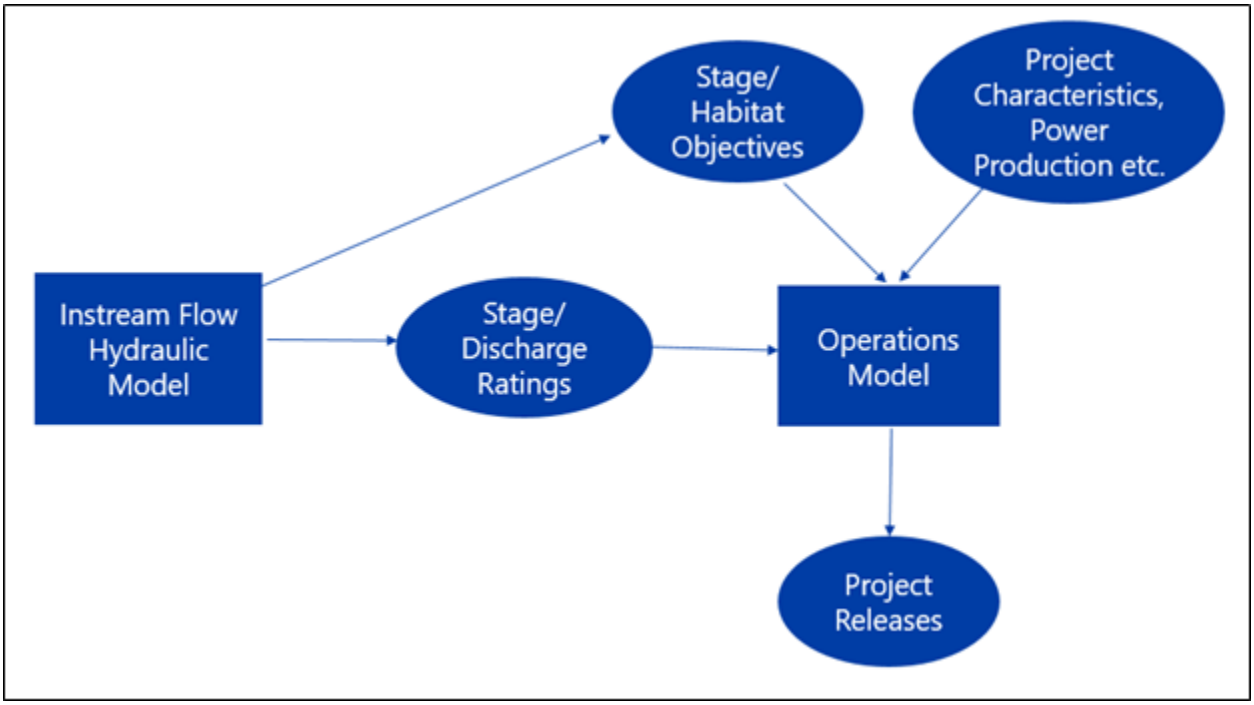

Figure 2.6-1. Linkage between Operations Model and Instream Flow Model.

The proposed approach is to use the Operations Model to perform simulations (Model runs), comparing outputs/effects relative to a Base Case scenario. This alternatives analysis process will then show the direct effect of proposed operating protocols on Project operations and other endpoints of interest.

2.6.1 Model Development

Major Operations Model development activities include:

- Assembly and compilation of historical operational data.
- Assembly of system information pertaining to the physical and operational characteristics of the Ross, Diablo, and Gorge developments.
- Development or identification of inflow dataset.
- Initial Operations Model development using physical data such as reservoir storage curves, dam spillway capacity, headwater curves, tailwater curves, turbine performance curves, generator performance curves, as well as operational data including minimum flows, operation/dispatch routines, and operating/elevation limits.
- Model validation and establishment of Base Case scenario.

This study will be considered complete when the Operations Model has been developed and validated, and the Base Case developed. Separate from the study, the Operations Model will be utilized to simulate alternative operations scenarios identified by City Light and LPs through the relicensing process.

2.6.1.1 Model Validation

Operations Model validation (i.e., determining that the Operations Model is well-founded and fulfills the purpose for which it was constructed) will occur in two steps. In the first step, the Operations Model will be evaluated by comparing the Operations Model output to the period of the historical record that represents current operations, specifically, mean daily flows, reservoir elevations or storage, generation, etc., over an appropriate representative period of recent operations. It is expected that there will be some differences between the Operations Model output and the historical record since it is not uncommon for change to occur in operating strategy over time, changes in equipment performance with age, and the occurrence of minor and major unplanned outages. More importantly, it must be recognized that all input data contain measurement errors. Where substantial differences cannot be explained, the Operations Model logic/input data will be adjusted so that the Operations Model output estimates better reflect historical values.

The second step will verify that the computer Operations Model is a reasonable representation of the Project's operating rules. This will be done by making a number of model runs and comparing the results with actual Project data.

2.6.1.2 Develop Base Case and Current Operations Baseline

The Operations Model will be configured to represent current FERC license requirements as well as how the Project is currently operated, including all physical, regulatory, and contractual constraints. The underlying assumption is that this Base Case represents the current FERC license requirements and other agreements, and the Current Operations Baseline represents current operations, including voluntary measures. All subsequent Operations Model runs will be compared to both Base Case and Current Operations Baseline.

2.6.1.3 Model Logic and Validation Report

A report summarizing the Operations Model development, including detailed summaries of all input parameters and sources, Operations Model validation, Base Case, and Current Operations Baseline settings will be prepared. The Operations Model logic and verification report will include the following elements:

- Project introduction and background;
- Study area;
- Methodology;
- Discussion of the hydrologic data review, and inflows utilized in the Operations Model;
- Discussion of Operations Model setup, operating rules for each development and downstream modeled nodes, validation of input parameters, and definition of modeled Base Case and Current Operations Baseline scenarios;
- Results provided in graphical and tabular format compared to historical reservoir elevation and flow release data including discussions of Operations Model validation;
- Any LP correspondence and/or consultation; and
- Literature citations.

2.6.1.4 Consultation Process with Licensing Participants

City Light proposes to engage the resource agencies, Indian tribes and First Nations, and other interested parties through a series of study workshops at key milestones through both the Operations Model development and execution. A minimum of three full-day study workshops will be conducted, and it is envisioned these study workshops may include the following:

Workshop 1 – General Model Introduction

a. Morning session Operations Model Methodology/Overview
    i. Operations Model selection
    ii. Operations Model applications for other FERC licensings
    iii. Operations Model functionality
        1. General overview
        2. Custom functionality specific to the Project
    iv. Operations Model development outline
b. Afternoon session Hydrology
    i. Review of available data
    ii. Climate change
    iii. Riverine node selection

Workshop 2 – Operations Model validation and establishment of Base Case and Current Operations Baseline

a. Morning session Operations Model validation
    i. Data sources
    ii. Project operations
    iii. Validation results
b. Afternoon session Base Case and Current Operations Baseline
    i. Operations as required under the current FERC license and other agreements
    ii. Voluntary operations

Workshop 3 – Operations Model training execution

a. Full day Operations Model execution
    i. Scenario development
    ii. Analysis of results

2.6.1.5 Evaluate Alternative Project Operation Scenarios

The Operations Model will be capable of evaluating alternative Project operation scenarios developed by City Light and/or LPs.

2.7 Consistency with Generally Accepted Scientific Practice

The proposed methods for this study are consistent with professional and scientific practices and the overall approach is commonly used in relicensing proceedings. CHEOPS has been widely employed to evaluate physical and operational changes considered during FERC relicensing of well over 75 individual hydropower developments. CHEOPS has been used in all areas of the country to assist owners with assessing, optimizing, and managing their hydropower operations. Accordingly, CHEOPS has proven applicable to a broad range of sites and operating conditions and has been relied upon by LPs and FERC staff in numerous FERC relicensing projects including, but not limited to:

- AmerenUE – Osage Hydroelectric Project (FERC No. 459)
- AmerenUE – Taum Sauk Pumped Storage Project (FERC No. 2277)
- Brookfield Renewable – Bear Swamp Pumped Storage Project (FERC No. 2669)
- Chelan County PUD – Lake Chelan Hydroelectric Project, (FERC No. 637)
- Duke Energy – Keowee-Toxaway Hydroelectric Project (FERC No. 2503)
- Duke Energy – Catawba-Wateree Hydroelectric Project (FERC No. 2232)
- Grant County PUD No. 2 – Priest Rapids Hydroelectric Project (FERC No. 2114)
- Sabine River Authority – Toledo Bend Hydroelectric Project (FERC No. 2305)
- SMUD – Upper American River Hydroelectric Project (FERC No. 2101)

2.8 Schedule

- Develop Project Operations Model – April 2020 to December 2020
- Consultation Workshop 1 – January 2021
- Validate Model and Establish Base Case – January 2021 to March 2021
- Consultation Workshop 2 – April 2021
- Draft Report – Summer 2021
- Consultation Workshop 3 – August 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation, reporting, and consultation associated with this study is approximately $200,000.

3.0 REFERENCES

Bandaragoda, C., S. Lee, E. Istanbulluoglu, and A. Hamlet. 2020. Hydrology, Stream Temperature, and Sediment Impacts of Climate Change in the Sauk River Basin, HydroShare. [Online] URL: http://www.hydroshare.org/resource/e5ad2935979647d6af5f1a9f6bdecdea.

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OPERATIONS MODEL PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	Each plan suffers from an abbreviated scope and lack of clarity in guiding hypotheses and the questions the studies are designed to answer. From NMFS' perspective, the study plans should clearly state the anticipated utility of the proposed research in understanding the past, current, and future effects of the project on ESA-listed salmonids, Critical Habitat, Essential Fish Habitat, and Treaty Trust Responsibilities. Fish habitat includes a diverse assemblage of aquatic and terrestrial species that are affected in time and space by the operations at the dams. Further, the study plans should clearly state the anticipated utility of proposed research in understanding the status quo, assessing ongoing project effects, and predicting the effects of future management plan scenarios under a new license, including climate change scenarios.	City Light acknowledges the need for consultation with NMFS related to its regulatory responsibilities as required in the FERC process and that the information resulting from the study program is intended to inform consultation with NMFS during future steps within the process. The FERC process schedule positions the integrated environmental analysis subsequent to the completion of the study program and prior to the filing of a Project License Application.
2.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The study plans should describe in detail how they will inform our collective understanding of fish and aquatic habitat and ecology. To that end, the study plans should be forward thinking in connecting the anticipated results between these and other study plans. The connections between study plans should be made explicit now to ensure researchers are thinking ahead about the utility of their data from both technical and analytical perspectives and so that plans and associated cost estimates fully reflect foreseeable tasks. Explicitly making these connections will also assist NMFS and other LPs understand exactly how our data needs will be met through multiple study plans.	The integrated environmental analysis referred to in Comment #1 will specifically address links across resource areas. City Light will work with the RWGs to integrate information from related studies as part of the ILP process.

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3.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The geographic and temporal scopes of the draft Geomorph and Operations Model study plans are insufficient. The Geomorph study should be extended to include the full extent of project effects on geomorphic processes. That includes at a minimum, downstream to Puget Sound and upstream through the bypass reach and Stetattle Creek where the project precludes a known population of ESA-listed steelhead from migrating and spawning. The Geomorph and Operations Model draft study plans should be developed to improve our collective understanding of historical processes (including pre-dam conditions) so that they can be compared to the status quo and future management scenarios. **New comments from Brock Applegate (WDFW) provided on 05/05/2020:** Currently, the Project blocks downstream and upstream fish passage with current project and operations. SCL should consider this existing condition. SCL has some effect below the confluence of the Sauk River. Cumulative effects below the Sauk River confluence, which would include effects from this hydroproject, impact the estuary through lack of sediment and wood and disconnected channels and wetlands through loss of usual timing, duration and magnitudes of flows.	Please refer to the Geomorphology study plan for City Light's respective responses for that study. The FERC baseline is existing conditions, and therefore pre-dam conditions are not considered in this study plan. Project effects would more than likely be indiscernible in the lower reaches of the Skagit River and Puget Sound given the complex array of factors contributing to existing environmental conditions in the lower reaches of the Skagit River. City Light plans to assess the nature of the Project's contribution to cumulative effects downstream of the Sauk River confluence using existing available information as part of the relicensing process. **Response to comments provided on 05/05/2020:** Thank you for your comment. Additional discussions regarding the issue of Project fish passage are anticipated and City Light welcomes discussion of this issue with LPs in the future.
4.	Steve Copps, Jim Myers, and David Price (NMFS)	04/13/2020	General Comments	The draft study plans would benefit from collaboration within the FA Group to harmonize LP comments and explore opportunities for improving efficiency and	The requested collaboration is underway, as evidenced by the 2019-2020 voluntary study identification process, including this study plan and associated comment response effort.

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				utility of the anticipated results in meeting the needs of all License Participants. **New comments from Brock Applegate (WDFW) provided on 05/05/2020:** Many LPs would not consider this a collaborative process. SCL telling LPs to submit their study request to FERC does not represent a collaborative process. SCL did not choose a collaborative licensing process, the Alternative Licensing Process (ALP). I would describe the identification of study issues as the most collaborative process in the voluntary exercise. Currently, the LPs consult on study plan creation. However, SCL can choose their desired licensing process and the way they will consult with the LPs. The LPs currently consult on the study plans. We can agree to disagree.	Moreover, City Light will continue collaboration with LPs regularly throughout the ILP process. **Response to comments provided on 05/05/2020:** Thank you for your comments.
5.	USFS	04/13/2020	General Comments	Quantification of sediment (bedload) and wood arrest by project operation and consequent downstream resource impacts. This is a significant omission and is a clear project effect on downstream resources now and into the new license.	Thank you for your considered comment. The reservoir sedimentation study at reservoir locations with specific resource related concerns, and the shoreline erosion study will provide some information of relevance to the stated concern. Ongoing wood management activities will also provide information on wood inputs to the reservoirs. City Light is committed to expanding the wood management activities under the current PM&E measure to address sediment deposition at these tributary confluence locations, if access issues are identified. Cross-sectional transects of the mainstem downstream of the dams (i.e., to establish

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					stage/discharge/habitat relationships for the instream flow study) should also provide information of relevance to consider how the Project is interrupting bedload transport from upstream--where those transects are positioned in locations where gages were previously established (i.e., by examining changes in cross-sectional area, some effects of interruption in bed-load transport over time may be inferred). City Light acknowledges that most study plans put forward are focused on collecting information and developing tools that inform our understanding of existing conditions that may or may not support current and future environmental resource objectives in the Skagit River downstream of the Project (i.e., Gorge Dam to Sauk River.) These studies should expand our understanding of the limiting factors to fish populations that could be further addressed through the implementation of the current (or modified) instream flow program, through identifying and implementing active restoration projects that address these limiting factors in a strategic manner (e.g., reflective of Skagit River Chinook, steelhead and bull trout recovery plans), and through effectiveness monitoring from which appropriate adaptive management measures can be identified and actioned upon. City Light, favors this type of resource benefit management approach (i.e., identifying locations in the Skagit River below the Project and then targeting eventual PME measures to improve ecological function at those locations) and looks forward to further discussions with

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					all LPs for means to explore this approach in concert with meeting their resource management objectives. The current studies, including the Operations Model, are parameterized by work that can be done within the 2-year time frame prescribed by the ILP and for which there is current evidence of a resource impact. While it is recognized that the dams interrupt sediment and wood transport, we are not aware of current evidence from this effect on resources of concern, which is one of the qualifiers through which study plans are to be approved by FERC. Hence, a study of the scope proposed cannot be accommodated under the time line and qualifiers of the FERC study plan program, but will be considered in in consultation with the LPs in the subsequent 'integrated environmental effects analysis' step of the relicensing process, and/or under future management plans resolved through settlement agreement under the new license.
6.	USFS	04/13/2020	General Comments	Evaluation of geomorphic change as a result of project effect. The study plan attempts to study the existing condition without isolating the project effect on the resource of concern.	See Comment Responses #1 and #5.
7.	USFS	04/13/2020	General Comments	Address the geomorphic change downstream as a consequence of the range of flows released by the project not just peak flows. It seems imprudent to omit nearly the entire range of flow conditions from analysis when attempting to study project effects on downstream resources.	This comment has also been submitted as part of the Geomorphology from Gorge Dam to Sauk River Study Plan. City Light is working on responding to this comment in that study plan. Please refer to the applicable response to this comment in the Geomorphology from Gorge Dam to Sauk River Study Plan when available.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
8.	Brock Applegate (WDFW)	04/13/2020	Section 1.2 Relicensing Process	"This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans….." **New comment provided on 05/05/2020:** Outside of the study issue identification, most LPs don't consider this a collaborative process. The LPs consult on the current study plans. WDFW understands that SCL can choose the licensing and consultation process. We appreciate all processes that helps us to work with SCL.	Section 1.2 and 1.3 were redrafted to better describe the 2019 process. Formal consultation does not begin until after the PAD is officially submitted. Although the informal 2019 process leading up to the development of draft study plans did not result in consensus regarding all issues raised by LPs, City Light views this process as a collaborative effort (i.e., the action of working together). **Response to comment provided on 05/05/2020:** City Light appreciates your agency's input and looks forward to working with you to address resource issues during the relicensing proceeding.
9.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 1.3 Study Plan Development	"City Light operation and maintenance of the Project affect Ross, Diablo, and Gorge lakes' storage levels, reservoir releases, and the rates of change of each." O and M also affects tributaries flowing into reservoirs, as well as downstream segment of the free flowing Skagit River, please add affect.	Thank you for this observation. Edits have been made to address this comment.
10.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 1.3 Study Plan Development	Comment on Issue Forms list: Suggestions is either add to list in comphrenesive way; or remove section given the depth of studies this will inform. CR07 Ross Lake Geomorph study CR06 Bypass Reach Survey CR08 Downstream FA02 Aquatic Invasive Species Plan FA03 Recreational fisheries FA04 Fish Passage	Agreed. City Light concurs with this suggestion and have removed references to these issue forms from this study plan. Text has also been added to Section 1.3 to better explain the role of the issue forms in contributing to City Light's suite of study proposals.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				FA05 FA06 FA09 Littoral and riparian Habitat FA11 Spawning.. FA12 Effective fish… FA33 Juvenile Outmigration flows Etc…	
11.	Rick Hartson (Upper Skagit Indian Tribe)	03/31/2020	Section 1.3 Study Plan Development	Comment on Issue Forms list: Missing: geomorphology, beavers, others – still need to do full comparison of issue forms submitted	Thank you. See Comment Response #10.
12.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 1.3 Study Plan Development	"Modeling would also inform future power generation alternatives (for example, the California Energy Imbalance Market [EIM])." Modeling can also support SCL's Integrated Resource Plans as established by WA State law ESHB 1010	Thank you. Edits have been made to incorporate this suggestion.
13.	Rick Hartson (Upper Skagit Indian Tribe)	03/31/2020	Section 1.3 Study Plan Development	"Operations modeling may also consider potential future hydrologic regimes due to climate change and the effects such changes may have on Project operations and environmental resources." Also consider alternative PME regimes, which may result from adaptive management or changes in energy market over course of license.	Comment acknowledged. Alternative PME regimes can be evaluated following the results of the relicensing studies and in consideration of the results of the integrated environmental effects analysis to be conducted after the FERC study program is completed before an application for a new license is submitted.
14.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	"Any modifications to current operations may affect reservoir storage/surface elevations, flood control, streamflows, fish and wildlife habitat,…."	Thank you. Edits have been made to address this comment.
15.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3	"Any modifications to current operations may affect reservoir storage/surface elevations,	Thank you. Edits have been made to address this comment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Study Plan Development	flood control, streamflows, fish and wildlife habitat,…" Plants? Are there sensitive plants in the project area, including on the transmission corridors? For all studies explain how data and assessments might be used/shared between resources, i.e., fish, wildlife, and plants/riparian areas, cultural, recreation…. I am curious about how flow scenarios might encourage non-native species and affect riparian or sensitive plants. Operational modeling could take into consideration key data from the vegetation mapping study to determine affected areas.	Please refer the question regarding sensitive plants to City Light's Terrestrial Resources Work Group Lead. Regarding cross resource coordination, please See Comment Responses #1 and #2.
16.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Any modifications to current operations may affect reservoir storage/surface elevations, flood control, streamflows, fish and wildlife habitat, riparian habitat, wetland and floodplain connectivity,…"	Thank you. Edits have been made to address this comment.
17.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	"Model of the Project to support the evaluation of alternative operating scenarios considered during the relicensing process." The LPs would like the ability to try different scenarios to see the effects on all resources. WDFW requests that we have a transparent discussion with economic data involved to research scenarios.	The workshops identified in Section 2.6.1.4 are intended to integrate the LPs in the model development process and to be transparent about key steps in model development. City Light also will provide training to the LPs for model execution--including scenario development and analysis of results. Once model development is complete, City Light welcomes the LPs engagement in running different scenarios. To support this, a process will be developed for the LPs to request scenarios to be simulated and results documented within the licensing (e.g., a scenario request form or other process developed in coordination with LPS will be used). Additionally, City Light will provide

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					LPs access to the model for simulation of LP trial scenarios. Economic modeling is outside the scope of this study plan however City Light will work with LPs to develop an acceptable reference scenario for approximation of economic differences between trial scenarios.
18.	Brock Applegate (WDFW)	04/13/2020	Section 1.3 Study Plan Development	3rd Paragraph – Add red text "The modeling results would also provide information needed to drive discussion of scenarios with the LPs and conduct review under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Clean Water Act (CWA) Section 401."	Thank you. Edits have been made to address this comment.
19.	Judy Neibauer (USFWS)	04/13/2020	Section 1.3 Study Plan Development	"Modeling would also inform future power generation alternatives (for example, the California Energy Imbalance Market [EIM])." This modeling should also be used to meet the Fish and Wildlife Coordination Act components of FERC (i.e. Section 10j in the FERC process)	Thank you. Edits have been made to address this comment. The study program and subsequent integrated environmental analysis and NEPA document will provide the information necessary for LPs to execute their statutory responsibilities under the Federal Power Act.
20.	USFS	04/13/2020	Section 1.3 Study Plan Development	**The FS recommends** only including those issues, and referencing those issue forms, that are explicit goals and/or objectives of this study plan. If methods are not designed to study the specific data gaps identified in the issue forms, then issues should not be included here. Alternatively, describe in sufficient detail how conclusions drawn from this study plan will inform project effects on the issues brought forward in this paragraph.	See Comment Response #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				The FS recommends adding Wild and Scenic River Act (WSRA) as another law requiring information needed for regulatory compliance.	Thank you. Edits have been made to address this comment.
21.	Judy Neibauer (USFWS)	04/13/2020	Section 2.0 Study Plan Elements	I found a great source that identifies what Study Guide Criteria should be addressed in these study plans. Maybe you have seen it, but here is the link… https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf …sorry if you already have discussed this.	City Light appreciates the input.
22.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 2.1 Study Goals and Objectives	"The Base Case has specific relevance in FERC relicensing proceedings as it represents the baseline conditions to which other scenarios of potential future operations are compared." Since operations are driven by power generation and/or economic profit, the Tribe is requesting that a related goal be added in connection with this or supported by this effort. The related goal is a modeling support tool in connection with, or inside the existing model platform of CHEOP, that can forecast Base Case and Alternative Project Scenarios economically. The goal would be to provide a transparent and reasonably accurate estimate of the economics of the different operational scenarios. Understanding the economic analysis ultimately being used by the utility for their planning and decision making is their own imitative, however educating LPs with the transparency of an economic assessment tool would aid future discussions and understandings.	See Comment Response #17.

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23.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.1 Study Goals and Objectives	"In addition to the Base Case, defined by current FERC license requirements, a Current Operation Baseline scenario will be developed to simulate the voluntary fish-protection flows released from the Project" Rick lets see about your comment going somewhere below in document. Because the section is Goals and objectives, and after establishing BaseCase why do they throw out "we can model our voluntary fish protection flow" – PR suggestion is request that example be removed. Plus is it really voluntary fish protection-thought 2011 Biop made them requirements?	Comment acknowledged.
24.	Rick Hartson (Upper Skagit Indian Tribe)	03/31/2020	Section 2.1 Study Goals and Objectives	Another useful scenario would be Minimum Operations – reservoirs remain at low pool. Though not realistic economically, this would provide a helpful reference for understanding resource impacts and developing impactful PMEs	Thank you for this suggestion. Separate from the study, the Operations Model will be utilized to simulate alternative operations scenarios identified by City Light and LPs through the relicensing process. City Light will work with LPs to identify and evaluate individual scenario requests. Typically, scenario requests from different LPs may overlap with one another or be outside the physical capability of the system. Each scenario request requires a detailed review and will be discussed with LPs on the most efficient application of requested scenarios.
25.	Brock Applegate (WDFW)	04/13/2020	Section 2.1 Study Goals and Objectives	"Project operation scenarios considered during the relicensing process will aid in decision-making regarding the effects of various operating scenarios on water allocation, flood control, fish and wildlife habitat,…."	Thank you. Edits have been made to incorporate the suggested text.
26.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	"Project operation scenarios considered during the relicensing process will aid in decision-making regarding the effects of various	Thank you. Edits have been made to incorporate the suggested text.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				operating scenarios on water allocation, flood control, fish and wildlife habitat, instream flows, reservoir levels, wetland and floodplain connectivity,…."	
27.	Brock Applegate (WDFW)	04/13/2020	Section 2.1 Study Goals and Objectives	"In addition to the Base Case, defined by current FERC license requirements, a Current Operation Baseline scenario will be developed to simulate the voluntary fish-protection flows released from the Project." Didn't the fish-protection flows become part of the license, which no longer makes them voluntary? Does this refer to the adaptive management in flows that SCL does every season? WDFW does appreciate the past consultation with the Co-Managers on flows for spawning and incubation.	Thank you for the comment – the practices commonly referred to as "voluntary" have indeed been codified into the License since the 2013 amendment. There are still elements of spawning and incubation flow management that may be considered voluntary or adaptive however this language and the operational descriptions will be clarified in the next iteration of this study plan.
28.	Judy Neibauer (USFWS)	04/13/2020	Section 2.1 Study Goals and Objectives	I had that question too, but it seems that the 2012 Biological Opinion, says they are implementing a new amendment that included what use to be voluntary flows. If this is this correct it should be mentioned somewhere here, and in the existing information section?	Thank you. See Comment Response #27
29.	USFS	04/13/2020	Section 2.1 Study Goals and Objectives	**The FS Recommends** identifying, at least preliminarily, the possible project operation scenarios that SCL anticipates evaluating (as mentioned in section 2.2) here in 2.1. In particular, an operations scenario that incorporates climate change impacts to seasonal flow regimes seems prudent given the length of the new license.	Thank you. See Comment Response #24. This process may include alternative hydrologic conditions such as potential impacts of climate change. Also as noted in section 2.3, as part of the hydrologic data compilation, City Light will request input from LPs to make sure all relevant hydrologic information is considered. Typically, a contiguous long-term hydrologic period is selected to ensure the evaluation of wet, dry, and normal conditions; including extended multi-year conditions, such as multi-

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					year droughts. Additionally, scenarios can be simulated with alternate hydrologic conditions which represent potential climate change conditions.
30.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.2 Resource Management Goals	2nd Bullet – Comment "Reservoir water surface level fluctuations (habitat, recreation, navigation)" Cultural site protection	Thank you. Edits have been made to address this comment.
31.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.2 Resource Management Goals	3rd Bullet – Comment "Seasonal targets for reservoir levels under a range of hydrologic conditions" What is the range? Is this based on climate change scenarios and/or hydro extremes over the last license period or since the dams were constructed ? Can you be more specific?	Thank you. See Comment Response #29.
32.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 2.2 Resource Management Goals	3rd Bullet – Comment "Seasonal targets for reservoir levels under a range of hydrologic conditions" Climate change and climate planning data. SCL has been participating in many climate change forums. Given the long temporal length of the potential FERC licenses, the Tribe expects all new and relevant climate data applicable to the Skagit and the Utility operations will be used to test future operating scenarios.	Thank you. See Comment Response #29.
33.	Jon-Paul Shannahan	04/12/2020	Section 2.2 Resource	"Several agencies have resource management goals related to reservoir water levels and Skagit River flows. These include the U.S.	Agreed. Edits have been made to incorporate the Upper Skagit Indian Tribe, the Swinomish

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
	(Upper Skagit Indian Tribe)		Management Goals	Army Corps of Engineers (USACE) for flood management; U.S. Fish and Wildlife Service (USFWS), NPS, National Marine Fisheries Service (NMFS), Washington State Department of Ecology (Ecology), National Park Service (NPS) and the Upper Skagit Indian Tribe tribes." Given court affirmed Treaty Rights and Sovereignty status please use Proper pronouns in this section, as relating to resource management authority. I'm aware of three tribes that have federal fishing rights in the Skagit watershed	Indian Tribal Community, and the Sauk-Suiattle Tribe.
34.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.2 Resource Management Goals	"Several agencies have resource management goals related to reservoir water levels and Skagit River flows. These include the U.S. Army Corps of Engineers (USACE) for flood management; U.S. Fish and Wildlife Service (USFWS), NPS, National Marine Fisheries Service (NM FS), Washington State Department of Ecology (Ecology), National Park Service (NPS) and the Upper Skagit Indian Tribe tribes."	Thank you for your suggestion. Please note that "NPS" is identified earlier in this paragraph, and "National Park Service" is first used in Section 1.1.
35.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	According to guidelines for the ILP…this section should also include Information about public input considerations…Maybe you have this somewhere else? See this link: https://www.ferc.gov/industries/hydropower/gen-info/guidelines/guide-study-criteria.pdf	City Light appreciates the input.
36.	Brock Applegate (WDFW)	04/13/2020	Section 2.2 Resource Management Goals	"City Light's goal for the proposed study is to develop a tool to simulate Project operations for the evaluation of the effects of numerous, and potentially competing, alternative future	Thank you. Edits have been made to incorporate the suggested text.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				operating scenarios for consultation by the LPs."	
37.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	2nd Bullet – Add red text Reservoir water surface level fluctuations (aquatic and wildlife habitat, riparian vegetation, recreation, navigation)	Thank you. Edits have been made to incorporate the suggested text.
38.	Brock Applegate (WDFW)	04/13/2020	Section 2.2 Resource Management Goals	4th Bullet – Add red text Instream flows in the Skagit River downstream of the Project and within the bypass reach	Thank you. Edits have been made to incorporate the suggested text.
39.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	5th Bullet – Added new bullet and comment "Connectivity of wetlands, floodplains, and tributaries to river and reservoirs" It seems that connectivity of adjacent tributaries should be thought about both above and below the dams. It could be lumped into aquatic and wildlife habitat…but needs to be thought about early in development of a study, rather than later, when fish passage studies are designed…so that data can be gathered with the geomorphology and sediment deposition studies can include these areas too.	Thank you. Edits have been made to incorporate the suggested text.
40.	Brock Applegate (WDFW)	04/13/2020	Section 2.2 Resource Management Goals	7th Bullet – Added new bullet "Aquatic habitat particularly with salmonid spawning, incubating, and rearing flows"	Thank you. Edits have been made to incorporate the suggested text.
41.	Brock Applegate (WDFW)	04/13/2020	Section 2.2 Resource Management Goals	"These include the U.S. Army Corps of Engineers (USACE) for flood management; U.S. Fish and Wildlife Service (USFWS), NPS, National Marine Fisheries Service (NMFS), Washington State Department of Ecology (DOE), National Park Service (NPS),	Thank you. Edits have been made to incorporate the suggested text. Please also See Comment Response #33.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Washington Department of Fish and Wildlife (WDFW), and the tribes."	
42.	Judy Neibauer (USFWS)	04/13/2020	Section 2.2 Resource Management Goals	"These include the U.S. Army Corps of Engineers (USACE) for flood management; U.S. Fish and Wildlife Service (USFWS), NPS, National Marine Fisheries Service (NMFS), Washington State Department of Ecology (Ecology), National Park Service (NPS), Washington Department of Fish and Wildlife (WDFW), and the tribes." Should BIA be included here too….maybe they come in later, but should figure this out before these get developed to far down the road… USFS? They likely have some resource management goals in some areas, especially along roads and transmission corridors?	Thank you for the suggestion. City Light supports BIA involvement however they have not participated in the process to date. Please also See also Comment Responses #33 and #43.
43.	USFS	04/13/2020	Section 2.2 Resource Management Goals	**The FS recommends** adding the USFS as an agency with resource management requirements including but not limited to, the National Forest Management Act (NFMA) and Wild and Scenic River Act (WSRA) **The FS recommends** maintaining consistency throughout the suite of study plans by referencing the following FS management planning documents: 1990 Mt. Baker Snoqualmie National Forest Land and Resource Management Plan (LRMP) 1994 Record of Decision - Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the	Thank you. Edits have been made to address this comment. Please also See Comment Responses #33 and #43.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Northern Spotted Owl - Attachment A to the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. 1983 Skagit River Management Plan Volume II.	
44.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.3 Background and Existing Information	"A summary of the data available is provided in the PAD and includes reservoir area-storage-elevation information for each reservoirs' historical operations data on reservoir water levels, reservoir releases, power generation, and flows downstream of the Project (City Light 2020)." What section of the PAD contains info on reservoir storage volumes for the different reservoir water level elevations? Tables 3.5-10 to 12 only include ouflows from 2014 to 2018. Will this study provide info for the entire license period? It would be beneficial to assess flows (peak, min, and duration) through the project starting when each of the dams were completed.	Operations data is not typically available for the entire license period. The model will be developed, calibrated and verified utilizing available operations data. Once this development process is complete, and it is determined that the model adequately represents the Project, the model will then be utilized to simulate scenarios over a longer and more varying hydrologic period. As part of the hydrologic data compilation, City Light will request input from LPs to make sure all relevant hydrologic information is considered in development of the long-term hydrologic dataset for model application. Area-storage-elevation information is provided in the PAD in section 4.4.1.2.
45.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.3 Background and Existing Information	"Adequate information currently exists to…" "Adequate data exists" and Preliminary Review of PAD 3.5.3 influences this comment. What data gaps exist for entire period of record for operations across all three reservoirs? Does inflow data exist across temporal and spatial scale to cover historic conditions?	Thank you for your questions. Adequate physical and operational information exists to develop an operations model of the Project. The hydrologic dataset to be utilized in the simulation of the operations model will be determined as part of this study. Please also See Comment Responses #44 and #29.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
46.	Rick Hartson (Upper Skagit Indian Tribe)	03/31/2020	Section 2.3 Background and Existing Information	A summary of the data available is provided in the PAD and includes reservoir area-storage-elevation information for each reservoirs' historical operations…." Does this account for sedimentation and changing reservoir capacity over time?	Area-storage-elevation information was provided in the PAD in section 4.4.1.2. As part of this study, Project records will be reviewed for additional data sources to provide the area-storage-elevation relationship for each reservoir.
47.	Brock Applegate (WDFW)	04/13/2020	Section 2.3 Background and Existing Information	WDFW agrees. If we only have four years of data, we should have more information on flows.	Thank you for your comment. See Comment Response #44.
48.	Jon Riedel (NPS)	03/27/2020	Section 2.3 Background and Existing Information	"A summary of the data available is provided in the PAD and includes reservoir area-storage-elevation information for each reservoirs' historical operations data on reservoir water levels, reservoir releases, power generation, and flows downstream of the Project (City Light 2020)." IT is important to consider the range of flows represented by our highly variable climate, including positive and negative phases of the PDO and ENSO	Thank you for your comment. See Comment Response #44.
49.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Current Project operations and flow management requirements are summarized in Section 3.5 of the PAD (City Light 2020)." Since this is a separate study plan. Identify a table showing what information you currently have, the questions it will help address, and show how new information will either add to that assessment, or have its own question it will answer. Mixing sources of information can be hard to compare if collections vary across time…and by types of data collected.	Thank you for your suggestion. City Light has opted to refer readers to existing information where it is available in the PAD. Also, please See Comment Response #44 above.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Attach an appendix to this study, or right here, add the words in here to identify what background data you will use in the study, so folks know what data still needs to be collected and so that it will help show that data is comparable and usable…	
50.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.3 Background and Existing Information	"The hydrologic modeling work associated with this report includes analyses of naturalized streamflow at Project reservoir locations (Ross, Diablo, and Gorge) and at sixteen tributaries…" Which tributaries? Is this the proposed scope/geographic extent? Are you proposing to expand Bandaragoda 2020 to Skagit basin? Is there a scientific reviewed publication to accompany the web site?	Thank you for your comment. Bandaragoda 2020 was identified as a potential data source of hydrologic data for this study, as well as the Instream Flow Model Study, and will be evaluated as part of these studies. The geographic scope and data available within Bandaragoda 2020 have not yet been reviewed, so it is not yet known which tributary data, if any, will be applicable to these studies. See Comment Response #44.
51.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	Can you include a list of the 16 tribs here? Are they key tributaries for fish and flows?	Yes. The 16 tributaries referenced in the Study plan are part of the Bandaragoda 2020 research. This research is identified as a potential data source for the Operations Model Study, not necessarily key tributaries for fish and flows. Also, please See Comment Response #50 above.
52.	Brock Applegate (WDFW)	04/13/2020	Section 2.3 Background and Existing Information	"Additional information related to river hydraulic characteristics and water quantity at and below the Project is proposed to be developed as part of the Instream Flow Model Development Study." I would work closely with the DOE on this one. SCL will need the information for their 401 water certification.	Thank you. We anticipate working closely with Ecology to consider how results from this study and that of the Water Quality Study plan can be implemented to meet their needs for 401 Water Quality Certification.
53.	Brock Applegate (WDFW)	04/13/2020	Section 2.3 Background and	The Operations Model study will be closely coordinated with the Instream Flow Model	We concur. See Comment Response #52.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Existing Information	Development Study to ensure the two models are fully integrated. I would reiterate that you should work with DOE for the reason above.	
54.	Brock Applegate (WDFW)	04/13/2020	Section 2.3 Background and Existing Information	"Development and flows/elevations at points of interest (nodes) along the Skagit River downstream of the Gorge Development." Does this refer to river cross sections or something different?	Thank you for your question. For this study, node locations are cross sections along the Skagit River downstream of the Gorge Development and will be identified as part of the Instream Flow Model Development Study.
55.	Judy Neibauer (USFWS)	04/13/2020	Section 2.3 Background and Existing Information	"Development and flows/elevations at points of interest (nodes) along the Skagit River downstream of the Gorge Development." As you develop flow models, include in the model, additional points of interest (at rec sites, boat launches, tributary mouths, depositional areas, etc.) where the flow releases cause impacts within the reservoirs. We may need to work together to identify these issue areas and their timing, magnitude, and duration. This gets at the timing, magnitude, and duration of the flow events and potential operational effects to aquatic species and other wildlife. It would also be good to know if there are operational or maintenance procedures that cause SCL to stop spilling for any reason…and what the timing, magnitude, and duration of those events are.	Comment acknowledged. Downstream areas of interest would be identified through the Instream Flow Model Development Study, as a node location that could then be integrated into the Operations Model. The Operations Model will provide lake levels on a sub-daily basis for the duration of the scenario simulation. Comment acknowledged.
56.	USFS	04/13/2020	Section 2.3 Background and Existing Information	**The FS recommends** including all available hydrological data for the period of record in the operations model. It is important to capture the full range of flows that can be anticipated which would include extreme years and highly	Thank you. See Comment Response #44

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				variable climate conditions associated with positive and negative phases of the PDO and ENSO.	
57.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.4 Project Operations and Effects on Resources	"The Operations Model will inform the continuation or development of new operations and maintenance (O&M) measures that may become license terms under a new FERC license." Can the model be used to inform pump storage currently being proposed or considered in draft PAD?	Yes, the model can simulate pump-storage operations under consideration in the PAD.
58.	Judy Neibauer (USFWS)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	This is a section described in the study plan guidelines that I shared earlier…where you can to talk about how the results from the Project will affect the resources. This section could link up to the goals and objectives above and share how the information will be used to assess effects. This section just seems like it lacks description, and more like a general statement, without the details of how the data will be used to address the effects…Maybe add a paragraph showing how data will be used in the effects analysis…you could put that in a table too?	Comment acknowledged.
59.	USFS	04/13/2020	Section 2.4 Project Operations and Effects on Resources	Does SCL anticipate having those operation scenarios ran as part of this study plan, or will they become available at a later time (possibly NEPA review period)? **The FS recommends** clarification on when the outputs from those other scenarios will be made available for review.	Identifying and evaluating operational scenarios are envisioned as a subsequent step to the Operations Model Study (focused on model development only) and per the schedule are to occur no earlier than 2022.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
60.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.5 Study Area	"The Operations Model will include Ross Lake, Ross Dam and Powerhouse, Diablo Lake, Diablo Dam and Powerhouse, Gorge Lake, Gorge Dam, Gorge bypass reach, Gorge Powerhouse, and tailrace." The Utility has shown their climate sensitivity and leadership in many forums on many climate change issues; Will study area include large glaciers inside the Skagit Watershed, particularly in the upper watershed that feeds the three reservoirs?	Thank you for that acknowledgement. See Comment Response #44.
61.	Brock Applegate (WDFW)	04/13/2020	Section 2.5 Study Area	"The scope of the Operations Model Study is the geographic region of the Skagit River from the upper end of Ross Lake to the Gorge Powerhouse tailrace." If this model includes stream flows, I would recommend the study area extends to the downstream water gauge, where SCL will measure flow and ramping rates.	Thank you for the recommendation. The downstream reach will be part of the Instream Flow Model Development Study, with node locations to be incorporated into the operations model. Node locations will be identified as part of the Instream Flow Model Development Study.
62.	Brock Applegate (WDFW)	04/13/2020	Section 2.5 Study Area	"Additionally, within the study area limits of the Instream Flow Model, the Operations Model will be integrated with the Instream Flow Model to evaluate the potential effects of alternative flow/stage measures and timing along the Skagit River." Does this include the Skagit River below the powerhouse?	Yes, please See Comment Response #61.
63.	Judy Neibauer (USFWS)	04/13/2020	Section 2.5 Study Area	"Additionally, within the study area limits of the Instream Flow Model, the Operations Model will be integrated with the Instream Flow Model to evaluate the potential effects of alternative flow/stage measures and timing along the Skagit River."	Thank you for your suggestions. See Comment Response #61.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				You will likely need to be able to explain effects from spill operations to areas downstream of dams, upstream of dams, and to tributaries where effects go some distance upstream. Maybe you have existing information downstream of the Gorge Power house to the mouth of the Skagit? If yes, you can include that statement in here and the data below in background information. Show how you will be using previously collected information along with new data to identify affected resources. If no, you should include data collection points downstream of the dam to the mouth in the study to so you will be able to see where habitat issues may form. Points of interest would be areas like tributaries, key spawning habitat, etc. to show how they are impacted with different flow scenarios. You will want to be able to show the level of affects to habitat and populations both upstream, downstream of dams and at key tributaries; that will be expected from operational and maintenance work flows/drawdowns and from climate change scenarios.	
64.	Jon Riedel (NPS)	03/27/2020	Section 2.5 Study Area	"Dynamic hydraulic modeling to simulate the timing and flow attenuation relationship between nodes along the Skagit River and discharge from Gorge dam will be simulated with the Instream Flow Model."	Thank you for the suggestion. See Comment Response #61. Also, Bandaragoda 2020 was identified as a potential data source. See Comment Response #44.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Would be helpful to have a map showing where these nodes are., presumably including 16 streams already modeled in Bandaragoda.	
65.	Brock Applegate (WDFW)	04/13/2020	Section 2.5 Study Area	I agree with Jon. A map will prove useful. SCL will need to consider the gauges, one below and one above the powerhouse as well to measure flow and ramp rates in the bypass reach and below the powerhouse. We might have less questions if the LPs could see these areas on a map. See Comment #37)	See Comment Response #61.
66.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6 Methodology	1st Paragraph – Comment City Light proposes to develop an Operations Model using the CHEOPS™ model (Computer Hydro Electric Operations and Planning Software). Citation needed for source of the model.	CHEOPS is a modeling tool developed by HDR, and customized to represent a Project. Several examples of use of the model in other FERC license applications are provided in Section 2.7 of the Study Plan.
67.	Brock Applegate (WDFW)	04/13/2020	Section 2.6 Methodology	1st Paragraph – Comment Will LPs have the ability to run their own scenarios with this model selection?	Yes, please See Comment Response #17.
68.	Brock Applegate (WDFW)	04/13/2020	Section 2.6 Methodology	1st Paragraph – Comment “CHEOPS is a flexible, reliable, and easy-to-use tool created….” If CHEOPS is a proprietary model, I am concerned about the “black box” that the numbers enter and the lack of transparency.	See Comment Response #17. Additionally, all model inputs and outputs are provided in text file format which can be evaluated.
69.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6 Methodology	1st Paragraph – Comment “CHEOPS is a flexible, reliable, and easy-to-use tool created more than two decades ago specifically to evaluate a wide range of factors	Two examples are provided in section 2.7

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				considered during FERC relicensing that may affect natural resources and project operations, including reservoir levels, water uses and generation." Can you provide citations of where this has been used in the PNW?	
70.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6 Methodology	1st Paragraph – Comment "Additionally, CHEOPS is designed to be user-friendly, it can be run from PC or personal laptop through an easy-to-use graphical interface and utilizes Microsoft Excel as the output data analysis platform, this allows the Operations Model to be used by LPs…." Thanks. This helps with transparency. Is the software open source/free? Where/how do we access?	You are welcome and the comment is appreciated. The model will be available to LPs; please See Comment Response #17. The model is not open source, but all model inputs and outputs are provided in text file format which can be evaluated by the LPs. The model has a user friendly interface and allows for the retention and easy tracking of scenarios. Model output is in either text files or DSS format, and is easily evaluated within excel. There are several excel based tools to help automate the evaluation of model output, and these are often customized to specific Projects areas of interest.
71.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6 Methodology	2nd Paragraph – Comment "The Operations Model will include characteristics of the three Project reservoirs powerhouses, and water conveyance structures; as well as incremental tributary flows and discharge rating curve relationships at select nodes along the Skagit River." Can you identify nodes or points of interest in reservoirs, so that we can see at what reservoir elevations, key tributaries becomes disconnected and/or connectivity becomes an	Thank you for your questions. The model utilizes level pool elevation-storage relationships to account for reservoir storage. If key elevations are identified, evaluations of duration and magnitude at those elevations could be estimated from the model output data. City Light currently mitigates for potential effects on fish migration/passage resulting from sediment and woody debris deposition in Project reservoirs, and intends to continue the effort. The 1991 Settlement Agreement stipulates that City Light is to survey for and

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				issue? I am also interested if any passage barriers show up in the reservoir itself as water levels decrease. Can you add in reservoir bathymetry into the model so you can see if there are any passage barriers or shallow areas that show up in the reservoirs as they drop?	remove transitory barriers to spawning migration in tributaries to Project reservoirs. City Light has agreed to expand the annual barrier surveys and barrier removal efforts beginning in 2020 following NCC approval.
72.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6 Methodology	3rd Paragraph – Comment "The proposed approach is to use the Operations Model to perform simulations (Model runs), comparing outputs/effects relative to a Base Case scenario." Again, it would be good to know the range of conditions you are proposing to model.	See Comment Response #17. Future scenarios have not yet been identified.
73.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6 Methodology	2nd Paragraph – Comment "The proposed Operations Model will encompass an inflow dataset including streamflows into Ross Lake, incremental inflows to Diablo and Gorge lakes, as well as incremental flows to nodes along the Skagit River downstream of the Gorge Development." Inputs should also include direct precipitation, seasonal snow melt, and glacier inputs, can you explain how these variables are captured or if not how the data gap will be managed?	Thank you for your suggestions. The inputs identified would be represented in the hydrologic dataset to be developed as part of the study.
74.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6 Methodology	2nd Paragraph – Comment "The proposed Operations Model will encompass an inflow dataset including streamflows into Ross Lake, incremental inflows to Diablo and Gorge lakes, as well as	See Comment Response #44. Also, note that the data review has yet to be completed, so data gaps are not yet known.

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				incremental flows to nodes along the Skagit River downstream of the Gorge Development." What spatial and temporal data gaps exist and what methodology will be used to address?	
75.	Rick Hartson (Upper Skagit Indian Tribe)	03/31/2020	Section 2.6 Methodology	2nd Paragraph – Comment "The Operations Model will include characteristics of the three Project reservoirs powerhouses, and water conveyance structures; as well as incremental tributary flows and discharge rating curve relationships at select nodes along the Skagit River. These discharge rating curve relationships will be developed as part of the Instream Flow Model Development Study." Why do both Operations Model and Instream Flow Model include tributary inflows downstream of Gorge Powerhouse? Clarify this apparent redundancy and how these two models will be integrated.	Thank you for your observation and questions. The tributary flows will be incorporated into the modeling efforts to represent total flow at identified node locations. The Operations Model will incorporate the Instream Flow Model node locations downstream of Gorge discharge. The Operations Model will be capable of evaluating reservoir operations to attempt to support flows/stage targets at these node locations.
76.	Brock Applegate (WDFW)	04/13/2020	Section 2.6 Methodology	3rd Paragraph – Comment I agree. Should we assume that SCL will run anything that most LPs agree with running, within reason?	See Comment Response #24.
77.	USFS	04/13/2020	Section 2.6 Methodology	**The FS appreciates** the level of detail and logical sequencing of the methods described in this section.	Comment acknowledged, thank you.
78.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6 Methodology	Is there a 3-d type of a model that you can use along with this model to show data visually? A model that will show how flows will inundate streams/ channels/ wetlands, as well as show	Comment acknowledged. The suggested methodology is outside the scope of this study. City light agrees this methodology is exciting

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				how a reservoir drains across time under several scenarios we choose? I have seen this done with watershed restoration and it can be very helpful.	and powerful when used in the appropriate context.
79.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6.1 Model Development	1st Bullet – Comment "Assembly and compilation of historical operational data." What time period?	Thank you for your question. The time period will be identified as part of this study. See Comment Response #44.
80.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1 Model Development	1st Bullet – Comment SCL should have a conversation with the LPs on the historic inflow data.	See Comment Response #44.
81.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6.1 Model Development	3rd Bullet – Comment "Development or identification of inflow dataset." Does this refer to the 16 tribs discussed earlier?	Bandaragoda 2020 was identified as a potential data source. See Comment Response #44.
82.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1 Model Development	3rd Bullet – Comment "Development or identification of inflow dataset." Please see early comment about precipitation, (rain and snow melt), and glaciers	Comment acknowledged. See Comment Response #17.
83.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6.1 Model Development	4th Bullet – Comment "Initial Operations Model development using physical data such as reservoir storage curves, dam spillway capacity, headwater curves, tailwater curves, turbine performance curves, generator performance curves, as well as operational data including minimum flows,	Yes, the data will be reviewed through the Workshop Process and documented in the study report.

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				operation/dispatch routines, and operating/elevation limits." All of this info will be made available to LPs? When?	
84.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1 Model Development	WDFW would support this availability.	See Comment Response #83.
85.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1 Model Development	4th Bullet – Comment "Initial Operations Model development using physical data such as reservoir storage curves, dam spillway capacity, headwater curves, tailwater curves, turbine performance curves, generator performance curves, as well as operational data including minimum flows, operation/dispatch routines, and operating/elevation limits." Can we consider ramping rates as well?	Thank you for your question. Yes, the model can simulate ramping rates. This would be a part of future analysis after model development is completed.
86.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.1 Model Development	4th Bullet – Comment Can you add in reservoir elevations at which the tributaries might disconnect or become a connectivity barrier. Also, add any bathymetry that shows any shallow areas, or barriers within the reservoirs themselves during operational drawdowns. Same question as above….	Thank you for your suggestion. The model utilizes level pool elevation-storage relationships to account for reservoir storage. If key elevations are identified, evaluations of duration and magnitude at those elevations could be estimated from the model output data.
87.	USFS	04/13/2020	Section 2.6.1 Model Development	**The FS recommends** clarity on whether the assembly and compilation of these development activities will be available for iterative review by the LPs during the licensing process? In particular the development and identification of inflow data.	See Comment Response #44. The Workshop process will facilitate LP review and engagement in data review and selection.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				The FS recommends having the following statement in the Study Plan Development section 1.3: "Separate from the study, the Operations Model will be utilized to simulate alternative operations scenarios identified by City Light and the LPs through the relicensing process."	Edits have been made to address this comment.
88.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1.1 Model Validation	"In the first step, the Operations Model will be evaluated by comparing the Operations Model output to the period of the historical record that represents current operations,…." Will LPs and Utility work collaboratively to address this model input or assumption? Annual records over the last license term represent significantly different water budgets and demands.	Yes, the Workshop process will facilitate LP review and engagement in data review and selection.
89.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.1 Model Validation	1st Paragraph – Comment "In the first step, the Operations Model will be evaluated by comparing the Operations Model output to the period of the historical record that represents current operations, specifically, mean daily flows…." WDFW would recommend that we consider the time period from which SCL will gather the datat. Other utilities on the river have started to adjust the years to more recent years because the average of those years better represents what will happen in the future.	Thank you for this recommendation. See Comment Responses #44 and #88.
90.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6.1.1 Model Validation	2nd Paragraph – Comment	Thank you for your question. Review of available data and the time period to be evaluated will be identified as part of the Study.

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				"This will be done by making a number of model runs and comparing the results with actual Project data." Can you provide more detail on the data will be used to build the model and the data will be used to validate?	
91.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.1 Model Validation	2nd Paragraph – Comment I agree with Ashley. We would prefer more detail at these steps.	Comment acknowledged. The workshops will facilitate LP review and engagement in data review and selection. There may not be substantial differences, this is not known until the Model development and data review is initiated.
92.	USFS	04/13/2020	Section 2.6.1.1 Model Validation	**The FS recommends** clarity on whether during the validation of the operating model that input data with "substantial differences" that cannot be explained will be available for iterative review by the LPs? Can SCL identify when during the relicense process that will occur.	See Comment Response #91.
93.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1.2 Develop Base Case and Current Operations Baseline	"The Operations Model will be configured to represent current FERC license requirements as well as how the Project is currently operated, including all physical, regulatory, and contractual constraints. The underlying assumption is that this Base Case represents the "No Action Alternative" or the current FERC license requirements, and the Current Operations Baseline represents current operations, including voluntary measures. All subsequent Operations Model runs will be compared to both Base Case and Current Operations Baseline." Upper Skagit Indian Tribe TEAM THINK THROUGH NEPA? Base case no action	City Light welcomes further discussion regarding use of base case for comparison to additional operational scenarios. While base case is defined by current operations, this does not limit the ability for LPs and City Light to explore scenarios that are beyond the scope of current operations.

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				current operations baseline is current operations?? The significance here is lost with confusing language???	
94.	Judy Neibauer (USFWS)	04/13/2020	Section 2.6.1.2 Develop Base Case and Current Operations Baseline	I am confused as to what you are calling voluntary flows. In the current USFWS BiOp we have for the Skagit, we covered a set of 4 voluntary flows, and they were adopted into the license. Wouldn't that be the Base Case…and the no action alternative at this point? Page 16 of that BiOp shows that you are implementing flows for Steelhead and Chinook with a down ramp rate; for Salmon fry protection; for Chum spawning, and for Chum Incubation. It looks like you have been implementing them since 1995 in the BiOp. Are there other flows that you are operating at, that are not currently covered in a Biological Opinion? Please review the 2012 Biological Opinion and describe what your current operations are, especially, if these flows are not considered "Base Case" flows here or for the next license.	See Comment Response #27.
95.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.2 Develop Base Case and Current Operations Baseline	"The underlying assumption is that this Base Case represents the "No Action Alternative" or the current FERC license requirements, and the Current Operations Baseline represents current operations, including voluntary measures." SCL should make sure that these measures did not get integrated into the license already.	See Comment Response #27.

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96.	Ashley Rawhouser (NPS)	03/25/2020	Section 2.6.1.3 Model Logic and Validation Report	SCL should also provide all data and metadata used to develop the model in an electronic (.csv or .xlxs) format to LPs. A sensitivity analysis should also be conducted.	Agreed. Model input and output is available in .csv format. Additional simulations will be evaluated after this study is completed.
97.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.3 Model Logic and Validation Report5	7th Bullet – Make edits below Any LP ~~agency~~ correspondence and/or consultation	Thank you, edits made to address this comment.
98.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1.4 Consultation Process with Licensing Participants	"City Light proposes to engage the resource agencies, tribes, and other interested parties…" LP base or ?	"other interested parties" is includes LPs as well as others with an interest in the relicensing process..
99.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.4 Consultation Process with Licensing Participants	"iii. Riverine node selection" Will the LPs select or will SCL tells why they have selected the nodes?	In collaboration with the LPs, nodes will be identified as part of the Instream Flow Model study.
100.	Brock Applegate (WDFW)	04/13/2020	Section 2.6.1.4 Consultation Process with Licensing Participants	"ii. Voluntary operations" Voluntary operation should not include any measure already in the license, but more adaptive management changes done because of consultation.	Thank you for your comment.
101.	USFS	04/13/2020	Section 2.6.1.4 Consultation Process with Licensing Participants	**The FS appreciates** this section of the study plan. Thank you for the addition.	You're welcome, glad it was helpful.
102.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1.5 Evaluate Alternative	"The Operations Model will be capable of evaluating alternative Project operation scenarios developed by City Light and/or LPs."	Thank you for this observation and comment. See Comment Response #24. Evaluating alternative operations scenarios are intended to

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			Project Operation Scenarios	Not knowing the need, cost, or technical expertise, degree of needed information etc.. to run the model, if any of the above limit model runs. Then, we should address early on a process for deciding how alternative model selection is identified and run. Utility presents reasonable case in this outline of study design, "the models capable of evaluating alternative project operations", but Steering Committee will need to address process for evaluating different alternatives put forth by Lps and Utility that receive official modeling. Just because it is capable doesn't mean we have agreement to see what it says.	be a process that occurs after the study is complete.
103.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/11/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	"Accordingly, CHEOPS has proven applicable to a broad range of sites and operating conditions and has been relied upon by LPs and FERC staff in numerous FERC relicensing projects including, but not limited to:" Does CHEOPS support pump storage operations, and any examples of using CHEOPS for feeding economic modelling?	Yes, the model can simulate pump-storage operations.
104.	Brock Applegate (WDFW)	04/13/2020	Section 2.8 Schedule	▪ Initial Study ~~Final~~ Report (ISR)– March 2022 ▪ ISR Meeting ▪ Requests for study plan modification (in needed) This language better represents the format that FERC likes, based on the use of Federal Power Act language.	The model is crucial to inform discussions regarding proposed operations. While the FERC process allows for two seasons, it is City Light's intent to complete the model on the timeline proposed. Therefore, the requested edits have been removed. **Response to comment provided on**

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				New comment provided on 05/05/2020: I have included two steps in the process that FERC requires. FERC requires the ISR Meeting and the report. Why not include the edits? SCL will conduct them whether one or two seasons. How About: --Final report of the Initial Study Report (ISR) --ISR Meeting	**05/05/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.

RA-01 RECREATION USE AND FACILITY ASSESSMENT PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Acronyms and Abbreviations

ABA .....Architectural Barriers Act
ADA .....Americans with Disabilities Act
CFR .....Code of Federal Regulations
City Light .....Seattle City Light
DLA .....Draft License Application
ELC .....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
FPA .....Federal Power Act
ISR .....Initial Study Report
LP.....licensing participant
NCI.....North Cascades Institute
NEPA .....National Environmental Policy Act
NPS .....National Park Service
OHV .....off-highway vehicle
O&M .....operation and maintenance
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
QA/QC .....quality assurance/quality control
RARWG.....Recreation and Aesthetics Resource Work Group
RCO .....Recreation and Conservation Office
RD.....recreation days
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SR.....State Route
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife
wse .....water surface elevation

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

For City Light, LPs, and FERC to evaluate the Project's recreation resources, including existing Project recreation opportunities and whether those opportunities are meeting recreation demand, an inventory and assessment of Project recreation facilities and opportunities, and visitor use within the Project Boundary, is proposed. This study plan addresses elements of the RA01 (Recreation and Visitor Use), RA02 (Recreation Inventory), RA04 (Whitewater Recreation), RA10 (Visitor Use Impacts), and FA03 (Recreational Fisheries) issue forms provided during the 2019 Study Plan Development Process.

On March 12, 2020, City Light released the Recreation Use and Facility Assessment Draft Study Plan for LP review and comment. On March 24, 2020, the draft study plan was discussed at a Recreation and Aesthetics Resource Work Group (RARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 18, 2020. The revised draft was discussed on June 25, 2020 at a RARWG meeting. Written comments were received from U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife Service (WDFW), Upper Skagit Indian Tribe, NPS, North Cascades Institute (NCI), and Nlaka'pamux Nation Tribal Council and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. The following study requests pertaining to recreation facilities and visitor use were submitted: USFS-01 Recreation Facility and Use Study, and NPS-15 Recreation Facilities and Visitor Use Study. The NPS and USFS study requests are substantially identical. This study plan addresses, with modifications, some of the elements identified in the study requests listed above, as explained in Section 6 of the PSP. In particular, this study plan was revised to update the visitor survey instrument (as attached to this study plan) to include questions requested by the NPS and USFS. Much of the NPS and USFS study requests were not adopted because City Light deems the methods in its study plan to be sufficient for meeting the study objectives and information needs.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of this study are to determine: (1) the condition, accessibility, and use impacts of the Project's recreation facilities; (2) the preferences, attitudes, and characteristics of the Project's recreation users at Project recreation facilities and reservoirs; (3) current Project recreation use and activities; and (4) future demand for Project recreation facilities and opportunities.

Goal 1 Objectives (Determine the Condition of Project Facilities, Impacts, and Accessibility)

- Determine the condition of the Project's recreation facilities.
- Evaluate accessibility at all existing Project recreation facilities.
- Inventory Project recreation facilities and trails and document recreational use and access impacts (e.g., erosion, user-created trails, trash/waste disposal, etc.).
- Evaluate the usable periods of the Gorge Lake Boat Launch ramp.

Goal 2 Objectives (Determine the Preferences, Attitudes, and Characteristics of the Project Facilities' Recreation Users)

- Describe recreation visitors and their trip characteristics, including seasonality and access routes, by Project recreation facility and type of user (anglers, boaters, campers, hikers, etc.).
- Describe user preferences and expectations at Project recreation facilities, including water surface elevation; level and quality of interpretation and posted information; and condition of recreation facilities.
- Identify any recreation issues such as safety, conflicts, and crowding.
- Describe recreation visitors' activities (including primary activity and all activities engaged in while visiting) at Project recreation facilities.
- Describe Project recreation visitors' socio-demographic characteristics.
- Describe Project recreation visitors' access experience and any Project-related potential barriers to participation in recreation activities.
- Describe Project visitors' recreation use in the Project Boundary.

Goal 3 Objectives (Current Project Recreation Use and Activities)

- Identify the amount, activity type, and spatial and temporal distribution of existing and desired recreation use within the Project Boundary, and, where reasonable and possible, describe historical recreation use trends within these areas.
- Identify the current facility capacity/occupancy of the Project recreation facilities.
- Identify Project-related recreation opportunities within the Project Boundary that may have unmet demand.
- Identify Project-related potential constraints or barriers to recreation use.

- Assess the regional uniqueness and relative significance of the Project's primary recreation opportunities.

Goal 4 Objectives (Future Demand for Activities)

- Roughly estimate future recreation demand within the Project Boundary through the term of the new license (30 to 50 years).

2.2 Resource Management Goals

In addition to providing information needed to characterize Project effects, this study will provide information to help LPs with responsibility for recreation and land use within the Project area to identify potential measures for consideration in a recreation management plan for the Project. To that purpose, City Light has the following goals:

- Determine the adequacy of the Project's recreation facilities to meet the current and future recreation demand for the Project.
- Ensure the safety of the public in its use of Project lands and waters and Project recreation facilities.
- Identify user conflicts and resource impacts as a result of recreational use.

Relevant recreation agency resource management goals are summarized below:

- FERC – City Light has a responsibility under the Federal Power Act (FPA) to provide recreation opportunities at hydroelectric projects under the FERC's jurisdiction. Per 18 CFR Subsection 2.7 (Recreational Developments at Licensed Projects), "FERC will evaluate the recreational resources of all projects under Federal license or applications therefor and seek, within its authority, the ultimate development of these resources, consistent with the needs of the area to the extent that such development is not inconsistent with the primary purpose of the project." Specifically, FERC requires licensees to:
  - Acquire lands to assure optimum development of the recreational resources afforded by the project;
  - Develop suitable public recreational facilities with adequate public access, considering the needs of people with disabilities in the design of facilities and access;
  - Coordinate efforts with other agencies in the development of recreation areas and facilities;
  - Provide for planning, operation, and maintenance of these facilities; and
  - Inform the public of opportunities for recreation at licensed projects.
- National Park Service (NPS) – NPS manages recreation within RLNRA following the guidance provided in the 2012 RLNRA General Management Plan (NPS 2012). Management of the North Cascades National Park north and south units is guided by the General Management Plan for the North Cascades National Park Complex (NPS 1988). Approximately 70 percent of RLNRA is part of the Stephen Mather Wilderness, the management of which is guided by the Stephen Mather Wilderness Management Plan (NPS 1989). Since many of the

Project recreation facilities and opportunities on Ross Lake, Diablo Lake, Gorge Lake, and on the Skagit River downstream of Gorge Lake are located on or adjacent to NPS-managed lands within RLNRA, City Light will collaborate with the NPS on developing appropriate study assessment methods. In addition, NPS coordination will be necessary for City Light to implement selected elements of the study plan at facilities located on NPS-managed lands. NPS will play a key role in the evaluation of study results and implementing a long-term management plan for Project recreation resources.

- US Forest Service (USFS) – The USFS manages recreation in the Okanogan-Wenatchee National Forest and the Mount Baker-Snoqualmie National Forest, which border the Ross Lake National Recreation Area on the east and west sides consistent with the Okanogan Forest Land and Resource Management Plan, the Wenatchee Forest Land and Resource Management Plan, and the Mt. Baker-Snoqualmie National Forest Land and Resources Management Plan (USFS 1989; USFS 1990a; and USFS 1990b, respectively as amended by the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, April, 1994). Within the Project Boundary, the USFS has jurisdiction over the recreation facilities at the Marblemount Boat Launch (Skagit River) and the Sauk River Boat Launch (Sauk River). In addition, the USFS manages recreation on federal land in the Skagit River Wild and Scenic River corridor downstream of the Project per the 1983 Skagit Wild and Scenic River Management Plan (Volumes I and II).
- Washington Department of Fish and Wildlife (WDFW) – WDFW works with tribes to co-manage the state's fisheries and is responsible for managing wildlife in the state of Washington. WDFW will evaluate visitor survey study results related to angling on the Project reservoirs and in the Skagit River downstream of Gorge Powerhouse.

Additionally, this study plan will identify Project-related recreation opportunities that may help address some regional and/or statewide recreation interests identified by the Washington State Recreation and Conservation Office (RCO 2017). The RCO is a state agency that manages grant programs to create outdoor recreation and conservation opportunities, and is responsible for completing several statewide plans, including ones for recreation, trails, and boating. The RCO's 2018-2022 Recreation and Conservation Plan for Washington State identifies the near and long-term priorities to meet the needs of residents for outdoor recreation and conservation in Washington State. The plan includes five priority areas to meet these needs, including: (1) sustain and grow the legacy of parks, trails, and conservation lands; (2) improve equity of parks, trails, and conservation lands; (3) get youth outside; (4) plan for culturally relevant parks and trails to meet changing demographics; and (5) assert recreation and conservation as a vital public service.

2.3 Background and Existing Information

The Skagit River Project is in a remote area, with steep terrain and harsh winter conditions that both define and limit recreation opportunities. The Project is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley and the one highway in the vicinity (State Route [SR] 20) is seasonally closed each year, usually from November until April. Nonetheless, the Project reservoirs and surrounding area provide numerous recreational opportunities and receive a significant level of visitation, especially in the summer.

The Project is unique in that the generation facilities are almost entirely within a national recreation area, the RLNRA, which was established in 1968—after initial licensing and development of the Project—and is managed by the NPS as part of the North Cascades National Park Complex. Additionally, the Project is bordered on the east and west by National Forests and is upstream of the Skagit River Wild and Scenic River System. The Project Boundary also encompasses two towns, which are owned by City Light, and the ELC.

The Project supports public access and recreation activities on Ross Lake, Diablo Lake, Gorge Lake, and the towns of Newhalem and Diablo. Public recreation opportunities within the Project Boundary include developed recreation facilities, trails, dispersed sites, boat launches, and reservoir-based activities. However, most of the recreation facilities within the Project Boundary, as well as those adjacent to the Project Boundary, are non-Project recreation facilities managed by the NPS as part of the RLNRA. Project recreation facilities, on the other hand, are located either on City Light or federal land and managed by City Light.

The Project serves as a launching point for a range of recreation opportunities that extend far beyond the Project Boundary. Visitor use ranges from car trips through the Project vicinity on SR 20 with brief stops to view an interpretive display or photograph one of the Project waterbodies, to multiday stays in a frontcountry campground with excursions onto Project waters for day-use activities, or hikes into the backcountry for a wilderness camping experience. Visitors to the area come from across the United States and other countries. Visitation to the RLNRA is highest in the summer months of July and August with lower levels of recreation activity in the spring and fall shoulder seasons. Closure of SR 20 from November to April limits visitor access to the area and associated recreation use, although cross-country skiing and snowshoeing occur on NPS lands within the Project Boundary. Several NPS facilities in the RLNRA close by the end of September. Adjacent USFS facilities also close by November. Similarly, the road gate at the U.S.-Canada border at Hozomeen is usually closed for the winter season by November.

NPS reports annual use for RLNRA and City Light's 2015 Licensed Hydropower Development Recreation Reports present a picture of overall use of the Project and RLNRA. Overall, visitation to RLNRA generally ranged from 700,000 to 900,000 visitors annually from 2010 to 2019 with a peak visitor use of 1,088,528 visitors in 2019. City Light filed a FERC Licensed Hydropower Development Recreation Report (Form 80 report) every six years from 1997 to 2015 for each of the respective developments; Ross, Diablo, and Gorge. Notably, the Form 80 reports include recreation use at both Project recreation facilities within the Project Boundary as well as some non-Project recreation facilities adjacent to (but outside) the Project Boundary. City Light's data collected as part of the Form 80 reports for the 2014 recreation season from May 1 to October 31 is summarized below for the recreational use specific to the Project recreation facilities at each development – all of which is day-use since the Project does not include any overnight recreation facilities. In 2014, the total use at the Project recreation facilities was 96,596 visitors. Of note, the following City Light use data summary was intended for only Project recreation facilities, but there is the potential for minor inclusion of use that occurs at non-Project recreation facilities, particularly where Project and non-Project facilities intersect or border one another.

- Ross Development: 7,426 daytime visitors (City Light 2015a).
- Diablo Development: 30,866 daytime visitors (City Light 2015b).

- Gorge Development: 58,304 daytime visitors (City Light 2015c).

Currently, the Project provides a variety of existing recreation resources and opportunities, which need to be evaluated to determine if these resources and opportunities are meeting current and future recreation demand.

2.4 Project Operations and Effects on Resources

Continued operation and maintenance (O&M) of the Project has the potential to affect recreation resources, including access to Project waters and lands and availability and use of recreation facilities and opportunities. The study results will help inform City Light and LPs on the development of a Project recreation management plan to guide the long-term O&M of the Project recreation facilities and opportunities at Ross Lake, Diablo Lake, Gorge Lake, Newhalem, and Diablo.

2.5 Study Area

For the purpose of this study, the study area includes the lands and waters within the Project Boundary (Figure 2.5-1) at Ross Lake, Diablo Lake, and Gorge Lake, and the towns of Newhalem and Diablo (see maps attached to this study plan).

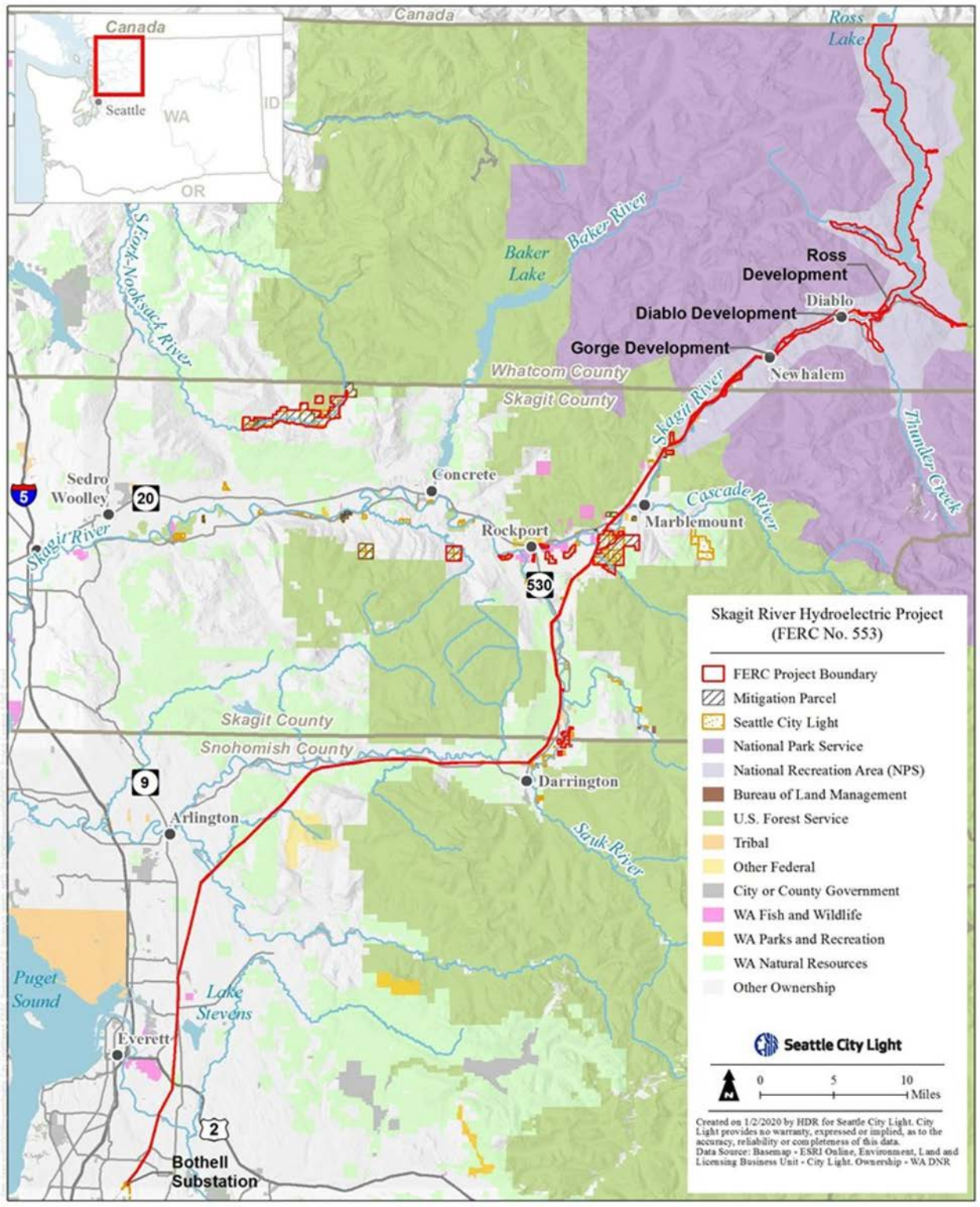

Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

The study will consist of six elements. These include: (1) an inventory and evaluation of the Project recreation facilities for condition, accessibility compliance, facility capacity, and use impacts, as well as an assessment of the usable periods of the Project's developed boat launch; (2) identifying recreation uses and visitor attitudes, beliefs, and preferences at Project recreation facilities; (3) estimating the current recreation use at Project recreation resource areas (i.e., Project reservoirs and areas where Project recreation facilities are located); (4) identifying future use and demand opportunities; (5) a quality assurance/quality control (QA/QC) review and data entry of visitor and observation survey data; and (6) analyzing the data and preparing the report. The methodology for each of these elements is described below.

2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities

Specifically, this step will include five tasks: (1) an inventory of Project recreation facilities, including the boat launch, picnic areas, signs, interpretive displays, parking areas, restroom buildings, trails, etc.; (2) an assessment of the condition of each site amenity (tables, restrooms, parking areas, other structures, etc.) of the Project recreation facilities; (3) an assessment of whether each element complies with current applicable accessibility guidelines; (4) an assessment of the recreation access and use impacts at each recreation facility; and (5) an assessment of the usable periods of the Gorge Lake Boat Launch ramp. City Light will inventory all the Project recreation facilities identified in Table 2.6-1 and on the maps attached to this study plan. In addition, Table 2.6-1 identifies the specific types of evaluations that City Light will conduct at each facility as not all of the evaluations will apply to each facility. For instance, City Light will not conduct condition, use impact, or accessibility assessments at structures such as the North Cascades ELC, Gorge Powerhouse Visitor Gallery, Skagit Information Center, or Gorge Inn Museum, as these are atypical recreation buildings and constructed to different standards and codes than common recreation facility amenities (e.g., parking areas, restroom buildings, picnic sites, and boat launch facilities). The intent of this recreation facility assessment is not to be a building code compliance exercise, but rather assess the Project's public outdoor recreation facilities.

Table 2.6-1. Project recreation facilities that will be inventoried and evaluated of the condition, ADA compliance, and use impacts.

FERC Project Development	Resource Area	Land Management	Facility Type	Project or Non-Project Facility	Recreation Facility	Type of Evaluation			
						Inventory	Condition	Accessibility	Use Impact
Diablo Lake	Diablo Lake	Federal (NPS)	Day use	Project	Skagit Tour Dock[1]	X	X	X	X
		Federal (NPS)	Day use	Project	West Ferry Landing (parking and dock)	X	X	X	X
		Federal (NPS)	Day use	Project	East Ferry Landing	X	X	X	X
		Federal (NPS)	Day use[2]	Project	North Cascades Environmental Learning Center	X			
Gorge Lake	Gorge Lake	City Light	Day use	Project	Ross Lodge Picnic Shelter	X	X	X	X
		City Light	Day use	Project	Gorge Lake Boat Launch	X	X	X	X
	Newhalem	Federal (NPS)	Day use	Project	Ladder Creek Falls Trail and Gardens	X	X	X	X
		Federal (NPS)	Day use	Project	Trail of the Cedars	X	X	X	X
		City Light	Day use	Project	Gorge Powerhouse Overlook	X	X	X	X
		City Light	Day use	Project	Gorge Powerhouse Visitor Gallery	X		X	
		City Light	Day use	Project	Skagit Information Center	X		X	
		City Light	Day use	Project	Gorge Inn Museum	X		X	
		City Light	Day use	Project	Newhalem Picnic Sites	X	X	X	X
		City Light	Day use	Project	Newhalem Parking Area (Main Street)	X	X	X	X
		City Light	Day use	Project	Newhalem Parking Area (State Route 20)	X	X	X	X
		City Light	Day use	Project	Newhalem Interpretive Displays (standalone)[3]	X	X	X	X
		City Light	Day use	Project	Newhalem Playground	X	X	X	X

1 The standalone restroom building near Diablo Dam will be included in the Skagit Tour Dock assessment.
2 The North Cascades Environmental Learning Center also provides some overnight programs.
3 The standalone interpretive displays dispersed throughout Newhalem include: "The Iron Horse of the Skagit," "Automobiles Come to the Skagit," "The Meaning of Place," "Newhalem Company Town," "Spinning Waterwheel," "Temple of Power," and "Chinook Redd."

2.6.1.1 Inventory Recreation Facilities

City Light will inventory the number and type of recreation facilities at the Project recreation facilities listed in Table 2.6-1. Photographs will be taken as appropriate as either a representative photograph of similar facilities or of each one-of-a-kind facility. Facilities of interest include picnic sites, campsites, restrooms, parking areas/spaces, boat launch, and recreation signs. This inventory will inform the site capacity for each Project recreation facility (e.g., total parking capacity, picnic capacity, etc.).

All recreation facility-related signs will be inventoried and each type of sign will be photographed and documented (e.g., type of sign, condition, text, location). Representative photographs will be taken as appropriate. City Light will use a basic inventory form (an example form is attached to this study plan).

2.6.1.2 Facility Condition Assessment

City Light will conduct a qualitative assessment of the condition of developed recreation facilities and signs at each of the facilities identified in Table 2.6-1. The assessment categories are poor, fair, good, and excellent condition. Table 2.6-2 provides evaluation criteria that will be used by type of recreation facility amenity. City Light will provide the individual condition ratings for each site amenity within a facility as well as an overall facility rating as part of the study report.

Based on the rating of each site amenity in Table 2.6-2, an overall facility evaluation score will be calculated by summing the total of each of the site amenities at each facility. City Light will categorize the overall facility condition using the rating scale, categories, and general rehabilitation timeframes in Table 2.6-3. The general rehabilitation timeframes are not intended to be rigid, but rather guidelines. The purpose of these general timeframes is to understand where the Project recreation facilities rank in terms of rehabilitation priorities.

City Light will use a condition form to evaluate each facility, and an example form is attached to this study plan. City Light's condition assessment form has been used on other relicensings and may be modified based on review of existing information and field reconnaissance.

Table 2.6-2. Facility condition evaluation categories and criteria.

Condition Rating	Condition Description	Examples of Condition by Facility Type			
		Vehicle Parking (surfacing on vehicle spurs and parking areas)	**Recreation Site Amenities** (tables, , boat ramps, docks, trails and trailheads, etc.)	**Recreation Site Buildings** (public restrooms and outdoor recreation structures)	**Signs** (Project and recreation signs)
1 – Poor	All or most facilities are in disrepair and need of immediate reconditioning or replacement. Current conditions create safety hazards and impact function. Little evidence of recent maintenance.	Widespread areas of cracking, eroding edges, potholes, visible subgrade.	Splitting or rotten boards or planks, missing bolts or fasteners, overgrown or impassable trail tread, rutted or eroded trail surface	Rot, leaks, sagging roofs, holes in exterior.	Signs do not exist, sign panels are bent/broken, posts or supports are broken, holes in panels.
2 – Fair	Need for improved maintenance and repair in some areas. No major safety concerns. Repairs should be made, but are not needed immediately.	Limited areas of cracking, eroding edges, potholes, striping faded or lacking, curbs/wheel stops missing or damaged.	Loose bolts or boards, rusted or bent grills, dock boards loose, dock floatation or anchoring in disrepair, early signs of vegetation encroaching on trail width/height, limited areas of trail tread erosion	Surfaces need painting, roof shingles need replacement or repair, inoperable lock, door hinge in disrepair.	Sign panels faded, loose bolts or posts, some text not readily legible.
3 – Good	All facilities in good condition and well maintained. No significant signs of disrepair or aging.	Surfacing still consistent and intact, striping visible but slightly faded, no cracking or potholes.	Materials not clearly new, but fully operable, fasteners and grills secure, boards and planking secure, no signs of damage observed, clear trail tread/width, no signs of vegetation encroachment on trail width/height.	Minor signs of weathering but in functional condition. Facilities operable and only need minor maintenance.	Minor signs of weathering, but fully intact, legible, and secure.
4 – Excellent	All facilities are new, near new, or recently reconditioned and well maintained.	Newly surfaced or resurfaced with clear striping.	New materials, newly built or restored trail surface with clearly defined vegetation clearances.	Newly installed or reconditioned structure	New sign panels and posts.

Table 2.6-3. Overall facility condition evaluation ratings, categories, and general rehabilitation timeframes.

Overall Condition Rating Score	Overall Condition Category	General Rehabilitation Timeframe
1 to 3	Poor	Immediate
4 to 6	Fair	Within 5 Years
7 to 10	Good	5 to 10 Years
11 to 13	Excellent	More than 10 Years

2.6.1.3 Accessibility Compliance Assessment

City Light will assess the developed recreation facilities identified in Table 2.6-1 for consistency with current accessibility guidelines. For the Project recreation facilities located on City Light lands and constructed using City Light funds, City Light will use the 2010 ADA Standards for Accessible Design (ADA) for public accommodations (USDOJ 2010). For the Project recreation facilities located on federal lands, City Light will use the 2015 Architectural Barriers Act (ABA) Standards (USAB 2015).

City Light will evaluate each facility against these standards and then utilize a rating system that categorizes the level of accessibility at each facility. City Light will use the following three ratings: inaccessible, partially accessible, and fully accessible. City Light will assign a rating using the evaluation criteria in Table 2.6-4. These ratings are included in the inventory form contained in an attachment to this study plan. Notably, this form has been used on other relicensings and may be modified based on review of existing information and the availability of forms developed by the United States Access Board.

Table 2.6-4. Level of accessibility compliance categories and rating system.

Accessibility Rating System and Categories		
0 – Inaccessible	**1 – Partially Accessible**	**2 - Accessible**
Little or no consideration for accessibility. Clearly not in compliance with current ADA or ABA standards.	Some accessible facilities, but in disrepair or not up to current ADA or ABA standards (e.g., slopes too steep, docks inaccessible, etc.)	High quality of accessibility. Facilities appear fully consistent with current ADA or ABA standards.

2.6.1.4 Recreation Use Impact Assessment

City Light will also assess the recreation use impacts at each of the Project recreation facilities identified in Table 2.6-1. The recreation use impact assessment at each facility is categorized as low, moderate, or high depending on the amount and dispersion of use impact evidence (Table 2.6-5). Evidence of use impact typically include the presence of litter, dumping, tree cutting, inadequate vegetation clearances around fire pits/rings, visible off-highway vehicle (OHV) use/tracks, trampled vegetation, erosion, human waste, toilet paper, etc.

Table 2.6-5. Recreation use impact assessment categories and rating system.

Use Impact Rating System and Categories		
0 – Low	**1 – Moderate**	**2 - High**
Few, if any evidence of use impact are observed at each site	Several signs/evidence of use impact but not extensive or widespread impacts	Extensive evidence of use impact; widespread use with many impacts evident

In some instances, selecting a single impact category may not be practical, and as a result, the impact level may span two categories (e.g., low-to-moderate or moderate-to-high). This broader categorization may be used when a facility has satellite areas where impact conditions vary significantly from the majority of the facility. In addition, City Light will provide the impact assessment form data to LPs in Microsoft Excel format.

The form (as adapted) used to evaluate the recreation use impact and the impact parameters (included in attachment to this study plan) has been used on other relicensing projects (Whitaker and Shelby 2001). The form may be modified based on review of existing information.

2.6.1.5 Assessment of the Usable Periods of the Gorge Lake Boat Launch Ramp

In this step, City Light will identify the usable periods of the Project's developed boat ramp at the Gorge Lake Boat Launch facility. City Light will identify the constructed top and lower end of the boat ramp to determine the functional water surface elevation (wse) vertical range of the boat ramp. The boat ramp will be considered functional from the constructed top of the boat ramp down to three feet above the lower end of the constructed ramp. City Light will then use the output from the Operations Model to compare the daily median reservoir wse for the period of record to the functional wse range of the ramp to identify the periods of the recreation season (April through October) that the boat ramp is usable. The output of this assessment will be tables and/or figures that identify the usable period for the Gorge Lake Boat Launch ramp. Notably, the usable periods and ranges for the non-Project boat launch ramps at Hozomeen and Winnebago Flats are already known and provided in City Light's PAD, though City Light will evaluate the effect of sedimentation on those ramps as part of a separate relicensing study (i.e., Sediment Deposition in Reservoirs Affecting Resource Areas of Concern study plan). The usable periods and range of the remaining non-Project boat launch ramp (i.e., Colonial Creek Boat Launch) is currently unknown due to an ongoing sedimentation issue, which City Light will also evaluate as part of that same relicensing study.

2.6.2 Identify Recreation Uses and Visitor Attitudes, Beliefs, and Preferences Within the Project Boundary

City Light will conduct observations and visitor surveys to gather information to address the study goals, objectives, and issues at each of the recreation facilities/study sites listed in Table 2.6-6. The study sites for this element of the study include Project recreation facilities as well as more limited information on non-Project recreation facilities. The non-Project recreation facility study sites for this study element are included because they provide direct access to Project reservoirs (i.e., boat launches, boat docks, and fishing piers).

Table 2.6-6. Study areas and study sites for visitor and observation surveys.

FERC Project Development	Resource Area	Land Management	Facility Type	Project or Non-Project Facility	Recreation Facility/Study Site	Study Sub-site
Ross Lake	Ross Lake	Federal (NPS)	Day use	Non-Project	Hozomeen Boat Launch	▪ Parking area ▪ Launch ramp/dock
		Federal (NPS)	Day use	Non-Project	Winnebago Flats Boat Launch	▪ Parking area ▪ Launch ramp/dock
		Federal (NPS)	Day use	Non-Project	Ross Lake Resort Dock	▪ Dock ▪ Intersection of Ross Lake Trail and Haul Road
Diablo Lake	Diablo Lake	Federal (NPS)	Day use	Project	West Ferry Landing	▪ West ferry dock ▪ Parking area
		Federal (NPS)	Day use	Non-Project	Colonial Creek Boat Launch	▪ Parking area ▪ Launch ramp/dock
		Federal (NPS)	Day use	Non-Project	Colonial Creek Fishing Pier	▪ Fishing pier
		Federal (NPS)	Day use[1]	Project	North Cascades Environmental Learning Center	▪ Parking area
-Gorge Lake	Gorge Lake	City Light	Day use	Project	Ross Lodge Picnic Shelter	▪ Picnic shelter
		City Light	Day use	Project	Gorge Lake Boat Launch	▪ Parking area ▪ Launch ramp/dock
	Newhalem	Federal (NPS)	Day use	Project	Ladder Creek Falls Trail and Gardens	▪ Parking area ▪ Trailhead/start of trail
		Federal (NPS)	Day use	Project	Trail of the Cedars	▪ Parking area ▪ Trailhead/start of trail
		City Light	Day use	Project	Gorge Powerhouse Overlook	▪ Parking area
		City Light	Day use	Project	Gorge Powerhouse Visitor Gallery	▪ Parking area
		City Light	Day use	Project	Gorge Inn Museum	▪ Museum
		City Light	Day use	Project	Newhalem Picnic Sites	▪ Picnic sites
		City Light	Day use	Project	Newhalem Parking Area (State Route 20)	▪ Parking area
		City Light	Day use	Project	Newhalem Parking Area (Main Street)	▪ Parking area
		City Light	Day use	Project	Newhalem Playground	▪ Playground

1 The North Cascades Environmental Learning Center also provides some overnight programs.

City Light will conduct the observation and visitor surveys directly at the study site's use areas where visitors are observed (i.e., parking areas, picnic areas, fishing piers, boat launch ramps, docks, shoreline access areas, etc.). City Light will generally observe the overall use patterns at each site during each survey day. City Light will also conduct visitor surveys and record observation use counts where City Light observes use in areas immediately adjacent (i.e., within approximately 200 yards) to the formal study sites if City Light is not able to correlate the use area/uses to an adjacent non-study site facility or use (i.e., neighboring trailhead, parking area, campground, residence, etc.).

Refer to the attachment to this study plan for maps of the study sites.

2.6.2.1 Observation Survey

City Light will conduct a single, point-in-time observation or use count during each visit to a study site each survey day. During observation surveys, the City Light surveyors will count and record the following date, facility, and use parameters as observed from each study site.

- Date
- Time observation started and ended
- Location/study site
- General weather conditions (sunny, partly cloudy, cloudy, rain/snow)
- Observed vehicles (single vehicle)
- Observed vehicles with trailers
- Observed trailers (no vehicle)
- Observed docked boats (as visible from the study site)
- Observed people
- Observed types of shoreline recreation activities (as visible from the study site)
- Observed types of reservoir/water-based recreation activities/watercraft (if reservoir/water views exist; as visible from the study site)
- Observed user conflicts or issues

Observations will be made and recorded by facility to include parking outside provided parking areas. This data will be used to identify the types of recreation activities visitors participate in at the Project. In addition, this data will also be used to calculate aspects of the Project recreation use estimate (Section 2.6.3 of this study plan). Once the counts are completed, the surveyor will also administer an on-site recreation visitor questionnaire survey to randomly selected recreation visitors (Section 2.6.2.2 below).

2.6.2.2 Visitor Survey

The visitor survey will collect visitor perceptions, attitudes, and satisfaction levels on current resource conditions (e.g., recreation facilities, recreation use levels, and users' feedback on lake elevations relative to their recreation experience), visitors' zip codes, user characteristics,

recreation activities, management concerns, and overall recreation experiences. Non-response bias will also be collected during visitor survey collection, whereby City Light's surveyor will collect the following information from visitors who refuse to complete the survey: reason, observed activity, gender, and age (if possible). For all survey efforts, the number of refusals will be recorded. The visitor survey at the Project recreation facilities will be administered as an on-site survey as the first option, but will also utilize a mail-back windshield survey at Project recreation facilities to meet the target number of surveys in instances where visitors are not readily available (e.g., boat launches, trailheads, docks, visitor centers).

Types of Visitor Surveys

On-Site Visitor Survey

The on-site visitor survey will be administered at all Project recreation study sites where recreation visitors are readily visible and willing to participate (e.g., picnic areas, interpretive sites, boat launches, and trailheads). When visitors are not readily visible (i.e., where vehicles are parked and visitors cannot be located), City Light will contact visitors via a mail-back windshield survey. City Light will prioritize securing on-site visitor surveys whenever possible but may need to employ mail-back windshield surveys when use patterns at study sites necessitate their use.

For the on-site survey, only members of a group who are 18 years or older will be asked to complete a survey. City Light's recreation researchers will train surveyors on random selection techniques for choosing groups at a facility and participants within groups, introduction strategies, recording, and tracking refusals. Upon completion of a survey by a respondent, the recreation researcher will review the survey for skipped or missed questions and anomalous data or responses in order to maximize the quality of the survey data and minimize anomalous data during data entry.

Mail-Back Windshield Visitor Survey

The mail-back windshield visitor survey will be administered at recreation facilities where recreation visitors are not present, but their vehicles are. City Light anticipates utilizing mail-back surveys at parking areas for the boat launches, ferry docks, visitor centers, and trailheads. In these cases, a mail-back version of the visitor survey will be left on vehicle windshields with pre-addressed envelopes and postage for convenient response and return. The survey packet of information left on the windshield will include a cover letter which explains the purpose of the survey. City Light will number each survey in order to track both on-site response and mail-back response rates.

Visitor Survey Development

The visitor survey will address the study objectives. Survey topics will address items such as visitors' perceptions of the following:

- Existing and desired recreation facilities
- Whether reservoir water levels affect visitor's recreation experience
- Satisfaction with shoreline access and opportunities
- Comparison of project recreation resource areas to other regional recreation areas that provide similar recreation opportunities

- Personal safety
- Crowding
- Conflict
- Constraints or barriers to participation that are potentially within City Light's or agencies' control (e.g., lawlessness, trail conditions, campfire use, parking access and fees)
- Ways to enhance their recreation experience

The draft of the survey instrument is attached to this study plan. The survey instrument content (i.e., questions) will be refined in consultation with LPs based on Project-related issues identified in the Study Plan Development Process. Prior to survey implementation, the survey instrument will be pre-tested in the field with recreation users, and refined for clarity, if necessary. The pre-test will include a total of 10 to 15 completed surveys, with the intent to receive feedback on readability, length, and general understanding of survey content. If necessary, minor changes to the survey instrument may be made in consultation with the LPs to make the survey easier to complete and understand. City Light will develop a Project area map to assist respondents in orienting themselves and provide an understanding of the area and facility naming conventions. City Light's recreation researchers will provide this map upon intercepting respondents and provide direction to help respondents orient themselves.

Field Reconnaissance, Logistics and Preparation

This task will involve logistical preparation including developing field work logistics and protocols; field crew training; selection of sampling dates; pre-testing field logistics and protocols; and revising schedules, logistics, or protocols based on preliminary findings.

2.6.2.3 Sampling Approach and Data Collection

Target Number of Visitor Surveys

The target number of visitor surveys on the Project recreation survey population is based on the recreation use at the Project recreation facilities as part of City Light's 2014 FERC Licensed Hydropower Development Recreation Report data collection effort. City Light is using the Form 80 recreation use data for this purpose because it provides the most up-to-date available use data for the Project recreation facilities. Overall, in 2014, the total recreation use at Project recreation facilities was 96,596 recreation days[1] (RD) and the breakdown of use by development is shown in Table 2.6-7. All of the Project recreation use was day use.

Table 2.6-7. 2014 Project recreation use summary (City Light 2015a, 2015b, 2015c).

FERC Project Development	2014 Recreation Use (RDs)
Ross Development	7,462
Diablo Development	30,866
Gorge Development	58,304
Total	96,596

[1] A Recreation Day, as defined by FERC, equals a visit to an area for recreation purposes for any portion of a 24-hour period.

Using a 95 percent confidence interval with a sampling error no more than +/-5 percent, City Light's target number of surveys for the Project recreation survey population is 383 surveys, at a minimum (Salant and Dillman 1994). Since it is not apparent how varied the Project sample population is in its response to various questions, City Light will use a more conservative sampling approach that utilizes a "50/50 split," which assumes the sample population is relatively varied (Salant and Dillman 1994).

To meet the minimum target number of surveys (i.e., 383 completed surveys) and also provide consistent data collection across all study sites or groupings of study sites, City Light selected a target of 35 completed surveys for each study site or study site grouping (Table 2.6-8). City Light will make every attempt to secure the identified target number of surveys by development. City Light will continuously monitor the survey returns to ensure survey targets are met during the established study year. For all survey study sites, City Light will continue the survey effort throughout the established study year, even if the target survey numbers have been met.

Sampling Frequency for Observation and Visitor Surveys

The sampling frequency for the observation and visitor surveys will be divided into two categories – peak and off-peak seasons. The peak season for recreation use is the summer season (July 1 through Labor Day). The off-peak season includes the shoulder seasons of spring (May and June) and fall (Tuesday after Labor Day through October). The closure of SR 20 from November through April limits visitor access to the area and associated recreation use during the winter months.

The sampling frequency for the peak season will be:

- Two randomly selected weekday days per month (separated by at least one week)
- Three randomly selected weekend days (Saturday or Sunday) per month (non-consecutive)
- Two holiday days (Saturday and Sunday) for each three-day holiday weekend (Independence Day and Labor Day holiday weekends) (four survey days total)

The sampling frequency for the off-peak season will be:

- Two randomly selected weekday days per month (separated by at least one week)
- Two randomly selected weekend days (Saturday or Sunday) per month (non-consecutive)
- One pre-selected holiday day (Saturday or Sunday) for the three-day Memorial Day holiday weekend

City Light will conduct up to two selected days of preliminary testing to clarify any problems/confusion with the survey instrument and/or process.

To identify recreation visitor's attitudes, beliefs, and preferences at Project recreation resource areas, City Light will conduct a roving use survey using a stratified two-stage (geographic and temporal) probability sampling approach (Malvestuto 1996; Pollock et al. 1994). During the survey, City Light's surveyor will conduct a recreation visitor survey at all the study sites identified in Table 2.6-6. The survey sample will be stratified by development/resource area, type of day (weekdays, non-holiday weekends, and holiday weekends), and time of day.

Table 2.6-8. Target number of visitor surveys by Project development and study site grouping.

FERC Project Development	Resource Area	Land Management	Facility Type	Project or Non-Project Facility	Study Site	Target Number of Surveys
Ross Lake	Ross Lake	Federal (NPS)	Day use	Non-Project	Hozomeen Boat Launch	35
		Federal (NPS)	Day use	Non-Project	Winnebago Flats Boat Launch	
		Federal (NPS)	Day use	Non-Project	Ross Lake Resort Dock	35
Diablo Lake	Diablo Lake	Federal (NPS)	Day use	Project	West and East Ferry Landings	35
		Federal (NPS)	Day use	Non-Project	Colonial Creek Boat Launch	35
		Federal (NPS)	Day use	Non-Project	Colonial Creek Fishing Pier	
		Federal (NPS)	Day use[1]	Project	North Cascades Environmental Learning Center (Parking area)	35
Gorge Lake	Gorge Lake	City Light	Day use	Project	Ross Lodge Picnic Shelter	35
		City Light	Day use	Project	Gorge Lake Boat Launch	35
	Newhalem	Federal (NPS)	Day use	Project	Ladder Creek Falls Trail and Gardens	35
		Federal (NPS)	Day use	Project	Trail of the Cedars	35
		City Light	Day use	Project	Gorge Powerhouse Visitor Gallery	35
		City Light	Day use	Project	Gorge Inn Museum	35
		City Light	Day use	Project	Newhalem Picnic Sites	
		City Light	Day use	Project	Newhalem Parking Area (State Route 20)	
		City Light	Day use	Project	Newhalem Parking Area (Main Street)	
		City Light	Day use	Project	Newhalem Playground	
Total	--	--	--	--	--	385

1 The North Cascades Environmental Learning Center also provides some overnight programs.

Timing of Sampling

City Light's surveyors will conduct the surveys on each survey day in a linear visitation pattern, whereby, the surveyors will start each day at the next study site on the linear visitation pattern. This approach will vary the times each study site is visited to ensure a range of visitation times and potential user groups over the course of the survey period. City Light anticipates utilizing multiple survey teams to conduct the surveys on each survey day. The final survey team/staff approach will be determined based on field testing and logistics prior to starting the surveys.

2.6.3 Estimate Current Recreation Use at Project Recreation Resource Areas

2.6.3.1 Project Recreation Facility Use and Occupancy

City Light will accomplish this study element in two parts. First, for each recreation facility listed in Table 2.6-9, City Light will calculate the average existing use levels for several recreation parameters (e.g., people, vehicles, facility occupancy rates/percent of capacity) by season (peak and off-peak) and day type (i.e., weekend, weekday, holiday) during the survey season. In addition, for each Project recreation facility or group of facilities, City Light will calculate the frequency distribution of observed recreation activities during the survey season. As part of the study report, City Light will provide a summary of the Project recreation facility occupancy at parking areas and picnic areas and the distribution of observed recreation activities at Project recreation facilities.

2.6.3.2 Project Recreation Use Estimate

To estimate the recreation use that occurs within the Project Boundary, City Light will estimate the existing annual day and overnight visits for the Project overall in RDs by developing one use estimate specific to the Project recreation facilities and a separate use estimate for the non-Project recreation facilities within the Project Boundary. This division is necessary given the differing data collection methods for the data sources (i.e., Project recreation facilities versus non-Project recreation facilities). City Light will estimate the Project recreation facilities use based on the visitor use data collected as part of this study (see Section 2.6.2 of this study plan). Further, City Light will incorporate additional visitor use data from operators of the North Cascades ELC, which provides visitor use programs and services at Project recreation facilities.

For the non-Project recreation facilities use estimate, City Light will utilize a combination of NPS overnight and day use data, third party data (e.g., Ross Lake Resort), and USFS data (as available). Where available and provided by other parties, City Light will summarize the use information from the non-Project recreation facilities within the Project Boundary.

The sources of use information that City Light will utilize for the Project and non-Project recreation facilities within the Project Boundary are described below.

For the study sites where daily or regular visitation records are not kept, City Light will use the observation and visitor survey data collected as part of Section 2.6.2 of this study plan. In these instances, City Light will multiply the average number of vehicles observed (by day type) from the observation surveys by the average group size from the visitor survey results at the respective day use facilities to develop the overall Project recreation use estimate.

Table 2.6-10 identifies the Project and non-Project recreation facilities that will comprise the overall recreation use estimate as well as the data source for the use estimate.

Table 2.6-9. Project recreation facilities where use and occupancy will be estimated based on observation surveys.

FERC Development	Resource Area	Land Management	Facility Type	Project or Non-Project Facility	Project Recreation Facility	Use Estimate	Facility Occupancy
Diablo Lake	Diablo Lake	Federal (NPS)	Day use	Project	Skagit Tour Dock	X	X (parking area)
		Federal (NPS)	Day use	Project	West Ferry Landing	X	X (parking area)
		Federal (NPS)	Day use	Project	East Ferry Landing	X	
		Federal (NPS)	Day use[1]	Project	North Cascades Environmental Learning Center	X	X (parking area)
Gorge Lake	Gorge Lake	City Light	Day use	Project	Ross Lodge Picnic Shelter	X	X (picnic site)
		City Light	Day use	Project	Gorge Lake Boat Launch	X	X (parking area)
	Newhalem	Federal (NPS)	Day use	Project	Ladder Creek Falls Trail and Gardens	X	X (parking area)
		Federal (NPS)	Day use	Project	Trail of the Cedars	X	X (parking area)
		City Light	Day use	Project	Gorge Powerhouse Overlook	X	X (parking area)
		City Light	Day use	Project	Gorge Powerhouse Visitor Gallery	X	X (parking area)
		City Light	Day use	Project	Skagit Information Center	X	
		City Light	Day use	Project	Gorge Inn Museum	X	
		City Light	Day use	Project	Newhalem Picnic Sites	X	X (picnic site)
		City Light	Day use	Project	Newhalem Parking Area (State Route 20)	X	X (parking area)
		City Light	Day use	Project	Newhalem Parking Area (Main Street)	X	X (parking area)
		City Light	Day use	Project	Newhalem Interpretive Displays	X	
		City Light	Day use	Project	Newhalem Playground	X	

1 The North Cascades Environmental Learning Center also provides some overnight programs.

Table 2.6-10. Recreation facilities where use data will be collected (as available).

FERC Project Development	Resource Area	Land Management	Facility Type	Project or Non-Project Facility	Recreation Facility	Use Data Source
Ross Lake	Ross Lake	Federal (NPS)	Overnight	Non-Project	Hozomeen and Winnebago Flats Campgrounds, Boat-in Campsites (19 sites)	NPS
		Federal (NPS)	Day use	Non-Project	Hozomeen and Winnebago Flats Boat Launches	Observation survey
		Federal (NPS)	Overnight	Non-Project	Ross Lake Resort	Ross Lake Resort
Diablo Lake	Diablo Lake	Federal (NPS)	Day use	Project	Skagit Tour Dock	City Light
		Federal (NPS)	Day use	Project	East and West Ferry Landings	City Light
		Federal (NPS)	Day use[1]	Project	North Cascades Environmental Learning Center	NCI
		Federal (NPS)	Overnight	Non-Project	Colonial Creek North and South Campgrounds	NPS
		Federal (NPS)	Overnight	Non-Project	Thunder Point, Hidden Cove, and Buster Brown Boat-in Campsites	NPS
		Federal (NPS)	Day use	Non-Project	Colonial Creek Boat Launch	Observation survey
		Federal (NPS)	Day use	Non-Project	Colonial Creek Fishing Pier	Observation survey
		Federal (NPS)	Day use	Non-Project	Diablo Lake Overlook	NPS
Gorge Lake	Gorge Lake	City Light	Day use	Project	Ross Lodge Picnic Shelter	Observation survey
		City Light	Day use	Project	Gorge Lake Boat Launch	Observation survey
		Federal (NPS)	Day use	Non-Project	Gorge Creek Overlook	NPS
		Federal (NPS)	Overnight	Non-Project	Gorge Campground	NPS
	Newhalem	Federal (NPS)	Day use	Project	Ladder Creek Falls Trail and Gardens	Observation survey
		Federal (NPS)	Day use	Project	Trail of the Cedars	Observation survey
		City Light	Day use	Project	Gorge Powerhouse Overlook	Observation survey
		City Light	Day use	Project	Gorge Powerhouse Visitor Gallery	Observation survey
		City Light	Day use	Project	Skagit Information Center	City Light
		City Light	Day use	Project	Gorge Inn Museum	Observation survey
		City Light	Day use	Project	Newhalem Picnic Sites	Observation survey
		City Light	Day use	Project	Newhalem Parking Area (State Route 20)	Observation survey
		City Light	Day use	Project	Newhalem Parking Area (Main Street)	Observation survey
		City Light	Day use	Project	Newhalem Playground	Observation survey
	Skagit/Sauk River	Federal (NFS)	Day use	Non-Project	Marblemount and Sauk River Boat Launches	Forest Service

1 The North Cascades Environmental Learning Center also provides some overnight programs.

Project Recreation Facilities

Boat Launch, Day Use Areas, and Trails

For the Project recreation facilities, City Light will utilize the observation survey data collected as part of the study (Section 2.6.2 of this study plan). City Light will rely on the average number of vehicles observed (by day type) from the observation survey results and the average group size from the visitor survey results at the respective facilities to generate use estimates.

Informational and Educational Centers and Tours

For the North Cascades ELC, Skagit Tours, Diablo Lake Ferry, and Skagit Information Center, City Light will utilize visitation records from these facilities. City Light will coordinate with the operators and staff of each facility ahead of the study season so they may be prepared to collect and provide daily visitor use data.

For the Gorge Powerhouse Visitor Gallery and Gorge Inn Museum, City Light will utilize observation survey results and/or the average group size from the visitor survey results at the respective facilities to generate use estimates.

Non-Project Recreation Facilities

Ross Lake Resort

For the Ross Lake Resort, City Light will utilize the resort's use records to estimate this use.

NPS Facilities

For NPS recreation facilities, City Light will utilize the NPS recreation use data, where available, for the campgrounds, boat-in campsites, day use areas, and boat launches within the Project Boundary at Ross Lake, Diablo Lake, and Gorge Lake, with the exception of the Hozomeen Boat Launch, Winnebago Flats Boat Launch, Colonial Creek Boat Launch, and Colonial Creek Fishing Pier, where City Light will utilize observation and visitor survey data to estimate the use.

USFS Facilities

For USFS recreation facilities, City Light will utilize the USFS recreation use data, where available, for any day use and boat launch use within the Project Boundary at Marblemount and Sauk River boat launch facilities.

2.6.4 Identify Future Use and Demand Opportunities

City Light will identify the future use and demand opportunities from three perspectives: (1) assessing the existing unmet demand; (2) assessing future recreation demand; and (3) assessing the regional recreational uniqueness and significance of the Project. Each of these perspectives is described in detail below.

2.6.4.1 Existing Unmet Demand Assessment

Existing recreation use does not always represent the total existing recreation demand because there may be constraints that limit participation. While there are many potential constraints on recreation use (e.g., lack of free time, cost, geographic distance, lack of skills or equipment), a

subset of participation constraints may be closely associated with site-specific management (e.g., limited access to lands or water, use limits or full occupancies at facilities, project operations that eliminate or diminish the quality of experiences and opportunities, or the lack of information about available recreation opportunities). To assess the general level of unmet demand for recreation opportunities within the Project Boundary, City Light will perform the three tasks described below.

Assess Statewide and Regional Unmet Recreation Demand Information

City Light will review and summarize relevant information from the 2018-2022 Recreation and Conservation Plan for Washington State (RCO 2017). City Light will review other sources of demand from the region, if readily available, including the RLNRA General Management Plan (NPS 2012) and the NPS Comprehensive Survey of the American Public (NPS 2001). The focus of this assessment will be to identify possible recreation activities with substantial unmet demand with a qualitative discussion of participation constraints and whether these constraints are likely affected by Project operations.

Collect Unmet Recreation Demand Information within the Project Boundary

City Light will collect additional unmet recreation demand information from Project visitors within the Project Boundary in City Light's visitor surveys.

Identify Potential Activities with High Unmet Demand within the Project Boundary

City Light will identify potential activities with high unmet demand within the Project Boundary based on the review of unmet demand information derived from the NPS, the Project visitor survey, Project monitoring data, and any other regional unmet demand sources (if any). Analysis will also attempt to identify likely barriers or constraints on participation, and whether those are related to Project operations.

2.6.4.2 Future Recreation Demand Assessment

This element of the study will provide information regarding the projected future recreation use within the Project Boundary over the estimated period of the new license. For this assessment, City Light will assume a license term of 50 years. Obviously, projecting the future is a speculative activity, especially over a 50-year period. These projections, though, can be useful for general planning purposes to identify potential management issues that may occur in the future. This approach will include four steps.

Review Existing Recreation Use Trends

Since past use often helps predict future use, City Light will review trends of recent Project recreation use. Likely sources of use data within the Project Boundary will be: FERC Form 80 Recreational Use Reports NCI data on ELC visitation, the RLNRA General Management Plan, NPS RLNRA use data, Washington tourism data, fishing license sales, boating vessel registrations (for the counties where the majority of Project visitors originate from), local recreation resources, and recreation equipment sales, where available.

Review Existing Population and Recreation Activity Participation Projections

City Light will summarize existing information on existing and future population rates from the State of Washington Office of Financial Management Department of Finance website

(https://www.ofm.wa.gov/washington-data-research) for the counties where the majority of the Project visitors originate from. The population growth rates will be used to project the overall Project recreation use estimate over the term of a new license period (i.e., 30 to 50 years).

City Light will also research outdoor recreation activity projections from available sources such as Outdoor Recreation Trends and Futures (Cordell 2012) and other appropriate sources on future projections (as available and applicable). These projection indices will be used to project recreation facility occupancy at Project recreation facilities (refer to Table 2.6-9) over the term of a new license period.

Review Reasonably Foreseeable Events that May Influence Future Use

Reasonably foreseeable events in the watershed may reasonably be expected to influence recreation use at the Project over the license period. If an event is determined to be reasonably foreseeable, City Light will make a qualitative assessment of its potential effect on future recreation use, if feasible.

Estimate Future Recreation Use over the License Period

Based on historical trends, future growth projections, and likely foreseeable events in the watershed, City Light will use professional judgment to estimate Project recreation use and facility utilization over the expected term of the new license. For this assessment, City Light will assume a license term of 50 years. These estimates must be considered very speculative and will only provide a general indication of how recreation use is expected to change over the license period.

For the Project recreation use estimate, City Light will project the use based on the population growth rates where the majority of Project visitors reside as identified in the visitor survey element of the study (Section 2.6.2.2 of this study plan).

For the Project recreation facility utilization projections (e.g., day use areas, boat launches, and trails), City Light will rely on the activity participation indices in Outdoor Recreation Trends and Futures (Cordell 2012) unless other applicable sources on future projections are available.

2.6.4.3 Regional Uniqueness and Significance Assessment

This component of the study will assess the regional uniqueness of the Project's primary recreation opportunities in three steps.

Review Results of Visitor Surveys

City Light will review the results of the visitor survey that address regional uniqueness and significance. In addition, City Light will identify the primary activities and opportunities of visitors surveyed to help in assessing the overall regional uniqueness in comparison to other regional recreation facilities and opportunities.

Identify Regional Recreation Opportunities

City Light will identify the geographic draw of the Project's top primary recreation opportunities identified during the review of the visitor survey results above. City Light will assess the geographic extent of visitors' origins and location of the alternative recreation resource areas

where visitors participate in their primary recreation activities. City Light will identify regional alternatives for comparable facilities or areas from sources such as guidebooks, on-line resources, state and national parks, USFS, and county or regional tourism sources.

Assess the Uniqueness and Significance of the Recreation Opportunities Within the Project Boundary

First, City Light will analyze the visitor responses to a typical survey question that asks visitors to rate the relative uniqueness of the project reservoir they visited. The question has pre-set responses using a 5-point scale with a rating of 1 meaning the reservoir provided an "extremely common" opportunity and a rating of 5 meaning the reservoir provided an "extremely unique" opportunity. Based on the average responses, City Light will categorize the relative uniqueness of the Project using six categories, as shown in Table 2.6-11.

Table 2.6-11. Regional uniqueness categories and rating system.

Regional Uniqueness Rating System and Categories					
1.0	**1.1 to 2.0**	**2.1 to 3.0**	**3.1 to 4.0**	**4.1 to 4.9**	**5.0**
Extremely Common	Common	Somewhat Common	Somewhat Unique	Unique	Extremely Unique

Second, for the Project's most popular primary recreation activities, City Light will identify if these recreation opportunities are of local, regional, or state significance. City Light will determine the level of significance based on the county (United States) where visitors reside based on the following designations.

- Local Significance: visitors from counties where the Project resides (i.e., Skagit, Whatcom, and Snohomish counties).
- Regional Significance: visitors from the counties surrounding the counties where the Project resides, including San Juan, Island, Kitsap, King, Chelan, and Okanogan counties.
- State-Wide Significance: visitors from all other areas outside of the local and regional areas in Washington.

In addition, text will describe what is unique and special about the most popular recreation opportunities based on the comments provided by the visitors on the visitor survey.

2.6.5 Data Entry and QA/QC Review of Data

Following data collection, City Light will enter the raw data into a statistical database program (e.g., IBM SPSS software) that will allow visitor survey responses to be analyzed. Survey responses will be coded, edited and entered for analysis through a separate effort (Section 2.6.6.1 of this study plan). City Light will subject all visitor and observation survey data to QA/QC procedures including, but not limited to: (1) spot-checking visitor/observation surveys to be sure errors were not made during data entry; and (2) reviewing the visitor and observation survey databases for completeness/anomalous data. City Light will conduct these QA/QC procedures both manually by City Light staff and electronically using the statistical analysis program, which has the ability to sort through large quantities of data. If any datum seems inconsistent during the

QA/QC procedure, City Light will investigate the problem by going back to the source questionnaire or data form. Values that are determined to be anomalous will be removed from the database if the reason for the values cannot be identified.

2.6.6 Data Analysis and Report Preparation

2.6.6.1 Data Analysis

The survey responses should provide a rich source of information about visitor use patterns, characteristics, preferences, and perceptions. Following data entry and comprehensive QA/QC procedures, City Light will address the study objectives and issues through analysis of the responses to questionnaires and observation data. Descriptive statistics will be employed to explain visitor responses to each of the survey questions, including number of responses and percentage of responses for each survey question as well as averages for select questions (e.g., scale-response questions, general trip characteristics, and some socio-demographic questions). Survey data will be analyzed and reported by Project resource facility or grouping of proximate similar facilities (e.g., town of Newhalem study sites). City Light will code or categorize the survey data to allow for the additional survey analyses (e.g., seasonality, primary recreation activity, type of site access). Within the analysis, City Light will check for non-response bias through demographics and visitor behavior variables. Observation use data will address the types and frequency of use occurring within each Project recreation resource area. City Light will provide the raw data to LPs in the statistical program format used (e.g., IBM SPSS software) as well as Microsoft Excel format.

2.6.6.2 Report Preparation

City Light will synthesize the data collected and analyzed into a study report at the conclusion of the study, which will include summary data in tables, attachments and/or appendices; and be further summarized in narrative form. Specifically, the report will include the following sections: (1) Study Goals and Objectives; (2) Methods; (3) Results; (4) Discussion; and (5) Description of Variances from the FERC-approved study plan, if any.

2.7 Consistency with Generally Accepted Scientific Practice

City Light's methodology for planning, implementing, and analyzing visitor surveys is consistent with professional practice (Salant and Dillman 1994; Watson et al. 2000). In addition, City Light will be implementing professionally accepted survey practices for contacting visitors and choosing sample sizes (Dillman 2000). Assessing existing recreation use through a combination of observation and questionnaire surveys is a common practice for large geographic areas that contain multiple accesses to desired recreation use areas (Malvestuto 1996; Pollock et al. 1994; Watson et al. 2000; Yuan et al. 1995). In addition, assessing future recreation demand through an evaluation of existing use, demographic data, and participation trends and projections in the region is common practice (Kelly and Warnick 1999). Furthermore, this approach has been successfully applied in other FERC relicense proceedings.

2.8 Schedule

- Survey Planning and Coordination .....December 2020 – March 2021
- Survey Field Training, Logistics, and Pre-test.....March – April 2021
- Observation and Visitor Surveys ..... April – October 2021
- Facility Inventory, Condition, Accessibility, and Use Impact Assessments ....June – July 2021
- Boat Ramp Usable Periods Assessment ..... April – October 2021
- QA/QC Review and Data Entry.....May – December 2021
- Data Analysis..... November 2021 – January 2022
- Final Report (Initial Study Report [ISR]) ..... March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $370,000.

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RECREATION USE AND FACILITY ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Nikolai Ferrell (USFS)	05/04/2020	Section 1.1 General Description of the Project	Given the study plan objectives 'Describe Project visitors' recreation use in the Project Boundary' (within goal 2 (Goal 2 Objectives (Determine the Preferences, Attitudes, and Characteristics of the Project's Recreation Users)) and 'Identify the amount, activity type, and spatial and temporal distribution of existing and desired recreation use within the Project Boundary' (within goal 3 (Goal 3 Objectives (Current Project Recreation Use and Activities)) listed on page 2-1, coupled with the lack of Forest Service recreation monitoring data comparable to that proposed in this study plan, the monitoring plan should include primary data collection at these islands within the project boundary.	Thank you for your comments. City Light assumes this comment is in reference to the Marblemount and Sauk River boat launch facilities that the Forest Service operates and maintains. While these facilities are located within the FERC Project Boundary, they are not Project recreation facilities and City Light does not operate or maintain these facilities. This study will only conduct primary data collection at Project recreation facilities.
2.	Brock Applegate (WDFW)	05/04/2020	Section 1.2 Relicensing Process	In-Text Edit: This study plan reflects the RWG consultation ~~effort,~~ and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11–5.13), and through the relicensing process generally.	Thank you for your comment. Edits to text made to better reflect the RWG and consultation process.
3.	Nikolai Ferrell (USFS)	05/04/2020	Section 1.3 Study Plan Development	18CFR 2.7 (e): [The Commission expects to assume the following responsibilities]: (e) To cooperate with local, State, and Federal Government agencies in planning, providing, operating, and maintaining facilities for recreational use of public lands administered by those agencies adjacent to the project area. In addition, the project boundary is not fixed and may be amended during relicensing or other times as there is also no regulatory	Thank you for your comment. The study is based on the current FERC Project Boundary. The study area is described in Section 2.5 of the draft study plan. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				requirement that constrains analysis or study to within the project boundary. It would useful to describe here the differnces between the study area and the area encompassed by the Project boundary.	
4.	Brock Applegate (WDFW)	05/04/2020	Section 1.3 Study Plan Development	This study will not help us manage the harvest or the fish in the fisheries, but I guess we might collects some fishing pressure information and facility information like parking and ramps, although only at some of facilities. Besides information on specific sites, I am not sure we learn much with this study for recreational fisheries.	Thank you for your comments. The purpose of this study is not to study the fishery, but rather recreational uses and resources within the FERC Project Boundary. No edits made.
5.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/16/2020	Section 1.3 Study Plan Development	The methodology of this plan should include cross-coordination with the CRWG to identify those recreation sites that are alsoe cultural resource sites (although such sites will not likely be reported in the plan to maintain confidentiality).	Thank you for your comments. A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). LPs will have an opportunity to consider effects of Project recreation, if warranted, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process. No edits made.
6.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: The goals of this study are to determine: (1) the condition, accessibility, and use impacts of the Project's recreation facilities (i.e., FERC approved recreation facilities); (2) the preferences, attitudes, and characteristics of the Project's recreation users at those facilities that FERC approved; (3) current Project recreation use and activities; and (4) future demand for Project recreation facilities and opportunities. Comment:	Thank you for your comment. The use of the word "Project" implies "FERC approved" and the purpose of this FERC study is to understand the Project's recreation uses. As such, the study area and study sites include FERC-approved recreation facilities, and, where appropriate, some non-Project (non-FERC approved) recreation facilities that provide direct access to Project reservoirs (i.e., visitor survey sites at boat launches on Ross Lake and Diablo Lake). The study plan as written provides City Light with adequate baseline recreation information for its Project (i.e., FERC approved) recreation facilities and resources. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				How do you can you get a full understanding of recreationists interests, preferences, and use when you only look at some of the facilities? Comment: How do you find the baseline, when SCL will only look at some of the facilities? Do the other facilities, not recognized as Project facilities, reside on land not owned by SCL or outside the Project boundary?	
7.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	Please see our comment regarding the study area. Expand the scope of this to include all sites within the project boundary and vicinity including NPS managed sites that are affected by on-going project operations. This includes campsites along the reservoirs, all boat ramps, trails alongside and connecting to the reservoirs, and reservoir view points like Gorge overlook and Diablo overlook. This applies to all the goals.	Thank you for your comment. The purpose of this FERC study is to understand the FERC Project recreation uses. As such, the study area and study sites include FERC-approved recreation facilities, and, where appropriate, some non-FERC approved recreation facilities that provide direct access to Project reservoirs (i.e., visitor survey sites at boat launches on Ross Lake and Diablo Lake). The non-Project NPS-managed recreation sites (i.e., boat-in campsites, trails, and reservoir view points) are not FERC Project recreation sites and were developed as part of the larger national park and national recreation area and not for the purposes of providing recreational access to FERC Project lands or waters.
8.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	WDFW agrees with this statement. SCL will learn very little about the reservoir fisheries with this study, particularly harvest. The study will only cover some facilities. SCL maintains these reservoirs, which creates fishing pressure and harvest, but refuses to look at the full recreational use in the reservoirs that	Thank you for your comments. Please see the response to Comment #7 above regarding expansion of scope. The purpose of this study is not to study the recreational fishery, but rather recreational uses, which may include anglers. As requested by LPs, City Light has removed the angling questions from the visitor survey questionnaire since they do not adequately address LPs' comments regarding fish populations. LPs still have the opportunity

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				they maintain and impact through their operations.	to submit a study request for a standalone creel survey directly to FERC or as part of their comments on City Light's proposed study plans filed with FERC. City Light also welcomes discussion with the current managers of fisheries for the development of a fisheries-related management plan.
9.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: Inventory Project recreation facilities and trails and ~~qualitatively~~ document recreational use and access impacts (e.g., erosion, user-created trails, etc.). Comment: A qualitative assessment is broad and could mean anything from a cursory, less than substantive description to a more thorough observation that delineates locations of erosion, user-created trails. The NPS recommends removing "qualitative" from the objective.	Thank you for your comments. City Light has included the suggested edit in the revised study plan.
10.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.1 Study Goals and Objectives	Waste disposal	Thank you for your comments. Edit incorporated into the revised version.
11.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	Evaluate the Colonial Creek Boat Launch, Winnebago Boat Launch, and the Hozomeen Boat Launch to determine the functional water surface elevation range of each boat ramp. Evaluate the sedimentation happening at the Colonial Creek boat launch and how this will affect access and usability in the future.	Thank you for your comments. The Sediment Deposition in Reservoirs Affecting Resources of Concern draft study plan (Fish and Aquatics Resource Work Group) proposes to evaluate sedimentation at the Colonial Creek, Winnebago Flats, and Hozomeen boat launches. The evaluation of the Colonial Creek boat launch will include its usable ranges. The usable ranges of the boat launches at Hozomeen and Winnebago Flats are already known and this information was provided in the PAD and is provided to the public on the NPS

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					website. Edits were made to the text that clarify the above as it relates to the non-Project boat launch ramps' usable range existing information.
12.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	WDFW agrees. SCL's project operations affect all of these recreational facilities. Why would you not look at the effects to recreation?	Thank you for your comments. See response to Comment #11 above.
13.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: Goal 2 Objectives (Determine the Preferences, Attitudes, and Characteristics of the Project's Facilities Recreation Users) Comment: SCL will not cover everyone recreating on the Project.	Thank you for your comments. See response to Comment #7 above. No edits made.
14.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	Please include the following additional goals/topics - what visitors value, why they choose to recreate in the area, identify issues, desired changes for the future, visitor information needs and current sources of information, visual and dark sky quality and any perceived impacts, and visitors use of adjacent sites for recreation.	Thank you for your comments. The intent of the goals and objectives section is not to state every possible topic that will be evaluated, but rather to identify the over-arching objectives. No edits made.
15.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	How about a creel survey for people fishing?	Thank you for your comment. The study's goals and objectives do not include a recreational fishery study, but rather the recreation uses at Project recreation facilities and reservoirs. City Light does not plan to conduct a standalone creel study of the project reservoirs or Skagit River. LPs still have the opportunity to submit a study request for a standalone creel survey directly to FERC or as part of their comments on City Light's

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					preliminary study plans filed with FERC. No edits made.
16.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	What if they choose a recreational facility not on the Project recreational facility list? Does SCL not record the information?	Thank you for your comment. The first question on the visitor questionnaire identifies the study site/facility that the visitor was intercepted at. The intent is for the survey administrator to fill in this question and not leave it up to the visitor being surveyed. The visitor intercept protocol will include the survey administrator explaining the intent of the survey and that much of the questionnaire is about the specific recreation facility they are intercepted at and in some instances the Project reservoir that the facility is located at. This administrator-respondent interaction will clarify the intent and minimize the possibility of the suggested site confusion. No edits made.
17.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	See comment above.	It is not clear which comment is being referenced. If related to the scope of the study sites, please see response to Comment #7 above. No edits made.
18.	Gilje Kristofer (NCI)	05/03/2020	Section 2.1 Study Goals and Objectives	How is this data being collected for the ELC?	Thank you for your comment. The ELC keeps separate visitor use records which includes basic socio-demographic information. City Light will coordinate with the ELC to get a summary of the ELC data concurrent with the study season for other study sites. No edits made.
19.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: Describe Project visitors recreation use of recreational facilities which are in the vicinity of the Project Bounday (e.g, use of trails accessed from Ross Lake).	Thank you for your suggested edit. The study is focused on FERC Project recreation facilities. The “use of trails accessed from Ross Lake” provide access to non-Project areas and recreation facilities. As such, these are not part of the FERC study. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
20.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	Incoporate impact analysis	Thank you for your comment. The use impact analysis is covered under the Goal 1 objectives and detailed in Section 2.6.1.4 of this study plan. No edits made.
21.	Brock Applegate (WDFW)	05/04/2020	Section 2.1 Study Goals and Objectives	Does this only include Project facilities or does SCL have other recreational facilities within the Project Boundary? I would think that any recreational facilities within the Project Boundary should have the label of Project Facilities.	Thank you for your comment. The identification of Project-related recreation opportunities that may have unmet demand within the Project Boundary is not explicit to Project recreation facilities. The study methods in Section 2.6.4.1 detail the various methods for identifying unmet demand. Some of the unmet demand information will come from visitor surveys at Project recreation facilities, but other sources of unmet demand information will be reviewed that are not specific to the Project recreation facilities (e.g., statewide and regional planning documents). No edits made. Regarding terminology, see response to Comment #6 for an explanation of what is a Project recreation facility.
22.	Susan Rosebrough (NPS)	04/20/2020	Section 2.1 Study Goals and Objectives	Recreation Needs assessment: synthesise needs from other study components. Explore new opportunities to meet unmet demand in highway 20 corridor including trails, camping, and ADA accessible facilities; options for meeting needs by re-designing existing facilities.	Thank you for your comments. Synthesis of the recreational needs will be part of the recreation resource effects analysis that will be developed and integrated during the preparation of the DLA, but is not part of this study. LPs will have an opportunity to consider the potential effects of recreation resources in their review of the DLA in the NEPA process. No edits made.
23.	Brock Applegate (WDFW)	05/04/2020	Section 2.2 Resource Management Goals	In-Text Edit: **2.2 Recreational Resource Management Goals**	Thank you for your comment. Section 2.2 is a standard, common section in all the FERC study plans and is intended to describe relevant agencies' resource management goals related to the resource being studied. To be consistent with the other study plans, no edits were made to the heading. However, resource agencies and other LPs are encouraged to provide resource

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					management goals specific to the proposed study as well. No edits made.
24.	Dave Pettebone (NPS)	04/22/2020	Section 2.2 Resource Management Goals	What are the "Resources" referred to in the title of section 2.2. "Resource Management Goals"? Typically, a title such as this would reference natural resource management goals but this section seems to be referencing recreation resources such as facilities. Perhaps the title needs to be clarified.	Thank you for your comment. See response to Comment #23 above.
25.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	In-Text Edit: In addition to providing information needed to characterize Project effects, this study will provide information to help LPs with responsibility for recreation and land use within and in the vicinity of the Project area to identify potential measures for consideration in a recreation management plan for the Project.	Thank you for your comment. The study states "within the Project area," which includes the vicinity of the Project. No edits made.
26.	Brock Applegate (WDFW)	05/04/2020	Section 2.2 Resource Management Goals	I would assume that SCL would include all three reservoirs.	Thank you for your comment. All three project reservoirs (Ross Lake, Diablo Lake, and Gorge Lake) are included in the Project and the study area.
27.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.2 Resource Management Goals	For example, cultural resources.	Thank you for your comment. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. LPs will have an opportunity to consider effects of Project recreation, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made.
28.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	In-Text Edit: US Forest Service (USFS) – The USFS manages recreation in the Okanogan-Wenatchee National Forest and the Mount Baker-Snoqualmie National Forest, which border the Ross Lake National Recreation Area on the east and west sidesconsistent with the	Thank you for your comments. City Light agrees with the proposed edits to this sentence. Edits made to the text to reflect this.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Wenatchee Forest Land and Resource Management Plan, the Okanogan Forest Land and Resource Management Plan, and the **Mt. Baker-Snoqualmie National Forest Land and Resources Management Plan** (USFS 1990a; USFS 1989; and USFS 1990b, respectively as amended by the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, April, 1994). Within the Project Boundary, the USFS has jurisdiction over the recreation facilities at the Marblemount Boat Launch (Skagit River) and the Sauk River Boat Launch (Sauk River).	
29.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	Clarify that these facilities were brought into the Project Boundary and describe SCL's existing obligation for O&M at both.	Thank you for your comment. The Marblemount and Sauk River boat launch facilities are within the Project Boundary, but are not Project recreation facilities. City Light does not operate or maintain these facilities. Refer to Section 4.8 of the PAD for details on any ongoing support by City Light for these facilities.
30.	Brock Applegate (WDFW)	05/04/2020	Section 2.2 Resource Management Goals	WDFW sees a good opportunity to conduct a creel survey?	Thank you for your comment. See response to Comment #15 above.
31.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.2 Resource Management Goals	Is not the Upper Skagit Indian Tribe a co-manager of fish in the project area?	Thank you for your comment. City Light revised the text to reflect that WDFW and the tribes are responsible for managing fish in the state of Washington.
32.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	As currently written, the study plan does not identify interview locations that would target Skagit River anglers. Surveying only anglers captured at interview locations that are not on	Thank you for your comments. The study plan is related to FERC Project recreation and the Skagit River downstream of the Project is not in the FERC Project Boundary. In addition,

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				the Skagit River would provide an inadequate sample for characterizing Skagit River anglers.	City Light removed the angling questions from the questionnaire (see response to comment #8 above). No edits made.
33.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	Please include detail of the visitor surveying approaches that will be implemented downstream of the Gorge Powerhouse to provide information on visitor angling behavior.	Thank you for your comment. See response to Comment #32 above. In addition, City Light removed the angling questions from the questionnaire (see response to comment #8 above).
34.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.2 Resource Management Goals	Need to explain what this means	Thank you for your comment. The highlighted text is language from the Washington State Recreation and Conservation Office's (RCO) 2018-2022 Recreation and Conservation Plan for Washington State and not City Light. No edits made.
35.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	Questions 12-17 on the draft survey do not include reference to the Skagit River, how will Skagit River fishing be separated in the survey data from fishing behavior that occurred elsewhere.	Thank you for your comment. See response to Comment #32 above. In addition, City Light removed the angling questions from the questionnaire (see response to comment #8 above).
36.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	In-Text Edit: Additionally, the Project is bordered on the east and west by National Forests and is upstream of the Skagit River Wild and Scenic River System.	Thank you – edit accepted.
37.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	To what extent do visitors to the Project use these facilities?	Thank you for your comment. These are non-Project recreation facilities associated with the North Cascades National Park and/or RLNRA. However, aspects of the study, particularly visitor surveys at Project recreation facilities, will identify where else in the area respondents visited or intend to visit during their trip/visit. Detailed information about visitors to these non-Project recreation facilities is not relevant to FERC's jurisdiction of the Skagit River Project.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
38.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.2 Resource Management Goals	Need to study the scale and scope of this project related recreation.	Thank you for your comment. See response to Comment #37 above.
39.	Jack Oelfke (NPS)	04/27/2020	Section 2.3 Background and Existing Information	although cross-country skiing and snowshoeing occur on NPS lands within the project boundary.	Thank you for your comments. City Light included the edits to this sentence as proposed in the comment. Edits made to the text to reflect this.
40.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.3 Background and Existing Information	In-Text Edit: Several NPS facilities in the RLNRA close by the end of September. Adjacent Forest Service facilities also close by November, Similarly, the road gate at the U.S.-Canada border at Hozomeen is usually closed for the winter season by November. Comment: However there is still recreational use on USFS lands during winter such as skiing, snowshoeing, backcountry, dispersed camping, etc.	Thank you for your comments. City Light agrees with the proposed edits to this sentence. Edits made to the text to reflect this.
41.	Brock Applegate (WDFW)	05/04/2020	Section 2.3 Background and Existing Information	Overall, visitation to RLNRA generally ranged from 700,000 to 900,000 visitors annually from 2010 to 2018~~89~~ with a peak visitor use of 1,088,528~~905,418~~ visitors in 2018~~96~~ (coinciding with the National Park centennial celebration across the U.S.).	Thank you for your comments. City Light agrees with the proposed edits to this sentence. Edits made to the text to reflect this.
42.	Susan Rosebrough (NPS)	04/20/2020	Section 2.3 Background and Existing Information	Add in use data from 2019.	Thank you for your comment. See response to Comment #41 above.
43.	Jack Oelfke (NPS)	04/27/2020	Section 2.3 Background and Existing Information	which was 1,088,528 visitors	Thank you for your comment. See response to Comment #41 above.

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44.	Gilje Kristofer (NCI)	05/03/2020	Section 2.3 Background and Existing Information	Does this include the ELC?	Yes, the Form 80 data for the Diablo Development includes the ELC.
45.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.3 Background and Existing Information	Please summaize the Form 80 data for recreation use in the vicinity of the Project.	Thank you for your comment. City Light edited the text to reflect only the recreational use associated with the Project recreation facilities in this section since the Project facilities are the focus of the FERC study. The use data is based on the supporting documentation for the Form 80 data collection effort in 2014. Regarding non-Project recreational use, refer to City Light's summary in the PAD (Section 4.8.2).
46.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.5 Study Area	Need to assess recreation use and impacts along the transmission line corridor and on mitigation lands. Project-related vegetation clearing and access roads along the transmission corridor allow ready access for a variety of users. Mitigation lands are sensitive resource protection areas where increased monitoring of human activity is warranted. Impacts to fish, aquatic, and terrestrial resources may be caused by improper waste disposal leading to water quality concerns, vegetation clearing on uplands and riparian areas, and off-road vehicle use including fords through fish-bearing streams. Upper Skagit Indian Tribe staff have observed such activities at various locaitons within the project boundary. The extent of these impacts must be documented with this study, or separate studies, so that a comprehensive management plan can be developed for the entire area within the project boundary.	Thank you for your comments. Management of the transmission line corridor and the mitigation lands is an ongoing focus of the current license and City Light welcomes discussion with LPs on how these areas will continue to be managed into the future. At this time, City Light is proposing no new activities for these areas; to the extent that any new activities are proposed for these areas in the future, the effects of those activities will be studied. It should also be noted that the biological, cultural, and geologic study plans will evaluate those resources in the transmission line corridor and on mitigation lands. The information from those studies will be used for the comprehensive resource effects analysis that will be developed during the preparation of the DLA. No edits made.
47.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.5 Study Area	This smaller study area is inconsistent with the objectives of goals 2 and 3 on page 2-1 relative to describing recreation within the project	Thank you for your comments. The study area encompasses the Project Boundary where Project recreation facilities and use are

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				boundary. On page 1-1 and elsewhere, the project boundary is described as larger than this study area.	prevalent. While the study sites for primary data collection (inventory, condition, accessibility, use impact, observation and visitor surveys) are focused on Project recreation facilities, the study does incorporate secondary sources of use information from non-Project recreation facilities and sites as it relates to amount and type of recreation use that occurs within the Project Boundary. No edits made.
48.	Susan Rosebrough (NPS)	04/20/2020	Section 2.5 Study Area	**Geographic Scope and Study Plan Area** The geographic scope of the proposed study will leave significant facilities and opportunities within the project boundary and area without analysis and understanding. The NPS recommends expanding the scope of the project to include the list of facilities provided in NPS Table 1 [inserted at the end of this comment/response table]. The project affects recreation activities on the reservoirs and in the river downstream. Within the Federal Energy Regulatory Commission (FERC) boundary, the project area provides public recreation opportunities including developed recreation sites, trails, dispersed sites, and recreational use of the reservoirs. Visitors are attracted to the water, the reservoirs, and existing recreation facilities surrounding the lakes. Visitor use has continually increased over the life of the existing license. Many of the recreation sites are within or partially within the FERC project boundary and/or impacted by on-going project operations. The changing lake levels from on-going operations directly impact recreation use. For example, in 2019 due to low lake levels, all campsites on Ross Lake had to be closed, which not only impacted recreation on the reservoirs,	See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. The geographic scope of this study appropriately focuses on Project recreation facilities and opportunities, primarily at Diablo Lake, Gorge Lake, and the town of Newhalem, where City Light has provided public access and recreational opportunities dating back prior to the establishment of the North Cascades National Park and RLNRA. The development of non-Project recreation facilities and the larger North Cascades National Park and RLNRA are not a result of demand for recreation related to the Project or a change in Project operations. Rather, the increased recreation demand of the non-Project NPS recreation sites and facilities is a result of the development of a much larger, broader North Cascades National Park and RLNRA that dwarf the FERC Project, exceed City Light's requirements related to the Project, and therefore do not fall within the scope of the present study.

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				but also decreased access to recreation opportunities on trails adjacent to the reservoir. The ongoing project operations extend the boating season of the river downstream by delivering more consistent flows into the summer season. SCL is also considering adding pump storage operations to the Skagit Hydroelectric Project. This change in operations has the potential to affect lake levels and recreation activities throughout the project area.	Having said that, City Light looks forward to working with NPS to identify shared management responsibilities within the Project area, including the goals of and data needed to manage each area, and developing management plans for that purpose. To the point on fluctuating water levels at Ross Lake, extreme low or high water years impact Project operations and flood control measures as well as recreational use of rivers, lakes, and reservoirs in this region of the North Cascades where the annual hydrograph is dependent on snowmelt. Low water conditions are a result of the annual hydrograph and complex watershed management protocols, not Project operations. With regard to any proposed changes to Project operations, such as pumped storage, LPs will have the opportunity to consider the effects of these changes on recreational and other resources during the preparation of the DLA if pumped storage or other changes become a part of the project proposal. No edits made.
49.	Brock Applegate (WDFW)	05/04/2020	Section 2.5 Study Area	I agree, although SCL operations affect the fisheries in the reservoirs, SCL will not analyze their effects on the fish and harvest. WDFW manages the fishery in the reservoirs, but will not have creel data for the users of the reservoir. SCL has limited their geographical area of study too narrowly.	Thank you for your comments. See response to Comment #15 above. No edits made.
50.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.5 Study Area	There are several recreational facilities downstram of the Project which are included within project boundary islands. These should	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.

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				be described here.See also comment above about defining study area and compared to the area within the Project Boundary.	
51.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.5 Study Area	As described above, this seems inappropriately limited given for example the statement that the Project serves as a "launching point for a range of recreation opportunities which extend beyond the Project Boundary." Please explain this contradiction.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.
52.	Brock Applegate (WDFW)	05/04/2020	Section 2.6 Methodology	Only assessing the recreation in the Project facilities does not describe the full amount of recreation. SCL project operations affect recreation, but yet SCL will only describe a portion of the recreation it has affect on in and outside the Project boundary, because of the narrow geographic scope. SCL needs to define their impacts on all fishing and recreation in the area from their project operations, not just those confined to the Project facilities. To do define their effects, SCL will need to have a baseline of all recreation in and around the Project Boundary and related to the reservoirs.	Thank you for your comments. The study plan as written is not limited to only Project recreation facilities, but also Project reservoirs. Primary data collection occurs at Project recreation facilities, but the data collected (observation surveys and visitor surveys) is not limited to just the recreation facilities. Regarding geographic scope, see responses to Comment #s 7, 11, 32, and 37. No edits made.
53.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities	Specify use impacts. The impacts on water quality should be emphasized here. For example, do restroom facilties leach into the water table?	Thank you for your comments. Section 2.6.1.4 and the assessment form in Attachment C to the revised study plan provide the use impact details. This study does not address water quality impacts; rather, the Water Quality Monitoring study will address any water quality issues associated with the Project. No edits made.
54.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1 Inventory and Evaluate the Existing Project	Needs to cover access and use of all lands within the project boundary. See comment above regarding importance of documenting impacts along transmission line corridor and mitigation lands.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.

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			Recreation Facilities		
55.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities	The ELC is listed on Table 2.6.1	Thank you for your comment. Table 2.6-1 lists the ELC, but only indicates that an inventory of the ELC will be conducted. The condition, use impact, and accessibility assessments are not selected for the ELC in this table. No edits made.
56.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities	Table 2.6-1. The NPS recommends the study scope be expanded to include the sites listed in NPS Table 1. For the majority of the sites, the condition and accessibility information does not have to be collected in the field but can be compiled from reports and databases from NPS. The impact analysis is needed at the majority of the sites.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.
57.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities	Table 2.6-1. Criteria of use impact should be defined. What consustes a use impact? This could become quite subjective if not defined prior to the evaluation. Is it a use impact to the natural recources? To the integretity of the facality? Both? It would be helpful to differieniate what type of use impact is being evaluated.	Thank your for the comment. The study includes a use impact field assessment form in Attachment C, which provides detailed use impact parameters that will be collected at each respective study site. No edits made.
58.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.1 Inventory and Evaluate the Existing Project Recreation Facilities	Table 2.6-1. Why is the ELC listed as day use?	Thank you for your comment. In all applicable tables, the text has been edited to reflect overnight use as well as day use. Edits made to the text to reflect this.
59.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.1 Inventory and Evaluate the Existing Project	Table 2.6-1. Does the Goodell Picnic Shelter and Boat Launch, which was built with SCL recreation	Thank you for your comment. The Goodell Picnic Shelter and Boat Launch was constructed with City Light funds under the current license, but City Light has no on-going

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			Recreation Facilities	funds under the current license, belong on this list?	management, operations, or maintenance responsibility for it, and it is therefore not a Project recreation facility. No edits made.
60.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.1 Inventory Recreation Facilities	Why incidental data collection? This could be important information that should be collected systematically.	Thank you for your comments. City Light has removed this sentence as the use impact assessment (Section 2.6.1.4) that will be conducted concurrent with the inventory will cover use impacts. Edits made to the text to reflect this.
61.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.6.1.1 Inventory Recreation Facilities	Or refuse dump locations.	Thank you for your comment. The use impact form (Attachment C of the revised study plan) includes questions related to litter and dumping at the study sites. No edits made.
62.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.1 Inventory Recreation Facilities	Vegetation clearing.	Thank you for your comment. The use impact form (Attachment C of the revised study plan) includes questions related to vegetation loss, bare ground, and clearances at the study sites. No edits made.
63.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. Many of the cells in this table need to specify objective, empirical, and observable criteria, otherwise the assessment becomes highly subjective, and not “qualitative”, as claimed in the paragraph above.	Thank you for your comments. City Light agrees and has edited Table 2.6-2 to provide clarity between the condition categories, including providing examples. Edits made to the text to reflect this.
64.	Brock Applegate (WDFW)	03/24/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. If we don’t describe the difference between good and excellent through some sort of conditions, the evaluation becomes objective. Perhaps lines newly painted equals excellent and parking lines faint and some missing equals good. I am just trying to think of an example.	Thank you for your comments. See response to Comment #63 above.
65.	Jack Oelfke (NPS)	04/27/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. I agree with Brock's concern	Thank you for your comments. See response to Comment #63 above.

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66.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.2 Facility Condition Assessment	There is a lot of room for interpretation here.	Thank you for your comments. See response to Comment #63 above.
67.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. Boat docks should include the part of the ramp that lies underwater. SCL should evaluate the entire ramp for all intended reservoir elevations.	Thank you for your comment. The condition assessment of the boat ramps will aim to assess the full length of the boat ramp surface. However, reservoir water levels may preclude City Light from observing the full extent of the ramps. No edits made.
68.	Brock Applegate (WDFW)	03/24/2020	Section 2.6.1.2 Facility Condition Assessment	I have the same comment as above.	Thank you for your comments. See response to Comment #63 above.
69.	Jack Oelfke (NPS)	04/27/2020	Section 2.6.1.2 Facility Condition Assessment	I agree with Brock's concern	Thank you for your comments. See response to Comment #63 above.
70.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. Proper functioning of waste disposal mechanisms (e.g. septic systems, leaky vaulted toilts, storm water runoff systems, and RV cleanouts) should be evaluated for their imacts to natural (particurarly aquatic) resources and water quality.	Thank you for your comments. See response to Comment #53 above.
71.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. These two categories seem very like. SCL should create a rubric to describe the differences in the conditions.	Thank you for your comments. See response to Comment #63 above.
72.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.2 Facility Condition Assessment	Table 2.6-2. It should be noted in the evaluation criteria if the restroom facilities leach waste. A strucute could appear to be in excellent condition to the user, but the septic system	Thank you for your comment. City Light understands your concern, but the Project recreation facilities do not include standalone recreation facility related restroom buildings (vault or flush). Rather, the restroom facilities

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				could be faulty and leaching into the river, for example.	associated with Project recreation facilities are located in Newhalem and these are connected to the public sanitation system, which is a separate regulatory and compliance process. As such, this issue is not relevant to the Project recreation facilities. Further, City Light is not aware of any impacts the commenter is referring to. No edits made.
73.	Brock Applegate (WDFW)	03/24/2020	Section 2.6.1.2 Facility Condition Assessment	I like the description of excellent condition.	Thank you for your comments. See response to Comment #63 above.
74.	Jack Oelfke (NPS)	04/27/2020	Section 2.6.1.2 Facility Condition Assessment	I agree with Brock's concern	Thank you for your comments. See response to Comment #63 above.
75.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.2 Facility Condition Assessment	I am fine with some leaway in rehabilitation and maintenance, but FERC may find some more specific time units with tasks more enforceable in their license. For example, SCL would draw designs to fix certain Project Facility in License Year 3 and implement fix/maintanence certain Project Facility in License Years 5. SCL would have a better idea of timing if they had more specific guidelines.	Thank you for your comments. City Light recognizes that the rehabilitation schedule will likely be more detailed. However, the intent of this study element is to get an overall view of the condition of the Project recreation facilities so as to inform the development of potential recreation measures. This study will not determine the exact year of rehabilitation. No edits made.
76.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.2 Facility Condition Assessment	SCL should strive to understand the time it will take for the task, as well, to make the information useful to write a license article.	Thank you for your comment. Comment noted.
77.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.4 Recreation Use Impact Assessment	The environmental impact of the Diablo Ferry is not addressed, and should be evaluated in in the Recration use impact assessment as it pertains to access to the reservoir system.	Thank you for your comment. It is not clear what type(s) of environmental impact the commenter is referring to and City Light is not aware of any environmental impacts related to the ferry. As it pertains to this study, the recreation use impact assessment methodology

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					in this study does not address potential environmental impacts of the Diablo Ferry.
78.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.4 Recreation Use Impact Assessment	More clear and precise to say “evidence”	Thank you for your comment. Edits made to the text to reflect this.
79.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.6.1.4 Recreation Use Impact Assessment	Poaching (illegal harvest) and misshandeling of fish and wildlife resources (i.e. illegal means for capturing fish or feeding wildlife) should be included as an imact of useage on the resources.	Thank you for your comment. The comment refers to compliance with state or federal wildlife regulations, which is beyond the scope of this study and outside the responsibility of on-the-ground study field surveyors. These issues would need to be addressed by a law enforcement entity, not City Light field surveyors. No edits made.
80.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.4 Recreation Use Impact Assessment	In those cases where cultural sites and recreational facilities co-occur, this rating will be helpful to assessing effects. This will require cross-coordination with the CRWG.	Thank you for your comment. A comprehensive resource effects analysis will be conducted during the preparation of the DLA, when LPs will have an opportunity to consider effects of recreational use of the Project, if warranted, on other resources and related to any proposed changes in Project operation in their review of the DLA in the NEPA process.
81.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.1.4 Recreation Use Impact Assessment	Table 2.6-5. It is not clear how the information collected on the form translates to these ratings. This rating system may be too broad for some purposes. Suggest creating a rating system for more specific resource impacts. For example, a rating for fish and aquatics impcats may consider water quality contamination risk, signs of illegal harvest, riparian clearing, etc.	Thank you for your comment. The rating system and categories allow general classification of the use impacts observed at each Project recreation facility (study site). The assessment provides adequate information to understand the types and amounts of use impacts occurring and has been used in other relicensings to provide this same type of information. However, City Light revised the text to state that it would provide the raw data as part of the report for review by interested LPs.

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82.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.1.4 Recreation Use Impact Assessment	Table 2.6-5. The NPS does not think this rating system is really sufficient to address true impacts. There are significant difference between types of impacts and what needs to be completed to address the impacts. Vegetation trampling is compounded year after year if it is not addressed some impacts will not /cannot be addresses or changed.	Thank your for your comment. See response to Comment #81 above.
83.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.4 Recreation Use Impact Assessment	Table 2.6-5. WDFW agrees. Please create a rubric to create a less subjective assignment of sites to categories. Please consult with the NPS on this rubric.	Thank your for your comment. See response to Comment #81 above.
84.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.1.4 Recreation Use Impact Assessment	The NPS recommends modifying the impact analysis approach to be able to obtain impact information that could be used to develop license implementation actions to address impacts and feed into the carrying capacity analysis of the recreation facilities. The NPS recommends conducting an inventory of existing recreation sites to identify current impacts to vegetation and soil; presence of ax scars or nails in trees; presence of trash and human waste; and presence of informal user-created/non-designated trails. The data collection should include the total size of the area impacted including designated and satellite sites so that it can be determined if the impacts are included in the existing site or reach beyond the intended area; on and off site vegetation cover; map of user-created trails; and campsite functionality data.	Thank you for your comment. City Light believes the stated methods for the use impact data collection in the study plan are adequate to inform City Light and LPs on potential use impact concerns at study sites. Further, the suggested methodology (Jeff Marian's Campsite sustainability protocol) is specific to campsites in a protected area or wilderness setting. The Project does not have any Project campgrounds; therefore, this protocol is not relevant to the Project. The Project provides primarily developed and hardened day-use recreation facilities, including picnic sites, parking areas, boat docks, boat ramps, and visitor information or education facilities. No edits made.

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				The methodology should follow common practices such as Jeff Marian's Campsite sustainability protocol or similar protocol.	
85.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.4 Recreation Use Impact Assessment	I agree. Please use something less subjective than mentioned in the text of this document.	Thank your for your comment. See responses to Comment #s 81 and 84 above.
86.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.1.5 Assessment of the Usable Periods of the Gorge Lake Boat Launch Ramp	SCL should make the ramp usable for boats for the average reservoir elevations during April through October.	Thank you for your comment. Comment noted.
87.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2 Identify Recreation Uses and Visitor Attitudes, Beliefs, and Preferences Within the Project Boundary	The referenced table is not included in the document.	Thank you for your comment. The reference to Table 2.6-6 is correct in the text. However, the table on the following page was incorrectly numbered and has been corrected in the revised study plan to Table 2.6-6 (Study areas and study sites for visitor and observation surveys). Edits made to the text to reflect this.
88.	Brock Applegate (WDFW)	05/04/2020	Section 2.6.2 Identify Recreation Uses and Visitor Attitudes, Beliefs, and Preferences Within the Project Boundary	SCL should include non-Project recreation facility areas and this rational for the rest of the information collection as well.	Thank you for your comment. City Light has included these select non-Project recreation facilities for the observation and visitor surveys in order to characterize the recreational uses where these facilities provide direct access to the Project reservoirs (i.e., boat launches and fishing piers). The other non-Project recreation facilities located within the Project Boundary do not meet this same criterion. Edits made to the text to clarify this distinction.
89.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2 Identify Recreation Uses and Visitor	Also, re: methods for survey—want to ensure we are using all resources at our disposal. Online and social media?	Thank you for your comment. City Light is proposing to use in-person surveys as the primary method of survey administration with mailback surveys as a secondary or backup

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			Attitudes, Beliefs, and Preferences Within the Project Boundary		method where in-person surveys are not adequate to meet the study targets. City Light has selected the above noted survey administration methods because the focus of the study's visitor use questionnaire is on Project site specific and date specific information. Online surveys often lose the connection to the specific Project study site and date since they are primarily completed after ending their trip and/or leaving the study site/reservoir, where the study is seeking the visitors' input (i.e., loss of site data control). No edits made.
90.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2 Identify Recreation Uses and Visitor Attitudes, Beliefs, and Preferences Within the Project Boundary	Need to add surrounding USFS developed and dispersed sites in order to understand full extent of project related recreation.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37. No edits made.
91.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.6.2.1 Observation Survey	Add Observation of fishing useage to this list to aid in evaluating the impacts of recreational use on the natural resources A more focused evaluation of boating traffic is needed to fully evaluate the impacts of recreational boating useage on natural resources. This would entail observing and interviewing boating activity on the reservoir rather than observations made from the shore (shore observations are very limited in scope).	Thank you for your comment. The current study methods include counts of observed people and observed types of shoreline recreation activities, which would include anglers, if observed. However, the study's goals and objectives are not to determine fishing usage, which is typically done via a creel survey (see response to Comment #15 re: creel survey). City Light is not aware of any boating issues on the Project reservoirs related to natural resource impacts. No edits made.

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92.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.2.1 Observation Survey	Observation Study description does not discuss sampling plan. o Need to know number of days of observation, number of observations per day or system for collecting observations. o Use photographic documentation? Automated counters? These would allow for post processing and provide a better documentation library. More generally speaking, it is not clear what resolutions of visitor use data are needed for this study. It seems we are rushing to put a study plan together without identifying what data are needed (e.g. seasonal data, annual data, monthly data, hourly data to describe daily use and demand). o Clearly, is not possible to capture all of these onsite locations over extensive periods of time but a goal of the study could be to develop indicator counts that have statistical relationships to site specific use levels. o These indicator counts should be tied to the existing traffic counters. Use at site specific locations can then be estimated from these models.	Thank you for your comments. City Light has made edits to Section 2.6.2.3 to make it clear that the sampling frequency detailed in this section applies to both the observation and visitor surveys. Further, Section 2.6.2.1 details City Light's observation survey methods (onsite, in-person observation counts) to be conducted concurrently with visitor surveys during each visit to a study site. City Light does not intend to use other forms of observation counts such as cameras or counters. Finally, City Light's methods are designed to provide site-specific use data, by season, day type, and hourly to characterize the types and distribution of use at the Project recreation facilities and facilities that provide direct access to Project reservoirs. The methods detailed in the study plan are consistent with the sampling plans used on many other FERC relicensings to assess recreation use. No edits were made regarding the study methods.
93.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.2.1 Observation Survey	In addition, the NPS recommends collecting the estimated compliance with self-registry systems, length of stay, and any user conflicts/issues observed.	Thank you for your comment. City Light has made edits to include observed user conflicts or issues during the observation survey and added the time the observation started and ended to capture the period of the observation. City Light did not include collecting compliance with self-registry systems as this is the responsibility of operations staff and not the

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					study field surveyors. The intent of the observation survey is for City Light's study field surveyors to observe recreational use by visitors and not to address compliance or non-compliance with onsite self-registry systems.
94.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.2.1 Observation Survey	Based on our phone call with the study team it was communicated that the observation study will consist of a single observation per day. This will not provide a large enough sample size to produce substantive results that can inform the requirements of section 1.1.1.2, Project Recreation Use Estimates. There are different sampling approaches (e.g. cluster sampling) that can be used for this type of study but they all include multiple observations per day or hour. There are other sampling approaches that can be considered and I suggest that a chosen sampling approach be detailed in this study plan.	Thank you for your comment. See response to Comment #92 above.
95.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.2.2 Visitor Survey	Data Analysis Plan. Please include a plan on how each question or group of questions will be utilized.	Thank you for your comment. Additional details on the data analysis plan is provided in Section 2.6.6.1 (Data Analysis) of the study. No edits were made.
96.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2.2 Visitor Survey	Additional information is needed on how visitors and groups will be selected to participate. For instance will the surveyor follow a systematic pattern of traveling through parking lots and contact any group they intercept? Will they contact every other (or some other number of groups)? Significant care needs to be established so particular sorts of groups that are easier to interact with (e.g., certain activity groups, certain types of users) are not over-represented in the sample. Once a group is contacted, the plan implies one	Thank you for your comments. The study plan includes details on respondent selection under the *On-Site Visitor Survey* subsection in Section 2.6.2.2. No edits made.

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				individual will be presented with the opportunity to do the survey, but that should be clarified.	
97.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2.2 Visitor Survey	Consider use of an online survey similar to what Washington Trails Association did during the Sustainable roads study on Mt Baker Snoqualmie National Forest several years ago	Thank you for your comment. See response to Comment #89 above.
98.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.2.2 Visitor Survey	The NPS recommends that the survey locations be defined per NPS Table 1. Page 2-27. Target Number of Surveys. The proposed count data is from 2014 visitor use data. Use has grown since then and NPS recommends using the most recent data to determine the survey counts. In 2019, Ross Lake National Recreation Area had 1,088,528 compared to 710,612 in 2014. A similar breakdown could be used with an increase based on the percentage of increase in use. Which sites were used to develop the count data in 2014, was it all the sites in Table 2.6.10? At a minimum, the NPS recommends that all of the sites in Table 1 be used for a count data for the surveys.	Thank you for your comments. See response to Comment #s 7, 11, 32, and 37 regarding geographic scope/study sites. The target number of surveys was determined based on the 2014 FERC Form 80 data since this is the most recent use data that provides Project recreation use estimates. City Light recognizes that the Form 80 data does also include some non-Project recreation use data, but the 2014 data is still the most recent comprehensive use data for the Project. City Light understands that the NPS has some more recent use data for non-Project NPS use areas (North Cascades National Park and RLNRA), but this data does not include Project recreation facilities (unlike the 2014 data) and this study is a FERC study, not a North Cascades National Park or RLNRA study. No edits made.
99.	Dave Pettebone (NPS)	04/22/2020	Section 2.6.2.2 Visitor Survey	I do not recommend the survey administration being proposed here that splits respondents into on-site and mailback participants. o First, there is no way to gather non-response data from the “windshield survey” respondents. There may be systematic differences between those who complete the mailback surveys and those who don’t and there will be no way to estimate this difference. Furthermore, I do not think that OMB will approve of this approach.	Thank you for your comment. City Light understands the concerns raised regarding mailback surveys. Onsite survey administration is the primary and preferred method, but City Light also recognizes there may be limitations of onsite surveys at some study sites and proposes to use mailback surveys as a backup administration method. While extensive non-response data is not possible, City Light, at a minimum, will track the number of windshield surveys administered and calculate the response

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				o Although there is a potential for a higher response rate by administering an onsite survey there are also some limitations. § First, there are questions on the survey that ask respondents to forecast some of their plans that may or may not be accurate. § A mailback survey would address this limitation although it introduces different limitations such as recall bias and potentially a lower response rate. · In other words, a trade off that must consider. § It would be beneficial if an online survey option can be developed for visitors to complete the survey. · I.e. when respondents get home after their trip they can log on and complete the survey as an option. The NPS recommends that the survey be administered via intercepting individuals so that non-response data can be collected and the surveys can be distributed randomly and that survey respondents be provided an opportunity to mailback their responses with an option to complete the survey online (i.e when respondents get home after their trip they can log on and complete the survey as an option).	rate. Finally, the use of mailback surveys (while not without drawbacks) is a common practice in FERC relicensings to supplement onsite surveys. City Light will make every reasonable attempt to intercept visitors for onsite surveys. No edits were made.
100.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2.2 Visitor Survey	Or online	Thank you for your comment. See response to Comment #89 above.
101.	Brian Lanouette (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.2.2 Visitor Survey	Are there any incentives in place to increase user participation (i.e. a lottery for people who mail-back the windshield survey). It can often be difficult to ensure voluntary participation without a motive to do so.	Thank you for your comment. City Light does not propose to include any incentives to increase user participation. City Light understands that mailback surveys have a low response rate, which is why City Light will always attempt to secure onsite surveys and not utilize mailback surveys. As detailed in the

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				User participation in the mail-back survey should be monitored and routinely analyzed to determine if the system is effective. If not, adaptive management should be employed to increase user participation.	study plan, City Light will provide a unique identification number for all mailback surveys so that the response rate may be tracked. No edits made.
102.	Brian Lanouette (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.2.2 Visitor Survey	Interactions with fish and wildlife should be included in the visitor surveys. This includes a fishing/creel survey estimate to evaluate the impacts of recreational use on the fishery resources.	Thank you for your comment. See response to Comment #15 above.
103.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2.2 Visitor Survey	In-Text Edit: Whether visiting the Project was the primary purpose of their trip, what activities do they plan to undertake, before, during and after their visit to the Project, etc.	Thank you for your suggested edit. The bulleted list of survey topics is intended to be an example of the types of questions and not be all-inclusive. No edits made.
104.	Dave Pettebone (NPS)	04/22/2020	Section 2.6.2.2 Visitor Survey	The study plan does not include any language about the NPS Information Collections Process (ICR) process which will be required to conduct this survey. If the survey only includes questions from the pool of known question we can anticipate a 4-6 month review period. If the study requires a full review process we can expect a 12+ month review.	Thank you for your comments. Comment noted.
105.	Dave Pettebone (NPS)	04/22/2020	Section 2.6.2.2 Visitor Survey	In terms of the statement "…will utilize questions from the NPS' Programmatic Clearance for NPS-Sponsored Public Surveys Pool of Known Questions (NPS 2015), where possible.", be aware that including questions on the survey that are not on the NPS pool of known questions will trigger the full OMB review that can take over 12 months to complete. Similarly, pre tests without OMB approval can only include 9 or less participants.	Thank you for your comments. Comment noted.

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106.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.2.3 Sampling Approach and Data Collection	See comment above about summarizing the data reported on the Form 80 reports for sites located outside of the Project Boundary.	Thank you for your comments. See response to Comment #45 above.
107.	Brian Lanouette (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.2.3 Sampling Approach and Data Collection	During survey target evaluation, will effort be increased if it is determined targets are not met?	Thank you for your comment. As stated in Section 2.6.2.3, "City Light will continuously monitor the survey returns to ensure survey targets are met during the established study year." No edits made.
108.	Dave Pettebone (NPS)	04/22/2020	Section 2.6.2.3 Sampling Approach and Data Collection	Table 2.6-8. Having reviewed the survey I believe the sample sizes will be too small to provide substantive answers some of the questions. Similar to the observation study, section 1.1.1.2 requires that data from this component of the study be used to generalize and develop estimates for specific locations in the study. The description of the visitor survey component will not provide enough data to develop site specific generalizations. If we only have enough data to roll up to the global level, results will be diluted by experiences of people at the different types of facilities where surveys will be distributed (i.e. boat launch ramps, visitor gallery, museum, picnic areas, etc.) As such I would recommend a minimum sample size of 35 completed surveys at each of the Recreation Facility/Study Site for a total sample size of ~600 completed surveys.	Thank you for your comment. City Light has revised the target survey approach to 35 completed surveys per study site or groupings of study sites, where facilities are neighboring and similar (i.e., Hozomeen/Winnebago Flats boat launches; Colonial Creek Boat Launch and Fishing Pier; and the cluster of Newhalem town study sites). Edits were made to reflect this change in approach.
109.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.2.3 Sampling Approach and Data Collection	Separate sampling frequency will need to be developed for assessing use and impacts along transmission line corridor and mitigation lands. These areas will not follow the same seasonal use restrictions as the areas around the reservoirs.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.

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110.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.2.3 Sampling Approach and Data Collection	NPS generally supports the timing proposed. However we recommend that the use of the river be counted during the winter months because this project affected use is year-around.	Thank you for your comment. See response to Comment #32 above.
111.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.2.3 Sampling Approach and Data Collection	The ELC is open and can be full during the winter.	Thank you for your comment. City Light will coordinate with the ELC to get visitor use data collected by the ELC as part of their program, as outlined in Section 2.6.3.2 in the study plan. No edits made.
112.	Brian Lanouette (Upper Skagit Indian Tribe)	04/15/2020	Section 2.6.2.3 Sampling Approach and Data Collection	Is this off peak-season for all recreation activities? What about hunting and fishing? Although a majority of the area is in NPS, some are in USFS. With that, hunting and fishing opportunities often peak in the fall, with some fishing opportunities peaking in the spring. How will the sporting usage be factored into this sampling frequency?	Thank you for the comments. Of note, hunting is not permitted within ¼-mile of any developed site within the RLNRA, which would effectively eliminate hunting as a use within the Project. Nonetheless, the study plan proposed by City Light is for the FERC Project recreation facilities and reservoirs and includes the spring (May-June) and fall (Sept-Oct) shoulder seasons. Thus, the current methodology would potentially intercept hunters or anglers at the Project recreation facility study sites during the off-peak season. No edits were made.
113.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.2.3 Sampling Approach and Data Collection	**Other Survey Methods and Focus Groups** • Based on the results from the surveys and remaining questions, conduct focus group workshops with various user groups and communities to get additional feedback on specific issues, potential barriers to use, and potential management actions to address these issues. • Conduct a potential user survey to understand what the barriers to visitation are to the project area. This survey will help us better understand why different communities aren't visiting; or conversely, what recreational facilities would be needed to encourage them to visit?	Thank you for the comments. City Light does not propose to utilize focus groups as a means of visitor use data collection. Rather, City Light will rely on the study site visitor surveys to provide direct feedback on the Project recreation facilities and resources. Also, a user or market-type survey for a user populations outside the FERC Project Boundary goes beyond the needs for this study and City Light's responsibilities as a licensee. No edits made.

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114.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.3.1 Project Recreation Facility Use and Occupancy	• The NPS recommends that the scope of this study component be expanded per NPS Table 1. • Establish whether existing recreation use levels are below, approaching, at, or exceeding the area's ability to adequately accommodate recreational use without adversely impacting the facilities, ecological, social, or managerial capacity of the area, including the reservoir surfaces, the Skagit River, developed recreation sites, and dispersed use areas. The assessment should incorporate information from the impact analysis. • Use the results of the recreation carrying capacity analysis to help define potential capacity indicators and standards/guidelines and determine whether management actions may be needed to maintain use levels at or below established standards/guidelines.	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. The observation survey methods proposed by City Light are adequate to address the existing physical capacity of Project recreation facilities, and potential social or managerial concerns will be identified through visitor surveys and condition/accessibility/use impact assessments. Further, these study methods are consistent with other FERC relicensing recreation use studies. No edits made.
115.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.1 Project Recreation Facility Use and Occupancy	It is not possible to assess the adequacy of this approach without an estimate of the number of expected observations by the strata listed here (e.g., day type and time of day) by facility listed in Table 2.6-9.	Thank you for your comments. City Light has made edits to Section 2.6.2.3 to make it clear that the sampling frequency detailed in this section applies to both the observation and visitor surveys. Further, Section 2.6.2.1 details City Light's observation survey methods (onsite, in-person observation counts) to be conducted concurrently with visitor surveys during each visit to a study site.
116.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.1 Project Recreation Facility Use and Occupancy	Given the small sample size likely to result for each facility in Table 2.6-9 from the sampling frequency identified above on this page, the resulting variances on the observed counts within these strata would likely be very high and yield a confidence interval that would effectively make the visit estimates for the individual facilities statistically meaningless	Thank your for your comments. The methods detailed in the study plan are consistent with the sampling plans used in other FERC relicensings to assess recreation use and are adequate to characterize the use at the FERC Project. No edits made.

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				because one would be unable to identify statistically-significant differences in use estimates between many of the facilities listed in Table 2.6-9. That is, the point use estimates may appear different, but the interval estimates of use for each facility would be so wide, that one will be unable to statistically say that use differs across individual recreation facilities listed in Table 2.6-9.	
117.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.1 Project Recreation Facility Use and Occupancy	How will the time of day of observations be incorporated in development of this observed recreation activity distribution given that time of day can reasonably be expected in influence recreation activity.	Thank you for your comment. As stated in Section 2.6.3.1, City Light will calculate and report the average existing use levels for several recreation parameters (e.g., people, vehicles, facility occupancy) by day type (i.e., weekend, weekday, holiday), and by time of day (i.e., morning, afternoon) during the survey season. No edits made.
118.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.3.1 Project Recreation Facility Use and Occupancy	Table 2.6-9. Why is the ELC listed as day use?	Thank you for your comment. In all applicable tables, the text has been edited to reflect overnight use as well as day use. Edits made to the text to reflect this.
119.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	What is the process for ensuring that overnight use counts provided by another source (e.g., NPS campground counts) are not double counted in daytime use during the daytime observation counts (e.g., a camper parking their vehicle at a boat launch during the day) when the use estimate is combined upwards across facilities? That is, a Winnebago Flats campground users that also uses the Winnebago Flats boat ramp represents only one visit to the Ross Lake Resource Area.	Thank you for your comment. Since the study's observation counts use a different methodology than the other, non-Project recreation facility use data, there will be the possibility of double-counting. As such, the Project recreation use estimate, as detailed in Section 2.6.3.2, will provide a distinct use estimate for the Project recreation facilities as well as a separate non-Project recreation use estimate. Ultimately, these are estimates based on a variety of data sources and an explanation of these issues and discrepancies will accompany the reported Project and non-Project use estimates. Edits were made in the text to clarify the development

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					of Project and non-Project recreation use estimates given the inconsistent data collection between the two areas.
120.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	For example, Ross Lake Resort As stated elsewhere surveys could be distributed here at this facility which clearly is linked to a project feature (Ross Lake). An explanation of why surveys will not be conducted at such sites should be provided.	Thank you for your comment. The Ross Lake Resort is a non-Project facility and City Light did not propose the Ross Lake Resort as a visitor survey study site since visitor's who may use the resort would be intercepted at the ferry study sites and the Ross Lake Resort dock. These study sites are the primary means of visitors accessing Ross Lake and potentially the Ross Lake Resort from this side of the reservoir. No edits made.
121.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.3.2 Project Recreation Use Estimate	This section specifies the necessity of this study to bolster the sample size for the visitor survey and observation study. If the project recreation use estimate for each site are being derived for each Project Recreation Facility listed in table 2.6-9 then we will need to be able to develop reliable and representative estimates at each of these 17 sites from the visitor survey and use observation study. As currently described in this study plan the data derived from this study will not achieve the needs specifed here.	Thank you for the comments. City Light has made edits to the text in Section 2.6.3.2 to make it clear that the intent is to develop a use estimate for the Project overall and not each site. Data from each site will be utilized to calculate the overall use estimate, but use will not be reported out by individual site.
122.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	How will these facility-level use estimates be assessed to determine their statistical reliability? Is there a target size of the confidence interval around the point estimates of recreation use at individual facilities?	Thank you for your comments. See response to Comment #121 above.
123.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	Section 2.6.3.1 states that observed use levels will be estimated by "time of day (i.e., morning, afternoon)" among others. That stratification is not reflected here, how will it be incorporated?	Thank you for your comments. See response to Comment #121 above.
124.	Susan Rosebrough	04/20/2020	Section 2.6.3.2 Project	. The NPS recommends expanding the scope of the study to include the sites listed in NPS Table	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding

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	(NPS)		Recreation Use Estimate	1. The NPS recommends that estimating the current use include the following steps: • Summarize existing data. Analyze existing data on visitor use including backcountry overnight use, Ross Lake Resort use, case incident information/search and rescue, visitor contacts (front and backcountry), Environmental Learning Center use, developed campground use, commercial use, special permit use, hunting harvest numbers, trail counts, creel survey, 2007 visitor use study, the Ross Lake General Management Plan, and USFS data. • Collect visitor use data on day-use including trails, public river use, and other day-use areas. While overnight use is well captured in existing data collection methods, day-use remains unknown. • Collect data through visitor observations and counts, trail counters, and self-registry. • Collect data on the river use only through the winter as this is a year-around use affected by the project.	geographic scope of the study. This study is focused on the FERC Project recreation use within the Project Boundary and not recreation use in areas outside the Project Boundary, such as the North Cascades National Park and surrounding areas. No edits made.
125.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.3.2 Project Recreation Use Estimate	Table 2.6-10. NPS does not have use data on this site.	Thank you for your comment. Comment noted.
126.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	Table 2.6-10. The Forest Service National Visitor Use Monitoring Program does not generate a use estimate for this site. To be incorporated in this analysis, use would need to be estimated at this site as part of the study plan.	Thank you for your comment. The study plan methods do not include collection of visitor use data at non-Project recreation facilities. No edits made.
127.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.3.2 Project	Larger sample sizes will need to be collected.	Thank you for your comment. The study methodology and survey targets are consistent with other FERC relicensing proceedings. City

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			Recreation Use Estimate		Light's methodology for planning, implementing, and analyzing visitor surveys is consistent with professional practice (Salant and Dillman 1994; Watson et al. 2000) and professionally accepted survey practices for contacting visitors and choosing sample sizes (Dillman 2000). Assessing existing recreation use through a combination of observation and questionnaire surveys is a common practice for large geographic areas that contain multiple accesses to desired recreation use areas (Malvestuto 1996; Pollock et al. 1994; Watson et al. 2000; Yuan et al. 1995). No edits made.
128.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	For all of these, see comments above as to making user profile surveys available at these sites.	Thank you for your comment. Visitors using the informational and educational centers and tours will be captured at adjacent study sites where visitors to these facilities must park or congregate before visiting the facilities. For example, Skagit Tours and ELC visitors will be intercepted at the ELC parking area study site; Skagit Information Center visitors will be intercepted at the Newhalem Main Street Parking Area study site; and Diablo Lake Ferry visitors will be intercepted at the West Ferry Landing study site (i.e., parking area and/or dock). No edits made.
129.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.3.2 Project Recreation Use Estimate	Confirm we are collecting the right data during the study period.	Thank you for your comment. City Light will coordinate with the ELC to assure NCI is collecting the appropriate data per the study. No edits made.
130.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.3.2 Project Recreation Use Estimate	Larger sample sizes will need to be collected.	Thank you for your comments. See response to Comment #127 above.

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131.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.3.2 Project Recreation Use Estimate	Larger sample sizes will need to be collected.	Thank you for your comments. See response to Comment #127 above.
132.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.3.2 Project Recreation Use Estimate	This will not be a useful way to incorporate Forest Service recreation use because the Forest Service does not have such data. Some other approach much be used to have this use represented in the study. One option is to have this site included following the approach used at other study sites. An alternative is to install a traffic counter at Forest Service sites to more correctly account for recreation at these sites. If that approach is adopted, some on-site observation will be necessary to parameterize the traffic counts to isolate river recreation traffic.	Thank you for your comments. City Light does not intend to conduct observation surveys at non-Project recreation facilities. No edits made.
133.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	Which survey questions will be used to collect unmet recreation demand? Review the Ross Lake General Management Plan for unmet demand information in addition to the other sources. Consider the changing demographics in the communities that the project is drawing from and what changes to the facilities may be needed due to cultural changes and consider other potential barriers to visitor use that could be address in license implementation.	Thank you for your comments. Question 20 on the questionnaire is the primary source of unmet demand data. However, other questions related to activity participation may also provide information related to unmet demand. City Light has edited the text in Section 2.6.4.1 to include review of the RLNRA General Management Plan. Regarding addressing changing demographics, City Light's proposed recreation measures for the term of the new license will take into account projections of future need, which will be based in part on demographic projections. These measures will be included in the DLA and FERC's NEPA documents where LPs will have an opportunity to review the basis for proposed recreation resource measures.

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134.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	Contains ONLY LIMITED INFO ON Forest Service sites and landscapes	Thank you for your comment. Comment noted.
135.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	What about meeting some of this demand with new project facilities and/or contributions to FS and NPS to do so?	Thank you for your comment. The study report will help City Light and LPs evaluate potential PMEs.
136.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	As noted above, delination of the study area to within the Project Boundary is inappropriate. For example, what about unmet recreation demand that exists for users who use the project as a launch pad for recreation into trails tributary to Ross Lake for example which could extend onto the OKA-WEN and MBS.	See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. Recreation uses and opportunities outside the Project are not Project related recreation and beyond the scope of this FERC Project study.
137.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	I suggest a more detailed description about the questons and approach this will be addressed. I don't see questions on the visitor survey, as currently proposed in the attachment C, that would substantively answer this question.	Thank you for your comment. See response to Comment #133 above. City Light is open to adding or replacing questions to better address unmet demand on the questionnaire.
138.	Dave Pettebone (NPS)	04/23/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	It seems that survey results about activities that respondents identify can be crosswalked with esimtated use data at particular types of facilities and locations along with the infratrsucture assessment to undertand how many visitors are able to participate in various activities within the park/study area.	Thank you for your comment. The study report and the comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA would potentially provide this information. LPs will have an opportunity to consider effects of recreation resources in their review of the DLA in the NEPA process. In addition, per Section 2.6.6.1 of the study plan, City Light will provide the raw visitor and observation survey data to LPs in the statistical program format used (e.g., IBM SPSS software) as well as Microsoft Excel format, which will allow LPs to further analyze the data. No edits made.

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139.	Gilje Kristofer (NCI)	05/03/2020	Section 2.6.4.1 Existing Unmet Demand Assessment	Incclude NCI data on ELC visitation. NCI has substantial data going back to 2005 for ELC and further back for Newhalem Mountain School.	Thank you for your comment. City Light edited the text to include this data source as part of the "Review of Existing Recreation Use Trends" subsection. Edits made to the text to reflect this.
140.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	There should be discussion of how future demand within the project area could affect use (and demand) outside of the project area.	Thank you for your comment. The future recreation demand assessment, as with the study overall, will focus on the FERC Project. Further, the future demand assessment will project Project recreation use levels and primary activities and how they may change over the term of a new license. No edits made.
141.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	A robust discussion of changing recreation trends and predicted trends, demand, needs to be incorporated.	Thank you for your comment. See response to Comment #140 above.
142.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Please add a review of the Ross Lake National Recreation Area General Management Plan, tourism information from Washington, and the Comprehensive Survey of the American Public to this list as this plan identifies some needs and expected trends.	Thank you for your comment. City Light edited the text accordingly to include these sources for review during the unmet demand assessment and/or the review of existing recreation use trends subsections. Edits made in the text to reflect this.
143.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Research and identify alternative ways and adaptive management approaches to address recreation needs over 40-50 years.	Thank you for your comment. The comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA would potentially provide this information. LPs will have an opportunity to consider recreation needs and proposed measures to address identified needs in their review of the DLA in the NEPA process. No edits made.
144.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Conduct a site analysis and alternative locations for the Colonial Creek campground, boat launch, and day-use area. This site is changing due to sedimentation of the reservoir and the boat launch is unusable by motorboats certain	Thank you for your comment. Studying the sedimentation issue at Colonial Creek Boat Launch is included in the Sediment Deposition in Reservoirs Affecting Resource Areas of Concern draft study plan. A comprehensive

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				times of the year. This trend is expected to worsen over the course of the next license. Conduct a site analysis to determine potential solutions to address this issue and explore alternative locations to provide similar amenities to the public.	resource effects analysis will be developed and integrated during the preparation of the DLA when LPs will have an opportunity to consider effects of sedimentation or other phenomena on recreation resources, if warranted, in their review of the DLA in the NEPA process. No edits made.
145.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Include recently completed Washinton Trails Association study of the ecomonic impact OF TRAILED RECREATION IN THE STATE	Thank you for your comment. City Light will review the study for relevance to the study plan methods. No edits made.
146.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	How will this information be used to predict future use and what does it mean practically?	Thank you for your comment. Existing recreation use trend data will merely provide insight into the current recreation use trends in the state/region to help City Light and LPs better understand what the future may look like. City Light will include population growth rates to project the overall Project recreation use estimate over the term of a new license period (i.e., 30 to 50 years). City Light will include outdoor recreation activity participation growth rates (Cordell 2012) and other appropriate sources on future projections, if available, to forecast Project recreation facility occupancy over the term of a new license period. Edits were made to the text to reflect the above clarifications.
147.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Include annual OIA reports on recreation trends	Thank you for your comment. City Light will likely utilize the Cordell 2012 outdoor recreation activity participation rate data as it is more relevant to projecting future use by specific types of activities that correlate to the Project. The OIA reports do not have this same specificity and relevance to the study methods. No edits made.

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148.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.2 Future Recreation Demand Assessment	Here, above and below, this information will be useful if it establishes adaptive management provisions in the new project license.	Thank you for your comment. See response to Comment #143 above.
149.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	As noted, these estimates will be very speculative. A more useful approach might development of a monitoring strategy that will be conducted over the course of the license and feed into an adaptive management framework.	Thank you for your comment. See response to Comment #143 above.
150.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	How will this be used to inform the Recreation Plan SCL will provide in its License Application?	Thank you for your comment. The regional uniqueness is simply another data point for consideration. If something is unique to the Project or the area, then it may require consideration for future recreation decision making. But, until the data is collected and analyzed, it is unclear exactly what the data will show and how it will be used for future recreation decision making. No edits made.
151.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	How will this be used to inform the Recreation Plan SCL will provide in its License Application?	Thank you for your comment. See response to Comment #150 above. This data helps inform the regional uniqueness of the Project or the Project's recreation resources. No edits made.
152.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	Account for predicted changes to resources over the course of the license term. For example, if the the fisheries reservoir studies indicate changing trends in fish populations, how might this change fishing opportunities and the uniqueness or significance.	Thank you for your comment. If a reasonably foreseeable future event is known and quantifiable, then such an assessment could be made speculatively. No edits made.
153.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	Again, this is good information, how will it be used to inform the Recreation Plan for the Projecct?	Thank you for your comment. See response to Comment #150 above.

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154.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	In-Text Edit: Recreation Needs Analysis Comment: **Recreation Needs Assessment** The NPS recommends that a recreation needs study component be developed to look at new or improved opportunities for recreation in the project area and identify management strategies to address visitor use for the Recreation Management Plan to be submitted as part of the license application. The study would: • Synthesize recreation needs from the recreation resource and visitor use study components and existing plans including the Ross Lake GMP. • Explore new potential opportunities: The GMP identified the Highway 20 corridor along the project area as a potential area for new trails and camping. This study will look at potential opportunities to expand camping and trails in the highway 20 corridor including ADA accessible facilities. • Identify opportunities to identify cultural needs from various changing demographics in the communities that the project draws from (i.e. this could include need for facilities for larger family gatherings).	Thank you for your comment. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA when LPs will have an opportunity to consider recreation needs and proposed measures to address identified needs in their review of the DLA in the NEPA process. No edits made.
155.	Susan Rosebrough (NPS)	04/20/2020	Section 2.6.4.3 Regional Uniqueness and Significance Assessment	Recreation Plan Develop and Considering Conceptual Designs for New and Expanded Recreation Sites: Several sites in the project area are known to be at or approaching carrying capacity or need improvements or re-designs. Other studies and outreach have identified the need for these improvements. This study element will build on the existing information	Thank you for your comment. See response to Comment #154 above. However, the recreation resource effects analysis will be focused on the FERC Project study sites.

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				and develop design options to address these needs as well as determine any potential impacts to natural and cultural resources. The study should evaluate the following areas: Hozomeen, Ross Lake parking, Sustainable trail from Ross Lake trailhead to the dam, Sourdough and Stetattle trailheads, Gorge Lake campground and day-use area, Visitor facilities in Newhalem (i.e. shower facilities), Goodell Put-in, Portage Site, Copper Creek Take-out.	
156.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.5 Data Entry and QA/QC Review of Data	What happens if the error (anomalous data) rate is high?	Thank you for your comment. The study outlines QA/QC procedures in Section 2.6.6 during data entry. In addition, City Light has edited the text in Section 2.6.2.2 (Visitor Survey) to include QA/QC measures by the recreation researcher upon completion of a survey by a respondent onsite. Specifically, the recreation researcher will review the survey for skipped questions and anomalous data or responses in order to maximize the quality of the survey data and minimize anomalous data during data entry. Edits were made to the text.
157.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.6.1 Data Analysis	This "user profile" information data is very important. See comments about broadening the survey outreach beyond "on site" (e.g., Parking lots) above.	Thank you for your comments. See response to Comment #89 above.
158.	Dave Pettebone (NPS)	04/29/2020	Section 2.6.6.1 Data Analysis	I suggest reporting results at a higher resolution based on the data being analyzed in section 1.1.1.2 It seems useful to see these estimates at this resolution since they are important to other results being investigated in this study. It appears that the researchers are going to code the data that will allow them to perform these analyses so reporting these results will not require much additional effort.	Thank you for your comment. City Light has edited the text to provide higher resolution of reporting by site or select groupings of sites (e.g., town of Newhalem sites). Edits made in the text.

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159.	Brian Lanouette (Upper Skagit Indian Tribe)	04/16/2020	Section 2.6.6.1 Data Analysis	Details on the descriptive statistics and rational for model selection are needed.	Thank you for your comment. City Light edited the text in Section 2.6.1 to include more detail on the descriptive statistics that will be used, which is consistent with other FERC relicensing proceedings where recreation visitor survey results are reported. Edits were made to the text.
160.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.6.6.1 Data Analysis	This is inconsistent with statements in 2.6.2 and elsewhere that results will be reported at the facility level.	Thank you for your comments. See response to Comment #158 above.
161.	Dave Pettebone (NPS)	04/29/2020	Section 2.6.6.1 Data Analysis	Non-response bias may be confounded by the mixed survey distribution (i.e. windshield survey).	Thank you for your comment. Comment noted. City Light recognizes this is a limitation of the study design, but City Light considers these acceptable methods to meet the goals and objectives of the study, and these methods have been successfully applied in other FERC relicensing proceedings.
162.	Dave Pettebone (NPS)	04/29/2020	Section 2.6.6.1 Data Analysis	The sample size to produce these desired results will ned to be larger to produce reliable results. ne observation per day will not provide enough resolution to say anything meaningful about types and frequencies of use occuring within each Project recreation resource area.	Thank you for your comments. City Light considers these acceptable methods to meet the goals and objectives of the study, and these methods have been successfully applied in other FERC relicensing proceedings.
163.	Dave Pettebone (NPS)	04/29/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	The Dillman approach does not include windshield surveys.	Thank you for your comment. Comment noted.
164.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	Who will implement this methodology? What are the professional qualifications required to collect interview data in order to inssure analyses will meet acceptable scientific standards?	City Light's field team will implement the study methodology. The field team will be trained by qualified researchers with experience implementing these types of studies using similar methodologies and in numerous other FERC relicensing proceedings.

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165.	Susan Rosebrough (NPS)	04/20/2020	Section 2.8 Schedule	Include OMB approval process	Thank you for your comment. City Light believes only FERC approval, not OMB approval, is needed for City Light to implement this FERC recreation study and visitor use questionnaire within the FERC Project boundary and for the purposes of informing the relicensing process. No edits made.
166.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.8 Schedule	As of 05/04/2020 Federal and State public lands are closed in WA due to COVID-19. This global pandemic may have lingering effects on recreation use. This should be considered when deciding survey timing, techniques, and analysis.	Thank you for your comment. Comment noted.
167.	Nikolai Ferrell (USFS)	05/04/2020	Section 2.8 Schedule	Flagging a typo here—"begin"	Thank you for your comment. Comment noted.
168.	Brock Applegate (WDFW)	05/04/2020	Section 2.8 Schedule	In-Text Edit: 2021	Edit accepted.
169.	Brock Applegate (WDFW)	05/04/2020	Section 2.8 Schedule	In-Text Edit: Initial Study ~~Final~~ Report (ISR)	Thank you for the edit. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have information from the studies available as soon as possible to inform development of management plans.
170.	Brock Applegate (WDFW)	05/04/2020	Section 2.8 Schedule	In-Text Edit: □ ISR Meeting □ Request for study plan modification (If needed) □ Observation and Visitor Surveys (if needed) April – October 2022 □ Facility Inventory, Condition, Accessibility, and Use Impact Assessments (if needed) June – July 2022	Thank you for your comments. See response to Comment #169 above.

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				Boat Ramp Usable Periods Assessment (if needed) April – October 2022 QA/QC Review and Data Entry (if needed) May – December 2022 Data Analysis (if needed) November 2022–January 2023 Final Report (if needed) March 2023	
171.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Attachment B	In the 3rd map down, the "Goodell Creek Boat Access Site" should read "Goodell Picnic Shelter and Boat Launch"	Thank you for your comments. The name "Goodell Creek Boat Access Site" is consistent with the name in the PAD and in the current license settlement agreement. No edits made.
172.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/17/2020	Attachment B	In the same map, note for accuracy that there is NO creek as shown, that runs west of Newhalem Cr. through NPS' Newhalem Cmpgrd. and that enters the Skagit across from Goodell launch and picnic shelter.	Thank you for your comments. City Light will work with the GIS team to try to remove that unmarked creek in future maps.
173.	Brock Applegate (WDFW)	05/04/2020	Attachment C	Please include the reservoir elevations that boaters can use the ramp. Inspect bottom end of ramp at low pool.	Thank you for your comments. The usable boat ramp elevations will be addressed in Section 2.6.1.5 and not part of the field inventory and condition assessment. Regarding inspecting the bottom end of the ramp at low pool, see response to Comment #67 above.
174.	Brock Applegate (WDFW)	05/04/2020	Attachment C	How about trail condition?	Thank you for your comment. City Light edited the form to include condition of the trail.
175.	Brian Lanouette (Upper Skagit Indian Tribe)	04/17/2020	Attachment C	Fish and wildlife interactions need to be added to this list. An active creel survey would accomplish this (separate from the volunteer form listed in Appendix C) and should be required due to the project's ongoing impacts to reservoir fisheries. Existence and ongoing maintenance of project roads, trails, and boat ramps facilitates access to the reservoirs, thereby impacting fishing pressure. Ongoing reservoir operations and mitigation programs	Thank you for your comment. Regarding the creel survey, see response to Comment #15 above. Regarding the restroom solid waste disposal, see response to Comment #72 above. Regarding boating pressure, such an analysis is beyond the scope of this land-based use impact assessment form. City Light edited the impact form to include presence of campsites out of designated areas and evidence of illegal fish and wildlife harvest.

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				for resident fish above Gorge impact angling opportunity and user experience. Also, add the status of refuse/solid waste disposal for restroom faculties (see previous in-text comments). The presence of campsites out of designated areas needs to be added to use impact evaluation. Record signs of illegal fish and wildlife harvest. Boating pressure needs to be added to this impact form. Include size of boat and motor, to assess potential for boat wake to erode reservoir shorelines.	
176.	Susan Rosebrough (NPS)	04/20/2020	Attachment C	1. The document talked about recording damage to vegetation from things like hatchet marks etc and this form only addresses cutting down trees. 2. Cutting trees - How are you going to determine the difference between what was cut by NPS or SCL for maintenance/site clearing vs visitors?	Thank you for your comments. City Light edited the form to expand tree damage beyond just cutting down trees. Based on site conditions, City Light's recreation researchers will need to make a determination in the field about whether the tree cutting appears to be maintenance related versus visitor related.
177.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Attachment C	Number of trees over 6" DBH felled.	Thank you for your comments. City Light edited the form to include this item.
178.	Susan Rosebrough (NPS)	04/20/2020	Attachment C	Assess impacts to vegetation, trampling.	Thank you for your comment. Impacts to vegetation/trampling is covered under the "Bare Ground" variable on the form.
179.	Rick Hartson (Upper Skagit Indian Tribe)	04/17/2020	Attachment C	Separate question for ORV stream crossings.	Thank you for your comments. City Light edited the form to include this item.

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180.	Susan Rosebrough (NPS)	04/20/2020	Attachment C	Many of the questions like distance from creeks, fire rings, tent pads availability are not needed for NPS managed sites as they are already covered in the standards	Thank you for your comment. Comment noted.
181.	Susan Rosebrough (NPS)	04/20/2020	Attachment C	An important component that is needed is to understand what bareground is outside the designated site and what is inside. The impacted areas that we are looking for is areas outside of designated tent pads being used for camping, and fire rings being created out side of designated NPS sites. The bare ground category does not help determine if the amount of bare ground is acceptable for the type of site or allow for any way to determine if the amount of bare ground has increased or will increase in the future. Mapping of the sites, amount of bare ground, and user-created trails is needed.	Thank you for your comment. City Light edited the "Bare Ground" question to focus on the areas outside the designated site. Regarding additional quantitative bare ground impact data collection, City Light believes the current use impact information is adequate to make decisions about future site management, particularly as it relates to the FERC Project recreation facilities.
182.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	• How do we define the term "recreation facility"? Is it a reservoir, a National Forest, a boat ramp, parking lot o The wording in the latter parts of the survey suggest it is a reservoir or something similar. The term recreation facility vs the terms "reservoirs or areas" will be confusing for respondents.	Thank you for your comment. "Recreation facility" refers to the facility identified in the first question on the questionnaire. City Light has made edits the questionnaire to make it clear the focus of the questions is on the "recreation facility/reservoir" as most of the questions seek input on the specifics at the Project recreation facility but also the overall Project reservoirs as well. In addition, City Light edited the first question identifying the location of the survey to include the Project reservoir as well as the Project recreation facility where the survey is being administered.
183.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	In survey question 2, the survey does ask visitors if they also visited Forest Service land on their present visit. However, I think visitors will NOT properly answer this question because they lack reliable understanding of	Thank you for your comment. City Light intends to include a detailed map for the recreation researchers intercepting visitors and for inclusion in the mailback survey package. As such, City Light edited Section 2.6.2.2 to

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				public land agencies and local ownership. As result, 1) it is doubtful visitors will know whether they visited Forest Service land (and certainly not MBS NF versus Oka-Wen NF) unless they are presented with a detailed map, and 2) without a clear definition for the respondent of what the "current trip" entails it is unclear of if they are given us information about the present visit. Survey question 2 could be improved to provide more information about use within the project boundary and periphery lands by including more detailed locations and a map.	include this detail. Regarding potential confusion about what "current trip" means, City Light's recreation researchers will address this during their introduction and explanation of the survey questionnaire. Current trip is their trip from home that includes a stop at the site where the interview is taking place. Depending upon visitor, the "current trip" may be just a visit to the study site/reservoir or it could be part of a larger trip. Questions 3 and 4 on the questionnaire will inform what type of trip it was.
184.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	In-Text Edit: Where did you stay?_____	Thank your for your suggested edit. City Light did not adopt this edit since part C of the question addresses where the respondent stayed overnight. No edits made.
185.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Could Question 3 be expanded so Forest Service campgrounds are listed as a discreet lodging segment. That would provide the potential ability to describe how frequently recreation users within the project boundary are using FS campgrounds as part of their recreation.	Thank you for your comment. City Light edited the responses to include Forest Service campground.
186.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Given the interest stated in section 2.6.4.3 and elsewhere it might be useful to expand this question to gather more specific information on the nearby destinations that are included in the recreation trip to the project. That might include collecting information on a map included in the survey.	Thank you for your comments. Responses to questions 2 and 4 will provide this information. No edits made.
187.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	In-Text Edit:	Thank you for your comment. The combination of the first and third response options as

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				☐ This recreation facility/reservoir or other recreation facility/reservoir in the Project **is my primary destination**	originally written for this question addresses this suggested edit. No edits made.
188.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Since we have the zip code already, this is questions could be removed and the information derived from the zip code.	Thank you for your comment. City Light agrees with your suggested edit, particularly to keep the questionnaire as short as possible.
189.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	In-Text Edit: X. Where did your trip start?_____	Thank you for your suggested edit. See response to Comment #188 above.
190.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Should be broken out by day hiking and walking and BACKCOUNTRY hiking.	Thank you for your comment. City Light edited the response options as suggested.
191.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please include the following activities: viewed wildlife, viewed lakes, took photographs, had a picnic, camped overnight in backcountry away from lakeshore, camped overnight at boat-in campsite, camped overnight in car/drive-in campground, read educational displays and materials, went horseback riding, went climbing.	Thank you for your comment. City Light edited the response options to include most of these additional options. Respondents have the option to provide "other" responses, if needed.
192.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Break out by developed and dispersed	Thank you for your comment. City Light edited the response options as suggested.
193.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	Environmental Education	Thank you for your comment. City Light edited the response options as suggested.
194.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	On this trip or anytime?	Thank you for your comment. City Light edited the response to specify "on this trip."
195.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	FA03 Recreational Fisheries Issue form requested a creel survey to be conducted to assess mortality related to recreational fishing and to measure CPUE and HPUE for salmonids. As per comments from SCL at the last RWG, this study is not intended to fill any of those data gaps. Therefore, the NPS recommends that the fishing questions be removed from this survey and that a creel survey be conducted as a standalone study.	Thank you for your comments. City Light agrees that the angling questions are not essential for this study and has removed them. Regarding a creel survey, see response to Comment #15 above.

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196.	Brock Applegate (WDFW)	05/04/2020	Attachment D	Thanks Susan, WDFW agrees. We have standard forms and a survey methods manual to assist SCL in the implementation of the creel survey.	Thank you for your comments. See response to Comment #195 above.
197.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Keep the angling questions and expand study area beyond reservoirs including downstream of the Gorge. Study should be able to answer the who/what/where regarding recreational and commercial angers. Could modify the questions as it is not necessary to have a full creel survey to understand public and commercial recreational angling use. It is important to understand the amount of use, the timing of use, access points used, and fishing locations on the river during a range of flows.	Thank you for your comments. See response to Comment #195 above.
198.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Is this going to be correlated with the level of the reservoir on the day they visited? The NPS recommends that the data be correlated.	Thank you for your comments. The visitor survey data could be correlated to the daily water surface elevation using publicly available elevation data. City Light does not intend to correlate the data as part of the study report. However, a comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA when LPs will have an opportunity to consider Project effects on recreation resources in their review of the DLA in the NEPA process. No edits made.
199.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	We assume this refers to facility conditions. It could potentially refer to other visitor behaviors. We may consider being a little more specific in this this wording.	Thank you for your comment. The question is meant to be general to capture any potential unsafe conditions. City Light edited the question to include “or behaviors.”
200.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Separate out motorized and human-powered boating activities.	Thank you for your comment. City Light edited the response options as suggested.

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201.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	Parking? Where?	Thank you for your comment. City Light removed the overall crowding response option of "during your entire visit" as it is too vague.
202.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	Crowded parking? Where?	Thank you for your comment. City Light edited the response options to include a parking area response.
203.	Nikolai Ferrell (USFS)	05/04/2020	Attachment D	Add stock use	Thank you for your comment. City Light edited the response options as suggested.
204.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Separate out motorized and human-powered boating activities.	Thank you for your comment. City Light edited the response options as suggested.
205.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	This is not in the pool of questions. Can this be modified to another question on the list or removed?	Thank you for your comment. City Light has removed this question as Question 20 already addresses this topic.
206.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Add privacy screening at campsites to this list.	Thank you for your comment. City Light edited the response options as suggested.
207.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	ELC	Thank you for your comment. City Light edited the response options as suggested.
208.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	add ELC	Thank you for your comment. City Light edited the response options as suggested.
209.	Gilje Kristofer (NCI)	05/03/2020	Attachment D	Nonbinary	Thank you for your comment. City Light edited the response options as suggested.
210.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Include Hispanic or Not Hispanic option in demographics.	Thank you for your comment. City Light edited the questionnaire to include a "Hispanic or Latino" and "Not Hispanic or Latino" options.
211.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	I am putting this as a comment and track changes so it can be seen better. Please add the following questions: • In order to understand where people are going, add the following or similar question (DEST5), that shows all the facilities listed in Table 1. DEST5	Thank you for your comment. City Light's questionnaire includes a question similar to this (Question 2), focused on the FERC Project resources, not the National Park sites, which are not part of the FERC Project. No edits made.

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				What other areas of the park do you plan to visit today? □□Provide a list of specific locations within the [NPS SITE] □□Use a map to show specific locations within the [NPS SITE]	
212.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • In order to better understand if parking is an issue for visitors, Please add the following series of parking questions (parking 10, 15, & 16) or a similar questions.	Thank you for your comment. City Light edited the questionnaire to include the PARKING15 question, but tailored it to the Project recreation facility/reservoir, not the National Park. City Light believes this question is adequate to address parking issues. The other questions (PARKING10 and PARKING 16) are too similar or too specific to the National Park setting (not the FERC Project) to include. Further, multiple questions on parking would unnecessarily add to the length of the survey, which is a concern for City Light during implementation (i.e., response rate).
213.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To understand information about why people are motivated to visit this area, please add this (RecEXP 12) or a similar question. It is our understanding that we can modify the choices but not the question and still meet OMB requirements. The NPS recommends that we add a choice or two about enjoying the water or viewing the lakes as options.	Thank you for your comment. City Light did not include this question as it is lengthy (i.e., concerns about survey length and response rate) and other questions on the questionnaire are more focused on the recreation use and activity motivations, which is the focus of the survey overall. No edits were made.
214.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To gather input on night skies, please include the following or similar question (NSKies11):	Thank you for your comment. City Light did not add this question to the questionnaire as it is not clear how the question would provide substantive information to help inform relicensing decisions regarding recreation resources at the Project. Rather, the Project Facility Lighting Inventory study will provide information to inform relicensing decisions

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					related to any Project impacts to night skies. No edits made.
215.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To gather more input on relationship between lake levels and visitors, look at the new pool of questions (coming out soon) and see if there is a similar question that was asked in the 2005 survey (report published in 2007).	Thank you for your comment. City Light did not add this question to the questionnaire as the question is too vague and location specific to provide substantive information to help inform relicensing decisions regarding recreation resources at the Project.
216.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To gather input on information sources please include the following or similar question (ITINN 22).	Thank you for your comment. City Light has edited the questionnaire to include simplified question that asks how visitors obtained information; City Light also modified the response options to apply to the FERC project. As written, the secondary question as part of the OMB question ITINN 22 (i.e., helpfulness) is lengthy and not necessary for the relicensing needs. Edits made to text to reflect this.
217.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To better understand visitor impacts, please add the following or similar question (ATT1):	Thank you for your comment. City Light did not add this question to the questionnaire as it is not clear how the question would provide substantive information to help inform relicensing decisions regarding recreation resources at the Project. No edits made.
218.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To better understand the visitor's lodging experience, please add the following question after #3, (ACCOM5):	Thank you for your comment. City Light did not add this question to the questionnaire as it is too specific to National Park settings and not the FERC project setting. Further, the questionnaire already has a question addressing visitors' lodging experience (Question 3). No edits made.
219.	Susan Rosebrough (NPS)	04/20/2020	Attachment D	Please add the following questions: • To gather information on unmet needs, the NPS would like to see a general question such as below, "Are there any additional recreation amenities or other changes would you like to	Thank you for your comment. City Light has added the first proposed question as it aids in understanding unmet demand. City Light did not include the other three proposed questions as they are not relevant to the FERC project or

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				see?" This question is not in the current pool of questions but some similar such as the ones listed could work. A new version of the known pool of questions should also be available in the coming months. DEST12 What change or changes would make you stay longer in the area? EVALSERV25 If you or your personal group used any of the above services, please describe any changes you would recommend to the current system. OPMGMT19 If you could ask Seattle City Light or the National Park Service to change some things about the way they manage this area, what would you ask them to do?	needed for relicensing decisions (i.e., DEST12 and EVALSERV25) or an existing question on the questionnaire is similar (i.e., OPMGMT19). Edits were made to the text to include the first question.
220.	Susan Rosebrough (NPS)	04/24/2020	Attachment D	In Text Edit: *NPS added table, referred to as NPS Table 1* NPS Table 1- Recreation Facilities for Inventory, Condition, Accessibility, Use Impact, Use Counts, and Survey Location	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.
221.	Susan Rosebrough (NPS)	04/27/2020	Attachment D	In-Text Edit: Hozomeen Visitor Center	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.
222.	Susan Rosebrough (NPS)	04/27/2020	Attachment D	In-Text Edit: Thunder Creek Thunder Knob Trail Diablo Lake Trail	Thank you for your comments. See responses to Comment #s 7, 11, 32, and 37 regarding geographic scope of the study. No edits made.
223.	Judy Neibauer (USFWS)	05/13/2020	General Comments	Connectivity for fish and wildlife is important. We have not really talked too much about studying how the project lies within any type of connectivity corridor for wildlife. For the new license it would be appropriate to look at adjacent connectivity corridors, to see how the project area intersects with them, and see how the project area could compliment connectivity	Comment noted. City Light encourages USFWS to propose connectivity issues as a discussion topic at upcoming Terrestrial Resources or Recreation Resources Work Group meetings.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				into the future within the term of a new license. This may be a new study, or combined with other studies, not sure where it fits in exactly, but is seems understanding where recreational areas intersect with connectivity would be important to understand.	
224.	Judy Neibauer (USFWS)	05/13/2020	General Comments	Recreational impacts from facilities, fishing, and boat/roads/access trails should be looked at where we have listed / sensitive fish and wildlife species. We will need to understand how these project elements intersect to understand impacts. Key issues that may be connected include how recreation may cause degraded habitat; how recreational fisheries impact bull trout; how recreation impacts spotted owl, marbled murrlett, G. Bear, and G. wolf; how recreation causes invasions of invasive species; and how recreational plans may affect potentially other future listing or sensitive species during the life of a new license. It will be important to integrate information from multiple sources of information and study plans for some of these evaluations.	Thank you for your comments. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. LPs will have an opportunity to consider effects of Project recreation, if warranted, on other resources in their review of the DLA in the NEPA process.
225.	Denise Schultz (NPS)	6/25/2020	Section 2.3 Background and Existing Information	This statement is incorrect and should be deleted. The National Park Service centennial was in 2016.	Thank you for the comment. The statement regarding peak use originally referred to 2016. Redline edits from licensing participants added 2019 visitor use data. The reference to the NPS centennial celebration has been removed from the study plan.
226.	Nlaka'pamux Nation Tribal Council (NNTC)	June 2020	General Comments	See Nlaka'pamux Nation Tribal Council letter included after this table.	Thank you for your comments. City Light acknowledges that NNTC has particular concerns about unanticipated discoveries as they may relate to Traditional Cultural Properties (TCP) and will be

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					consulting with NNTC and other participants of the CRWG. City Light has cultural resources training protocols and unanticipated discovery plans in place for staff and contractors. These protocols and plans will be updated during the relicensing process in consultation with the CRWG. City Light acknowledges that NNTC has already inventoried and identified TCPs within the Project's Boundary as part of the current license and are in the process of evaluating National Register eligibility with the NPS. Any of the recreation sites City Light manages will incorporate management strategies for protection of TCPs in consultation with tribal and First Nations partners and City Light will work in coordination with the NPS for the protection of TCPs on the recreation sites they manage within the Project Boundary. As part of the relicensing process, City Light, in collaboration with the CRWG, is developing Study Plan CR-04, Inventory for Properties of Traditional Religious and Cultural Significance (PTRCS). This study plan will focus on identifying and evaluating PTRCS within the Project Area of Potential Effects, which is currently being developed with the CRWG. Project effects will also be evaluated as part of the relicensing process, and Project-related adverse effects on PTRCS will be resolved in consultation with the CRWG.

NPS Table 1. Recreation Facilities for Inventory, Condition, Accessibility, Use Impact, Use Counts, and Survey Location.

Name	*Inventory*	*Condition*	*Accessibility*	*Use Impact*	*Observation Survey/ Use Counts*	*Carrying Capacity*	*Location for Visitor Surveys*
Ross Lake							
Green Point	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*[1]	*X*	
Cougar Island	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Roland Point	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
McMillan	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Spencer's	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Big Beaver	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
May Creek	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Rainbow Point	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Devil's Junction	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Ten Mile Island	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Dry Creek	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Ponderosa	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Lodgepole	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Lightning Creek Stock Camp	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Lightning Creek Boat Camp	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Cat Island	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Little Beaver	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	

Name	*Inventory*	*Condition*	*Accessibility*	*Use Impact*	*Observation Survey/ Use Counts*	*Carrying Capacity*	*Location for Visitor Surveys*
Boundary Bay	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Silver Creek	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Hozomeen Visitor Center					*X*		
Hozomeen Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Winnebago Boat Launch	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Hozomeen Boat Launch	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Ross Lake Resort					*Compile from Ross Lake Resort*	*X*	*At Dock*
Ross Dam Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	*X (Trailhead)*
Happy Creek Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
East Bank Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	*X (Trailhead)*
Happy Panther Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Lightning Creek Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Devil's Dome Loop Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Desolation Peak Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Little Beaver Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Big Beaver Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Pacific Northwest Scenic Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Diablo Lake							

Name	*Inventory*	*Condition*	*Accessibility*	*Use Impact*	*Observation Survey/ Use Counts*	*Carrying Capacity*	*Location for Visitor Surveys*
Skagit Tour Dock	*X*	*X*	*X*	*X*	*SCL data*		
West Ferry Landing (parking and dock)	*X*	*X*	*X*	*X*	*SCL data*		*X*
East Ferry Landing	*X*	*X*	*X*	*X*	*SCL data*		*X*
North Cascades Environmental Learning Center	*X*				*NCI data*		*X*
Diablo Overlook	*Compile from NPS data*	*Compile from NPS data*	*X*		*Compile from NPS data*	*X*	*X*
Colonial Creek Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	*X*
Colonial Creek Boat Launch and Dock	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	*X*
Buster Brown	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Hidden Cove	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Thunder Creek	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Thunder Knob Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Thunder Point	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Sourdough Mountain Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Stetattle Creek Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Diablo Lake Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Diablo Dam			*X*			*X*	
Gorge Lake							
Ross Lodge Picnic Shelter	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Gorge Lake Boat Launch	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Gorge Overlook	*Compile from*	*Compile from*	*X*		*X*	*X*	

Name	*Inventory*	*Condition*	*Accessibility*	*Use Impact*	*Observation Survey/ Use Counts*	*Carrying Capacity*	*Location for Visitor Surveys*
	NPS data	*NPS data*					
Gorge Lake Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS*	*X*	
Skagit River							
Ladder Creek Falls Trail and Gardens	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Trail of the Cedars	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Newhalem Creek Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Goodell Put-in	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	*X*
Portage Site	*X*	*X*		*X*	*X*	*X*	
Copper Creek Take-out	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Goodell Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Upper Goodell Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Lower Goodell Campground	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*Compile from NPS data*	*X*	
Thornton Lake Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Rock Shelter Boardwalk and Trail	*Compile from NPS data*	*Compile from NPS data*	*X*	*X*	*X*	*X*	
Marblemount and Sauk River Boat Launches	*X*	*X*	*X*	*X*	*X*	*X*	*X*

1 Areas highlighted in green are already included in the draft study plan.

NNTC Commentary on Recreation Assessment Study Plan: June 2020

Conflict and Opportunity:

When the Nlaka'pamux Nation Tribal Council (NNTC) and Seattle City Light (SCL) signed an Agreement whereby the NNTC was to survey the Skagit Project APE around Ross Lake to create an inventory of Traditional Cultural Properties for the existing license, neither party was aware that in fact the level of the reservoir reached the level of the Nlaka'pamux trail corridor through the Upper Skagit River Valley. Used for millennia, this high-density use area and travel corridor for the Nlaka'pamux was well known by tribal members and was later documented ethnographically. On the shores of this now beautiful reservoir this valley has become a popular destination for modern outdoor enthusiasts.

The recreation mandate of the SCL agreements and the landowner (NPS,) facilitate modern recreational activities, activities that have impacted and will continue to impact cultural sites. Co-existence of both interests is currently not data supported and would be a first step to preserving the cultural sites. Recreation trails have frequently been built along and over traditional trails - for the obvious reason of this being the logical place to cross an area. But in the process, the integrity of the traditional indigenous trail is threatened: the function of the original trail could be lost. The traditional trail is the key to understanding the relationship of Nlaka'pamux to the valley's resources – trail marker trees point to camp sites and other resource trails or resource sites. One expects to find everything one needs for a short or long, summer or winter stay close to, or signposted along this trail. We have found places where the indigenous trail is parallel and very close by but was burdened and obscured by the debris of the recreation trail maintenance. In some instances it has been built over and erased. We have found stumps of culturally modified trees close to modern camp sites – though it must be said these were cut down some time ago. Where there is no clear intention to survey for Cultural Sites before enhancing recreation facilities, many existing traditional sites can be destroyed or over built – not deliberately but through oversight and cultural unfamiliarity.

Western concepts of camps and camping are understood in a temporary context and as such camps sites are given relatively short shift in order of significance. The definition of modern camping involves overnight stays away from home. But, for indigenous nations in the northwest, these sites are part of a whole and permanent cultural, economic and spiritual context. Elders

and early anthropologists have described the traditional Nlaka'pamux life-style as logistically organized, dependent on an intimate knowledge, strategic stewardship of and deep relationship with every part of the territory, from the high mountain ridges through the resource-rich watersheds. At different seasons and for different resources groups from different communities would stay at specific locations for months at a time on a regular basis. These were not temporary encampments and as such of temporary significance: These were homes, they were chosen very deliberately and specifically for their locations. Modified trees show that habitations were constructed, either summer mat lodges or winter dwellings where the depressions are still visible. There is evidence of various land management techniques including intentional burning to improve the berry crops and to attract deer to the fresh green grasses of the spring. The footprint is very light to unfamiliar eyes but to Nlaka'pamux they are at the core of our identity.

Spiritual sites are always found near camp locations and is a primary decision variable for choosing a camp location. Modern recreational camp sites have been built close by a number of Nlaka'pamux spiritual sites. The area was not surveyed for cultural sites prior to the construction of these recreational camps and as a result questions of audio sheds and visual sheds were obviously not considered. There is also the minor but cumulative affects such as: trampling, burning fuel, moving cobbles, obscuring of previous use.

We are in a situation where different interests, cultural and recreational and each absolutely valid in their own way, are in conflict in this long narrow APE. In fact, the modern recreational planner can identify the specialness of the place, they are just seeing how the place is special for their needs, just as Nlaka'pamux identifies it for theirs, as they have for millennia. Any plans for enhancing recreational access and activities could further damages and desecrate cultural sites in the Ross Lake Recreation Area which includes the APE for this relicense. The Relicensing Process could be an opportunity to resolve conflict and find ways to enhance each others interest.

Study Plan does not Address Conflicting Interests

Conflict is inherent within The Draft Recreation Assessment Study Plan The Study Plan Goals and Objectives (2.1) refer only to the Project recreation sites and facilities – they don't include the recreation facilities and activities within the Project Boundary around Ross Lake which are managed by the NPS.

The goals of the study (2.2) include a stated intention to

* identify user conflicts and resource impacts as a result of recreational use.

The methodology however does nothing to address the conflict between extant traditional cultural sites and recreation activities-or the activities of the people collecting the data for this study. To date SCL and NPS research has not included traditional cultural properties: their focus has been on identifying and researching archaeological sites and physical structures of the built environment. US Tribes and Canadian First Nations have had to take responsibility for the identification and protection of their own cultural sites – a task for which the indigenous people of course have the expertise but a task which nevertheless needs to be included in the comprehensive research required for relicensing - and given equal significance to the other resource research.

The methodology for the Ross Lake area does not appear to include an avenue "to provide information to help LP's with responsibility for recreation *and land use* within the Project area to identify potential measures for consideration in a recreation management plan for the Project." It is clear from the Draft that it is up to the individual LP's themselves to identify their concerns and to propose management and mitigation measures. But there is no mention of any place where such concerns and proposals would be received, let alone considered or acted upon.

Likewise the Draft Study Plan refers to the legislation for the protection of archaeological and physical buildings sites and it does not note that the legislation is supposed to offer the same protection for traditional cultural properties. This is of particular relevance because of Nlaka'pamux experience over the last decade. While FERC has jurisdiction and the SCL holds the licence in the area, they take no responsibility for any potential or real damage for sites or facilities in the NPS-managed Project Areas. When any concern has been broached the responsibility for any mitigation appears to have been referred back and forth between the SCL and the NPS – and there has been no resolution for the Nlaka'pamux. As the NPS mandate concentrates on archaeology sites at Ross Lake (there are no historic buildings) there is no mechanism in place where such "user conflicts" can be resolved. "User conflicts" – such as protection of the principal Nlaka'pamux trail – is currently our responsibility. It is a great and unnecessary expense and could be easily resolved with co-operation.

The NNTC TCP is not constrained to the Project Boundary: the old trail circulated through the area as a main artery from which many trails lead off. In the light of NNTC experience of cultural surveys and research in all other Nlaka'pamux watersheds, we know that there are many more Traditional Cultural Properties outside of this FERC APE. Recreation trails too, lead away from the shoreline camp facilities to explore the superb mountain terrain around them. Of course the mountains have attracted people from all over the world for the last 150 years and initially they likely followed traditional indigenous trails. But the excellent NPS-camp and SCL-constructed boat access facilities along the banks of the Ross Lake reservoir, within the Project area, now draw thousands of visitors – as documented in the Study Plan. This popular access to areas outside of the Project presents an extension of the Nlaka'pamux concern about preservation of Nlaka'pamux traditional cultural properties. The number of well-maintained new NPS recreation trails for the exploration of the surroundings area would not have been built **but for** the facilities within the FERC APE and the license-based agreement between the SCL and the NPS.

Resolution:

The location co-incidence of the high-density recreation use of the Ross Lake lakeshore and the Nlaka'pamux traditional cultural property was not foreseen – but it exists. This is opportunity for a further **protocol to be developed at least between the SCL and the NPS** and hopefully with the Nlaka'pamux at Ross Lake and Tribes south of the Ross Dam along the transmission and mitigation areas whereby preservation and mitigation issues regarding TCP's are finally identified, protected where possible by avoidance, minimizing affect or mitigating affects of the recreation fueled by this FERC license.

The most immediate concern for the Nlaka'pamux is the protection of our cultural sites within the Upper Skagit River Valley travel corridor. While considering the future of recreation activities here and for drawing up a general management from this research, it is axiomatic that current concerns and problems be addressed in the recreation study plan.

We have noted that many of our concerns deal with unfamiliarity with cultural practices and history of the original inhabitants of the Valley. What is required is an **Unanticipated Discoveries Protocol** training so any SCL or NPS personnel on the ground for any reason would

improve their chances of knowing if they have inadvertently encountered a TCP – such training obviously led by or in conjunction with the Tribes or First Nation who call this area home.

This is critical to all recreation studies for the area – but precisely during the next five years when the lands around the dams and the hydro project will all be meticulously researched for so many different reasons. Twenty-four study plans are currently being developed and more are intended. How does SCL propose to make certain that all the field researchers associated with the relicense process do not damage cultural sites? The NNTC is particularly concerned as to how SCL proposes to co-ordinate with other agencies such as NPS-on all actions that would not be happening **but for** the existing license and the relicense.

NNTC recommends that any management plan or protocol include such a co-operative mechanism, to be negotiated between the interested parties, land managers and agencies who are responsible for actions that result from the FERC license – this should include all work that is funded or required by FERC agreements.

The Recreation Assessment Study should co-ordinate user interests, into consideration early in the planning stages. The existing cultural sites, the living indigenous relationship to the lands are not incidental in the real world, nor in the legislative one … and it prudent and legally defensible to **incorporate this relationship into the study and management plans from the start.**

Recommendations:

- NNTC to complete survey and documentation of cultural sites within FERC boundary prior to more field scientists working in the APE.
- Training Protocols for all personnel – including for Unanticipated Discoveries Protocol.
- Protocol for protection of existing TCP locations during 5 yr. period of intense multidisciplinary studies in area
- Protocol for delineating areas of responsibility for management for and mitigation measures for TCP's.

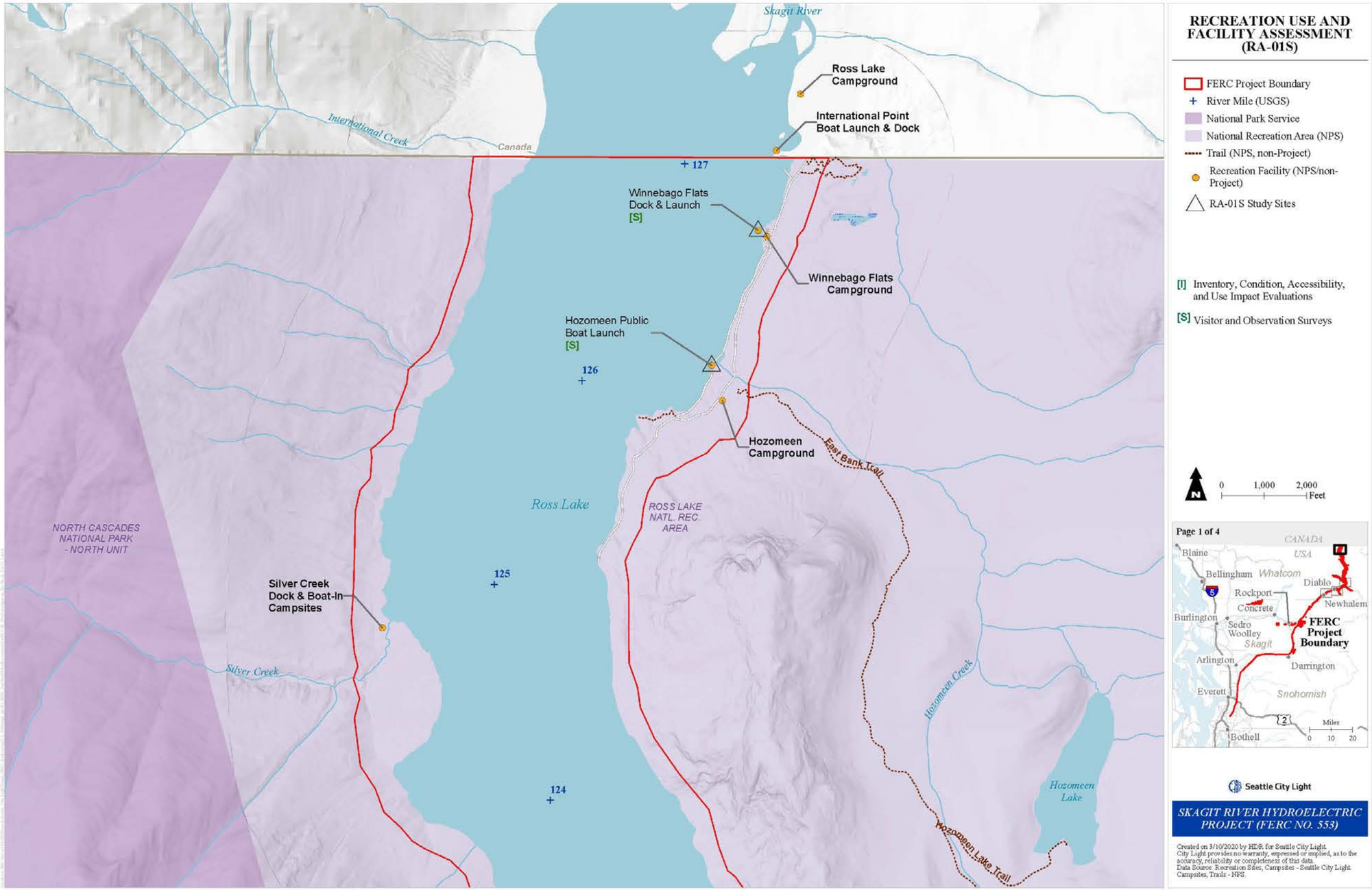
NNTC.

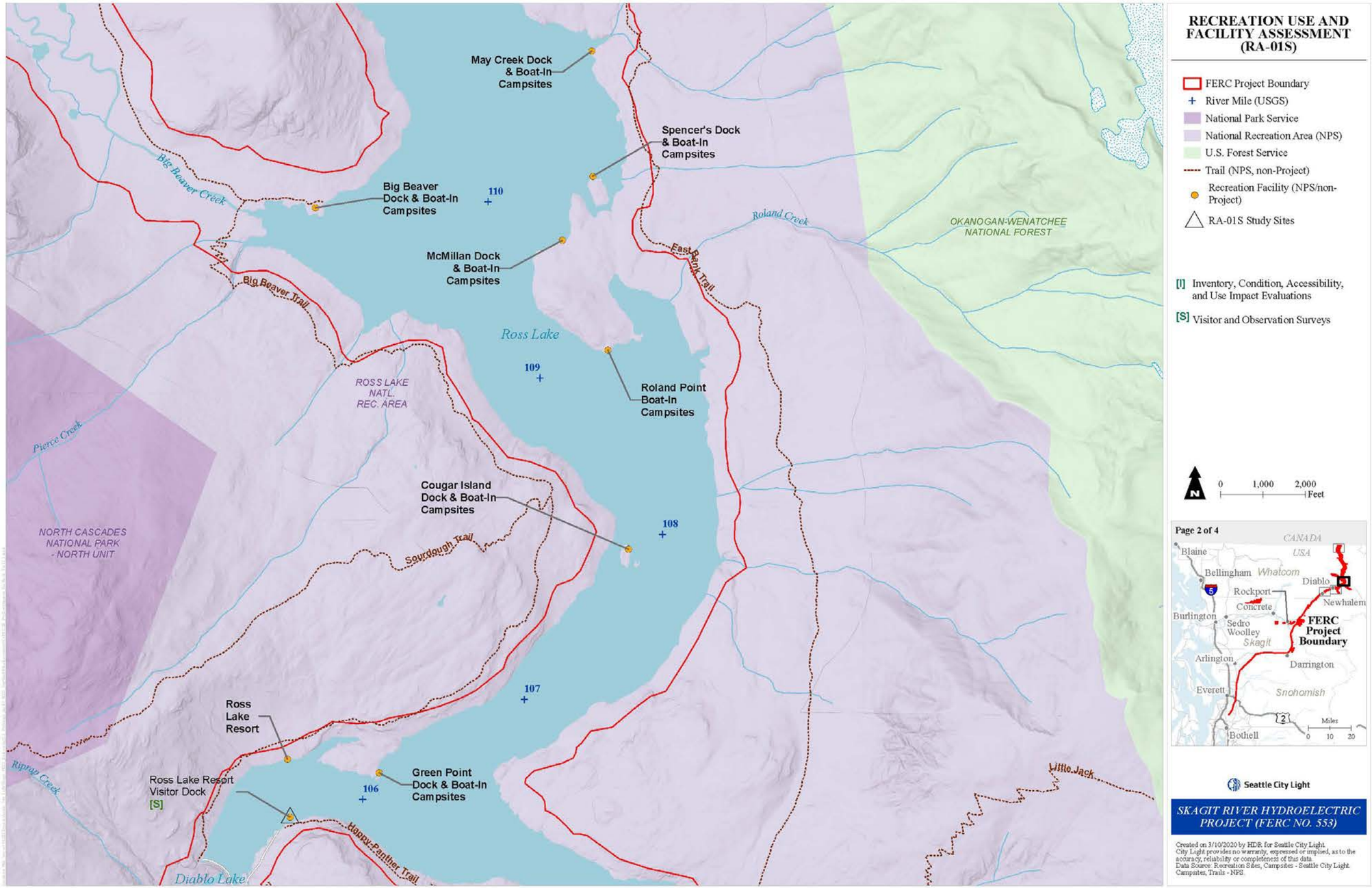
June 2020.

RECREATION USE AND FACILITY ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT B

STUDY SITE MAPS


Skagit River
Ross Lake Campground
International Point Boat Launch & Dock
International Creek
Canada
+ 127
Winnebago Flats Dock & Launch [S]
Winnebago Flats Campground
Hozomeen Public Boat Launch [S]
126 +
Hozomeen Campground
East Bank Trail
Ross Lake
ROSS LAKE NATL. REC. AREA
NORTH CASCADES NATIONAL PARK - NORTH UNIT
Silver Creek Dock & Boat-In Campsites
125 +
Silver Creek
Hozomeen Creek
124 +
Hozomeen Lake
Hozomeen Lake Trail
RECREATION USE AND FACILITY ASSESSMENT (RA-01S)
FERC Project Boundary
River Mile (USGS)
National Park Service
National Recreation Area (NPS)
Trail (NPS, non-Project)
Recreation Facility (NPS/non-Project)
RA-01S Study Sites
[I] Inventory, Condition, Accessibility, and Use Impact Evaluations
[S] Visitor and Observation Surveys
N
0 1,000 2,000 Feet
Page 1 of 4
CANADA
USA
Blaine
Bellingham
Whatcom
Diablo
Rockport
Concrete
Newhalem
Burlington
Sedro Woolley
Skagit
FERC Project Boundary
Arlington
Darrington
Everett
Snohomish
Bothell
Miles
0 10 20
Seattle City Light
SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)
Created on 3/10/2020 by HDR for Seattle City Light.
City Light provides no warranty, expressed or implied, as to the accuracy, reliability or completeness of this data.
Data Source: Recreation Sites, Campsites - Seattle City Light.
Campsites, Trails - NPS.



RECREATION USE AND FACILITY ASSESSMENT (RA-01S)

- FERC Project Boundary
- River Mile (USGS)
- National Park Service
- National Recreation Area (NPS)
- U.S. Forest Service
- Trail (NPS, non-Project)
- Recreation Facility (NPS/non-Project)
- RA-01S Study Sites

[I] Inventory, Condition, Accessibility, and Use Impact Evaluations

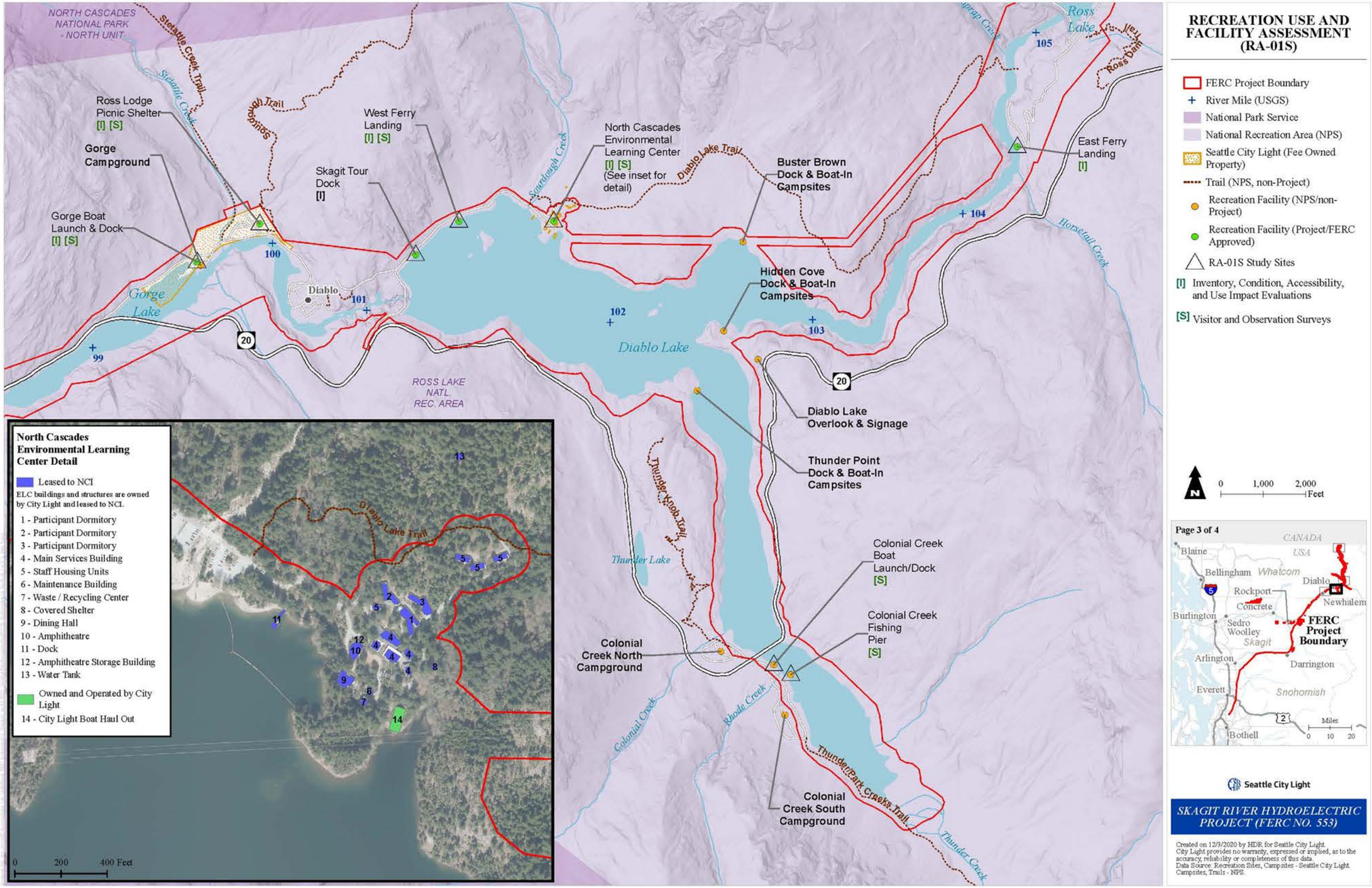
[S] Visitor and Observation Surveys

N 0 1,000 2,000 Feet

Seattle City Light

SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)

Created on 3/10/2020 by HDR for Seattle City Light.
City Light provides no warranty, expressed or implied, as to the accuracy, reliability or completeness of this data.
Data Source: Recreation Sites, Campsites - Seattle City Light.
Campsites, Trails - NPS.


NORTH CASCADES NATIONAL PARK - NORTH UNIT
Stetattle Creek Trail
Stetattle Creek
Sourdough Trail
Ross Lodge Picnic Shelter [I] [S]
Gorge Campground
Gorge Boat Launch & Dock [I] [S]
West Ferry Landing [I] [S]
Skagit Tour Dock [I]
Sourdough Creek
North Cascades Environmental Learning Center [I] [S] (See inset for detail)
Diablo Lake Trail
Buster Brown Dock & Boat-In Campsites
East Ferry Landing [I]
Ross Lake
Jim Ross Dam
Horsetail Creek
Hidden Cove Dock & Boat-In Campsites
Diablo
Gorge Lake
Diablo Lake
ROSS LAKE NATL. REC. AREA
Diablo Lake Overlook & Signage
Thunder Point Dock & Boat-In Campsites
Thunder Knob Trail
Thunder Lake
Colonial Creek Boat Launch/Dock [S]
Colonial Creek Fishing Pier [S]
Colonial Creek North Campground
Colonial Creek South Campground
Rhode Creek
Colonial Creek
Thunder Creek
Thunder Arm Creeks Trail
99
100
101
102
103
104
105
20
North Cascades Environmental Learning Center Detail
Leased to NCI
ELC buildings and structures are owned by City Light and leased to NCI.
1 - Participant Dormitory
2 - Participant Dormitory
3 - Participant Dormitory
4 - Main Services Building
5 - Staff Housing Units
6 - Maintenance Building
7 - Waste / Recycling Center
8 - Covered Shelter
9 - Dining Hall
10 - Amphitheatre
11 - Dock
12 - Amphitheatre Storage Building
13 - Water Tank
Owned and Operated by City Light
14 - City Light Boat Haul Out
0 200 400 Feet
RECREATION USE AND FACILITY ASSESSMENT (RA-01S)
FERC Project Boundary
River Mile (USGS)
National Park Service
National Recreation Area (NPS)
Seattle City Light (Fee Owned Property)
Trail (NPS, non-Project)
Recreation Facility (NPS/non-Project)
Recreation Facility (Project/FERC Approved)
RA-01S Study Sites
[I] Inventory, Condition, Accessibility, and Use Impact Evaluations
[S] Visitor and Observation Surveys
0 1,000 2,000 Feet
Page 3 of 4
CANADA
USA
Blaine
Bellingham
Whatcom
Diablo
Rockport
Concrete
Newhalem
Burlington
Sedro Woolley
Skagit
FERC Project Boundary
Arlington
Darrington
Everett
Snohomish
Bothell
Miles
0 10 20
Seattle City Light
SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)
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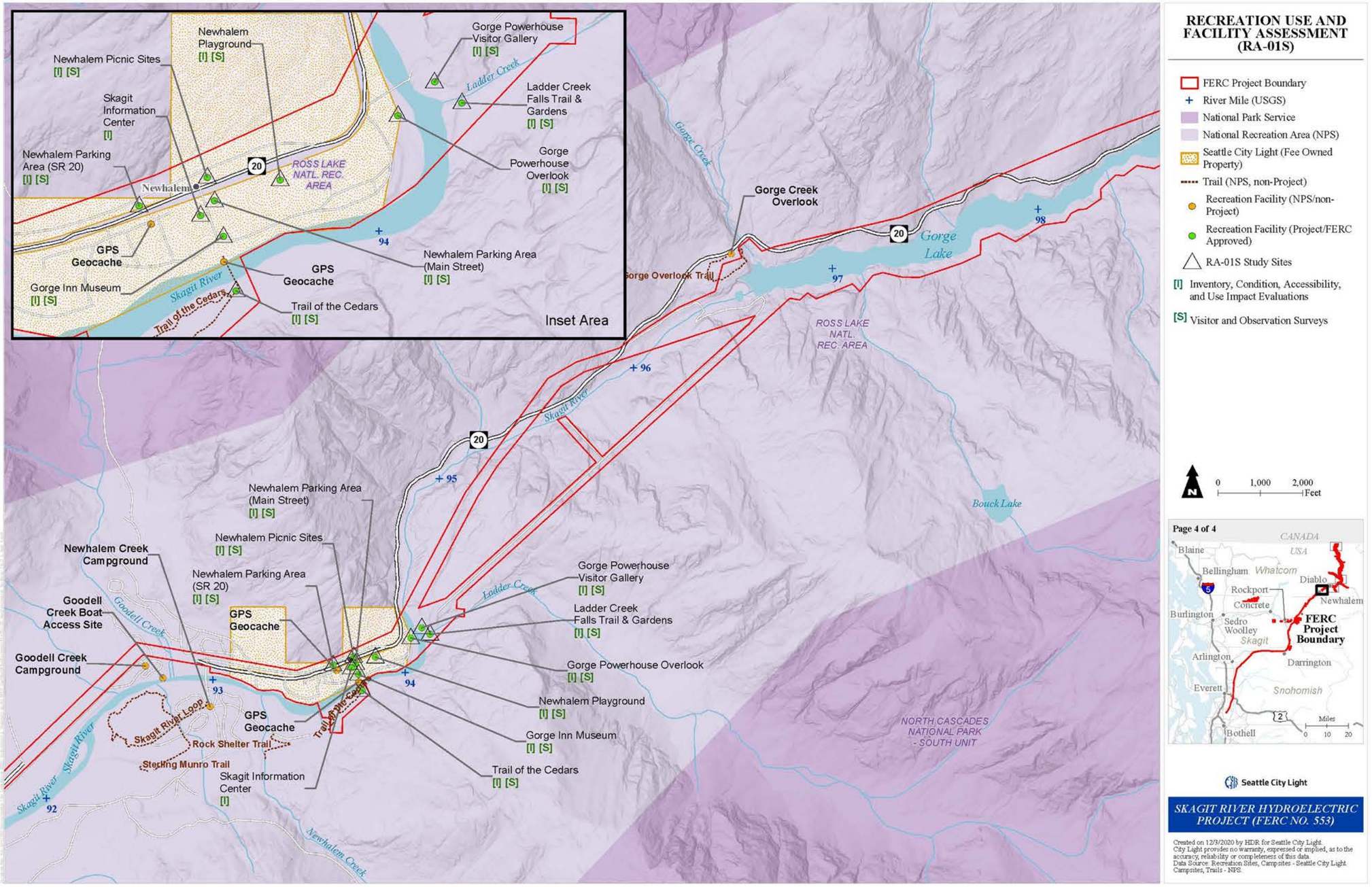
Inset Area
Newhalem Picnic Sites [I] [S]
Newhalem Playground [I] [S]
Skagit Information Center [I]
Newhalem Parking Area (SR 20) [I] [S]
Newhalem
ROSS LAKE NATL. REC. AREA
Gorge Powerhouse Visitor Gallery [I] [S]
Ladder Creek
Ladder Creek Falls Trail & Gardens [I] [S]
Gorge Powerhouse Overlook [I] [S]
GPS Geocache
Gorge Inn Museum [I] [S]
Skagit River
Trail of the Cedars
GPS Geocache
Newhalem Parking Area (Main Street) [I] [S]
Trail of the Cedars [I] [S]
+ 94
20
Gorge Creek
Gorge Creek Overlook
Gorge Overlook Trail
Gorge Lake
+ 97
+ 98
+ 96
+ 95
Skagit River
Bouck Lake
NORTH CASCADES NATIONAL PARK - SOUTH UNIT
Newhalem Parking Area (Main Street) [I] [S]
Newhalem Picnic Sites [I] [S]
Newhalem Creek Campground
Newhalem Parking Area (SR 20) [I] [S]
Goodell Creek Boat Access Site
Goodell Creek
GPS Geocache
Goodell Creek Campground
+ 93
+ 94
Ladder Creek
Gorge Powerhouse Visitor Gallery [I] [S]
Ladder Creek Falls Trail & Gardens [I] [S]
Gorge Powerhouse Overlook [I] [S]
Newhalem Playground [I] [S]
Gorge Inn Museum [I] [S]
Trail of the Cedars [I] [S]
Skagit River Loop
Rock Shelter Trail
Sterling Munro Trail
Skagit Information Center [I]
Skagit River
+ 92
Newhalem Creek
RECREATION USE AND FACILITY ASSESSMENT (RA-01S)
FERC Project Boundary
River Mile (USGS)
National Park Service
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N
0 1,000 2,000 Feet
Page 4 of 4
CANADA
USA
Blaine
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FERC Project Boundary
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RECREATION USE AND FACILITY ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT C

FACILITY ASSESSMENT FORMS
(INVENTORY, CONDITION, ACCESSIBILITY, AND USE IMPACT)

INVENTORY FORM - RECREATION FACILITIES

Facility:		Date:		Surveyor:		
Feature	**Variables**	**Response Options**				
Entrance Sign	Material	wood	synthetic	plastic	other	
	Condition	1-poor	2-fair	3-good	4-excellent	
	Comment	<*manual input*>				
Sign	Type	informational	directional	interpretive	regulatory	other
	Panels, number	<*input number*>				
	Material	metal	wood	plastic	other	
	Condition	1-poor	2-fair	3-good	4-excellent	
	Comment	<*manual input*>				
Information Board	Material	metal	wood	plastic	other	
	Panels, number	<*input number*>				
	Condition	1-poor	2-fair	3-good	4-excellent	
	Accessibility	0-inaccessible	1-partial	2-accessible		
	Comment	<*manual input*>				
Site Marker	Material	wood	synthetic	plastic	other	
	Condition	1-poor	2-fair	3-good	4-excellent	
	Comment	<*manual input*>				
Picnic Site	Type	single	group			
	Accessible	0-inaccessible	1-partial	2-accessible		
	Table, material	wood	concrete	wood/metal	none	
	Table, number	<*input number*>				
	Table, condition	1-poor	2-fair	3-good	4-excellent	
	Table, accessibility	0-inaccessible	1-partial	2-accessible	4	
	Grill, number	<*input number*>				
	Grill, condition	1-poor	2-fair	3-good	4-excellent	
	Grill, accessibility	0-inaccessible	1-partial	2-accessible	4	
	Comment	<*manual input*>				
Pathway	Surfacing	concrete	asphalt	gravel	dirt	other
	Condition	1-poor	2-fair	3-good	4-excellent	
	Width (ft)	<*input number*>				
	Resting Intervals	yes	no			
	Accessible	0-inaccessible	1-partial	2-accessible		
	Comment	<*manual input*>				
Restroom	Type	vault	flush	pit	portable	other
	Construction	CXT	concrete block	wood	other	
	Exterior, condition	1-poor	2-fair	3-good	4-excellent	
	Roof, construction	concrete	wood shingle	metal	other	
	Roof, condition	1-poor	2-fair	3-good	4-excellent	
	Stalls, number	<*input number*>				
	Sinks, number	<*input number*>				
	Interior, condition	1-poor	2-fair	3-good	4-excellent	
	Accessibility	0-inaccessible	1-partial	2-accessible	4	
	Comment	<*manual input*>				
Potable Water	Type	hydrant	fountain	other		
	Lever Type	paddle	twist/knob	lever	other	
	Condition	1-poor	2-fair	3-good	4-excellent	
	Accessibility	0-inaccessible	1-partial	2-accessible	4	
	Comment	<*manual input*>				

INVENTORY FORM - RECREATION FACILITIES

Facility:		Date:		Surveyor:		
Feature	**Variables**	**Response Options**				
Parking Area	Surfacing	asphalt	gravel	dirt	concrete	other
	Condition	1-poor	2-fair	3-good	4-excellent	
	Type	striped	wheel stop	unmarked		
	Space, single (std)	<*input number*>				
	Space, single (ADA)	<*input number*>				
	Space, double (std)	<*input number*>				
	Space, double (ADA)	<*input number*>				
	Unmarked, length (ft)	<*input number*>				
	Unmarked, width (ft)	<*input number*>				
	Barriers	curb	post	boulder	guardrail	other
	Comment	<*manual input*>				
Trash, Receptacle	Number	<*manual input*>				
	Recycling	yes	no			
	Wildlife-resistant	yes	no			
	Condition	1-poor	2-fair	3-good	4-excellent	
	Accessibility	0-inaccessible	1-partial	2-accessible	4	
	Comment	<*manual input*>				
Trash, Dumpster	Number	<*input number*>				
	Size (cu. yds)	<*input number*>				
	Wildlife-resistant	yes	no			
	Condition	1-poor	2-fair	3-good	4-excellent	
	Accessibility	0-inaccessible	1-partial	2-accessible	4	
	Comment	<*manual input*>				
Boat Ramp	Material	concrete	gravel	dirt	other	
	Ramp Size, lanes	<*input number*>				
	Width, ft	<*input number*>				
	Condition	1-poor	2-fair	3-good	4-excellent	
Boat Dock	Type	floating	pier	other		
	Width, ft.	<*input number*>				
	Length, ft.	<*input number*>				
	Condition	1-poor	2-fair	3-good	4-excellent	
	Comment	<*manual input*>				
Trail	Surface Type	dirt	asphalt	gravel	concrete	
	Width, ft	<*manual input*>				
	Condition	1-poor	2-fair	3-good	4-excellent	
	Comment	<*manual input*>				
Building, Misc.	Type	public	maintenance	other		
	Access Means	pathway	stairs			
	Condition	1-poor	2-fair	3-good	4-excellent	
	Stories	<*input number*>				
	Accessible	0-inaccessible	1-partial	2-accessible		
	Comment	<*manual input*>				

INVENTORY FORM - SIGNS

Facility:				Date:	Surveyor:
#	Type	Material	Condition	Location	Description
1	ent / dir / inf / int	w / m / s	1 2 3 4		
2	ent / dir / inf / int	w / m / s	1 2 3 4		
3	ent / dir / inf / int	w / m / s	1 2 3 4		
4	ent / dir / inf / int	w / m / s	1 2 3 4		
5	ent / dir / inf / int	w / m / s	1 2 3 4		
6	ent / dir / inf / int	w / m / s	1 2 3 4		
7	ent / dir / inf / int	w / m / s	1 2 3 4		
8	ent / dir / inf / int	w / m / s	1 2 3 4		
9	ent / dir / inf / int	w / m / s	1 2 3 4		
10	ent / dir / inf / int	w / m / s	1 2 3 4		
11	ent / dir / inf / int	w / m / s	1 2 3 4		
12	ent / dir / inf / int	w / m / s	1 2 3 4		
13	ent / dir / inf / int	w / m / s	1 2 3 4		
14	ent / dir / inf / int	w / m / s	1 2 3 4		
15	ent / dir / inf / int	w / m / s	1 2 3 4		
16	ent / dir / inf / int	w / m / s	1 2 3 4		
17	ent / dir / inf / int	w / m / s	1 2 3 4		
18	ent / dir / inf / int	w / m / s	1 2 3 4		
19	ent / dir / inf / int	w / m / s	1 2 3 4		
20	ent / dir / inf / int	w / m / s	1 2 3 4		
21	ent / dir / inf / int	w / m / s	1 2 3 4		
22	ent / dir / inf / int	w / m / s	1 2 3 4		
23	ent / dir / inf / int	w / m / s	1 2 3 4		
24	ent / dir / inf / int	w / m / s	1 2 3 4		
25	ent / dir / inf / int	w / m / s	1 2 3 4		
26	ent / dir / inf / int	w / m / s	1 2 3 4		
27	ent / dir / inf / int	w / m / s	1 2 3 4		
28	ent / dir / inf / int	w / m / s	1 2 3 4		
29	ent / dir / inf / int	w / m / s	1 2 3 4		
30	ent / dir / inf / int	w / m / s	1 2 3 4		

Legend: TYPE: ent=entrance sign; dir=directional; inf=information; int=interpretive. MATERIAL: w=wood; m=metal; s=synthetic

USE IMPACT FORM (adapted from Whittaker & Shelby, 2001) | Surveyor: | Date:

Variable	Question	Response Choices
Facility Name	Name of the facility	
Resource Area	Which reservoir/resource area is the facility at?	
Litter	In general, how much litter is found at this facility?	1. Trace amounts: less than a handful or none 2. Small: about a handful 3. Medium: about a bucketful 4. Large: about a 33 gallon garbage bag full 5. Excessive: over one garbage bag full
Dump	Does this facility get used as a dump (not just litter from camping)?	1. No, rarely 2. Yes, sometimes (large items such as cars, beds, etc. in evidence)
Tree cutting	Does the facility show signs of tree cutting for firewood or other tree damage from human use?	1. Low: few signs 2. Medium: some signs, especially lower branches of live trees 3. High: many signs, including excessive cutting of live trees
	Number of trees over 6" DBH felled	
Access Barriers	Are there management- placed barriers to prevent vehicle access to parts of the facility & have people moved the barriers?	1. No barriers placed there 2. Barriers there & have not been moved 3. Barriers have been moved
Fire rings/ vegetation clearances	How many fires rings do not have appropriate vegetation clearing?	Report # of fire rings that to do not have 8 to 10 feet vertical & 5 feet horizontal vegetation clearance:
Campsites	Is there evidence of dispersed campsites at the designated site?	1. No 2. Yes
Vegetation	What is dominant vegetation type at facility?	Report % vegetation types: Forest_____ Meadow_____ Riparian_____ Other_____
Soil	What is the dominant soil type at the facility?	Report the % of soil type: Sandy____ Clay____ Rock____ Other____ Comment on drainage:
Shade	Does the facility have good shade from rocks or trees?	1. Low: few trees or rocks with shade 2. Medium: some shade trees/rocks for some parts of the day 3. High: many trees/rocks that offer shade through entire day.
Screening	Does the facility screen groups from each other?	0. Not applicable: single site (not cluster) 1. Low: virtually no screening between sites 2. Medium: some screening 3. High: extensive screening
Reservoir views	Does the facility have views of the reservoir?	1. Poor or no views. 2. Some views, but not high quality 3. High quality views.

USE IMPACT FORM (adapted from Whittaker & Shelby, 2001) | Surveyor: | Date:

Variable	Question	Response Choices
Landscape views	Does the facility offer views of the surrounding landscape?	1. Poor or no views. 2. Some views, but not high quality 3. High quality views.
Reservoir proximity	Is the facility on or off the reservoir?	1. < 100 feet 2. 100 to 200 feet 3. > 200 feet
Reservoir accessibility	Is the reservoir easy to access from the facility?	1. Easy: <20' above reservoir, obvious trail/shorter trail (<100'), not steep. 2. Medium difficulty: over 20' above reservoir less obvious trail, narrower trail, some switchbacks, some scrambling over talus, some poison oak. 3. Hard: >200' above reservoir; less obvious trail; extensive scrambling.
Creeks	Is the facility close to other creeks or springs?	1. < 100 feet 2. 100 to 200 feet 3. > 200 feet
	Does the facility show signs of ORVs crossing streams nearby?	1. No 2. Yes
Trail Type	Is the trail developed or user-created?	1. Developed trail 2. User-created trail
Trail Length	Length of trail (feet)?	
ORV	Does the facility show signs of nearby ORV use?	1. No 2. Yes
Bare ground	Does the facility show signs of extensive use & loss of ground vegetation outside the designated site?	1. Low: small areas around fire rings & tent sites 2. Medium: large areas around fire rings & tent sites 3. Large: large contiguous areas & multiple trails to satellite use areas
White Flowers	# "White Flowers" present (toilet paper)?	
Illegal Fish & Wildlife Take	Is there evidence of illegal fish or wildlife take at the site?	1. No 2. Yes

RECREATION USE AND FACILITY ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT D

VISITOR SURVEY INSTRUMENT

The following survey will help Seattle City Light understand the needs of users of the recreational facilities and opportunities it provides and/or supports at Ross Lake, Diablo Lake, Gorge Lake, and the towns of Newhalem and Diablo. The survey is 6 pages long and takes approximately 15 minutes to complete. Most questions are about the **specific recreation facility** and **reservoir** you are visiting on your current trip.

SECTION 1 - YOUR TRIP CHARACTERISTICS

1. Write the name of the recreation facility and select the reservoir where you received this survey:

(A) **Recreation facility**: _____ .

(B) **Reservoir/area**: ❑ Ross Lake ❑ Diablo Lake ❑ Gorge Lake ❑ Town of Newhalem

2. On your current trip, have you already or do you plan to visit any of the other following reservoirs or areas?

[Please check all that apply]

- ❑ Ross Lake
- ❑ Diablo Lake
- ❑ Gorge Lake
- ❑ Town of Newhalem
- ❑ Town of Diablo
- ❑ Ross Lake National Recreation Area
- ❑ North Cascades National Park
- ❑ Lake Chelan National Recreation Area
- ❑ Okanogan-Wenatchee National Forest
- ❑ Mt. Baker-Snoqualmie National Forest
- ❑ Skagit River downstream of Gorge Powerhouse

3. (A) Are you staying overnight in the area or is this a day trip? *[Check only one]* ❑ Overnight ❑ Day Trip

(B) If you are staying overnight on this trip, what accommodations do you expect to use? [Check all that apply]

- ❑ Campground, commercial
- ❑ Campground, NPS
- ❑ Campground, Forest Service
- ❑ Backcountry boat-in camping
- ❑ Backcountry hike-in camping
- ❑ Environmental Learning Center
- ❑ Personal seasonal residence
- ❑ Residence of friends or relatives
- ❑ Lodge/hotel/motel/cabin/rental property/bed & breakfast
- ❑ Other: _____

4. When did you arrive and plan to depart this recreation facility? *(Please specify AM or PM)*

Arrival: _____ (Date) _____ (Time) AM / PM Departure (estimated): _____ (Date) _____ (Time) AM / PM

5. How did your visit to this recreation facility/reservoir fit into your travel plans? [Please check only one]

- ❑ This recreation facility/reservoir **is my primary destination**
- ❑ This recreation facility/reservoir is **one of several destinations**
- ❑ I am **passing through** the recreation facility to my primary destination, which is (specify):_____
- ❑ I **did not plan to visit** this recreation facility/reservoir

6. Regarding your visitation to this recreation facility/reservoir…

(A) Are you a first-time visitor to this recreation facility/reservoir? ❑ YES ❑ NO

(B) In which year did you make your first visit to this recreation facility/reservoir? _____ ***Year***

(C) Over the past 12 months, how many visits have you made to this recreation facility/reservoir? _____ ***Visits***

7. (A) How many people (including yourself) travelled here in the same vehicle as you on this visit?

____ ***Number of people*** ❑ Not Applicable (did not arrive by vehicle)

(B) How many of those people are under the age of 16? _____ ***Number of people***

8. By what means did you enter this recreation facility/reservoir? [Please mark **[X]** only one]

- ❑ Personal vehicle
- ❑ RV/motorhome
- ❑ Vehicle with camper trailer
- ❑ Public transportation or shuttle
- ❑ Motorcycle
- ❑ Walk/hike
- ❑ Bicycling
- ❑ Watercraft
- ❑ Aircraft
- ❑ Other (specify) _____

9. Check **all** the activities that **you expect to participate in** during this visit to this recreation facility/reservoir:

- ❑ Day hiking or walking
- ❑ Backcountry hiking
- ❑ Bicycling
- ❑ Developed drive-in camping
- ❑ Dispersed drive-in camping
- ❑ Backcountry camping
- ❑ Boat-in camping
- ❑ Picnicking
- ❑ Angling
- ❑ Motorized boating on lakes
- ❑ Non-motorized boating on lakes
- ❑ River boating
- ❑ Climbing
- ❑ Horseback riding
- ❑ Historic or interpretive tour
- ❑ Environmental education program
- ❑ Nature or wildlife viewing
- ❑ Driving for pleasure
- ❑ Swimming
- ❑ Outdoor photography
- ❑ Other: _____
- ❑ Other: _____

10. Which **ONE** of the above activities is your **PRIMARY ACTIVITY** for your current visit? _____

11. Please list up to three (3) other areas in the region where you participate in the **PRIMARY ACTIVITY on this trip** identified in Question 10 above.

1. _____ 2. _____ 3. _____

12. (A) Please rate the relative uniqueness of the **recreation opportunities** at this recreation facility/reservoir relative to the opportunities at the above three (3) areas you identified:

Extremely Common Opportunity ← → **Extremely Unique**				
1	2	3	4	5

(B) Please explain what, if anything, is **special** or **unique** about this recreation facility/reservoir relative to other areas in the region. _____

_____

_____

SECTION 2 - EXISTING CONDITIONS

13. (A) Please indicate if **level of the reservoir** or **river** was a problem for your recreation activities at the recreation facility/reservoir you are currently visiting.

Not a Problem	Small Problem	Neither	Moderate Problem	Large Problem	No Opinion/Don't Know
1	2	3	4	5	❑

(B) If you indicated it was a problem, please explain: _____
_____

14. Has anything impacted your ability to participate in any recreation activities at this recreation facility/reservoir?
❑ NO ❑ YES. If **YES**, specify the: (A) **activity**: _____; and (B) **reason**: _____
_____ .

15. Did you experience or see any unsafe conditions or behaviors while recreating at this recreation facility/reservoir? ❑ NO ❑ YES. If **YES**, please specify those conditions: _____
_____

16. (A) How crowded did you feel while recreating at these locations today at this recreation facility/reservoir? *[**Select one number** for each or indicate it was **not applicable** to your visit.]*

LOCATION/AREA	Not at all	Slightly	Moderately	Very	Extremely	Not
On trails	1	2	3	4	5	❑
At the parking area	1	2	3	4	5	❑
At the picnic area	1	2	3	4	5	❑
At a developed campsite	1	2	3	4	5	❑
At a boat-in campsite	1	2	3	4	5	❑
Fishing from the shoreline	1	2	3	4	5	❑
While motorized boating/fishing	1	2	3	4	5	❑
While non-motorized boating/fishing	1	2	3	4	5	❑

(B) **If you felt crowded**, did you modify your recreation plans because you felt crowded? ❑ YES ❑ NO

(C) **If YES**, what did you do? ❑ Moved to a new location ❑ Changed your activity ❑ Continued with current plans ❑ Changed the time of day ❑ Chose not to recreate ❑ Other:_____

17. Did the actions or behavior of any other group or individual interfere with your enjoyment on this trip?
❑ NO ❑ YES. If **YES**, what type of group or person interfered with your enjoyment on this trip?

Group/Person	Reason(s)		
	Proximity	Loudness	Other (specify)
Hikers	❑	❑	❑ _____
Bicyclists	❑	❑	❑ _____
Motorized boaters	❑	❑	❑ _____
Non-motorized boaters	❑	❑	❑ _____
Vehicles	❑	❑	❑ _____
Campers	❑	❑	❑ _____
Stock use	❑	❑	❑ _____
Other: _____	❑	❑	❑ _____

18. Are there any additional recreation amenities or other changes you would like to see at this recreation facility/reservoir? _____

_____

_____

19. How satisfied were you with the following **amenities** at this recreation facility/reservoir today.

Important*: Please only circle a number for the items* ***you used during your current visit*** *to this recreation facility/reservoir. Also, please* ***check*** *the "Did Not Use" box if you did not use the item or it does not exist at the facility.*

		Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied	Did Not Use	If you were dissatisfied, please explain why:
FACILITIES	Picnic sites	1	2	3	4	5	❑	
	Restroom	1	2	3	4	5	❑	
	Trash receptacles	1	2	3	4	5	❑	
	Vehicle parking areas	1	2	3	4	5	❑	
	Boat ramp parking area	1	2	3	4	5	❑	
	Boat ramp	1	2	3	4	5	❑	
	Boat dock	1	2	3	4	5	❑	
	Ferry dock	1	2	3	4	5	❑	
	Tour dock	1	2	3	4	5	❑	
	Visitor center/museum	1	2	3	4	5	❑	
	Playground equipment	1	2	3	4	5	❑	
	Environmental Learning Center	1	2	3	4	5	❑	
	Other:_____	1	2	3	4	5	❑	
ACCESS	Roads within the facility	1	2	3	4	5	❑	
	Trails	1	2	3	4	5	❑	
	Signage to the facility	1	2	3	4	5	❑	
	Signage within the facility	1	2	3	4	5	❑	
	Other:_____	1	2	3	4	5	❑	
INFORMATION	Interpretive/educational information	1	2	3	4	5	❑	
	Recreation visitor information	1	2	3	4	5	❑	
	Reservoir elevation information	1	2	3	4	5	❑	
	River flow information	1	2	3	4	5	❑	
	Other:_____	1	2	3	4	5	❑	

20. How did you obtain information to plan your current trip? (Please select all that apply)

- ❑ Federal or State website
- ❑ City/local/municipal website
- ❑ City Light website
- ❑ Other websites
- ❑ Package tour companies
- ❑ City Light mailers
- ❑ Visitor bureaus/centers
- ❑ Maps/brochures/pamphlets
- ❑ Previous visits
- ❑ Word of mouth
- ❑ Social media (Facebook, Twitter, etc.)
- ❑ Travel guides and tour books
- ❑ Newspaper/magazine article
- ❑ Radio/TV broadcasts
- ❑ Other: _____

SECTION 3 - ABOUT YOU

21. What is the zip code where you live or country if not in the United States?

Zip code: _____ or, country (if not the United States): _____

22. What is your Age: _____.

23. What is your Gender? ❑ Male ❑ Female ❑ Non-binary

24. Which of these categories best indicates your race? Answer only for yourself. Please select **one or more**.

❑ American Indian/Alaskan Native	❑ Asian	❑ White
❑ Native Hawaiian/other Pacific Islander	❑ Hispanic or Latino	❑ Other (specify): _____
❑ Black/African-American	❑ Not Hispanic or Latino	❑ Don't know

25. What is your primary spoken language? ❑ English ❑ Other (specify): _____

26. Please let us know if you have any additional comments regarding your recreation experience during your visit:

Seattle City Light thanks you for taking the time to participate in this survey!

RA-02 GORGE BYPASS REACH SAFETY AND WHITEWATER BOATING PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

City Light.....Seattle City Light
Ecology .....Washington State Department of Ecology
ELC.....Environmental Learning Center
FARWG .....Fish and Aquatics Resource Work Group
FERC.....Federal Energy Regulatory Commission
ISR .....Initial Study Report
LP.....licensing participant
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RARWG.....Recreation and Aesthetics Resource Work Group
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
U.S.C.....United States Code
USFWS .....U.S. Fish and Wildlife Service
USR.....Updated Study Report
Ecology .....Washington Department of Ecology
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

Issues to be addressed in this study were identified during the Study Plan Development Process and in the RA04 Whitewater Recreation issue form.

Gorge Dam diverts water to Gorge Powerhouse downstream, bypassing 2.5 miles of the Skagit River. The reach is referred to as "the Gorge bypass reach." Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach, and public access is restricted in the bypass reach for safety. Flows in the bypass reach are limited to accretion flow, spill-gate seepage, tributary input, and precipitation runoff, except when water is being spilled at Gorge Dam. Evaluating whitewater opportunities in the bypass reach during spill events is of interest to LPs. The study will evaluate the feasibility of recreational whitewater boating in the Gorge bypass reach, including public access, safety concerns, potential effects of recreational whitewater boating on other resources including archaeological sites, and operational constraints.

On March 13, 2020, City Light released the Gorge Bypass Reach Safety and Whitewater Boating Draft Study Plan for LP review and comment. On March 24, 2020, the draft study plan was discussed at a Recreation and Aesthetics Resource Work Group (RARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 30, 2020. The revised draft was discussed on May 7, 2020 at a RARWG meeting. The revised draft study plan was also provided to the Fish and Aquatics Resource Work Group (FARWG) on June 19, 2020 for review. Written comments were received from Upper Skagit Indian Tribe, Washington Department of Fish and Wildlife (WDFW), American Whitewater, NPS, and U.S. Fish and Wildlife Service (USFWS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC. However, the Washington State Department of Ecology (Ecology) provided a study request (Ecology-02 Instream/Recreation Flow Study) related to instream flow that included recreation flow components downstream of the Gorge bypass reach. This study plan addresses, with modifications, some of the elements identified in the study request, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to evaluate the suitability of the Skagit River in the Gorge bypass reach for whitewater boating under current conditions, inform future operational scenarios that include the range of instream flow measures that may be included in a future license, and assess potential constraints such as Project operations and safety concerns. This study will include identifying any river access needs and potential effects of access on other Project resources. Information obtained from other studies examining resources in the Gorge bypass reach, such as FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study (Bypass Instream Flow Model Development Study), will be considered in the Gorge Bypass Reach Safety and Whitewater Boating Study analysis. Due to the physical characteristics of the Gorge bypass reach, e.g., channel shape, substrate and gradient, the study is designed to investigate whitewater suitability for expert paddlers only. The study is not intended to investigate commercial whitewater boating opportunities in the Gorge bypass reach.

The study has the following objectives:

- Describe the whitewater boating opportunity in the Gorge bypass reach including the whitewater difficulty, character of rapids, number of portages, suitability for expert paddlers, and uniqueness of opportunity;
- Determine the range of flows that would provide whitewater boating opportunities in the Gorge bypass reach;
- Quantify the frequency, timing, duration, magnitude, and rate of change of spill events from Gorge Dam annually within the whitewater boating flow range;
- Assess the feasibility of expert whitewater boating, including public safety, effects on generation, and cost of providing whitewater boating in the bypass reach;
- If boating is determined feasible, compare the results of this assessment with an estimate of potential whitewater boating use; and
- If boating is determined feasible, identify existing and potential river access needs and routes, challenges with utilizing those routes, including potential effects to natural, cultural, and other Project resources from increased public access.

2.2 Resource Management Goals

City Light's goal is to evaluate the suitability of the Skagit River in the Gorge bypass reach for expert whitewater boating under current operating conditions, and assess potential constraints and opportunities for these boating opportunities, such as potential effects to natural, cultural, and other Project resources from increased public access as well as Project operations and safety concerns.

The study will provide information to help Indian tribes and resource agencies with jurisdiction in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities. Ecology's resource management goals were identified in its study request.

NPS manages recreation within RLNRA, including the Gorge bypass reach, following the guidance provided in the 2012 RLNRA General Management Plan (NPS 2012). Management of the North Cascades National Park north and south units is guided by the General Management Plan for the North Cascades National Park Complex (NPS 1988).

2.3 Background and Existing Information

The 2.5-mile-long reach of the Skagit River extending from Gorge Dam to Gorge Powerhouse (Gorge bypass reach) flows through a steep, confined canyon that is characterized by bedrock and large boulder substrate. American Whitewater has identified the Gorge bypass reach as a potential whitewater boating opportunity. No published information is available on the whitewater difficulty of the Gorge bypass reach from past trip reports or attempted trips. Public access is restricted in the Gorge bypass reach for safety. Flows in the bypass reach are limited to accretion flow, spill-gate seepage, tributary input, and precipitation runoff, except when water is being spilled at Gorge Dam (City Light 2020). As a result, the existence of a whitewater boating opportunity in the Gorge bypass reach, river access needs associated with whitewater boating, public safety concerns associated with whitewater flows, and effects on other resources including Project operations is unknown at this time.

2.4 Project Operations and Effects on Resources

Gorge Dam diverts water to Gorge Powerhouse downstream, bypassing 2.5 miles of the Skagit River. Project operations at the Gorge Development affect flows in the Gorge bypass reach. Under the current and previous licenses, public access is restricted in the bypass reach for safety. Under normal operations flow in the bypass reach is limited to accretion and tributary inputs during rainfall events and spring snowmelt. Bypass flows also increase when Gorge Dam is spilling. This occurs on an annual basis during maintenance outages as well as when inflow to Gorge Lake exceeds the generation capacity of Gorge Powerhouse. LPs have expressed an interest in investigating the potential for whitewater boating opportunities and public access in the Gorge bypass reach.

2.5 Study Area

The study area is the 2.5-mile Gorge bypass reach from Gorge Dam to Gorge Powerhouse. The reach is a relatively steep, confined canyon characterized by bedrock and large boulder substrate. The suitability of this reach for expert whitewater boating has not been investigated. Public access to the Gorge bypass reach is restricted for safety. There are no established locations to access the river. Access to the river requires crossing over large boulders on steep slopes.

A map of the study area is provided in Figure 2.5-1.

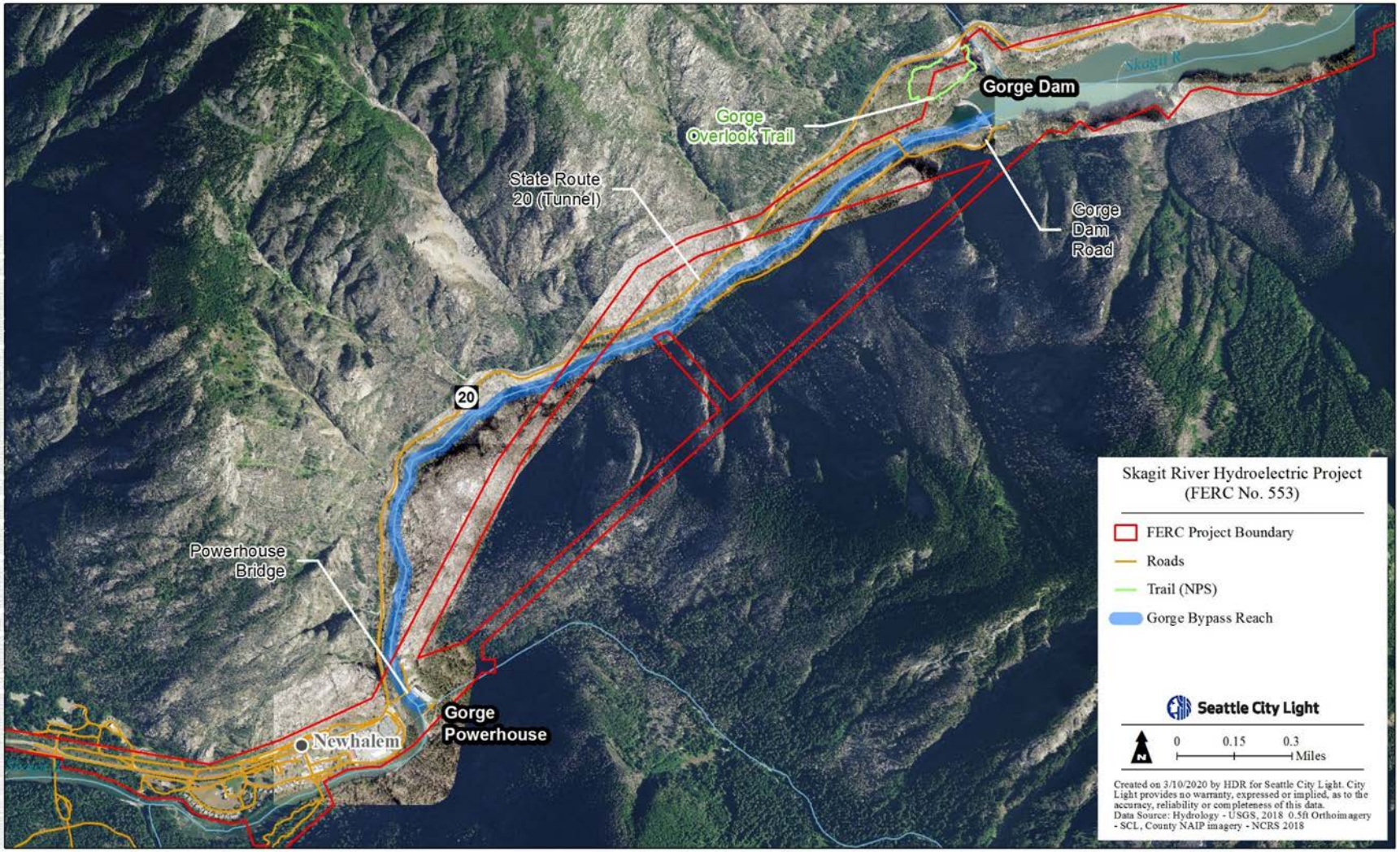

Figure 2.5-1. Proposed Gorge bypass reach study area.

2.6 Methodology

The Gorge Bypass Reach Safety and Whitewater Boating Study will consist of a three phased sequential investigation referred to as Levels 1, 2, and 3 (Whittaker et al. 2005). The phased sequential approach is designed to increase study resolution as investigations progress from one level to the next, as well as share interim results earlier in the relicensing process across resource disciplines. Advancing to more intensive study levels is dependent on results and recommendations in the prior study level.

Each investigation level contains distinct study objectives, methods, and products captured in interim reports. The respective interim reports will include the following information where known: a description of the current understanding of the suitability of whitewater boating opportunity in the Gorge bypass reach, public safety issues, Project operational constraints, competing resources, and explicit decision criteria whether to proceed to the next level of study or suspend further investigation. Progression to the next level of investigation will be terminated if results from the current level indicate the Gorge bypass reach is not a suitable whitewater opportunity due to overly difficult rapids, safety concerns associated with public river access, Project operational constraints or if agency regulations prohibit further investigation due to concerns for effects on competing resources.

The three levels of investigation are described in this study plan, including objectives, potential data sources, methods, anticipated products in interim report for each level, and potential triggers for advancement to the next level of investigation.

Field investigations in Levels 2 and 3, if warranted from previous levels, will be limited to opportunistic flows in the Gorge bypass reach and to the extent practicable, will also take advantage of controlled spills as part of the Bypass Instream Flow Model Development Study. Spill events will not be scheduled specifically for this study. Opportunistic flows may be caused by storm events, or by dam safety tests or other operational requirements in the Project system. Field investigations may be scheduled on short notice based on anticipation of opportunistic flow events.

2.6.1 Level 1: Desktop Analysis

Level 1 investigation will include literature reviews, structured interviews, summary of hydrology in the bypass reach, Gorge Dam spill gate operation, physical description of the river channel in the bypass, description of existing river access, and summary of regulatory agency resource management goals in the bypass reach and tribal interests.

Literature review will include whitewater guidebooks, magazine publications with a focus on whitewater recreation, electronic whitewater guidebooks available online, and Internet searches for trip reports. A table summarizing whitewater opportunities in the Skagit River basin to the confluence with the Sauk River will be compiled. The table will include the name of the whitewater run, river name, put-in and take-out location, length, gradient (feet per mile), and whitewater difficulty. Detailed information on the Gorge bypass reach will be included in the table where information is available. This will include length, gradient, whitewater difficulty and potential access points. Cells where information is unknown will remain blank.

Structured interviews will be conducted with individuals in the whitewater boating community with knowledge of the Gorge bypass reach. The interviews will focus on individuals' knowledge of Gorge bypass reach, any dates with direct observations of Gorge bypass reach, opinion on whitewater difficulty, estimated range of preferred flows for whitewater boating, and other individuals with knowledge on whitewater boating in the bypass.

The recent hydrology of the bypass reach will be analyzed. Analysis will include the annual frequency and timing of spill events, duration, magnitude, and rate of change. The hydrology section of the Level 1 interim report will include a description of Gorge Dam spill gate operations, including the predictability, timing, and reason for planned spill events.

The Level 1 investigation will summarize regulatory agency resource goals and tribal interests for the bypass reach. The Level 1 interim report will include a matrix of relicensing studies being conducted in the bypass reach for respective resource areas.

The Level 1 interim report will include explicit decision criteria whether to proceed to Level 2. Progression to a Level 2 field reconnaissance will be evaluated based on results from the Level 1 interim report. Evaluation criteria will include at a minimum the criteria listed below. Decision Criteria:

(1) Level 1 investigation determines Gorge bypass reach contains rapids suitable / not suitable for whitewater boating;

(2) Access to the river is / is not feasible;

(3) Potential effects on natural and cultural resources can / cannot be resolved for next level of proposed study;

(4) Agency regulations and/or tribal concerns do / do not prohibit further investigation; and

(5) Project operations are / are not able to provide opportunistic spills in range suitable for whitewater boating; and

(6) Opportunities for coordination with other studies.

2.6.2 Level 2: Field Reconnaissance

Level 2 investigations involve opportunistic shore-based observation of flow in the bypass reach during a spill event or controlled spill as part of other relicensing studies. The objective is to observe flow in the bypass reach to evaluate navigability and whitewater difficulty and estimate a suitable range of flows for Level 3 investigation if warranted. River access and safety concerns will also be evaluated during the field reconnaissance.

Participants in the field reconnaissance will receive a brief overview of the relicensing process, the study plan process within the broader relicensing, objectives of the field reconnaissance, and specific criteria to evaluate. The study plan lead will identify areas of interest for the field reconnaissance tour. City Light will coordinate transportation during the field reconnaissance. The field reconnaissance will conclude with a structured focus group in Newhalem. Focus group questions will prompt discussion on navigability, whitewater difficulty, suitable range of flows for whitewater boating, river access needs, safety, other areas of concern, and uniqueness of the Gorge bypass reach compared to other opportunities in the region.

Participants in the Level 2 reconnaissance will be identified in advance of the field reconnaissance. Participants will be nominated collaboratively with the whitewater community. Selection will be based in part on knowledge of whitewater boating opportunities in the Skagit River basin, high level of whitewater boating skills, and experience to evaluate potential safety and whitewater difficulty for the Gorge bypass reach as well as familiarity with the Project relicensing process. The field reconnaissance will be limited to six or fewer participants from the whitewater community for tour logistics and to facilitate focus group discussion.

The Level 2 interim report will summarize findings from the field reconnaissance. The report will include notes from group discussions at individual field locations during the tour, opinions expressed in focus groups, river access needs, potential resource issues identified and summary of findings reported in the Level 1 desktop analysis. Decision criteria identified in the Level 1 desktop analysis will be refined in the Level 2 assessment to determine if the study should progress to Level 3. Progression to a Level 3 multiple flow evaluation will be based on results from the Level 2 interim report.

2.6.3 Level 3: Multiple Flow Evaluation

The Level 3 multiple flow evaluation will consist of a team of six or fewer boaters paddling two to four flows. The range of flows will be based on volumes previously identified in the Level 2 field reconnaissance. Participants will complete a single flow evaluation form after each flow event and participate in a structured focus group. Boaters will complete a comparative flow evaluation form and final structured focus group upon completion of all flow events. The single flow and comparative flow evaluation forms will be developed upon determination that a Level 3 multiple flow evaluation is warranted. The multiple flow reconnaissance will be limited to spill events as described in the Level 2 field reconnaissance.

Similar to the Level 2 field reconnaissance, boaters will be identified in advance collaboratively with representatives of the whitewater community. Participants will need to commit to each flow evaluation for comparison purposes. Participants may elect not to boat if they perceive conditions in the channel are unsafe. Representatives of the whitewater community will be responsible for determining if individuals possess the necessary skills to participate in the Level 3 evaluation. All study participants will be required to sign a liability waiver.

The Level 3 multiple flow evaluation will analyze the boaters' single flow and comparative flow evaluation forms as well as opinions expressed in focus group discussions. The analysis will identify the range of flows identified for whitewater boating including the minimum acceptable flow and the optimum flow, if applicable. The report will also identify the overall whitewater difficulty and list of significant rapids. For safety reasons, non-boater access into the Gorge bypass reach will be limited during Level 3 flow events. Flow conditions and boating opportunities will be documented with photographs and video at key observation points in the Gorge bypass reach for LP review in the reporting phase.

2.6.4 Reporting

The Gorge Bypass Reach Safety and Whitewater Boating Study final report will synthesize information and analysis for the respective levels of study warranted for investigation. For Levels 1 and 2, the report will include the following: (1) description of the whitewater boating opportunity

observed in the Gorge bypass reach; (2) description of the existing access to the Gorge bypass reach; (3) public safety concerns; and (4) summary of natural and cultural resources and operations that could be affected by providing whitewater opportunities. Level 3 reporting, if warranted, will include analysis of multiple flow comparisons as described by Whittaker et al. (2005).

2.7 Consistency with Generally Accepted Scientific Practice

The sequential study approach proposed for the Gorge Bypass Reach Safety and Whitewater Boating Study is based on the publication, Flows and Recreation: A Guide to Studies for River Professionals by Whittaker, et al. (2005). This approach has been successfully applied in other FERC relicensing proceedings.

2.8 Schedule

The Gorge Bypass Reach Safety and Whitewater Boating Study relies on a sequential framework with progression to subsequent levels of study dependent on results from previous levels. Furthermore, the field component is dependent on observation of flows in the Gorge bypass reach, which may include unscheduled spill events from Gorge Dam and controlled releases as part of other relicensing studies. As such, the schedule for completion of specific stages is dynamic.

A tentative schedule is provided below. The Level 1 desktop analysis will be completed in the winter of 2021 (February) allowing sufficient time for Level 2 study planning if warranted by Level 1 results. Level 2 field reconnaissance would then be positioned to take place in the summer or fall of 2021 when anticipated tributary inputs increase flows in the Gorge bypass reach or unscheduled spill events occur at Gorge Dam. If warranted by Level 2 results, Level 3 multiple flow evaluation timing would be based on opportunistic flows from tributary inputs and unscheduled spill from Gorge Dam as well as safety considerations. Interim reports will be provided upon completion of each level of study. Details of the proposed schedule for respective levels of study in the sequential framework are listed below.

<u>Level 1: Desktop Analysis</u>

- Data Collection and Analysis – Winter 2020 – 2021
- Draft Interim Report – Spring/Summer 2021

<u>Level 2: Field Reconnaissance</u>

- Identify Team of Boaters and Agency Representatives for Field Reconnaissance – Summer 2021
- Develop Participant Liability Forms – Spring 2021
- Develop Focus Group Questions – Spring 2021
- Single Flow On-shore Reconnaissance – Summer/Fall 2021 (dependent on when opportunistic or controlled flows occur)
- Draft Report (Initial Study Report [ISR) – March 2022

Level 3: Multiple Flow Evaluation

- Develop Single Flow and Comparative Flow Evaluation Forms – Winter 2022
- Develop Focus Group Questions – Winter 2022
- Identify Team of Boaters and Agency Representatives for Level 3 Multiple Flow Evaluation – Winter 2022
- Multiple Flow On-water Evaluation – Summer/Fall 2022 (dependent on when opportunistic or controlled flows occur)
- Final Report (Updated Study Report [USR) – March 2023

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $75,000.

3.0 REFERENCES

Corbett, R. 1990. A Method for Determining Minimum Instream Flow for Recreation Boating. SAIC Special Report 1-239-91-01. McLean, VA: Science Applications International Corporation.

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Whittaker, D., B. Shelby, W. Jackson, and R. Beschta. 1993. Instream Flows for Recreation: A Handbook on Concepts and Research Methods. U.S. Department of Interior, National Park Service, Anchorage, AK.

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GORGE BYPASS REACH SAFETY AND WHITEWATER BOATING PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Title	As worded, implies a general safety assessment for the bypass reach. Remove "safety" or reword title to better describe the focus of the study on "whitewater boating safety."	Thank you for your comment. Safety is identified as a study objective in terms of safe access to the river, evaluation of the whitewater difficulty and assessment of potential increased public access to the bypass reach in general. No edits made.
2.	Brock Applegate (WDFW)	04/13/2020	Section 1.2 Relicensing Process	In-Text Edit: "This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans…"	Thank you for your comment. Edits to text made to better reflect the RWG and consultation process.
3.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 1.3 Study Plan Development	This study could inform a number of fisheries-related information requests. Study development and implementation should be coordinated with fish & aquatics group.	Thank you for your comment. Licensing participants from other work groups including the F&A RWG are encouraged to review and comment on this study plan. In addition, the implementation schedule will be shared with the other work group participants. No edits made.
4.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 1.3 Study Plan Development	Given the different lengths reported in the many different reports one goal would be measure the length of the Skagit Mainstem that is currently dewatered available for whitewater rafting.	Thank you for your comments. An objective of the study is to describe the physical characteristics of the reach being studied for whitewater boating suitability. The length of the reach will be included in the physical description. No edits made.
5.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 1.3 Study Plan Development	Is there an interest in evaluating flows in this section other than the spill event? Understanding what mechanisms exist for different flows in the reach and then evaluating a range of flows that might be proposed under new license operations would be an interest to a broader range of paddlers than extreme spill events.	Thank you for your comments. The Level 1 Desktop Analysis will include an analysis of spill events in terms of frequency, timing, duration, magnitude of spill volume (cfs) and rate of change. The spill hydrology analysis will be combined with other information gathered in the Level 1 Desktop Analysis in the interim report. The Level 1 interim report

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				New comment Brock Applegate (WDFW) provided 05/7/2020: I support Jon-Paul's comment. We should evaluate the flows at many levels, not just extreme spill.	will make a determination whether Level 2 study is warranted based on the information collected. The determination to proceed to Level 2 or Level 3 will not be limited to the hydrology of extreme spill events only. Field implementation of Levels 2 and 3, if warranted, are limited to opportunistic spill events. No edits made. **Response to comment provided on 05/7/2020:** Thank you for your comment. Comment noted.
6.	Brian Lanouette (Upper Skagit Indian Tribe)	04/7/2020	Section 1.3 Study Plan Development	As well as fishery resources **New comment Brock Applegate (WDFW) provided 05/7/2020:** WDFW considers fishery resources very important. I would wager all the Co-Managers do. WDFW also recommends that you add fishery resources for consideration.	Thank you for your comment. Fishery resources are included in the phrase "other resources…" in the sentence. No edit made. **Response to comment provided on 05/7/2020:** Thank you for your comment. Comment noted.
7.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 2.1 Study Goals and Objectives	Current conditions there is no water, goal should be a range of flows as identified in the re-license process. **New comment Brock Applegate (WDFW) provided 05/7/2020:** I would think that SCL would want to spill less than more, so WDFW recommends that the Fish and Aquatic WG coordinate with the Recreation WG do gather data at opportunistic flows. Let's work together on this relicensing.	Thank you for your comments. Current conditions include spill events in the Gorge bypass reach. No edits made. **Response to comment provided on 05/7/2020:** Thank you for your comment. Comment noted. Please see response to comment #39.
8.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: "The goal of this study is to evaluate the suitability of the Skagit River in the Gorge bypass reach for whitewater boating under	Thank you for the suggested edit. Accepted with minor amendment. In the study phase, the goal is limited to current conditions in the Gorge Bypass. Future operational scenarios in

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				current conditions and future operational scenarios that include the range of instream flow measures that may be included in a future license, and assess potential constraints such as Project operations and safety concerns."	the Gorge Bypass will be evaluated in the development of the Draft License Application (DLA).
9.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.1 Study Goals and Objectives	And cultural and fisheries.	Thank you for your comment. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process. No edits made.
10.	Brian Lanouette (Upper Skagit Indian Tribe)	04/7/2020	Section 2.1 Study Goals and Objectives	Include in objectives: If boating is determined feasible, identify the impacts of boating and necessary bypass reach flows on fishery and other natural resources downstream. If boating is determined feasible, identify the impacts of the flow regimes on the George reservoir's aquatic community.	Thank you for your comments. Evaluation of flow regimes at the Project may be part of the comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider the potential effects of modified flow regimes on respective resources in their review of the DLA in the NEPA process. No edits made.
11.	Thomas O'Keefe (American Whitewater)	04/15/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: Add: "Assess the recreational potential of the river corridor for recreational boating if portions of the project are removed;" Comment: We can wordsmith this and coordinate with other resource groups. If agencies or tribes are considering studies to evaluate project removal alternatives, we would like to see a basic recreational assessment. This could be a	Thank you for your comments. The study does not consider project removal scenarios. No edits made.

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				narrative based on historical information, photos, and gradient profiles.	
12.	Thomas O'Keefe (American Whitewater)	03/26/2020	Section 2.1 Study Goals and Objectives	In-text edit: "Quantify the frequency, timing, duration, ~~and~~ magnitude, and rate of change of spill events from Gorge Dam annually within the whitewater boating flow range;"	Thank you for your comments. Edit accepted. Rate of change will be included in the hydrologic analysis of spill events.
13.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.2 Resource Management Goals	In-text edit: "City Light's goal is to evaluate the suitability of the Skagit River in the Gorge bypass reach for expert whitewater boating under current operating conditions, and assess potential constraints and opportunities for these boating opportunities, such as potential effects or benefits to natural, cultural, and other Project resources from increased public access as well as Project operations and modified flow regimes and safety concerns." Comment: You may need to wordsmith this but as written it all assumes negative impact. As in the Jackson Hydropower licensing, often we can find opportunities and positive benefits of flushing flows or ecological process flows that also provide a recreational experience. The goal of the study should be to identify or highlight any of these opportunities.	Thank you for your comments. City Light agrees with the proposed edits to this sentence expanding the assessment of the potential constraints and "opportunities" as suggested by the respondent. However, it is premature for the study to assess modified flow regimes at this stage in the licensing process. Edits made to the text to reflect this. Evaluation of flow regimes at the Project may be part of the comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider the potential effects of modified flow regimes on respective resources in their review of the DLA in the NEPA process.
14.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.2 Resource Management Goals	Why limit assessment of constraints to those caused by public access? If whitewater boating will be seeking spills over Gorge, the study should seek to identify potential conflicts with natural resources needs. Conversely, how might whitewater boating needs coincide with natural resources needs?	Thank you for your comment. The assessment of potential effects is not limited to public access alone. The potential effects associated with public access were provided in this section as examples. In addition, the study goals and objectives do not include a recommendation for scheduled spills for

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					whitewater boating purposes as the comment suggests. No edits made.
15.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.2 Resource Management Goals	Does SCL have specific management goals in mind? If so, it would help to see that described here.	Thank you for your comment. Paragraph 1 in Section 2.2 describes City Light's goals as they relate to this study. The study plan follows FERC's seven criteria for study requests. One of those criteria is to explain the relevant resource management goals (5.9(b)(2). City Light provided their goals for the study. Resource agencies and other license participants are encouraged to provide resource management goals specific to the proposed study as well. No edits made.
16.	Brian Lanouette (Upper Skagit Indian Tribe)	04/11/2020	Section 2.3 Background and Existing Information	Add "cultural, and fishery and aquatic resources" to this list. **New comment Brock Applegate (WDFW) provided 05/7/2020:** WDFW highly recommends that you give details and examples. Details help the reader understand the meaning of your statement.	Thank you for your comments. The phrase "other resources…" in this sentence includes cultural, fishery and aquatic resources. No edits made. **Response to comment provided on 05/7/2020:** Thank you for your comment. Comment noted.
17.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.4 Project Operations and Effects on Resources	A holistic treatment of the resource should also include benefits of dynamic flow regime. **New comment Brock Applegate (WDFW) provided 05/7/2020:** I would assume that SCL will do an effects analysis when they implement the operations model, a current study plan. The LPs will need to know the effects of different flow regimes before the submittal of the DLA. WDFW recommends that SCL coordinate with other staff in the Fish and Aquatic WG.	Thank you for your comments. It is beyond the scope of this study to evaluate the effects on other resources resulting from various flow scenarios. Evaluation of flow regimes at the Project may be part of the comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider the potential effects of modified flow regimes on respective resources in their review of the DLA in the NEPA process. No edits made.

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					Response to comment provided on 05/7/2020: Thank you for your comment. Comment noted. Please see response to comment #21.
18.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/11/2020	Section 2.4 Project Operations and Effects on Resources	I don't see any discussion of effects on resources here, only a statement on operations.	Thank you for your comment. The intent of this section is to discuss the potential effects on resources in order to inform the study goals and objectives. No edits made.
19.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/12/2020	Section 2.4 Project Operations and Effects on Resources	Frequency, magnitude and duration of spills should be noted in PAD over the term of last license, and used in this document to address study goals.	Thank you for your comment. The Desktop Analysis in Level 1 will include a detailed hydrologic analysis of spill events including frequency, timing, duration, magnitude of spill volume (cfs) and rate of change. No edits made.
20.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	Would "irregular basis" be a better description? If spill events are predictable, explain the reason, time of year, and how far in advance it is known that a spill will occur.	Thank you for your comments. Spill events occur on a near annual basis but cannot be predicted with accuracy because they are dependent on annual snowpack and snowmelt run-off patterns combined with short term weather events. You are correct in referring to them as "irregular" but data also indicates spill events occur in most years. The Desktop Analysis in Level 1 will include a detailed hydrologic analysis of spill events. No edits made.
21.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.4 Project Operations and Effects on Resources	LPs have expressed an interest in investigating instream flows, woody debris, and sediment transport for fisheries & aquatics, and this study should consider potential conflicts with these other resource needs.	Thank you for your comments. It is beyond the scope of this study to evaluate the effects on other resources resulting from various flow scenarios. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				New comment Brock Applegate (WDFW) provided 05/7/2020: SCL will do evaluate the effects of different flows when they implement the Operation Model Study Plan and to some degree, during the Instream Flow Model implementation, which informs the Operations Model.	whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made. **Response to comment provided on 05/7/2020:** Thank you for your comment. City Light agrees that the Operations Model and the Instream Flow Model will inform evaluation of effects that will occur during preparation of the DLA.
22.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.5 Study Area	This study should consider how other resource interests may impact the study area. For example, fisheries and aquatics have expressed the need to understand how interruption of wood and gravel transport have affected the geomorphology of the bypass reach.	Thank you for your comments. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made.
23.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/13/2020	Section 2.5 Study Area	Regarding cultural resources, Upper Skagit Indian Tribe will propose the By-pass reach be included in the project boundary and in the APE.	Thank you for your comments. Comment Noted.
24.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6 Methodology	"Competing or coincident resource needs"	Thank you for your comments. The interim reports for respective levels in the study are designed, in part, for license participants to evaluate the suitability for whitewater boating in the Gorge Bypass reach based on information collected at the current level of study and make a determination if progression to the next level of study is warranted. Potential competing and/or complimentary resources, if any, will be identified as part of the decision process but detailed analysis will not be completed on the other resource areas as part of this study.

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					A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made.
25.	Brock Applegate (WDFW)	04/13/2020	Section 2.6 Methodology	In-text edit: "Progression to the next level of investigation will be terminated if results from the current level indicate the Gorge bypass reach is not a suitable whitewater opportunity due to overly difficult rapids, overly dangerou(s) ~~concerns with~~ public river access…"	Thank you for your comments. The study plan is referring to concerns for public safety. Edits made to the text to reflect the safety concerns associated with public river access.
26.	Thomas O'Keefe (American Whitewater)	04/15/2020	Section 2.6 Methodology	My one concern here is "overly dangerous" can mean different things to different people based on their skill and experience.	Thank you for your comments. The phrase "overly dangerous" was proposed by a comment respondent. The study plan is referring to concerns for public safety. Edits made to the text to reflect the safety concerns associated with public river access. Assessment of the whitewater boating difficulty will be objective using the International Scale of Whitewater Difficulty. This reference will be added to the text.
27.	Thomas O'Keefe (American Whitewater)	03/26/2020	Section 2.6 Methodology	I am not sure what this means. Just having "concerns" does not seem like the appropriate threshold.	Thank you for your comments. Edits made to the text to reflect the safety concerns associated with public river access.
28.	Thomas O'Keefe (American Whitewater)	03/26/2020	Section 2.6 Methodology	What type of "agency regulations" are we talking about here?	Thank you for your comments. The Gorge Bypass reach is located on NPS lands. As such, NPS has oversight on managing natural resources, recreation and access. The interim reports for each level of study will need to consider NPS regulations prior to progressing

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					to the next level of study, if warranted. No edits made.
29.	Brian Lanouette (Upper Skagit Indian Tribe)	04/8/2020	Section 2.6 Methodology	, for example, the impacts that the use or any changes in flow may have on fishery resources.	Thank you for your comments. Fishery resources are included in the term "resources". No edits made.
30.	Thomas O'Keefe (American Whitewater) Brock Applegate (WDFW)	03/26/2020	Section 2.6 Methodology	In-text edits by Multiple Authors: "Spill events will not be scheduled specifically for this study~~.~~ ~~—~~but may be coordinated with other instream flow studies designed to address other instream flow issues for fisheries or geomorphic processes. Opportunistic flows may be caused by storm events, or by dam safety tests or other operational requirements in the Project system. Field investigations ~~will —~~may be scheduled on short notice based on anticipation of opportunistic flow events~~.~~ ~~–~~but every attempt will be made to provide enough lead time~~. SCL will give best effort to~~ and coordinate with interested LPs~~, when future spills look possible.~~"	Thank you for your comments. The suggested edits were incorporated (in part) into the revised version.
31.	Thomas O'Keefe (American Whitewater)	03/26/2020	Section 2.6 Methodology	You can wordsmith this. I am fine with not scheudling solely for whitewater but if we are doing other flow studies, let's document a commitment to coordinating. I heard that sentiment expressed in our recent webinar, but it needs to be reflected in the document.	Thank you for your comments. See response to Comment 30 above.
32.	Susan Rosebrough-Jones (NPS)	04/14/2020	Section 2.6 Methodology	NPS supports American Whitewater's comments and also recommends the study be coordinated with other studies vs. solely making use of unscheduled spill events as it allows more time for planning and addressing a safe study.	Thank you for your comments. City Light has accepted (in part) the edits recommended by American Whitewater and WDFW in comment No. 30 above. City Light will certainly attempt to coordinate resource studies taking place in the Gorge Bypass reach where co-location of study efforts is permissible and safety measures are in place.

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					At this point in time, there is no planned spill events specific for resource studies in the Gorge Bypass reach. Should that change during the licensing process then City Light will communicate across resource areas to coordinate field investigation efforts where permissible and safe.
33.	Thomas O'Keefe (American Whitewater)	04/15/2020	Section 2.6 Methodology	I would not assume they all "will" be scheduled on short notice. If for example we have a good snowpack we should be able to have some heads up on liklihood of spill events and opportunities we can take advantage of.	Thank you for your comments. The predictability of spill events is contingent, in part, on run-off forecasts. In years with higher snowpack longer range forecasts can be made. In years with shallower snowpack spill events can occur with less predictability and are typically associated with individual storm events with heavy precipitation. No edits made.
34.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.6.1 Level 1: Desktop Analysis	Let's also include timing and not just physical attributes of the gate operation. What do we know about when gates are opened or adjusted for spills, maintenance, etc.	Thank you for your comments. Analysis of "Gorge Dam spill gate operation" includes physical capabilities of the gates as well as analysis of when and why spill gates are operated. This will include opening for maintenance purposes and safety tests. The volume of discharge spilled during maintenance and safety tests will be reported. No edits made.
35.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1 Level 1: Desktop Analysis	And how conditions might change under various PMEs, such as restored transport of woody debris and sediment.	Thank you for your comments. The intent is to describe the current physical conditions of the Gorge Bypass reach in the Level 1 Desktop Analysis. It is premature at this stage to predict what PM&E's might be included in the new license and how PM&E's may alter the physical description of the river channel in the Gorge Bypass reach. No edits made.

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36.	Thomas O'Keefe (American Whitewater)	03/26/2020	Section 2.6.1 Level 1: Desktop Analysis	I have had good luck on a couple of projects having people fill out a simple survey to identify a pool of people with interest and based on responses we can identify good candidates for interviews.	Thank you for your comments. Input appreciated. We look forward to working with you in this phase of the study. No edits made.
37.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1 Level 1: Desktop Analysis	And rate of change.	Thank you for your comments. Edit incorporated into the revised version.
38.	Rick Hartson (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Level 1: Desktop Analysis	Including the predictability, timing, and reason for planned spill events.	Thank you for your comments. Edit made. Timing of spill events is included in the hydrology analysis as part of the Level 1 Desktop Analysis. The reasons for spill events will be added to the analysis using a categorized list. Predictability of spill will be an outcome of the hydrology analysis.
39.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.6.1 Level 1: Desktop Analysis	In-Text Edit: "The Level 1 interim report will include a matrix of relicensing studies being conducted in the bypass reach for respective resource areas~~.~~ ~~–~~that includes relevant details on timing and flows. Comment: This needs a bit more elaboration. At a minimum let's include information on timing and flows for any other studies in this reach. See my suggested edit.	Thank you for your comments. The Level 1 Desktop Analysis will be completed early in the study process most likely before any other studies have started field implementation. As such, the matrix will be limited to a list of other studies being conducted in the Gorge bypass reach, study objectives, and, where available, schedule for field work. At this point in time no resource studies include a schedule for spill. Results from other studies will not be available when the Level 1 Desktop Analysis is completed. No edits made.
40.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1 Level 1: Desktop Analysis	What information will be included in the matrix? Specific points of overlap with other studies, including information that will be shared across studies? Will specific agency and tribal interests be identified and listed? Explain how coordination across resource groups, agencies, and tribes will lead to a	Thank you for your comments. The Level 1 Desktop Analysis will be completed early in the study process most likely before any other studies have started field implementation. As such, the matrix will be limited to a list of other studies being conducted in the Gorge

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				complete matrix that adequately identifies information needs and interests.	bypass reach, study objectives, and, where available, schedule for field work. The matrix is not intended to coordinate all information related to the bypass reach. City Light welcomes further discussion with licensing participants on broader coordination issues and information needs. No edits made.
41.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.6.1 Level 1: Desktop Analysis	While this is part of desktop analysis, presumbably these first two criteria will be based on site knowledge and involve a field trip. If consultants or SCL personnel will be in the field to evalute these critera, a representative from American Whitewater and NPS should be present.	Thank you for your comments. Comment noted. City Light will coordinate field investigation efforts with licensing participants where permissible and safe.
42.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.1 Level 1: Desktop Analysis	Nowhere does this draft reference the Cultural Resources By-pass Survey plan, which clearly overlaps with this study. Somewhere this Methodology section needs to explicitly say it will coordinate with overlapping studies and identify them in more than just a "matrix". The cross-resource coordination that we've been hearing much about at CRWG meetings needs to show up here.	Thank you for your comments. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made.
43.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.1 Level 1: Desktop Analysis	Usage of "mitigation" here is premature, if it is referring to the term's regulatory meaning in the Nat. Hist. Preserv. Act. You can't mitigate without first knowing significance and effects.	Thank you for your comments. Edit made. The term "mitigation" will be replaced with the word "resolved" to avoid regulatory interpretations.
44.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.6.1 Level 1: Desktop Analysis	In-Text Edit: Add Bullet Point: "Opportunities for coordination with other studies" Comment: Not sure if this belongs here but somehwere in Level 1 it would be good to	Thank you for your comments. Edit made. City Light agrees with the additional criteria recommended by the respondent.

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				identify opportunites for coordination with other studies (e.g. geomorphic studies of this reach).	
45.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.2 Level 2: Field Reconnaissance	Is it possible that spill events will be shaped to attain the variety of flow conditions desired? If so, it will be imperative to coordinate with fisheries and aquatics interests.	Thank you for your comments. The Level 2 Field Reconnaissance is intended to observe spill without shaping. With that said, the Level 1 Desktop Analysis may recommend a target range of spill during which the Level 2 Field Reconnaissance might take place but the recommendation should be viewed as an estimate only and not involve shaping at this point in time. No edits made.
46.	Brian Lanouette (Upper Skagit Indian Tribe)	04/12/2020	Section 2.6.2 Level 2: Field Reconnaissance	Upper Skagit Indian Tribe again requests opportunity to observe spill events in the bypass reach. Additionally, Upper Skagit Indian Tribe requests notification in advance of all spill events, regardless of whether they will be observed as part of the whitewater boating study, as well as an understanding of how spill events are scheduled and the amount of lead time that can be expected.	Thank you for your comments. Participation in levels 2 and 3 of the Gorge Bypass Safety and Whitewater Boating Study will be limited to minimize congestion and oversee safety measures. City Light will coordinate with LPs on opportunities to observe spill events. The Upper Skagit Indian Tribe's requests to observe spill events have been responded to directly at staff level outside of the relicensing process. Scheduling of spill events for planned maintenance is dynamic and dependent on market conditions and other factors. Other events are unscheduled in response to natural flows. The PAD describes the nature and frequency of spill operations post facto. City Light will coordinate field investigation efforts with licensing participants where permissible and safe. Additional follow up on this item is invited outside of this forum to improve understanding of City Lights operations. No edits made.

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47.	Susan Rosebrough-Jones (NPS)	04/14/2020	Section 2.6.2 Level 2: Field Reconnaissance	NPS would like to be present in the field for the Level 2 and Level 3 studies. The NPS recommends that the same boaters be utilized for each of the Level 2 and Level 3 flows.	Thank you, your request is noted. City Light will coordinate field investigation efforts with all licensing participants where permissible and safe. City Light agrees it will be ideal to have the same group of whitewater boaters participate in Level 2 and Level 3 of the investigation.
48.	Bob Mierendorf (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.2 Level 2: Field Reconnaissance	Presumably the cultural survey will be referenced in the Level 1 analysis and any cultural survey results should feed into the Level 2 assessment, as it's scheduled ahead of this study's completion. None of this is made clear in this plan.	Thank you for your comments. The Level 1 Desktop Analysis will be completed early in the study process most likely before the cultural resource study in the Gorge Bypass has started field implementation. As such, it is not anticipated the results of the cultural resources study will be available for the Level 2 Field Reconnaissance. Nonetheless, the interim report from the Level 1 Desktop Assessment will be publicly available for members of the cultural resources work group to review and provide input. No edits made.
49.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.6.3 Level 3: Multiple Flow Evaluation	Prior to setting flows, assessing existing mechanisms for adding a range of flows into the by-passed reach should be evaluated. Maybe a difference of 20 CFS provides greater boater experience and safety but cannot be obtained from spill, but valves and other water ways may exist in the dam already. However, water quality assessments should be addressed from different release points through the dam.	Thank you for your comments. The Level 3 Multiple Flow Evaluation will utilize opportunistic spill events using the spill gates. There is no plan to use other infrastructure to alter the volume of spill flows. Furthermore, 20 cfs differences in flow volume are likely not detectable by whitewater boaters given the channel width, depth and structure in the Gorge Bypass. No edits made.
50.	Rick Hartson (Upper Skagit Indian Tribe)	04/11/2020	Section 2.6.3 Level 3: Multiple Flow Evaluation	Is it possible that spill events will be shaped to attain the variety of flow conditions desired? If so, it will be imperative to coordinate with fisheries and aquatics interests.	Thank you for your comments. The Level 3 Multiple Flow Evaluation will utilize opportunistic spill events using the spill gates. There is currently no plan to shape opportunistic spill events at this point in time. No edits made.

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51.	Brian Lanouette (Upper Skagit Indian Tribe)	04/8/2020	Section 2.6.3 Level 3: Multiple Flow Evaluation	Again, Upper Skagit Indian Tribe requests notification of spill events and flow evaluations. Upper Skagit Indian Tribe would like to observe the flow evaluations for analysis of potential impacts to fishery resources.	Thank you for your comments. See Comment #46.
52.	Brian Lanouette (Upper Skagit Indian Tribe)	04/8/2020	Section 2.6.3 Level 3: Multiple Flow Evaluation	Upper Skagit Indian Tribe requests that the report evaluate the impacts of the flow ranges proposed on cultural and fishery resources.	No edits made. It is beyond the scope of this study to evaluate the effects on other resources resulting from various flow scenarios. Evaluation of flow regimes at the Project may be part of the comprehensive resource effects analysis that will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider the potential effects of modified flow regimes on respective resources in their review of the DLA in the NEPA process.
53.	Brian Lanouette (Upper Skagit Indian Tribe)	04/12/2020	Section 2.6.4 Reporting	Add natural or fishery resources and cultural resources here for clarity	Thank you for your comments. Edits incorporated into revised version.
54.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	04/13/2020	Section 2.8 Schedule	Recommend to specifically share and request comments on these interim reports with ALL other RWGs.	Thank you for your comments. Comment noted.
55.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.8 Schedule	I assume you believe opportunistiic flows will be avaialble during this time and maybe you could comment on when spills occur. Driving up the highway I think I have seen water in the channel more often during the spring and would have thought spring 2021 would be the time to do this. Please include some justification for timing and any information you have on when spills occur to validate this timing. Alternatvely, if this information will	Your observations are appreciated, but no edit made. Our preliminary analysis presented in the PAD suggests that during the current license term, spill events occur most frequently in June and July followed by October and November. Flow forecasting and operational scheduling will be taken into account when planning the field components.

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				be collected as part of Level 1 analysis, please build in some flexiblity on timing based on that analysis and knowledge of when opportunistic flows are likely to occur.	
56.	Brian Lanouette (Upper Skagit Indian Tribe)	04/8/2020	Section 2.8 Schedule	Consultation with co-managers regarding the impacts of the field reconnaissance.	Thank you for your comments. Interim reports will be provided to all LPs to review and provide input. No edit made.
57.	Thomas O'Keefe (American Whitewater)	04/16/2020	Section 2.8 Schedule	Same coment as above? Is summer/fall likely to work? Or do we need to build in flexibility to include spring?	Thank you for your comments. During the current license term, spill events occur most frequently in June and July followed by October and November. No edit made.
58.	Judy Neibauer (USFWS)	05/13/2020	General Comments	In terms of looking at recreation in the Gorge bypass reach, you should plan at looking at where recreation will be in terms of access facilities, parking, trails, use of riverine habitat and water for rafting, and how they may overlap with key salmonid habitat. Should that reach become important and watered up for anadromous fish to use, there could be key areas (thermal, gravels, forage, spawning, rearing, cover, etc.) that should be protected from degradation at certain times of the year. When finalizing recreational study plans, drawing upon and linking to information collected in the geomorphology study, erosion study, etc., may help determine other key survey sites or types of data collection to assist in effects analysis.	Thank you for the comments. The study includes an evaluation of ingress and egress to the river. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made.
59.	Susan Rosebrough-Jones (NPS)	05/19/2020	General Comments	The NPS needs to be part of the team assessing access, safety, and other resource issues at all 3 phases of study. All LPs should be given the opportunity to observed the study. Advance notice of 14 days would be optimal, but it is understandable that SCL may not be able to accommodate this. However, we	Thank you for the comments. LPs will have an opportunity to provide input for the Level 1, 2 and 3 reports. City Light will make every effort to provide advance notification to LPs where possible. Scheduling of spill events for planned maintenance is dynamic and dependent on market conditions and other

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				need agree on what (# days) the advance notification will be prior to the study.	factors. Other events are unscheduled in response to natural flows. The PAD describes the nature and frequency of spill operations post facto. City Light will coordinate field investigation efforts with licensing participants where permissible and safe. No edits made.
60.	Susan Rosebrough-Jones (NPS)	05/19/2020	General Comments	Geologic hazards need to be considered in the assessment (rock falls, snow avalanche, etc.)	Thank you for the comment. The study will examine the structure of the river channel from a paddler's perspective, e.g., interaction between river flow and the channel bed surface resulting in hydraulic features. Geologic hazards are part of that evaluation of river hydraulics. Rockfall and avalanche paths will also be considered in the safety evaluation of river ingress and egress. No edits made.
61.	Susan Rosebrough-Jones (NPS)	05/19/2020	General Comments	It would be helpful to know what the discharge is for typical operational spill events. The study should look at hydraulics (depth, velocity, etc.), as well as hydrology of flows. It is our understanding that these are covered in Phase I of the study.	Thank you for the comments. Level 1 will include an analysis of spill events including discharge volume. The PAD describes the nature and frequency of spill operations post facto. Depth and velocity will not be measured at river cross-sections as part of this study. The Corbett method (Corbett 1990) utilized depth and velocity measures to estimate minimum flows for recreation boating but this method does not serve as good predictor of boatability (Whittaker et al 1993). No edits made.
62.	Susan Rosebrough-Jones (NPS)	05/19/2020	General Comments	The WW Study should also address and link to fish and aquatic resource issues and the Instream Flow Study. SCL should coordinate this study with the FAWG by including updates as part of the FAWG agenda.	Thank you for the comments. The Gorge Bypass Safety and Whitewater Boating Study will be provided to the FARWG for their review. All LPs, including members of the FARWG have the opportunity to review and comment on the Level 1, 2, and 3 reports. City Light will inform all RWGs when Level 1, 2,

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					and 3 reports are available for review and comment. A comprehensive resource effects analysis will be developed and integrated during the preparation of the DLA. License participants will have an opportunity to consider effects of whitewater boating, if warranted, on other resources in their review of the DLA in the NEPA process. No edits made. It is beyond the scope of the Gorge Bypass Safety and Whitewater Boating Study to address fish and aquatic issues directly in the study report. No edits made.
63.	Susan Rosebrough-Jones (NPS)	05/19/2020	General Comments	The NPS is concerned about the potential for fish stranding depending on how this study is implemented and the NPS would like to be part of this assessment.	Thank you for your comment. Per requirements of the current license, ramping rates associated with any spill event must follow established operating rules which account for salmon and steelhead protection measures, including spawning flows and associated minimum flows, fry outmigration flows, juvenile rearing flows, downramp amplitudes, and ramping rates. City Light will make every effort to provide advance notification of spill events to LPs where possible. No edits made.

RA-03 PROJECT FACILITY LIGHTING INVENTORY PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

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List of Acronyms and Abbreviations

BMP .....best management practice
City Light .....Seattle City Light
ELC .....Environmental Learning Center
fc .....footcandles
FERC.....Federal Energy Regulatory Commission
IDSA .....International Dark Sky Association
IES.....Illuminating Engineering Society
IESNA.....Illuminating Engineering Society of North America
ISR .....Initial Study Report
lm .....lumens
LP.....licensing participant
mLux.....milli-Lux
NEC.....National Electrical Code
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RARWG.....Recreation and Aesthetic Resources Work Group
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SR.....State Route
U.S.C.....United States Code
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

A study will be undertaken to conduct an inventory and map the locations of outdoor lighting equipment installed at Project facilities and identify the current use and need for lighting at Project facilities. This study addresses issues raised in Issue Form RA05 – Night Sky submitted by the NPS. Washington Department of Fish and Wildlife (WDFW) also raised that dark skies protect migrating passerines which can become confused by lights at night. WDFW recommends downward pointing lights; red-flashing lights at the least amount per minute as required by the Federal Aviation Administration for all towers and airspace obstacles; to reduce light pollution by specifying lighting only where it is needed and when it is needed; when light is needed use less light; specifying energy efficient lighting that is shielded and directed downward; and to specify light with a warmer color. (Issue Form RA-05: Night Sky).

On April 24, 2020, City Light released the Project Facility Lighting Inventory Draft Study Plan for LP review and comment. On May 7, 2020, the draft study plan was discussed at a Recreation and Aesthetics Resource Work Group (RARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 18, 2020. The revised draft was discussed on June 25, 2020 at a RARWG meeting. Written comments were received from NPS, WDFW, and U.S. Fish and Wildlife Service (USFWS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to inventory Project facilities located within the Project Boundary and within the RLNRA that utilize lighting at night. The objectives are as follows:

- Identify Project facilities within RLNRA that utilize outdoor nighttime lighting and describe characteristics of the luminaires.[1]
- Describe outdoor lighting needs at each Project facility and the operating periodicity, design, and intensity of lights being used.

2.2 Resource Management Goals

City Light maintains lighting at Project facilities for safety reasons, and to protect historic character, and other Project purposes. NPS has resource management goals related to artificial lighting that may apply in the vicinity of the Project.

The National Park Service Organic Act of 1916 states that the purpose of national parks is "… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Night sky resources are considered a part of the "scenery and the natural and historic objects" that are conserved under this act. NPS management policy 4.10 states that NPS "will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light" (NPS 2006). Additionally, NPS "will minimize light that emanates from park facilities, and also seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks" (NPS 2006).

Preserving the natural cycles of light and dark have ecological value to park system resources, recreational and aesthetic importance to park visitors and are part of the natural and cultural aesthetic of the parks. NPS outlines the policy for protecting night skies in Management Policies (NPS 2006) and as identified by the RLNRA General Management Plan (NPS 2012): "The NPS will complete an inventory of night sky conditions and will work with partners and adjacent land managers to protect night sky by reducing light pollution within RLNRA and on adjacent lands. For example, the NPS will work with Seattle City Light to reduce light pollution in Diablo and Newhalem."

2.3 Background and Existing Information

Details about Project lighting and the night sky can be found in the PAD (City Light 2020). Because of the Project's location within the North Cascades National Park Complex, development is generally limited to City Light, NPS facilities, and State Route (SR) 20 (Washington State Department of Transportation facility). The existing nighttime environment in the Project is dark,

[1] Luminaire definition: "A complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light" (Illuminating Engineering Society [IES] 1947; National Electrical Code (NEC), Article 100 [NEC 2017]).

with very limited introduced nighttime lighting. The Stephen Mather Wilderness, designated in 1988, borders much of the Project Boundary in the RLNRA. The nighttime photic environment is a resource that NPS manages, and stray light at night has the potential to affect wilderness character qualities and wildlife habitat therein.

NPS conducted ground-based photometric measurements in North Cascades National Park and RLNRA and identified the Project to be a source of light pollution (Hoffman et al. 2015). Light sources are currently being used at Project hydroelectric facilities, housing and security structures, and City Light visitor service facilities. NPS identified Diablo Dam as having no shielding or other modifications to direct the light to where it is needed and reduce light disbursement and glare (Hoffman et al. 2015). An analysis of the light emitted from the post lamps on top of the dam showed a vertical illuminance value of 0.1 milli-Lux (mLux) at a distance of 5.3 km. Light is also introduced by vehicle traffic on SR 20.

2.4 Project Operations and Effects on Resources

Safe environments require adequate illumination levels as recommended by the Illumination Engineering Society of North America (IESNA) and documented in the IESNA Lighting Handbook (Rea and IESNA 2000). Recommended lighting levels vary by the task to be performed, such as walking along a path or working on machinery.

However, lighting also can obscure views of the stars and have negative effects on night sky resource management goals. The illumination levels recommended by the IESNA to create a safe environment may conflict with an area's night sky goals. This study will collect information on the safety benefits and use requirements of existing lighting as well as characteristics of the lighting.

2.5 Study Area

The study area includes all Project facilities within the Project Boundary within the RLNRA that utilize lighting at night. A map of the study area is attached to this study plan. The Project facilities include:

- Generating facilities (powerhouses and dams):
  - Ross Dam and Powerhouse
  - Diablo Dam and Powerhouse
  - Gorge Dam and Powerhouse
- Operations and maintenance support areas
- Townsites, including housing:
  - Diablo
  - Newhalem
- Transmission, transportation (vehicle and boat) and communications infrastructure, including:
  - High tension transmission towers

  - Diablo and Ross Lake Boathouses
  - Radio antennae and microwave repeaters
- Visitor service and recreation areas:
  - ELC
  - Ladder Creek Falls Trail and Gardens

2.6 Methodology

The study consists of inventorying outdoor Project-related luminaires installed within the study area.

The study will consist of a site visit to catalog the physical characteristics of existing lighting for lights that do not have existing documented information (e.g., building lighting plans). All outdoor luminaires in the study area will be cataloged for the purpose of creating an "As-Found" lighting document to serve as a record of existing luminaires. Representative luminaires will be photographed and data will be recorded as described below. In addition to the cataloging process, City Light Project operations staff will document purpose of lighting for the study report.

The "As-Found" documents will include information on all outdoor lighting within the study area, including:

- Quantity (number of lamps [bulbs]);
- Locations (including estimated height of luminaire to the ground);
- Condition of existing luminaires (qualitative description of condition of structure [broken, corrosion, requiring replacement, etc.], age of luminaire [if available]);
- Voltage;
- Lamp type (e.g., LED, metal halide, incandescent, high pressure sodium, etc.);
- Source wattage (information on lamp or luminaire);
- Lighting distribution (e.g., directional floodlight, light focused below luminaire, etc.; may require additional night visit);
- Shielding (is the lamp housed in a full cutoff luminaire or does the light produce direct glare and/or trespass outside the task area);
- Illuminance (in footcandles [fc]; a footcandle is the measure of density of lumens (lm) falling onto a square foot surface [1 fc = 1 lm/ft^2]; a measure of total amount of visible light to the human eye from a light source);
- Ballast information (electrical information, condition, part number); and
- Luminaire control method (e.g., switch, individual photocell, central astronomical time clock, centralized photocell, etc.).

Information on use to be incorporated into the "As-Found" documents will include the:

- Hours of operation of the luminaire;
- Safety and security concerns and activities in the lit area;
- Purpose of the luminaire; and
- Historic values of the luminaire.

Data on luminaires will be collected using a digital data collection tool (i.e., ESRI Collector for ArcGIS).

A report will be generated containing the data recorded during the site visit and information on use of the luminaire and lamp characteristics. The report will identify potential opportunities for reducing light pollution while maintaining adequate illumination levels required for safe operations, visitor use, and Project activities.

Electric light illumination reduction measures recommended by the study shall address five considerations and/or methods of minimizing the effect of light: assessing the purpose, lowering intensity, controlling direction of illumination, changing the spectrum of emitted light, and limiting duration of emitted light as defined by the International Dark Sky Association (IDSA) (2020). Possible strategies for light reduction that could be identified include:

- Assess if the light is required at a location.
- Lowering Intensity – When less light is emitted into the environment there is less potential for that light to become light pollution.
- Controlling Direction – When all light is directed down, light must interact with a surface where its intensity is reduced before it goes into the sky and becomes light pollution. Directing illumination down also creates a more efficient design.
- Limiting or changing the lighting spectrum emitted by electric lighting to a narrow band that is smaller than the full range visible spectrum (380-740nm) can be used to create a lighting specification that provides functional lighting for humans while limiting other visual effects.
- Limiting Duration of Emitted Light – Light cannot become light pollution when it is not emitted. By limiting the duration of emitted illumination to only the times when lighting is necessary the effect of night lighting can be reduced. Possible measures include motion sensors to turn lights off and on as needed, or timers for lights that are needed only at certain times.

2.7 Consistency with Generally Accepted Scientific Practice

Field methods and reporting are consistent with the design and application standards specified in the Illuminating Engineering Society Lighting Handbook (Rea and IESNA 2000). The study will follow those standards and will be overseen by a professional electrical or architectural engineer who meets the National Council on Qualifications for the Lighting Professions Professional Qualification Standards for Lighting Certification.

2.8 Schedule

- Site Survey – May – September 2021
- Analysis and Creation of "As Found" Lighting Inventory – Fall 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $50,000.

3.0 REFERENCES

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PROJECT FACILITY LIGHTING INVENTORY
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Jack Oelfke (NPS)	05/19/2020	List of Acronyms and Abbreviations	Can be deleted. Is not in the Study Plan and is not a required metric in the lighting inventory	Thank you for your comment. The abbreviations list has been revised.
2.	Jack Oelfke (NPS)	05/19/2020	Section 1.0 Introduction	Note: all the comments attributed to Jack are actually from Bob Meadows, an NPS employee within the Natural Sounds and Night Skies Division in Ft. Collins, CO	Thank you. Comment noted.
3.	Brock Applegate (WDFW)	05/07/2020	Section 1.2 Relicensing Process	In-Text Edit: This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally.	Thank you for your comment. Edits to text made to better reflect the RWG and consultation process.
4.	Brock Applegate (WDFW)	05/26/2020	Section 2.1 Study Goals and Objectives	WDFW recommends that SCL evaluate any towers or other structures with great height, as well. I am not sure if this description includes these structures.	Thank you for your comment. The study area includes transmission infrastructure within the RLNRA, including towers. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
5.	Judy Neibauer (USFWS)	05/22/2020	Section 2.2 Resource Management Goals	I have similar comments as I submitted for the sound study plan. Please consider aquatic species in the assessments. Bull trout typically travel at night and light may interrupt passage during key migrations. For example, when work occurs in key habitat, DOT is using conservation measures to change lighting or to limit work at night so bull trout and other salmonids can pass the project site. An assessment of areas that might be an issue would be good information for the ESA Section 7 consultation. The USFS and other land owners may have requirements in other project areas like the transmission corridors and other purchased, managed lands, including restoration projects if operations occur at night.	Thank you for your comment. This study plan is an inventory; it does not propose to evaluate effects to aquatic species or any other resource. Lighting effects will be analyzed during the preparation of the Draft License Application (DLA). City Light appreciates any information on resource agency goals or requirements in the transmission line right-of-way with regards to lighting.
6.	Jack Oelfke (NPS)	05/19/2020	Section 2.2 Resource Management Goals	In-Text Edit: The National Park Service Organic Act of 1916 states that the purpose of national parks is "… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Night sky resources are considered a part of the "scenery and the natural and historic objects" that are conserved under this act. Comment: National Park Service Organic Act, 54 U.S.C. §§ 100101 et seq. (1970).	Thank you for providing this agency resource management goal. Edit accepted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
7.	Jack Oelfke (NPS)	05/19/2020	Section 2.2 Resource Management Goals	In-Text Edit: National Park Service (NPS) management policy 4.10 states that NPS "will preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light" (NPS 2006).	Thank you. Edits accepted.
8.	Jack Oelfke (NPS)	05/19/2020	Section 2.3 Background and Existing Information	In-Text Edit: The Stephen Mather Wilderness, designated in 1988, borders much of the Project Boundary in the RLNRA. The nighttime photic environment is a resource that NPS manages, and stray light at night has the potential to affect wilderness character qualities and wildlife habitat therein.	Thank you. Edits accepted.
9.	Jack Oelfke (NPS)	05/19/2020	Section 2.3 Background and Existing Information	In-Text Edit: Light sources are currently being used at Project hydroelectric facilities, housing and security structures, and City Light visitor service facilities. NPS identified Diablo Dam as having no shielding or other modifications to direct the light to where it is needed and reduce light ~~disbursement~~ trespass and glare (Hoffman et al. 2015). An analysis of the light emmited from the post lamps on top of the dam showed a vertical illuminance value of .1 mLux at a distance of 5.3k. This is significant important as this is the brightness of Venus, which is the brightest single object in the night sky, absent the moon. As you move closer to the dam, the brightness values increase above desired natural conditions while still within the Stephen Mather Wilderness of North Cascades NP. ~~Light is also introduced by vehicle traffic on SR 20.~~	Thank you for your comment. City Light will include information on all outdoor lighting within the study area in the "As-Found" documents. City Light will add the light metrics for the Diablo Dam to the Existing Information section. Edits partially accepted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
10.	Jack Oelfke (NPS)	05/19/2020	Section 2.4 Project Operations and Effects on Resources	There is acknowledgment that lights are necessary at the installations, but there are numerous luminaires that are purely decorative and currently most of the luminaires cause light trespass into the adjoining Wilderness	Thank you for the comment. Numerous luminaires serve a decorative or historic purpose.
11.	Jack Oelfke (NPS)	05/19/2020	Section 2.4 Project Operations and Effects on Resources	In-Text Edit: However, lighting also can obscure views of the stars and have negative impacts on ~~dark~~ night sky resource management goals. The illumination levels recommended by the IESNA to create a safe environment may conflict with an area's ~~dark~~ night sky goals.	Thank you for your comments. Edits accepted.
12.	Jack Oelfke (NPS)	05/19/2020	Section 2.4 Project Operations and Effects on Resources	NPS notes that it may be appropriate to apply more protective measures in areas near national parks, and particularly in those that are proximal to designated Wilderness	Thank you for your comment. City Light looks forward to working with NPS at the conclusion of the lighting inventory to identify potential actions to reduce light where applicable to reduce infringements to night sky goals while still meeting the safety and operations needs of the Project.
13.	Jack Oelfke (NPS)	05/19/2020	Section 2.4 Project Operations and Effects on Resources	In-Text Edit: This study will collect information on the safety benefits and use requirements of existing lighting as well as characteristics of the lighting, to determine how best to minimize light trespass into sensitive areas adjacent to the project boundary.	Thank you for your comment. The goal of the study is to conduct an inventory of Project lighting. No edits made.
14.	Judy Neibauer (USFWS)	05/22/2020	Section 2.4 Project Operations and Effects on Resources	Please include aquatic species in the study, they have effects from light, including but not limited to…issues with migration and foraging	Thank you for your comment. Please see response to #5.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
15.	Brock Applegate (WDFW)	05/26/2020	Section 2.4 Project Operations and Effects on Resources	In-Text Edit: Project lighting can also have effects on species that migrate such as bull trout and passerines. Lighting can confuse these species during migration, may not allow aquatic species to forage, and may cause mortality when passerines become confused and collide with towers, wires, and other structures near the lights.	Thank you for your comment. Please see response to comment #5. No edits made.
16.	Judy Neibauer (USFWS)	05/22/2020	Section 2.5 Study Area	You should add in any areas you may have maintenance where you might do work at night, stream crossings, restoration areas, transmission corridors, etc…	Thank you for your comment. An inventory of lighting related to possible maintenance activities performed at night is beyond the scope of this study. Night related maintenance is a non-routine activity. Also, please see response to comment #17 and #18.
17.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	I agree with Judy. SCL should consider possible projects that may happen over the next 50 years. SCL should develop a set of BMPs for possible future projects that will occur at night.	Thank you for your comment. City Light appreciates the suggestion and looks forward to discussing the development of best management practices (BMP) for nighttime illumination of maintenance activities and other projects.
18.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	WDFW recommends that you add any night construction projects as well, such as new structure or road construction.	Thank you for your comment. City Light looks forward to discussing the development of BMPs for lighting for night construction projects. Please note also that City Light currently develops environmental plans for each construction project and will continue to do so.
19.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	SCL should evaluate all electrical infrastructure with lights, particularly with the danger of collision.	Thank you for the comment. The intention of this study plan is to include electrical infrastructure with lights within the RLNRA described in the Study Area (Section 2.5). Additional detail added to the text.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
20.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	Recommend that a site visit is made both during the day and night. It is usually not possible to capture all the required info during one or the other.	Thank you for your comment. As stated in the methods, City Light will conduct an additional night visit if necessary to assess the distribution of the lighting. No edits made.
21.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	In-Text Edit: ~~▪ Quantity (number of lamps [bulbs]);~~ ~~▪ Locations (including estimated height of luminaire to the ground);~~ ~~▪ Condition of existing luminaires (qualitative description of condition of structure [broken, corrosion, requiring replacement, etc.], age of luminaire [if available]);~~ ~~▪ Voltage;~~ ~~▪ Lamp type (e.g., LED, metal halide, incandescent, high pressure sodium, etc.);~~ ~~▪ Source wattage (information on lamp or luminaire);~~ ~~▪ Lighting distribution (e.g., directional floodlight, light focused below luminaire, etc.; may require additional night visit);~~ ~~▪ Ballast information (electrical information, condition, part number); and~~ ~~▪ Luminaire control method (e.g., switch, individual photocell, central astronomical time clock, centralized photocell, etc.).~~	Thank you for the list of information. City Light has included most of these elements of this information in the methods. Text revised to add shielding and illuminance to data collected. Data on color temperature will be included when information is available from the lamp manufacturer. City Light appreciates the guidance on lamp CCT preference.
22.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	Instead of the above list, I would recommend these items be collected during the field inventory. Some appear above and others do not. We have found through numerous lighting inventories in other protected areas that these items will provide the needed information to make improvements in the lit environment at night. The goal should be to improve lighting efficiency and effectivenessI	See response to Comment #21.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
23.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	In-Text Edit: Location & height above ground Task (what is the purpose of the lamp) Historical (is the luminaire potentially historically or architecturally significant) Quantity (number of lamps on single luminaire) Lamp type (LED, CFL, incandescent, HPS, LPS, metal halide, etc.) Shielding (is the lamp housed in a full cutoff luminaire or does the light produce direct glare and/or trespass outside the task area) CCT (color temperature of lamp) The use of lamps with a CCT =<3000k are preferred Lumens (a measure of total amount of visible light to the human eye from a light source) Source wattage (information from lamp or luminaire) Controls (dimmer, timer, motion sensor, etc.) Is the light on at night (requires night site visit) Functional (is the lamp or luminaire damaged or missing) Notes (any helpful information, possible)	

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
24.	Brock Applegate (WDFW)	05/26/2020	Section 2.6 Methodology	In-Text Edit: Notes (any helpful information, possible) including possible effects to all resources	Thank you for your comment. The analysis of potential effects will occur as part of the DLA. No edits made.
25.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	Collected as "task" above	Thank you for your comment. See response to Comment #21. No edits made.
26.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	In-Text Edit: ▪ Historic and cultural values of the luminaire. Comment: Can this be identified in the field? Who needs to make this determination? The fact that a luminaire is historic should not preclude a retrofit that maintains the same appearance while improving efficiency and reducing the unwanted impacts.	Thank you for your comment. No edit made. City Light will use existing documented information and/or consult with Cultural Resources staff to determine the historic values of the luminaire. City Light will take historic values and lighting needs into consideration of illumination reduction measures to minimize the impact of light.
27.	Brock Applegate (WDFW)	05/26/2020	Section 2.6 Methodology	In-Text Edit: The report will identify potential opportunities for reducing light pollution and reduction off effects on resources listed, while maintaining adequate illumination levels required for safe operations, visitor use, and Project activities. **New comment provided 06/25/2020:** I would think that you would this as the goal of the study. Why not have someone write some thoughts on effects reduction while out there doing the inventory?	Thank you for your comment. The proposed edit is outside the scope of this inventory. While the study will provide an inventory of lighting with potential actions to reduce light pollution where applicable, it does not propose to include an analysis of how those actions may potentially reduce effects on resources. No edit made. **Response to comment provided on 06/25/2020:** Thank you for the comment. Please see earlier response to comment # 27 and comment #5.

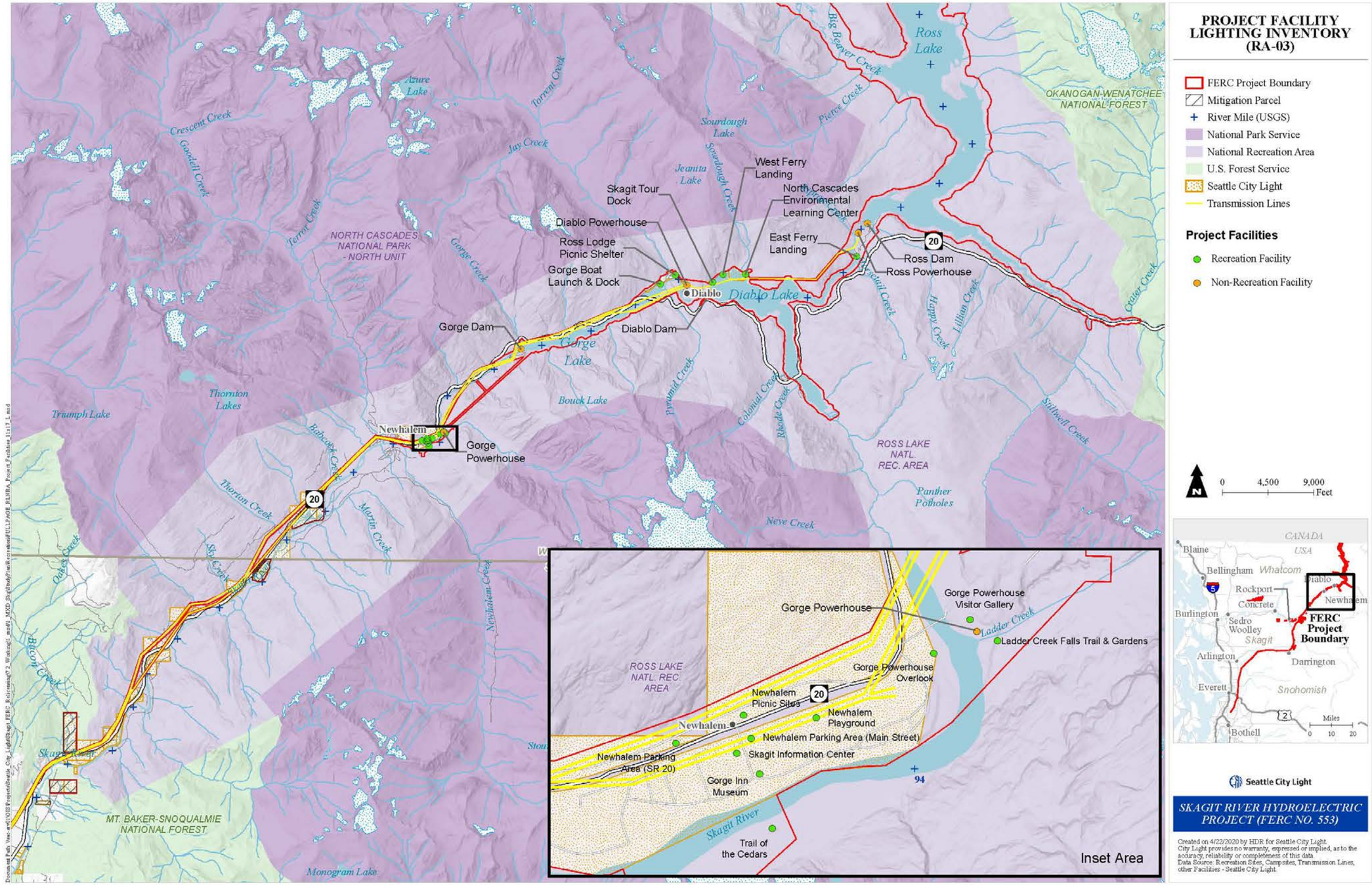
No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
28.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	In-Text Edit: Electric light illumination reduction measures recommended by the study shall address five considerations and/or methods of minimizing the impact of light: assessing the purpose, lowering intensity, controlling direction of illumination, ~~minimizing~~ changing the spectrum of emitted light, and limiting duration of emitted light as defined by the International Dark Sky Association (IDSA) 2020).	Thank you for the comment. Edit accepted.
29.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	In Text Edit: ▪ ~~Limiting~~ Changing the lighting spectrum emitted by electric lighting to a narrow band that is smaller than the full range visible spectrum (380–740nm) can be used to create a lighting specification that provides functional lighting for humans while limiting other visual impacts. Comment: you are not actually “limiting” the spectrum, you would be changing it to warmer colors in the 500- 600nm range.	City Light appreciates the input. Text revised.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
30.	Brock Applegate (WDFW)	05/07/2020	Section 2.6 Methodology	In-Text Edit: ▪ Final Initial Study Report – March 2022 ▪ Initial Study Report Meeting -- 2022 **New comment provided 06/25/2020:** I think that the LPs decide whether you will modify the study plan at the study meeting, which includes a recommendation of another year or not.	Thank you for your comment. City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting. No changes were made to the schedule in the draft study plan as City Light intends to complete the study in one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 06/25/2020:** Thank you for your comment. Any potential modifications to the FERC-approved study must be approved by FERC. For more information, please see 18 CFR § 5.15.
31.	Brock Applegate (WDFW)	05/26/2020	Attachment B Study Area Map	WDFW recommends that SCL include towers for electrical transmission and communication in the study area map. WDFW would assume that some of those towers reside on top of hills, higher areas, and rights-of-ways.	Thank you for your comment. The study area map shows the study area described in Section 2.5 of this study plan which consists of the portions of the Project Boundary within the RLNRA. The map resolution does not identify the individual locations of towers for electrical transmission and communication. The Study Area section (Section 2.5) has been edited to make it clear that it includes high tension transmission towers, radio antennae, microwave repeaters and structures, that will be individually assessed.

PROJECT FACILITY LIGHTING INVENTORY
PROPOSED STUDY PLAN

ATTACHMENT B

STUDY AREA MAP


PROJECT FACILITY LIGHTING INVENTORY (RA-03)
FERC Project Boundary
Mitigation Parcel
River Mile (USGS)
National Park Service
National Recreation Area
U.S. Forest Service
Seattle City Light
Transmission Lines
Project Facilities
Recreation Facility
Non-Recreation Facility
0 4,500 9,000 Feet
CANADA
USA
Blaine
Bellingham
Whatcom
Rockport
Concrete
Burlington
Sedro Woolley
Skagit
Arlington
Darrington
Everett
Snohomish
Bothell
Diablo
Newhalem
FERC Project Boundary
Miles
0 10 20
Seattle City Light
SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)
Created on 4/22/2020 by HDR for Seattle City Light.
City Light provides no warranty, expressed or implied, as to the accuracy, reliability or completeness of this data.
Data Source: Recreation Sites, Campsites, Transmission Lines, other Facilities - Seattle City Light.
Ross Lake
Diablo Lake
Gorge Lake
Skagit Tour Dock
West Ferry Landing
North Cascades Environmental Learning Center
Diablo Powerhouse
Ross Lodge Picnic Shelter
Gorge Boat Launch & Dock
East Ferry Landing
Ross Dam
Ross Powerhouse
Gorge Dam
Diablo Dam
Gorge Powerhouse
NORTH CASCADES NATIONAL PARK - NORTH UNIT
OKANOGAN-WENATCHEE NATIONAL FOREST
ROSS LAKE NATL. REC. AREA
MT. BAKER-SNOQUALMIE NATIONAL FOREST
Inset Area
Gorge Powerhouse Visitor Gallery
Ladder Creek Falls Trail & Gardens
Gorge Powerhouse Overlook
Newhalem Picnic Sites
Newhalem Playground
Newhalem Parking Area (Main Street)
Skagit Information Center
Newhalem Parking Area (SR 20)
Gorge Inn Museum
Trail of the Cedars

RA-04 PROJECT SOUND ASSESSMENT
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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Attachment A	City Light Responses to LP Comments on the Study Plan
Attachment B	Study Area Map

List of Acronyms and Abbreviations

ANSI .....American National Standards Institute
City Light.....Seattle City Light
ELC.....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
GIS .....Geographic Information System
GMP.....General Management Plan
ISR .....Initial Study Report
LP.....licensing participant
NPS .....National Park Service
PAD .....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RARWG.....Recreation and Aesthetics Resource Work Group
RLNRA .....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
SR.....State Route
U.S.C.....United States Code
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

This study plan discusses how City Light will characterize the existing outdoor soundscape near City Light facilities and define the extent of Project-related noise emitting from Project facilities, equipment, or activities within the Project Boundary. The study plan addresses elements of the RA06 (Soundscapes), RA07 (Noise), CR09 (Transmission Line Auditory Effects), TE16 (Northern Goshawk), and TE17 (Marbled Murrelet) issue forms provided during the 2019 Study Plan Development Process.

On April 24, 2020, City Light released the Project Sound Assessment Draft Study Plan for LP review and comment. On May 7, 2020, the draft study plan was discussed at a Recreation and Aesthetics Resource Work Group (RARWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 23, 2020. The revised draft was discussed on June 25, 2020 at a RARWG meeting. Written comments were received from NPS, Washington Department of Fish and Wildlife (WDFW), and U.S. Fish and Wildlife Service (USFWS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to: develop estimates of Project-related noise to facilitate analysis of how Project-related noise may affect other resources (e.g., wildlife, cultural resources, recreation resources, etc.). The objectives of the study include:

- Inventory and assess the Project facilities, equipment, and activities that emit noise throughout the Project Boundary, and measure or otherwise identify the spectral noise emissions characteristics of those Project features.
- Identify when those Project-related features, maintenance, and operations produce noise (i.e., day/night, what seasons).
- Identify and delineate noise-sensitive land uses that are also representative of other noise-sensitive land uses in the study area. Delineate those areas in Geographic Information System (GIS) for later use in the noise assessment.
- Perform unattended noise measurements for a continuous seven-day period to describe and document existing noise levels at those noise-sensitive locations. Measured noise levels are assumed to be representative of comparable land uses.
- Model Project-related noise. Develop noise contour maps that show how Project-related noise propagates and attenuates throughout the noise study area.

2.2 Resource Management Goals

A goal of the Sound Assessment study is to inventory and assess the extent to which Project facilities, equipment, and activities emit noise. This information will provide baseline information for other studies and assessments of potential ongoing Project effects on wildlife, recreation, cultural, and other resources within the Project Boundary.

At this time, one participating agency, NPS, is known to have noise management goals.

- The National Park Service Organic Act of 1916 states that the purpose of national parks is "… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Acoustic resources are considered a part of the “scenery and the natural and historic objects” that are conserved under this act.
- NPS has soundscape management goals for National Park resources including both units of the North Cascades National Park. These goals are stated in the NPS Director’s Order 47, Soundscape Preservation and Noise Management (NPS 2000). The stated goal of this order is “to articulate National Park Service operational policies that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise source” (NPS 2000).
- Direction for the management of NPS soundscapes is represented in NPS Management Policy 4.9 (NPS 2006). It states the NPS will “preserve, to the greatest extent possible, the natural soundscapes of parks.” Furthermore, this document states that the National Park Service will

"restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts." Further guidance for soundscape management is also provided in 2006 Management Policies 4.1.4 Partnerships, 4.1.5 Restoration of Natural Systems, 8.2 Visitor Use, 8.2.2 Recreational Activities, 8.2.3 Use of Motorized Equipment, and 8.4 Overflights and Aviation Uses (NPS 2006).

- NPS also published the Ross Lake National Recreation Area General Management Plan (GMP) (NPS 2012), which contains measurable indicators used to evaluate if NPS needs to take action to preserve key aspects of the RLNRA including the soundscape. The GMP includes noise indicators or standards which NPS monitors, such as the percent of time boating noise is audible in various management zones in the RLNRA. These indicators are not regulatory noise effect thresholds; they are soundscape management goals.

2.3 Background and Existing Information

The generating facilities and reservoirs associated with the Skagit River Project are located in a remote area, within the RLNRA, and much of the surrounding soundscape is natural, punctuated by noise from traffic on roadways (primarily State Route [SR] 20), boat traffic on the reservoirs, occasional helicopter use, hydroelectric operations, and general recreational activity. The northern portions of the Project Boundary are undeveloped, mountainous, heavily wooded lands with trails and roadways in some areas. The Stephen Mather Wilderness, designated in 1988, borders much of the Project Boundary in the RLNRA. Environmental noise is a resource that NPS manages, as explained in Section 2.2 of this study plan. The southern portions of the Project Boundary, especially outside the RLNRA, are flatter and more developed and populated; in those areas the Project facilities primarily include transmission lines that deliver electricity to the Seattle metropolitan area.

The NPS has conducted acoustic monitoring throughout the RLNRA, including areas within the Project Boundary, since at least 2006. Monitoring comprised of collecting acoustic data at several locations that represented acoustic zones.

2.4 Project Operations and Effects on Resources

Noise measurements have been requested by the NPS and Sauk-Suiattle Indian Tribe to characterize Project-related noise near City Light facilities within the RLNRA and define the extent of that noise. City Light has agreed to propose this study as the information is of shared interest to assess the potential of ongoing effects of noise on marbled murrelet; northern goshawk, northern spotted owls, and other raptor species; cultural resources; and recreation and other resources, including wilderness character qualities such as opportunities for solitude in designated Wilderness areas adjacent to the Project Boundary.

Project-related noise (detailed in the PAD [City Light 2020]), including the operation of heavy equipment and tools (i.e., chainsaws) used for maintenance of structures, utilities, and roads, and vegetation management activities, has the potential to disturb avian species, cultural, and recreational resources.

Boat traffic, such as the tugboat and barge used to shuttle equipment and supplies across Diablo Lake to Ross Powerhouse and/or Ross Dam several times per week for operations and

maintenance, generates short-term noise that might affect noise-sensitive resources. There are multiple daily powerboat trips to shuttle crews to and from the Ross Powerhouse and/or Ross Dam, which generate noise that have the potential to affect visitor experience on and around Diablo Lake and at the ELC. Some Project-related boat noise also occurs on Ross Lake from research boats and seasonal work boats collecting floating driftwood or transporting employees to maintain the Hozomeen facilities. However, the majority of boat use on Ross Lake is related to recreation and NPS management activities.

City Light uses helicopters to visually inspect the transmission line towers. During these infrequent inspections the helicopter flies quickly along the lines and only hovers if potential structural problems are noted, which is rare. Through coordination with the NPS, the Natural Resources Conservation Service conducts snow surveys by helicopter for two days each month from the end of December through early May (and more often if SR 20 is closed between Newhalem and Gorge). City Light participates in these snow surveys. Helicopter noise is most noticeable at take-off and landing in Newhalem and Diablo, at the snow course stations, and during ascents and descents in the Gorge bypass reach area. Noise from helicopters has the potential to affect noise-sensitive resources, but the frequency of occurrence is low and intermittent. Snow surveys occur at a time of year when sensitive avian species use in these areas is relatively low, and is largely outside of the nesting season. This period of helicopter use also coincides with the period of lowest recreational use in the area. Helicopter activity is also associated with firefighting and other specific projects year-round. City Light consults with the NPS and USFWS, as necessary, to determine potential noise effects on listed species if helicopter use is needed for maintenance projects. If possible, helicopter use for maintenance projects is scheduled to avoid the nesting season for most birds (April through August).

2.5 Study Area

The study area includes an area covering 0.6 mile from noise-generating facilities, activities, and ongoing/known maintenance and construction projects within the Project Boundary, and a 500-foot buffer on either side of Project transmission lines for corona noise assessment. A map showing the study area is attached to this study plan. The noise propagation equations in the international acoustical standard that will be used in the noise modeling task (ISO 9613) are considered accurate to distances of 0.6 mile. Beyond that distance, calculated noise levels are considered less accurate, particularly in areas where the terrain in the propagation path is not flat.

2.6 Methodology

The noise study consists of two measurement tasks and a modeling task. The first noise measurement task, measuring ambient noise (see Section 2.6.3.1 of this study plan) will produce a record that shows existing noise levels and how they vary in certain portions of the study area. Those measurement locations will be selected based on the extent to which they are representative of other locations. In this manner, a limited number of existing noise measurement results can be used to quantify existing noise levels at a larger number of areas. These measurements will have a duration of a continuous 7-day period, and the measurements will be unattended.

The second noise measurement task, measuring Project-related noise (see Section 2.6.3.2 of this study plan) will produce detailed measurements of noise emissions from activities and features of the Project that emit noise into the outdoor environment. Some of this type of information may

also be obtained from publicly available and reasonably obtainable literature (i.e., construction equipment noise levels). Results of this task will also identify where and when those Project-related noise emissions occur. Results of this task will be used in the noise models.

The noise modeling task (see Section 2.6.5 of this study plan) will estimate how Project-related noise travels and attenuates throughout the study area. It will also estimate how much Project-related noise reaches certain areas of concern. That will be achieved by modeling Project-related noise and creating colored noise contours that are overlaid upon digital aerial photographs. The modeling task also includes an inventory of noise-sensitive land uses and locations. Modeling results will provide information about Project-related noise to assess potential effects on noise-sensitive land uses and locations. Those noise contour images also allow resource-specific assessments of the effects of Project-related noise on certain areas or other Project resources. Those resource-specific assessments will be presented in the Draft License Application.

The noise study methods include the following steps.

2.6.1 Inventory and Assess Noise-Emitting Project Facilities and Activities

Information gathered in this task will be used in the noise modeling task, to simulate Project-related noise. City Light will perform an inventory of activities and equipment that emit noise into the outdoors environment. Through measurements and/or literature searches, the sound pressure level and spectrums of each activity and equipment will be quantified for use in the modeling task. Project-related facilities, equipment, and outdoor maintenance activities that produce noise with distinct tonal characteristics (e.g., dominated by high or low frequencies) are particularly important because those types of sounds are more distinctly perceivable in the outdoor noise environment, and therefore, should be included in the noise modeling task.

2.6.2 Assess Land Use

Information gathered in this task will be used in the noise modeling task, to identify areas where Project-related noise may have a potential adverse effect on Project resources. City Light will review and assess available noise-sensitive land uses (areas or specific locations) within 0.6-mile of each Project dam and powerhouse, the townsite of Newhalem, and one additional site on Diablo Lake and within 500 feet of the transmission line. These areas and locations will be categorized into different representative land uses based on activities with respect to noise-activity, noise-sensitivity, and the overall noise environment (e.g., within 100-200 feet of a road corridor; areas surrounding campgrounds; trails away from development; etc.). Areas will be delineated into polygons based on land use so that representative noise environments can be identified. City Light will also review these land uses to inform the noise measurement site selection process.

2.6.3 Select Sites and Perform Field Noise Measurements

2.6.3.1 Ambient Noise Measurements (Long-term)

City Light will select three to six locations where continuous 7-day unattended outdoor noise measurements will occur. At each location City Light will measure wind speed, store spectral noise measurements, and also continuously record a digital audio file for the duration of the 7-day measurement. Measurements will occur during the summer to coincide with the highest recreation levels and minimize the adverse effects of meteorological conditions (rain, wind) which can

adversely affect noise measurements.

The 7-day measurement system consists of Larson Davis Model 831 (LD 831) real-time sound level analyzers connected to a Larson Davis 831-INT (LD 831-INT) docking station. An Edirol R-09 digital audio recorder is used to continuously store a digital audio record of the entire measurement duration. The analyzer and recorder systems are stored in a weather-resistant Pelican case during deployment. A microphone attached to a self-calibrating preamplifier, and a R. M. Young anemometer (or similar) are also connected to the LD 831-INT. The microphone is covered by a large windscreen, which is installed inside a cage-like device to keep the wind screen in place and discourage birds from sitting on the windscreen (it has spikes on the top of it).

In this configuration, a digital audio file is stored in the Edirol R-09, and sound pressure level measurement results and wind speeds are stored in the LD 831. The power supply often consists of external batteries stored in a Pelican case, sometimes supplemented by a passive photovoltaic solar panel(s).

2.6.3.2 Project-related Noise Measurements (Short-term)

For Project-related equipment or activities where noise emissions data are unavailable or insufficiently described in the public domain, City Light will also perform additional short-term attended measurements of noise from select Project-related activities and equipment (e.g., corona noise emitted from transmission lines, chainsaws, etc.). This information will be used to simulate Project-related noise emissions in the noise modeling task. Equipment noise measurements will utilize a LD 831 or LD 824 real-time analyzer.

2.6.4 Process and Analyze 7-Day Noise Measurement Results

Each hour's worth of the 7-day noise measurement results will be processed to produce the following characterizations of hourly ambient noise:

- Minimum noise level (Lmin);
- Maximum noise level (Lmax);
- Energy-equivalent noise level (Leq), a mean average noise level; and
- Statistical descriptors (Ln) that characterize noise levels exceeded n percent of the hour (i.e., L10, L33, L50, and L90). Ln descriptors help explain how much sound levels vary (or how consistent they are) during each hour. The L50 descriptor is a median average, and a comparison of the mean (Leq) and median (L50) is another way to evaluate the amount of variation in sound levels during an hour.

A modest amount of selective audio review will be performed on the digital audio files to identify anthropogenic noises that occurred during the measurement periods. Often this involves identifying peaks or spikes in the measurement data, locating the timestamp associated with those spikes, locating that timestamp in the digital audio file, and listening to the audio in an attempt to identify the source or cause of the data spike.

2.6.5 Noise Modeling

City Light will perform noise modeling to evaluate transmission line noise (corona noise), and noise from other Project features and activities. The noise modeling will utilize three basic tools: GIS, Cadna-A (3D noise modeling software), and CFI8X (a corona noise model; Bonneville Power Administration Corona and Fields Interactive 1989 Experimental model) to produce noise contours figures.

The process of creating noise contours consists of assembling a GIS mapbook that includes features of the study area (locations of Project features, digital terrain files, location of noise-sensitive areas, polygons of similar ground cover types, etc.). These spatial attributes are imported into the Cadna-A environmental noise modeling software. Cadna-A is a 3D environmental noise modeling tool that incorporates international acoustical standards for outdoor sound propagation (ISO 9613). A database of noise sources and activities will be developed in Cadna-A which includes noise emissions from field measurements. Cadna-A will be configured to calculate overall noise levels from the defined noise sources at specific locations (receptors) in the study area. Cadna-A is also configured to calculate noise levels at points throughout a user-defined Cartesian coordinate grid. These results are converted into noise contours, which can be exported into GIS and overlaid upon digital aerial photographs to create noise contour figures. Cadna-A will be configured to calculate noise contours from the noise source to the point at which they attenuate to existing noise levels (as determined by 7-day measurements).

Noise contour figures will be developed for both corona noise and Project-related noise models.

2.6.5.1 Corona Noise

To evaluate corona noise, City Light will use CFI8X to develop an estimate of corona noise. That noise level will be input into Cadna-A to calculate corona noise at a 500-feet distance from the centerline of the transmission lines. The Cadna-A model will also include digital terrain information, areas where dense vegetation exists ("tree zones"), and other information about the acoustical characteristics of the ground cover that have been delineated using GIS. The entire transmission line right-of-way may be subdivided into smaller segments to facilitate the Cadna-A analysis. Cadna-A will produce color noise contours which will be overlaid upon digital aerial photos in GIS to create noise contour figures. Cadna-A results will also be presented in text and tables.

2.6.5.2 Project-related Noise

City Light will also use Cadna-A to calculate sound propagation from other Project-related activities. The Project-related noise measurement results will be input into Cadna-A and used as noise source terms (telling the model how loud a noise source is at a fixed distance so it can calculate sound propagation from that source). Those Cadna models will also incorporate digital terrain data, tree zones, and other information about the acoustical characteristics of the ground cover that have been delineated using GIS. Cadna-A will produce color noise contours which will be overlaid upon digital aerial photos in GIS to create noise contour figures. Cadna-A results will also be presented in text and tables. Specific modeling scenarios will be selected once City Light completes data collection tasks described earlier in this study plan.

2.7 Consistency with Generally Accepted Scientific Practice

The unattended 7-day noise measurement is based on American National Standards Institute (ANSI) ANSI-ASA_S3-SC1.100_S12.100-2014, Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas. Short-term attended measurements of noise from select equipment and activities, and use of those measurement results to model Project-related noise is a standard technique used by environmental acousticians to explain how Project-related noise propagates throughout a study area.

2.8 Schedule

- Field Work – June to September 2021
- Analysis – October to November 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $175,000-200,000.

3.0 REFERENCES

ANSI. 2014. ANSI-ASA_S3-SC1.100_S12.100-2014, Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas.

National Park Service (NPS). 2000. Director's Order #47: Soundscape Preservation and Noise Management. [Online] URL: https://www.nps.gov/policy/dorders/dorder47.html. Accessed April 6, 2020.

___. 2006. NPS Management Policies 2006. U.S. Department of Interior, National Park Service. 180p. [Online] URL: https://www.nps.gov/policy/MP_2006.pdf. Accessed April 21, 2020.

___. 2012. Ross Lake National Recreation Area. General Management Plan. National Park Service, U.S. Department of the Interior. July 2012.

Seattle City Light (City Light). 2020. Pre-Application Document (PAD) for the Skagit River Hydroelectric Project, FERC Project No. 553. April 2020.

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PROJECT SOUND ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Jack Oelfke (NPS)	05/19/2020	Section 1.0 Introduction	All comments attributed to Jack are from Emma Brown, of the NPS Natural Sounds and Night Skies Division in Ft. Collins, CO	Thank you, comment noted.
2.	Brock Applegate (WDFW)	05/06/2020	Section 1.2 Relicensing Process	In-Text Edit: This study plan reflects the RWG consultation ~~effort~~, and City Light will continue to engage the RWG structure in the preparation of the Proposed and Revised Study Plans (18 Code of Federal Regulations [CFR] §§ 5.11-5.13), and through the relicensing process generally.	Thank you for your comment. Edits to text made to better reflect the RWG and consultation process.
3.	Judy Neibauer (USFWS)	05/22/2020	Section 1.3 Study Plan Development	I am wondering about the Northern Spotted Owl (NSO) and noise effects to them. Please include them in the sound study. Typically in forested environments we have conservation measures that deal with timing of noise generation and have conservation measures associated with timing windows.t was confusing in meeting notes as to how NSO would be addressed. I did not see this in an issue paper. You will need to be looking at locations of NSO nesting, roosting, foraging locations in relation to project operations. Please adjust this study or develop other studies to understand how project operations could impact nesting roosting and foraging of NSO.	Thank you for your comment. A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). LPs will have an opportunity to consider effects of Project recreation, if warranted, on wildlife and other resources in their review of the DLA in the National Environmental Policy Act (NEPA) process. With respect specifically to the Northern Spotted Owl, the results of the sound assessment will be used to determine any effects of Project-related noise on NSO nesting, roosting, and foraging locations. Information on these locations is sufficiently provided in the existing literature.
4.	Brock Applegate (WDFW)	05/26/2020	Section 1.3 Study Plan Development	I agree with Judy. WDFW would assume that SCL could easily map the results of this study and NSO habitat.	See response to comment #3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
5.	Judy Neibauer (USFWS)	05/22/2020	Section 1.3 Study Plan Development	There are also noise effects associated with aquatic species. Depending on the type of noise it can travel distances through water. Please include an assessment of types of activities that could impact aquatic species from project elements including maintenance…across the project area including but not limited to… things such as dam operations and maintenance, recreation areas, work along transmission corridors on lands owned, managed, restored. **New comment Brock Applegate (WDFW) provided 06/25/2020:** Please add the BMPs to this study report to address concerns to aquatic species.	Thank you for your comment. This study addresses a data gap associated with routine Project operations and the type of noise created. City Light anticipates proposing specific measures for specific, non-routine noise-causing activities with known effects on a case by case basis, and currently employs BMPs to limit effects of in-water work on aquatic species. No edits made to the draft study plan at this time. Regarding routine Project operations, City Light is not aware of any regulatory thresholds for continuous noise as related to freshwater aquatic species. City Light is aware of the 2008 interim fish injury thresholds for impact pile-driving established by the Fisheries Hydroacoustic Work Group, which included Regions 1 and 8 of the USFWS. However, to date, no other injury or behavioral underwater noise thresholds have been established for salmonids, including bull trout. City Light would appreciate receiving any specific documentation of noise effects on aquatic species related to routine Project operations or the activities listed in the comment. If changes in operations are proposed that may introduce additional in-water sources of noise, City Light anticipates that these could be reviewed with USFWS during development of the Biological Assessment. **Response to comment provided on 06/25/2020:** Thank you for your comment. The identification of potential BMPs may discussed as part of the DLA or in development of management plans.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
6.	Brock Applegate (WDFW)	05/26/2020	Section 1.3 Study Plan Development	I agree with Judy. SCL should include aquatic species in the analysis.	Thank you for your comment. Please see response to Comment #5. No edits made.
7.	Brock Applegate (WDFW)	05/26/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: The goal of this study is to: develop estimates of Project-related noise to facilitate analysis of how Project-related noise may affect other resources (e.g., wildlife, aquatic species, cultural resources, recreation resources, etc.).	Thank you for your comment. Please see response to Comment #5. No edits made.
8.	Brock Applegate (WDFW)	05/26/2020	Section 2.1 Study Goals and Objectives	In-Text Edit: ▪ Identify when those Project-related features, maintenance, and operations produce noise (i.e., day/night, what seasons).	Thank you. Edits accepted.
9.	Brock Applegate (WDFW)	05/06/2020	Section 2.2 Resource Management Goals	SCL has not even conducted the study yet and has already told us about mitigation that they will not do. Could SCL find that dampening sound with a filter or a muffler might reduce their noise in a sensitive area to an acceptable level? WDFW recommends that SCL complete the study before they take any mitigation possibilities off the table.	Thank you for your comment. This sentence has been removed from the study plan.
10.	Judy Neibauer (USFWS)	05/22/2020	Section 2.2 Resource Management Goals	Agreed, this is probably not the right place for this statement.	See response to Comment #9.
11.	Brock Applegate (WDFW)	05/26/2020	Section 2.2 Resource Management Goals	In-Text Edit: This information will provide baseline information for other studies and assessments of potential ongoing Project effects on wildlife, aquatic species, recreation, cultural, and other resources in the Project Boundary.	Thank you for your comment. Please see response to Comment #5. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
12.	Judy Neibauer (USFWS)	05/22/2020	Section 2.2 Resource Management Goals	You could probably put in species specific goals to minimize noise around NSO, MM, Norther Goshawk, aquatics…there is guidance in some of the USFWS critical habitat documents. There is a some management guidelines about timing in the USFS LRMPs and NWFP standards and guidelines as well. **New comment Brock Applegate (WDFW) provided 06/25/2020:** WDFW recommends that you put this request on the integrated effects analysis list. SCL should mark on a map known marbled murrelet and raptor nests on a nest with your sound map from project maintenance, construction, and any other project-related discontinuous noise. As SCL pointed out, most of this information should accompany BMPs and a map.	Thank you for your comment. This study addresses the data gap associated with sound emanating from Project operations. An integrated effects analysis will probably consider species specific goals, as will any actions or BMPs subsequently deemed necessary to prevent, mitigate, or eliminate potential effects. Please also see responses to Comment #5. **Response to comment provided on 06/25/2020:** Thank you for your comment. Comment noted.
13.	Brock Applegate (WDFW)	05/26/2020	Section 2.2 Resource Management Goals	I agree with Judy. SCL could also include noise guidelines for most raptors, which includes bald and golden eagles, peregrine falcons, and ospreys.	Thank you for your comment. Please see response to Comment #12.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
14.	Jack Oelfke (NPS)	05/19/2020	Section 2.2 Resource Management Goals	In-Text Edit: ▪ The National Park Service Organic Act of 1916 states that the purpose of national parks is "… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Acoustic resources are considered a part of the "scenery and the natural and historic objects" that are conserved under this act Comment: National Park Service Organic Act, 54 U.S.C. §§ 100101 et seq. (1970).	Thank you for providing this resource management goal. Edit accepted.
15.	Jack Oelfke (NPS)	05/19/2020	Section 2.2 Resource Management Goals	In-Text Edit: ▪ Direction for the management of NPS soundscapes is represented in NPS Management Policy 4.9 (NPS 2006). It states the NPS will "preserve, to the greatest extent possible, the natural soundscapes of parks." Furthermore, this document states that the National Park Service will "restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts." Further guidance for soundscape management is also provided in 2006 Management Policies 4.1.4 Partnerships, 4.1.5 Restoration of Natural Systems, 8.2 Visitor Use, 8.2.2 Recreational Activities, 8.2.3 Use of Motorized Equipment, and 8.4 Overflights and Aviation Uses (NPS 2006). Comment: National Park Service. 2006. Management Policies 4.9: Soundscape Management.	Thank you for providing this resource management goal. Edit accepted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
16.	Jack Oelfke (NPS)	05/19/2020	Section 2.3 Background and Existing Information	In-Text Edit: Environmental noise is a resource that NPS manages, as explained above in Section 2.2 of this study plan, and noise has the potential to affect wilderness character qualities such as opportunities for solitude..	Thank you for the suggested edit. Section 2.3 discusses background and existing information, whereas the suggested edit discusses potential Project effects. The suggested edit was therefore inserted in Section 2.4, Project Operations and Effects on Resources.
17.	Brock Applegate (WDFW)	05/06/2020	Section 2.3 Background and Existing Information	In-Text Edit: The NPS has conducted acoustic monitoring throughout the RLNRA, including areas within the Project Boundary, since at least 2006. Monitoring comprised of collecting acoustic data at several locations that represented acoustic zones.	Thank you. Edit accepted.
18.	Judy Neibauer (USFWS)	05/22/2020	Section 2.3 Background and Existing Information	Mention here what kind of information you already have from monitoring with your existing permit, where you have data gaps…as well….link to existing studies about noise for the species.	Thank you for your comment. City Light has not conducted acoustic monitoring within the Project Boundary to date. No edits made.
19.	Brock Applegate (WDFW)	05/26/2020	Section 2.3 Background and Existing Information	I agree with Judy. SCL could list or map the areas that SCL conducted the acoustic monitoring as well.	Please see response to Comment #18.
20.	Brock Applegate (WDFW)	05/26/2020	Section 2.4 Project Operations and Effects on Resources	In-Text Edit: City Light has agreed to propose this study as the information is of shared interest to assess the potential of ongoing effects of noise on northern goshawk, marbled murrelet, northern spotted owls, other raptor species, aquatic species, cultural, recreation, and other resources.	Thank you for your comment. Please see responses to Comment #3 and 5. Edits accepted with exception of “aquatic species.”

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
21.	Judy Neibauer (USFWS)	05/22/2020	Section 2.4 Project Operations and Effects on Resources	Please think about adding aquatic and underwater noise into this study as well. We know today that bull trout seem to avoid structure, noise and light, and may be why they don't like to enter traps. In literature there are examples of noise and light affecting fish species. In the Wenatchee radio tag study, some bull trout would not enter fish traps while the hydraulic weir was up, some did enter at night as well. Some would wait until it was down to pass (Kelly Ringel et al 2012). I have read other studies where salmonids react to noise. Dept of Transportation, and Corp of Engineers have some conservation measures for noise for fish in their current programmatic ESA Sec 7 Biological Opinion that may be useful…I can provide those if you would like to see them.	Please see response to Comment #5.
22.	Brock Applegate (WDFW)	05/26/2020	Section 2.4 Project Operations and Effects on Resources	WDFW considers aquatic species important in consideration of noise impacts as well.	Thank you for your comment. Please see response to Comment #5.
23.	Brock Applegate (WDFW)	05/06/2020	Section 2.4 Project Operations and Effects on Resources	Can SCL define "occasional?" WDFW would recommend a unit of time and frequency. **New comment provided 06/25/2020:** How about something more definitive like a couple times a decade? I find occasional and infrequent very subjective.	Thank you for your comment. Text changed to "infrequent." The most recent helicopter surveys of the transmission line towers occurred in 2010 and 2018. Each inspection lasted fewer than four hours. **Response to comment provided on 06/25/2020:** Thank you for this comment. City light believes "infrequent" is the appropriate term to describe the intermittent and irregular pattern of helicopter surveys.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
24.	Jack Oelfke (NPS)	05/19/2020	Section 2.5 Study Area	NPS recommends carrying modeling propagation out to the point of inaudibility, considering established natural sound levels at measurement sites in RLNRA	Thank you for this comment. Calculating the distance to where Project-related noise is inaudible is beyond the scope of this study. A National Recreation Area surrounds many of the Project features, and noise from recreation activities such as boat motors, traffic on State Route (SR) 20, etc. are common components of the existing soundscape. No edits made.
25.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	I agree with the NPS. Although less accurate beyond 0.6 miles, SCL should consider the greatest possible impact to resources by noise. SCL should extend the noise out until attenuation with natural sound levels.	Thank you for your comment. Please see response to Comment #24.
26.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	In-Text Edit: The study area includes an area covering 0.6 mile from noise-generating facilities and ongoing/known maintenance and construction projects within the Project Boundary, and a 500-foot buffer on either side of Project transmission lines.	Thank you. Edits accepted.
27.	Judy Neibauer (USFWS)	05/22/2020	Section 2.5 Study Area	500 feet may not be enough, depends on the type of noise, geology, locations	Thank you for your comment. Corona noise in the transmission line right-of-way will be evaluated from the centerline of the transmission line to a distance of 500 feet on either side of the transmission line centerline, as per BPA corona noise model (CFI8X). Project-related activities (including the operation of heavy equipment and tools [i.e., chainsaws] used for maintenance of structures, utilities, and roads, and vegetation management activities will be evaluated from the source of the noise to a distance of 0.6 miles. No edits made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
28.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	I agree with Judy. SCL will want to consider greater than 500 feet, particularly if we consider pole driving in the rights-of- ways.	City Light currently follows BMPs to reduce or restrict timing of noise from activities such as pole driving. Activities such as pole driving will be evaluated from the source of the noise to a distance of 0.6 miles. Also, see response to Comment #27.
29.	Judy Neibauer (USFWS)	05/22/2020	Section 2.5 Study Area	Please use most recent science developed in looking at noise for NSO, MM, goshawk, and underwater noise for aquatic species to help determine the study areas. Need to include underwater areas in the study.	Thank you for your comment. Please see responses to Comments #3, #5, #12, and #21.
30.	Brock Applegate (WDFW)	05/26/2020	Section 2.5 Study Area	I agree with Judy. Please include other raptor species as well.	Thank you for your comment. Please see responses to Comments #3, #5, #12, and #21.
31.	Jack Oelfke (NPS)	05/19/2020	Section 2.6 Methodology	NPS suggests use of ANSI-ASA_S3-SC1.100_S12.100-2014, Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas. This standard calls for continuous measurements over a period of at least 7 days. NPS protocol (established in Lynch, E., Joyce, D., & Fristrup, K. (2011). An assessment of noise audibility and sound levels in US National Parks. Landscape ecology, 26(9), 1297.), recommends a measurement period of at least 25 days.	City Light proposes to measure existing noise levels for a continuous 7-day period using a methodology that is based on ANSI-ASA_S3-SC1.100_S12.100-2014, Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas.
32.	Brock Applegate (WDFW)	05/26/2020	Section 2.6 Methodology Page 2-4	I agree with NPS. When SCL measures the sound will affect the results. SCL will get a different measurement of sound for weekends, holiday weeks after weekends, and during different types of weather.	See response to Comment #31.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
33.	Judy Neibauer (USFWS)	05/22/2020	Section 2.6.1 Inventory and Assess Noise-Emitting Project Facilities and Activities	There are methods to measure aquatic noise, it would be good to establish a baseline and or use existing noise measurements to compare to. Our Lacey office has a document with some guidelines. Let me know if you would like that.	Thank you for your comment. See responses to Comments #5 and #21.
34.	Judy Neibauer (USFWS)	05/22/2020	Section 2.6.3 Select Sites and Perform Field Noise Measurements	Add some underwater locations near operation sites and during maintenance activities. It may have to be studied at different flow levels to determine how far noise may travel underwater during typical activities and unusual activities (operation of the dams, turbines/spill; maintenance activities; restoration and road work where pounding occurs, etc.)	Thank you for your comment. See responses to Comments #5 and #21.
35.	Jack Oelfke (NPS)	05/19/2020	Section 2.6.4 Process and Analyze 24-hour Noise Measurement Results	This is close, but not exactly right. For a given hour (or other specified time period), LAnat is calculated to be the sound level exceeded x percent of the time, where x is defined as x= (100-PH/2) + PH and PH is the percentage of the hour that contained noise. In summary, LAnat is a percentile sound level that corresponds to the percentage of an hour where noise occurred.	Thank you for your comment. City Light does not propose to calculate the LAnat, therefore the reference to it was deleted.
36.	Jack Oelfke (NPS)	05/19/2020	Section 2.6.4 Process and Analyze 24-hour Noise Measurement Results	NPS recommends that hourly sound source audibility be a component of the analysis, as well as calculation of LA50, as it will clarify the likely sources (including those that are loud, but also encompassing those that may be less loud but are nevertheless persistently audible) of sound measured during the study period.	Thank you for your comment. Evaluating audibility of Project-related noise is beyond the scope of this study. Also please see response to Comment #24.

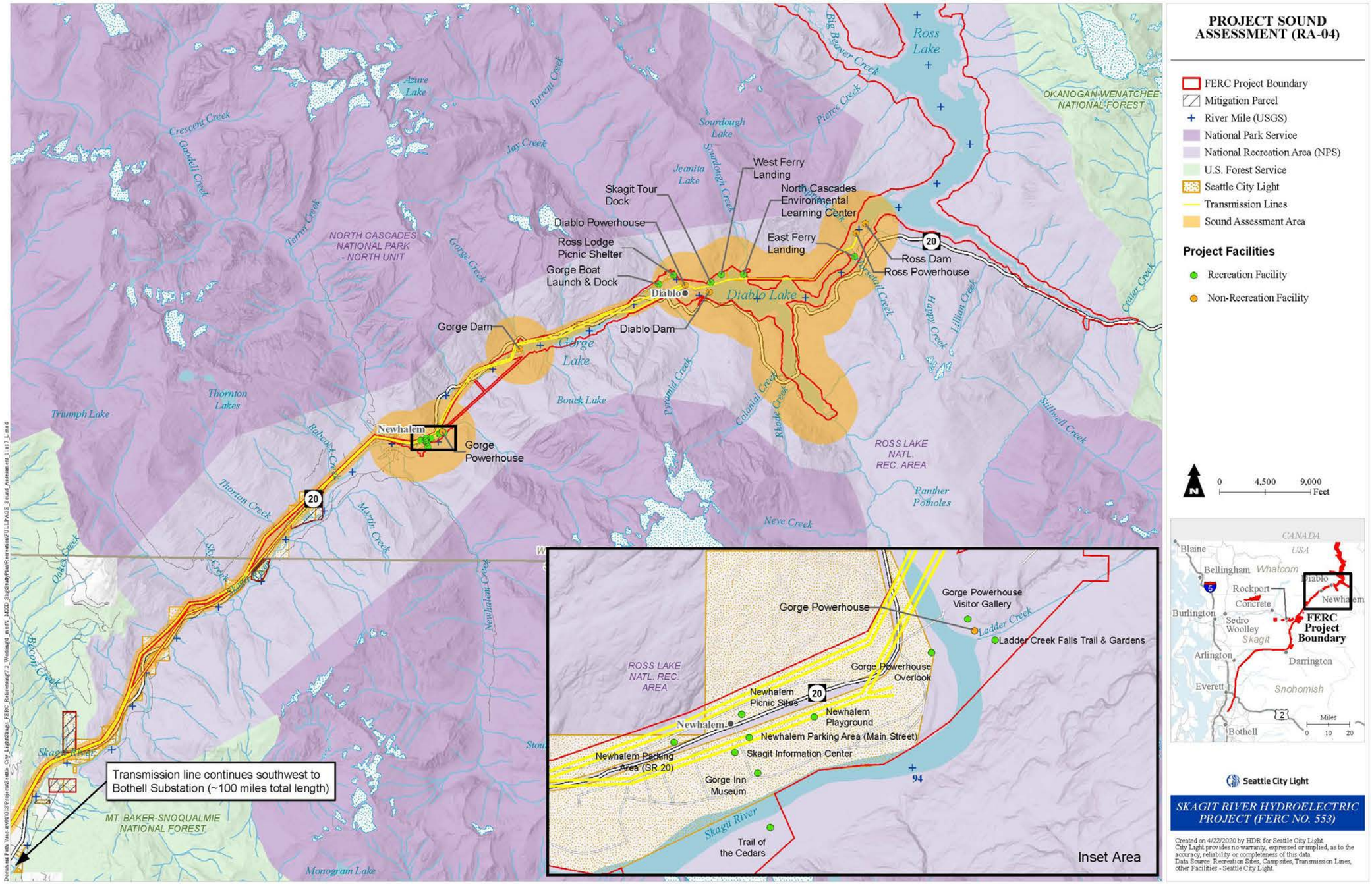
No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
37.	Jack Oelfke (NPS)	05/19/2020	Section 2.6.5 Noise Modeling	Please clarify which metric will be used to represent existing noise levels. Also, NPS suggests it may be more informative to carry noise contours out to the point at which they attenuate to natural sound levels (as established in previous measurements near the project boundary), or at the least, to the LA90 percentile level. This will provide a clearer picture of the effects of project-related noise emissions on the acoustic environment of surrounding park lands.	Refer to Section 2.6.4 for a discussion of acoustical metrics used to express existing (measured) noise levels. Modeled Project-related noise will be expressed as an Leq, with an intended duration equal to the duration during which the noise source produces noise. The calculation area is proposed to be 0.6 miles from the noise source.
38.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.5 Noise Modeling	I agree with the NPS. SCL should attenuate noise to the point of natural sound levels.	Thank you for your comment. Please see response to Comments #24 and #37.
39.	Jack Oelfke (NPS)	05/19/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	As stated above, NPS recommends instead the use of ANSI-ASA_S3-SC1.100_S12.100-2014, Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas.	Thank you for your comment. Text revised. Also, please see response to Comments #24 and #31.
40.	Judy Neibauer (USFWS)	05/22/2020	Section 2.8 Schedule	To measure aquatic noise may take a different schedule, please account for studying aquatic noise in the schedule.	Thank you for your comment. Please see responses to Comments #5 and #21.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
41.	Brock Applegate (WDFW)	05/07/2020	Section 2.8 Schedule	In-Text Edit: ▪ Final Initial Study Report – March 2022 ▪ Initial Study Report Meeting-- 2022 **New comment provided 06/25/2020:** The requested edit has no bearing on whether SCL finishes the study in one year or two.	Thank you for your comment. City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the Initial Study Report (ISR) and discussed at the ISR meeting. No changes were made to the schedule in the draft study plan as City Light intends to complete the study in one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 06/25/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
42.	Jack Oelfke (NPS)	05/19/2020	Section 3.0 References	In-Text Edit: ___. 2012. Ross Lake National Recreation Area. General Management Plan. National Park Service, U.S. Department of the Interior. July 2012. https://parkplanning.nps.gov/document.cfm?parkID=327&projectID=16940&documentID=47962	Thank you, reference added.

PROJECT SOUND ASSESSMENT
PROPOSED STUDY PLAN

ATTACHMENT B

STUDY AREA MAP


PROJECT SOUND ASSESSMENT (RA-04)
FERC Project Boundary
Mitigation Parcel
River Mile (USGS)
National Park Service
National Recreation Area (NPS)
U.S. Forest Service
Seattle City Light
Transmission Lines
Sound Assessment Area
Project Facilities
Recreation Facility
Non-Recreation Facility
0 4,500 9,000 Feet
Seattle City Light
SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)
Created on 4/22/2020 by HDR for Seattle City Light.
City Light provides no warranty, expressed or implied, as to the accuracy, reliability or completeness of this data.
Data Source: Recreation Sites, Campsites, Transmission Lines, other Facilities - Seattle City Light.
Ross Lake
Diablo Lake
Gorge Lake
Skagit Tour Dock
West Ferry Landing
North Cascades Environmental Learning Center
Diablo Powerhouse
Ross Lodge Picnic Shelter
Gorge Boat Launch & Dock
East Ferry Landing
Ross Dam
Ross Powerhouse
Diablo
Gorge Dam
Diablo Dam
Newhalem
Gorge Powerhouse
Transmission line continues southwest to Bothell Substation (~100 miles total length)
NORTH CASCADES NATIONAL PARK - NORTH UNIT
OKANOGAN-WENATCHEE NATIONAL FOREST
ROSS LAKE NATL. REC. AREA
MT. BAKER-SNOQUALMIE NATIONAL FOREST
Inset Area
Gorge Powerhouse
Gorge Powerhouse Visitor Gallery
Ladder Creek Falls Trail & Gardens
Gorge Powerhouse Overlook
Newhalem Picnic Sites
Newhalem Playground
Newhalem Parking Area (Main Street)
Skagit Information Center
Newhalem Parking Area (SR 20)
Gorge Inn Museum
Trail of the Cedars
CANADA
USA
Blaine
Bellingham
Whatcom
Diablo
Rockport
Concrete
Burlington
Sedro Woolley
Skagit
Arlington
Darrington
Everett
Snohomish
Bothell
FERC Project Boundary
Miles

TR-01 VEGETATION MAPPING
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on Study Plan

List of Acronyms and Abbreviations

City Light.....Seattle City Light
ELC.....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
GIS .....geographic information system
LiDAR.....Light Detection and Ranging
LP.....licensing participant
NCNP.....North Cascades National Park
NPS .....National Park Service
NVC .....National Vegetation Classification
OBIA.....Object-based Image Analysis
PAD.....Pre-Application Document
PHS .....Priority Habitat and Species
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
ROW .....right-of-way
RWG .....Resource Work Group
SGCN.....Species of Greatest Conservation Needs
SRSC.....Skagit River System Cooperative
SSIT .....Sauk-Suiattle Indian Tribe
STI.....Stillaguamish Tribe of Indians
SWAP .....State Wildlife Action Plan
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

A baseline characterization of vegetation resources within the Project Boundary and vicinity was identified as an early study need during 2019 discussions with the Terrestrial Resources and Reservoir Erosion Work Group (TRREWG).

On October 10, 2019, City Light released the Vegetation Mapping Draft Study Plan for LP review and comment. On October 15, 2019, the draft study plan was discussed at a TRREWG meeting. City Light reviewed all comments received and released a revised version of the draft study plan on March 3, 2020. The revised draft was discussed on March 17, 2020 at a TRREWG meeting. City Light reviewed additional comments received and released a second revised version of the draft study plan on March 31, 2020. Written comments were received from Washington Department of Fish and Wildlife (WDFW), NPS, Skagit River Systems Cooperative, Upper Skagit Indian Tribe, and U.S. Forest Service (USFS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC. However, this study will provide information requested as part of the following study requests: SSIT-03 Impacts of Transmission Line Right of Way (ROW) on Aquatic Habitat and Riparian Zone for the Skagit River Hydroelectric Project, STI-06 Spotted Owl Habitat Map, and USFWS-19 Impact of the Operations of Skagit Hydroelectric Project (#553) on Northern Spotted Owl, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Vegetation Mapping Study is to develop a complete and systematic vegetation mapping geographic information system (GIS) database to describe existing conditions, assess potential Project-related habitat effects, and inform development of terrestrial resource management plans and, as needed, protection, mitigation and enhancement measures. Specific objectives of this study are as follows:

- Compile existing data and use remote sensing to describe and map vegetation to the "Group" level within the study area using the National Vegetation Classification (NVC) Standard.[1] The Group level is defined as a combination of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), with broadly similar composition and diagnostic growth forms reflecting biogeographic differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes. For highly modified areas such as the transmission line, a custom set of cover types will be used during mapping.
- Develop an overlay of potential Project-related disturbances to prioritize field surveys.
- Describe baseline vegetation resources and environmental conditions within the study area.
- Provide information on wetland communities within the study area (see Wetland Assessment Study).
- To the extent possible, provide information for assessing wildlife habitat (e.g., marbled murrelet, golden eagle, northern goshawk, beaver, and select Priority Habitat and Species [PHS] wildlife [https://wdfw.wa.gov/species-habitats/at-risk/phs/list] and WDFW Species of Greatest Conservation Needs [SGCN]) within the study area [https://wdfw.wa.gov/species-habitats/at-risk/swap]), as well as species of concern for NPS.
- To the extent possible, provide information for assessing important tribal resources including forage for important wildlife and culturally important plants (information will be considered confidential and not included in materials distributed to general public).

2.2 Resource Management Goals

City Light's goal is to compile and update existing information to provide a comprehensive vegetation type database to describe existing conditions, inform analysis of potential effects of Project operations and maintenance on vegetation and wildlife, and to inform natural resource management actions in the study area.

Management goals related to vegetation are described below.

- Ross Lake National Recreation Area General Management Plan and Environmental Impact Statement – Published by the NPS in 2012. The General Management Plan states that a Vegetation Management Plan will be developed to guide the vegetation management program. The Vegetation Management Plan will have priorities for restoration based on threats to high-

[1] For more information on the NVC Standard and categories including definitions for Group, Association, and Alliance levels, see: http://usnvc.org/data-standard/natural-vegetation-classification/.

quality habitats.

- U.S. Forest Service Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan – Published by the U.S. Forest Service in June 1990. The Land and Resource Management Plan was developed to guide resource management and establish standards for the management of resources, including vegetation, throughout the Mt. Baker-Snoqualmie National Forest.

2.3 Background and Existing Information

NPS, in partnership with the Washington Natural Heritage Program and the Institute for Natural Resources (based at Portland State University), is in the final stage of developing a vegetation map at the Association level for the North Cascades National Park (NCNP) using the NVC Standards. The Association level is a more refined unit below the Group level that classifies vegetation based on a characteristic range of species composition, with diagnostic species occurrence, habitat conditions, and physiognomy reflecting topo-edaphic conditions, climate, substrates, hydrology, and disturbance regimes. This is part of an eight-year-long effort to map the three National Parks in Washington State – NCNP, Mt. Rainier National Park, and Olympic National Park. City Light will use mapping provided by NPS by the end of 2019 to cover the NPS portion of the study area. With this vegetation mapping effort, the target is an overall accuracy of 80 percent.

City Light owns approximately 10,850 acres of land in scattered tracts within the Sauk, Skagit, and South Fork Nooksack basins that have been acquired for wildlife and fish mitigation under the current Project license. These lands, known as the fish and wildlife mitigation lands, were purchased in accordance with the Wildlife Settlement Agreement and Fisheries Settlement Agreement. City Light has mapped vegetation cover types of most of these lands but has used a different vegetation classification scheme than the NPS. The transmission line right-of-way (ROW) within the Project Boundary has not been mapped, except for the portion that is within the RLNRA or that cross fish and wildlife mitigation lands.

In this study, the NPS vegetation mapping (Group level) results for the NPS areas will be adopted within the study area. The existing Alliance-level mapping completed by the NPS will be retained and would be available. The NPS detailed field vegetation plots database will be leveraged along with a limited number of additional training plots and remote sensing methods to map vegetation at the Group level for all other vegetated areas in the study area. Vegetation mapping at the Group level was chosen because it provides the appropriate level of floristic detail and composition when combined with structural data from Light Detection and Ranging (LiDAR) to assess wildlife issues and inform vegetation management planning efforts. The Group level focuses on the dominant overstory species and does not include understory species. As needed for effect assessment and management planning, specific sites may be further refined to Alliance or finer levels. Along the transmission line and other highly altered vegetation types, traditional air-photo interpretation techniques will be used to map disturbed areas using custom cover types.

Existing resources include the following:

- Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. NRTR – NPS/NCCN/NRTR – 2009/211.
- Mapping of vegetation cover types surrounding Project reservoirs for the 1995 FERC relicensing.

- The EcoVeg approach in the Americas: U.S., Canadian, and International Vegetation Classifications. Faber-Langendoen, et al. Phytocoenologia. December 2017.
- Skagit Mitigation Lands Management Plan. Seattle City Light. 2006.
- Skagit Watershed Council Riparian Assessment. ESA. 2017.
- Skagit Watershed Council Reach Level Analysis – Middle Skagit River. Skagit River System Cooperative. 2011.

  Washington Department of Fish and Wildlife High Resolution Land Cover Mapping. https://wdfw.wa.gov/conservation/research/projects/aerial_imagery/.
- Mapping Riparian Land Use within Agricultural Zones. A case study in Skagit County. Whitefield, E. 2010. https://www.skagitcounty.net/SalmonStrategy/Documents/White%20Paper%20v23%20booklet-style.pdf.
- Seattle City Light Skagit River LiDAR – 2018.
- USGS Western Washington 3DEP LiDAR. 2016/2017. http://lidarportal.dnr.wa.gov/.
- High Spatial Res: 2018 4”/6” Pictometry, 1m 4band NAIP (normalized difference vegetation index).
- Spectral/Temporal: Sentinel 2 – 12-bands (10m, 20m), coverage every 5 days.
- National Park Service – SRI Soil Survey (SSURGO) for North Cascades National Park Complex. https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/washington/NorthCascadesWA2012/NOCA_WA.pdf.
- Conservation Biology Institute forest age mapping https://databasin.org/galleries/90e11cbab3724db2aa801e67643d9151#expand=13863.

2.4 Study Area

The study area will consist of land within the Project Boundary, the area within 0.5 mile of the Project Boundary, and the channel migration zone from Gorge Powerhouse to the confluence of the Sauk and Skagit Rivers. A location map of the Project Boundary and fish and wildlife mitigation lands is shown in Figure 2.4-1.

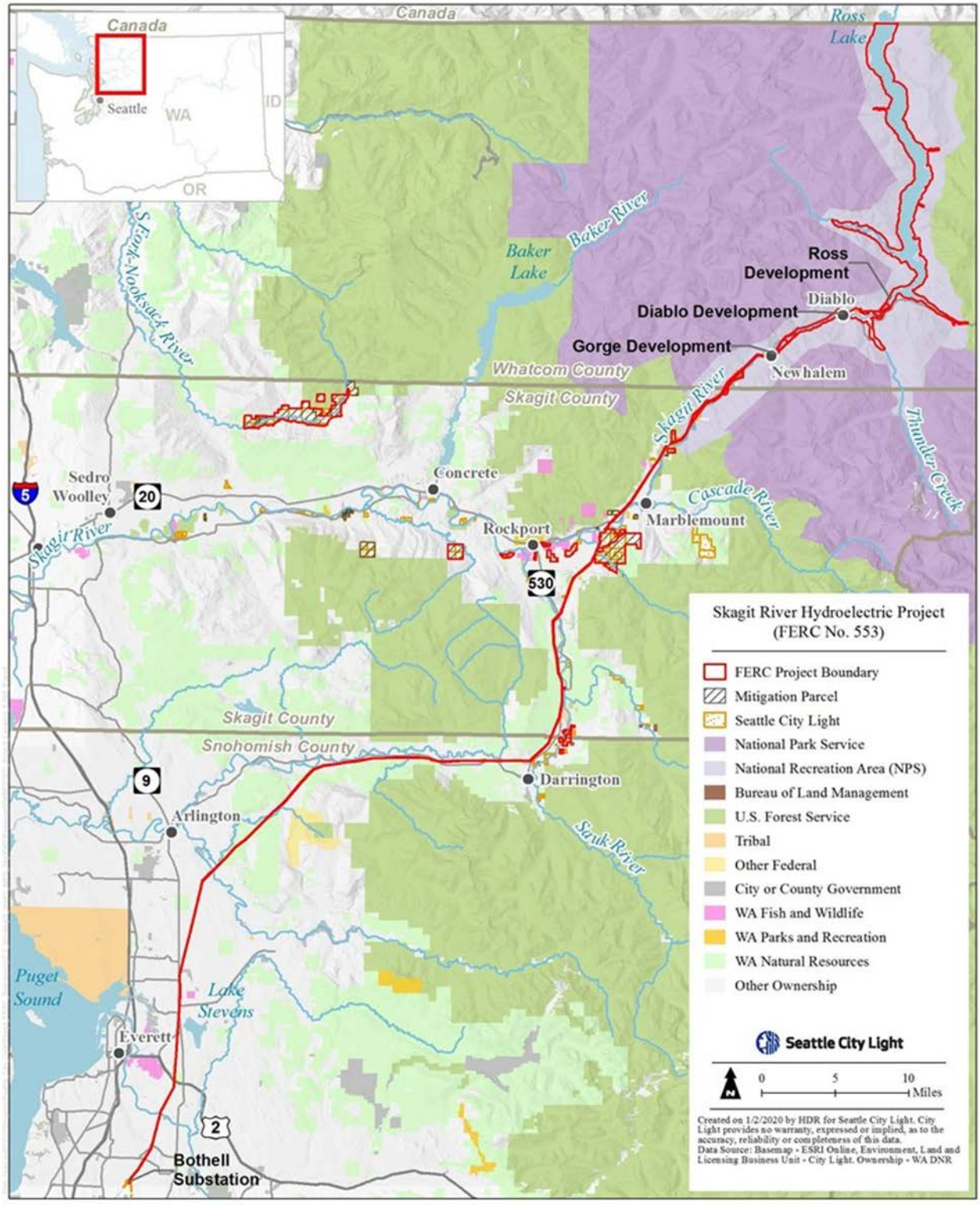

Figure 2.4-1. Location map of the Skagit River Project.

2.5 Methodology

2.5.1 Compile and Review Existing Information

City Light will work with the TRREWG to compile and summarize existing information including reports, documents, existing geospatial data, and similar studies relevant to the study area (see above existing resources list).

2.5.2 Validate Field and Remote Sensing Methods

The NPS has developed and applied a set of methods for their vegetation mapping inventory for NCNP based on a hierarchical classification of vegetation using the NVC Standard system. This approach uses a combination of random forest modeling and Object-based Image Analysis (OBIA) techniques. Random forest modeling is the most commonly used non-parametric classification method, which allows for the use of multiple, correlated input variables that are not normally distributed. Random forest is an ensemble, decision tree method, which uses a different random subset of training data (bootstrap) to build a multitude of decision trees and uses the mode of all decision trees to classify objects (Breiman 2001).

OBIA is a remote sensing technique used to identify patterns in raster imagery. For high-resolution mapping (<1 meter), OBIA improves classification accuracy, especially when the objects being resolved are larger than the pixel resolution of the imagery used (Blaschke et al. 2014). For efficiency purposes, the completed field and map products from NPS will be used as a basis, and the NPS field and remote sensing (random forest modeling and OBIA) framework will be applied to complete mapping vegetation in the study area outside of NCNP. The TRREWG will be informed of this approach, and intermediate products (maps, data summaries) will be shared as the study progresses.

2.5.3 Pre-process Geospatial Resources (Imagery, LiDAR, etc.)

Input and ancillary datasets will be compiled and pre-processed for incorporation into the analysis. Pre-processing includes re-projecting datasets into a common geographic projection and clipping data to the study extent.

2.5.4 Assess NPS Vegetation Mapping and Classification

The NPS vegetation mapping and classification output will be integrated into the final mapping product. In order to align results with the NPS classification, the NPS results will first be clipped to the study extent. Secondly, the NPS classification results mapped at the Group level will be spot checked based on limited field verifications and focus on areas where there is the greatest potential for Project effects (e.g., reservoir fluctuation zone and adjacent to Project facilities, buildings, and infrastructure).

2.5.5 Apply Field and Remote Sensing Methodology

A Group level vegetation map will be created based on a random forest model using multiple sources of remotely sensed (i.e., imagery, LiDAR-derived datasets) and ancillary (e.g., soils data) input variables identified as a first step in this analysis. A preliminary classification map will be produced for the portion of the study area not covered by NPS to interpret the initial model results, help identify areas to review in the field to inform the model, and to assist with field data collection

efforts. The classification will be refined and the classification accuracy will be validated using the collected field data.

2.5.6 Input Datasets

As stated above, any existing datasets that could be used in the random forest model will first be compiled and reviewed. The following input datasets will be tested for the preliminary model:

- Imagery
- High-resolution aerial imagery
- Sentinel-2 satellite imagery
- Landsat satellite imagery
- LiDAR-derived datasets
- Digital terrain model
- Canopy height model
- Slope index
- Topographic wetness index
- Topographic indices (plan curvature, grad curvature, profile curvature)
- Ancillary datasets
- Geology
- Soils

In addition, the potential of other LiDAR-derived vegetation metrics will be evaluated such as canopy bulk density, sub-canopy metrics (i.e., number of LiDAR points at different height stratifications), and rumple (i.e., canopy complexity). Only input variables that show model significance will be used for the preliminary random forest model that is run over the part of the study area not covered by NPS.

2.5.7 Preliminary Model

As a first step, a preliminary random forest model will be developed using training data taken from the NPS classification that falls within the study extent and run the model across the study area. The training data will be maximized by using existing data from as many of the NPS vegetation plots within proximity of the study area as possible.

This preliminary modeling effort will serve two purposes. First, it will provide an early look at the random forest model, which will help to identify which remote sensing data inputs are the most significant in the vegetation classification and if additional datasets are needed. Second, the preliminary classification can be used to stratify sampling for the field data collection effort. Outside of the NPS-mapped area, field assessment will prioritize areas with the greatest mapping uncertainty and representative sampling of Groups. Some field assessment will occur within the areas already mapped by NPS focusing on areas where there are obvious errors such as along transmission line ROWs or near towns. Preliminary maps will be output in raster format with each

pixel containing information on probability of vegetation group class membership. The pixel will be classified by the class with the highest probability of class membership. The prediction error output and input variable performance will be used, and two metrics will be provided through the Random Forest package in R (Liaw and Wiener 2002), to assess overall model performance and the significance of each of the input variables. In addition, the accuracy of the preliminary classification will be assessed using field data points collected by the NPS in NCNP.

2.5.8 Collection of Model Training and Verification Data

A stratified sampling approach will be used to collect vegetation information at representative sites not well covered by NPS data. These data will be used to develop an initial training and validation dataset to verify areas within the potential effects overlay and where model interpretation is less certain. Stratification will be based on a combination of vegetation mapping units and a combination of topography, soils, and other key components.

In order to increase efficiency in field data collection, the training and validation dataset will be refined by constraining the sampling sites to areas that are both safe and easily accessible to field ecologists. Areas with a steep slope, non-easement private property, and areas greater than a half-mile from a road will not be sampled for safety and field efficiency. The training dataset will be supplemented with opportunistic sampling by collecting additional data points for every group class encountered during travel to a sample point. These points can help boost the number of training data points needed for the random forest model. A proportion of sample points will be reserved for validation of the model to assess the accuracy of the classification. Accuracy assessment methods are described below. Validation data points will not include opportunistic collection of data. Resource leads will coordinate and will determine what data should be collected opportunistically during a specific study that would help inform another study's sampling scheme.

While not required for mapping at the Group level, additional vegetation data will be collected during field verification efforts to supplement the mapping effort at certain locations. These metrics include the following:

- Cover estimates of co-dominants of each strata – tree, shrub, and groundcover.
- Diameter-at-breast-height for co-dominant trees.
- List of common species of each strata.
- Incidental observations of special features such as high snag density, beaver activity, wildlife sightings, and associated items.

During fieldwork, biologists will document plant species that Indian tribes or First Nations listed as culturally-important for the relicensing studies.

2.5.9 Develop Draft and Final Vegetation Map

An OBIA approach will be used for a draft and final model instead of a pixel-based approach as was used in the preliminary modeling effort. While OBIA can produce more accurate results than pixel-based approaches, it is more computationally intensive. Therefore, only OBIA will be run for the final modeling effort. Object statistics (e.g., mean, min, max elevation) will be calculated, which is unique to OBIA, and will be integrated into the final random forest model.

The preliminary random forest model will be refined by using the training data collected within the study area and selecting the input variables that have the highest overall model importance. While random forest models can handle highly correlated input datasets, reducing the number of input variables will improve computing performance. Input variables will be checked for multi-collinearity and any datasets with a correlation greater than 0.8 will be removed.

Running filters will be evaluated on the final habitat classification to remove patches below a minimum mapping unit of 5 square meters. This is commonly done to remove the "popcorn" effect that can make maps illegible. In addition, manual refinements will be applied using very high spatial resolution imagery to address clear visual errors.

OBIA segmentation and calculation of object statistics will occur using Orpheo toolbox as part of QGIS. Random forest modeling will occur in R using the statistical package randomForest (Liaw and Wiener 2002). Post-processing, clean-up, and final map products including FGDC-compliant metadata will be done using ESRI ArcGIS desktop software.

The townsites and transmission line right-of-way are heavily altered habitats that require a modified mapping approach. Similarly, vegetation types likely modified through modern agriculture and traditional ecological management practices may not fit into natural vegetation categories. As such, separate cultural classifications will be developed for these areas because these vegetation communities are not included in typical vegetation classifications. Aerial photography will aid in determining the classifications of these sites and LiDAR will inform vegetation height determination on the transmission line ROW. Field verification will be conducted in the townsites and along the transmission line at representative sites where vegetation management occurs.

Specific study products include:

- GIS-based map of vegetation at group or cultural group level within the study area. The database will include information on dominant plant species composition and field- and LiDAR-derived structural data (e.g. tree size and canopy closure, riparian/wetland deciduous tree and shrub cover, etc.) that will inform assessment of wildlife habitat for marbled murrelet, golden eagle, northern goshawk, and beaver studies, and the large woody debris component of the geomorphology study.
- Overlay of potential Project-related disturbances.
- A description of vegetation resources and environmental conditions within the study area.
- Cross-walk table that translates mapped vegetation groups (alliances in area covered by NPS mapping) to PHS habitats and State Wildlife Action Plan (SWAP) habitats and separate GIS layer of obvious snag-rich areas in the study area.
- Initial data on wetland communities to inform the Wetland Assessment Study.

Draft and final maps will be reviewed by the TRREWG and manual refinements to the vegetation map will be made based on expert input.

2.5.10 Accuracy Assessment

Accuracy of the final habitat classification will be assessed using standard accuracy assessment procedures as outlined in Congalton and Green (2010). The overall accuracy will be calculated as well as the individual class accuracy using the validation sample data collected in the field. An alternative approach is to use a bootstrap method of the entire sample dataset; a method that relies on random sampling to estimate the measure of accuracy. Consistent with the NPS vegetation mapping inventory, 80 percent overall accuracy will be targeted.

2.6 Consistency with Generally Accepted Scientific Practice

Random forest classification is a widely accepted approach for land cover classification. OBIA is commonly used for high spatial resolution remote sensing where spectral resolution is confined to 3 or 4 bands (red, blue, green, infrared). OBIA has been shown to increase overall accuracy of high spatial resolution classifications and overall map aesthetics. The standard accuracy assessment outlined by Congalton and Green (2010) will be implemented.

2.7 Schedule

- Draft Study Plan – October 2019 for TRREWG review
- Revised Study Plan – March 2020
- Initial Model Run – Spring 2020
- Fieldwork – Summer 2020
- Data Analysis and Map Development – Autumn 2020
- Draft Maps – February 2021
- Draft Report – June 2021

2.8 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $300,000.

3.0 REFERENCES

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VEGETATION MAPPING PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	10/31/202019	Section 2.1 Study Goals and Objectives	Hi Ron, I am sorry it took this long to get to your request at the meeting. I just remembered. Please see PHS List : https://wdfw.wa.gov/publications/00165 Additional Habitat Parameters: https://wdfw.wa.gov/species-habitats/at-risk/phs/recommendations Species of Greatest Conservation Need and Habitats of Greatest Conservation Need: https://wdfw.wa.gov/species-habitats/at-risk/swap	WDFW noted at the October 10, 2019 TRREWG meeting that this information would be provided as a resource. Comment noted.
2.	Brock Applegate (WDFW)	10/31/202019	Section 2.1 Study Goals and Objectives	As stated in the past comments, SCL should include all important habitat parameters for Washington State Priority Species and Habitat and Species of Greatest Conservation Need Lists, which have much overlap I like the bullet that SCL has in the Wetland Assessment Draft Study because it captures my thought on this study as well. "Additional habitat-related data to inform other efforts, such as the rare, threatened, and endangered (RTE) plant, invasive plant, beaver, and amphibian studies."	City Light will use high resolution imagery, LiDAR, and other existing sources to develop the Group Level Vegetation Map and make generalized assessments based on these data for select PHS and SGCN species. The expansion of the species list is not necessary to inform relicensing. Information from the Wetland Assessment Study and other planned studies will feed into this effort. This mapping effort is a baseline data effort that will be used for later impact assessments and management recommendations.
3.	Brock Applegate (WDFW)	10/31/202019	Section 2.3 Background and Existing Information	WDFW finds transmission line corridors important, including those near the project lands for sensitive species, especially ones that migrate substantial distance between habitats, (IE raptors, waterfowl, etc.)	See the above response to Comment #2.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
4.	Brock Applegate (WDFW)	10/31/2019	Section 2.3 Background and Existing Information	I like the continuation of other mapping projects, but we may need more information beyond this particular effort. Let's look at all the habitat parameter needs for each species and habitat and make sure that we have it covered in the mapping project before we start.	The Vegetation Mapping Study is one piece of foundational information. Other data such as wetlands, weeds, rare plants, and other studies will provide supplemental information that will be used to make a high level assessment of important wildlife species.
5.	Brock Applegate (WDFW)	10/31/2019	Section 2.4 Study Area	Since SCL has lands in the South Fork of the Nooksack and on the Skagit River downstream, SCL should consider extending the boundaries to Concrete.	City Light is mapping the wildlife mitigation lands plus a 0.5-mile buffer that will provide context for general discussion of habitat connections.
6.	Brock Applegate (WDFW)	10/31/2019	Section 2.4 Study Area	SCL should consider the quality of migration corridors between their wildlife mitigation lands. Do we have enough foraging and staging trees and snags for eagles? Should we focus on the quality of habitat in riparian areas for migration corridors? Riparian zones have some of the best quality habitat. SCL should consider the connection between the mitigation lands as trespass, dumping, and noxious weeds degrade habitat on and off mitigation lands. SCL should consider species entire home range, which often includes these riparian corridors. I see a connection with fish and aquatics resources group as they consider the quality of riparian zones on wildlife and fish resources. What does the surrounding habitat near the river look like? How should we focus or management of the mitigation lands? **New comment Shauna Hee (USFS) provided 3/23/202020:** Can I please get a copy of the current Management Plan? When does City Light anticipate updating the plan?	The Vegetation Mapping Study concentrates on the wildlife mitigation lands where City Light has management control. An updated Wildlife Habitat Protection and Management Plan will address specific goals and objectives for each parcel. No data will be collected outside of the mitigation lands and a 0.5-mile buffer. Habitat connections among the parcels may be assessed on a high-level scale using government and other protected lands data; such an assessment will not be done as a part of this study. **Response to comment provided on 3/23/202020:** A copy of this document is posted on the LP SharePoint site under the TRREWG / Background Documents folder.
7.	Mignonne Bivin (NPS)	10/31/2019	Section 2.1	In reference to adding spotted owl to the example species list.	The U.S. Fish and Wildlife Service (USFWS) said they have the information they need for

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Study Goals and Objectives	**New comment Shauna Hee (USFS) provided 3/23/202020:** How will forest/stand age be determined?	spotted owl. Forest age will be part of the mapping data and will be available to LPs. **Response to comment provided on 3/23/202020:** The NPS vegetation map and the map that will be developed for portions of the study area outside of the national park use the NVC system, which does not include an age component. Forest age will be developed for two other studies – the marbled murrelet and goshawk nesting habitat studies. Forest stand age will be determined using Conservation Biology Institute data for the North Cascades, adjusting as needed. See: https://databasin.org/galleries/90e11cbab3724db2aa801e67643d9151#expand=13863
8.	Mignonne Bivin (NPS)	10/31/2019	Section 2.3 Background and Existing Information	National Park Service - SRI - Soil Survey Geographic (SSURGO) for North Cascades National Park Complex, Washington	Reference added to bulleted list.
9.	Mignonne Bivin (NPS)	10/31/2019	Section 2.5 Methodology	Define, how steep, major river crossing?	Safety is of paramount importance for all field work. No technical rope-work will be allowed. Steepness of terrain and any water crossings will be reviewed once we have a draft map and have identified areas that need to be surveyed. City Light and all team members will adhere to the comprehensive safety plan for all field work.
10.	Mignonne Bivin (NPS)	10/31/2019	Section 2.5 Methodology	Spotted owl?	The USFWS has indicated that they have all the data they need to develop an effects assessment for spotted owl. No further work is planned for this species.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					City Light will work with USFWS and NPS to consolidate their spotted owl data and provide the vegetation mapping data for consolidation with USFWS existing information.
11.	Stacy McDonough (NPS)	03/23/2020	Section 2.1 Study Goals and Objectives	How will this help to prioritized field surveys? Seems like the priority should be ensuring all potential vegetation types in the project area are identified, sampled and mapped. This seems more like a method for determining where the field work and remote sensing will be completed.	There will be two steps in field assessment. The first will be to inform and refine the model. The second step is further verification that will concentrate on areas that may be affected by the Project (as outlined) where more precise information is needed.
12.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	It seems like we should cast a broad net at this stage for the baseline. Species that are abundant today may be at risk in the future depending on changes in temps, precip and fire regime	This study is a broad vegetation mapping effort, not a broad scale habitat assessment. However, results of the study may be used along with other environmental parameters (topographic, LiDAR, etc.) to assess high-level habitat for many wildlife species. Additional studies have been developed to respond to specific resource concerns brought forth to the TRREWG – for instance, for the goshawk, amphibian, marbled murrelet, and golden eagle studies.
13.	Brock Applegate (WDFW)	03/17/2020	Section 2.1 Study Goals and Objectives	Would we describe these species for the study plan? We might want to include Priority Habitats as well.	The link provided includes both Priority Habitats and Priority Species.
14.	Brock Applegate (WDFW)	03/17/2020	Section 2.1 Study Goals and Objectives	We might solve the difference between Priority Species and Priority Habitats (two different lists in the same document) and keep the list updated by adding a link.	The provided link is WDFW's current document that covers both Priority Habitats and Priority Species. The list of PHS habitats likely in study area: ▪ Herbaceous balds ▪ Old-growth/mature forest ▪ Freshwater wetlands and fresh deepwater ▪ Instream ▪ Cliffs (larger ones) ▪ Snag-rich areas ▪ Talus

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					City Light will develop a cross-walk matrix that will allow anyone to see which plant groups correspond to each PHS habitat (see added text in Section 2.5.9). One exception is snag-rich areas. For that City Light will map obvious stand-level areas with high snag density on a separate GIS layer, using combination of remote sensing and field observations. List of PHS wildlife species is extensive. Providing the URL in the study plan is adequate.
15.	Brock Applegate (WDFW)	03/17/2020	Section 2.1 Study Goals and Objectives	Although the Priority and Greatest Conservation lists overlap immensely, I would say we might have the same issues with the Species of Greatest Conservation Need list, one section of species and one section of habitats. A link also keeps the list updated.	The link provided is WDFW's current document for PHS and the SWAP.
16.	Stan Walsh (SRSC)	03/17/2020	Section 2.1 Study Goals and Objectives	This needs to be coordinate with tribal staff on the cultural committee, some plants may be considered non-public intormation	Text added.
17.	Stacy McDonough (NPS)	03/23/2020	Section 2.3 Background and Existing Information	Does this mean that the data collected and mapped by NPS at the alliance and association level will be mapped for this project at the Group level? If so won't a lot of information be lost?	The baseline maps will be presented at the Group level; NPS mapped at the alliance and association level and that information will still be available for parties to review if desired. It will also be available if more detailed analyses are needed at specific locations covered by NPS mapping. Text edited.
18.	Rick Hartson (Upper Skagit Indian Tribe)	03/23/2020	Section 2.4 Study Area	The Study Area should extend downstream to the mouth of the Skagit, including the Skagit delta and/or estuary. Issue/concern: The Study Area should extend downstream to the mouth of the Skagit, including the Skagit	The study area extends downstream of the Gorge powerhouse to the confluence of the Skagit and Sauk rivers in order to first address the area with potential direct, attributable effects of the Project. Beyond this point, and further downstream, it is not possible with reasonable scientific certainty (and within the time frames

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				delta and/or estuary. Resource Impact: Salmonid habitats, including for ESA-listed populations, encompassing the area within the 100-year floodplain or geomorphic floodplain, whichever is larger. Also, the natural and free-flowing state of the Skagit Wild & Scenic River system. Relevant Project Operations: Instream flow manipulations, including those associated with flood control and power generation. For example, the combination of two hydropower projects in the Skagit River basin (Seattle City Light and Puget Sound Energy) reduces peak flow at the USGS gage near Concrete, WA by nearly 50,000 cfs during the 1% annual chance exceedance (ACE), or 100-year event. Operations also impact floods more common than the 1% ACE, as well as the timing and duration of peak flows (see Skagit River General Investigation). Of the two hydro projects, the Skagit project has the greater flood storage capacity, providing ample reason to suspect that SCL's project-related impacts are significant throughout the entire Skagit River. Relevance of Vegetation Mapping: Alterations to the hydrograph may disrupt natural geomorphic processes that create and sustain ESA critical habitats, including priority juvenile Chinook rearing habitats such as river banks with large woody debris, low-angle gravel bars, log jams, backwaters, and floodplain channels. These habitats are important for other salmonid species, including	of the ILP) to determine whether, or to what extent, Skagit River Project operations or maintenance is affecting a resource. The potential for, and the degree to which, Project operations might affect resources below the Sauk River requires (1) a determination that a resource is actually being impacted, (2) if it is, the formation of various hypotheses as to the cause(s), and (3) either detailed studies, modeling, or large scale experimentation to investigate the hypotheses. It is reasonable to expect such efforts to require time frames well beyond what is available under the ILP. Seattle City Light may have an interest in participating in such longer-term studies if such studies can be reasonably scoped to have useful study results. Such efforts could be part of a settlement agreement or an agreed-upon long term study outside of relicensing.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Steelhead and Coho. A component of these geomorphic processes is the interaction of flow with forested channel banks and floodplains. Another important service of forested floodplains is terrestrial subsidies to the aquatic food web, for instance when high flow connects floodplain terraces to river channels (see Skagit Chinook Recovery Plan for discussion of geomorphic process and terrestrial subsidies to productivity). Specific Information Need: A remaining uncertainty is the extent to which instream flow manipulations have interrupted the geomorphic processes that create and sustain salmonid habitats, including for ESA-listed populations. Also, it is uncertain to what extent terrestrial subsidies have been impacted. To answer these questions a number of interrelated studies will be required, including the mapping of forest cover and stand age or tree size, as well as understory composition, throughout the area impacted by project-related flow manipulations. The size of trees is relevant for determining the geomorphic response. Understory composition and presence of non-native species may impact terrestrial subsidies.	
19.	Rick Hartson (Upper Skagit Indian Tribe)	03/23/2020	Section 2.4 Study Area	To account for ESA critical habitat, the study area should encompass the FERC 100-year floodplain (see FEMA NFIP BiOp for Puget Sound, 2008). The FERC 100-year floodplain should be determined in the absence of project-related flood control (see Upper Skagit Indian Tribe's Regulatory Floodplain Issue Form).	The CMZ data developed by the NPS will be used for this vegetation study. The CMZ expands the study area well beyond the existing 100-year floodplain. Any data needs regarding effects on salmonids (FEMA NFIP BiOp reference) will be determined by studies discussed within the Fish and Aquatics Workgroup.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
20.	Rick Hartson (Upper Skagit Indian Tribe)	03/23/2020	Section 2.4 Study Area	It is not clear how the channel migration zone will be defined. Rather than rely on this ambiguous term, SCL should ensure the study area encompasses the needs of the relevant regulatory authorities and affected tribes. For example, see our previous comment regarding importance of understanding impacts to ESA-listed populations. To account for ESA critical habitat, the study area should encompass the FERC 100-year floodplain (see FEMA NFIP BiOp for Puget Sound, 2008). The FERC 100-year floodplain should be determined in the absence of project-related flood control (see Upper Skagit Indian Tribe's Regulatory Floodplain Issue Form). This approach for mapping the floodplain attempts to directly relate information requests to ongoing project operations. The study area should be expanded beyond the 100-year floodplain where geomorphic assessment suggests a possibility for bank erosion and channel meandering over the course of the relicense period.	The study will use the CMZ developed and mapped by NPS. The CMZ encompasses the existing floodplain. Additional data needs to address salmonids (FEMA NFIP BiOp reference) will be determined by studies discussed in the Fish and Aquatics Resource Work Group.
21.	Shauna Hee (USFS)	03/23/2020	Section 2.5 Methodology	Can I get examples of what areas may have the "greatest potential" for project effects?	Text added.
22.	Stacy McDonough (NPS)	03/23/2020	Section 2.5 Methodology	How will the study ensure all vegetation groups within the study area including in the training data for tha maps. What is the plan for addressing vegetation groups/alliances which may only occur at sizes smaller than the mapping unit size? ie wetlands, ripairian corridors, conifer swamps etc	Study will review training data to ensure major groups have sufficient data. Some groups may need to be directly mapped. The WIT output will be aligned to the coarsest data input. If LiDAR is a 1 sq meter pixel and weather data is at a 10 m pixel, the WIT output will be at 10 m. There is a separate wetland mapping study that is using a specific wetland model. This study will note where particular vegetation groups are

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					associated with riparian areas.
23.	Stacy McDonough (NPS)	03/23/2020	Section 2.5 Methodology	Can you clarify how limited the field data collection will be? Will this be based on the accuracy for the first mapping effort? How will you determined now much additional data will need to be collected?	There will be an initial field effort to help inform the model. After the second generation map field efforts will concentrate on sites where there is a potential project effect, where more precise information will help inform an overall effects analysis. Limited field verification will be conducted on an as-needed basis for specific areas where a Project-related effect has been identified around City Light facilities and errors will be corrected.
24.	Shauna Hee (USFS)	03/23/2020	Section 2.5 Methodology	How is “steep gradient” being defined?	A field safety plan will be developed with guidelines for parameters such as steepness, terrain, water crossings, etc.
25.	Shauna Hee (USFS)	03/23/2020	Section 2.5 Methodology	Why are areas greater than a half-mile from a road omitted from field data collection? Why were sites that could be accessed by boat, kayak or trail omitted? Would this mean that only the southern end of Ross Lake near Hwy 20, if it’s not too steep, may receive field review?	Potential effects from project roads into natural vegetation are less than one half mile. Keeping to these field guidelines will improve study efficiency. Areas along the reservoirs will be accessed by boat and then by foot, if necessary. NPS has already mapped the portion of the study area within the NCNP.
26.	Stacy McDonough (NPS)	03/23/2020	Section 2.5 Methodology	Will there be a standardiized protocol and size for the collection of opportunisitc data points? How will fiield crews determine what qualifiies as an opportunisitic site?	See text edits. Resource leads will coordinate to determine what opportunistic data should be collected to inform other studies prior to field work commencing.
27.	Stan Walsh (SRSC)	3/23/2020	Section 2.5 Methodology	Study products should also include species level vegetation for wildlife forage (specifically elk) on SCL Fish and Wildlife Lands. The purpose of this information is the development of Management Plans for the Fish and Wildlife Lands	Co-dominant species of the dominant cover class will be identified. An updated Wildlife Habitat Protection and Management Plan will be developed during this relicensing period. Additional information needed to inform management goals will be developed during the new license period.
28.	Shauna Hee (USFS)	03/23/2020	Section 2.5 Methodology	Why was the LWD geomorph. component dropped from the study plan?	Editing mistake – text added back.

TR-02 WETLAND ASSESSMENT
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on Study Plan

List of Acronyms and Abbreviations

City Light.....Seattle City Light
DO.....Director's Order
ELC.....Environmental Learning Center
EO.....Executive Order
FERC.....Federal Energy Regulatory Commission
GIS.....geographic information system
LiDAR.....Light Detection and Ranging
LP.....licensing participant
m.....meters
NPS.....National Park Service
NWI.....National Wetlands Inventory
PAD.....Pre-Application Document
Project.....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM.....river mile
RTE.....rare, threatened, and endangered
RWG.....Resource Work Group
TRREWG.....Terrestrial Resources and Reservoir Erosion Working Group
USACE.....U.S. Army Corps of Engineers
U.S.C.....Unites States Code
USFS.....U.S. Forest Service
USFWS.....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife
WIP.....Wetland Intrinsic Potential

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC) several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

A baseline characterization of wetlands within the Project Boundary and vicinity was identified as an early study need during 2019 discussions with the Terrestrial Resources and Reservoir Erosion Work Group (TRREWG). On October 10, 2019, City Light released the Wetland Assessment Draft Study Plan for LP review and comment. On October 15, 2019, the draft study plan was discussed at a TRREWG meeting. City Light reviewed all comments received and released a revised version of the draft study plan on March 3, 2020. The revised draft was discussed on March 17, 2020 at a TRREWG meeting. City Light reviewed additional comments received and released a second revised version of the draft study plan on March 31, 2020. Written comments were received from Washington Department of Fish and Wildlife (WDFW), NPS, Upper Skagit Indian Tribe, and U.S. Forest Service (USFS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC. However, this study will provide information requested as part of the following study requests: NMFS-02 Geomorphology and Aquatic Habitat, SSIT-03 Impacts of Transmission Line Right of Way (ROW) on Aquatic Habitat and Riparian Zone for the Skagit River Hydroelectric Project, USFWS-15 Geomorphology and Aquatic Habitat Complexity Study Request, USIT-08 Geomorphology and Anadromous Salmonid Habitat, and WDFW-05 Geomorphology and Anadromous Salmonid Habitat, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the Wetland Assessment Study is to map and describe wetlands within the study area that may be affected by Project operations and to rate the capability of these wetlands to provide water quality, hydrologic, and habitat functions. Overall condition and existing sources of impairment will also be evaluated. Specific objectives of this study are as follows:

- Gather information on wetlands currently mapped within the study area and downstream to the Sauk River confluence.
- Refine existing maps derived from remote sensing and map wetlands in a uniform manner based on the U.S. Fish and Wildlife Service (USFWS) Classification of Wetlands and Deepwater Habitat of the United States (Cowardin et al. 1979) classification system.
- Develop an overlay of Project-related potential disturbances to prioritize field survey efforts.
- Document plant species in sampled wetlands.
- Use the Washington State Wetland Rating System for Western Washington (Hruby 2014) to assess wetland functions and values.
- Identify possible sources of any observed impairments.
- Provide basic habitat-related data to inform other efforts, such as the rare, threatened, and endangered (RTE) plant, invasive plant, beaver habitat, and amphibian studies, as well as the geomorphology study and other Fish and Aquatics studies.
- To the extent possible, provide basic habitat mapping for select Priority Habitat and Species wildlife (https://wdfw.wa.gov/species-habitats/at-risk/phs/list) and WDFW Species of Greatest Conservation Needs within the study area (https://wdfw.wa.gov/species-habitats/at-risk/swap), as well as species of concern for NPS.
- To the extent possible, provide information for assessing important tribal resources including forage for important wildlife and culturally important plants.

2.2 Resource Management Goals

City Light's goal is to have accurate wetland mapping and functional analysis data for assessing wetlands in the study area and will provide basic information help resource agencies, Indian tribes and First Nations in the Project vicinity identify appropriate recommendations and conditions for the new Project license pursuant to their respective goals and authorities.. Management goals related to wetlands are described below.

- Protection of Wetlands, Executive Order (EO) 11990 of May 24, 1977 – This order requires federal agencies to consider alternatives to wetland sites and limit potential damage to minimize the destruction, loss, or degradation of wetlands to preserve and enhance the natural and beneficial values of wetlands.
- NPS Director's Order (DO) 77-1: Wetland Protection, effective October 30, 2002, establishes the policies, requirements, and standards for implementing EO 11990. Included in DO 77-1 are: (1) adoption of a "no net loss of wetlands" goal; and (2) adoption of the Cowardin et al.

(1979) wetland classification system as the NPS standard for defining, classifying, and inventorying wetlands.

- Ross Lake National Recreation Area General Management Plan and Environmental Impact Statement – Published by the NPS in 2012, this management plan includes several management strategies for the protection of wetlands within the RLNRA based on EO 11990 and DO 77-1.
- The National Forest Management Act includes provisions applicable to all projects and requires the following: (a) resource plans and permits, contracts, and other instruments shall be consistent with the forest land management plan; (b) ensure consideration of the economic and environmental aspects of management, to provide for outdoor recreation, range, timber, watershed, wildlife, and fish; and (c) provide for diversity of plant and animal communities.

2.3 Background and Existing Information

Since 1975, the USFWS National Wetlands Inventory (NWI) has been mapping wetlands throughout the United States. Wetlands mapped by NWI are classified according to the USFWS classification system (Cowardin et al. 1979). However, these mapping exercises are performed on a large scale and based on aerial imagery, frequently resulting in the exclusion of smaller-scale wetlands. Additionally, once NWI maps a wetland, these areas are rarely revisited or revised and natural or anthropogenic changes are not captured. Due to the variations of accuracy and precision of NWI maps, these resources are only used during high-level planning phases and a wetland reconnaissance or delineation is necessary where Project effects may occur. Skagit, Whatcom, and Snohomish counties have all based their county wetland inventories on NWI mapping. NWI currently maps approximately 820 acres of wetland within the Project Boundary.

Additionally, the NPS' Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks study (Crawford et al. 2009) has mapped 1,647 acres of plant communities that may include wetlands within the Project Boundary within North Cascades National Park. Classification of vegetation has been performed according to the National Vegetation Classification System to the Association level. However, the data are mapped at the Alliance level, which is the mapping standard for NPS projects. Thus, some vegetation categories may include both wetland and non-wetland areas.

City Light owns approximately 10,850 acres of land in scattered tracts within the Sauk, Skagit, and South Fork Nooksack basins that they have acquired for natural resource protection over the course of the current Project license. These lands, known as the fish and wildlife mitigation lands, were purchased in according to the Wildlife Settlement Agreement and the Fisheries Settlement Agreement. City Light has mapped habitat cover types of most of these lands. Approximately 164 acres of wetlands have been mapped on the fish and wildlife mitigation lands. However, the evaluation of conditions was done between 2001 and 2003 and focused on seral stage and structures. Site conditions will likely change over time and require further site evaluation (City Light 2006). In addition, City Light did not apply the same vegetation mapping classifications as used by NPS and one of the goals of the relicensing studies is to develop a uniform set of terrestrial resource data. The goal of this study is to map wetland areas within the study area in a uniform way based on the USFWS Cowardin classification system.

Existing resources include the following:

- USFWS National Wetlands Inventory. https://www.fws.gov/wetlands/data/Mapper.html
- Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks. Crawford et al., 2009. https://irma.nps.gov/DataStore/Reference/Profile/661669
- NPS Alliance-Level mapping within North Cascades National Park Service Complex.
- Washington Department of Fish and Wildlife Priority Habitats and Species Mapping. WDFW, 2019. http://apps.wdfw.wa.gov/phsontheweb/
- Washington Department of Natural Heritage Wetlands of High Conservation Value. WDNR 2019. https://www.dnr.wa.gov/NHPwetlandviewer
- Plant Life of Washington State: Big Beaver Valley and the Kettle Range. Washington Native Plant Society. 1988. Seattle, Washington. Douglasia Occasional Papers. Volume 3.
- Wetlands inventory in the North Cascades National Park Service Complex. Holmes RE and Kuntz RC, 1994. North Cascades National Park Service Complex, Resource Management Division.
- Skagit Mitigation Lands Management Plan and internal vegetation cover type mapping. City Light, 2006.
- Skagit River System Cooperative mapping of the "Barnaby Reach" portion of the Skagit River floodplain between Illabot Creek and SR530 bridge, 2017.
- Skagit Watershed Council Riparian Assessment. ESA, 2017. https://www.skagitwatershed.org/our-work/riparian/
- Skagit Watershed Council Reach Level Analysis – Middle Skagit River. Skagit River System Cooperative. 2011. https://www.skagitwatershed.org/wp-content/uploads/MiddleSkagit_Reach_Analysis_Final_Report_and_Appendices.pdf
- Mapping Riparian Land Use within Agricultural Zones. A case study in Skagit County. Whitefield, E. 2010. https://www.skagitcounty.net/SalmonStrategy/Documents/White%20Paper%20v23%20booklet-style.pdf
- Skagit County Wetland Map. Skagit County, 2004. https://www.skagitcounty.net/GIS/Documents/HydricSoils/t36r11_12.pdf
- Whatcom County Wetland Map. Whatcom County, 2006. https://www.whatcomcounty.us/DocumentCenter/View/1838/Wetlands-PDF?bidId=
- Snohomish County Wetland Maps. Snohomish County, 2016. http://www.snoco.org/docs/scd/PDF/PDS_CAR/Critical_Areas_Wetlands_ALLCounty_20160201.pdf
- Seattle City Light Skagit River Light Detection and Ranging (LiDAR) – 2018.
- USGS Western Washington 3DEP LiDAR. 2016/2017. http://lidarportal.dnr.wa.gov/

2.4 Study Area

This study area will consist of the area within the Project Boundary and the channel migration zone (mapped by NPS) from Gorge Powerhouse to the confluence of the Sauk and Skagit rivers. Field sampling will emphasize wetlands where there is the greatest potential for Project effects (e.g., reservoir fluctuation zone and adjacent to Project facilities, buildings, and infrastructure) or Project-related recreational activities, whereas wetlands not affected by the Project will not be field assessed (i.e., desktop analysis)

The study area includes the Big Beaver Valley as designated by the Project Boundary, but because there are no City Light activities that affect this reach of the Project vicinity, no wetland fieldwork will be conducted here. Wetlands will be mapped here, however.

A draft map of the affected areas will be developed and overlain on the preliminary wetland map for LPs review.

A location map of the Project Boundary is provided in Figure 2.4-1.

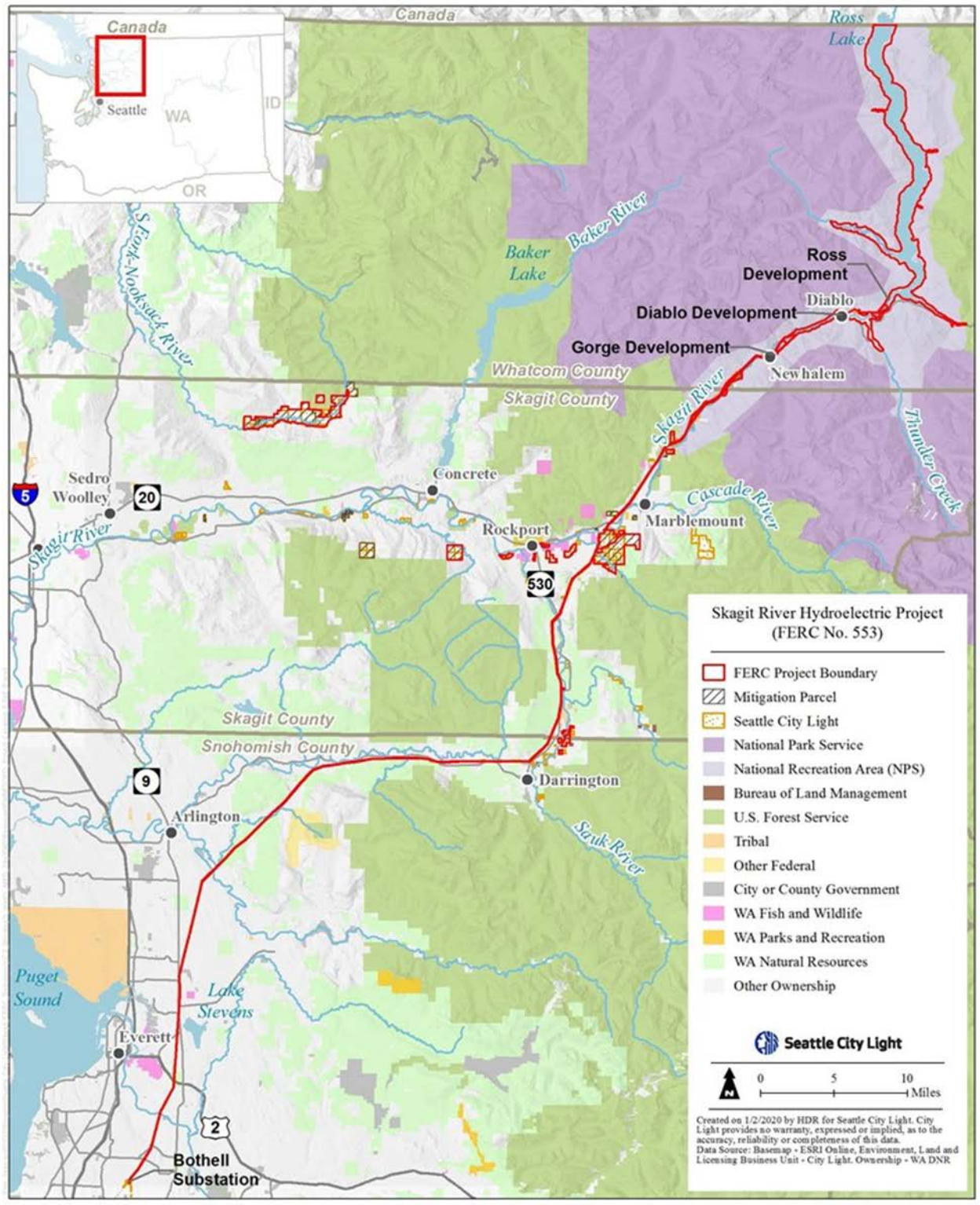

Figure 2.4-1. Location map of the Skagit River Project.

2.5 Methodology

2.5.1 Compile and Review Existing Information

The study team will prepare a preliminary map using existing NWI mapping as well as an interpretation of the most current high-resolution aerial photography (2018, 6-inch resolution color digital orthophotography). Working closely with City Light staff and the TRREWG, additional information on other wetland studies and inventories will be compiled. Results of the NPS's Vegetation Classification of Mount Rainier, North Cascades, and Olympic National Parks study (Crawford et al. 2009) will be analyzed to determine locations of water-related plant associations and added to the preliminary map. The team will assess the NPS mapping and flag those plant associations and areas where the presence of wetlands is not clear. The analysis will also draw upon the results of the separate Vegetation Mapping Study.

2.5.2 Collect Model Training Data

To improve the precision and accuracy of the model results, the team will conduct a field sampling of representative wetlands to verify existing wetland mapping (City Light, NPS, NWI, etc.). A field crew will visit a sample of wetland sites that cover the range of wetland types to assess the accuracy of the mapped data and wetland classifications and provide related information on plant species occurrence and cover. The location, extent, vegetation cover, and wetland class will be reviewed in the field. These data will be used to adjust the existing wetland data map that will be used by the remote sensing wetland model.

Accuracy of the final habitat classification will be assessed using standard accuracy assessment procedures as outlined in Congalton and Green (2010). The overall accuracy will be calculated as well as the individual class accuracy using the validation sample data collected in the field. An alternative approach is to use a bootstrap method of the entire sample dataset; a method that relies on random sampling to estimate the measure of accuracy.

2.5.3 Wetland Remote Sensing Analysis

As a preliminary step, the Washington State Department of Natural Resources' newly developed wetland mapping tool, the Wetland Intrinsic Potential (WIP) tool, will be used to identify wetlands that are not included in existing wetland mapping inventories. The WIP tool was designed to identify wetlands that are hard to detect in aerial imagery because they are ephemeral in nature or under tree canopy. The WIP tool uses LiDAR-derived datasets (available for lands within and adjacent to the Project Boundary) and aerial imagery to identify the likelihood any given area is a wetland or not using a random forest model. Several topographic indices, such as plan curvature and profile, are created as an intermediate step of the WIP tool and used as inputs in the random forest model. Topographic indices are calculated at multiple scales (30 meters [m], 150 m, 300 m), and improve errors of omission created by hummocky wetlands under forest canopy.

In addition to this study, these topographic indices are integral inputs into the remote sensing modeling effort to classify vegetation habitat classes that will be conducted under the Vegetation Mapping Study. Therefore, running the WIP tool in the beginning of this study will benefit both of these efforts.

The Random Forest model (Beiman 2001; Liaw and Wiener 2002) will be trained using sample points derived from the NWI polygons and any other wetlands identified during early wetland inventory compilation efforts. The WIP tool outputs a raster where each pixel provides a probability that an area is a wetland or upland. Areas with a higher probability of being a wetland than upland will be assessed through visual interpretation of aerial imagery.

2.5.4 Develop Disturbance Potential Overlay for Study Area

Portions of the Project Boundary that are potentially affected by the Project's operations and maintenance and Project-related recreational activities will be identified. These areas will be the focus of the field and analytical portion of the study.

2.5.5 Conduct Field Data Collection of Wetlands Potentially Affected by the Project in the Study Area

Plant species present at each site will be documented. Indicators of hydric vegetation, hydric soils, and wetland hydrology per the Regional Supplement to the U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (USACE 2010) will be recorded when observed. Jurisdictional wetland delineations will not be completed and official wetland data plots will not be established.

Analytical methods will be developed for an appropriate level of assessment. Wetlands that are near areas of Project activities will undergo a functional analysis using the Wetland Rating System for Western Washington (Hruby 2014). Additionally, a supplemental rating form will be developed to capture information important to the relicensing process. These data will include sources of wetland hydrology, observed impairments and possible sources, and habitat information relevant to other studies such as the RTE Plant Study, Invasive Plant Study, Beaver Study, and Amphibian Study. The wetland data will also be available for fisheries investigations, as appropriate.

The estimated boundaries of sampled wetlands will be recorded using iPads fitted with global positioning system capability and aerial imagery and data will be collected on electronic forms using the iPads to increase the efficiency of data collection. Wetland polygons will be drawn onto the maps using vegetation and topography as guides. Electronic forms lead to a more efficient field effort that requires less time transcribing data forms post-survey, as well as providing a means of backing up data while in the field.

Prior to fieldwork, study leads will coordinate with other resource leads to determine what opportunistic data may be collected during the fieldwork phase to inform other studies (e.g., amphibian, beaver, RTE plant, invasive species, fisheries studies).

2.5.6 Data Analysis and Reporting

The wetland assessment will calculate the acreage of each wetland type within the study area based on the Cowardin classification system. General descriptions of wetland classifications, functions, and impairments will be included in a technical report. Potential Project effects to wetlands will also be discussed. Results of the assessments of individual wetlands will be included in tabular form in the report. Spatial data will be presented as a kmz file that can be viewed on Google Earth. The attribute table will reflect the tabular data in the report.

Specific study products include:

- Geographic information system (GIS)-based map and Google Earth kmz of wetlands within the study area.
- An overlay of potential Project-related disturbances to prioritize field survey efforts.
- List of plant species in each sampled wetland.
- An analysis of mapped wetland functions and values.
- Description of possible sources of any observed functional impairments.
- Additional habitat-related data to inform other efforts, such as the RTE plant, invasive plant, beaver, and amphibian studies.

2.6 Consistency with Generally Accepted Scientific Practice

The study methods (as described above) are consistent with guidance generally accepted by the USACE and the Washington State Department of Ecology, and other entities of the scientific community regarding procedures for conducting wetland reconnaissance and functional analyses.

2.7 Schedule

- Draft Study Plan – October 2019 TRREWG review
- Revised Study Plan – March 2020
- Initial Model Run – Spring 2020
- Field Verification and Collection – Spring-Summer 2020 (during vegetation growing period)
- Draft Technical Report and Map – March 2021
- Supplemental Data Collection – As needed in 2021 in conjunction with other terrestrial studies

2.8 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $240,000.

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WETLAND ASSESSMENT PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON STUDY PLAN

Table 1. City Light responses to LP Comments on study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	10/31/2019	Section 2.1 Study Goals and Objectives	I think that we talked about a special effort around Big Beaver Creek and associated wetlands as well, because of the habitat value. **New comment Shauna Hee (USFS) provided 3/17/2020:** SCL has data to support that the project has no effects to the Big Beaver area? Please provide justification within the comment table. **New comments Brock Applegate (WDFW), and Ashley Rawhouser and Jack Oelfke (NPS) provided 3/17/2020:** Did you consider the reservoir as a source of reed canarygrass into the wetland? Agree with Brock the bathtub ring is a disturbed area that facilitates colonization and spread of RCG. And we have basic inventory informatin that includes RCG within the Big Beaver wetlands.	City Light agreed to run the wetland model for the Big Beaver Valley that is within the FERC Boundary, but no field work will be conducted here. These wetlands are well above the influence of the reservoir and there are no other project-associated effects. **Response to comments provided on 3/17/2020:** The Big Beaver wetlands are well above the influence of the reservoir fluctuations – the wetlands are about 0.8 miles away from the reservoir and over 100 feet above the maximum water surface elevation. City Light agreed to run the wetland model for the Big Beaver Valley that is within the Project Boundary, but no field work will be conducted. A separate Invasive Plants Inventory is in development. The LPs will have the opportunity to comment on the draft study plan
2.	Brock Applegate (WDFW)	10/31/2019	Section 2.1 Study Goals and Objectives	For around the reservoirs, I would focus on Columbia spotted frogs, Western toad, evidence of bull frogs, and cavity-nesting ducks (snags). We might think about Oregon spotted frogs if SCL will look at wetlands further down the Skagit River.	A separate Amphibian Study will be developed. The field wetland work also will serve as a reconnaissance level survey to determine the suitability of habitat for amphibians. General notes of the wetland habitat will be recorded. Additionally, a Washington State Department of Ecology wetland rating form will be completed, which captures the presence of snags, as part of a general wildlife habitat assessment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
3.	Brock Applegate (WDFW)	10/31/2019	Section 2.4 Study Area	SCL will want to map reed canarygrass in these disturbance areas, particularly in or near wetlands.	Wetland assessments will include notes on invasive species. A more detailed Invasive Plant Study Plan is under development and will provide more precise information on weeds.
4.	Mignonne Bevin (NPS)	10/31/2019	Section 2.4 Study Area	You mean wetland right? Not riparian or is that included in this study?	No – the term here is correct. A specific NPS vegetation classification sometimes includes both wetland and non-wetland zones. This information will be obtained using a more refined wetland mapping model.
5.	Brock Applegate (WDFW)	10/31/2019	Section 2.5 Methodology	WDFW assumes the study area includes all the mitigation lands as well. **New comment Brock Applegate (WDFW) provided 3/17/2020:** We have human access as a possible disturbance vector. Do we have bull frogs, fish, permanent water, or non-native fish? We have interest in the creation of management plans for these lands and think this information could prove useful.	Wetlands will be mapped on the mitigation lands but since there are no disturbance vectors here they will not be rated according to the Washington State Department of Ecology methods. Weed information will be collected, however. Preliminary wetland ratings will be completed as a desktop exercise to inform long-term management planning on the mitigation lands. Follow-up work will be completed post-licensing as needed. **Response to comments provided on 3/17/2020:** The fish and wildlife mitigation lands were purchased by City Light and are managed following the Wildlife Habitat Protection and Management Plan that was developed with the Wildlife Management Review Committee (signatories to the Wildlife Settlement Agreement) for preservation of natural resource values. Public access is permitted on the lands, and therefore, City Light agrees that it needs to be considered in management planning. To City Light's knowledge, none of the wildlife mitigation lands have bullfrogs. Fish

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					information is available for a few of the properties but not universally. An updated Wildlife Habitat Protection and Management Plan will be developed as part of the relicensing effort. Any specific studies needed to inform long-term management goals will be identified in the plan and information for which will be collected as part of implementation during the term of the new FERC license.
6.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	Provide a description of other studies this study will support/inform. For example, if this study is going to be used to ID and map off channel slough habitat for salmonids describe it's relationship to	This study is a wetland inventory and assessment. Geomorphology, fish and aquatics, amphibian, beaver, RTE plant, and invasive species studies may use information generated by this study to inform fish habitat analysis. Edits made to bullet #7 of the list of objectives in Section 2.1.
7.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	After reading below it would be more accurate to say "constrain field sampling"	Prioritize is an appropriate phrase here.
8.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	Additional information I would like collected: habitat associated with beaver use/dams; migratory bird observations; and, whether or not fish-bearing and/or surface water connected to a fish-bearing water body.	Text has been edited to indicate that resource leads will coordinate with one another to determine what opportunistic information should be collected that would help inform other technical studies.
9.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.1 Study Goals and Objectives	This should include bryophytes and lichens. Is that the case?	This is a wetland assessment study not a plant inventory. A separate RTE Plant Study is in development. The LPs will have the opportunity to comment on the draft study plan.
10.	Rick Hartson (Upper Skagit Indian Tribe)	03/17/2020	Section 2.4 Study Area	The Study Area should extend downstream to the mouth of the Skagit, including the Skagit delta and/or estuary Resource Impact: Salmonid habitats, including for ESA-listed populations, encompassing the area within the	The study area extends downstream of the Gorge powerhouse to the confluence of the Skagit and Sauk rivers in order to first address the area with potential direct, attributable effects of the Project. Beyond this point, and further downstream, it is not possible with reasonable scientific certainty (and within the time frames

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				100-year floodplain or geomorphic floodplain, whichever is larger. Also, the natural and free-flowing state of the Skagit Wild & Scenic River system. Relevant Project Operations: Instream flow manipulations, including those associated with flood control and power generation. For example, the combination of two hydropower projects in the Skagit River basin (Seattle City Light and Puget Sound Energy) reduces peak flow at the USGS gage near Concrete, WA by nearly 50,000 cfs during the 1% annual chance exceedance (ACE), or 100-year event. Operations also impact floods more common than the 1% ACE, as well as the timing and duration of peak flows (see Skagit River General Investigation). Of the two hydro projects, the Skagit project has the greater flood storage capacity, providing ample reason to suspect that SCL's project-related impacts are significant throughout the entire Skagit River. Relevance of Wetland Mapping: Alterations to the hydrograph may disrupt connectivity to and quality of existing ESA critical habitats, including priority juvenile Chinook rearing habitats such as relic floodplain channels and wetlands. These habitats are important for other salmonid species, including Steelhead and Coho. Project-related flow manipulations may isolate habitats previously accessible to fish, or may reduce the duration or frequency of fish-accessible connections. There may be a decoupling of seasonal flow events from evolved or	of the ILP) to determine whether, or to what extent, Skagit River Project operations or maintenance is affecting a resource. The potential for, and the degree to which, Project operations might affect resources below the Sauk River requires (1) a determination that a resource is actually being impacted, (2) if it is, the formation of various hypotheses as to the cause(s), and (3) either detailed studies, modeling, or large scale experimentation to investigate the hypotheses. It is reasonable to expect such efforts to require time frames well beyond what is available under the ILP. Seattle City Light may have an interest in participating in such longer-term studies if such studies can be reasonably scoped to have useful study results. Such efforts could be part of a settlement agreement or an agreed-upon long term study outside of relicensing.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				environmentally-driven fish behaviors, such as juvenile migrations timed to access productive floodplain habitats. Temperature or wetted area of floodplain habitats may be impacted by surface or groundwater connectivity to mainstem channel flows (see Skagit Chinook Recovery Plan for discussions of many of these topics). Specific Information Need: A remaining uncertainty is the extent to which instream flow manipulations have impacted the connectivity or quality of floodplain salmonid habitats, including for ESA-listed populations. To answer these questions a number of interrelated studies will be required, including the mapping of floodplain habitats throughout the area impacted by project-related flow manipulations. This may include areas that are only wetted during periods of connection to the mainstem channel. Such habitats may be dry throughout much of the year and potentially difficult to capture by formal wetland surveys. For example, an area may go several years without being inundated, and terrestrial vegetation may obscure signs of aquatic habitat potential. Hydraulic modeling may be necessary to support field identification of such habitats.	
11.	Shauna Hee (USFS)	03/17/2020	Section 2.4 Study Area	I have in my notes the study area included a buffer around the project area (0.5 mile – similar to the veg map study area), yet I see no mention of this buffer. The intent of the buffer was to gather data on those wetlands that may have connectivity to the respective reservoir via groundwater, and thus are affected by project-related actions such as reservoir fluctuation.	No buffer to the FERC Project Boundary is proposed for this study – there is such a buffer for the Vegetation Mapping Study. Around Ross Lake, as an example, the Project Boundary is from 0.05-0.1 miles from the shoreline of the reservoir, affording sufficient space to capture wetlands potentially influenced by the reservoir.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				Please explain why the buffer was dropped.	
12.	Rick Hartson (Upper Skagit Indian Tribe)	03/17/2020	Section 2.4 Study Area	It is not clear how the channel migration zone will be defined. Rather than rely on this ambiguous term, SCL should clarify how the study area will encompass the needs of the relevant regulatory authorities and affected tribes. For example, see our previous comment regarding importance of understanding impacts to ESA-listed populations. To account for ESA critical habitat, the study area should encompass the FERC 100-year floodplain (see FEMA NFIP BiOp for Puget Sound, 2008). The FERC 100-year floodplain should be determined in the absence of project-related flood control (see Upper Skagit Indian Tribe's Regulatory Floodplain Issue Form). This approach for mapping the floodplain attempts to directly relate information requests to ongoing project operations. The study area should be expanded beyond the 100-year floodplain where geomorphic assessment suggests a possibility for bank erosion and channel meandering	NPS modeled and mapped the channel migration zone downstream of the Project – these data will be used for the extent of the study area. The channel migration zone was mapped to encompass the 100-year floodplain as well as higher surfaces prone to bank erosion and channel meandering. Information needed to address salmonids (FEMA NFIP BiOp reference) determined by studies discussed in the Fish and Aquatics Resource Work Group.
13.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.4 Study Area	The map below stops at the BC border. What are the plans for including BC? The area around the mouth of the Skagit Rv contains a large amount of wetland habitat.	The Project Boundary and FERC's jurisdiction ends at the U.S.-Canada border. There are currently no plans to conduct field work in Canada.
14.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.4 Study Area	More detail needed. How are you determining what "wetlands farther from potentially affected areas" are?	Text edited. Wetlands not affected by the Project will not be visited.
15.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	More detail needed. Ensure adequate sample size for each relevant wetland type. How will you determine which aspects of the model need ground-truthing? That is, how do you determine which wetlands to visit?	The wetland model was developed at the University of Washington for specific application in western Washington and has been field verified on several landscape-level projects. The initial mapping verification will include briefly visiting a representative sample

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					of previously mapped wetlands across the range of types and locations to inform wetland intrinsic potential model. Edits added to indicate that a sample of sites representing the range of wetland types will be visited to assess accuracy. Primary attributes that will be verified at this stage are location, size, and vegetative cover. The full wetland assessment will be conducted for all wetlands that are potentially affected by the Project.
16.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	What metrics will be used to assess precision and accuracy?	Text added to clarify.
17.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	Please be specific about what "limited" means.	Verification surveys will be tailored to the outcome of the model mapping and the occurrence and distribution of wetlands over the study area. Text has been edited for clarity.
18.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	What criteria will be applied to make this decision	Location, size, and vegetative cover (Cowardin wetland class) will be verified.
19.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	What is the extent of existing LiDAR for the project area?	LiDAR is available for the lands within the Project Boundary and the Wetland Assessment study area.
20.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	These should undergo field verification and model improvement.	The WIP model has undergone extensive field testing during development and for several projects in western Washington. The model will be applied according to its developed standards and conduct field assessment to refine our results. Initial mapping will be sampled in the field to document wetland locations to be used in the wetland model.
21.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	Citations needed for the model, R code (assume using R), and application to wetland or veg classification.	Beiman, L 2001. Random Forests. Machine Learning, Vol. 45:1. Pp 5-32.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Liaw, A. and M. Wiener. 2002. Classification and Regression by Random Forest. R News 2(3), 18-22.
22.	Shauna Hee (USFS)	03/17/2020	Section 2.5 Methodology	I'm confused be the use of the word "factor". Please define within the document	Text edited for clarity.
23.	Shauna Hee (USFS)	03/17/2020	Section 2.5 Methodology	Why is the overlay a product before field data collection?	Wetlands potentially affected by the Project will be included in field surveys to gather additional information and ratings. Additional information has been added about the development of the disturbance overlay.
24.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	How will this be determined. Specific criteria need to be stated. This could have a large IMPACT on the extent of the study area.	See above #23 comment response. Text edited.
25.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	Assume all vascular plants but bryophytes and lichens should also be included.	This is a wetland assessment study not a plant inventory. A separate Rare, Threatened, and Endangered Plant Study is in development and will be available for comment. For this wetlands assessment the dominant vegetation types will be noted as will significant occurrences of moss (sphagnum). Non-vascular plants will not be documented.
26.	Rick Hartson (Upper Skagit Indian Tribe)	03/17/2020	Section 2.5 Methodology	Whether in this study or another, assess potential for connectivity to mainstem channels. Relevant to a variety of F&A issue forms, including those that address salmonid habitat in floodplains. 2-D hydraulic modeling would be appropriate to answer this, with a refined topographic mesh for potential connectivity pathways between wetlands and mainstem.	This study will map and rate wetlands. Other studies will draw on this information as needed. Text added.
27.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	Scale? (of mapping)	In addition to the map that will be provided in the report, a kmz file of wetlands will be made available. Data sources: High Resolution Spatial 2018 – 4'/6" Pictometry, 1m 4 band NAIP (2017, 2015), Spectral/Temporal:

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Sentinel 2 – 12 bands (10m, 20m) coverage every 5 days.
28.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	Is this described in Hruby 2014? If not, more detail needed. What are the sources of impairment that will be evaluated and what are the function impairments?	Yes – according to the Western Washington Wetland Rating System (Hruby 2014).
29.	Ashley Rawhouser (NPS)	03/17/2020	Section 2.5 Methodology	What specifically will this consist of? More detail needed.	We will coordinate with team resource leads to ensure we are collecting opportunistic data that is valuable.

TR-03 RARE, THREATENED, AND ENDANGERED PLANTS PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Acronyms and Abbreviations

BLM.....Bureau of Land Management
City Light.....Seattle City Light
DNR.....(Washington) Department of Natural Resources
ESA.....Endangered Species Act
ELC.....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
GIS.....geographic information system
GPS.....Global Positioning System
ISR.....Initial Study Report
LP.....licensing participant
NPS.....National Park Service
O&M.....operations and maintenance
PAD.....Pre-Application Document
Project.....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
QA/QC.....quality assurance/quality control
RLNRA.....Ross Lake National Recreation Area
RM.....river mile
ROW.....right-of-way
RTE.....rare, threatened, and endangered
RWG.....Resource Work Group
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USFS.....U.S. Forest Service
USFWS.....U.S. Fish and Wildlife Service
UW.....University of Washington
WNHP.....Washington Natural Heritage Program

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussions and study requests and comments submitted by LPs.

1.3 Study Plan Development

Information on rare, threatened, and endangered (RTE) plant occurrence is needed to identify existing species and populations in areas potentially affected by ongoing Project activities. The RTE Plants Study will document occurrence of special-status plant species at sites which may be affected by ongoing Project operations or Project-related activities. This study plan was developed to map and summarize the occurrence of RTE plants within the Project Boundary where there is a potential for a Project-related effect. A target list of RTE plant species was identified in the PAD (City Light 2020). This study is designed to address Terrestrial Issue 11 (TE11: Rare Plant Study).

On April 17, 2020, City Light released the RTE Plants Draft Study Plan for LP review and comment. On May 6, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 12, 2020. The revised draft was discussed on June 23, 2020 at a TRREWG meeting. Written comments were received from U.S. Forest Service (USFS), NPS, and U.S. Fish and Wildlife Service (USFWS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to provide information to determine whether and the extent to which certain Project operations and maintenance (O&M) activities may have the potential to adversely affect RTE plant species. This study will document occurrences of RTE plants within the study area as defined in Section 2.5 of this study plan which could potentially be affected by Project-related O&M activities. Specific objectives of this study are as follows:

- Identify list of RTE plant species that require protection based on federal or State regulation that have reasonable likelihood of occurring within the study area.
- Identify habitats with highest potential for RTE plant species occurrence and determine where Project-related activities could have an effect on such habitats.
- Develop a map depicting RTE plant species locations (locations will be kept confidential consistent with and to the extent provided by law).

2.2 Resource Management Goals

City Light's goal is to collect information about RTE plant occurrence in the Project vicinity to support Indian Tribes, First Nations, and agency information requests.

Agencies with an interest in these issues in the context of FERC relicensing of the Skagit River Project include but are not limited to:

USFWS has jurisdiction over federally protected species and critical habitats under the Endangered Species Act (ESA). Section 4 of the ESA requires USFWS to develop recovery plans for the purpose of recovering listed species and removing them from the list of Threatened and Endangered species. Section 7 of the ESA requires federal agencies to consult with USFWS prior to taking an action that "may affect" a threatened or endangered plant.

USFS plant species on the Region 6 Forest Service list of sensitive plants must be managed to maintain a viable population and avoid the need for listing them under the ESA (USFS 1990).

The NPS's General Management Plan for RLNRA includes a goal of enhancing habitat where sensitive species occur (NPS 2012).

Washington Department of Natural Resources (DNR), through the Washington Natural Heritage Program (WNHP), is responsible for mapping, monitoring, and conserving RTE plant species in Washington (DNR 2017).

2.3 Background and Existing Information

Information about RTE plant species is covered in Section 4.6.6 of the PAD (City Light 2020). For the purpose of this study plan, RTE plant species are defined in the same manner as the PAD which includes vascular plant species that fall into one of the following categories:

- **ESA Federally Listed or Proposed** – Species that are listed and protected under the ESA of 1973, as Endangered, Threatened, or Proposed for listing.
- **ESA Federal Candidates** – Species for which USFWS has sufficient information on the biological vulnerability and threats to support a proposal to list as Endangered or Threatened under the ESA, but the development of listing regulations has not occurred because of other higher priority listing activities.
- **ESA Federal Species of Concern** – Species, usually thought to be in decline, which may be considered for federal candidate status in the future.
- **State Listed Species** – Species listed by the WNHP on an advisory basis as Endangered, Threatened, or Sensitive.
- **USFS Sensitive Species** – Species on the Regional Forester's List of Sensitive Species for the Mount Baker – Snoqualmie National Forest (USFS 2019).

Available information compiled for the PAD (City Light 2020) showed there are no known ESA-listed, proposed, or candidate species that have potential to occur within the Project Boundary. NPS has identified the following WNHP state-listed species (also indicated in bold in Table 2.3-1) as known or likely to occur in the Project vicinity (Bivin 2019a):

- western moonwort (*Botrychium hesperium*)
- two-spiked moonwort (*B. paradoxum*)
- different-veined sedge (*Carex heteroneura*)
- Alaska long-awn sedge (*C. macrochaeta*)
- Montana sedge (*C. media*)
- black bog sedge (*C. pluriflora*)
- bulblet-bearing water-hemlock (*Cicuta bulbifera*)
- prickly tree clubmoss (*Dendrolycopodium dendroideum*; synonymous with tree ground-pine [*Lycopodium dendroideum*])
- tassel cottongrass (*Eriophorum viridicarinatum*)
- greater Canadian St. John's-wort (*Hypericum majus*)
- bog clubmoss (*Lycopodiella inundata*)
- western ladies'-tresses (*Spiranthes porrifolia*)

NPS also provided a list of plant species that it believes are known or likely to occur in the Project vicinity (Bivin 2019b) which included, in addition, the following species:

- stalked moonwort (*B. pedunculosum*)
- Buxbaum's sedge (*Carex buxbaumii*; not state-listed)
- bristly sedge (*Carex comosa*; not state-listed)
- yellow sedge (*Carex flava*; not state-listed)

- varied jewelweed (*Impatiens aurella*; not state-listed)

Of the above-mentioned species, Washington DNR has location data on stalked moonwort, prickly tree clubmoss, and bog clubmoss in Big Beaver Creek. No other Washington DNR records indicate state-listed species within three miles of the Project Boundary (City Light 2020).

Table 4.6-19 of the PAD (City Light 2020) includes a list of USFS Sensitive plant species for Mt. Baker-Snoqualmie National Forest which occurs intermittently within the Project Boundary southwest of RLNRA.

Table 2.3-1. RTE vascular species or species identified by agencies as species of interest potentially occurring in the study area based on existing information.

Species Name[1]	Common Name[1]	Last Documented[2]	State Status (Rank) 2019[3]	USFS Sensitive Species[4]	NPS Identified	Habitat Requirements[5]
Botrychium hesperium	**western moonwort**		S(S2)	X	X	Moist open areas in meadows and forests.[6]
Botrychium paradoxum	**two-spiked moonwort**	Suspected	T(S2)	X	X	Late-seral western redcedar forests on floodplains, perennial or intermittent stream terraces, wet or dry meadows, compacted old rockbeds, rocky subalpine slopes, and early-seral lodgepole pine communities.
Botrychium pedunculosum	**stalked moonwort**	2010	S(S2)	D	X	Moist or dry meadows, springs, stream terraces, coniferous forests, and forest edges.
Carex buxbaumii	**Buxbaum's sedge**				X	Bogs, marshes, wet meadows.
Carex capillaris	hair sedge	2010	T(S1)	X		Streambanks, wet meadows, bogs, and marshy lake lakeshores.
Carex comosa	**bristly sedge**				X	Marshes, lake edges, wet meadows.
Carex flava	**yellow sedge**				X	Wet meadows, forested wetlands, bogs, shores of streams, and lakes.
Carex heteroneura	**different-veined sedge**		S(S2S3)	X (var. *epapillosa*)	X	Wet meadows to dry slopes.[6]
Carex macrochaeta	**Alaska long-awn sedge**	2010	T(S1)	S	X	Moist open spaces, including seeps and wet meadows, and around streams, lakes, and waterfalls.
Carex media	**Montana sedge**		S(S2)	X	X	Moist meadows and perennial streams and ponds.[6]
Carex pluriflora	**black bog sedge**	1988	S(S2)		X	Wetlands, boggy lake margins, prairies, streambanks, and coastal inland areas.
Carex rostrata	northern beaked sedge	2010	S(S2)	S		Fens, bogs, quaking or floating peat, lake and stream shores, wet meadows; often in shallow water or on floating mats.
Cicuta bulbifera	**bulblet-bearing water-hemlock**		S(S2S3)	S	X	Edges of marshes, lakes, bogs, meadows, shallow standing or slow moving water.[6]
Coptis asplenifolia	fern-leaf goldthread		S(S2)	D		Moist, cool, old forests with a well-developed litter layer (30-930 meter elevation).

Species Name[1]	Common Name[1]	Last Documented[2]	State Status (Rank) 2019[3]	USFS Sensitive Species[4]	NPS Identified	Habitat Requirements[5]
Dendrolycopidium dendroideum (Lycopodium dendroideum)	**prickly tree clubmoss/tree ground-pine**		S(S2)	D	X	Rock outcrops, talus fields, moss, and significant debris layers.[6]
Draba aurea	golden draba whitlow-grass	Suspected	S(S1)	X		Forested slopes, alpine meadows, and dry, relatively open, sunny areas at high elevations.
Erigeron salishii	Salish daisy	2010	S(S2)	D		Alpine zone on dry, rocky, or scree slopes and ridge tops with granite, rock, talus, sand, or loess soils; 2,000 to 2,800 meters.
Eriophorum viridicarinatum	**tassel cottongrass**	2010	S(S2)	X	X	Obligate wetland species of cold, usually calcareous swamps, bogs, fens, ponds, and wet meadows.
Gentiana glauca	glaucous gentian	Suspected	S(S2)	D		On hummocks and in seepage areas in moist alpine and subalpine meadows.
Githopsis speculariodes	common bluecup	1970	S(S2S3)	X		Dry, open places at lower elevations, such as thin soils over bedrock outcrops, grassy balds, talus slopes, and gravelly prairies.
Hypericum majus	**greater Canadian St. John's-wort**		S(S2)		X	Along ponds and lakeshores, riparian areas.[6]
Impatiens aurella	**varied jewelweed**				X	Moist shaded areas at low elevations.
Kalmia procumbens (Loiseleuria procumbens)	alpine azalea	1963	T(S1)	D		Alpine slopes and cold, dry areas at high elevations (1,800-2,000 meters).
Luzula arcuata	curved woodrush	2010	T(S1)	D		Alpine to subalpine glacial moraines, mountain meadows, rocky and gravelly areas, rocky ridges, talus, bare patches of sandy soil; often adjacent to snow fields.
Lycopodiella inundata	**bog clubmoss**	2010	S(S2)	D	X	Sphagnum bogs, wet sandy places, and wetlands adjacent to lakes, marshes, and swampy grounds.
Montia diffusa	branching montia	Suspected	S(S1S2)	S		Moist forests and open fir woodlands in the lowland and lower montane zones; occasionally in xeric soils or disturbed sites.

Species Name[1]	Common Name[1]	Last Documented[2]	State Status (Rank) 2019[3]	USFS Sensitive Species[4]	NPS Identified	Habitat Requirements[5]
Oxytropis campestris var. *gracilis*	Slender crazyweed	Suspected	S(S2)	D		Montane sites on glacial outwash terraces in sandy loam soil, scree, and alpine tundra.
Parnassia kotzebuei	Kotzebue's Grass-of-Parnassus	2010	T(S1)	X		Damp mossy ledges at the base of granitic cliffs, and adjacent to lakes, in moist seepage at the base of talus slopes.
Platanthera chorisiana	choriso bog orchid	1991	T(S2)	D		Wettest regions of sphagnum bogs, streams, seeps, wet meadows, gravel outwashes, and moist areas with fine soils; often just above the water table (774-1,300 meters).
Polemonium viscosum	sticky polemonium		S(S2)	X		At high altitudes, commonly above timberline, in open rocky places, talus slopes, rock outcrops, glacial cirques, and alpine fellfields.
Saxifraga hyperborea	pygmy saxifrage	2010	S(S3)			Damp, shaded cliffs, rock crevices, and talus in alpine and subalpine areas; commonly as single plants.
Silene seelyi	Seely's silene	2000	S(S3)	X		Shaded crevices in ultramafic, granitic, or basaltic cliffs and rock outcrops, and occasionally among boulders in talus; restricted to sites with poor nutrient and water availability.
Spiranthes porrifolia	**western ladies'-tresses**		S(S2)	X	X	Meadows, seeps, streams.[6]

Source: Bivin and Rochefort (2010) unless otherwise noted.

1 Species names in bold are identified as known or likely to occur within the Project vicinity by NPS. Source: Bivin 2019a.

2 Last documented in North Cascades National Park Complex.

3 WDNR (2019a); S=Sensitive; T=Threatened. (More detail on state status codes see WDNR 2019b).

4 D=documented occurrence; S=suspected occurrence: in Mt. Baker-Snoqualmie National Forest; X=Region 6 Regional Forester Special Status Species Sensitive Species in Washington State (no occurrence status for Mt. Baker-Snoqualmie National Forest) (USFS 2019).

5 Source: Camp and Gamon (2011) unless otherwise noted.

6 Source: Bivin 2019a.

2.4 Project Operations and Effects on Resources

Certain Project O&M activities may have the potential to adversely affect RTE plant species. O&M activities may have direct effects, (e.g., ground disturbing activities associated with vegetation management; reservoir fluctuation; and maintenance of Project roads), indirect effects (e.g., recreation activity at City Light-owned facilities), or cumulative (e.g., activities associated with non-Project activity such as loss of habitat due to the introduction of invasive plants from a non-Project vector). Activities that could have an effect on RTE plants are described in more detail in Section 4.6.7 of the PAD (City Light 2020).

2.5 Study Area

2.5.1 Study Area

The study area consists of the area within the Project Boundary that is subject to Project-related O&M and/or Project-related recreation. The study area is shown in Figures 2.5-1 through 3[1], and includes the following specific areas within the Project Boundary:

- Project reservoirs
  - Upper portion of the reservoir fluctuation zone (e.g., between 10 feet below and 10 feet above normal maximum water surface elevation, including immediate banks affected by reservoir)
  - Tributary inlets
  - Known Project-related reservoir shoreline erosion treatment sites
- Transmission line right-of-way (ROW): portions of the ROW where City Light activities (vegetation management and patrol and access road maintenance) has potential to affect RTE plant habitats
- Project-related roads (50-foot buffer)
- Project facilities (50-foot buffer) includes dams, powerhouses, penstocks, surge tanks, roads, boathouses/docks/landings
- Project recreation facilities (details in Table 2.6-1 of the Recreation Use and Facility Assessment study plan; detail of study area associated with recreation facilities shown in Figures 2.5-2 through 3), including:
  - Skagit Tour Dock
  - West Ferry Landing (parking and dock)
  - East Ferry Landing
  - North Cascades ELC
  - Ross Lodge Picnic Shelter
  - Gorge Lake Boat Launch

[1] City Light is currently reviewing information on roads in the Project Boundary and will add Project roads to the maps in an updated study plan.

- Ladder Creek Falls Trail and Gardens
- Trail of the Cedars
- Gorge Powerhouse Overlook
- Gorge Powerhouse Visitor Gallery
- Skagit Information Center
- Gorge Inn Museum
- Newhalem Facilities:
  - Picnic Sites
  - Parking Area (Main Street)
  - Parking Area (State Route 20)
  - Interpretive Displays (standalone)
  - Playground

2.5.2 General Concepts

These general concepts apply to the study:

- Personal safety is an important consideration of each fieldwork team. City Light and their consultants will perform the study in a safe manner.
- Field crews may make minor modifications in the field to adjust to and to accommodate actual field conditions and unforeseeable events. Any modifications made will be documented and reported in the study report.

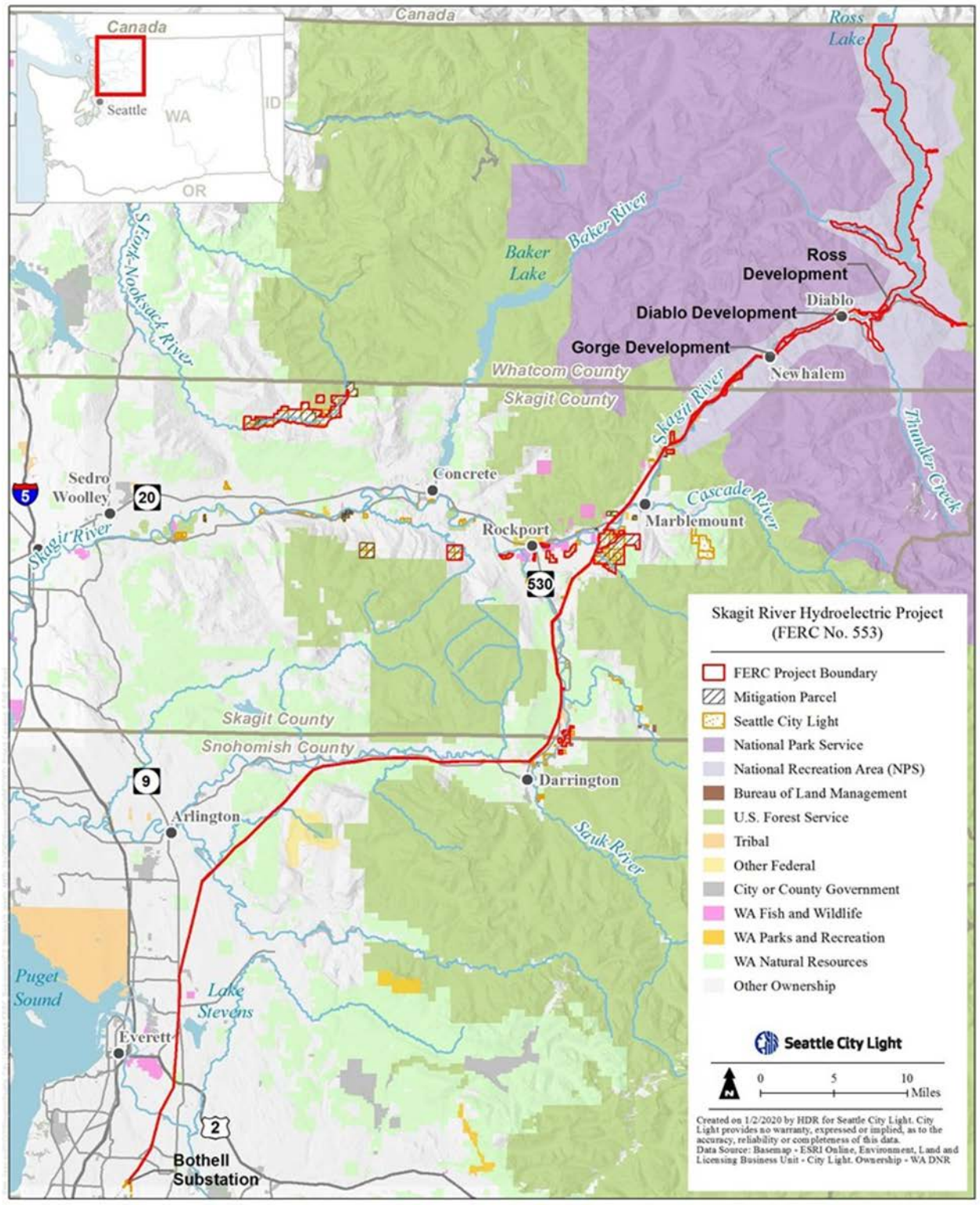

Figure 2.5-1. Study area overview.

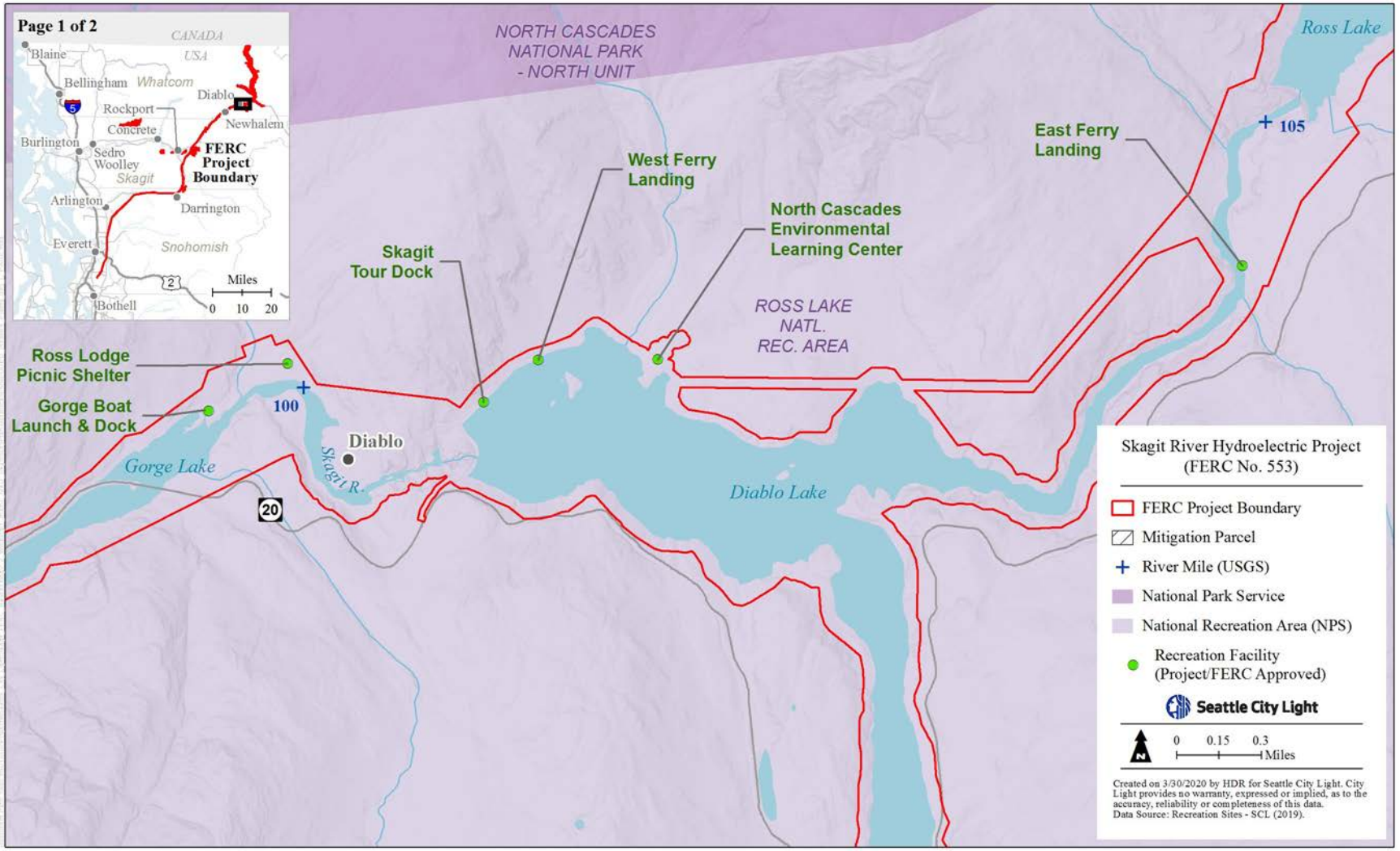

Figure 2.5-2. Study area associated with recreation facilities at and around Diablo and Gorge lakes.

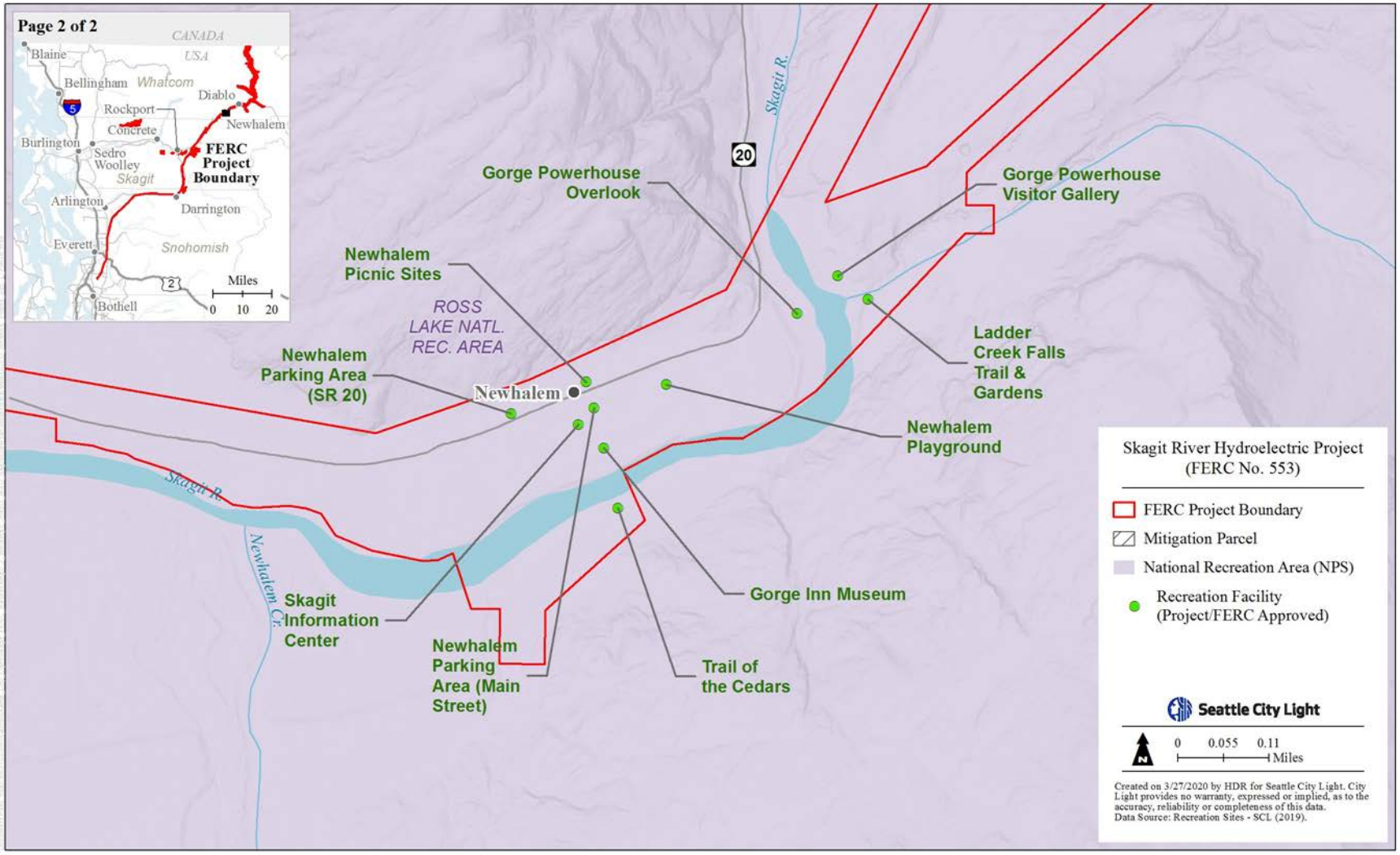

Figure 2.5-3. Study area associated with recreation facilities at and around Newhalem.

2.6 Methodology

Study methods will consist of the following steps: (1) develop list of species reasonably likely to occur in the Project vicinity; (2) determine survey locations; (3) gather data and prepare for field effort; (4) conduct field surveys; (5) compile field collected data and provide quality assurance/quality control (QA/QC) of the data; and (6) prepare report. Each step is described below. It is expected that this study will be conducted concurrently with the Invasive Plants study. Both studies will likely require permits for field work in RLNRA. If it is not possible to obtain permits, then City Light may need to forgo work in the RLNRA.

2.6.1 Step 1 – Develop Target RTE Plant Species List

RTE species with potential to occur within the Project Boundary are listed in Table 2.3-1. A refined target species list will be developed based on (1) known RTE species occurrences; and (2) presence of suitable habitat for RTE species with potential to occur in the study area. The list will include status categories, potential habitats (include suitable types from Vegetation Mapping and Wetlands Assessment studies), and identification periods. Known RTE species occurrences will be identified and mapped. The results of the Vegetation Mapping and Wetland Assessment studies will be used along with published information on species habitat associations to identify and map general habitats in the study area that are potentially suitable for each RTE species. The refined target list will be shared with the TRREWG for comment, before surveys begin.

2.6.2 Step 2 – Determine Survey Locations

Surveys for RTE plants will be conducted where Project activities occur in locations with known RTE occurrences or with potentially suitable habitat for RTE plants. Habitats for the target species list will be overlaid with the study area to determine these survey locations. Specific habitat requirements of each species will be used to prioritize field survey locations within each general habitat. Again, the habitats and locations to be surveyed for RTE species will be shared with the TRREWG before surveys begin.

2.6.3 Step 3 – Prepare for Field Effort

City Light will map known occurrences of RTE plants within the study area and prepare field maps for use by survey teams. Field maps will include aerial imagery, Project facilities, known RTE plant occurrences, and potentially suitable habitats for target species. A flowering matrix will be developed for the target species list, and survey timing will be planned based on when the species will be detectable and identifiable, typically during their flowering or fruiting phases, and based on herbarium collection dates.

Prior to the start of field surveys, the surveyor(s) will visit the University of Washington (UW) Herbarium and/or other local collections, as needed (e.g., NPS collection in Marblemount) to review specimens to help develop a key characteristics search image and also review the habitat conditions of the voucher specimens.

2.6.4 Step 4 – Conduct Field Surveys

The surveyors will conduct target RTE plant surveys in a manner that conforms to the Survey Protocols for Survey and Manage Strategy 2 Vascular Plants (Whiteaker et al. 1998) and Rare

Plant Surveys: Techniques for Impact Assessment (Nelson 1985), which are accepted methods for conducting a botanical survey in Washington. Species guides will include Hitchcock and Cronquist (2018), Camp and Gamon (2011), online guides including Washington DNR Rare Plant Field Guide (2020) and Oregon Flora Project Rare Plant Guide (Oregon State University 2020), and consultation with agency and UW taxonomic experts.

Field surveyors will visit survey locations as defined in Step 2 and verify the occurrence of the known RTE species and/or the extent of the potential habitat. Field staff will implement the Intuitive Controlled Survey method used by the Bureau of Land Management (BLM 2017) where more intense survey will occur in areas of highly suitable habitat and less intense cover will occur everywhere else. A team of two will cover the entire potential habitat area, wandering through the site guided by habitat parameters most likely to support RTE plant species. Survey areas and routes will be documented with Global Positioning System (GPS). The initial identification of RTE plant potential habitat will be guided by the results of the Vegetation Mapping and Wetland Assessment studies desktop and fieldwork efforts, which will determine where the areas of highly suitable habitat occur.

All vascular RTE plant species observed will be identified and recorded in a species list. Scientific and common names for all species will conform to the nomenclature found in the *Flora of the Pacific Northwest 2nd Edition* (Hitchcock and Cronquist 2018).

Due to safety considerations, population attributes may be difficult to assess for some species. Species that occur on rock outcrops or cliffs, such as Seely's silene (*Silene seelyi*), may be inaccessible. High quality, powerful binoculars or a spotting scope will be used to accurately estimate population extent and size for some occurrences of RTE plants, for sites with steep slopes.

When target RTE plants are documented in the study area, the following information will be collected to the edge of the occurrence, within the study area:

- General habitat type (i.e., mixed conifer forest, wet meadow, etc.), slope, soil features (i.e., mesic, clay, etc.), most common surrounding species, potential threats (including Project effects), and the level of existing ground disturbance.
- Photographs of the species, its habitat, and any potential threats (one set per species with other photographs to document potential threats, or as needed).
- Population extent (approximate length and width).
- Estimation of the number of individual plants in the population. If the population is estimated to cover an area greater than 0.1 acre, surveyors will delineate the occurrence boundary using a polygon (as safety and accessibility allow). For occurrences estimated less than 0.1 acre in size, the location of the approximate center of the occurrence will be taken as point data using GPS.
- Estimated phenology and descriptions of reproductive state.
- Relative population location and estimated distance to nearest Project facility, feature, or Project-related activity (reservoir fluctuation zone, recreation area, erosion site, active vegetation management area, etc.).

Additional details will be collected as described in the WNHP Rare Plant Sighting Form (example form is attached to this study plan). Due to the likely phenology of the mix of target species, it is expected that two full passes of the portions of the study area with highly suitable habitat will be needed to identify and map all the target RTE plant species.

All data will be collected using weatherproof iPads that are loaded with high resolution aerial photographs, the results of the Vegetation Mapping and Wetlands Assessment studies, and preliminary identification of habitat potentially supporting RTE plants. Digital data forms will be developed to eliminate the use of paper forms. Data will automatically backup to the hard drive and to a dedicated web-sever when phone service is detected.

2.6.5 Step 5 – Compile Data and Provide Data QA/QC

Following field surveys, maps will be developed depicting all target RTE plant occurrences and Project facilities in the study area. Field data will then be subject to QA/QC procedures, including either spot-checks of transcription or a digital application with integrated QA/QC review and comparison of geographic information system (GIS) maps with field notes to verify locations of mapped occurrences.

2.6.6 Step 6 – Threats Assessment

Once the locations of RTE plants in the study area are determined, City Light will assess all potential threats to these species, including invasive plant species, O&M, and Project-related recreation. In addition to field notation of potential threats to document RTE occurrences, City Light operations staff will be consulted to identify Project activities that occur in the area of the plant occurrences that have a potential to affect RTE plants.

2.6.7 Step 7 – Prepare Report

A report will be prepared to include the following information: (1) study goals and objectives; (2) methods; (3) results, including GIS-based maps of RTE plant occurrences; (4) discussion, including threats assessment; and (5) description of variances from the FERC-approved study plan, if any.

The results of the RTE Plants Study may include confidential location information regarding rare plant populations. Confidential information will be marked “confidential” and sharing will be restricted to distribution to agencies and Indian tribes. Documents shared with the public will have confidential rare plant population information removed.

2.7 Consistency with Generally Accepted Scientific Practice

The methodology for this study plan conforms to the Survey Protocols for Survey and Manage Strategy 2 Vascular Plants (Whiteaker et al. 1998) and Rare Plant Surveys: Techniques for Impact Assessment (Nelson 1985), and conforms to BLM survey guidelines (BLM 2017) which are used in many parts of the country.

2.8 Schedule

- Field Work – April to November 2021
- Analysis – June to December 2021

- Final Report (Initial Study Report) – March 2022

Depending on logistics and the need to access more remote areas of the Project to match RTE plant flowering times, some field work may extend into a second field season and an addendum report would be issued in 2022.

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $200,000.

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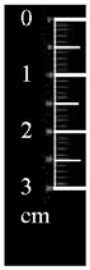
RARE, THREATENED, AND ENDANGERED PLANTS
PROPOSED STUDY PLAN

ATTACHMENT A

WASHINGTON NATURAL HERITAGE PROGRAM RARE PLANT SIGHTING FORM

Washington Natural Heritage Program Rare Plant Sighting Form



Please read instructions page. Shaded boxes are for Natural Heritage Staff use only.

Taxon Name: _____ EO #

Are you confident of the identification? ❑ yes ❑ no Explain: _____

Survey Site Name: _____

Surveyor's Name/Phone/Email: _____

Survey Date: _____ (yr-mo-day) County: _____

Quad Name: _____ Quad Code: _____

Township: _____ N Range: _____ Section(s): _____ 1/4 of 1/4: _____ (e.g. NW of NE)

Directions to site: _____

Mapping (see instructions): Attach a copy of the USGS 7.5 minute quad with the location and extent of the rare plant population clearly drawn. Do not reduce or enlarge the photocopy or printout of the map. If your map is a different scale (not recommended) please write the scale on the map.
Please answer the following:

1. I used GPS to map the population: ❑ No (skip to #2) ❑ Yes (complete #1 & #3)
   ❑ Coordinates are in electronic file on diskette (preferred) ❑ Coordinates written below or attached
   Description of what coordinates represent: _____
   GPS accuracy: ❑ Uncorrected ❑ Corrected to <5m
   GPS datum: _____
   GPS coordinates: _____

2. I used a topographic map to map the population:
   ❑ yes (complete #2) ❑ no (provide detailed directions & description above, and skip to #3)
   I am confident I have accurately located and mapped the population at map scale: ❑ yes (skip to #3)
   ❑ no, but I am confident the population is within the general area indicated on the map as follows:
   On the same map, use a highlighter to identify the outer boundary of the area where the population could be, given the uncertainties about your exact location.

3. I used the following features on the map to identify my location (stream, shoreline, bridge, road, cliff, etc.):

To the best of my knowledge, I mapped the entire extent of this population
❑ yes ❑ no ❑ unknown If no or unknown, explain: _____

Is a revisit needed? ❑ no ❑ yes - if yes, why?: _____

Ownership (if known): _____

page 1 of 2 Revised April 2002 - see instructions

Page 2 - Washington Natural Heritage Program Rare Plant Sighting Form

Population Size (# of individuals or ramets) or estimate: _____

Population (EO) Data (include population vigor, microhabitat, phenology, etc.): _____

Plant Association (include author, citation, or classification, e.g. Daubenmire): _____

Associated Species (include % cover by layer and by individual species for dominants in each layer):

Lichen/moss layer: _____

Herb layer: _____

Shrub layer(s): _____

Tree layer: _____

General Description (include description of landscape, surrounding plant communities, land forms, land use, etc.):

Minimum elevation (ft.): _____ Maximum elevation (ft.): _____

Size (acres): _____ Aspect: _____ Slope: _____

Photo taken? ❑ yes ❑ no

Management Comments (exotics, roads, shape/size, position in landscape, hydrology, adjacent land use, cumulative effects, etc.):

Protection Comments (legal actions/steps/strategies needed to secure protection for the site): _____

Additional Comments (discrepancies, general observations, etc.): _____

Please mail completed form with map to:

Washington Natural Heritage Program
Department of Natural Resources
PO Box 47014, Olympia WA 98504-7014

WASHINGTON STATE DEPT OF NATURAL RESOURCES

Instructions for Washington Natural Heritage Program Rare Plant Survey Form
(Form for external data contributors)

Please complete all sections except for the shaded areas. Those will be completed by WNHP staff.

Taxon Name: Please enter a complete scientific name.

Are you confident of the identification? If you had trouble with the identification, please explain why (e.g. immature or senescent plants, similarity to other species, etc.). If a specimen was verified by an expert on the taxon, please indicate, such as "verified by ....".

Survey Site Name: This should be a place name near the population, preferably something that appears on the USGS quad map. It should help someone, not intimately familiar with the area, locate this population.

Surveyor's Name: Enter the name(s) of the person who located the plant. Include their contact information so that they can be contacted if more information is need.

Survey Date: When was the plant located? Please use year-month-day format (e.g. 2001-07-05)

County: In what county is the site located?

Quad Name: Please enter name of the USGS 1:24,000 scale quad map where the site is located.

Township, Range, Section, and _ of _: Enter the legal description of this site. Quarter sections should be entered in the form "NW of SE", which indicates that the site is within the northwest quarter of the southeast quarter-section.

Directions to site: Please explain how someone else could relocate the site, starting from a named paved road.

Mapping: Attach a copy of the USGS 7.5 minute quadrangle map with the location and extent of the rare plant population clearly drawn. Do not reduce or enlarge the photocopy or printout of the map . If you're using a map at a different scale (not recommended) please write the scale on the map. Follow the three steps listed in describing your location. Include detailed comments here; these are useful to us.

1. **GPS:** When mapping with GPS, the best way to submit data to us is to export this data to a floppy disk and mail with your survey from. Submitting a short list of GPS coordinate values is also acceptable. Whether you submit a disk or a list, please provide the accuracy and datum used by your GPS. Also, write a description of what these coordinates represent. For instance, do your GPS points represent the centers of individual patches, each with an estimated size?

2. **Topographic Map:** Submitting this is helpful to interpreting your survey, even if you are submitting data collected via GPS. If neither a map nor GPS was used to collect to the information you are reporting, we will rely on written comments in 'directions to site' and mapping question #3.

I am confident I have accurately located and mapped the population at map scale: The most common answer is 'no'. When surveying away from roads or mapped streams, one usually cannot reference their position accurately to map scale. Use this rule of thumb: to map at 1:24,000 scale, your marks must be within one pencil line's width of their correct location. Often the field biologist can estimate location to within a small area visible on the map (i.e., 'I know I'm between these two streams and between 1000 and 1400 ft. elevation'). If you can estimate your location, draw this area surrounding your mapped feature.

3. I used the following features on the map to identify my location: Please include comments that will help us map the site accurately. If the population is located near or within some feature on the map, please describe. For instance, we want to know if the plants are located within a wetland, at the base of a cliff, on the west bank of a river, or within the littoral zone of a lake.

I mapped the entire extent of the population? Might there be more of these plants in this general area? For instance, did you do an exhaustive survey of all surrounding appropriate habitat, or did you stop at a fence line or ownership boundary.

Is a revisit needed? Check yes if, for instance, identification should be verified at another time, the population should be mapped more accurately, if you did not survey all of the potential habitat, if you think there is some imminent threat, etc.

Ownership: If you know who owns the property, please enter that here.

Population Size: Your count or estimate of the number of individuals or ramets.

Population Data: Describe the population quality and phenology. For example: "45 plants scattered in a wet depression with an area of 10 by 45 meters. Vigorous plants with 30% flowering and 70% vegetative."

Plant Association: If you have access to a vegetation key, please include the plant association of the immediate area along with the author of the key.

Associated Species: Please enter the scientific names of the other plant species that are found in the immediate area and their percent cover, if determined. These should be described by layer as listed on the form.

General Description: Describe the local landscape, including physical land forms, vegetation, and land use.

Minimum & Maximum Elevation: Enter values in feet and a maximum elevation only if this is a large population with a range of elevations.

Size: How many acres does the population cover? If less that 0.1 acre, you can leave this blank.

Aspect: Enter the direction of slope as degrees or as a compass direction such as SW.

Slope: Enter as degrees or percent.

Photo taken? Check yes if you took a photograph of the population, otherwise, check no.

Management Comments: Enter information about land use and threats (exotic species, recreation, road maintenance, grazing, etc.) here as well as recommended changes in site use that will help ensure continued existence of the population.

Protection Comments: Enter any legal steps that you think should be taken to protect the population.

Additional Comments: Enter anything that you think is important about this population that did not fit in any other space on the form.

RARE, THREATENED, AND ENDANGERED PLANTS
PROPOSED STUDY PLAN

ATTACHMENT B

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Shauna Hee (USFS)	05/15/2020	Section 2.1 Study Goals and Objectives	The list of RTE species does not address nonvascular plants or fungi that require federal or state regulation. Either include these species or provide justification as to why project related actions has no effect to these species. The list of RTE species also does not address lichenized fungi or macro-fungi. Either include these species or provide justification as to why project related actions has no effect to these species. Species lists can be found: https://www.dnr.wa.gov/NHPlists	Please refer to the criteria used to define RTE species in Section 2.3 of the Rare, Threatened, and Endangered Plants Draft Study Plan. Information on nonvascular plants were cross-referenced with the USFS Region 6 Forester's List of Sensitive Species. Species that were not documented or suspected within the Mt. Baker-Snoqualmie National Forest (MBSNF) were excluded. The next step was to review the habitat information in the species accounts provided by the USFS/BLM Interagency Special Status/Sensitive Species Program to review the habitat requirements and typical landscape occurrence of the species. No Washington National Heritage Program (NHP) fungi are included in the MBSNF Sensitive Species List. The series of nonvascular plants that do or may occur in the MBSNF were reviewed for their habitat type and cross-referenced with what is available in the study area. Habitats not included in the study area, such as alpine, were not included. Two non-vascular species will be added to the RTE target species list based on this review: *Leptogium cyanescens* and *Ramalina thausta* on USFS land. NPS provided an RTE target species list that included no non-vascular species. If USFS has additional species they are required to survey for under similar circumstances, City Light would be glad to consider these.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
2.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin this species [*Carex flava*] occurs at Hozomeen lake	Thank you for your comment. City Light appreciates the information.
3.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin this species [*Coptis asplenifolia*] is unlikely to occur in NOCA	Thank you for your comment. City Light appreciates the information.
4.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	This [*Coptis asplenifolia*] occurs on McAlester mountains	Thank you for your comment. City Light appreciates the information.
5.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin this species [*Githopsis speculariodes*] does not occur in NOCA	Thank you for your comment. City Light appreciates the information.
6.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin - this species [*Saxifraga hyperborea*] occurs at boulder butte	Thank you for your comment. City Light appreciates the information.
7.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin this species [*Spiranthes porrifolia*] occurs at coon lake	Thank you for your comment. City Light appreciates the information.
8.	Judy Niebauer (USFWS)	05/22/2020	Section 2.5 Study Area	Please expand the scope to look at full areas of the project boundary, any nearby/adjacent areas with populations of RTE plants to be able to determine if adjacent populations could be expanded or connected to similar habitat types. Looking for connectivity between populations and potential for new populations should be a goal for such a long term project. Because Canada is within the boundary, please determine if populations exist in the areas	The study plan focuses efforts on areas where there is the potential for Project effects. City Light is interested in any existing data on RTE plant populations both within and outside of the Project Boundary as well as any incidental observations. Looking for connectivity potential is beyond the scope of this study. Canada is outside the Project Boundary as FERC has no jurisdiction in Canada.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				within the reservoir/river beds within the drawdown zones in Canada. This may require and MOU for sharing data.	
9.	Shauna Hee (USFS)	05/15/2020, 05/22/2020	Section 2.5.1 Study Area	This is a great study area for invasive plants. I don't quite understand why it was determined that facilities have suitable habitat for RTE species (based on the above listed habitat requirements). Please provide justification as to why facilities are included in the study area. **Comment edited on 5/22 to the following:** Please provide an explanation why the same study are is being used for both the rare plant and invasive plant studies. I don't quite understand why it was determined that facilities have suitable habitat for RTE species (based on the above listed habitat requirements). Please provide justification as to why facilities are included in the study area.	Surveys for RTE plants will be conducted where Project reservoir management and O&M activities have a reasonable potential to affect plant communities that could include RTE species. For built facilities a 50-ft buffer will be assessed for potentially suitable habitat for the RTE plant species. Areas beyond that distance would only be surveyed if field observations indicate high potential habitat occurs where the Project could reasonably affect them. City Light does not manage lands or many of the recreation facilities that happen to be within FERC Project Boundary.
10.	Shauna Hee (USFS)	05/15/2020	Section 2.5.1 Study Area	As the reservoir flucuation zones likely have suitable habitat for RTE species, please provide a full description of the sites or areas that are included in the study area. If the example provided is indeed the study area - 10-ft above and below max water surface - then provide references and justifciation as to why impacts from reservoir water flucuation to shoreline vegetation is restricted to 10-feet from full pool.	The elevational range 10 ft above and below the normal maximum water surface elevation was selected as a reasonable range for potential effects in the reservoir fluctuation zone. If effects from Project shoreline erosion treatment extend beyond 10 ft, that area would be included. In addition, it is unlikely that plants will be growing 10 ft below full pool. However, habitats and locations to be surveyed for RTE species will be shared with the TRREWG before surveys begin.
11.	Shauna Hee (USFS)	05/21/2020	Section 2.5.1 Study Area	Please include project trails plus a buffer.	Project-related trails including Ladder Creek Falls Trail and Gardens and Trail of the Cedars, as well as trails maintained by City Light for O&M purposes are included in the study area. These areas will be included, as applicable, with habitats and locations to be surveyed for

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					RTE species as described in response to Comments #9 and #10
12.	Shauna Hee (USFS)	05/21/2020	Section 2.5.1 Study Area	How did you come up with the 50-foot buffer? Please cite references and provide an explanation.	The 50-ft buffer distance is a reasonable assumption for the effects of Project facilities and roads for the purpose of a RTE Plants Study. USFS publication Backcountry Road Maintenance and Weed Management (Ferguson, Leslie; Duncan, Celestine Lacey; Snodgrass, Kathleen. 2003. Backcountry Road Maintenance and Weed Management. 0371 2811P. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 22 p.) indicates a declining effect from roads and associated maintenance after 50 ft from the source.
13.	Shauna Hee (USFS)	05/15/2020	Section 2.5.1 Study Area	Please include dispersed recreation sites within the project area or provide justification as to how dispersed recreation is not considered a project related recreation use.	Project-related recreation sites have been included in the study area. Dispersed recreation sites are administered by National Park Service. While these facilities are located within the FERC Project boundary, they are not Project recreation facilities and City Light does not operate or maintain these facilities. The Project provides a variety of Project recreation facilities and opportunities, primarily at Diablo Lake, Gorge Lake, and the town of Newhalem, where City Light has provided public access and recreation opportunities dating back prior to the development of the NCNP and RLNRA. The development of non-Project recreation facilities and the larger NCNP and RLNRA are not a result of demand for recreation related to the Project or a change in Project operations.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Rather, the increased recreation demand of the non-Project NPS recreation sites and facilities is a result of the development of a much larger, broader NCNP and RLNRA that dwarf the FERC Project, which was in place at the time of the Park's establishment and exceed City Light's requirements related to the Project.
14.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1 Step 1 – Develop Target RTE Species List	The Vegetation Mapping effort is too coarse a filter for suitable habitat. The NPS Association delineation should be used for a rough habitat suitability analysis.	City Light has access to the NPS Alliance-level mapping for the study area within the NCNP, including reservoirs and Project facilities, and part of the transmission line right-of-way. All other areas will be mapped at the Group level. Field data will be collected to train the vegetation model and to collect reconnaissance level data on the shrub layer. Supplemental information on typical vegetation associations will be derived from standard publications such as the NPS mapping effort, Franklin and Dyrness (1973. Natural vegetation of Oregon and Washington. Gen. Tech. Rep. PNW-GTR-008. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 427 p.), and other available documents. City Light is confident that these combined efforts will allow for accurate determination of potential RTE plant habitat as matched up with species descriptions and vegetation associations.
15.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1 Step 1 – Develop Target RTE Species List	Describe methods that would be used to generate or delineate potential suitable habitat. Cite references.	Multiple data sources will be used to match RTE plant potential occurrence areas with the vegetation mapping effort. These include species accounts from the USFS available on the Interagency Special Status / Sensitive Species Program website, the Oregon Flora Project, Natural Heritage accounts, discussions with experts, and other available sources.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Interagency Special Status / Sensitive Species Program. https://www.fs.fed.us/r6/sfpnw/issssp/ Oregon Flora Project. 2020. http://www.oregonflora.org/index.php https://www.dnr.wa.gov/NHPlists
16.	Shauna Hee (USFS)	05/15/2020	Section 2.6.2 Determine Survey Areas	How much of the study area will be surveyed for RTE species? 25% 50% 100%?	City Light will survey for RTE plants where Project activities occur in locations with known RTE occurrences or with potentially suitable habitat for RTE plants. Habitats for the target species list will be overlaid with the study area to determine these survey locations. Habitats and locations to be surveyed for RTE species will be shared with the TRREWG before surveys begin. There is no predetermined percent of the overall study area.
17.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Determine Survey Areas	Why are locations in which project acitivities occur the only sites where surveys would occur? What are examples of project aciivities? Please provide justification.	Surveys for RTE plants will be conducted where Project reservoir management and O&M activities have a reasonable potential to affect plant communities that could include RTE species. For built facilities a 50-ft buffer will be assessed for potentially suitable habitat for the RTE plant species. Areas beyond that distance would only be surveyed if field observations indicate high potential habitat occurs where the Project could reasonably affect them. The goal of this study is to provide information to determine whether and the extent to which certain Project O&M activities adversely affect RTE plant species and define PME measures to protect the species. Examples of Project

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					activities are listed in Sections 2.4 and 2.5 of the Study Plan.
18.	Shauna Hee (USFS)	05/15/2020	Section 2.6.2 Determine Survey Areas	How will field sites be prioritized based on habitat requirements? Please cite references and provide justification on how this is an acceptable method. Why would field sites not be prioritized on the liklihood of greatest impact to suitable habitat and potential loss or RTE species?	Locations will be surveyed if specific habitat requirements of one or more RTE species are present. Habitat requirements will be used to select field locations for survey. Field sites initially will be determined based on potential for effects by Project activities – the intersection between potential effects and potential suitable habitat. Habitats and locations to be surveyed for RTE species will be shared with the TRREWG before surveys begin. If LPs have additional direction for selecting survey sites that are affected by Project City Light would appreciate the information. Also refer to the response to Comment #15.
19.	Judy Niebauer (USFWS)	05/22/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	Please include a map of potential RTE areas outside of project boundary to be able to determine if there are key connectivity corridors for increasing populations on lands within the project boundary or on nearby adjacent lands.	Mapping potential RTE plants habitats outside of the Project Boundary or potential for connectivity is beyond the scope of this study.
20.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	Why is an Oregon field guide proposed for use in NW WA State?	The Oregon Flora Project Rare Plant Guide would be used as a supplemental resource to facilitate proper plant identification and nomenclature. The intent is not to supplant Washington-oriented lists or resources.
21.	Shauna Hee (USFS)	05/15/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	How much of the field site would receive an intense survey? At least 50%?	The extent of intensive survey would depend on the quality of the habitat based on professional judgment of the surveyors. This will vary with the specific conditions found in the field.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
22.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	We need to ensure the timing of surveys is ensures that identification is possible especially for plants for which idenfication is dependent upon characteristics them may be sort lived, or only occuring in specific phenological stage.	A flowering matrix will be developed for the target species list, and survey timing will be planned based on when the species will be detectable and identifiable, typically during their flowering or fruiting phases, and based on herbarium collection dates.
23.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	How does general habitat type crosswalk with the Veg Mapping and wetland studies? Habitat type within the Park should conform to their Alliance or Association delineation as it is the best available science.	City Light will include a direct crosswalk from Vegetation Mapping and Wetland Assessment studies.
24.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	A list of associated species should be recorded to help desribe the microsite conditions that would be needed to maintain the population.	Such information will be collected and will be part of the electronic datasheet used for the study. In addition, a general incidental observation data form will be used during fieldwork for all studies to collect information on observations, including those not necessarily connected to this RTE Plants Study.
25.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	Please include collection of voucher specimens per NPS collection and vouchering policy. The collection of voucher speciemens would allow the verification of the proposed species ID. All identifications made in the field would need verification by an expert.	City Light will collect voucher specimens for species that are unusual or unidentifiable in the field. Field staff will be trained in rare plant identification skill. On NPS land, City Light will follow NPS guidance on collecting any voucher specimens. City Light will defer to USFS guidance on their land. On all other land we will follow WA Natural Heritage and Native Plant Society guidance on voucher specimens. The RTE Plants Study will be led by a botanist experienced in plant taxonomy of rare species and with extensive Pacific Northwest survey experience. Prior to fieldwork one of the identified steps is visiting the University of

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Washington herbarium to review any problematic species.
26.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	How is a population being defined? What about sub-popualtions? What is the minimum mapping distance?	In general terms we are using a standard definition of a plant population for all individuals in one location that are close enough for genetic exchange. If there are "subpopulations" further from one another but still within the area of Project influence, they will be surveyed. If what is meant by "minimum mapping distance" is the minimum mapping unit for the RTE Plants Study, then the vegetation mapping minimal unit is about 18 sq. m. Minimum pixel size is 9 sq. m, so any plant occurrence polygons smaller than 9 sq. m will be indicated as a point. There is a longer technical explanation of why predictor models used for the vegetation mapping results in a minimum mapping unit larger than the minimum pixel size.
27.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	need to determine how this data will be protected in accordance with NPS requirements	City Light will follow guidelines to protect confidential information. As stated in the study plan, confidential information will be marked "confidential" and sharing will be restricted to distribution to agencies and tribes. Documents shared with the public will have confidential rare plant population information removed.
28.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 - Conduct Field Surveys	You could use imagery instead of photos. Also - I find bare ground lidar really helpful for delineating locations when GPS accuracy is very very low.	City Light appreciates the information.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
29.	Judy Niebauer (USFWS)	05/22/2020	Section 2.6.6 Step 6 – Threats Assessment	Provide a connectivity assessment to see if there are key locations adjacent to project boundary that could help develop conservation sites within the project boundary or visa versa. Understanding if the project intersects key connectivity areas will provide another level of effects analysis, as well as provide for understanding if there are opportunities for future conservation.	See response to Comment #19.
30.	Shauna Hee (USFS)	05/21/2020	Section 2.8 Schedule	I would expect most field work to occur from June-August. Please provide an explanation of why surveys may occur as early as April and as late as November.	The study area covers a large area, including the transmission line right-of-way (where vegetation management occurs); the extent of survey season includes surveys for the extent of the study area.
31.	Shauna Hee (USFS)	05/21/2020	Section 2.9 Level of Effort and Cost	Why is the cost for the RTE study higher than the Invasive Plant study? I would assume that it would be significantly lower since the liklihood of documenting sites is lower.	RTE plants, because of more specialized habitat requirements and sporadic occurrence over the landscape, will take more intensive field time than the weed survey. In addition, because of differences in blooming time across the season and the associated logistics, the RTE Plants Study may spill into a second year of survey.

TR-04 INVASIVE PLANTS
PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

Board.....State of Washington Noxious Weed Control Board

City Light.....Seattle City Light

EA .....Environmental Assessment

ELC.....Environmental Learning Center

FERC.....Federal Energy Regulatory Commission

Forest Plan .....Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan

GIS .....Geographic Information System

GPS .....Global Positioning System

ISR .....Initial Study Report

LP.....licensing participant

NISIMS .....National Invasive Species Information Management System

NPS .....National Park Service

O&M.....operations and maintenance

PAD.....Pre-Application Document

Project .....Skagit River Hydroelectric Project

PSP.....Proposed Study Plan

QA/QC .....quality assurance/quality control

RLNRA.....Ross Lake National Recreation Area

ROW .....right-of-way

RWG .....Resource Work Group

SR.....State Route

TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group

U.S.C.....United States Code

USFS.....U.S. Forest Service

USFWS .....U.S. Fish and Wildlife Service

WDFW.....Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC by April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

This study plan was developed for the purpose of mapping and summarizing the extent of occurrence of a target list of invasive plant species and likely vectors for their distribution within the study area. This study is designed to address Terrestrial Issue 10 (TE10: Invasive Plant Survey) that identifies that Project-related activities (operations and maintenance [O&M], and Project-related recreation) may contribute to the introduction and spread of invasive plants.

On April 24, 2020, City Light released the Invasive Plants Draft Study Plan for LP review and comment. On May 6, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 12, 2020. The revised draft was discussed on June 23, 2020 at a TRREWG meeting. Written comments were received from Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), NPS, and U.S. Forest Service (USFS). A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC. However, this study will provide information requested as part of the SSIT-03 Impacts of Transmission Line Right of Way (ROW) on Aquatic Habitat and Riparian Zone for the Skagit River Hydroelectric Project study request, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of the invasive plants study is to document occurrences of a target list of plant species designated as invasive[1], which could potentially be spread by Project O&M and Project-related recreation activities, and to assess effects. Specific objectives of this study are as follows:

- Develop a target list of invasive species that have the potential to cause significant ecological or economic damage within the study area.
- Identify locations within the study area where there are Project-related disturbance and pathways for invasive species dispersal.
- Develop a map depicting invasive species locations, based on existing data and field verification.
- Describe the status, distribution, likely vectors, and limiting factors for target invasive plant species.

2.2 Resource Management Goals

City Light's goal is to have invasive plant mapping data and provide basic information to the licensing participants necessary to meet their regulatory mandates within the FERC relicensing process. Management goals related to invasive plants are described below.

- U.S. Forest Service (USFS)

USFS controls the spread of noxious weeds on National Forest System land in compliance with the objectives, standards, and guidelines of the Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan (Forest Plan) (USFS 1990, as amended), as well as federal law and direction. In 2005, an Environmental Assessment (EA) and corresponding decision notice on invasive plant control were issued for the Mt. Baker-Snoqualmie National Forest. Region 6 provides guidance in the Pacific Northwest Region's Invasive Plant Program Record of Decision

Amendments include the 2016 ROD for Invasive Plant Treatment on the MBS, 2005 Determination of Non-significance (DN) for Treatment of Invasive Plants on the MBS, 2005 Record of Decision Preventing and Managing Invasive Plants, and the 1999 DN Forest-Wide Noxious Weed Management.

- National Park Service (NPS)

The following goals were identified in the North Cascades National Park Service Complex Invasive Non-Native Plant Management Environmental Assessment (NPS 2011):

- Prevent new invasive species from entering the park and prevent the spread of existing invasive species;

[1] Control is required for all Class A and Class B-designate species by the Washington State Noxious Weed Control Board and by County Noxious Weed Control Boards if their designation is different from the State designation.

- Conduct a comprehensive inventory of invasive plants in the park and monitor known populations;
- Create management priorities based on the invasive plant occurrences' ability to affect natural systems;
- Restore treated areas as quickly as possible; and
- Use outreach, education, and cooperation to increase understanding of the prevention and control of invasive plants.

- Washington State Noxious Weed Control Board (Board).

The Board is responsible for the designation and management of invasive plants, in cooperation with County Noxious Weed Control Boards (Board 2020).

- County Noxious Weed Control Boards.

Each County containing the Project has a Noxious Weed Control Board that designates rankings to manage invasive plants in conjunction with the Board (Skagit County 2020; Snohomish County 2020; Whatcom County 2020).

2.3 Background and Existing Information

Information about invasive plant species in the Project is covered in detail in Section 4.6.3 of the PAD (City Light 2020). For the purpose of this study plan, invasive plant species are those listed in the PAD which are:

- Washington State-designated noxious weeds (Washington State Noxious Weed Control Board 2020);
- County-designated noxious weeds (Skagit County 2020; Whatcom County 2020; Snohomish County 2020);
- NPS-designated highest priority species (NPS 2011); and
- Specific species identified as targeted concerns during the 2019 Study Plan Development Process, including traveler's joy (*Clematis vitalba)*, reed canarygrass[2] (*Phalaris arundinacea*), Japanese knotweed (*Polygonum cuspidatum*), and sycamore maple (*Acer pseudoplatanus*).

County-designated weed species are listed in Table 2.3-1.

[2] Note that reed canarygrass populations in the study area may be native, non-native, or intraspecific hybrid, based on herbarium records (Consortium of Pacific Northwest Herbaria Specimen Database 2020) and recent genetic studies (Merigliano and Lesica 1998, Jakubowski et al. 2013).

Table 2.3-1. County-designated weed species in Whatcom, Skagit, and Snohomish counties known or suspected to occur within/near the Project vicinity.

Scientific Name	Common Name	Designation[1]			
		State	Skagit	Whatcom	Snohomish
Artemisia absinthium	absinthe	C	C	-	-
Buddleja davidii	orange-eye butterfly bush	B	B-no con.	B-sel.	-
Centaurea stoebe	knapweed, spotted	B	B-des.	B-sel.	B-des.
Cirsium arvense	thistle, Canada	C	C	C	-
Cirsium vulgare	thistle, bull	C	C	C	-
Clematis orientalis	Oriental clematis	A	A	A	A
Clematis vitalba	traveler's joy	C	C	C	-
Convolvulus arvensis	field bindweed	C	C	-	-
Crataegus monogyna	English hawthorn	C	C	C	C
Cytisus scoparius	Scot's broom	B	B-no con.	B-sel.	-
Daucus carota	wild carrot (except where commercially grown)	C	C	-	-
Dipsacus fullonum	common teasel	C	C	-	-
Epilobium hirsutum	fiddle grass	B	B-des.	B-sel.	B-des.
Euphorbia oblongata	balkan spurge	A	A	A	A
Fallopia x bohemica	knotweed, bohemian	B	B-sel.	B-sel.	B-sel.
Fallopia japonica	knotweed, Japanese	B	B-sel.	B-des.	B-sel.
Fallopia sachalinensis	knotweed, giant	B	B-des.	B-des.	B-sel.
Geranium robertianum	herbrobert	B	B-no con.	B-sel.	-
Hedera helix 'Baltica', 'Pittsburgh', and 'Star'; *H. hibernica* 'Hibernica'	English ivy (four cultivars only)	C	C	C	-
Hypericum perforatum	common St. Johnswort	C	C	C	-
Impatiens glandulifera	policeman's helmet	B	B-des.	B-sel.	B-des.
Iris pseudacorus	pale yellow iris	C	C	C	-
Jacobaeu vulgaris	tansy ragwort	C	B-sel.	B-sel.	B-sel.
Lamiastrum galeobdolon	yellow archangel	B	B-des.	B-des.	-
Leucanthemum vulgare	oxeye daisy	C	C	-	-
Linaria dalmatica ssp. dalmatica	Dalmatian toadflax	B	B-des.	B-des.	B-des.
Persicaria wallichii	knotweed, Himalayan	B	B-des.	B-des.	B
Phalaris arundinacea	reed canarygrass	C	C	C	-
Potentilla recta	sulphur cinquefoil	B	-	B-des.	B
Rhaponticum repens	knapweed, Russian	B	B-des.	B-des.	B-des.
Rubus armeniacus	Blackberry, Himalayan	C	C	C	-
Rubus laciniatus	Blackberry, evergreen	C	C	C	-
Sonchus arvensis ssp. arvensis	perennial sowthistle	C	C	-	-
Tanacetum vulgare	common tansy	C	C	C	-

Source: Board 2020; Skagit County 2020; Whatcom County 2020; Snohomish County 2020.

1 no con. = no control, des. = designated, sel. = selected.

Additionally, the NPS has designated species that have spread beyond historic cultivation in Newhalem and select other non-native species as "Highest Priority Species" (NPS 2011). A list of these species is included in Table 2.3-2.

Table 2.3-2. Highest Priority non-native plant species observed in RLNRA.

Scientific Name	Common Name
Acer ginnala	Amur maple
Acer negundo	Box elder
Acer platanoides	Norway maple
Acer pseudoplatanus	Sycamore maple
Acer rubrum	Red maple
Acroptilon repens	Russian knapweed
Aesculus hippocastanum	Horse chestnut
Arctim lappa	Greater burdock
Cytisus scoparius	Scot's broom
Ilex aquifolium	English holly
Juglans cinerea	Butternut
Juglans nigra	Black walnut
Linaria purpurea	Purple toadflax
Lunaria annua	Annual honesty
Prunus avium	Wild cherry
Prunus cerasifera	Thundercloud plum
Prunus domestica	Domestic cherry
Prunus laurocerasus	Cherry laurel
Robinia pseudoacacia	Bristly locust
Sorbus aucuparia	European mountain ash
Verbascum thapsus	Common mullein
Vinca minor	Small-leave periwinkle

Source: NPS 2011.

Invasive species documented during surveys within the North Cascades National Park Complex, townsites, the State Route (SR) 20 corridor, and transmission line right-of-way (ROW) are included in Table 2.3-3.

Table 2.3-3. Invasive[1] species documented in the portion of the Project Boundary within the RLNRA (2016-2018).

Scientific Name[2]	Common Name[2]	Location Observed				
		Diablo	Newhalem	SR 20	Transmission Line	Ross Lake
Acer negundo	**box elder**		X			
Acer pseudoplatanus	**sycamore maple**	X	X			
Aesculus hippocastanum	**horse chestnut**		X			
Aegopodium podagraria	bishop's goutweed	X	X			
Artemisia absinthium	**absinthe**	X	X	X[5]		
Arctium lappa	**greater burdock**	X				
Bromus arvensis	field brome		X			
Brassica sp.	mustard		X			
Bromus inermis	smooth brome	X				
Campanula rapunculoides	creeping bellflower		X			
Centaurea stoebe	**spotted knapweed**		X	X		
Chenopodium album	lambsquarters					
Cirsium arvense	**Canada thistle**	X		X		X[5]
Cirsium vulgare	**bull thistle**		X	X[5]		
Clematis vitalba	**traveler's joy**		X	X		
Convolvulus arvensis	**field bindweed**	X		X[5]		
Conium maculatum	**Poison-hemlock**					
Crataegus monogyna	**One-seed hawthorn**	X	X			
Cytisus scoparius	**Scot's broom**		X	X[5]	X	
Dactylis glomerata	Orchard grass					
Digitalis purpurea	purple foxglove	X	X	X		
Erysimum cheiranthoides	wormseed wallflower		X			
Euphorbia oblongata[3]	**spurge, balkan**	X				
Euphorbia peplus[3]	spurge, petty		X			
Fagus sylvatica	European beech		X			
Fallopia japonica	**knotweed, Japanese**			X		
Geranium lucidum	**shining cranes-bill**					
Geranium robertianum	**herbrobert**		X	X		
Hedera helix	**English ivy**	X[5]	X			
Hesperis matronalis	Dame's rocket	X	X	X[5]		
Hieracium caespitosum	**hawkweed, meadow**			X		
Hieracium floribundum	**hawkweed, flowery**			X		
Hypericum perforatum	**common St. Johnswort**	X	X	X[5]	X	
Ilex aquifolium	**English holly**					
Impatiens glandulifera	**policeman's helmet**			X[5]	X	
Juglans nigra	**black walnut**		X			
Lapsana communis	common nipplewort	X	X	X[5]		
Lathyrus latifolius	everlasting-pea			X		

Scientific Name[2]	Common Name[2]	Location Observed				
		Diablo	Newhalem	SR 20	Transmission Line	Ross Lake
Leucanthemum vulgare	**oxeye daisy**	X	X	X		
Linaria dalmatica* ssp. *dalmatica	**Dalmatian toadflax**	X	X	X		
Melilotus officinalis	yellow sweet-clover	X	X[5]	X[5]		
Mycelis muralis	wall lettuce	X	X[5]	X[5]		X[5]
Phalaris arundinacea	**reed canarygrass**				X	X[4]
Plantago lanceolata	English plantain	X				
Polygonum sp.	**knotweed**	X				
Potentilla recta	**sulphur cinquefoil**			X		
Prunus spinosa	blackthorn	X				
Robinia hispida	bristly locust		X			
Robinia pseudoacacia	**black locust**	X	X		X[5]	
Rumex acetosella	common sheep sorrel	X	X[5]	X[5]		X[5]
Rubus armeniacus	**blackberry, Himalayan**	X	X	X	X	
Rubus laciniatus	**blackberry, cutleaf**		X		X	
Rumex crispus	curly dock	X	X	X[5]		
Silene vulgaris	bladder campion		X			
Sonchus arvensis	**field sow-thistle**	X	X	X[5]		
Sonchus asper	Spiny leaf sow thistle		X			
Sorbus aucuparia	**European mountain ash**		X			
Tanacetum vulgare	**common tansy**	X	X	X[5]	X	X[5]
Verbascum thapsus	**great mullein**	X	X	X		
Vinca minor	**lesser periwinkle**	X	X			

Source: NPS National Invasive Species Information Management System (NISIMS 2020) database unless otherwise noted.

1 This table includes species listed as "exotic" by the NPS which is defined as "those that occupy park lands as a result of deliberate or accidental human actions" (Rochefort et al. 2016).
2 Species names in bold are on the State NWCB list or listed as a "Priority Species" by NPS.
3 Source: Denovan 2019.
4 Source: McAvinchey et al. 2017; McAvinchey and Wilhoit 2019.
5 Source: Bivin 2020.

Additionally, traveler's joy, reed canarygrass, Japanese knotweed, and sycamore maple were identified during the 2019 Study Plan Development Process as target species.

2.4 Project Operations and Effects on Resources

Certain aspects of Project-related recreation and O&M may increase the spread of invasive plant species. The spread could be the result of direct actions (i.e., ground disturbing activities such as vegetation management in the absence of best management practices) or indirect (i.e., caused by a Project activity in association with a non-Project activity, such as introduction of invasive species from a non-Project vector). Activities that could contribute to the spread of invasive plant species are described in more detail in Section 4.6.7 of the PAD (City Light 2020).

2.5 Study Area

2.5.1 Study Area

The study area consists of the land within the Project Boundary and the shorebanks of the Skagit River to the confluence with the Sauk River. The study area is shown in Figures 2.5-1 through 2.5-4.[3] Field survey locations will be prioritized to include areas where specific Project-related disturbance and pathways are known to occur. A detailed list of these areas is included in Section 2.6.6 of this study plan. However, observations of invasive species throughout the study area will be recorded.

2.5.2 General Concepts

These general concepts apply to the study:

- Personal safety is an important consideration of each fieldwork team. City Light and their consultants will perform the study in a safe manner.
- Field crews may make minor modifications in the field to adjust to and to accommodate actual field conditions and unforeseeable events. Any modifications made will be documented and reported in the study report.

[3] City Light is currently reviewing information on roads in the Project Boundary and will add Project roads to the maps in an updated study plan.

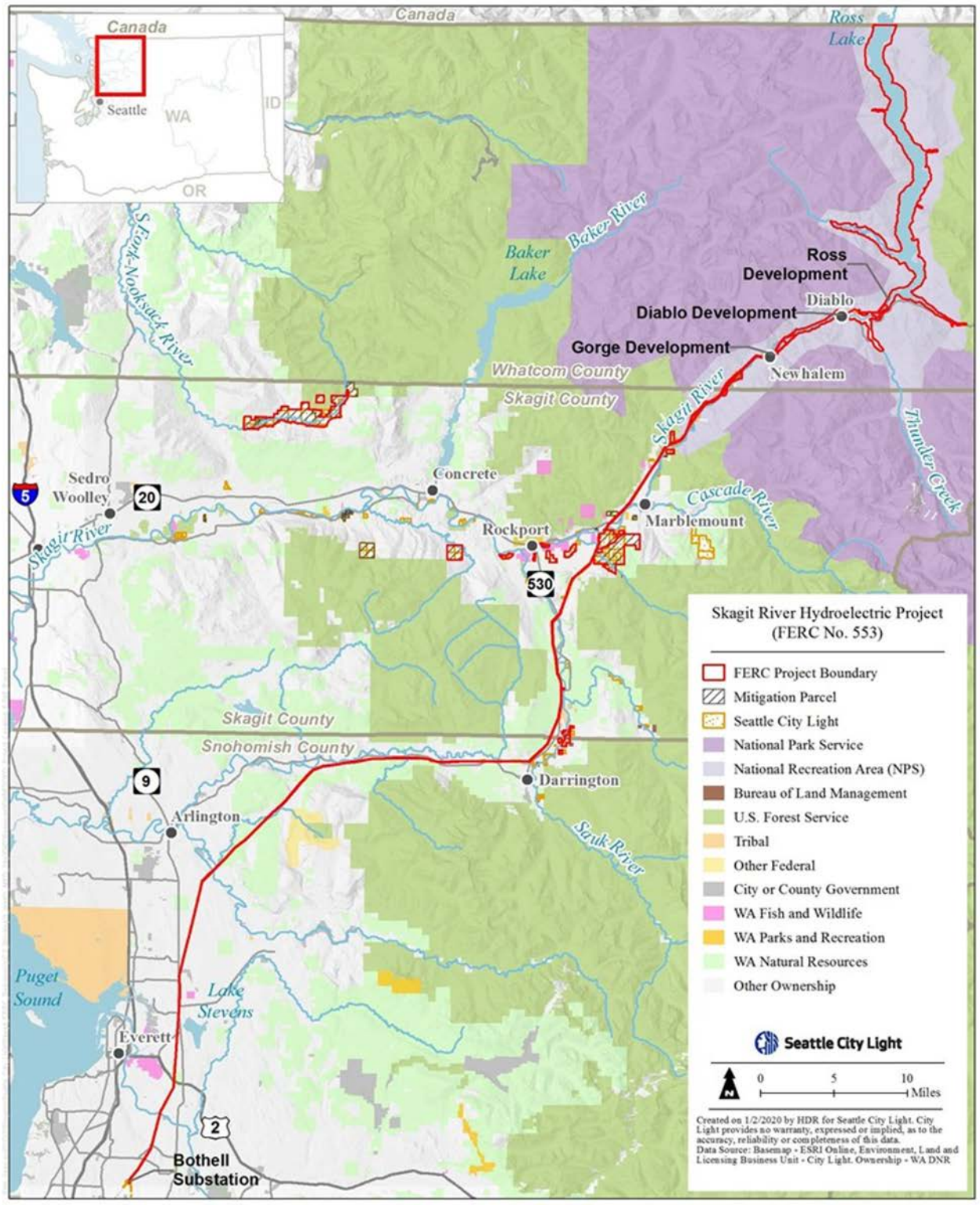

Figure 2.5-1. Location map of the Skagit River Project, including study areas associated with transmission line right of way and fish and wildlife mitigation lands.

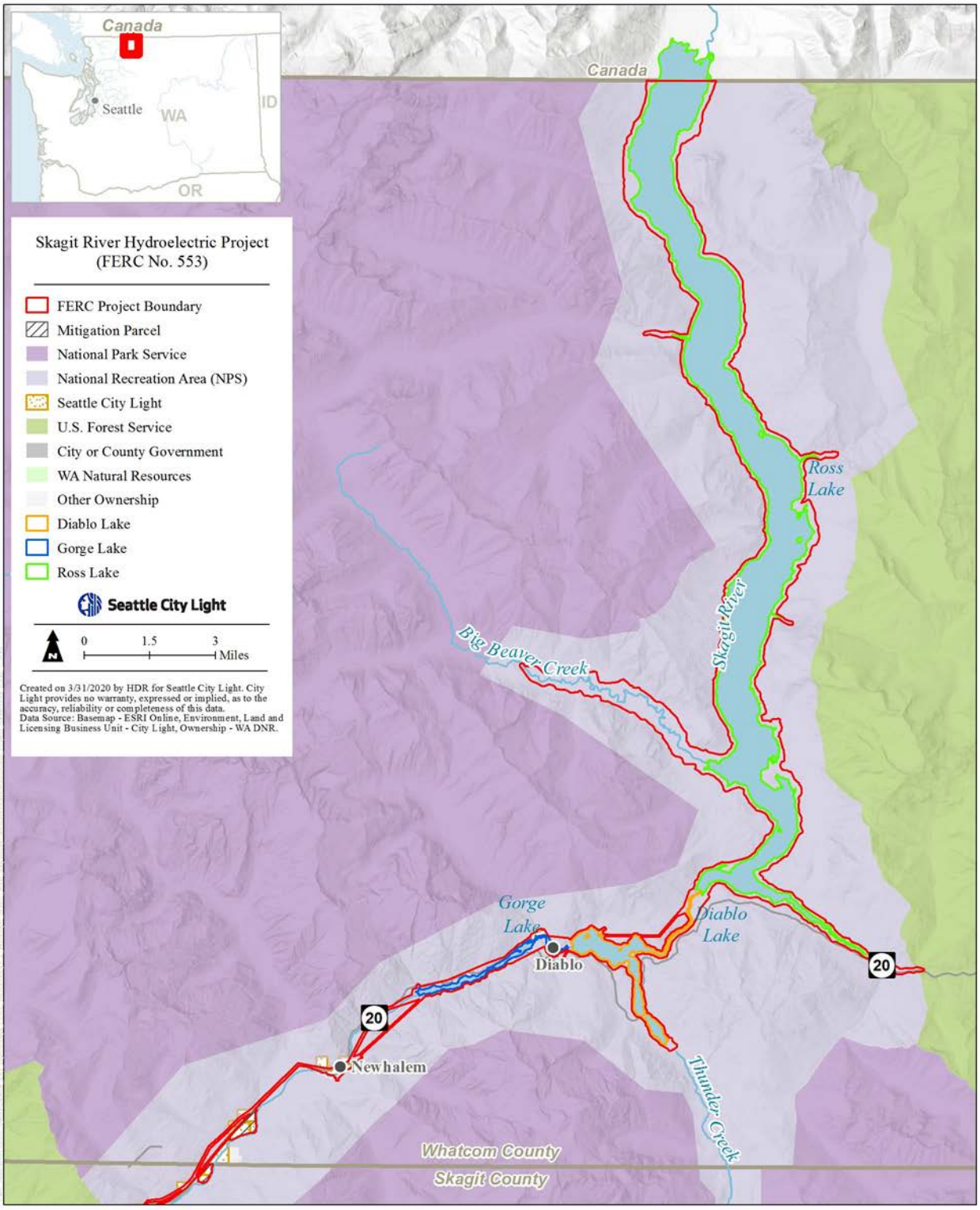

Figure 2.5-2. Study area associated with reservoir shorelines.

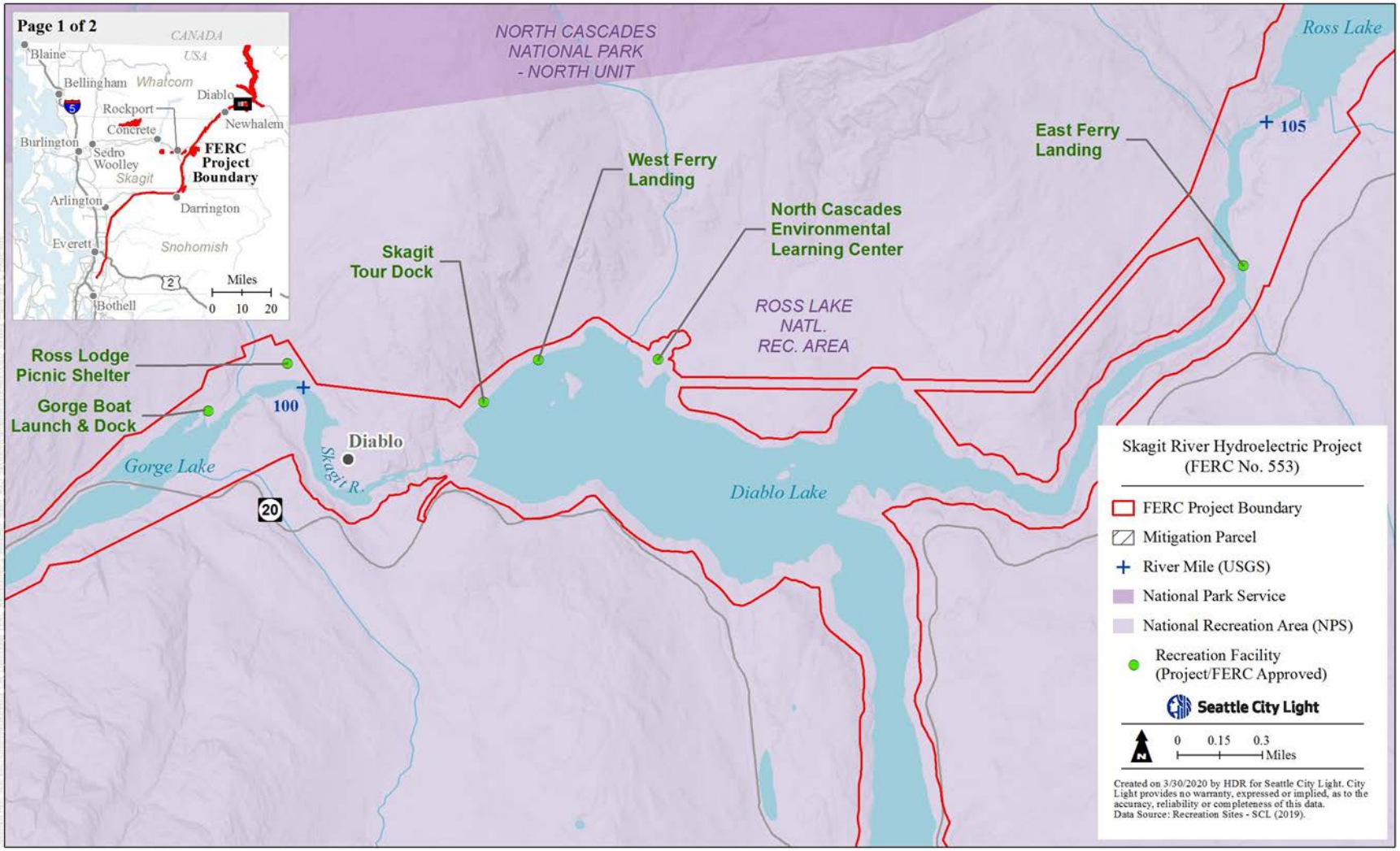

Figure 2.5-3. Study area associated with recreation facilities at and around Diablo and Diablo and Gorge lakes.

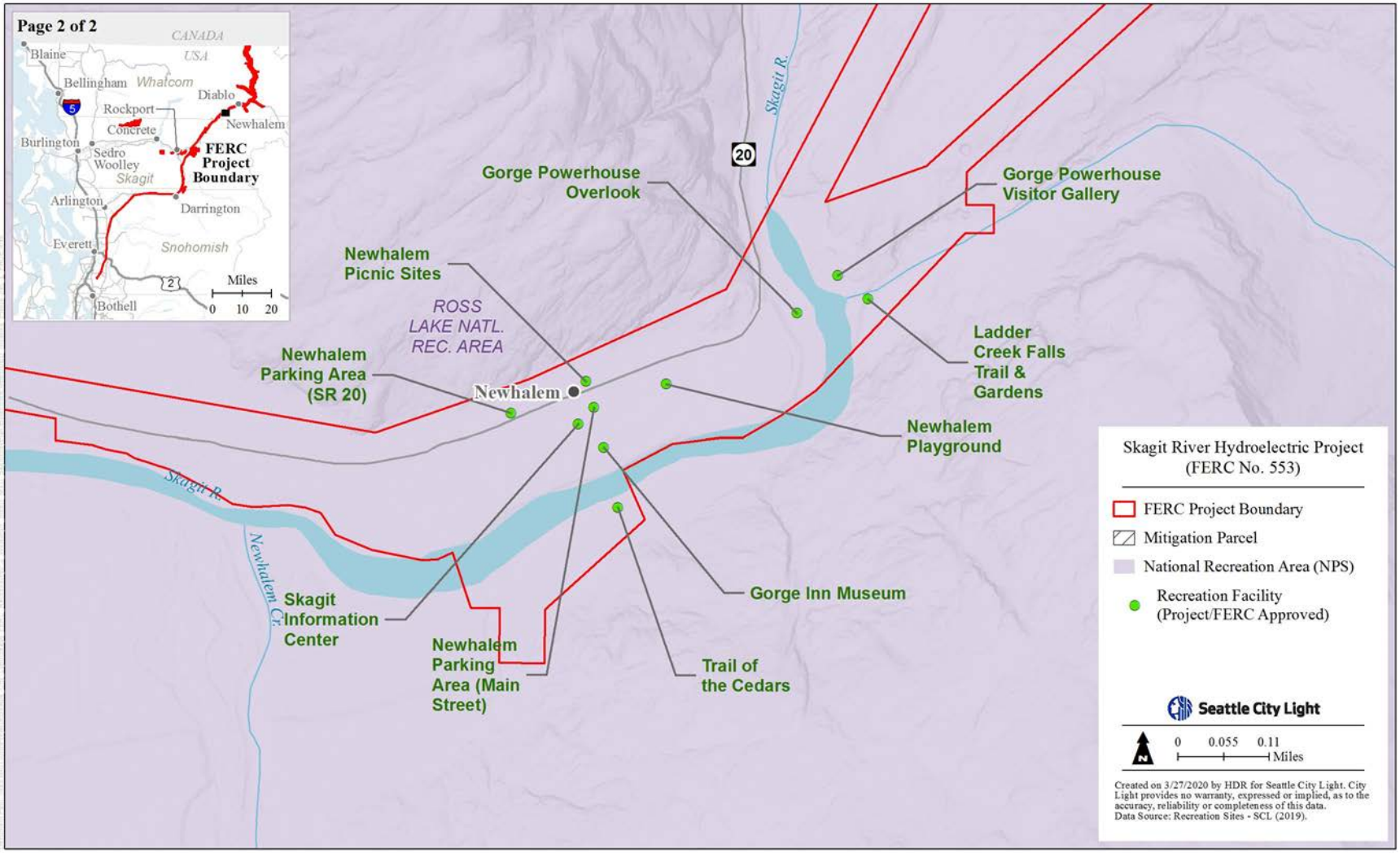

Figure 2.5-4. Study area associated with recreation facilities at and around Newhalem.

2.6 Methodology

The study will map target invasive plant species populations in the study area. Study methods will consist of the following steps: (1) compile and review existing information and develop target species list; (2) determine survey locations; (3) gather data and prepare for field effort; (4) conduct field surveys; (5) compile field collected data and provide quality assurance/quality control (QA/QC) of the data; and (6) prepare report. Each step is described below. It is expected that this study will be conducted concurrently with the Rare, Threatened, and Endangered Plant Study.

2.6.1 Step 1 – Compile Information and Develop Target Species List

Existing information regarding known and potentially occurring invasive plant species will be used to develop a target list of invasive plants.

2.6.1.1 Compile and Review Existing Information

Existing information on invasive plant occurrence in the study area will be compiled and reviewed including, but not limited to, the following:

- Aerial imagery of the study area;
- Information about potential invasive plant species occurrences from the Vegetation Mapping and Wetland Assessment studies;
- Skagit River Cooperative Weed Management Area – Upper Skagit Knotweed Control Program (Skagit Fisheries Enhancement Group 2019 Report; Miller 2020);
- Strategy for Invasive Plant Management and Habitat Restoration for Newhalem and Diablo 2016–2017 (City Light 2016a);
- Assessment of the Ecological Impacts of Non-Native Trees In and Around the Town of Newhalem, WA (City Light and Seattle University 2015);
- Goodell Creek Fire, Weed Management Memo (City Light 2016b);
- Invasive Non-Native Plant Management, Environmental Assessment (NPS 2011);
- Exotic Plant Inventories in Mount Rainier, North Cascades, and Olympic National Parks (Rochefort 2016);
- Newhalem Riparian Restoration Project, Seattle City Light (Skagit Fisheries Enhancement Group 2015);
- North Cascades 2015 Fires Post-Fire Response Plan (NPS 2015);
- Ross Lake Invasive Weed Survey by Boat (NPS 2017) and treatment of targeted weeds using the Integrated Pest Management;
- Sycamore Maple Control Along the Skagit River Through Newhalem (City Light 2017);
- NISIMS weed mapping data for much of the Project Boundary (2020); and
- Available information on invasive plant species in Canada, as relevant to the Project.

2.6.1.2 Develop Target Invasive Plant Species List

Target invasive plant species will be defined in the following manner:

- Species listed as Class A or Class B weeds by the County Noxious Weed Boards of Skagit, Whatcom, and Snohomish counties;
- Highest Priority species identified by NPS as listed in the PAD (City Light 2020) in NPS managed lands; and
- Species identified as target species during the 2019 Study Plan Development Process (i.e., reed canarygrass, Japanese knotweed, traveler's joy, and sycamore maple).

If licensing participants recommend additional species, a valid assessment tool (e.g., Washington Invasive Species Council's (WISC) Invasive Species Impact and Prevention/Early Action Assessment Tool [WISC 2019] and Invasive Species Management Priorities grid [WISC 2017]) and existing information will be used to evaluate potential additions jointly with RWG to consider ecological and economic risks and control feasibility.

2.6.2 Step 2 – Prioritize Survey Locations

Surveys for invasive plant species will be conducted on lands within the study area identified as having potential Project-related disturbance or pathways due to Project O&M and Project-related recreational activities. Surveys will be conducted on City Light-owned lands and lands administered by federal, state, or local agencies.

Locations for surveys include (but are not limited to) the following areas of potential Project-related disturbance or pathways within the study area:

- Within and adjacent to the reservoir fluctuation zone and areas of known Project-related reservoir erosion management locations
- Tributary inlets and low gradient shorelines with wetlands along Project reservoirs
- Riparian margins of the Skagit River downstream of Gorge Dam to the Sauk River confluence
- Areas with active vegetation management in the transmission line ROW and within a 50-ft buffer
- Project-related roads and trails and within a 50-foot buffer
- Portions of fish and wildlife mitigation lands along riverbanks or affected by City Light, recreationists, or unauthorized activities
- Project facilities and within a 50-foot buffer
- Townsites and wildland interface
- Project recreation facilities and within a 50-foot buffer (details in Table 2.6-1 of the Recreation Use and Facility Assessment Study Plan), including:
    - Skagit Tour Dock
    - West Ferry Landing (parking and dock)

- East Ferry Landing
- ELC
- Ross Lodge Picnic Shelter
- Gorge Lake Boat Launch
- Ladder Creek Falls Trail and Gardens
- Trail of the Cedars
- Gorge Powerhouse Overlook
- Gorge Powerhouse Visitor Gallery
- Skagit Information Center
- Gorge Inn Museum
- Newhalem Facilities:
  - Picnic Sites
  - Parking Area (Main Street)
  - Parking Area (SR 20)
  - Interpretive Displays (standalone)
  - Playground

If invasive plant occurrences are located, the survey area will be expanded to the full extent of the occurrence or the Project Boundary, whichever is less. General notes will be recorded to document infestations that extend significantly beyond the Project Boundary but the outer extent will not be mapped.

2.6.3 Step 3 – Gather Data and Prepare for Field Efforts

The study lead will identify and map known occurrences of target invasive species within the study area, and prepare field maps for use by survey teams. The maps will include aerial imagery, Project features (which are Project facilities associated with Project O&M and Project recreation facilities), known invasive plant occurrences, study area boundary, and Project-related roads and trails. Survey timing will be planned based on suitable identification periods in the literature and herbaria records. Locations to be surveyed for invasive species will be shared with the TRREWG before surveys begin. City Light will develop a datasheet and review with TRREWG prior to initiation of fieldwork.

2.6.4 Step 4 – Conduct Field Surveys

The surveyors will conduct invasive plant surveys in a manner that conforms to Survey Protocols for Survey and Manage Strategy 2 Vascular Plants (Whiteaker et al. 1998) and Inventory and Survey Methods for Nonindigenous Plant Species (Rew and Pokorny 2006), which are accepted methods for conducting botanical surveys in Washington. Surveys will be conducted in conjunction with Rare, Threatened, and Endangered Plants surveys, where practicable (i.e., coincidental detectable and identifiable timing). Surveys will be conducted following the

qualitative "exploratory" method outlined and described by Rew and Pokorny (2006). Assessing populations using this method is ideal for large areas where relatively little is known about the location and extent of species populations, and existing knowledge is based on informal or casual observations from other field efforts (Rew and Pokorny 2006).

Field surveyors will observe target species and collect data to document the general distribution of species at survey locations accessible by land. For survey locations associated with Project reservoir shorelines and riparian margins of the Skagit River where land access is impractical or unsafe, surveys will be conducted visually via boat. Invasive plant species presence will also be noted incidentally during fieldwork for other studies. Scientific and common names for all species will conform to the nomenclature found in the Flora of the Pacific Northwest 2nd Edition (Hitchcock and Cronquist 2018).

The data collected will follow the minimum mapping standards for invasive plants, as established by the Mapping Standards Committee of the North American Invasive Species Management Association (NAISMA 2020). Specifically, when target invasive plants are observed in the study area the following information will be collected:

- Species
- Location
- Estimation of extent of area infested by the species:
    - A polygon of the general distribution of the species will be mapped using Geographic Information System (GIS) (desktop) or Global Positioning System (GPS) (in the field). For example, any large infestations of woody invasive species within the managed portions of the transmission line may be observed using aerial imagery.
    - Stem density and/or percent cover would be recorded, as appropriate. For example, an ocular estimate of percent cover for woody species while a stem count in a subset of the population may be more appropriate for herbaceous species.
    - Ubiquitous or widespread species (e.g., St. Johnswort [*Hypericum perforatum*]) will be noted as observed, and described more generally, with specific reference to nearby Project features, unless an occurrence is unusual or novel, where more detailed information will be gathered.
- General habitat type (i.e., mixed conifer forest, wet meadow, etc.), and the level of existing ground disturbance.
- Representative photographs of the species and its habitat (one set per species).
- Pathways or disturbance due to Project O&M and Project-related recreation activities observed in the vicinity of the occurrence that have a potential to spread invasive plant species (e.g., recreational trails and uses).
- Estimated phenology and descriptions of reproductive state of that invasive plant occurrence.

2.6.5 Step 5 – Process Data and Provide Data QA/QC

Following field surveys, maps will be developed depicting all target invasive plant occurrences and Project facilities. Field data will then be subject to QA/QC procedures, including spot-checks of transcription or a digital application with integrated QA/QC review and comparison of GIS maps with field notes to verify locations of mapped occurrences.

2.6.6 Step 6 – Prepare Report

A report will be developed and will include GIS maps that show each target invasive plant occurrence and all Project features. The report will also include a list of observed ubiquitous or widespread species which will include a population estimate observed in the Project. Finally, the report will include likely disturbance or pathways for the target invasive plant occurrences.

2.7 Consistency with Generally Accepted Scientific Practice

The methodology for this study plan conforms to the Survey Protocols for Survey and Manage Strategy 2 Vascular Plants (Whiteaker et al. 1998) and Inventory and Survey Methods for Nonindigenous Plant Species (Rew and Pokorny 2006), which is an approved scientific method used for conducting invasive plant surveys in Washington.

2.8 Schedule

- Field Work – April to November 2021
- Analysis – June to December 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $155,000.

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INVASIVE PLANTS
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	05/26/2020	Section 1.2 Relicensing Process	1st Paragraph – Add: consultation Delete: effort	Change made in different location of sentence and paragraph. Text modified to include discussion and consultation.
2.	Judy Neibauer (USFWS)	05/22/2020	Section 1.3 Study Plan Development	1st Paragraph – Add: identifies that Delete: which suggests Delete: may	One edit made to add requested language. Other edit not incorporated.
3.	Judy Neibauer (USFWS)	05/22/2020	Section 1.3 Study Plan Development	You probably already know that your operations, roads worksites, etc contribute to invasive plants from your current operations. Mention that here.	City Light is conducting the Invasive Plant study to determine where Project operations may affect invasive species; the purpose of the study is to identify those sites.
4.	Brock Applegate (WDFW)	05/26/2020	Section 1.3 Study Plan Development	I agree with the good edits by Judy. At the very least, SCL's company trucks provide an invasive weed vector throughout the road system that they need to address. In addition, the ongoing operation of the project encourages reed canarygrass in the fluctuation zone. The fluctuation zone acts as a source population for the spread of invasive reed canarygrass throughout the waterways and wetlands, including the reservoir backflow up tributaries, and causes habitat degradation.	See response to Comment #3.
5.	Judy Neibauer (USFWS)	05/22/2020	Section 2.1 Study Goals and Objectives	I looked in the issue forms for other non-native species, but did not see any other studies…Is there a study for other invasive species…fish and wildlife? I know there are issues with fish, not sure about any wildlife…are there nutria in the project boundary? If so there should be a study plan to identify numbers, locations, etc. for at lease non-native fish. Share this comment or link to a study with the Fish & Aquatics work group.	Thank you for your comment. The Invasive Plants study plan focuses on terrestrial plant species; invasive aquatic and wildlife species are outside the scope of this study. As referenced and described in the PAD (Section 5.4.2; and agreed to by Steering Committee), City Light will address aquatic invasive species (AIS) in an AIS Management Plan (AISMP). The Special-Status Amphibian study and incidental sightings will document any American bullfrog detected by survey or

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					incidentally. City Light is not aware of any observations or documentation of invasive wildlife species in the Project Boundary. Bullfrogs have been documented in lower valley, but not in Project Boundary. City Light would appreciate any information on nutria, bullfrogs, and other invasive wildlife in the area.
6.	Brock Applegate (WDFW)	05/26/2020	Section 2.1 Study Goals and Objectives	I agree with Judy. LPs submitted invasive, non-native fish, brook trout, and invasive aquatic invertebrate study issue forms, so we should have a study plan somewhere.	See response to Comment #5.
7.	Stacy McDonough (NPS)	05/20/2020	Section 2.1 Study Goals and Objectives	MIG BIV - How will this be decided? Wil they onlyse use the state.county weed list. This is not sufficient because some invasivies are not listed by the state, we don't want any weeds in the park if possible. Are they accounting for climate change taht may fovor expansion of species that have an ecological advantage with a new climate	City Light will provide the LPs the opportunity to propose additional species to include on the target species list. City Light appreciates information regarding species of management concern to include that do not occur on the county weed lists. Results of the surveys will inform effects analysis in DLA and development of BMPs for the new license that could incorporate climate change.
8.	Shauna Hee (USFS)	05/21/2020	Section 2.1 Study Goals and Objectives	What are limiting factors for invasive plants? Do you mean actions that could be taken to limit introduction, establishment and spread?	"Limiting factors" refers to biotic and abiotic factors that limit populations or spread of invasive species.
9.	Brock Applegate (WDFW)	05/26/2020	Section 2.1 Study Goals and Objectives	I agree with Shauna. Please make this phrase clearer.	See response to Comment #8.
10.	Judy Neibauer (USFWS)	05/22/2020	Section 2.2 Resource Management Goals	When we do ESA consultations, for land management type activities, we typically have conservation measures for non-native species as well. I would say WDFW and the services have some resource management goals for the control of invasive. We have an invasive species plan for aquatic (i.e. mussels, snails, aquatic plants…)	Thank you for your comment. See response to Comment #5. In the interim, City Light follows BMPs to prevent boats and equipment from spreading invasive species.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				We would be concerned with boats and recreational gear transporting aquatic invasive species. Studying and or having some sort of a cleaning station would help with determining what species may be transported. Currently there is new guidelines for boat cleaning stations (see WDFW for regulations). This may soon become an issue in the water ways within the project boundary. FYI…western Montana geared up for invasive aquatic species invasions 5 years ago. More recently, Eastern WA and Idaho have within the Columbia Basin.	
11.	Brock Applegate (WDFW)	05/26/2020	Section 2.2 Resource Management Goals	WDFW recommends that SCL address the issue of aquatic invasive species here or in another study plan.	See responses to Comment #5 and #10.
12.	Shauna Hee (USFS)	05/21/2020	Section 2.2 Resource Management Goals	1st Paragraph – Add: inventory Delete: mapping	While City Light intends to map locations of invasive species associated with the Project, it is not feasible to do an "inventory", which would include a 100% coverage for all species.
13.	Shauna Hee (USFS)	05/21/2020	Section 2.2 Resource Management Goals	Amendments include the 2016 ROD for Invasive Plant Treatment on the MBS, 2005 DN for Treatment of Invasive Plants on the MBS, 2005 ROD Preventing and Managing Invasive Plants, and the 1999 DN Forest-Wide Noxious Weed Management.	Thank you, text has been updated.
14.	Shauna Hee (USFS)	05/21/2020	Section 2.2 Resource Management Goals	3rdst Paragraph – Delete: In 2005, an Environmental Assessment (EA) and corresponding decision notice on invasive plant control were issued for the Mt. Baker-Snoqualmie National Forest. Region 6 provides guidance in the Pacific Northwest Region's Invasive Plant Program Record of Decision. Region 6 policy on the use of native	Thank you, last sentence has been deleted and the provided additional information has been added to the text.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				and non-native plants is provided in USFS (1994); Mt. Baker-Snoqualmie National Forest guidelines on plant movement are provided in Potash and Aubry (1997).	
15.	Judy Neibauer (USFWS)	05/22/2020	Section 2.3 Background and Existing Information	Include other aquatic species,	See response to Comment #5 and/or #10
16.	Shauna Hee (USFS)	05/21/2020	Section 2.3 Background and Existing Information	The most recent lists should be used at the time of field data collection.	City Light will use most up to date lists for fieldwork.
17.	Shauna Hee (USFS)	05/21/2020	Section 2.3 Background and Existing Information	I'm not really sure what info. about nativeness you gleaned from the PNW Herbaria. I'm not aware of any herbarium records of native occurrences of PHAR3 in WA State. Please share information if you know otherwise. Although a native occurrence of PHAR3 was last collected in a remote location of Alaska in 1996, no native populations are known to exist in the lower 48. There is some evidence there were natives in Idaho, Wyoming, Montana and Minnesota pre-European settlement. I think it's a stretch to state there may be natives in the "study area". If there is question as to the native status of mapped occurrences within the study area, multiple samples can be taken from all of the sites and the study could include a genetic analysis. Or – the distribution and abundance of mapped occurrences could be used to infer "invasiveness". It is assumed that native populations did not have the same pernicious invasiveness as European cultivars (or they would be more widespread and common) or their hybrid progeny.	City Light has reviewed herbaria records back to the 1870s, in Western BC and Western WA – noted as dominant at Hozomeen on BC side in early 70s, records not far from Hope, from the 30s. It is certainly a native species, although it is possible that populations within the Project Boundary are an intraspecific hybrid. The functional behavior of the hybrid in the Puget lowland appears to be more aggressive. City Light is interested in managing for diversity (richness and evenness), and also needs to consider ecosystem services provided by PHAR3 before attempting complete eradication. This question deserves nuanced consideration about what we want to accomplish and what are possibilities. City Light may have an interest in managing PHAR3, but not a jump to a blanket herbicide approach. Regardless of its origin, City Light will consider the species in the study and in management, effectiveness and impact of management or control. City Light would consider focus on management for biodiversity

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					and ecosystem services, but not an automatic commitment to eradication of a native species.
18.	Brock Applegate (WDFW)	05/26/2020	Section 2.3 Background and Existing Information	Thank you Shauna, Native or non-native, SCL needs to address the propagation of reed canarygrass by their ongoing project operation and the degradation of wetlands, aquatic, and riparian habitat.	See response to Comment #17.
19.	Shauna Hee (USFS)	05/21/2020	Section 2.3 Background and Existing Information	Based on what criteria? There are numerous species that I suspect occur within the project boundary - such as Impatiens capensis and Myriophyllum spicatum – that are not on the list. Please disclose the information used to determine whether the species is known or suspected within the project boundary, in addition to justification as to why the remaining County/State species were not.	The species list was developed using the combined weed list of Skagit, Whatcom, and Snohomish County Weed Control Boards supplanted by NPS information and data from City Light from their work on the fish and wildlife mitigation lands, transmission line work, and coordination with agencies, Tribes, and NGOs on weed control in the Skagit valley of the past several decades. The two species specifically mentioned - *Impatiens capensis* and *Myriophyllum spicatum* - are both Class C species that do not require control and were not included in the target species list.
20.	Brock Applegate (WDFW)	05/26/2020	Section 2.3 Background and Existing Information	SCL probably needs to update their invasive plant list.	See response to Comment #19.
21.	Shauna Hee (USFS)	05/21/2020	Section 2.3 Background and Existing Information	Please use the same reference for scientific name and common name. Some of the taxonomy and common names cited are not widely used.	The scientific and common names follow *Flora of the Pacific Northwest, 2nd Edition* as listed by the Univ. of Washington Herbarium, except where quoting or listing from a reference that uses a different name. (WTU Herbarium: Giblin, D.E. & B.S. Legler (eds.). 2003+. WTU Image Collection Web Site: Vascular Plants, MacroFungi, & Lichenized Fungi of Washington State.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					University of Washington Herbarium. http://biology.burke.washington.edu/herbarium/imagecollection.php)
22.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	Per M Bivin this work was done nine years ago but written up in 2011. Weeds are moving targets and all the weeds should be recorded and re-evaluated	City Light appreciates any information NPS can provide on this topic.
23.	Stacy McDonough (NPS)	05/20/2020	Section 2.3 Background and Existing Information	M Bivinn updates to table added for species she has observed but does not have documentation	Thank you, edits accepted.
24.	Judy Neibauer (USFWS)	05/22/2020	Section 2.4 Project Operations and Effects on Resources	Aquatic Species ?	See response to Comment #5 and/or #10
25.	Shauna Hee (USFS)	05/21/2020	Section 2.4 Project Operations and Effects on Resources	Does this mean that project has a set of BMPs for the prevention or introduction and spread of invasive plants? If so, please cite the reference.	City Light does not have existing BMPs for prevention of introduction or spread of terrestrial invasive plants.
26.	Brock Applegate (WDFW)	05/26/2020	Section 2.4 Project Operations and Effects on Resources	I agree with Shauna. If SCL does not have BMPs for invasive weeds, then they should produce BMPs from this study plan.	BMPs may be part of a settlement agreement. City Light anticipates using information from this study to inform BMP development. See response to Comment #25.
27.	Judy Neibauer (USFWS)	05/22/2020	Section 2.5.1 Study Area	Does this include the reservoirs…if not, please increase the scope to include reservoir areas. This may involve Canada, as weed seed float across the border. Maybe think about development of an MOU to share data with Canada. Reservoir drawdown zones can be a source area for invasives. Reservoirs can be source areas for aquatic invasive plants, fish, invertebrates, etc. Other areas like transmission corridors,	The reservoir fluctuation zone and lands within the transmission line right-of-way are included in the study area. City Light will address aquatic invasive species in a Management Plan (see response to Comment #5). City Light will consider involving Canada in management considerations, however land in Canada is outside of the FERC boundary.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				restoration areas etc. are likely sources of invasive weeds, if not include already, please include those areas.	
28.	Brock Applegate (WDFW)	05/26/2020	Section 2.5.1 Study Area	I agree with Judy. Please include the entire reservoir system, mitigation lands, and ROWs	See response to Comments #27 and #29.
29.	Shauna Hee (USFS)	05/21/2020	Section 2.5.1 Study Area	1. Please confirm even though they are shown on the map – does this include all of the wildlife acquisitions and associated roads within them? Please list the migation parcels here. 2. If FS managed lands are within the study area… such as along the transmission line, then the MBS Invasive Plant Target List should be included. 3. Please include non-system access roads to the transmission line that are outside of the project boundary.	City Light will include lands within the Project Boundary, which includes fish and wildlife mitigation lands. These lands are shown in the study area maps. Please see details on mitigation parcels in the PAD. City Light appreciates any information on an Invasive Plant Target List for Mt. Baker-Snoqualmie National Forest. Project-related roads will be included in the study area, non-Project-related roads are not.
30.	Shauna Hee (USFS)	05/21/2020	Section 2.5.1 Study Area	Please define a distance in which invasive plants will be inventoried along the shoreline.	City Light will survey the area influenced by Project O&M: immediate river banks, connected channels, hydrologically connected wetlands. Invasive species will also be noted during the Wetland Assessment study.
31.	Shauna Hee (USFS)	05/21/2020	Section 2.5.1 Study Area	For the wildlife parcels, I would like an inventory of all sites that may have had disturbance or modification prior to acquisition. These sites may have weeds that are continuing to spread and degrade wildlife habitat even though no ongoing or future on the ground actions by the project are proposed.	City Light will survey for invasive plants in the study area to determine current extent of infestation based on potential Project-related disturbance or pathways due to Project O&M and Project-related recreational activities. Activities or disturbances that occurred on these parcels prior to acquisition are not Project-related, however, the surveys will assess current invasive plant extent.
32.	Judy Neibauer (USFWS)	05/22/2020	Section 2.6 Methodology	May need different methods for aquatic species	See responses to Comment #5 and/or #10.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
33.	Shauna Hee (USFS)	05/21/2020	Section 2.6 Methodology	Will incidental species not included on the target list but present on the State & County lists be inventoried?	City Light will survey for species on the target list; incidental observations of other species not on this target list or in other study plans is outside the scope of this study plan. If licensing participants recommend additional species, a valid assessment tool (e.g., Washington Invasive Species Council's (WISC) Invasive Species Impact and Prevention/Early Action Assessment Tool [WISC 2019] and Invasive Species Management Priorities grid [WISC 2017]) and existing information will be used to evaluate potential additions jointly with RWG to consider ecological and economic risks and control feasibility.
34.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1 Step 1 – Compile Information and Develop Target Species List	The FS also has existing info.	City Light would appreciate receiving any information related to this topic from LPs.
35.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.1.1 Compile and Review Existing Information	Per M Bivin - These surveys were conducted in 2000 and 2001	City Light appreciates the information.
36.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	See comment above about FS Invasive Plant list inclusion.	See response to Comment #29.
37.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	Why are Class C species not included? Although these species may be more widespread in WA State, they are not necessarily common outside of agricultural or urban areas. Field data collection would provide information on abundance and distribution within the project area. This	City Light has included some Class-C species. If licensing participants recommend additional species, a valid assessment tool (e.g., Washington Invasive Species Council's (WISC) Invasive Species Impact and Prevention/Early Action Assessment Tool

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				information would then be used to prioritize treatments.	[WISC 2019] and Invasive Species Management Priorities grid [WISC 2017]) and existing information will be used to evaluate potential additions jointly with RWG to consider ecological and economic risks and control feasibility.
38.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	I agree with Shauna's reasoning. SCL already has the large Class C species listed, reed canarygrass.	See response to Comment #37.
39.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	None of the examples are valid assessment tools for the project scale. Please provide a tool developed specifically for the project and add it as an attachment for review.	USFWS provides a commonly used construct for weed survey and management. See: https://www.fws.gov/invasives/staffTrainingModule/assessing/inventory.html The first step in the management program is a Reconnaissance Level Survey for areas that are large, where observations to date have been casual, and where basic weed occurrence data is needed. The result is a map of occurrences, relative densities, and priorities for follow-up work and control measures. City Light appreciates any information or proposed assessment methods to meet these needs.
40.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	This tool is to assess risk to WA state and not the appropriate scale for the project.	See response to Comment #39.
41.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	This requires s prioritization framework that has yet to be developed or proposed by SCL/RWG.	See response to Comment #39.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
42.	Shauna Hee (USFS)	05/21/2020	Section 2.6.1.2 Develop Target Invasive Plant Species List	If economic risk (is it really a risk?) is to be included in the evaluation, then please provide a weighted measure for each risk – and list all risks that would be considered. Will economic risk by 90% of the consideration vs. ecological risk 10%?	Economic risk refers to risk of potential impacts of invasive plant species to commercial recreational uses of resources (e.g., invasive plant is potentially toxic to livestock, not financial risk to City Light). Risk assessment will be conducted in a general manner.
43.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	At a minimum I think this should include potential areas and areas with in the project where know populations exist to ensure we have a handle on how large those populations are.	City Light will review existing information on invasive plant occurrence in the study area in order to inform prioritization of survey locations based on occurrence.
44.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	Please elaborate on how this applies to the shoreline/banks of the Skagit River? Will lands under private ownership be excluded? Please define local agencies. Are these city and county?	City Light will include riparian margins of the Skagit River downstream of Gorge Dam to the Sauk River confluence in the study area. Surveys will be conducted on City Light-owned lands and lands administered by federal, state, or local agencies (including city, county, etc.), and lands not privately-owned. Surveys on privately-owned lands are outside the scope of this study plan. If surveys are conducted via boat, occurrence will be noted and indicated as on private land.
45.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	There's a 50-foot buffer for some locations. How was this buffer determined? Please cite a reference used to determine buffer length. Is the buffer based on the longest distance a specific species could disburse based on XX vector?	The 50-ft buffer distance is a reasonable assumption for the effects of Project facilities and roads for the purpose of an RTE Plant survey. Mean seed rain decreases 5 meters from roads (Betz, J. A. 2019. Fire and Road disturbance Impacts on Forest Plant Species and Seed Rain in Table Mountain Fire Area, Kittitas County, Washington. Masters Thesis, Central Washington University, Ellensburg, WA) and the road effect on differences in plant composition was less than 5 meters in forested stands (Avon, Catherine, Berges, L., Dumas, Y., Dupouey J.L. 2010. Does the effect of forest

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					roads extend a few meters or more into the adjacent forest? A study on understory plant diversity in managed oak stands. Forest Ecology and Management. V. 259:8, 1546-1555).
46.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	Per Cheryl Decke - Big Beaver Wetland? I can't tell from the map if this is included but it really should be, and so should inland lakes and tributaries near Hozameen. They are not directly in the resivoir fluctuation zone, but the reservoir is the reason reed cadnary grass has infested these areas **New Comment from Brock Applegate (WDFW) provided on 06/23/2020:** Study area should include Big Beaver Creek and Wetlands. The source population of reed canarygrass from the reservoir has expanded upstream of Big Beaver Creek by tributary backflow, wind, or beaver. The infestation continues upstream in the creek and up to the wetland. Big Beaver Wetland has habitat degradation due to reed canarygrass and possible additional predation of native amphibians by larger fish that have fish passage due to the elevation of the reservoir. In the past 20 years, red side shiners have turned resident trout and bull trout more piscivorous, which increases their size. The larger fish can navigate the partial fish passage barrier easier and cause greater mortality on all life stages of special status amphibians that could frequent the wetlands: Federal listed species, Oregon spotted frog, State Candidate Species, the Columbia spotted frog and western toad, and other native species.	City Light has not received any evidence or mechanism of how Project operations are foreseeably spreading reed canarygrass to wetlands upstream of the Project in the Big Beaver Valley. The Project has no effect on the hydrology of these wetlands, which are located between about 0.85 to 2 miles from Ross Lake and above the normal maximum water surface elevation (NMWSE). City Light would appreciate any information or evidence regarding the reservoir as a source for reed canarygrass in Big Beaver Valley. **Response to comment provided on 06/23/2020:** See previous response above. Potential effects on amphibians in Big Beaver Valley are addressed in the Special-Status Amphibian Study.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
47.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	WDFW highly recommends that SCL include Big Beaver Wetland as the reed canarygrass population exists from reservoir, up the creek, and through the wetland.	See response to Comment #46.
48.	Stacy McDonough (NPS)	05/20/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	what is the reason for 50"?	See response to Comment #45.
49.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	I'd like to review a list of all roads and trails - and a map of the extent of each linear feature - in which surveys would occur listed in the plan. I would also like the opportunity to review and comment on the sites proposed.	City Light is currently reviewing information on roads in the Project Boundary and will add Project roads to the maps in an updated study plan. Locations to be surveyed for invasive species will be shared with the TRREWG before surveys begin.
50.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	Please provide a list and map of stated locations. Also - please see my comment above about including sites that were modified prior to SCL acquisition and about including roads. If ther are disperesed recreation sites on the parcels, these should be included too.	For comment regarding sites modified prior to City Light acquisition, please see response to Comment #31. See PAD for description of extent of mitigation lands. Non-motorized, day-use recreation is permitted in these areas, but recreation use is not a primary use of the transmission line corridor and mitigation lands. City Light will include areas on fish and wildlife mitigation lands with potential vectors for dispersal of invasive plants.
51.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	SCL should include all lands within the wildlife parcels. The presence of invasive weeds degrades habitat.	See responses to Comments #29 and #50.
52.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	What is the wildland interface? How is this area being defined? Is there a buffer/distance?	“Wildland interface” is the area where townsites, dams, powerhouses and other infrastructure meet or intermingle with

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					undeveloped wildland vegetation. The wildland interface effectively is the buffer and extends up to 50 feet.
53.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	Please include dispersed recreation sites within the project area. These are sites in which early introduction of invasives can occur.	See response to Comment #50.
54.	Shauna Hee (USFS)	05/21/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	Why not? Aerial imagery and spatial mapping apps can allow one to estimate infestation extent without field verification (trespassing), although the entire extent should be mapped if trespass is not an issue. Federal land is within and adjacent to a large portion of the project area. If O&M of the project lead to the introduction and spread of invasive plants outside of the project boundary, the project may be responsible for control of said infestation. Estimate of extent at the time of data collection would eliminate the need to revisit sites for additional information.	Where aerial photographs facilitate this, City Light will map extent of significant infestations.
55.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.2 Step 2 – Prioritize Survey Locations	SCL should document the extent of the infestation if easy to accomplish or if the infestation came from SCL's lands.	See response to Comment #54.
56.	Shauna Hee (USFS)	05/21/2020	Section 2.6.3 Step 3 – Gather Data and Prepare for Field Efforts	Please include a draft data sheet as an attachment to the document. I would like the opportunity to review and comment on the datasheet.	City Light will develop a datasheet and review with TRREWG at a later date prior to initiation of fieldwork.
57.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	The S&M Strategy 2 Survey Protocol is not a widely accepted method for surveying for invasive plants. This is not the appropriate survey method to use for invasives.	City Light will identify areas based on disturbance factors and habitat features where invasive plants are likely to occur, then will employ methods from Whiteaker et al. (1998), including random meander. The Survey and Manage Strategy 2 Survey Protocol is not the basis for this survey – see the above literature reference to the random

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					meander technique that will be used when visiting an area of invasive species interest. City Light appreciates any information on other methods or references to incorporate. Also see response to Comment #39.
58.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	The study is not assessing a large area. Occurrences are known within the study area. Inventories have occurred in the past. The study has already identified specific sites and 100% of these sites should be surveyed. The exploratory method is very coarse. Either the extensive or intensive survey method should be implemented.	Please provide any additional information regarding locations of invasive plant species. City Light finds the exploratory method appropriate for the needs and goals of the study. See the response to Comment #39.
59.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	How much of an area and how intensively will an area be surveyed?	Surveys will prioritize areas with Project-related effects and areas most likely to have invasive plant occurrence. Potential disturbance from Project facilities, recreation at City Light-owned facilities and operation, and vegetation management on the transmission line right-of-way will be used to define Project-related disturbances that can contribute to weed infestations.
60.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	What about now target species that are WA State Class A, B, & C species that weren't suspected in the project area… but are present?	Please see response to Comment #37.
61.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Please update all species names within this study to conform to this nomenclature.	Please see response to Comment #21.
62.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	The minimum standards basically describe the minimum amount of information one should collect when inventorying for invasive plants. So - the plan is proposing to collect the minimum amount of information. Although	Thank you for your comment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				this may speed up field work, it may not provide enough information to assess whether or not there are values at risk/impacts to natural processes or the ecological conditions present to prescribe an integrated treatment method. There can always be a revisit/remeasurement if additional information is needed.	
63.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	ArcPad is available for both GPS and tablets.	Thank you for your comment. City Light appreciates the information.
64.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	What are examples of the transmission line corridor that would not receive management actions within the next 50 years?	Areas where line clearance is sufficient and does not require vegetation management.
65.	Brock Applegate (WDFW)	05/26/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	WDFW would think that the transmission corridors receive mowing every 5 years or so.	See response to Comment #64. Not all areas on the transmission line right-of-way are mowed.
66.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	This makes me think that not all sites will receive field visits. Is this a correct assumption? How much of the transmission line will be field surveyed?	Areas that undergo vegetation management, which will be indicated on the map provided for review in early phases of study.
67.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Aerial observations are not adequate for mapping forbs. The start and stop of infestations within the transmission line should be mapped in the field?	Text revised to refer to “Large infestations of woody invasive species.”
68.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	What is the minimum mapping size for an infestation? What is the minimum percent infested mapping size for a polygon?	Minimum pixel size is 9 sq m, so any plant occurrence polygons smaller than 9 sq m will be indicated as a point. There is a longer technical explanation of why predictor models used for the vegetation mapping results in a minimum mapping unit larger than the minimum pixel size. Infestations density will be noted as a polygon or point as appropriate and the density, likely a

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					choice of 5 categories beginning with "trace" will be used.
69.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	All invasives should follow the same inventory protocol. Allowing different protocol for "locally abundant" species assumes that those species are not having an ecological impact to the infestation site. Species though to be widespread, and it is infeasible to control and there is low ecological risk should not be included in the target list.	City Light has an interest in information of widespread species. Thank you for your comment.
70.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Please include observations of herbivory and try to get photos of any insects on plants. Would be valuable to know if any biocontrols are present within the infestation.	City Light appreciates the comment. This is outside the scope of the study.
71.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Please include soil type and soil moisture. Plese include distance from standing water or potential standing water.	This is outside the scope of this study.
72.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	I don't understand how general habitat type crosswalks with the veg mapping study or the wetlands study Please provide an explanation. Also – how would the level of ground disturbance be measured and why is that important? Please include a list of associated species.	City Light will include a direct crosswalk from Vegetation Mapping and Wetland Assessment studies. Ground disturbance levels will be measured by estimate of percent bare soil in categories. Disturbance is important in relation to invasive species spread. Associated species will be addressed via general habitat type for vegetation and wetland studies.
73.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Where are voucher specimens not being collected? In some cases, species ID cannot be verified from photos.	City Light will collect voucher specimens for species that are unusual or unidentifiable in the field.
74.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Will a list of options be provided to surveyors? Will the surveyors have the knowledge for each	City Light will look for disturbance factors based on the observed O&M. Pathways refers to the Project-related feature that has potential

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				species reproductive/invasive biology to make this observation in the field?	to contribute to spread, not the biology of the species and how it propagates.
75.	Shauna Hee (USFS)	05/21/2020	Section 2.6.4 Step 4 – Conduct Field Surveys	Please provide an explanation has to why distance to the nearest project feature is important to record?	Deleted. Will list nearby Project features.
76.	Shauna Hee (USFS)	05/21/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	Please see my comments above.	See responses to comments as indicated above.
77.	Shauna Hee (USFS)	05/21/2020	Section 2.8 Schedule	Please use the State and Counties weed lists for 2021.	See response to Comment #16.
78.	Brock Applegate (WDFW)	05/26/2020	Section 2.8 Schedule	3rd Bullet – Add: Initial Study 4th Bullet – Add Initial Study Report Meeting - 2022	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis.
79.	Brock Applegate (WDFW)	06/23/2020	Section 2.5.1 Study Area	Study area should include Big Beaver Creek and Wetlands. The source population of reed canarygrass from the reservoir has expanded	Thank you for your comment. Please see response to Comment #46.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				upstream of Big Beaver Creek by tributary backflow, wind, or beaver. The infestation continues throughout the creek area up to the wetland. Big Beaver Wetland has habitat degradation by reed canarygrass and possible additional predation of native amphibians by larger fish that have fish passage due to the elevation of the reservoir. In the past 20 years, red side shiners have turned resident trout and bull trout more piscivorous, which increases their size. The larger fish can navigate the partial fish passage barrier easier and cause greater mortality on all life stages of special status amphibians that could frequent the wetlands: Federal listed species, Oregon spotted frog, State Candidate Species, the Columbia spotted frog and western toad, and other native species.	

TR-05 MARBLED MURRELET PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

BMP .....best management practice
City Light .....Seattle City Light
DNR .....(Washington) Department of Natural Resources
ELC .....Environmental Learning Center
ESA .....Endangered Species Act
FERC.....Federal Energy Regulatory Commission
FR.....Federal Register
HCP.....habitat conversation plan
hr .....hour
ISR .....Initial Study Report
km .....kilometer
LiDAR.....Light Detection and Ranging
LP.....licensing participant
m .....meter
mph .....miles per hour
NOAA .....National Oceanic and Atmospheric Administration
NPS .....National Park Service
NVCS.....National Vegetation Classification Standards
O&M .....operation and maintenance
PAD.....Pre-Application Document
PME .....protection, mitigation, and enhancement
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA .....Ross Lake National Recreation Area
RM .....river mile
ROW .....right-of-way
RWG .....Resource Work Group
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USFS .....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service

WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

The Marbled Murrelet Study will be used to establish whether marbled murrelets are present within the Project Boundary, where Project-related activities potentially affect suitable habitat or where Project-generated noise could affect nesting murrelets. This likelihood of presence data, along with analysis of habitat data from the Vegetation Mapping and Project Sound Assessment studies and other sources such as Light Detection and Ranging (LiDAR) data, will inform consultation with LPs and, as needed, the development of best management practices (BMP). Murrelets are listed under the federal Endangered Species Act (ESA) as threatened in Washington State and are listed as an endangered species by the State of Washington. This study addresses the TE17 Marbled Murrelet issue form.

On March 12, 2020, City Light released the Marbled Murrelet Draft Study Plan for LP review and comment. On March 17, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 29, 2020. The revised draft was discussed on May 6, 2020 at a TRREWG meeting. Written comments were received from Washington Department of Fish and Wildlife (WDFW), U.S. Forest Service (USFS), NPS, and U.S. Fish and Wildlife Service (USFWS) and responded to in an attachment to this study plan. By A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of the study are to map potentially suitable marbled murrelet nesting habitat within the study area and assess likelihood of marbled murrelet nesting. There have been limited surveys that have documented murrelet flights at several sites between Newhalem and Marblemount but no surveys have been conducted within the Project Boundary to determine if the species occurs this far inland from their marine habitat. However, a pair of murrelets were observed in 2017 on Ross Lake near Roland Point, which is 2.9 miles northeast of the Ross Lake Dam.

The objectives of the study are to:

- Develop map of potentially suitable nesting habitat within the study area using existing vegetation mapping data from the National Park Service, data developed for the Vegetation Mapping study, and criteria identified in the scientific literature to determine areas of potentially suitable murrelet nesting habitat and select appropriate locations for radar-based surveys to document murrelet flight activity upriver of Thornton Creek and along Project reservoirs, focusing on areas near Project facilities and existing and likely future maintenance and construction noise sources.
- Conduct limited habitat assessments to verify the accuracy of the mapping of potentially suitable marbled murrelet nesting habitat.
- Conduct peak nesting season (May-July) simultaneous radar and audio-visual surveys at selected sites to assess the likelihood of presence of marbled murrelets. If present, determine the relative abundance of birds at each survey site within the Project Boundary.

2.2 Resource Management Goals

The study will provide information needed to characterize potential Project effects on the marbled murrelet. Management goals related to marbled murrelet are described below.

- Seattle City Light

The goal of Seattle City Light is to gather information to determine the occurrence of marbled murrelets within the Project Boundary, and if they occur, to develop any best management practices to offset any identified Project-related effects to ensure long-term coordinated management of marbled murrelets during the new license period.

- U.S. Fish and Wildlife Service (USFWS)

The USFWS Marbled Murrelet Recovery Plan of September 1997 (USFWS 1997) states that the interim objective of the recovery plan is to stabilize marbled murrelet population sizes at or near current levels by: (1) maintaining and/or increasing productivity of the population as reflected by changes in total population size, the adult:juvenile ratio, and nesting success by maintaining and/or increasing marine and terrestrial habitat and by; and (2) removing and/or minimizing threats to survivorship, including mortality from gill-net fisheries and oil spills.

- U.S. Forest Service (USFS)

The stated objective of the Northwest Forest Plan is to maintain and restore nesting habitat conditions that would provide for viability of murrelet populations, well-distributed along their current range on federal lands (FEMAT 1993). The expectation was that the Plan "...would eventually provide substantially more suitable nesting habitat for murrelets than currently (in 1994) exists on federal lands" (USDA and USDI 1994).

- National Park Service (NPS)

The marbled murrelet is listed by NPS as an at-risk species in the North Cascades National Park Service Complex. All NPS management actions and projects are required to evaluate potential effects to murrelet habitat prior to implementation and follow applicable consultation with USFWS when appropriate. Preservation of murrelet habitat, such as old growth nesting trees around Ross, Diablo, and Gorge lakes, is resource management priority of the agency.

- Washington Department of Fish and Wildlife (WDFW)

The marbled murrelet was listed as threatened by the Washington State Fish and Wildlife Commission (Commission) in 1993 (Washington Administrative Code 232-12-001). "Without solutions that can effectively address the major threats in the short-term, it is likely the situation for Marbled Murrelets will only worsen and the species could be lost from some landscapes in the decades ahead. Therefore, our recommendation is to up-list the Marbled Murrelet to the status of a state endangered species in Washington" (Desimone 2016). The Commission upgraded the marbled murrelet on the list to "Endangered."

- Washington Department of Natural Resources (Washington DNR)

The Board of Natural Resources adopted a long-term conservation strategy for the marbled murrelet at its meeting on December 3, 2019 and a Final Amendment to the 1997 State Trust Lands Habitat Conservation Plan (HCP; Washington DNR 2019). The goal of the HCP amendment is to provide forest conditions in strategic locations on forested state trust lands that minimize and mitigate incidental take of marbled murrelets resulting from Washington DNR's forest management activities. In accomplishing this objective, Washington DNR expects to make a significant contribution to maintaining and protecting marbled murrelet populations. The intent of the Washington DNR's Habitat Conservation Plan is to improve current population trends through conservation and recruitment of additional nesting habitat on Washington DNR-managed lands.

2.3 Background and Existing Information

The marbled murrelet (*Brachyramphus marmoratus*) is a small seabird that inhabits the nearshore marine environment in western North America where it forages for small fish and zooplankton. The distribution of murrelets in Washington State includes the southern Salish Sea and the outer coast. It is unique among seabirds in that it will fly considerable distances inland during the breeding season to nest in old growth and mature coniferous forests. In Washington, marbled murrelets usually nest in older forests dominated by western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*) trees that have large branches that support substantial moss, epiphytes and debris to form platforms on which a single egg is laid (Hamer and Nelson 1995). Marbled murrelets exhibit strong

site fidelity to nesting areas, appear to nest in alternate years, on average, and have a naturally low reproductive rate (Desimone 2016).

The species was listed as threatened under ESA in 1992 in Washington, Oregon and California, primarily due to loss of old-growth forest nesting habitat from commercial timber harvesting and mortality associated with net fisheries and oil spills. The USFWS designated critical habitat for the marbled murrelet in 1996 (61 Federal Register [FR] 26255). The Project vicinity does not contain any designated critical habitat for marbled murrelet. Critical habitat is mapped approximately one mile south of the Bacon Creek confluence with the Skagit River (Project transmission lines cross near this confluence) and the Illabot Creek fish and wildlife mitigation land property (USFWS 2019a).

The species was also subsequently listed by the Washington Fish and Wildlife Commission as threatened in 1993. In 1997, the Washington Forest Practices Board enacted State Forest Practices Rules to address effects to murrelets from timber management on non-federal lands. At-sea population monitoring from 2001 to 2015 indicated a 4.4 percent decline in the murrelet population annually, which represents a 44 percent reduction since 2001. The 2015 population estimate for Washington is about 7,500 birds (Desimone 2016). In a 2016 status review by the Washington Department of Fish and Wildlife (WDFW), it was recommended to list the marbled murrelet as a state endangered species in Washington State (Desimone 2016). A review of its status by USFWS found that the California/Oregon/Washington marbled murrelet population is a distinct population segment that continues to be subject to a broad range of threats, such as nesting habitat loss, habitat fragmentation, and predation (USFWS 2009; USFWS 2019b). Based on this assessment, USFWS concluded in January 2010 that removing the species from the list of threatened species was not warranted (75 FR 3424).

The distance inland that marbled murrelets breed is variable and is influenced by several factors, including the availability of suitable habitat, climate, topography, predation rates, and maximum forage range (McShane et al. 2004). In Washington, the primary nesting range extends 40 miles inland, but occupied nesting habitat has been documented 52 miles from the coast (Hamer 1995; Madsen et al. 1999), and the species has been detected up to 70 miles inland (57 FR 15328). However, 90 percent of all observations have been within 37 miles of the coast in the northern Washington Cascades (57 FR 15328). Marbled murrelets typically nest in old-growth forests and select large, old trees with branches that support mats of epiphytes (McShane et al. 2004). Nesting in Washington occurs over an extended period from late April through late August (McShane et al. 2004). Incubation lasts about 30 days and chick rearing takes another 28 days.

The most downstream Project facility, the Gorge Powerhouse, is 54 miles straight-line distance from Puget Sound, which is beyond the 50-mile zone generally considered to be the farthest distance from saltwater for murrelets in Washington (USFWS 1997). Nonetheless, the Project does contain some suitably large trees and could possibly be used by murrelets for nesting. Within the Project Boundary, the fish and wildlife mitigation lands at Illabot Creek, Bacon Creek, and South Fork Nooksack and forests adjacent to the transmission line also contain some patches of large conifer trees that could provide potential habitat. These parcels range 20-45 miles from Puget Sound. An assessment of a small portion of the Nooksack parcel found a patch of trees >32 inches diameter at breast height with potentially suitable nest platforms based on Washington DNR survey methodology.

In May and June 2008, pre-dawn radar surveys recorded detections of possible marbled murrelets flying along the Skagit River near the mouths of Bacon, Thornton, and Damnation creeks (Hamer Environmental 2010). The Thornton Creek survey site is approximately 2 miles from the Gorge Powerhouse. Eleven of the flight path detections were very close to the Bacon Creek mitigation lands, but all were high-speed flights indicative of birds passing through as opposed to flights near nest sites. Follow-up ground-based surveys in 2009 detected murrelet-like audio-visual observations 1.5 miles up the Thornton Creek drainage but failed to detect any possible murrelet activity at survey stations 4.6 miles up the Bacon Creek drainage (Hamer Environmental 2010). Additional survey effort would be necessary to verify actual murrelet use in these drainages.

Surveys for marbled murrelets have not been conducted on Gorge, Diablo, or Ross lakes. NPS records show few visitor or staff sighting records of this species in the RLNRA. However, NPS staff observed a pair of murrelets on Ross Lake in 2017, near Roland Point (Ransom 2019). Roland Point is 2.9 miles northeast of the Ross Lake Dam. Murrelets have been documented foraging on inland freshwater lakes in Alaska, British Columbia, Washington, and Oregon. In Washington they have been documented using Lake Washington near Seattle and Lake Quinault on the Olympic Peninsula. In British Columbia, most freshwater lakes used by murrelets were within 12 miles of the coast, but use did extend to inland lakes up to 46 miles from the coast (Carter and Sealy 1986).

2.4 Project Operations and Effects on Resources

The USFWS has previously completed analyses of the potential for disturbance to murrelets (USFWS 2003; USFWS 2006) and has concluded that project noise or activities can disrupt normal murrelet nesting behaviors in some situations. The USFWS considered significant disturbance to occur when project noise or activity causes a murrelet to become so agitated that it flushes away from an active nest site or aborts a feeding attempt during incubation or brooding of nestlings (USFWS 2003). They defined a flush from a nest site as including movement out of an actual nest, off the nest branch, and away from a branch of a tree within suitable habitat during the nesting season. Such events were considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles and adults (USFWS 2003).

The USFWS (2006) analysis grouped potential exposures of nesting murrelets to noise and human activity into three categories: (1) aircraft noise (helicopters and planes); (2) ground-based continuous noise and human activity (e.g., chainsaws, heavy equipment) and; (3) impulsive noise (pile-driving and blasting). It concluded that under certain scenarios these activities could result in significant disruptions of normal behaviors that result in a likelihood of injury to marbled murrelets. Behavioral responses considered significant were: (1) an adult murrelet flushing from a nest or perch within the vicinity of a nest site, including delay or avoidance in nest establishment; and (2) an adult murrelet delaying or aborting one or more feedings of nestlings. The analysis found that these behaviors were likely to occur when: (1) aircraft noise exceeds 92 dBA SEL at a nest site, or aircraft approach within a distance of 100 meters (m)(110 yards), whichever is greater and; and (2) ground-based activity occurs during the nesting season within 100 m (110 yards) of a nest site (USFWS 2006).

Project operation and maintenance (O&M) activities and recreation may affect nesting murrelets if they occur in the vicinity of murrelet nests. Project-related noise disturbance could include the operation of heavy equipment and loud tools, such as chainsaws, used for maintenance of

structures, utilities, and roads. In addition, vegetation management activities have the potential to disturb wildlife. For marbled murrelets, these noise effects would likely be greatest during the breeding season which is defined by the USFWS as April 1 to September 23 for Washington State (USFWS 2012). Boat traffic also generates short-term disturbances, which might affect wildlife. Some boat noise occurs on Diablo Lake from operating the barge and crew ferry and on Ross Lake from research boats and seasonal work boats collecting floating driftwood. However, the majority of boat use on Ross Lake is related to recreation and NPS management activities.

In addition, City Light uses helicopters to visually inspect the transmission line towers. During these occasional inspections the machine only hovers if potential structural problems are noted, which is rare. Project-related snow surveys, conducted by helicopter for two days each month from the end of December through early May, also generate noise, which is most noticeable at take-off and landing in Newhalem and at the snow course stations, and during ascents and descents in the Gorge bypass reach area. Noise from helicopters has the potential to affect wildlife in and around the Newhalem area and in the Gorge bypass reach but the frequency of occurrence is low and intermittent and mostly at a time of year when marbled murrelet use in these areas is relatively low, and is largely outside of the nesting season. City Light consults with the NPS and USFWS to determine potential noise effects on listed species if helicopter use is needed for maintenance projects outside the winter season. If possible, helicopter use for Project-related work is scheduled to avoid the breeding and rearing season for most birds (April through August).

2.5 Study Area

The study area will include lands within the Project Boundary (Figure 2.5-1) and a 0.5-mile buffer area with an emphasis on locations where potentially suitable marbled murrelet habitat and potential Project effects intersect. This will include the lands around the Project reservoirs (Ross, Diablo, and Gorge lakes) and facilities, the transmission line right-of-way (ROW), and fish and wildlife mitigation lands.

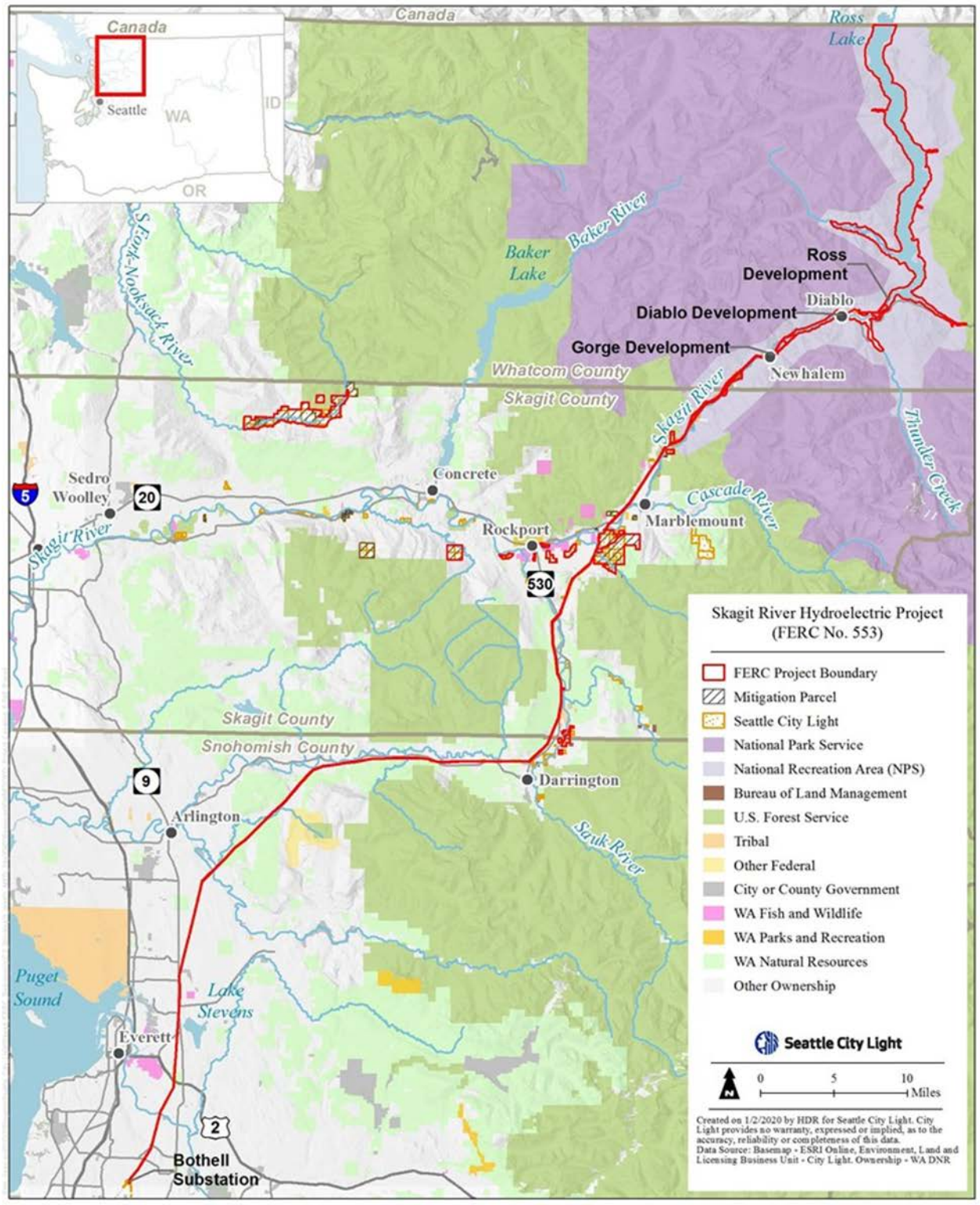

Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

2.6.1 Map Potential Marbled Murrelet Nesting Habitat

NPS has mapped vegetation associations within the North Cascades National Park using the National Vegetation Classification Standards (NVCS). These data will be reviewed to determine those mapped vegetation association units in the study area that meet potential marbled murrelet habitat criteria. Old growth forest will be the primary indicator used for this effort. LiDAR-derived variables (tree height) will be used to refine the extent of potential murrelet habitat. Vegetation within the study area outside of the North Cascades National Park will be mapped as part of the Vegetation Mapping Study. These areas will be mapped using NVCS to the association level. These data, along with LiDAR-derived tree height data will be used to map potential murrelet habitat. Limited field verification during the Vegetation Mapping and the Wetland Assessment studies will provide additional refinement of the initial murrelet habitat maps, providing information on the availability of suitable limb nesting platforms. These maps will assist in selecting radar survey stations that scan or are located near suitable nesting habitat in the vicinity of Project noise sources, thus increasing the likelihood of detecting nesting marbled murrelets.

2.6.2 Conduct Limited Ground Surveys to Verify Accuracy of Habitat Mapping

If deemed necessary, using some of the methods outlined in the Vegetation Mapping Study, we will also conduct limited habitat assessments to verify the accuracy of the mapping of suitable marbled murrelet nesting habitat in areas to be surveyed by radar for marbled murrelets. We will use two biologists to sample and conduct a rapid assessment of representative sites (up to 5 days field effort) to verify accuracy of the mapping of murrelet nesting habitat. A 25-m radius plot will be conducted in each stand and information collected on potential nest platform abundance. A platform is a relatively flat surface at least 10 centimeters (4 inches) in diameter and 10 m (33 feet) high in the live crown of a coniferous tree. Platforms can be created by a wide bare branch, moss or lichen covering a branch, dwarf mistletoe, witches brooms, other deformities, or other structures (Evans Mack et al. 2003). We will also collect information on average percent moss cover on tree limbs, average moss depth on tree limbs, presence of dwarf mistletoe, tree species composition, tree diameters, and an assessment of flight access for murrelets to nest platforms. At least 5 stands could be sampled per day or a total of ~25 stands during the week.

2.6.3 Radar and Audio-Visual Surveys

2.6.3.1 Choosing Radar Survey Locations

Radar survey locations will be chosen using four criteria: (1) within the Project Boundary where O&M activities may have the highest likelihood of affecting nesting marbled murrelets if present; (2) presence of suitable marbled murrelet nesting habitat; (3) presence of a major river valley or reservoir which could be used as potential flight corridors; and (4) suitability to detect birds using ornithological radar. The radar survey locations will not include the wildlife mitigation lands as there are no disturbance sources on these parcels.

Using the criteria above, the radar study will include horizontal radar sampling at one location near Hozomeen Campground on Ross Lake (using radars mounted on a boat), one location near Roland Point on Ross Lake (by boat), one site on Ross Lake near Ross Lake Resort above Ross Lake Dam (by boat), two sites adjacent to Diablo Lake (using a radar utility trailer as a radar lab), one site 400 m west of Diablo Dam, two sites along Gorge Lake, and one site at Newhalem. Therefore, a

total of nine sites will be sampled. Preliminary radar sampling station locations have been proposed based on occurrence of suitable habitat, intersection with potential effect vectors, sampling efficiency, and logistics (Figure 2.6-1). These locations will be further refined as described in the methods. Final radar survey locations will be chosen in the field and will depend on site access, safety, logistics, and suitability in detecting birds.

2.6.3.2 Radar and Audio-Visual Survey Methods

In the first radar study of marbled murrelets in northern California, Hamer et al. (1995) determined that radar was a useful tool to detect and monitor marbled murrelets at inland sites as they transited to nest sites from the marine environment. Craig et al. (2016) conducted a study testing three different methods for monitoring *Brachyramphus* murrelets breeding in the Kodiak Archipelago, Alaska. These included standard audio-visual surveys, radar surveys, and autonomous acoustic recorders for monitoring vocal activity. They found that of the three methods, radar sampled the largest area and detected silently flying murrelets, thus providing the most reliable data on local populations. In addition, Cooper et al. (2008) conducted a 3-year study and chose to use a combination of ornithological radar and standard audio-visual surveys to collect baseline information on distribution and abundance of marbled murrelets in the Cedar River Municipal Watershed in Washington during 2005-2007. The monitoring of murrelets using radar methods is also described in the 2003 Pacific Seabird Group Marbled Murrelet Survey Protocol (Cooper and Hamer 2003).

Radar can supply information on the murrelets' flight path and flight behavior, flight direction of targets to the nearest degree, number of targets, and the distance from the radar to the target to the nearest meter (Hamer et al. 1995, Cooper and Hamer 2003). All of this information is critical in determining where birds are headed, which forest stands are likely being used, and the relative abundance of birds in the area. Thus, the quality and usefulness of the survey information collected by radar is much higher than data produced by the audio-visual ground survey protocol (Cooper and Hamer 2003). Radar also improves survey efficiency because it reliably samples a much larger area (up to a 1,500 m radius) than audio-visual observers (less than 100 m radius for visual detections) (Hamer et al. 1995). Maximal distances of detection of birds by the radar depends on body size of the birds, flock size, flight profile of the birds, distance between flying birds, atmospheric conditions, and, to some extent, the amount and location of ground clutter. Marbled murrelets are usually detectable to at least a 1.5-kilometer (km) radius, whereas single, small passerines are detectable to ~1 km (Cooper et al. 2001). However, if murrelets are detected by radar, audio-visual surveys would still be necessary to determine if a particular stand is 'occupied' by nesting murrelets. Because radar energy cannot penetrate forest vegetation, it generally cannot be used to determine whether a specific stand is being used by nesting marbled murrelets (Hamer et al. 1995; Cooper and Hamer 2003).

Murrelets are primarily identified on radar by their flight speed, which tends to be greater than most other species (Hamer et al. 1995). There are individual sites, however, that can have problematic species present, like band-tailed pigeons or waterfowl that can fly at speeds similar to those of murrelets. Therefore, it is important that concurrent audio-visual observations (at the radar lab) and radar observations be made to assess the relative abundance of potentially confounding species and to help filter out non-murrelets from the radar database (Hamer et al. 1995; Cooper et al. 2001; Burger 2001).

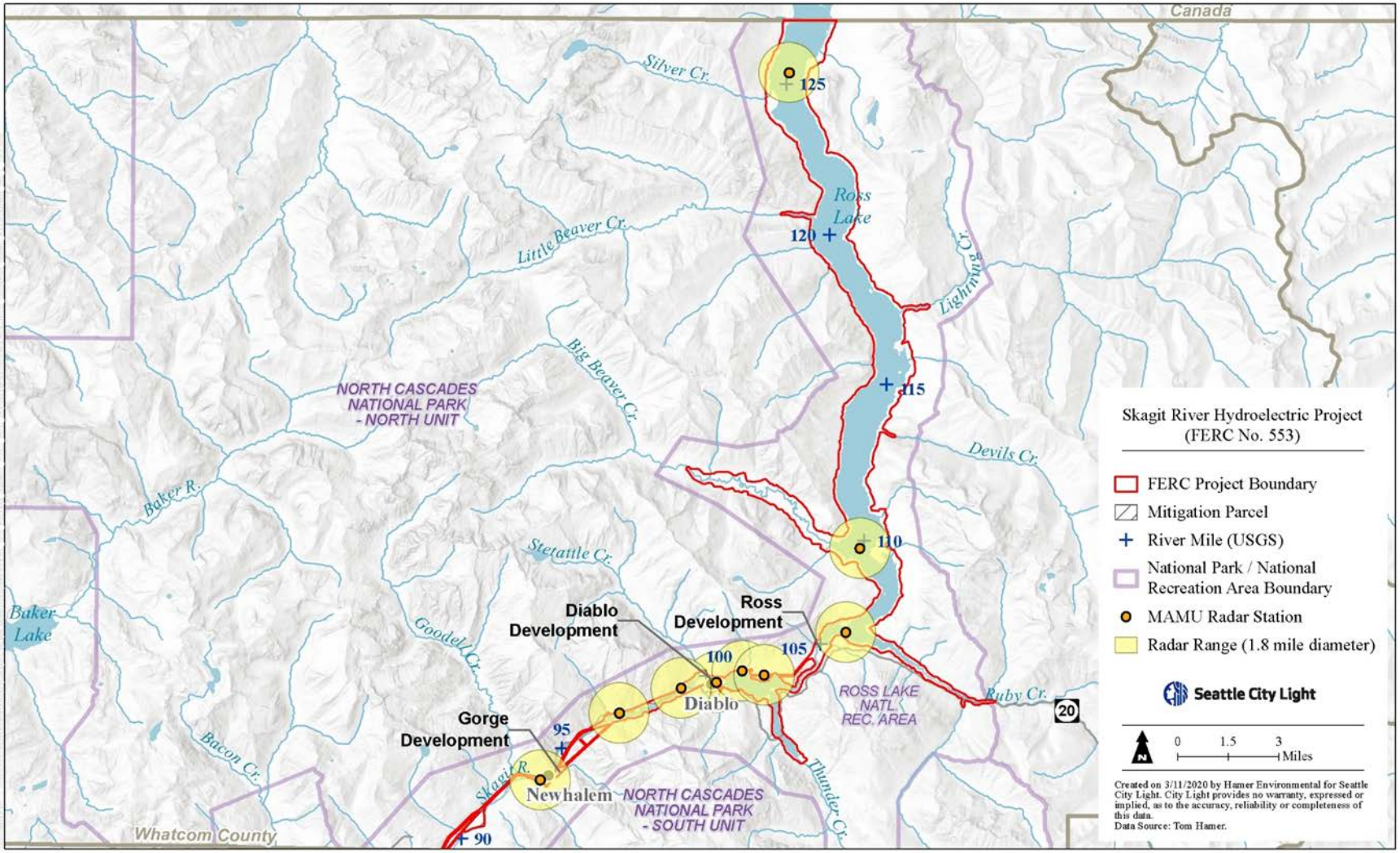

Figure 2.6-1. Preliminary proposed radar survey station locations (specific locations to be refined as described in Section 2.6.3.1 of this study plan).

Therefore, for this study, simultaneous radar and audio-visual surveys will be completed during the morning murrelet activity period beginning approximately 105 minutes before official sunrise and ending 75 minutes after sunrise for a total of 3 hours of sampling each day. This period encompasses the known peak of daily murrelet activity (Burger 1997). The audio-visual observer will be located just outside the radar unit and will attempt to verify the identification of each radar target. Sunset and sunrise times for each site will be obtained from the National Oceanic and Atmospheric Administration (NOAA) Sunrise/Sunset tables available for the nearest location.

Five radar and audio-visual surveys will be completed at each of nine sites for a total of 45 surveys. Surveys will be completed in May, June and July, the peak breeding season for marbled murrelets. One survey will be completed at each site in May, two in June, and two in July. The higher sampling intensity in June and July corresponds to higher probabilities of detecting marbled murrelets during the breeding season.

2.6.3.3 Ground Clutter Reduction

For terrestrial radar survey sites located near Ross Dam, Diablo Lake, and associated transmission lines, the ability to detect marbled murrelets with ornithological radar declines with increasing ground clutter. Ground clutter forms on the radar monitor when radar energy bounces off solid objects such as landforms, trees, buildings, etc. Ground clutter creates solid echoes on the radar monitor creating conditions where the echoes of individual flying birds cannot be seen. In order to reduce this ground clutter, radar station locations will be carefully selected and pre-tested with the radar system to ensure their suitability for detecting marbled murrelets. In areas where ground clutter may be an issue, many natural landforms (low berms) and surrounding vegetation (hedgerows or lines of low trees) will be used to create a "radar fence" that clips off the lowest portion of the radar beam and creates a ground clutter-free air space beyond where murrelet targets can then be accurately detected and tracked. Hamer Environmental horizontal radar systems have also been modified to significantly reduce ground clutter. In areas where a radar fence is not available, our radar units have a built-in ground clutter reduction screen that is adjustable in 5° increments and can be raised to clip off the lowest portion of the beam and create clutter-free air space beyond. In addition, our radar systems are built so that the radar antennas can be tilted upwards, and thus focus energy in the sky where birds are flying and lessen the amount of energy hitting or scanning the ground or surrounding landforms. Hamer Environmental radar antennas can be tilted in 5° increments from 0° to 60°. Radar survey station locations will be chosen that allow access for the radar lab and to maximize the surveillance area of the radar.

For the aquatic sites that will be surveyed by boat on Ross Lake, sites will be chosen on the lake where the boat and radars will be somewhat protected by wind and waves to minimize wave clutter on the radar monitors. Thus, areas protected from wind by ridges and other landforms, such as behind spits and in bays, will be chosen as radar survey locations. Standing waves created by wind reflect energy back to the radar causing "wave clutter" on the radar screen. Lake sites will also be chosen to maximize the area of wave and ground clutter-free air space beyond where murrelet targets can then be accurately detected and tracked. We will also use our ground clutter reduction screens and radar tilt modifications to further reduce any clutter at these survey stations. Radars were built to work on water so that the lake sites should experience much lower clutter issues than terrestrial sites. Both lake and terrestrial sites will be chosen so that the radars are scanning areas

that are likely to be flight corridors or areas with suitable marbled murrelet habitat to increase our chance of detecting marbled murrelets.

2.6.3.4 Radar Equipment

Radar tracking in horizontal (surveillance) mode will be performed using high-frequency marine radars (Furuno Model FR-1510 Mark 3 and Furuno Model 2117, Furuno Electric Company, Nishinomiya, Japan) transmitting at 9,410 megahertz (MHz) ±30 MHz (i.e., X-band) with 2 m-long slotted wave guide antennas with peak power output of 12 kW. Target detection will be enhanced by sophisticated signal processing techniques Furuno employs, such as the radar interference rejecter, which reduces the amount of noise received by the radar, while not affecting the resolution of targets being detected.

The radar antennas have a beam width for the vertical span of 20° and a horizontal beam width of 1.23°. To enhance detection of small targets and discrimination between close targets, the pulse length will be set to 0.07 microsecond when operating the units within the 0.25 to 3 km (0.16 to 1.86-mile) ranges. The shorter pulse allows better definition of small targets and increased range resolution. Range resolution is a measure of the capability of the radar to detect separation between targets on the same bearing with small differences in range. Maximum detection range capability can be reduced when using the shorter pulse length, but better target definition and range accuracy allow for more accurate assessments of bird passage rates and behavior, justifying some reduction in range. Range accuracy was 1 percent of the maximum range of the scale in use, or 30 m (98 feet), whichever was greater.

The horizontal scanning radar will be operated at a range of 1.5 km (0.9-mile) radius. The unit will be mounted on a motorized boat that will be docked on Ross Lake at the Ross Lake Resort. A gasoline or propane powered generator will provide power to each radar unit and associated computers.

2.6.3.5 Radar Tracking Software

Horizontal (surveillance) radars will be operated each sampling morning. The horizontal (surveillance) radar antenna rotates and scans the horizon once every 2.5 seconds. With each rotation the radar monitor displays an echo of the targets being tracked. Echoes on the radar display will be retained for 30 seconds resulting in a trail of echoes as the targets moved, which will enable the flight paths of all birds to be plotted. Because the radar rotates at fixed time intervals, the distance between adjacent echoes is directly proportional to the ground speed of the targets. Therefore, the speed of the target can be calculated by measuring the distance between echoes. Echoes farther apart indicated faster moving targets. The horizontal radar will collect information on flight direction, flight behavior (straight, arcing or circling flight path), overall flight path, movement rates (targets/hour, targets/morning), relative body size, and the ground speed of birds (km/hour [hr]). To plot the flight paths of each bird, the x and y coordinate of each echo will be recorded by the software.

Raw output (video, trigger pulse, ships heading marker, and bearing pulse) from the radar will be collected using a dedicated computer. Each sweep of the radar and associated echoes will be stored as a single digital archive file. All the sweeps from a given survey period will be archived together

in a single folder on an external hard drive, which will be cloned to a separate hard drive at the end of each morning for data back-up.

Echoes on the radar screen will be recorded for the duration of each morning survey using digital radar technologies and automatic tracking software. Automated data collection and software analysis systems allow permanent digital storage of all radar data along with replay or re-analysis of the data from any morning at any time. After the removal of any clutter (non-moving objects) from the screen, detections of moving targets will be processed. As in other studies, the term "target" will be used to describe birds detected by radar because the species composition and size of a group of birds is usually unknown. For the horizontal radar, for each detection of a target, automated software will record the date, detection time, flight speed, echo size (targets can be filtered by several measures of size including radial span, angular span, perimeter and/or area), echo shape, number of echoes, echo locations, distance between each echo, flight direction and reflectivity (a measure of the strength of each echo).

All radars have a corona-effect, where radar signal interference creates clutter within a small area immediately surrounding the radar location, and effectively masking any target detections. The corona-effect for this study will include a 200 to 250 m radius area surrounding each radar site location. Thus, no targets will likely be detected with ranges <200 m from the radar.

Target Tracks and Filtering

Individual targets will be tracked over time using a complex multi-frame correspondence model. A minimum of four echoes will be needed before a target's flight path will be tracked and recorded by the software to help eliminate non-murrelet targets and to achieve higher accuracy of speed and flight direction measurements. The resulting tracks will then be filtered based on flight speed and echo reflectivity to exclude insects and smaller avian targets. Under ideal conditions murrelet type targets can be detected up to 1,500 m away from the radar.

Murrelet type targets detected on radar will be distinguished from other avian species by the target timing of activity, flight speed, flight direction, and body size. The most important discriminating factor will be the timing of activity. For birds flying in an inbound-outbound direction from saltwater, the earlier the detection before sunrise, the higher the likelihood that the detection is a marbled murrelet. The one species usually confused with murrelets, band-tailed pigeons, usually do not become active until 20 minutes after sunrise (Colclazier et al. 2010) and no other shorebird or seabird would be as likely to be flying inland as early as a marbled murrelet.

An additional factor we will use in determining the likelihood of a target being a marbled murrelet will be flight speed. The faster the flight speeds of targets flying inbound or outbound towards the ocean over the threshold of 40 miles per hour (mph) the more likely the species is a marbled murrelet (Cooper and Hamer 2003). Murrelet flight speeds can range from 40 mph to over 70 mph. In a 2010 radar study in North Cascades National Park (Hamer Environmental 2010), murrelet-type targets had an average speed of 84.92 km/hr (50.85 mph) with the fastest targets recorded at 130.26 km/hr (78 mph). In general, the faster the flight speed the more likely the target could be a marbled murrelet. At inland sites, Hamer et al. (1995) found the only other common inland species of similar size and flight speed to the murrelet was the band-tailed pigeon (*Columba fasciata*), which overlapped at the lower end of murrelet flight speed. Only birds flying ≥40 mph (at the 1.5 km range) will be recorded as murrelets to minimize the number of non-murrelet targets recorded.

In addition, murrelet type targets will sometimes show a somewhat higher mean flight speed for outbound versus inbound flights. This discrepancy results from the murrelets losing altitude after visiting nest sites in the nearby hills and mountains as they descend back to sea level. Murrelets heading inland to nest sites usually have to gain some altitude to fly over nearby ridges and hills and this slows their flight speed. However, Craig et al. (2016) concluded that radar identification of murrelets was found to be more unreliable in winds exceeding 18 km/hr (11 mph). In a summary of radar methods, Cooper and Hamer (2003) recommended to only sample when average wind speeds were <25 km/hr (15 mph), so that slowly flying birds with tailwinds would not be counted as murrelet targets. Therefore, we will avoid sampling on days with higher wind speeds.

The more direct flight paths of murrelets along drainages and east-west flight directions on their way to and from marine waters will also help distinguish the murrelet from other species. Typically, detections are considered inbound if the target was headed inland within ±45° of an easterly direction (90°) and outbound if the target had a flight bearing within ±45° of a westerly direction (270°).

In addition to speed and flight direction, a marbled murrelet's compact body and relatively large muscle mass make comparatively large, round, echo sizes on the radar monitor. The timing of the detections will also be considered. Murrelets start flying inland as much as 105 minutes before sunrise when most other birds are not yet active (Cooper and Hamer 2003). Therefore, targets flying inland predawn are more likely to be murrelets. In addition, daily murrelet type detections will usually show a pulse of early inbound detections and then a pulse of outbound detections sometime later in the morning. The difference between the inbound and outbound flight times is due to the time it takes the birds to fly inland to exchange incubation duties and feed young along with the time it takes to return back to the ocean. These criteria, when considered together, assist in the identification of murrelet targets using radar and in the final assessment of whether a site has a likelihood of murrelet presence. Radar targets occurring before sunrise, with high flight speeds, showing roughly east-west flight patterns, large echo sizes and arriving in pulses of inbound and outbound detections have a much higher likelihood of being marbled murrelets than other similar radar targets (Hamer Environmental 2010).

2.6.3.6 Audio-visual Surveys

Simultaneous audio-visual surveys will be conducted adjacent to the radar unit to attempt to confirm the identification of radar targets. Since radar cannot absolutely determine species identification of targets detected, audio-visual surveys will assist in confirming radar detections as marbled murrelets. The Pacific Seabird Group Marbled Murrelet Survey Protocol (Evans Mack et al. 2003) methods for audio-visual surveys will be used to collect this data. All Hamer personnel working as audio-visual surveyors will be trained and certified to conduct marbled murrelet surveys at our week-long Prairie Creek Redwoods State Park training session in Northern California.

Data in the field will be recorded using hand-held digital recorders during surveys. On the digital files, the surveyors will note any murrelet detection and details of the observation, record survey start and end times, note any pertinent changes in weather conditions, and record detections of other species of concern. The audio-visual surveyor will be in radio contact with the radar technician. The radar technician will provide the surveyor with the distance and direction of radar targets to assist the observer with locating and identifying these avian targets. The data will be

transcribed onto standardized survey forms and if the target was also recorded by the radar, this will also be noted.

2.6.4 Data Analyses

2.6.4.1 Radar Counts and Passage Rates

Data will be analyzed by hour and by survey morning for the breeding season. Counts of murrelet type flight tracks during each sampling period will be summed. We will use these counts to calculate movement rates (targets/hr) based on the number of hours sampled in each period analyzed (per hour and per morning).

Radar passage rates are an index of the number of murrelet type targets flying over a location and can be used to assess the relative biological importance of sites being analyzed. Passage rates will be adjusted for minutes of lost data due to rain or other radar clutter during these time periods.

2.6.4.2 Flight Directions and Locations

Flight directions will be calculated for each radar target track by averaging the bearing of each echo within the track and then converting the final bearing to a cardinal direction based on the track echo x and y coordinates. Flight directions (degrees) for each track will then be summarized ORIANA 4.02 software (ORIANA 2013). Mean flight directions, 95 percent confidence intervals and standard error will also be calculated for all survey periods at each radar site.

2.6.4.3 Flight Paths

We will map all the target flight paths throughout each of the 1.5 km-radius survey areas for the entire breeding season sampling period. Flight tracks will be analyzed by plotting the average x and y coordinates of each track using ArcMap. All flight tracks will be plotted over maps of suitable habitat to help determine areas that could contain nesting murrelets.

2.6.4.4 Weather Data

Weather data will be collected by the radar operator each morning just before the start and end of each radar survey session. Weather variables collected will include wind speed (km/hr) using a hand-held wind meter, wind direction (degrees), cloud cover (percent), estimated ceiling height (m), minimum horizontal visibility (m), light condition (daylight, twilight, dark), precipitation, and air temperature (°C). It will not be possible to collect radar data during periods of heavy rain because the electronic filtering required to remove the echoes of the precipitation from the display screen also removes bird targets.

2.7 Consistency with Generally Accepted Scientific Practice

The study adheres to currently accepted scientific methods for evaluating marbled murrelet habitat suitability (Evans Mack et al. 2003), potential for noise disturbance, developing a radar and audio-visual sampling protocol (Burger 1997; Cooper et al. 2001; Hamer Environmental 2010; Evans Mack et al. 2003), analyzing potential Project effects (USFWS 2013), and developing appropriate PMEs (USFWS 2013).

2.8 Schedule

- Habitat Mapping, Ground-truthing, and Desktop Analysis – Spring 2021
- Field Work – April to July 31, 2021
- Analysis – September to November 30, 2021
- Final Report (Initial Study Report [ISR]) – March 2022

If 2021 is deemed a poor nesting season for marbled murrelets in Washington State, an additional year of radar and audio-visual surveys may be necessary in 2022. To help determine if a poor nesting year occurred, data will be reviewed from: (1) at-sea surveys of marbled murrelets off the coast of Oregon and Washington conducted by the USFS that collect data on the number of fledglings observed on the water; (2) data on frequency of nesting and nesting success from murrelet telemetry and nest monitoring study in Oregon by Oregon State University; (3) data on warm water events collected by NOAA (e.g., El Niño) and poor reproductive performance of related seabirds (common murres, etc.) off the coast of Washington (WDFW and USFWS) and; (4) results of inland audio-visual surveys being conducted at inland sites in Washington and Oregon (WDFW, Oregon Department of Forestry, and Oregon Department of Fish and Wildlife survey data).

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $207,000.

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MARBLED MURRELET PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	04/17/2020	Section 1.2 Relicensing Process	1st Paragraph Add: consultation Delete: effort	Change made in different location of sentence and paragraph. Text modified to include discussion and consultation.
2.	Brock Applegate (WDFW)	04/17/2020	Section 1.3 Study Plan Development	I am not sure that we can declare 100% absence of marbled murrelets. I would recommend that SCL remove the word or add a footnote with the error associated with a determination of absence, probably something more than 95% sure of absence.	Edit made: text changed to "This likelihood of presence data".
3.	Shauna Hee (USFS)	04/15/2020	Section 2.1 Study Goals and Objectives	What is the distance inland?	The distance from Roland point to the closest saltwater (Bellingham Bay) is 64.4 miles straight line distance.
4.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	I agree with Shauna. WDFW would recommend that SCL add a number of miles inland for this detection.	See response to Comment #3.
5.	Shauna Hee (USFS)	04/15/2020	Section 2.1 Study Goals and Objectives	Radar-based surveys seem appropriate for landscape investigation	City Light appreciates the input.
6.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	I agree, but not able to pinpoint nest areas, which SCL may want to do to find project operations effects on murrelets. Where would SCL apply marbled murrelet BMPs for further project operations, maintenance, and construction? I don't think this study plan will answer this question. **New comment provided on 05/05/2020:** I am not sure that you can pinpoint a breeding spot surrounded by 0.5 miles with this survey. How do you determine the location of a nest when you use this method? Does the sighting or detection of a migrating murrelet mean the nest resides closeby? I am not sure	The purpose and intent of the Marbled Murrelet Study is to determine where murrelet activity and potential occupancy is located in the study area (i.e., likelihood of presence) and where potential nesting habitat exists within 0.5 miles of locations where most Project noise generation occurs; not to determine occupancy in specific stands. This is a phased approach: 1) Conduct study to determine if and where murrelet activity is located in the study area using **Radar Surveys**, as described in Pacific Seabird Group Marbled Murrelet Protocol Surveys (Evans Mack et al. 2003) to identify

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				you can say anything other than a murrelet has flown by this detection point on the route to somewhere. I am just trying to help meet the objective for this study plan. Does SCL set a BMP for a large swath of land and place a 0.5-mile buffer around it? I am confused on how most of the time, SCL will have the ability to pinpoint an area to consider for BMPs, unless you will consider many acres. Does SCL have limited areas of possible nesting habitat? Please note that presence behaviors and occupied behaviors do not mean the same thing. Occupied behaviors do indicate the nest resides close. What will you do with the presence behaviors (non-circling above canopy activities)? Can SCL determine how far away the nesting area resides with a radar presence detection?	where occupancy is a possibility. Results to be reported in Initial Study Report (ISR). If activity is detected, then next steps will be determined based on those results: A) If likelihood of murrelet presence is extremely low, then ground surveys are unlikely to be needed to locate specific occupied sites. B) If consistent murrelet activity is detected by radar surveys in some areas, then follow up Pacific Seabird Group Protocol **Intensive Surveys** (Evans Mack et al. 2003) to determine probable absence or presence and occupancy of murrelets at a specific stand may be conducted for one or two years to find occupied sites (likely nesting areas) depending on potential for Project effects. (City Light could also assume occupancy for these sites and determine if best management practices (BMP) can be applied to avoid effects.) Radar surveys are appropriate for this first phase, especially given the size of the Project, as radar surveys detect murrelets over a significantly larger area and during dark periods, which is more effective at detecting murrelets than a single observer. The Pacific Seabird Group Survey Protocol does not determine nest locations, it only determines if birds are present in the canopy or not (occupied behaviors). If present, then there is a likelihood that birds are nesting in that forest patch or nearby.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					Response to comment provided on 05/05/2020: City Light appreciates your comments. Currently there is very little known about murrelet nesting activity in the upper portion of the Skagit watershed so this study is intended to be an initial assessment of likelihood of murrelet nesting activity in portions of the study area with potential Project noise but is not intended to pinpoint nest locations. Even audio/visual surveys do not locate nests. Each radar station will be located such that they cover the potentially suitable habitat out up to 1,500m from the radar so they will give good coverage. All of the detected flight paths will be assessed to determine if birds are preparing to fly into forest or if they are exhibiting directional flight which would mean they are likely nesting in a forest that is farther from the radar station. Given the great distance inland from marine foraging habitat, murrelet flight detections are a good indicator of nesting activity somewhere in the area. City Light will review the results of the study with the TRREWG to determine if any follow-up surveys beyond this study are warranted in certain areas to identify likely nesting stands, depending on potential for Project effects. (City Light could also assume occupancy for these sites and determine if BMPs can be applied to avoid effects.) The locations and characteristics of detections from this study and any follow-up surveys may be used to

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					assess any potential Project-related effects and then develop and inform BMPs. In some cases, nest stand identification might be necessary, but for most City Light activities, general location of potential nesting habitats will be sufficient to implement BMPs. For future new construction or vegetation clearing activities within a certain distance of suitable habitat, we would have a working assumption that the habitat is occupied until a protocol survey is conducted to verify absence.
7.	Shauna Hee (USFS)	04/15/2020	Section 2.1 Study Goals and Objectives	What protocol will be used in the audio-visual surveys? Please cite references. Would it be advantageous to schedule the combined audio-visual surveys after confirming murrelet presence with the radar surveys in area.	The audio-visual surveyor (observer) will be following the Pacific Seabird Group (PSG) Survey Protocol (Evans Mack et al. 2003) methods for audio-visual surveys. For second question, see response to Comment #6.
8.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	I agree with Shauna. Do we want to find areas of occupation? Usually if a surveyor can see the murrelets below canopy or circling behavior above canopy, a surveyor can infer that a certain amount of acreage has a nest somewhere. If SCL stops at presence or the majority of these radar detections, especially on the reservoir tributaries, we will know that a murrelet passed by on its way to somewhere. SCL will not have the ability to determine if noise from the project affects nests with just a presence determination, because SCL will have less accuracy on the location of the nest. **New comment provided on 05/05/2020:**	See response to Comment #6. **Response to comment provided on 05/05/2020:** See response to Comment #6. We would consider additional surveys if they are important for developing PMEs.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				See my responses to your response in # six. If you don't get occupied behaviors, the murrelet has flown by going somewhere. Can you determine where to conduct an intensive survey with a just a radar presence detection? I am not sure, but wonder about the probability of finding the location of the occupied area. Continued from the comment above on "When SCL receives radar presence (not occupied) detections): Do you move the radar farther up the reservoir next time? Let me give an example of what I am trying to say: When on the Coast, you can get many detections from murrelets flying by, but the murrelets may fly many miles before they get to the nest (occupied) area. How do you find the nest area with radar presence (not occupied) behavior detections? Do you just protect (invoke a BMP over) a larger area?	
9.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	In addition, SCL may need two years of surveys to better locate some murrelet nests, because a surveyor often finds presence, but cannot determine occupation.	See response to Comment #6.
10.	Brock Applegate (WDFW)	04/17/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Add: and potential future construction, operations, or maintenance areas that generate noise.	Future construction locations are very likely to be at existing facilities. Edit made: sentence modified to "…near Project facilities and existing and likely future maintenance construction noise sources."
11.	Brock Applegate (WDFW)	04/17/2020	Section 2.2 Resource Management Goals	SCL will need better locations of the nests, which more than likely will lead to two seasons of surveys or more. SCL could just assume occupation and develop management	See response to Comment #6.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				practices. I would assume that SCL will want to know the most precise and accurate information of the location of the nests for management purposes, hence the probability of two years or more of audio-visual surveys.	
12.	Brock Applegate (WDFW)	04/17/2020	Section 2.2 Resource Management Goals	After reading the methodology of the study plan, I don't think you will have the ability to answer this question because the radar study will basically detect the migration routes, not the actual nest areas. You would need audio-visual surveys for probably a few years to answer this question. Radar surveys will more than likely not provide specific enough information to identify project effects on murrelets, because SCL will not know the more specific locations of nesting areas.	See response to Comment #6.
13.	Brock Applegate (WDFW)	04/17/2020	Section 2.2 Resource Management Goals	See my comment above. How and how long you survey will depend on how accurate that you want the nest locations.	See response to Comment #6.
14.	Brock Applegate (WDFW)	04/17/2020	Section 2.2 Resource Management Goals	WDFW would expect that SCL would want more accurate nest locations to create BMPs for certain areas.	See response to Comment #6.
15.	Jason Ransom (NPS)	04/14/2020	Section 2.2 Resource Management Goals	2nd Bullet – Add: The marbled murrelet is listed by NPS as an at-risk species in the North Cascades National Park Service Complex. All NPS management actions and projects are required to evaluate potential impacts to murrelet habitat prior to implementation, and follow applicable consultation with USFWS when appropriate. Preservation of murrelet habitat, such as old growth nesting trees around Ross, Diablo, and Gorge reservoirs, is resource management priority of the agency.	Thank you for the information. Text revised to include the supplied information.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
16.	Brock Applegate (WDFW)	04/17/2020	Section 2.2 Resource Management Goals	3rd Bullet – Add: (Commission)_ Add: The Commission upgraded the marbled murrelet on the list to "Endangered."	Thank you for the information. Text revised to include the supplied information.
17.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	The background information has shown why SCL should conduct more than one year of survey. The marbled murrelets, presumably individually, nest every other year.	The adequacy of one year of radar surveys will be assessed at the end of Year 1 using the criteria outlined at the end of the study plan. If it was deemed a good breeding year, a second year of surveys are unlikely to shed additional light or change the results. Even non-breeding murrelets fly inland and not all murrelets are on the same alternating years schedule. Follow up Pacific Seabird Group Protocol **Intensive Surveys** (Evans Mack et al. 2003) to determine probable absence or presence and occupancy of murrelets at a specific stand may be conducted for one or two years to find occupied sites (likely nesting areas) depending on potential for Project effects. (City Light could also assume occupancy for these sites and determine if BMPs can be applied to avoid effects.)
18.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	I agree.	See response to Comment #17.
19.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	How do marble murrelets negotiate powerlines during flight? WDFW recommends that SCL investigate the probability of murrelet migration through their powerlines to the critical habitat.	The purpose and intent of the Marbled Murrelet Study is to determine where murrelet activity and potential occupancy is located in the study area (i.e., likelihood of presence) and where potential nesting habitat exists within 0.5 miles of locations where most Project noise generation occurs. The

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					habitat mapping will encompass the entire transmission line corridor. City Light has reviewed a number of scientific studies that indicate, in specific circumstances, there may be potential collision risks for murrelets posed by transmission lines. Based on information collected in this study, City Light will develop a transmission line collision risk model for murrelets for review with the License Participants during effects analysis.
20.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	Will SCL look at these areas for murrelets? Does SCL have concerns about powerline collisions? WDFW has noticed that SCL will conduct surveys, but do not see these areas listed on the map.	See response to Comment #19.
21.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	Could the murrelets migrate from hear up the Skagit River? Murrelets do fly over ridges sometimes.	Marbled murrelets could take many different flight paths to reach the study area, but murrelets are known to commonly follow drainages when transiting to and from nest sites, especially where topographic relief on each side of the drainage is high (>500 feet vertical).
22.	Judy Neibauer (USFWS)	04/17/2020	Section 2.3 Background and Existing Information	FYI…I there is historic info about a site just over the cascades I think near Cle Elum Reservoir…i.e., Snoqualmie Pass…	Thank you for your comment. We believe the WDFW database includes a detection of a murrelet just east of Snoqualmie Pass.
23.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	SCL will probably run into these same problems when they conduct their survey, especially just for one year.	See response to Comment #6.
24.	Brock Applegate (WDFW)	04/17/2020	Section 2.3 Background and Existing Information	These lakes reside much closer to the saltwater.	Thank you for your comment.
25.	Brock Applegate (WDFW)	04/17/2020	Section 2.5 Study Area	SCL should conduct surveys of their powerlines near suitable habitat.	See response to Comment #19.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
26.	Judy Neibauer (USFWS)	04/17/2020	Section 2.5 Study Area	I agree these areas should be included…Activities within and adjacent to powerline corridors and access roads can have effects.	See response to Comment #19.
27.	Shauna Hee (USFS)	04/15/2020	Section 2.5 Study Area	Are there any aquatic or other restoration projects planned for the mitigation lands (such as large woody debris placement in Illabot Creek per the 2006 Management Plan)? Why would actions identified in the Management Plan not be considered disturbances? Please provide justification.	Potential actions on fish and wildlife mitigation lands are undetermined and best addressed with pre-Project assessments prior to their implementation. The updated Wildlife Mitigation Land Management Plan will identify management actions and procedures for assessing whether the action requires protocol surveys or other BMPs. Edits made as follows: Study area description modified to include all areas within the Project Boundary including the transmission line ROW, fish and wildlife mitigation lands, and 0.5-mile buffer for the purposes of mapping of potentially suitable nesting habitat. Methods for radar survey locations modified to indicate that mitigation lands will not be included as there are no disturbance sources on these parcels.
28.	Judy Neibauer (USFWS)	04/17/2020	Section 2.5 Study Area	If there are any restoration or recreation on these lands, they may cause effects? You may need to include sites here…?	See response to Comment #27.
29.	Judy Neibauer (USFWS)	04/17/2020	Section 2.5 Study Area	Maybe include a map with the 50 mile buffer overlapping the project areas.	Tom Hamer recommends using a 55-mile minimum distance to determine where inland murrelet detections are expected to be low. As such, Gorge Powerhouse is very close to the 55 mile distance from saltwater (Bellingham Bay). All of the transmission line west and south of that point is less than 55 miles from saltwater. Ross Dam is ~63 miles and Hozomeen at the Canada border is ~66 miles from saltwater.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
30.	Shauna Hee (USFS)	04/15/2020	Section 2.6.1 Map Potential Marbled Murrelet Nesting Habitat	Are there any survey sites anticipated outside of the NPS lands? If no, then why not?	Potentially suitable nesting habitat will be mapped throughout the study area. Radar survey locations are located in areas where potential nesting habitat exists within 0.5 miles of locations where most Project noise generation occurs. The alignment with NPS-managed land is coincidental. Radar murrelet surveys by Hamer covered sites near the transmission line in the Thornton Creek and Bacon Creek watersheds, the latter of which has USFS land. Any need for additional surveys would be assessed in the ISR.
31.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.1 Map Potential Marbled Murrelet Nesting Habitat	SCL should survey those lands within the project effects area, whether owned by SCL or not. I would appreciatively point to the Vegetation Mapping Study Plan as a great example how SCL has addressed the effects area before.	See response to Comment #30.
32.	Judy Neibauer (USFWS)	04/17/2020	Section 2.6.1 Map Potential Marbled Murrelet Nesting Habitat	Agreed	See response to Comment #30.
33.	Shauna Hee (USFS)	04/15/2020	Section 2.6.2 Conduct Limited Ground Surveys to Verify Accuracy of Habitat Mapping	How will representative sites for platform check/suitable nesting habitat be selected?	Sites to conduct rapid habitat assessments will be selected by reviewing: 1) areas with mapped suitable habitat within the 1.5 km diameter radar survey area; 2) reviews of aerial photo imagery of this habitat, and; 3) ease of access.
34.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.1 Map Potential Marbled Murrelet Nesting Habitat	I would argue that it might not pinpoint nest locations better.	See response to Comment #6.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
35.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.3.2 Radar and Audio-Visual Survey Methods	See comment above.	See response to Comment #6.
36.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.1 Map Potential Marbled Murrelet Nesting Habitat	I will reiterate. If SCL wants to find nest areas that project noise may affect, then SCL should conduct more than one year of audio-visual surveys in the areas that the greatest radar detections occur. Many surveyors will use radar to focus their efforts for audio-visual surveys. If SCL wants to know how project noise and operation effect marbled murrelets, they will need to know where they breeding areas occur. With this current study plan, SCL will basically describe the migration areas of murrelets with this radar study.	See response to Comment #6.
37.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.3.5 Radar Tracking Software	Wouldn't this make it difficult to find stand occupation behaviors?	Thank you for your question. No, the radar is also looking out and surveying the other 1,300 m diameter circle. In addition, if you were interested in a particular stand of habitat and it was within this 200 m range, you could move the radar further away and then scan this area on subsequent surveys.
38.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.4.1 Radar Counts and Passage Rates	I don't think this information will help SCL find areas affected by the Project. This study will collect more general information about murrelet usage areas mostly through migration and less about areas where murrelets nest. I am not sure that SCL will have the information to make a project effects call or write BMPs on a specific area.	See response to Comment #6.
39.	Brock Applegate (WDFW)	04/17/2020	Section 2.6.4.3 Flight Paths	The information gained about nest location sounds very general.	See response to Comment #6.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
40.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Bulleted list – Add: Initial Study (ISR) Delete: Final Add: Study Plan Modification Requests (if needed) Add: or SCL needs additional audio-visual surveys to refine further nesting locations areas **New comment provided on 05/05/2020:** Didn't SCL say they may do two years of survey earlier in their comment # six? I am confused.	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions (such as a poor breeding year), any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 05/05/2020:** See response to Comment #17.
41.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Murrelets nest in alternate years. SCL may need an additional year just to discover another high-use site.	See response to Comment #17.
42.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Bulleted list – Add: Second season of studies and surveys (if needed) 2022 Add: Study Report (if needed)	See response to Comment #40.
43.	Brock Applegate (WDFW)	05/05/2020	Section 2.1 Study Goals and Objectives	First Bullet	Edit accepted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				"….and likely future maintenance construction noise sources." and?	

TR-06 GOLDEN EAGLE HABITAT ANALYSIS PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

APLIC .....Avian Power Line Interaction Committee
APP .....Avian Protection Plan
BGEPA .....Bald and Golden Eagle Protection Act
BMP .....best management practice
CFR .....Code of Federal Regulations
City Light .....Seattle City Light
ELC .....Environmental Learning Center
EMU .....eagle management unit
FERC .....Federal Energy Regulatory Commission
GIS .....geographic information system
GRA .....geospatial risk assessment
IEUA .....Important Eagle Use Area
ISR .....Initial Study Report
km .....kilometer
LAP .....local area population
LiDAR .....Light Detection and Ranging
LP .....licensing participant
MBTA .....Migratory Bird Treaty Act
MIS .....Management Indicator Species
NPS .....National Park Service
PAD .....Pre-Application Document
PHS .....Priority Habitats and Species
Project .....Skagit River Hydroelectric Project
PSP .....Proposed Study Plan
RLNRA .....Ross Lake National Recreation Area
RM .....river mile
ROW .....right-of-way
RWG .....Resource Work Group
TRREWG .....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C. .....United States Code
USDOI .....United States Department of the Interior

USFS .....U.S. Forest Service

USFWS .....U.S. Fish and Wildlife Service

WDFW.....Washington Department of Fish and Wildlife

1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

NPS and the Washington Department of Fish and Wildlife (WDFW) have limited data on golden eagle (*Aquila chrysaetos*) nests within several miles of the Project, but as recently as 2019, NPS biologists have observed occasional individual golden eagles in the general vicinity of Marblemount in the winter and spring. However, habitat assessments or migratory studies specific to golden eagles have not been conducted within the Project Boundary. WDFW has raised concerns about the potential threat to the species from collisions with powerlines, although there have been no documented golden eagle collisions in the area. City Light has acknowledged a shared natural resource management interest in ensuring that golden eagles are protected to the extent possible and agreed to conduct a limited study to clarify the issue and any potential hazard posed by the Project transmission lines. This study plan addresses the TE19 Golden Eagle Breeding Area issue form and will inform best management practices (BMP) and potentially City Light's Avian Protection Plan (APP)(City Light 2014) that it implements for the entire transmission and distribution system. The study will use information from the Vegetation Mapping and Wetland Assessment studies to characterize areas of potentially suitable golden eagle habitat for nesting, foraging, and movement corridors near the Project.

On March 12, 2020, City Light released the Golden Eagle Habitat Analysis Draft Study Plan for LP review and comment. On March 17, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 29, 2020. The revised draft was discussed on May 6, 2020 at a TRREWG meeting. Written comments were received from WDFW, U.S. Forest Service (USFS), and NPS and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to use existing information to map habitat for golden eagle nesting, foraging, and movement corridors in the study area (Section 2.5 of this study plan) and conduct a geospatial risk assessment (GRA) to identify potential risk associated with collision with Project transmission lines. This information will be used to assess the potential effects of continued operation and maintenance of the Project with respect to collision risk of golden eagles with transmission lines and inform BMPs and elements of City Light's APP.

Specific objectives are to:

- Use existing information to characterize areas of potentially suitable golden eagle habitat for nesting, foraging, and movement corridors within the study area.
- Map historical golden eagle observations and habitats used for nesting, foraging, and movement corridors within the study area.
- Develop GRA to identify and map areas of potential golden eagle risk of collision with Project transmission lines within the study area.

2.2 Resource Management Goals

The Golden Eagle Habitat Analysis Study will provide information needed to characterize potential Project effects on golden eagles so the risks to eagles can be reduced consistent with the City Light APP. The study will also provide information to the following agencies with jurisdiction or interest in the species and habitat: U.S. Fish and Wildlife Service (USFWS), USFS, NPS, and WDFW.

- U.S. Fish and Wildlife Service (USFWS)

USFWS is responsible for implementing 2016 regulations published under the Bald and Golden Eagle Protection Act (BGEPA) 50 Code of Federal Regulations [CFR] § 22 and the Migratory Bird Treaty Act (MBTA).

The BGEPA prohibits anyone without being permitted to do so to "take, possess, sell, purchase, barter, offer of sale, purchase, or barter, transport, export or import, at any time or in any manner of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof." See 16 United States Code (USC) § 668. The BGEPA also defines "take" to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb." See 16 USC § 668c. Prohibited actions result in criminal and civil penalties for violating the statute. See 16 USC § 668. Additionally, the term "disturb" is defined as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior. See 50 CFR § 22.3. USFWS is authorized to permit the take of eagles for certain purposes and under certain circumstances according to the BGEPA, including scientific or exhibition purposes, Indian tribe religious purposes, and wildlife, agricultural, or other interests' protection, so long as that take is compatible with the preservation of eagles.

In the 2009 regulations, the USFWS established that compatibility with mandates of the BGEPA are accomplished if permitting activities do not result in a net decrease in the number of breeding pairs of golden eagles (using 2009 as the baseline) within regional geographic management units, which in the case of the golden eagle are Bird Conservation Regions (U.S. North American Bird Conservation Initiative Monitoring Subcommittee 2007; USFWS 2009). In 2016, the USFWS revised the geographic management units from Bird Conservation Regions to use the Pacific flyway, Central flyway, and combine the Mississippi and Atlantic flyways for the golden eagle to better reflect regional populations and seasonal movement patterns (50 CFR § 22).

The USFWS manages eagle take at two geographic scales, regional eagle management units (EMU) and the local area population (LAP). The LAP is unique to each prospective permit and is defined as the area of the permitted activity bounded by the 90th quantile of natal dispersal distance for golden eagles. Eagle take at the EMU scale is governed by a take rate that is compatible with maintaining an equilibrium population size governed by the population objective which is to "maintain a stable or increasing eagle population" within regional geographic management units (USFWS 2016a, b). Take limits at the LAP-scale apply only to take permitted or authorized by the USFWS and are intended to prevent local extirpation of eagles.

In December 2016, the USFWS updated its regulation to allow for permits to be issued that address incidental take up to a maximum of 30 years (50 CFR § 22.26). Additionally, the USFWS addressed permits for removal of eagle nests (50 CFR §22.27). Additionally, the USFWS issued a Final Programmatic Environmental Impact Statement for the Eagle Rule Revision, December 2016 and the Record of Decision for the Final Programmatic Environmental Impact Statement for the Eagle Rule Revision, December 13, 2016.

Over 1,000 migratory bird species are protected under the MBTA, including bald and golden eagles. The USFWS administers the MBTA. The MBTA provides international migratory bird protections. In December 2017, the United States Department of the Interior's (USDOI) Office of the Solicitor issued a memorandum that found the prohibitions of take under the MBTA apply only to "affirmative actions that have as their purpose the taking or killing of migratory birds, their nest, or their eggs." In April 2018, the USFWS issued clarifying guidance that the USDOI does not consider incidental take a violation of the MBTA if the purpose of the activity is not to take birds. Additionally, the USFWS has proposed a rule that would codify the current Solicitor's Opinion.

- U.S. Forest Service (USFS)

The bald eagle is listed as a Sensitive Species and a Management Indicator Species (MIS) under the Northwest Forest Plan by a 1990 Forest Plan management action that covers the Mt. Baker-Snoqualmie National Forest. USFS monitors MIS to assess the effects of forest management activities on native species, and manages sensitive species to ensure that actions do not contribute to a loss of viability or cause a significant trend toward listing under the Endangered Species Act. Because golden eagles are protected under the BGEPA, USFS includes these birds under "other species of concern" in developing management actions on its lands.

- National Park Service (NPS)

The golden eagle is listed as one of 73 species of management concern in the North Cascades National Park by NPS (Hoffman et al. 2015).

- Washington Department of Fish and Wildlife (WDFW)

Golden eagles are listed under WDFW's Priority Habitats and Species (PHS) program as a State Candidate species, which are those under review by WDFW for possible listing as endangered, threatened, or sensitive. WDFW manages these species, as needed, to ensure the long-term survival of populations in Washington. WDFW has raised concerns about the potential threat to the species from collisions with powerlines.

2.3 Background and Existing Information

Although habitat assessments or migratory studies specific to golden eagles have not been conducted within the Project Boundary, Section 4.7 (Wildlife Resources) of City Light's PAD (City Light 2020) describes the extensive amount of existing information on the life history of golden eagles. This information is summarized below.

Golden eagle populations in the region are part of the Pacific flyway EMU. In Washington, golden eagles nest throughout much of the state but are most common in the north-central highlands transitional area between montane and shrub-steppe landscapes. Its occurrence west of the Cascade crest is considered uncommon (Larrison and Sonnenberg 1968), yet up to 86 golden eagle breeding territories have been recorded in western Washington (Hayes 2013). One study indicated that all observed western Washington golden eagle nests were within 1,500 feet of large clearcuts or open fields, which support populations of medium-sized mammals such as mountain beaver (*Aplodontia rufa*), snowshoe hare (*Lepus americanus*), and European rabbit (*Oryctolagus cuniculus*) (Bruce et al. 1982). Servheen (1978, as cited in Hansen 2017) noted that mountain beaver made up a substantial portion of golden eagle prey in western Washington, and this was further confirmed in a study conducted on the breeding ecology of golden eagles in western Washington. Forest clearcuts and younger forest stands create favorable foraging areas for golden eagles in western Washington as these habitats offer peak abundance and availability of mountain beaver (Thomas 1977; Servheen 1978, as cited in Hansen 2017).

Data for the North Cascades National Park Complex include 55 incidental observations of golden eagles west of the Cascade crest within the park, ranging from the summit of Sourdough Mountain to along Ross Lake over 49 years (NPS 2019). However, the NPS has no records of golden eagle nests in the North Cascades National Park Complex. There are 35 observations of golden eagles in the vicinity of the Project during 1979-2020 (eBird 2020). Most of these observations demonstrate seasonal movement along river valleys crossed by the Project by immature birds that occur in spring (over 50 percent of the observations, March-May). There is limited use during the winter (December-February, five observations), and limited use during the summer (eBird 2020). According to WDFW PHS data, multiple historic golden eagle nest sites have been documented in the Baker River watershed, but none have been documented in the Project vicinity. One nest site, last documented in 2013, is approximately eight miles from the nearest fish and wildlife mitigation lands parcel and ten miles from the transmission line; while another nest site, as reported in 2000, is more than three miles east of the South Fork Nooksack wildlife mitigation lands parcel. There is also a suspected golden eagle nest site in the upper elevations of the Cascade River watershed more than five miles from the transmission line and fish and wildlife mitigation lands.

2.3.1 Nesting Habitat Characteristics

Throughout much of their range, golden eagles usually nest on cliffs but also use large trees, artificial structures, or on the ground, depending in on availability (Dixon 1937; Bent 1961; McGahan 1968; Whitfield et al. 1969; Boeker and Ray 1971; Baglien 1975; Lish 1975; Seibert et al 1976; Olendorff et al. 1980; Bruce et al 1982; Smith and Murphy 1982; Houston 1985; Menkens and Anderson 1987; MacLaren et al. 1988; Phillips and Beske 1990; Phillips et al. 1990; Bates and Moretti 1994; Morneau et al. 1994). Cliff nests at northern latitudes generally avoid sites that accumulate large amounts of snow and prefer sites with a southern aspect (Kochert et al. 2002). Cliffs and rock outcrop sites are also chosen with topography sheer enough to provide protection from predators and then provide for clear take off (Watson 2010; Weber 2015).

In western Washington, golden eagles nested in Douglas fir, or relatively large trees in noncontiguous forest (Bruce et al. 1982). Tree nests occupied by golden eagles are typically built in the top one-third of large trees that are isolated, in small forest stands at or near the edge of clearcuts and open fields; large contiguous forest tracts are not used. A review of nesting territories of golden eagles in western Washington determined that high occupancy territories (repeated use) tended to have lower forest cover and higher open/shrub cover than low occupancy territories (Hansen 2017). In general, forest cover was negatively associated with occupancy of golden eagle territories in western Washington, likely related to prey accessibility. Clearcuts and open forests offer prime habitat for mountain beaver. These areas are strongly associated with golden eagle nesting in western Washington (Hansen 2017; Bruce et al. 1982).

Steenhof et al. (1983) found that human use may lead to high rates of golden eagle nest failure, mortality, or emigration. Human use such as roads, habitation and powerlines are a negative influence on golden eagles nesting habitat. Scott (1985) found more abandoned eagle territories in areas with residential dwellings within 1.6 kilometers (km) and in areas with higher human populations within 4.8 km than in territories that continued to be occupied.

2.3.2 Foraging Habitat Characteristics

Foraging habitat selection by resident eagles differ between breeding and non-breeding season (Marzluff et al. 1997). Golden eagles prey primarily on medium-sized mammals such as jackrabbits, beaver, ground squirrels, and snowshoe hare, although bird, reptiles, fish and carrion also are eaten (Bent 1961; Olendorff 1976; Bruce et al. 1982; Brown 1992; Watson et al. 1992; Kochert et al. 2002). Primary prey during the breeding season were more variable. In the Great Basin, golden eagles use shrubsteppe, native grassland, tame grassland, cropland, riparian habitats, open fields and clearcuts <500 meters from open areas or from clearcuts in which primary prey were found (Bruce et al. 1982). Golden eagles primarily inhabit arid regions east of the Cascade Mountains in Washington and there is limited information on their foraging habits on the west side of the Cascades (Bruce et al. 1982). In western Washington the primary prey item for nesting golden eagles was mountain beaver, followed by unidentified, general small mammals, and sooty grouse (Hansen 2017).

2.3.3 Risk of Transmission Line Collision

Golden eagles are aerial hunters with exceptional maneuverability and very good vision, as well as low wing loading and aspect ratio, making them less susceptible to collision (Avian Power Line Interaction Committee [APLIC] 2018). Golden eagles collide with transmission lines less

commonly than bald eagles (APLIC 2018). A number of specific factors contribute to collision risk for eagles in western Washington. These include but are not limited to adjacent habitat type, topography, height of transmission line relative to the height of adjacent vegetation, spacing of parallel lines, and other factors (APLIC 2012).

The Project transmission line has two parallel sets of towers with two sets of three electrical conductors 18 feet apart, arranged vertically. The easterly towers also have a fibre-optic cable above the conductor cables; the fibre-optic cable is a smaller diameter than the electrical cables (Springwood Associates, Inc. 2001).

There is no evidence that the Project transmission lines pose a collision hazard for golden eagles. There has been no known golden eagle collision mortality and only one bald eagle collision mortality associated with Project transmission lines documented since 1973 (Springwood Associates, Inc. 2001). During intensive monitoring of wintering bald eagles at the Corkindale Skagit River crossing from 1996-2000, Springwood (2001) saw no collisions. Due to observations of eagles modifying their flight paths at this location, City Light installed bird flight diverters at six sites where the transmission lines cross the Skagit River or a tributary stream (City Light 2014).

2.4 Project Operations and Effects on Resources

Eagles and other raptor species that perch on utility and transmission poles are vulnerable to electrocution and collisions when avian-safe spacing, wire marking, and insulating hardware are absent. Numerous studies indicate that electrocution and collisions with power lines are the leading cause of death for golden eagles in the U.S. (Franson et al. 1995; Kochert et al. 2002, Wayland et al. 2003; Tetra Tech 2011). As part of its APP for the entire generation, transmission, and distribution network (City Light 2014), City Light implements a combination of proactive and reactive measures to minimize avian collision and electrocution mortalities. The transmission cables use avian-safe spacing (more than 60 inches apart horizontally, more than 40 inches apart vertically) as recommended to decrease likelihood of an electrocution (APLIC 2018); electrocution on Project transmission lines is not a risk for eagles. City Light staff are trained to follow the APP-outlined reporting for bird injury or mortality in case of discovery or confirmation of a bird electrocution or collision and City Light submits annual reports on avian mortalities to USFWS and WDFW (City Light 2014).

2.5 Study Area

This study area will include a subsection of land within the Project Boundary (Figure 2.5-1), which will be limited to the transmission line right-of-way (ROW) and a 1-mile buffer on either side.

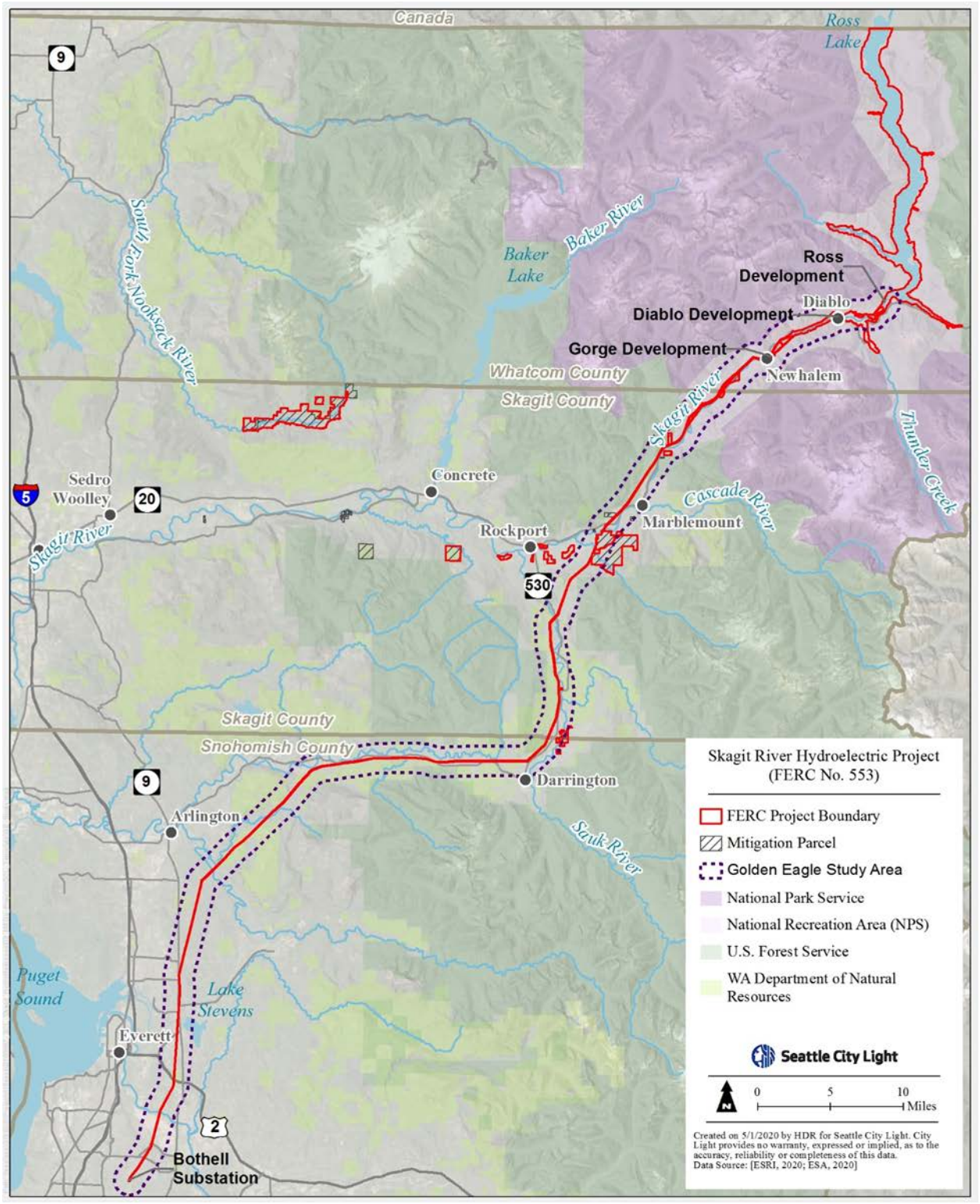

Figure 2.5-1. Overview of study area.

2.6 Methodology

The Golden Eagle Habitat Analysis Study will be a desktop review of habitat resources used by golden eagles for nesting, foraging, and movement corridors. The review will include identifying landscape level general cover types through the use of the Vegetation Mapping Study, U.S. Geologic Survey (USGS) National Land Cover Database, photo-interpretation, Light Detection and Ranging (LiDAR), National Hydrography Datasets, golden eagle observational plot data, known golden eagle nest data, and Washington Department of Transportation road data.

The habitat analysis will use GRA, or predictive relative abundance modeling, which can help to define the likelihood of eagle presence at any particular location or area of interest. GRA is geographic information system (GIS) exercise that overlays known resource occurrences with critical habitat parameters such as topography, land use, and habitat features to provide a quantifiable predictive relative abundance model. Habitat risk can incorporate local factors of known importance to the species. These GRAs involve associating golden eagle observation data with nesting, foraging, and movement corridor land features that strongly correlate with the presence of golden eagles.

2.6.1 Compile and Review Existing Information

Existing information on golden eagle nesting and foraging habitats in the region and golden eagle observations will be compiled and reviewed. Numerous citizen science-based databases document observations of golden eagle during the course of the year. Data sources including eBird, Washington Breeding Bird Atlas, and the USFWS Breeding Bird Survey among others provide spatial information on the distribution and timing of the presence of golden eagles.

2.6.2 Map Observations and Potential Nesting and Foraging Habitat

A map of golden eagle observations, and associated topography and land features will be developed from existing available data. Documented sightings of golden eagles within or adjacent to the study area will be plotted to analyze golden eagle use patterns and occurrences in the vicinity of the Project.

Potential nesting and foraging habitats will be identified within or adjacent to the study area using available geospatial information that maps land use, forest cover, topography and watercourses. Information will include regional golden eagle nest model data (Dunk et al. 2019) to inform nesting habitat.

Non-breeding foraging habitats include roads and open areas with an abundance of prey or carrion. Eagles scavenge on road-kill such as deer, elk, coyotes or other small mammals. Scavenging increases during the winter months when other food sources are less available. Landscape level map elements that identify grassland, open areas, or road features where carrion may be present and where observational data occurs will be used to identify potential non-breeding foraging sites.

2.6.3 Develop Golden Eagle Geospatial Risk Assessment

GRA objectives will include identifying golden eagle general use patterns (nesting, foraging, and movement corridors) within the study area. The GRA will summarize:

- Known golden eagle nest sites
- Golden eagle use areas
- Golden eagle observation locations
- Topography conducive to golden eagle movement

A key element to reducing eagle risk is to identify eagle foraging areas, nest sites, winter roosts, and movement corridors (Important Eagle Use Areas [IEUA]). An Important Eagle Use Area is defined as an "eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles" in permit regulations under the BGEPA (USFWS 2016a). Each of these areas is defined as follows:

- Roost sites and Winter Roosts (each a "communal roost site"): "an area where eagles gather repeatedly in the course of a season and shelter overnight and sometimes during the day in the event of inclement weather"
- Foraging Areas: "an area where eagles regularly feed during one or more seasons"
- Nest Sites: "any readily identifiable structure built, maintained, or used by bald eagles or golden eagles for the purpose of reproduction" (USFWS 2016a).

Geospatial risk models are a first step to identifying where IEUA's intersect with utility infrastructure. These models use GIS to incorporate spatial data, infrastructure system data, and knowledge of eagle ecology to complete an estimation of risk. The GIS analysis helps to identify all power lines within a set distance of eagle nests or IEUAs. These models provide an easily quantifiable estimate of risk zones by overlaying recorded eagle activity, foraging habitat, home range use, nest habitat and other identifiable habitat characteristics that are publicly available or can be derived from publicly available sources. Habitat risk assessments or predictive relative abundance modeling help to define the likelihood of golden eagle presence at a particular location or within a defined area of interest, specifically here, the transmission line ROW.

A list of correlative habitat influences will be created built on peer-reviewed studies about Washington golden eagle nesting characteristics, habitat use studies, species narratives, and a professional understanding of eagle nesting characteristics. Habitat characteristics known to be highly correlative to the presence of golden eagle nesting territories will be overlaid on other critical data layers using ArcGIS™ within the study area.

2.6.3.1 Initial Geospatial Habitat Assessment

The initial habitat assessment will utilize a GIS determination that examines existing land use and eagle use information. The following resources will be used to assemble data layers that identify areas having the highest probability to support nesting, foraging, concentrating, and migrating golden eagles:

- LiDAR
- National Land Cover Data

- Recent aerial photography
- Golden eagle observation location data (see Section 2.6.1 of this study plan)
- USGS quadrangle maps
- National Wetlands Inventory maps
- National Hydrography Dataset: Waterbodies
- National Hydrography Dataset: Area
- Washington Department of Transportation road data
- State, county, and local maps

2.6.3.2 Eagle Use Assessment

A second task will be to acquire official information held by the Washington State agencies, NPS, or USFWS regarding nest sites, winter roost sites, communal roosts, and foraging concentration sites all of which are regulated under the BGEPA. Biologists will ask WDFW, USFS, and USFWS for historic nest or eagle use information.

Information about important eagle use areas such as winter roost sites, communal roosts, and foraging concentration sites should also be obtained from WDFW, and reviewed to ensure compliance with the BGEPA and the MBTA. The additional agency information regarding important eagle use areas would provide information that could be used to identify high risk areas.

The resulting model will be used to identify golden eagle general use patterns within one mile of the Project transmission line centerline.

2.7 Consistency with Generally Accepted Scientific Practice

The study methods follow GRA standards outlined by APLIC's Eagle Risk Framework A Practical Approach to Power Lines (2018) and use standard scientific approaches by relying on documented occurrences of the species, a review of scientific literature and management guidelines, and a habitat assessment specific to western Washington using parameters for golden eagle use identified in the scientific literature.

2.8 Schedule

The anticipated schedule for the Golden Eagle Habitat Analysis Study is as follows:

- Compile and Map Existing Information – Spring 2021
- Develop Model – Summer 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $45,000.

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GOLDEN EAGLE HABITAT ANALYSIS
PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	04/10/2020	List of Acronyms and Abbreviations	Acronyms list - Add: "(either Council or Committee)" after Avian Powerline Interaction	Edit made: "Avian Power Line Interaction Committee"
2.	Brock Applegate (WDFW)	04/10/2020	Section 1.3 Study Plan Development	Eagle carcasses don't stay around for long with scavengers.	Thank you for your comment.
3.	Brock Applegate (WDFW)	04/10/2020	Section 1.3 Study Plan Development	Since SCL limited the Vegetation Mapping and Wetland Assessment in geographic scope and golden eagles can fly many miles, WDFW recommends that you extend geographical scope to include nearby cliff type areas when the study identifies possible nesting areas. We might have nesting areas farther out than 0.5 mile from the project boundary and large home ranges that overlap project boundary, but span a greater distance than 0.5 miles, particularly near the Skagit River. WDFW recommends that you consider mapping nearby eagle habitat features outside of the mapping projects. **New comment provided on 05/06/2020:** I thank you for the comment. As SCL does a risk assessment, SCL would want to consider areas with higher possibility for eagle migration, those areas near eagle habitat. SCL might want to consider areas with possible, future nests, because eagles would make many migration trips between the nest and other habitat, while nearing powerlines and project structures and activity, which increases the chance of project impacts.	The Golden Eagle Study addresses the potential for golden eagle interactions with the transmission line with a tiered GIS risk assessment mapping nesting and foraging habitats up to one mile from transmission line ROW using available geospatial information that maps land use, forest cover, topography, and watercourses. Within 0.5 miles of the line, the vegetation mapping study will provide finer-scale habitat information. The Project has no effect on nest sites and no nest sites are known to occur within five miles of the Project Boundary. Any newly discovered golden eagle nest sites brought to our attention will be considered during the study and during development of best management practices in the license application. **Response to comment provided on 05/06/2020:** Comment noted. This study will produce a map of potentially suitable habitat to assess where golden eagles might forage near the transmission line right-of-way. Assessing areas that could have "possible, future nests" is beyond the scope of this study. If City Light is made aware of new nests in the Project vicinity during the new license, we would evaluate the

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					need for additional assessment or management actions under an Avian Protection Plan.
4.	Brock Applegate (WDFW)	04/10/2020	Section 2.1 Study Goals and Objectives	1st Bullet – Add: , including eagle habitat features (IE cliffs),	Thank you for your comment. See response to Comment #3.
5.	Brock Applegate (WDFW)	04/10/2020	Section 2.1 Study Goals and Objectives	As stated before, you will need to go beyond the 0.5- mile area to discover eagle habitat features. I remain unsure if you plan on examining anything outside of the 0.5 mile "effects area".	This assessment focuses on the potential for interaction of golden eagles with the transmission line and towers, so habitats close to the transmission line are most important to include. The overall geospatial risk assessment extends one mile from the transmission line to include information on potential nesting and foraging habitat at a broader scale.
6.	Shauna Hee (USFS)	04/15/2020	Section 2.2 Resource Management Goals	Bald eagle as a MIS was a 1990 Forest plan management action, not a Northwest Forest Plan amendment. Please update the US Forest Service management direction.	Edit made: "Management Indicator Species (MIS) under the Northwest Forest Plan by a 1990 Forest Plan management action that covers the Mt. Baker-Snoqualmie National Forest."
7.	Brock Applegate (WDFW)	04/10/2020	Section 2.2 Resource Management Goals	Does SCL have some evidence, information, or a study that they can base this statement on about collisions? I would caution against the assumption that the lack evidence equals no collisions. Many collisions over rivers lead to the carcasses floating down the river. Predators scavenge eagles killed or injured during collision and electrocution before surveyors or even a bystander passes by the carcass.	Edit made: deleted the phrase: ", although there is currently no evidence of such a threat." Thank you for your comment.
8.	Brock Applegate (WDFW)	04/10/2020	Section 2.2 Resource Management Goals	2nd Paragraph – Add: However, scavengers quickly remove carcasses and rivers can transport dead or injured eagles away from the collision or electocution site.	Thank you for your comment. As this section of the study plan is summarizing agency policies this is not the proper location to include this sentence.
9.	Jason Ransom (NPS)	04/14/2020	Section 2.3 Background and Existing Information	I don't know where this statement comes from. (NPS 2019 is not a complete reference). We have a combination of reported obervations, survey data from our landbirds long-term	Edit made: After email discussion with Jason Ransom, it was determined that the information in the draft study plan is acceptable. The reference will be changed to indicate that the

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				inventory and monitoring dataset, and broader public reporting sources such as eBird (confirmed datasets only...which run about 2 years behind the current calendar year). Our at-risk species Focused Condition Assessment that is in development is based on records since the last license, which total 31 records from 1995-2018. I haven't yet updated any 2019 records. That total includes all sources listed above. You could cite that as (NPS, unpublished data)	NPS (2019) is "NPS unpublished data".
10.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and Existing Information	I think that we have found the distance for the more likely boundary of the effects area for golden eagle in these statements. I am making the point that SCL may want to extend the search for habitat features beyond the 0.5 mile vegetation mapping boundary.	This background information was included in the study plan to indicate that golden eagles typically nest at sites farther from residential and major developed areas. As indicated in the Study Area and Methods sections, potential nesting and foraging habitat will be identified within the one-mile (1.6-km) buffer area based on existing data for use in the geospatial risk analysis along with detailed vegetation mapping information to assess where collision risk is greatest.
11.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and Existing Information	With this said, powerlines killed many golden eagles in Wyoming due to collision. **New comment provided on 05/06/2020:** I read a newpaper piece 5-10 years ago that talked about the golden eagle fatalities with powerlines in Wyoming. I can't remember if Puget Sound Energy owned the lands, but a raptor specialist mentioned that powerlines had for more eagle fatalities than Washington State wind power projects that I referred to during a conversation.	It would be greatly appreciated if WDFW can provide the reference(s) for collisions specifically with transmission lines. We are aware of some information on collisions (e.g., a North American Golden Eagle Science Meeting held in 2010 [https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=83970&inline] that conflated electrocution and collision numbers and other studies indicating that collisions with vehicles, powerlines and other structures account for the greatest percentage of mortality [Franson et.al. 1995]).

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					(Franson, J. C., L. Sileo, and N. J. Thomas. 1995. Causes of eagle deaths. Page 68 in E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C., USA.) **Response to comment provided on 05/05/2020:** Comment noted. Thank you for your comment.
12.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and Existing Information	Did the researcher adjust the number for the greater number of bald eagles? **New comment provided on 05/06/2020:** I appreciate the answer and the information.	The statement cites reference to "a recent survey of utility companies". We are unaware of additional studies that support the statement. This statement is related to wing-loading and foraging behavior differences between the two species (golden eagles are more likely to forage on the wing and while using powered flight/bald eagles are perch or soaring hunters), i.e., golden eagles collide less often with transmission lines, not because there are fewer golden eagles than bald eagles, but rather due to physical and behavioral differences between the species. **Response to comment provided on 05/05/2020:** You are welcome.
13.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and Existing Information	Without marking the smaller diameter cable, eagles would less likely see it and collide with the fibre-optic cable.	Comment noted. Study is aimed at identifying where elevated risk potentially exists to determine where additional marking with bird flight diverters may be considered.
14.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and	Carcasses don't necessarily stay around for someone to find.	Thank you for your comment.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Existing Information		
15.	Brock Applegate (WDFW)	04/10/2020	Section 2.3 Background and Existing Information	Thank you, WDFW appreciates that you installed diverters.	Thank you for your comment.
16.	Brock Applegate (WDFW)	04/10/2020	Section 2.5 Study Area	I like this buffer distance much better. Do we have vegetation mapping 1-mile from the project boundary or will you look more at other maps with eagle habitat features?	Thank you for your comment. We will use USGS data for the coarse review for lands further from the transmission line ROW, then revise using information gathered by the Vegetation Mapping study within 0.5 miles of the transmission line ROW.
17.	Brock Applegate (WDFW)	04/10/2020	Section 2.6 Methodology	Can we identify cliffs and clear-cuts with these sources? I know the mapping study will only extend 0.5 miles, so we will need other sources. Eagles will fly between habitats in their home range, for example they will fly from the foraging areas back to the nest. You will increase the likelihood of finding the potential spots for collision, if you can understand where these habitats could exist. Perhaps I have stated what SCL would plan to do.	We will use the USGS data and other existing geospatial data and aerial photographs to map potential golden eagle foraging and nesting habitat within one mile. The greatest collision risk would be in areas where foraging habitat occurs under or very close to the transmission line so the vegetation mapping results will be best information source for the area within 0.5 mile of the line.
18.	Shauna Hee (USFS)	04/15/2020	Section 2.6.2 Map Observations and Potential Nesting and Foraging Habitat	Potential for transmission lines maintained in low vegetation to be foraging habitat? Please provide references that support the classification of “map elements” as foraging sites, or are map elements to based on observation only?	Golden eagles have been observed foraging in transmission line corridors in Montana. We will search for other information in Kochert et al. (2002), Bruce (1982), and other peer-reviewed sources to make this determination.
19.	Shauna Hee (USFS)	04/15/2020	Section 2.6.3 Develop Golden Eagle Geospatial risk Assessment, Page 2-8	How frequently do golden eagles have communal roost sites? Please provide references and background information to support this as an important golden eagle use area.	The statement in the study plan was from definitions in the Bald and Golden Eagle Protection Act that covers both species. While roosting is common for bald eagles, it is not common for golden eagles. Kochert et al. (2002) states “golden eagles rarely roost communally” and “roosts communally in unique

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					circumstances (rarely; e.g., extremely cold weather and abundant prey)." It has also been reported by Craig and Craig (1984). (Craig, T.H. and Craig, E.H. 1984. A Large Concentration of Roosting Golden Eagles in Southeastern Idaho. The Auk. Vol. 101. pp 610-613. [Online] URL: https://sora.unm.edu/sites/default/files/journals/auk/v101n03/p0610-p0613.pdf. Accessed April 24, 2020.)
20.	Shauna Hee (USFS)	04/15/2020	Section 2.6.3.2 Eagle Use Assessment	Could check USFS database.	Edit made: added USFS to list of agencies to contact to search for existing information.
21.	Brock Applegate (WDFW)	04/10/2020	Section 2.6.3.2 Eagle Use Assessment	I am alright with this approach, if we understand that we may need to extend out beyond the powerline more than one mile to find these important eagle habitats. When the eagles fly between the habitats, the eagles run the risk of the collision when it passes through or near the powerlines.	The intent of the GIS analysis is to find where habitat elements and eagle use areas overlap with the transmission line ROW and create the greatest risk, if any, along the right-of-way. City Light does not see a need to expand study area beyond the one mile. As stated in the Methods (Section 2.6) data will be gathered from the region ("Existing information on golden eagle nesting and foraging habitats in the region and golden eagle observations will be compiled and reviewed") and habitat elements and eagle use areas will be identified within the study area ("Potential nesting and foraging habitats will be identified within or adjacent to the study area using available geospatial information that maps land use, forest cover, topography and watercourses"). Locations where eagle use areas ("eagle foraging areas, nest sites, winter roosts,

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					and movement corridors") intersect with the transmission line ROW and 1 mile buffer will be identified.
22.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Bulleted list - Add: ▪ "Initial Study Report (ISR) – March 2022 ▪ ISR Meeting ▪ Study Plan Modification request (if needed) ▪ Additional activities through 2022 (if needed) ▪ Final Study Report (if needed)" **New comment provided on 05/06/2020:** How about adding the ILP milestones to the schedule, since they will occur? How about: --The Final Initial Study Report (ISR) -- The ISR Meeting	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 05/06/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.

TR-07 NORTHERN GOSHAWK HABITAT ANALYSIS PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

BMP .....best management practice
CBI.....Conservation Biology Institute
City Light.....Seattle City Light
dbh.....diameter at breast height
ELC.....Environmental Learning Center
FERC.....Federal Energy Regulatory Commission
GIS .....geographic information system
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
MBTA.....Migratory Bird Treaty Act
NPS .....National Park Service
NVC.....National Vegetation Classification
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USDOI .....U.S. Department of the Interior
USFS.....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comment submitted by LPs.

1.3 Study Plan Development

The northern goshawk (*Accipiter gentilis*) is considered a priority species by the Washington Department of Fish and Wildlife (WDFW) and is a Candidate species for state listing. Northern goshawks (hereafter, "goshawk") use a range of habitats, but occupied nest sites tend to be in areas with a high proportion of late seral stage forest (Finn et al. 2002) and foraging habitat is typically in mature and old-growth forests where understory is somewhat open (Reynolds et al. 1992). Several recent goshawk sightings within the Project Boundary and general Project vicinity are noted on eBird (eBird 2020).

If goshawk habitat exists in an area near Project-induced noise or tree clearing, there is potential for disturbing nesting goshawks. This study plan addresses the TE16 Northern Goshawk issue form.

On March 12, 2020, City Light released the Northern Goshawk Habitat Analysis Draft Study Plan for LP review and comment. On March 17, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on April 29, 2020. The revised draft was discussed on May 6, 2020 at a TRREWG meeting. Written comments were received from WDFW, U.S. Forest Service (USFS), and NPS and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to identify suitable goshawk nesting habitat within and near (i.e., within 0.5 mile) the Project Boundary. WDFW has specifically requested this habitat analysis, and City Light has agreed to do so as it has a mutual natural resource management interest. Objective is as follows:

- Develop a map of suitable goshawk nesting habitat within the study area.

2.2 Resource Management Goals

The Northern Goshawk Habitat Analysis study will inform long term resource management and provide information to the following agencies with jurisdiction or interest in the species and habitat.

- U.S. Fish and Wildlife Service (USFWS)

Over 1,000 migratory bird species are protected under the Migratory Bird Treaty Act (MBTA), including the goshawk. USFWS administers the MBTA. The MBTA provides international migratory bird protections. In December 2017, the U.S. Department of the Interior's (USDOI) Office of the Solicitor issued a memorandum that found the prohibitions of take under the MBTA apply only to "affirmative actions that have as their purpose the taking or killing of migratory birds, their nest, or their eggs." In April 2018, the USFWS issued clarifying guidance that the USDOI does not consider incidental take a violation of the MBTA if the purpose of the activity is not to take birds. Additionally, the USFWS has proposed a rule that would codify the current Solicitor's Opinion.

- U.S. Forest Service (USFS)

The goshawk is designated a "sensitive species" in Region 6 (Pacific Northwest Region), within its geographic range (Woodbridge and Hargis 2006). USFS manages Sensitive Species to ensure that actions do not contribute to a loss of viability or cause a significant trend toward listing under the Endangered Species Act. Additionally, USFS has an MBTA Memorandum of Understanding with USFWS that "further clarifies the USFS commitment to bird conservation during forest and project-level planning" (Brewer et al. 2009).

- National Park Service (NPS)

NPS includes goshawk as one of 73 bird species of management concern in the North Cascades National Park and notes that the status of many species within the park is difficult to determine because of rarity or a lack of data (Hoffman et al. 2015).

- Washington Department of Fish and Wildlife (WDFW)

The goshawk is listed under WDFW's Priority Habitat and Species as a Candidate Species for State listing as Threatened or Endangered (WDFW 2019). WDFW has raised concern about the potential threat to the species from Project-related noise disturbance, although there are no such

documented effects in the study area. WDFW is also concerned about possible effects from future maintenance and construction projects.

2.3 Background and Existing Information

A preliminary review of the existing literature was conducted to determine the potential for goshawk to occur within the Project Boundary. Additional literature will be reviewed as part of the study. Section 4.7 (Wildlife Resources) of City Light's PAD (City Light 2020) includes existing life history information for goshawk. This information is summarized below.

The goshawk is an accipiter that uses a range of habitats, but nest sites are consistently correlated with mature forests. In Washington, occupied historical nest sites tend to have a high proportion of late seral stage forest (>70 percent canopy closure of conifer species with >10 percent of the canopy trees >53 centimeters diameter at breast height [dbh]) (Finn et al. 2002). Douglas squirrel (*Tamiasciurus douglasii*), grouse (*Dendragapus obscurus* and *Bonasa umbellus*), and snowshoe hare (*Lepus americanus*) are the most frequently represented prey items for goshawks in both eastern and western Washington (Watson et al. 1998).

Prior to 2014, goshawk nesting activity had been suspected in the general vicinity of the Sourdough Trailhead but never confirmed. In 2014, a juvenile goshawk died after it flew into a Diablo Powerhouse window. Following this incident, City Light conducted acoustic broadcast goshawk surveys in 2015 along the lower portions of the Stetattle Creek Trail and Sourdough Trail for evidence of nesting goshawk, but no goshawks were detected. Survey methods were based on a Washington Department of Natural Resources protocol and approved by NPS staff (Tressler 2019).

Goshawks were detected 12 times during the NPS landbird Inventory and Monitoring surveys in the North Cascades National Park Complex from 2008-2018 (Ray et al. 2018; NPS unpublished data), and twice during Northern Spotted Owl surveys in 1995 (NPS unpublished data). The NPS wildlife observation records document 32 observations of goshawk from 1995-2018 (NPS unpublished data), and several recent goshawk sightings within the Project Boundary and general Project vicinity are noted on eBird (eBird 2020).

2.4 Project Operations and Effects on Resources

There is no known link between Project operations and effects on goshawks outside of the one incidental collision mortality referenced above. There are no known effects at the population level. WDFW has raised concern about the potential threat to the species from Project-related noise from operations and maintenance. City Light has agreed to conduct a study to gather information that will inform long-term management actions and best management practices (BMP), if necessary.

The goshawk uses a variety of forest types for nesting and foraging (USFS 2006). Project-related maintenance activities can generate loud noises, having the potential to disturb goshawk nesting pairs during the breeding season (mid-February through mid-September) (McClaren et al. 2015). Noise disturbance could result in egg predation, nest failure, premature fledging of young, and abandonment of young and the nesting territory (McClaren et al. 2015). Information from this study will inform a later potential effects analysis.

2.5 Study Area

The study area will consist of a 0.5-mile buffer surrounding the Project Boundary (Figure 2.5-1).

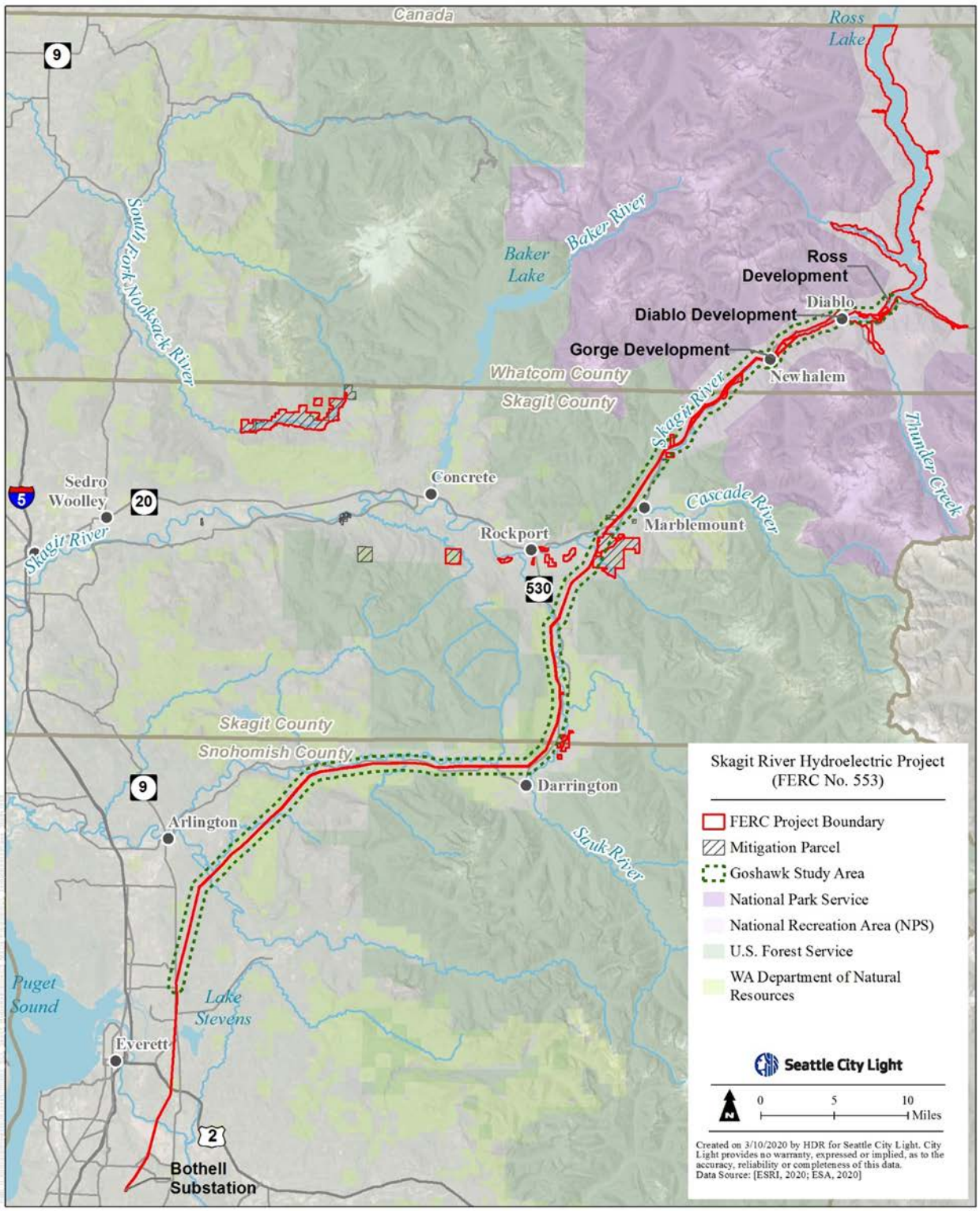

Figure 2.5-1. Overview of study area.

2.6 Methodology

The study will use available science to identify potentially suitable goshawk nesting habitat. The general steps for conducting the study are detailed below.

2.6.1 Review Scientific Literature

Habitat parameters identified in the literature will be reviewed and summarized in tabular and narrative format. The types of information that will be reviewed include state and federal agency reports and management plans, peer reviewed, published literature, NPS survey data, eBird records, and interviews with NPS, USFS, and WDFW knowledgeable staff and other species experts.

2.6.2 Identify and Map Potentially Suitable Habitat

Habitat parameters identified in the literature will be applied to the results from the Vegetation Mapping Study to map and quantify potentially suitable goshawk nesting habitat within the study area. A geographic information system (GIS) map of potential suitable habitat will be developed.

The NPS has mapped vegetation within the North Cascades National Park according to the National Vegetation Classification (NVC) system to the Association level, which includes co-dominant overstory species and primary understory species. The study area outside of the park will be mapped as part of the relicensing studies (see Vegetation Mapping Study including the transmission line, fish and wildlife mitigation lands, and Skagit River channel migration zone to the Sauk River confluence), but to the less precise Group level. The NVC does not use tree size as a classification element, thus a vegetation category – Western Hemlock/Red Cedar – may include portions of young, mature, and/or old-growth forest. Additional analysis using a combination of available Light Detection and Ranging (LiDAR)-derived Canopy Height Model and field data collection will be used to approximate age class from tree heights and canopy structure.

Existing data within the North Cascades National Park, data from the Vegetation Mapping Study, LiDAR analysis, and limited field review will be used to define the extent of potential goshawk nesting habitat in the study area. Based on the available information (as summarized in the PAD, City Light 2020) potential goshawk nesting habitat is defined as old-growth and mature conifer stands with >50 percent canopy, with tree dbh greater than 17 inches and a height of greater than 89 feet (Desimone and Hays 2003). These metrics will likely be refined once the North Cascades National Park NVC data has been analyzed and initial mapping of the study area outside of the North Cascades National Park has been completed as part of the Vegetation Mapping Study.

The Conservation Biology Institute (CBI) mapping of old growth and late seral stage forests of the North Cascades (CBI 2020) will be combined in GIS with the data layers described above to model goshawk nesting habitat within the 0.5-mile buffer. The CBI GIS data will be made available to interested LPs. The refined mapping within the study and the CBI data would be available to City Light to find potential goshawk breeding areas before construction, maintenance projects that produce noise, such as road maintenance, and herbicide/pesticide applications.

The data will be presented in map format and summarized in a narrative. The results of the study will be used in the license application to assess Project effects and to inform development of

goshawk protection BMPs for operation and maintenance activities and new construction in or near goshawk nesting habitat, if warranted.

2.7 Consistency with Generally Accepted Scientific Practice

The study methods use a standard scientific approach by relying on documented occurrences of the species, a review of scientific literature and management guidelines, and a habitat assessment specific to western Washington using parameters identified in the scientific literature. Noise disturbance thresholds will be summarized from the scientific literature and/or resource agency guidelines.

2.8 Schedule

- Literature Review – Spring 2021
- Habitat Mapping – Summer 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $38,000.

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NORTHERN GOSHAWK HABITAT ANALYSIS PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	04/10/2020	Section 1.3 Study Plan Development	Goshawks will use smaller trees for habitat than required by old-growth obligates like murrelets and spotted owls. I would recommend SCL considers areas with +50-year old coniferous stand with low amounts of deciduous trees. **New comment provided on 05/22/2020:** Thank you, WDFW prefers structural characteristics and height, instead of stand age. When I evaluated impacts to Northern Goshawk nesting on private timberland, Steve Desimone stated that they have found goshawks nesting in small trees than those in the management recommendations. He recommended the age class state in WDFW's comment, because we did not know heights and structures.	This study will map potential goshawk nesting habitat based on structural characteristics as stand ages are not available. Goshawks are known to use a variety of habitats for foraging but only later seral state stands for nesting. We are using the criteria for nesting habitat that is cited in WDFW's PHS Management Recommendations for the northern goshawk (Desimone and Hays 2003). City Light appreciates any specific criteria from the literature or WDFW policy – or from other LPs that they believe should help guide the mapping parameters. **Response to comment provided on 05/22/2020:** Comment noted. Thank you.
2.	Brock Applegate (WDFW)	04/10/2020	Section 2.2 Resource Management Goals	1st Paragraph – Add: State Add: as Threatened or Endangered Add: and possible impacts from future maintenance and construction projects.	Text changed to add WDFW concern on maintenance and construction projects.
3.	Shauna Hee (USFS)	04/15/2020	Section 2.2 Resource Management Goals	Is the assumption that SCL operations will continue in the current footprint for future maintenance and construction? Is there a suspected distance of noise or human disturbance?	This study will address current configuration and operation of the Project. If changes or new elements are proposed during relicensing process, we would evaluate those at that time. In Section 2.7, we indicate that noise disturbance thresholds will be summarized from the scientific literature and/or resource agency guidelines. City Light would appreciate receiving any information related to this topic from LPs.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
4.	Jason Ransom (NPS)	04/14/2020	Section 2.3 Background and Existing Information	Paragraph #4 – Add: detected 12 times during Delete: not observed in Add Inventory and Monitoring Add: from 2008-2018 (Ray et al. 2018; NPS, unpublished data), and twice during Northern Spotted Owl surveys in 1995 (NPS, unpublished data). Add: The NPS wildlife observation records document 32 observations of goshawk from 1995 – 2018 (NPS, unpublished data), and	Thank you for the information. Text edited to include changes.
5.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and Effects on Resources	Like many effects to fish and wildlife, they go undetected by us. A person will not usually see a pair abandoning their nest with or without chicks due to noise.	City Light appreciates the input.
6.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and Effects on Resources	SCL would not know the complex dynamics and effects on populations unless they created a study. **New comment provided on 05/22/2020:** WDFW has them listed as Washington Priority and State Candidate Species so we have concerns about every part of the population and the population's habitat. The literature referenced allows SCL to understand the impacts vectors caused by the project.	City Light is currently unaware of any specific Project-related adverse effects that would have corresponding population-level effects. City Light welcomes specific information or literature from the LPs regarding such effects. Given the relatively small portion of the North Cascades Ecosystem occupied by the Project, it appears highly unlikely that the Project is affecting goshawks on a population-scale level. **Response to comment provided on 05/22/2020:** Comment noted. The study is focused on gathering information on location of potential nesting habitat as it is more limited than foraging habitat.
7.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and Effects on Resources	1st Paragraph – Remove: but has provided no documented link	Edit made.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
8.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and Effects on Resources	Doesn't operations and maintenance create noise? I am confused by this statement.	The Project does cause noise from operation and maintenance, but it is currently unknown if there is any effect to nesting goshawks. A goal of this study is to provide information for such an analysis using results of the Sound Assessment study and other information in the License Application.
9.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and Effects on resources	Please see the "link" for above.	See response to Comment #8.
10.	Brock Applegate (WDFW)	04/10/2020	Section 2.4 Project Operations and effects on resources	1st Paragraph – Add: of nest and young	Edit made.
11.	Shauna Hee (USFS)	04/15/2020	Section 2.5 Study Area	What is the basis for the 0.5 mile buffer? The veg study? Please provide justification and references for the 0.5-mile buffer.	This was discussed with the Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) during the formation and editing of the Issue Form (TE16 Northern Goshawk) during the 7/30/2019 TRREWG meeting. The issue also was discussed during the 3/17/20 TRREWG meeting. Noise from typical Project operations and maintenance is expected to attenuate within 0.5 miles to below threshold levels for disturbance to nesting goshawks. See WDFW management recommendations for goshawk nest sites, which recommends a 0.5-mile buffer for active road building and timber operations. https://wdfw.wa.gov/sites/default/files/publications/00026/wdfw00026.pdf Noise generated from other, non-routine work, would be subject to individual project

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					evaluations and will be accounted for in BMPs developed later in the relicensing process.
12.	Shauna Hee (USFS)	04/15/2020	Section 2.6 Methodology	Why does the development of the suitable habitat overlay not take into account historic and current goshawk nest sites and sightings? (Similar to golden eagle study – where have goshawks been located in the landscape?)	This information will be assembled and reviewed as noted in the methods under Section 2.6.1 (Review Scientific Literature) of this study plan.
13.	Brock Applegate (WDFW)	04/10/2020	Section 2.6.2 Identify and Map Potentially Suitable Habitat	4th Paragraph – Add: SCL would create BMPs and guidelines in a Northern Goshawk Management Plan for areas in and near goshawk habitat found in the map format. Recommendations should include surveys, if SCL would conduct future projects, including construction and maintenance and could not avoid impacts. **New comment provided on 05/22/2020:** "During the RWG meeting, Ron asked me to leave a comment about the habitat area that may reside partially inside and outside the 0.5-mile vegetation mapping zone. WDFW made the comment that the vegetation mapping may only partially capture the suitable habitat, because the full breeding area may have small piece in the 0.5-mile vegetation mapping zone and extend beyond the vegetation map. WDFW recommends that SCL investigate and map any suitable habitat for goshawk breeding area described in WDFW PHS Management Recommendations that may have suitable habitat in <u>and</u> outside the 0.5-mile vegetation mapping zone."	Thank you for your comment. Text has been revised to attempt to clarify that the purpose of the study plan is to gather habitat mapping to inform analysis of potential effects on Northern Goshawk and BMP development. The analysis and BMP development will occur in the License Application. We are not certain whether the goshawk BMPs will be in a stand-alone goshawk plan or part of a larger environmental protection and BMP plan for the new license. City Light will consider recommendations for minimizing effects to goshawk nesting habitat and a procedure for assessing potential effects of new construction projects. **Response to comment provided on 05/22/2020:** City Light will make available the GIS data from the Conservation Biology Institute (CBI) that shows old-growth and mature forests to supplement the study mapping. This mapping can be used to look at overall distribution of potential nesting habitat at a larger scale. City Light would use these map products to find potential goshawk breeding areas before construction, maintenance projects that produce noise, such as road maintenance, and herbicide/pesticide applications. This information is inserted into Section 2.6.2.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				During the RWG meeting, Ron asked me to leave a comment about the habitat area that may reside partially inside and outside the 0.5-mile vegetation mapping zone. WDFW made the comment that the vegetation mapping may only partially capture the suitable habitat, because the full breeding area may have small piece in the 0.5-mile vegetation mapping zone and extend beyond the vegetation map. WDFW recommends that SCL investigate and map any suitable habitat for goshawk breeding area described in WDFW PHS Management Recommendations that may have suitable habitat in and outside the 0.5-mile vegetation mapping zone. *Note: identical comment written twice.*	
14.	Brock Applegate (WDFW)	04/10/2020	Section 2.6.2 Identify and Map Potentially Suitable Habitat	I thought we talked about the creation of this kind of product for use by SCL later, when needed.	See response to Comment #13.
15.	Brock Applegate (WDFW)	04/17/2020	Section 2.8 Schedule	Bulleted list - Add: ▪ Initial Study Report (ISR) – March 2022 ▪ ISR Meeting ▪ Study Plan Modification request (if needed) ▪ Additional activities (if needed) ▪ Final Report (if needed) **New comment provided on 05/22/2020:** Why not add these parts to the schedule then?	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis. **Response to comment provided on 05/22/2020:** Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.
16.	Jason Ransom (NPS)	04/14/2020	Section 3.0 References	Delete: Holmgren, A.L., R.L. Wilkerson, R.B. Siegel, and J.I. Ransom. 2017. North Coast and Cascades Network landbird monitoring: Report for the 2016 field season. Natural Resource Report NPS/NCCN/NRR—2017/1495. National Park Service, Fort Collins, CO. Add: Ray, C., Saracco, J.F., Holmgren, M.L., Wilkerson, R.L., Siegel, R.B., Jenkins, K.J., Ransom, J.I., Happe, P.J., Boetsch, J.R., and M.H. Huff. 2018. Landbird population trends in mountain and historical parks of the North Coast and Cascades Network 2005–2016 synthesis. Natural Resource Report NPS/PWR/NRR-2018/1673. National Park Service, Fort Collins, Colorado. 85 p.	Thank you for the information, edits made.

TR-08 SPECIAL-STATUS AMPHIBIAN PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Attachments

Attachment A City Light Responses to LP Comments on the Study Plan

List of Acronyms and Abbreviations

BMP .....best management practice
City Light .....Seattle City Light
DNA .....deoxyribonucleic acid
eDNA .....environmental DNA
ELC .....Environmental Learning Center
ESA .....Endangered Species Act
FERC .....Federal Energy Regulatory Commission
GIS .....Geographic Information System
ISR .....Initial Study Report
LiDAR .....Light Detection and Ranging
LP .....licensing participant
NMWSE .....Normal Maximum Water Surface Elevation
NPS .....National Park Service
NWI .....National Wetlands Inventory
O&M .....operations and maintenance
PAD .....Pre-Application Document
PBF .....physical or biological features
PME .....protection, mitigation, and enhancement
Project .....Skagit River Hydroelectric Project
PSP .....Proposed Study Plan
RLNRA .....Ross Lake National Recreation Area
RM .....river mile
ROW .....right-of-way
RWG .....Resource Work Group
SEEC .....Skagit Environmental Endowment Commission
SGCN .....Species of Greatest Conservation Need
TRREWG .....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C. .....United States Code
USFWS .....U.S. Fish and Wildlife Service
VES .....visual encounter survey
WDFW .....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

The study is designed to address Terrestrial Resources Issue 20 (TE20 Columbia Spotted Frog Survey), and aspects of TE03 (Littoral Riparian Habitat) and FA09 (Littoral and Riparian Habitat). TE20 as identified by Washington Department of Fish and Wildlife (WDFW) suggested that Project operations may affect Columbia spotted frog (*Rana luteiventris*), a WDFW candidate species, if this species occurs at the Project reservoirs and Project effects area. WDFW postulated that the Project may reduce or degrade aquatic, littoral, and emergent vegetation associated with potential spotted frog habitat through the fluctuations of the reservoirs. The study will also provide information on any other amphibians that are observed incidentally or during surveys, including western toad (or boreal toad *Anaxyrus boreas boreas*), a WDFW candidate species, and Oregon spotted frog (*Rana pretiosa*), a federal threatened and State endangered species, and native amphibians that do not have special status. As well, the study will report any detections (visual or auditory) of the non-native American bullfrog (*Lithobates catesbeianus*), a species which, while not documented in the Project area, is expanding its range and has been found in nearby waterbodies. The study partially overlaps and will use information derived from the Wetland Assessment study. The Reservoir Fish Stranding and Trapping Risk Assessment study will also identify potential habitats within drawdown zones on Ross, Diablo, and Gorge lakes that could be used by special-status amphibians. Because Oregon spotted frog is listed as a threatened species under the Endangered Species Act (ESA), information provided by this Special-status Amphibian Study could be used by U.S. Fish and Wildlife Service (USFWS) to fulfill its requirement for ESA compliance for the Project.

On April 10, 2020, City Light released the Special-status Amphibian Draft Study Plan for LP review and comment. On May 6, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 12, 2020. The revised draft was discussed on June 23, 2020 at a TRREWG meeting. Written comments were received from Washington Department of Fish and Wildlife (WDFW), NPS, Sauk-Suiattle Indian Tribe, U.S. Forest Service (USFS), and Upper Skagit Indian Tribe and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date. No formal study requests related to this study were filed with FERC.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of this study are to: (1) identify areas of potentially suitable breeding habitat for the special-status amphibians, Columbia spotted frog and Oregon spotted frog, within the study area; (2) assess the likelihood that either species occurs in areas where there is activity related to Project operations and maintenance (O&M), including at Project recreation facilities; (3) document occurrences of a third special-status species, western toad, and the locations and types of habitats used around the study area; and (4) collect relevant information on populations where these species are found, including numbers, life stages, habitat, and locations. Study results will provide information on special-status and other amphibian species present that will be combined with results of other studies (e.g., Wetlands Assessment, Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way, Reservoir Shoreline Erosion, Sediment Deposition in Reservoirs Affecting Resource Areas of Concern, Reservoir Fish Stranding and Trapping Risk Assessment) to develop appropriate best management practices (BMP) to protect wetlands, streams, and other sensitive habitats, or other protection, mitigation, and enhancement (PME) measures, if warranted. Specific study objectives are listed below:

- Develop a preliminary, working map of potentially suitable breeding habitat (i.e., habitats used for oviposition [egg-laying] and larval rearing) for special-status amphibians within the study area using existing, publicly available aerial imagery, wetland and soil maps, and vegetation data. Potential habitat will also be identified by the results of the Vegetation Mapping and Wetland Assessment studies and analyses of Light Detection and Ranging (LiDAR) data by the Reservoir Fish Stranding and Trapping Risk Assessment study. The preliminary map will indicate discernible wetlands and topographic depressions, as well as general areas, such as gently sloping shorelines, that might support special-status amphibian breeding and could strand and trap amphibians in different life stages. For this preliminary map habitat suitability will be broadly defined by reference to literature accounts that describe habitats successfully used by each special-status species.
- Conduct field reconnaissance in areas where additional information is needed to verify or correct preliminary assumptions of habitat suitability.
- Catalog and map incidental observations of special-status amphibians and other amphibians (including non-native bullfrogs) recorded during the wetland study and other studies during the relicensing.
- Perform a special-status amphibian field survey in areas identified as potentially suitable habitat where there is activity related to Project O&M or at Project recreation facilities and where additional information is needed on species occurrence, relative abundance, and life history timing.
- Prepare a final report including narrative descriptions of field reconnaissance and survey areas and relevant habitat characteristics, information regarding potentially suitable areas that were not surveyed, and final maps. The final maps will show habitat categories mapped by the Vegetation Mapping and Wetland Assessment studies; locations of field reconnaissance and amphibian surveys; and amphibians by life stage detected during surveys, field reconnaissance and by incidental observation.

2.2 Resource Management Goals

City Light will collect information on special-status amphibians in the study area which will be used for the Project relicensing process. Amphibian species with the potential to occur within the study area include Oregon spotted frog, which is a federal threatened and Washington State endangered species. Columbia spotted frog and western toad are State candidate species and also listed as Species of Greatest Conservation Need (SGCN; WDFW 2015), both because of regional declines (Columbia spotted frog in areas of shrub-steppe and western toad in lowlands of the Puget Trough and lower Columbia River Gorge). In general, federal and state management goals are aimed at protecting and achieving recovery of currently listed species, and preventing habitat removal, modification, or disturbance that would lead to future listing of any species.

WDFW's goals for priority habitats and species are to maintain or enhance the structural attributes and ecological functions of habitat needed to support healthy populations of fish and wildlife; maintain or enhance populations of priority species within their present and/or historical range in order to prevent future declines; and to restore species that have experienced significant declines. Amphibians are sensitive to degradation of essential habitats including wetlands, riparian habitat, seeps, and mature forests. Amphibian biomass is available to other trophic levels, which makes them important components of aquatic and terrestrial ecosystems. WDFW management recommendations specific to Oregon spotted frog and Columbia spotted frog were published in 1997 (Nordstrom and Milner 1997a, 1997b).

2.3 Background and Existing Information

As demonstrated in the PAD (City Light 2020) and summarized below, there is a great deal of existing information on the special-status amphibians—Columbia spotted frog, Oregon spotted frog, and western toad.

2.3.1 Columbia Spotted Frog

The Columbia spotted frog is a candidate species for state listing and regarded as a SGCN by WDFW on the basis of regional declines within areas of shrub-steppe habitat, especially in the Columbia basin, although the species reportedly remains common in many places elsewhere in Washington State (WDFW 2015). This aquatic species occurs over a large geographic area and in diverse biomes, including arid scrub and montane forests, with permanent ponds, lakes, or sluggish streams.

There are no confirmed records of Columbia spotted frog on any of the Project reservoirs. However, on May 5, 2012 City Light biologists incidentally observed and photographed two ranid (i.e., frogs of the family Ranidae) egg masses in wetlands associated with the north end of Ross Lake in British Columbia. The egg masses were in a low-gradient drainage channel within an extensive grass-, or sedge-dominated wetland (Tressler 2020). Based on known range of the species and the elevation of the site, these were probably Columbia spotted frog egg masses; although certain identification cannot be established without more information.

Columbia spotted frog is known to occur in the Big Beaver Valley west of Ross Lake, an area of extensive beaver-dammed wetlands. The frogs reportedly could not be reliably field-identified because they shared characteristics with northern red-legged frog (*Rana aurora*) and Cascades frog (*Rana cascadae*) (Holmes and Glesne 1997), but were later determined by genetic analyses

to be Columbia spotted frog (Holmes and Glesne 2000). The results of these genetic analyses are consistent with other information that Columbia spotted frog was the most likely species to occur in this area, whereas Cascades frog is found at higher elevations (e.g., in the Illabot Creek watershed at over 4,900 feet) and rarely occurs below 2,000 feet, and northern red-legged frog typically occurs at lower elevations (Dvornich et al. 1997).

Columbia spotted frogs typically deposit egg masses in vegetated, shallow water locations, including the margins of permanent water bodies and separate seasonal sites, and after hatching larvae require aquatic habitats that persist until at least mid- to late summer to complete metamorphosis. All life stages of this species are typically aquatic, but eggs and larvae are the most sensitive to site drying and changes in water level. Adult and juvenile Columbia spotted frogs are usually found in or near water, except possibly during dispersal.

Habitat suitability for Columbia spotted frog is not precisely described in the literature, in part because this species is so wide-ranging. Movements between essential habitats of Columbia spotted frog populations often follow stream and wetland corridors (Reaser and Pilliod 2005). However, Pilliod et al. (2002) documented individual radio-tagged Columbia spotted frogs at a high montane site (7,620-8,640 feet elevation) in Idaho making direct overland movements of over 540 feet through dry habitats, although some of these frogs stopped at seeps, springs, and isolated pools along the way when these were available (Pilliod et al. 2002). Habitats of Columbia spotted frog may include forested wetlands, but typically only as a component of a larger wetland habitat complex with emergent class wetlands (Reaser and Pilliod 2005).

2.3.2 Oregon Spotted Frog

There are no known historical or extant occurrences of Oregon spotted frog within the study area. Oregon spotted frog has not been documented to occur (including known extirpated populations) at elevations above about 650 feet elevation in western Washington, although there are known populations at higher elevations at Trout Lake and Conboy Lake in the southern Cascades of Washington (i.e., up to about 2,080 feet), and in the Oregon Cascades (i.e., over 5,000 feet). Like Columbia spotted frog, Oregon spotted frog is highly aquatic and generally associated with large wetland complexes (i.e., >10 acres) with areas of permanent water, vegetated shallows, and aquatic connections. Oregon spotted frog has been described as a warmwater marsh specialist, associated with sites where water is warm (i.e., 20-35˚C) during the late spring and summer season, when the frogs are active (Pearl and Hayes 2005).

Oregon spotted frog populations were first discovered in western Whatcom and adjacent Skagit counties in 2011 through 2013 at multiple sites in three lowland watersheds: the lower South Fork Nooksack River, Sumas River, and the upper Samish River (Bohannon et al. 2016). These and subsequent discoveries (unpublished WDFW data, 2015-2019) in the same watersheds resulted from one or more surveys per site within suitable habitat. Known historical occurrences of Oregon spotted frog in the Skagit River watershed near Mount Vernon, Sedro-Woolley, and Concrete are considered extirpated (Hallock 2013) and Oregon spotted frog was not detected by egg mass surveys of other sites in the Skagit Valley, including City Light surveys of wildlife mitigation lands in 2011 and repeat surveys of some of these sites in 2012 (unpublished WDFW data).

Contrary to expectations, Ovaska et al. (2019) found genetic evidence of Oregon spotted frog at one of 16 sampled water bodies in the upper Skagit basin in Canada. The site was located less than

2 miles north of Ross Lake and 2.75 miles north of the international border in British Columbia. This genetic evidence consisted of detections of environmental deoxyribonucleic acid (DNA) (eDNA) positive for Oregon spotted frog in two of three years, which suggested the species may be present[1], and DNA from a swab of a captured frog. The site is a beaver-dammed wetland on a tributary of the Skagit River at about 1,640 feet elevation. Columbia spotted frog was also detected by DNA from swabs of 3 captured frogs at the same site, but was not detected by eDNA at the site. Ovaska et al. (2019) reported that eDNA tests for Columbia spotted frog exhibited a high level of false negatives, detecting Columbia spotted frog in only 37 percent of sites where the species was observed to occur. Oregon spotted frog is otherwise only known to occur in Canada in the lower Fraser Valley in extreme southwestern British Columbia and has not been found previously at any sites with Columbia spotted frog in Canada or the US. Possible contact between the species, including hybridization and genetic introgression, has not been studied.

The final critical habitat rule for Oregon spotted frog (81 FR 29335) identified three physical or biological features (PBF) essential to the conservation of the species that may require special management considerations or protection. Formerly called "primary constituent elements", these PBFs include:

- Permanent or seasonal water bodies holding water continuously for a minimum of four months, which corresponds to the time of year required for eggs and larvae (generally, as early as February and as late as September) with:
  - Shallow water up to 12 inches deep (or up to 12 inches over vegetation in deeper water),
  - Gradual topographic gradient, and
  - If seasonal, hydrologic connection to deeper, more permanent water;
- Aquatic movement corridors up to 3.1 miles from breeding habitats and free of impassable impediments; and
- Habitat characteristics that provide refuge from predators.

Other considerations include vegetation conditions in potential oviposition habitats, which may limit or preclude egg-laying if the previous year's emergent growth remains tall and dense, or, where bent-over, completely covers the water. Most known Oregon spotted frog populations in lowland western Washington occur at sites with a recent history of livestock grazing, hay production, or mowing, which reduce reed canary-grass (*Phalaris arundinacea*). However, at a few sites with no apparent management of reed canary-grass, oviposition habitat is associated with submerged, flattened grass floating near the surface in unusually deep water. Seasonal habitats of Oregon spotted frog occasionally include forested wetlands within larger wetland complexes (Hallock 2013).

Habitat requirements of Oregon spotted frog and Columbia spotted frog are similar and are summarized in Table 2.3-1. Oviposition sites of both spotted frog species are typically located in shallow, still-water (occasionally in flowing streams), close to shore, gently sloped, where herbaceous vegetation is submerged or short-statured emergent when oviposition occurs, and

[1] Ovaska et al, 2019 notes that eDNA cannot be used to detect Oregon spotted frog if Columbia spotted frog also occurs at a site.

where exposed to sunlight. Populations of both species typically use additional habitats during non-breeding periods and these habitats may be essential to the species.

Table 2.3-1. Spotted frog species habitat requirements by life stage.

Egg Masses[1]	Larvae[1]	Juveniles/Adults[1]
Typically in clusters (i.e., piles of egg masses of multiple females) in unshaded, relatively shallow water, often 2-10 inches deep. May be found in deeper water because of water level changes, if egg masses drift, or where mats of submerged vegetation float near the surface. Egg mass substrate is usually submerged herbaceous vegetation (e.g., grasses or sedges). Associated with permanent or seasonally drying water bodies with still- or slowly-flowing water including lake or pond edges, marshes, streams, springs, and floodwater pools. Hatching occurs in about 8-24 days.	Early stages may remain in or near oviposition sites, but larvae may subsequently disperse distances of 100s of feet. May favor areas of shallow, warmer water, especially where there is hiding cover in the form of vegetation, detritus, or soft substrates. Columbia spotted frog larvae reportedly metamorphose 70-100 days after hatching and Oregon spotted frog larvae in 90-130 days. After metamorphosis, young-of-year may remain in the same habitat or emigrate as pools dry.	Occur in more varied habitats than other life stages but usually in or near water. In addition to use of breeding and larval rearing habitats, may be found in areas with taller emergent vegetation, especially where inter-mixed with wetland shrubs; in aquatic vegetation beds, and on fringes of deeper permanent water bodies. May bask for long periods or hide in dense vegetation. Both species may migrate long distances seasonally, but may be relatively sedentary in summer. Overwintering habitats include springs, streams, lakes, ponds, and shallow marshes that do not freeze completely.

1 Sources: Watson et al. 2003; Reaser and Pilliod 2005; Pearl and Hayes 2005; Pearl et al. 2007; Pearl et al. 2009; Popescu et al. 2013.

2.3.3 Western Toad

Western toad presumably occurs at Ross Lake, based on a few images of post-metamorphic individuals from City Light biologists and publically posted and verified images on iNaturalist, and also occurs at sites in Big Beaver Valley (Holmes and Glesne 1997). The species has also been detected anecdotally elsewhere in the Project Area over the last 20 years. Western toad breeding habitats are diverse, including seasonal to permanent ponds, small to large lakes, low gradient streams, side channels and backwaters of large rivers, rain pools, and various anthropogenic habitats such as ditches, tire ruts, and stock ponds (COSEWIC 2002, Jones et al. 2005, Muths and Nanjappa 2005). Common features of these habitats are still- or very slowly flowing water, shallow edges, prolonged sun exposure, and water levels that do not rapidly fluctuate. On lakes and ponds surrounded by forests, north and east shores are typically favored because of longer sun exposure. Breeding habitats may contain submerged aquatic vegetation or lack vegetation entirely (Hawkes and Tuttle 2013). Barren sites far from hiding cover (e.g., dense vegetation, small mammal burrows, or rock slides) may not be suitable (Rombough 2012). Western toads often breed in successive years at the same sites, but may also quickly exploit newly constructed ponds (Pearl and Bowerman 2006). Eggs are laid at sites where water temperatures are relatively warm and generally later than sympatric ranid frogs (Rombough 2012), with seasonal timing affected by latitude, elevation, and local conditions. For example, at lowland, stream-associated sites, breeding may be delayed until after springtime flows subside, but occur soon after spring thaw at some high elevation sites. As summarized by Muths and Nanjappa (2005): (1) egg laying is often communal; (2) depending on temperature, hatching occurs in 3-12 days; (3) the tadpoles, which exhibit distinctive schooling behavior, develop rapidly (30-45 days); and (4) the transformed toads often

aggregate on the shores of the natal site before emigrating en masse. Western toads are largely terrestrial after metamorphosis.

2.4 Project Operations and Effects on Resources

It is unknown whether suitable habitats for either spotted frog species occur in the study area. However, if spotted frogs or western toads occur, depending on the location, operational changes in water level could strand or deeply flood egg masses, or strand larvae, depending on life history timing. Other potential Project-related effects include recreational activity at Project recreation facilities, vegetation management and routine O&M on the transmission line access roads if adjacent to breeding habitats.

2.5 Study Area

This study will occur within the Project Boundary with emphasis on locations where suitable habitat and potential Project effects may intersect (Figure 2.5-1). This may include areas on the fringes of the Project reservoirs (including depressions in drawdown zones and littoral zones), Project recreation facilities (as defined in the Recreation Use and Facility Assessment study), areas adjacent to Project facilities and roads, within the transmission line right-of-way (ROW), wetlands affected by ongoing Project operations, and wetlands hydrologically connected to the Skagit River between Diablo Powerhouse and the Sauk River confluence. The wildlife mitigation lands are not included in the study area because no Project effects occur in these areas; in addition, previous surveys completed by City Light in 2011-2012 covered wetlands on the properties and found only one ranid species – northern red-legged frog. Field reconnaissance and survey locations will be determined based on the occurrence of suitable habitat, intersection with potential Project effects, and logistical constraints (e.g., safely accessible and permitted by the landowner, if located on private lands).

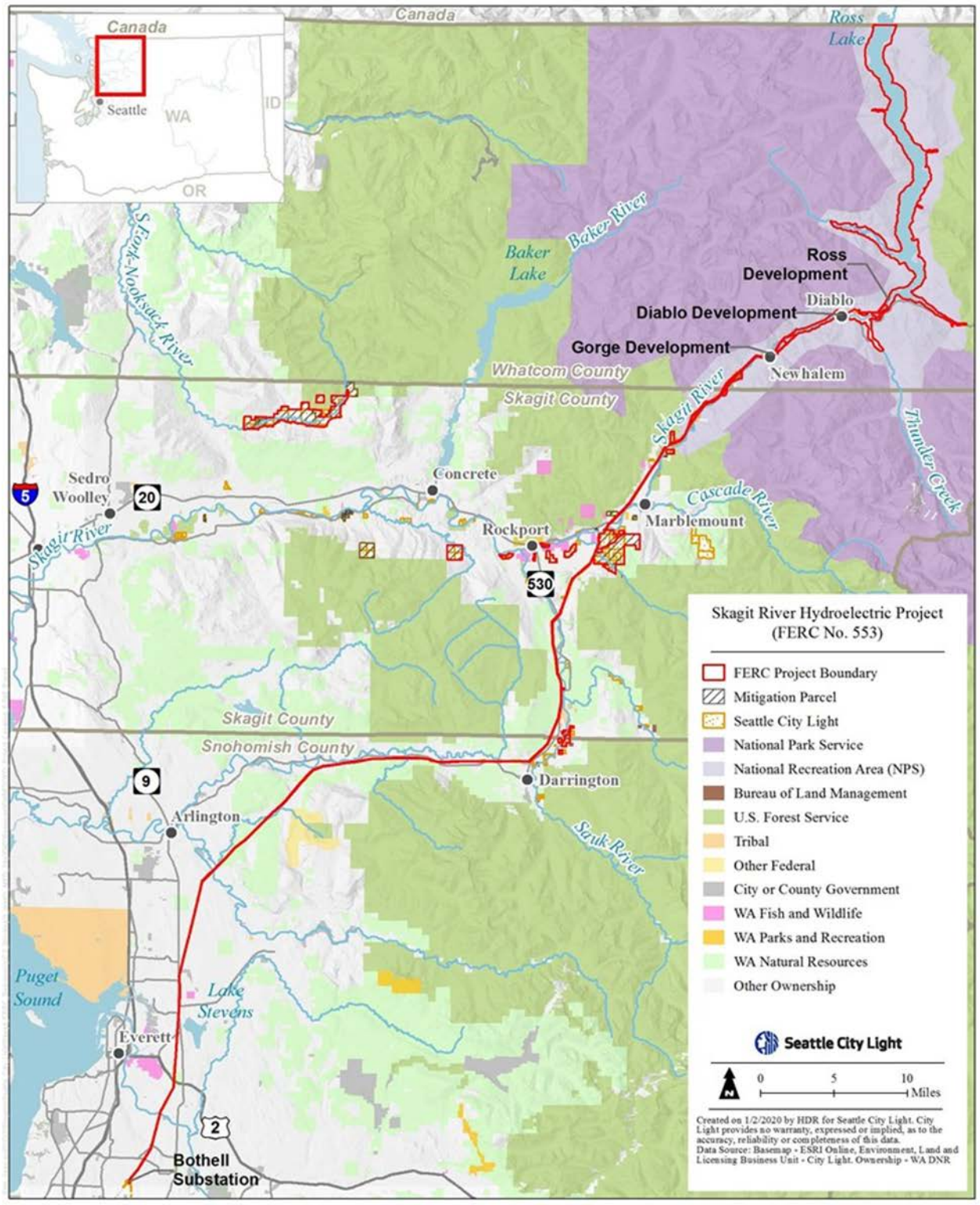

Figure 2.5-1. Location map of the Skagit River Project.

2.6 Methodology

The Special-status Amphibian Study will be performed in the following steps. Field data will be subject to quality assurance/quality control procedures, including spot-checks of transcription and comparison of Geographic Information System (GIS) maps with field notes to verify locations.

2.6.1 Identify and Map Potentially Suitable Habitat

Potentially suitable habitat for special-status amphibians will be identified and mapped within the Project Boundary beginning with a desktop GIS analysis of vegetation mapping and LiDAR, and historical reservoir pool level data. This analysis will use existing, publicly available information, including aerial imagery, vegetation data from the NPS, National Wetlands Inventory (NWI) maps, and soil survey maps, as well as information collected by the Vegetation Mapping and Wetlands Assessment studies to be performed in 2020. Mapping will include potentially suitable breeding habitats for the spotted frog species, for which mapping criteria are available, and more generally for western toad, for which mapping criteria are not as well defined and include characteristics and features that may not be detectable by remote source data. Around the Project reservoirs mapping will identify habitats that might support western toad breeding associated with broad, gradually sloped areas and depressions that hold water when reservoirs levels are below normal maximum water surface elevation. For other areas within the Project Boundary, including along the transmission line, mapping will note stream and wetland types that might be used by western toad. The purpose of the resulting maps is to guide the next steps of the study, beginning with field reconnaissance, and does not represent a final product of the study.

Work products of this step of the study will include GIS maps of wetlands with potentially suitable amphibian habitats indicated.

2.6.2 Reconnaissance and Incidental Observations

A field reconnaissance will be performed in areas where additional information is needed to verify habitat suitability. Field reconnaissance differs from formal surveys as it allows for a relatively quick assessment of site conditions and logistical considerations, prioritization of areas for sampling, and initial species observations. For example, field reconnaissance on a warm summer day may be more likely to document frogs than a spring egg mass survey. Field reconnaissance also provides an opportunity to detect tadpoles of various species because this life stage may be present at a site for a longer period than other stages. Western toad is later breeding than other species and has other features (see Section 2.3 of this study plan) that complicate survey timing and design, particularly at large sites, and may be as readily detected by reconnaissance (e.g., observations of schooling tadpoles) as by a survey.

Incidental observations of spotted frogs and other amphibians recorded during the Wetlands Assessment and other studies during the relicensing will also be catalogued and mapped by location, and summarized in the study report.

Work products of this step of the study will include GIS maps indicating areas that were examined during field reconnaissance and locations of amphibian observations, field photographs of amphibians and habitats, summary notes regarding site conditions and habitat suitability, and site conclusions regarding the need for any formal amphibian surveys and site-specific survey

methods. Prior to designating specific survey sites, maps and summary findings of field reconnaissance will be presented to the Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) for review and discussion.

2.6.3 Amphibian Surveys

Suitable habitats or, if extensive, a representative sub-set of total habitat, will be sampled as needed to determine species occurrence, identify the target species, and to collect additional information on life history habitat use and relative abundance. All amphibians found during surveys, as well as incidental detections during other studies, will be recorded, along with location information. Although field methods are focused on the two spotted frog species, they are generally applicable to other species that may occur. Because western toad egg-laying within the Project reservoirs would be difficult to predict by time or location, surveys will emphasize detection of tadpoles, as well as opportunistic sightings during field reconnaissance and survey. As described in Section 2.6.4 of this study plan, documentation will include photographic vouchers if possible, as well as photographs of habitat. Field surveys will be conducted in appropriate seasons for the target species and under suitable temperature and weather conditions that allow for observations. Surveys on warm (20-30˚C), sunny or partial sunny days with minimal wind generally provide the best opportunity to observe post-metamorphic spotted frogs of either species. Similarly surveys for egg masses will not be performed under conditions that obscure detections, such as heavy rain and wind. Multiple survey visits will be performed as needed to account for seasonal differences in detection and to describe timing of major life history events. It is anticipated that surveys will include two visits in summer (e.g., June and July) for detection of larvae, adults, and juveniles. Sites accessible earlier in the season when egg-laying may occur (i.e., late April or early May), may also be surveyed at that time. If surveys at a site do not detect spotted frogs, but the results are inconclusive (e.g., survey timing was compromised or there were possible sightings that could not be verified), additional visits may be conducted later in the season or a second year of surveys at the site (up to two visits) may be warranted. Visits may include the field reconnaissance or visits during the Wetland Assessment study if these visits provide sufficient information to meet the study objectives. In addition, a subsequent survey will not be performed if the first site visit indicates the site is not suitable.

Survey methods will include visual encounter surveys (VES) and dip-netting and may be supplemented by use of aquatic funnel traps for sampling larvae (Graeter et al. 2013). This approach is generally consistent with the presence survey methods described for Oregon spotted frog by Pearl et al. (2010) and for both species by Rombough (2012), and should be well suited for surveys at Ross Lake, where access during the period when egg-laying may occur is likely to be difficult to impossible. These sources recommend survey timing based on the length of time and ease with which each life stage is likely to be detected, especially in areas not previously surveyed. For spotted frogs, at least in the higher elevation and interior regions the sources discuss, adult and juvenile stage frogs are most easily detected and for a longer period; followed by larval stages, which may be localized, but can be detected for three months or more; and egg masses are most difficult to detect because they may be present at some sites for only two to four weeks, a period sometimes difficult to predict, and may be concentrated in one or just a few locations. Pearl et al. (2010) recommend two or more summer surveys and, if Oregon spotted frog is not detected in suitable habitat, one or more surveys the following year. VES will be performed in suitable habitats following procedures for Northwestern habitats and species by Olson et al. (1997).

Generally, a VES for amphibians provides data on the number of egg masses, larvae, and post-metamorphic stages (juveniles and adults) of each species observed *in situ* or captured by dip-net by searching for a prescribed period of time. Areas with limited habitat will be searched completely, whereas large areas of contiguous suitable habitat may require sub-sampling of representative habitat types (e.g., by depth and dominant vegetation) and geographic sub-division. Data may also be represented as the number found per unit time to allow comparison of sites.

In addition to visual detection, amphibians will be documented by auditory means. The three special-status species are not typically detected by calls: male western toads do not call and the spotted frog species have relatively weak calls that do not carry long distances and are generally not produced over a long period. However, Pacific chorus frog (*Pseudacris regilla*) and the non-native American bullfrog and green frog (*Lithobates clamitans*) have calls that can be heard at longer distances and over longer periods, aiding detection. Juvenile American bullfrogs also produce a high pitched "squawk" or "chirp" and leap into the water when alarmed, a behavior that can be elicited by walking along the shoreline of a site.

Because amphibian larvae are often under-detected by visual searches in dark, clouded, or vegetation-filled water, surveys for sampling larvae usually include rigorous dip-netting and may be supplemented by use of aquatic funnel traps. Aquatic funnel traps are an adjunct to active searches and can increase the number of sites that can be surveyed effectively, including surveying deeper water where dip-netting is ineffective. Trapping also sometimes reveals species or life stages (e.g., large larvae) that may escape detection by other means. Traps will be deployed in the afternoon or early evening, situated in a variety of suitable microhabitats, and secured to vegetation or sticks as needed to maintain an air pocket in the trap (a precaution to prevent mortality). After a night in place, traps will be pulled and the contents tabulated and released. Trapping for shorter periods during the day can also be effective for sampling spotted frog larvae and may be used at some locations instead of over-night trapping. Decisions regarding use of traps will be based on a determination that trapping could provide substantially more information on amphibian use of a site or do so more efficiently than other means.

In the event that spotted frog life stages are not found at sites associated with Project reservoirs with suitable breeding habitat, these sites or a representative sub-sample of these sites will be sampled for the presence of Columbia spotted frog and Oregon spotted frog eDNA. At each qualifying site, three replicate 1 liter water samples will be collected. Each sample will pass through filter membranes and will be analyzed for eDNA by a qualified genetics laboratory.

If surveys for Oregon spotted frog are warranted in lowland sites (e.g., associated with the transmission line), surveys will follow the WDFW (undated) "Survey Protocol for Detecting Presence of Oregon Spotted Frogs by Identifying Oviposition Sites." This is the recommended method for Oregon spotted frog surveys of lowland, western Washington watersheds known or suspected to be occupied by the species, and the higher elevation known populations at Conboy Lake and Trout Lake. This methodology offers ease of use, can be performed with little or no handling and low risk of adversely affecting the species or its habitat. Results provide information on presence and an estimate of adult population size. Presence of Oregon spotted frog may be detected with a single, well-timed survey or may require multiple surveys. This protocol relies on

information that is shared among the Washington Oregon Spotted Frog Working Group[2] to help determine when surveys should begin in an area. For example, Oregon spotted frog breeding typically begins at the earliest sites in western Whatcom County within about two to three weeks after the start of breeding in Thurston County, while other sites in Whatcom County may begin more than a week later. Over a nine-year period, the earliest recorded breeding in western Whatcom County occurred on February 26 or 27 (2015, 2016), March 4-6 (2012, 2020), March 11-13 (2013, 2014, 2017, 2018), and March 17 (2019). Pre-survey monitoring is frequently used to further "fine-tune" survey timing, including collection of water temperature data and observations of initial frog activity (e.g., detections of male Oregon spotted frogs gathering at breeding sites). Data to be recorded during amphibian surveys will include macrohabitat type description, survey method(s), weather (current and within past 24 hours), air temperature (start and end), water temperatures, and distance, area or percentage of site searched, as applicable. Search paths will be recorded as Tracks by a handheld consumer-grade GPS unit. Habitat data will include primary substrate, dominant vegetation, emergent vegetation cover (percentage), water color and turbidity (qualitative). Aquatic funnel trap data will be recorded by individual trap, including geographic coordinates, water depth, and trap contents.

Work products of this step of the study will include GIS maps indicating locations and results of amphibian surveys (i.e., survey locations, dates, and times, survey effort, locations and numbers of amphibian observations by species and life stage), field photographs of amphibians and habitats, and related field notes.

2.6.4 Identification and Handling of Amphibians

Amphibians will be identified in the field based on information contained in Jones et al. (2006), Altig et al. (undated), Rombough (2012), and authoritative on-line sources (e.g., https://whatfrogs.wordpress.com), as well as personal experience of the lead investigator. Identification of ranid tadpoles includes reference to labial tooth row formulae and other technical differences which may vary according to stages of development. To provide for vouchered identification and enumeration, samples of tadpoles will be photographed in a glass bowl or tray, including a view from above along with a ruler, from below, and from the side. Representative and unusual specimens of adult or juvenile amphibians (e.g., frogs displaying characters that may indicate hybrid forms) will also be photographed.

In practice, spotted frogs are typically field identified by differences in geographic range of the two spotted frog species, which are not known to overlap or be in contact, not by differences in morphology, coloration, or behavior. If Oregon spotted frog surveys are warranted at lowland sites outside of the range of Columbia spotted frog, photographs of ranid egg mass clusters are considered definitive evidence of Oregon spotted frog, especially if tracked to hatching (WDFW undated) (Oregon spotted frog is the only ranid species in lowland western Washington that lays eggs communally). An experienced surveyor will also be able to differentiate Oregon spotted frog egg masses from egg masses of the northern red-legged frog, the only similar egg masses at lowland sites. Because any finding of Oregon spotted frog would represent a "new" population, a

[2] The Washington Oregon Spotted Working Group (or Work Group) is an informal information exchange and species recovery network organized and facilitated by USFWS (Teal Waterstrat) and WDFW (Lisa Hallock). Group members represent public agencies, non-governmental organizations, landowners, and researchers who work with Oregon spotted frog in Washington and British Columbia.

genetic sample (e.g., embryos from an egg mass) would be collected in coordination with WDFW and USFWS through the Washington Oregon Spotted Frog Working Group.

Green et al. (1997) state that Columbia spotted frog and Oregon spotted frog are morphologically indistinct. However, Hayes (1994) indicated that Oregon spotted frogs are characterized by mottling on at least some part of the ventral abdomen, whereas Columbia spotted frogs lack this mottling. The extent of mottling, which is not retained in preserved specimens, may vary individually, but generally increases with age; and may be faint in frogs under stress. The efficacy of this characteristic to differentiate the species in the field throughout Washington has not been tested. Amphibian field guides also do not provide distinguishing characteristics to separate the species. To address identification issues in areas within the range of Columbia spotted frog, ranid frogs that are found during the study will, when possible, be documented with photographic vouchers that include dorsal, ventral, and lateral views. For spotted frogs (adults, juveniles or young-of-the-year) found at sites associated with the Project reservoirs, the surveyors will also take a skin swab sample for DNA analysis.

Similarly, tissue samples will be collected from tadpoles (i.e., the tip of the tail removed with sterile dissecting scissors) and from egg masses (i.e., a small number of individual embryos removed from the egg mass jelly). These tissue samples or skin swabs will be collected in separate, labeled, sterile vials when spotted frog life stages are found and will be preserved for genetic analyses. Samples will be provided to a laboratory recommended by WDFW that is qualified to make identifications. If embryos are collected for genetic analysis, the number of embryos will include no more than five per egg mass.

The following protocols will apply to documenting survey results and incidental sightings, including proper handling of amphibians. Prior to possible capture and handling of amphibians, the surveyors hands should be cleaned of any chemicals (e.g., insect repellant, perfumes, lotions, etc.) or residue of a previous amphibian capture, and rinsed with water, and must be kept moist during handling. Tadpoles are delicate and will be handled as little as possible (e.g., tadpoles captured by dip-net can typically be viewed within the net or a smaller aquarium net and transferred directly to a water-filled glass tray or clean zip-lock plastic bag).

Where possible, observations will be supported by photographs of the animal *in situ*. Oregon spotted frog and Columbia spotted frog are remarkably tolerant of a gradual, close approach for photographing and capture. A well-practiced surveyor will slowly approach and capture the frog by hand or dip-net (depending on the size of the frog, water depth, skill of the surveyor, etc.). Captured frogs may be temporarily held (ideally for 30 minutes or less) in separate, clean containers (e.g., zip-lock plastic bags) through which initial photographs may be taken. When handled for photographs, spotted frogs will be held gently, but securely around or slightly below the "waist" with the legs outstretched on the palm, so that the frog cannot kick or twist itself free and (for large frogs) using the other hand to support the upper part of the frog. Frogs will be photographed from multiple views.

For frogs being sampled for DNA, the surveyor will use a new pair of disposable gloves when handling frogs. Frogs will be swabbed 30 times on the underside with a sterile cotton swab to dislodge skin cells. Swabs will be air-dried and placed within individual, labeled, pre-sterilized

vials. Frogs will then be released at the original capture location. Samples will be held in a dark, cool place (e.g., a cooler) until analysis.

To enable reliable reporting of incidental sightings of amphibians by other field crews, an incidental field form and identification aids for all species will be provided. Procedures will also be specified for recording geographic coordinates, vouchering sightings with photographs, and regularly reporting sightings to the Special-status Amphibian study lead. All reported incidental sightings will be evaluated for accuracy by the study lead.

Prior to initiating field surveys, the lead investigator will obtain a NPS, USFWS, and Washington State Scientific Collection Permit, which will also list other survey participants, and all of the surveyors will adhere to the guidelines stipulated in the permit. Qualifications will include prior amphibian survey experience, familiarity with the target species and other amphibian species that may occur, and identification of species by life stage. Field activities will adhere to accepted field-gear cleaning and disinfection procedures to prevent the spread of amphibian pathogens (e.g., Murray et al. 2011). Traps, dip-nets, boots, waders, and other field gear will be cleaned and disinfected prior to each field period. All gear will be cleaned and then treated prior to field use either with quaternary ammonium (Quat-128) disinfection solution or freshly-prepared 10 percent bleach. Gear used at multiple sites during a day will be cleaned and disinfected between sites unless the sites are associated with the same water body (e.g., the same reservoir or the same stream system). Specimens will be released alive at collection sites immediately after data collection, except for any embryos collected for genetic analyses.

Study products for this study include:

- A report summarizing results of the study including:
  - Narrative description of field reconnaissance and survey areas and relevant habitat characteristics; and
  - Survey effort, timing, weather conditions, and species documented.
- GIS maps of wetlands with the following indicated:
  - Wetland and stream classification categories;
  - Areas examined during field reconnaissance for potentially suitable amphibian habitats;
  - Locations of amphibian observations; and
  - Locations and results of amphibian surveys.
- Photographs of amphibians and habitats;
- Summary notes regarding site condition and habitat suitability assessments; and
- A list of incidental observations of wildlife.

2.7 Consistency with Generally Accepted Scientific Practice

The study approach described above is consistent with methods commonly employed for inventory surveys of amphibians and comparable to approaches adopted in other FERC relicensings, including the Baker River Hydroelectric Project (FERC No. 2150) and Henry M. Jackson Hydroelectric Project (FERC No. 2157), and methods for Oregon spotted frog surveys used during licensing of the proposed Calligan Creek Hydroelectric Project (FERC No. 13948) and Sunset Fish Passage and Energy Project (FERC No. 14295). The study also includes survey methods that are commonly used for scientific studies of Oregon spotted frog and Columbia spotted frog.

2.8 Schedule

- Desktop Analysis (Identify and map potentially suitable habitat) – Summer 2020 (coordinated with Wetland Assessment study)
- Field Reconnaissance – Summer 2020 (coordinated with Wetland Assessment study)
- Field Surveys (Oregon spotted frog egg mass surveys, where warranted) – March to April 2021
- Field Surveys (reservoir sites and any associated sites) – April to July 2021
- Analysis – September to December 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $125,000. *[Depending on the number of sites.]*

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SPECIAL-STATUS AMPHIBIAN PROPOSED STUDY PLAN

ATTACHMENT A

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	05/10/2020	Section 1.2 Relicensing Process	1st paragraph - Delete: effort Add: consultation	Change made in different location of sentence and paragraph. Text modified to include discussion and consultation.
2.	Ashley Rawhouser (NPS)	5/13/2020	Section 1.3 Study Plan Development	As previously discussed throughout the collaborative process, NPS requests that habitat assessments and surveys be conducted for all amphibian species that could be affected by fluctuating reservoir levels, dewatering of the Bypass Reach, ramping in Skagit River, the floodplain and channel migration corridor of the Skagit River, and all roads and infrastructure associated with the Skagit Hydroproject including powerline corridors. These species should include those with a with a range that overlaps or is adjacent with the project boundary and the area inundated in BC by Ross Reservoir including those portions of the Skagit River that are influenced by reservoir elevations. Given SCLs desire for a 50 year license identifying potential range expansions of non-native species near the project boundary and changes in habitat use and range shifts of native species will be important for developing and implementing PMEs. Not only will it be important to understand competition and predation between native and non-native species but also competition and predation among native species. We will also need to understand if the reservoirs and power line corridors are impacting connectivity for amphibian species and if these areas are functioning as a sink for the populations that occur near the project. These species should include: Ambystoma gracile Northwestern salamander Ambystoma macrodactylum Long-toed salamander Ascaphus truei Tailed frog Anaxyrus boreas Western toad Dicamptodon tenebrosus Pacific/Coastal giant	The goal of the proposed study is to identify areas of potentially suitable breeding habitat for the special-status amphibians and provide information useful for assessing ongoing Project effects to those species. City Light does not believe there is justification for long-term ecological studies requested by the NPS given the lack of demonstrated Project effects. The requested far-reaching inventory of all amphibian species that may occur, regardless of conservation status or life history habitat association is unwarranted for hypothesized effects. However, surveys will document all amphibian species observed so there will be additional data for species that are not special-status. The amphibian study in combination with five other studies – Vegetation Mapping, Wetland Assessment, Reservoir Shoreline Erosion, Reservoir Fish Stranding and Trapping Risk Assessment, and Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way studies – will be used to characterize habitat conditions for amphibian species in the FERC Project Boundary as well as Skagit River floodplain wetlands downriver to the Sauk River and be used to assess effects in the DLA and develop appropriate protection, mitigation, and enhancement (PME) measures and best management practices (BMP). Future BMPs could include additional assessments where

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				salamander Plethodon veniculum Western red-backed salamander Pseudacris regilla Pacific (Chorus) tree frog Rana aurora Red-legged frog Rana cascadae Cascade frog Rana pretiosa Oregon Spotted frog Rana luteiventris Columbia spotted frog Taricha granulosa Rough-skinned newt Ensatina eschscholzii Ensatina Rana catesbeiana Bull frog (introduced) Rana clamitans Green Frog (introduced) We agree with SCL and WDFW that *[Note: NPS comment ends here.]*	proposed ground disturbing activities overlap important amphibian habitats. While areas north of the international border are outside of FERC or other U.S. agencies jurisdiction, City Light has already gathered existing reports on amphibians for the Skagit Valley Provincial Park to provide additional context. City Light cannot conduct field data collection in Canada but will explore options to obtain select information on wetlands and amphibians north of the international border through coordination with the Skagit Environmental Endowment Commission (SEEC) and BC Parks. The Project has existed for many decades and many amphibian species are persisting throughout the watershed. For example, a genetic study of tailed frogs in streams along and below Project dams by Grummer and Leache (2017) concluded that "…population connectivity is high throughout the North Cascades National Park Service Complex." City Light believes that the combination of studies will provide adequate information on the location of habitat for special-status amphibian species and habitat conditions for wetlands, shorelines, stream crossings along the transmission line and other sites in the Project Boundary for assessing effects of continued operation of the Project and to develop PMEs and BMPs. City Light would appreciate receiving any specific documentation of Project effects on amphibians that might be helpful for this study and analysis.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
3.	Emily Wirtz (Sauk-Suiattle Indian Tribe)	04/28/2020	Section 1.2 Relicensing Process	Why is the font different on this line?	SharePoint sometimes displays different fonts when viewing in browser. Recommend viewing in app.
4.	Brock Applegate (WDFW)	05/10/2020	Section 1.3 Study Plan Development	1st paragraph – Add: and Project effects area. Add: due to the fluctuation of the reservoir and the spread of the very invasive reed canarygrass and may allow fish access to Big Beaver Wetland. **New comment provided on 06/23/2020:** Reservoir tributary back flow, wind, or beavers can spread reed canarygrass up the Big Beaver Creek. In addition, the back up of tributary water has allowed fish passage into Big Beaver Creek and the wetlands. Although SCL has noted that reports of Cutthroats and spotted frogs have lived together twenty years ago, red-side shiners have increased the size of the fish in the reservoir. Bigger resident trout and bull trout may cause additional mortality of all life stages of spotted frog, with an additional degradation of habitat by reed canarygrass.	Thank you for the comment. First edit accepted. City Light does not agree that Project reservoir fluctuation has a documented effect on spread of reed canarygrass. WDFW has not provided any evidence or mechanism of how Project operations are foreseeably spreading reed canarygrass to wetlands upstream of the Project in the Big Beaver Valley. City Light would appreciate any information on this topic. **Response to comment provided on 06/23/2020:** Most of the wetlands within Big Beaver Valley are not adjacent to Big Beaver Creek and are not discernibly connected by channels to the creek. As such these wetlands may not be accessible to fish from Ross Lake. City Light would appreciate any evidence that fish are now more widely distributed in the wetlands in Big Beaver Valley or that these fish are causing spotted frog mortality. For reed canarygrass, please see response to Comment #26.
5.	Brock Applegate (WDFW)	05/10/2020	Section 1.3 Study Plan Development	WDFW listed western toad as State Priority and Candidate Species for listing. WDFW recommends that SCL map breeding habitat. SCL cannot know where to apply any PMEs or surveys unless they have	Around the Project reservoirs preliminary mapping from wetland characterization and fish stranding risk studies will identify potentially suitable habitats for special-status amphibians. This will include habitats that

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				breeding habitat mapped, especially when SCL has survey crews on the ground, who can verify habitat.	might support western toad breeding associated with broad, gradually sloped areas and depressions that hold water when reservoir levels are below normal maximum water surface elevation (NMWSE). These areas will be subsequently examined to verify suitability and to determine locations for surveys. (See also Response to Comment #42). Occurrences of western toad life stages will be mapped, which will likely indicate specific locations of breeding habitat as well as the types of habitats that are used. The study report maps will also show the National Wetlands Inventory (NWI) wetland and stream classification categories, or the categories as further refined or corrected during the Wetland Assessment study. As explained in the study plan, there are limited predictive criteria with which to identify where western toad breeding may occur.
6.	Shauna Hee (USFS)	05/10/2020	Section 1.3 Study Plan Development	Target amphibian frog species - not much available information that would suggest they may have been common in project area, but given that there has not been comprehensice studies, this proposal may be advantageos to better define habitat use. While other amphibians would be tallied, added attention might be targeted to invasives such as the bullfrog which is predator of the focus frog species during different life stages.	The study and incidental sightings will document any amphibian detected by survey or incidentally, including American bullfrog. Separate from the relicensing studies and due to the concern of American bullfrog range expansion, City Light is initiating annual periodic monitoring of wetlands on its fish and wildlife mitigation lands, which may include visual/auditory surveys, the use of AudioMoths, and soliciting sightings from the public. AudioMoths, electronic, programmable acoustic monitoring devices (Hill et al. 2018, 2019), will be deployed at selected sites. This methodology will allow for prolonged periods of monitoring male

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					territorial advertisement calls at sites where American bullfrog presence is suspected or where there is concern for invasion from adjacent areas outside of the Project Boundary. (Hill, A.P., P. Prince, E.P. Covarrubias, C.P Donaster, J.L. Snaddon, and A. Rogers. 2018. AudioMoth: evaluation of a smart open acoustic device for monitoring biodiversity and the environment. Methods in Ecology and Evolution 9:1199-1211. <https://doi.org/10.1111/2041-210X.12955>; Hill, A.P., P. Prince, J.L. Snaddon, C.P. Doncaster, and A. Rogers. 2019. AudioMoth: a low cost method for monitoring biodiversity and the environment. HardwareX 6:1-19. https://doi.org/10.1016/j.ohx.2019.e00073). Monitoring for non-native amphibians at mitigation lands may be included in the updated Mitigation Lands Management Plan. City Light is also willing to coordinate with NPS and other entities to initiate monitoring in other portions of the Project Boundary.
7.	Brock Applegate (WDFW)	05/10/2020	Section 2.1 Study Goals and Objectives	1st paragraph – Add: , western toad, Add: all three of the special-status	See response to Comment #5.
8.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.1 Study Goals and Objectives	This is pretty vague. Can you define what relevant info is?	Thank you for your comment. Text has been revised as follows: "collect relevant information on populations where these species are found, including numbers, life stages, habitat, and locations."
9.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.1 Study Goals and Objectives	NPS prefers that objects state a measurable/quantifiable component.	The objectives of this study are comparable to those of amphibian survey studies on other FERC project relicensings aimed at obtaining baseline information on amphibian breeding sites. These objectives are, by their nature, not

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
					quantifiable. The study report will present quantitative data on acreage of potential habitats surveyed, survey effort, and number of individuals by species/life stage.
10.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.1 Study Goals and Objectives	What will the scale/resolution of this mapping be conducted at.	The resolution of the preliminary map will be limited by the data sources. The final maps will reflect field observations of habitat during this study and the Wetland Assessment study, which may include habitats not detected by preliminary mapping.
11.	Brock Applegate (WDFW)	05/10/2020	Section 2.1 Study Goals and Objectives	WDFW recommends that you document breeding habitat as well.	See response to Comment #5.
12.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.1 Study Goals and Objectives	Prior to moving to the next objectives, the data here should be "ground-truth" with randomized sub-sample field observations of the habitat identified in the desktop exercise	As noted, field reconnaissance will be performed in coordination with the Wetland Assessment study in areas where additional information is needed to verify habitat suitability. The Wetland Assessment study also includes field data collection which would function to "ground-truth" remote sensing data. If the number of sites with potentially suitable habitat for the target species with a Project effect nexus requires sub-sampling, this may include randomization, but will also include considerations of accessibility and habitat quality, based on professional judgment. Prior to designating survey sites, maps and summary findings of field reconnaissance will be presented to the TRREWG for review and discussion.
13.	Brian (uploaded by Jon-Paul Shannahan)	05/05/2020	Section 2.1 Study Goals and Objectives	Emphasis on impacts of drawdowns (all drawdowns not just normal ones) on littoral primary/secondary productivity AND habitat should be made	Assessing primary/secondary productivity in the littoral zone is outside the scope of this study. The study area includes suitable habitat in areas on the fringes of Project reservoirs

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
	(Upper Skagit Indian Tribe)				including depressions in drawdown zones and littoral zones. Amphibian breeding habitats that are documented in this study will be assessed in the Draft License Application (DLA) for operational effects, including the effects of drawdowns.
14.	Brock Applegate (WDFW)	05/10/2020	Section 2.1 Study Goals and Objectives	Does this include western toad? If it does not, WDFW recommends that SCL should include western toad suitable breeding habitat on the map.	See response to Comment #5.
15.	Brock Applegate (WDFW)	05/10/2020	Section 2.1 Study Goals and Objectives	4th bullet – Add: , including western toad, Add: and western toad	See response to Comment #5.
16.	Brock Applegate (WDFW)	05/10/2020	Section 2.1 Study Goals and Objectives	Does this include weed spraying and road maintenance? Both activities will need special consideration for future impacts to amphibians. SCL should consider all effects from their project operations and maintenance, including ones from roads, powerline right-of-ways, and other impacts to waterbodies. **New comment provided on 06/23/2020:** I appreciate the explanation on herbicide use. Can I assume that future areas of road maintenance and construction projects will include BMPs or future surveys, if the map notes suitable habitat?	Vegetation management plans and BMPs developed for the new license will address protection of amphibian habitats from herbicides effects. Note that current City Light policy is to follow the City of Seattle pesticide reduction policy which includes strict limitations on types of pesticides that can be used. For example, in 2019, City of Seattle stopped using glyphosate herbicides on its properties. **Response to comment provided on 06/23/2020:** City Light will use the study results to develop appropriate BMP to protect wetlands, streams, and other sensitive habitats, or other PME measures, if warranted.
17.	Brock Applegate (WDFW)	05/10/2020	Section 2.2 Resource management Goals	Hence the reason that SCL should map the habitat of Western toad, as well.	See response to Comment #5.
18.	Ashley Rawhouser	5/13/2020	Section 2.2 Resource	Jointly developing a set of management questions for the study would help to provide clarity for SCL and	Thank you. City Light appreciates the input. The intent of this section is to refer to resource

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
	(NPS)		management Goals	LPs.	agency management plans, regulations, and policies pertaining to the subject matter. City Light would appreciate receiving specific information that should be incorporated into the study plan.
19.	Brock Applegate (WDFW)	05/10/2020	Section 2.2 Resource management Goals	Last paragraph – Add: WDFW also has created management recommendations for both spotted frogs. Please see: https://wdfw.wa.gov/sites/default/files/publications/00025/wdfw00025.pdf (Nordstrom, N., and R. Milner. 1997)	Thank you. Text and references have been added.
20.	Brock Applegate (WDFW)	05/10/2020	Section 2.3.1 Columbia Spotted Frog	I would underscore the possible impact by ongoing operations and a fluctuating reservoir by the Project.	This is noted in Section 2.4 (Project Operations and Effects on Resources).
21.	Emily Wirtz (Sauk-Suiattle Indian Tribe)	04/28/2020	Section 2.3.2 Oregon Spotted Frog	Sedro-Woolley	Thank you, change made.
22.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.3.2 Oregon Spotted Frog	This isn't an entirely accurate description of Ovaska's findings. While the findings were surprising and getting more data would be beneficial, the FLNRO biologist considers the findings valid. Seems like SCL is trying a bit too hard to downplay this work. However, NPS is appreciative that SCL sees the need to survey for this species.	An error in the description of the study findings has been corrected (specifically, Columbia spotted frog was detected by DNA from skin swabs, but was not detected by eDNA). The text does not in any way downplay, disparage, or portray the findings as invalid. On the contrary, City Light has included DNA analysis of spotted frogs in the Special-status Amphibian Study precisely because of the findings of Ovaska et al. (2019), which challenge previous assumptions regarding the distribution of spotted frog species in the region. Nevertheless, all good science is subject is further scrutiny, often raises as many research questions as it answers, and may be reinterpreted as new information is collected. As noted by Ovaska et al. (2019), potential contact between spotted

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					frog species raises the possibility of genetic introgression. DNA sequences used to differentiate the species might not distinguish a hybridized spotted frog from a genetically pure Oregon spotted frog.
23.	Emily Wirtz (Sauk-Suiattle Indian Tribe)	04/28/2020	Section 2.3.3 Western Toad	This seems warm for western Washington aquatic habitats. Could this be verified through another reference? I'm having a hard time finding this to be a requirement in other literature. I'm fairly certain that toads lay eggs in cooler temperatures. I will try to check the temperatures for our amphibian surveys at the reservation.	Thank you for the comment. City Light has revised the text.
24.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.4 Project Operations and Effects on Resources	Changes in water level could also impact littoral productivity reducing food and quality habitat availability.	See response to Comment #13. Thank you for the comment. The focus of this study is to determine where special-status amphibian species and habitat occur (primarily for egg-laying and larval life stages). As part of the DLA, the effects of reservoir water level management on special-status amphibian species will be conducted by combining results of this study with the wetland assessment and operations model. However, collecting data on littoral productivity is outside the scope of this study.
25.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.4 Project Operations and Effects on Resources	And associated use impacts	Effects will be assessed in the DLA using the results of this and other studies.
26.	Brock Applegate (WDFW)	05/10/2020	Section 2.5 Study Area	Big Beave Wetland lies within the Project boundary and effects area due to spread of reed canarygrass from reservoir, up Big Beaver Creek, and throughout the wetlands. Reed canarygrass has spread from the Ross Lake source population by water, wind, or beaver, but	Big Beaver Valley is included in the FERC Project Boundary only due to the High Ross Treaty; current Project operations have no effect on the hydrology of these wetlands, which are located between about 0.85 to 2

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				exists along the entire banks of the creek to the wetland. Please include Big Beaver Wetland in your study area. **New comment provided on 06/23/2020:** The degraded habitat in the lowland wetlands has mostly extirpated Oregon Spotted Frog from Skagit and Whatcom County. I am not sure how SCL can use an example of a frog population's habitat that has barely survived as an example of habitat that works well. WDFW recommends that we don't have habitat like the lowlands at Big Beaver Wetland and aim for a healthier population.	miles from Ross Lake and 10 to 15 ft above the NMWSE of the lake. Further, the reported presence of reed canarygrass is not evidence that conditions for Columbia spotted frog or other amphibians have been degraded. Although reed canarygrass is widespread in lowland wetlands in Washington, general effects to most species of amphibians have not been reported. Specific effects of reed canarygrass on Oregon spotted frog are generally associated with limiting availability of suitable oviposition habitat where the previous year's plant growth has not been removed by grazing or mowing, or compressed and submerged; these effects may be reduced in areas where heavy snow cover occurs. At some sites with no apparent management of reed canarygrass, suitable oviposition habitat is associated with submerged, flattened grass floating near the surface in uncharacteristically deep water. City Light would appreciate receiving information describing how mechanisms caused by Project operations are spreading reed canarygrass to wetlands upstream in the Big Beaver Valley, and references being used to indicate that reed canarygrass occurs along "entire banks of the creek to the wetland". **Response to comment provided on 06/23/2020:** The apparent extirpation of Oregon spotted frog in the lower Skagit River drainage is likely attributable to multiple factors, of which reed canarygrass is probably not the leading cause. Important factors include extensive loss

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					of wetlands to urban and agricultural development, flood control and diking, introduction of fish to lakes and ponds, and introduction of American bullfrog. The historical distribution of Oregon spotted frog in other drainages in Whatcom and Skagit County is unknown, but there is no evidence to describe the species as "mostly extirpated" in the Samish or lower South Fork Nooksack River drainages where multiple populations occur, and new discoveries of populations on private properties have occurred as recently as 2019 and 2020. The fact that populations occur on the upper Samish River, but not the lower Samish River, both areas where reed canarygrass is dominant, suggests that other factors may be more important. The comment also misconstrues City Light's response regarding the effects of reed canarygrass on amphibian habitat, the points of which included that spotted frog oviposition habitat may not be substantially degraded at sites with high snow cover or where reed canarygrass occurs on the edges of deep water. These conditions may apply to wetlands in Big Beaver Valley. Regardless of these considerations, the invasive form of reed canarygrass is unquestionably an undesirable plant species compared to the species it replaces. Separate from this issue is whether Project operations are responsible for the presence or abundance of reed canarygrass in Big Beaver Valley. Given the nearly ubiquitous nature of reed canarygrass in the Pacific Northwest, a Project effects nexus is not clear.

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27.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.5 Study Area	Wildlife mitigation lands should be included. Management of the mitigation lands should be considered an ongoing project effect.	Wetlands on wildlife mitigation lands were surveyed for Oregon spotted frogs in 2011-2012 as part of the WDFW-led Skagit/Whatcom County systematic surveys. The mitigation lands create and maintain many wetlands used by breeding amphibians. Management of the mitigation lands already focuses on protecting amphibian habitats and the updated Management Plan for the new license will further refine those protection measures. We do not believe that additional survey is necessary at this time or that surveys of these lands should be part of the relicensing studies.
28.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.3.3 Western Toad	NPS has documented large numbers of WT (toadlets) dispersing into Ross Reservoir at the mouth of Big Beaver Creek. In fact, we stopped a Boy Scout Troop from wantonly spiking and smashing 100's of them in their canoe bottoms.	Existing information on amphibian occurrences is invaluable to study plan development and implementation. City Light requests such information, including locations and dates of observations. As requested earlier, City Light would also appreciate if NPS can provide a copy of the following report, as well as any more recent information: Holmes R. E. and R. S. Glesne. 1997. NOCA NRPP Amphibian Inventory Big Beaver Watershed 1996 – Progress Report. North Cascades National Park, Sedro-Woolley, WA.
29.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	The study area needs to be specifically described so that there is no ambiguity for LPs.	The comment confuses "study area", which is unambiguously described in the study plan, with the identification of specific locations where amphibian field surveys will occur, which cannot be determined at this time. Prior to designating survey sites, maps and summary findings of field reconnaissance will be presented to the TRREWG for review and discussion.

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30.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	NPS requests that habitat assessments and surveys be conducted for all amphibian species that could be affected by fluctuating reservoir levels, dewatering of the Bypass Reach, ramping in the Skagit River, the floodplain and channel migration corridor of the Skagit River impacted by flow attenuation due to managed flows, and all roads and infrastructure associated with the Skagit Hydroproject including powerline corridors.	See response to Comment #2.
31.	Brock Applegate (WDFW)	05/10/2020	Section 2.5 Study Area	In addition, Big Beaver Wetlands has Columbia spotted frogs and the introduction of fish that may not had the ability to migrate from the reservoir to the wetland may exist. The reservoir backs up the creek and allows access over the falls to fish. Project operation and the reservoir elevation may affect access to fish that may not have access at some reservoir levels or during some times of year. New fish or new timing of fish can highly impact the frogs as fish may cause predation on all life stages of the frogs. SCL should explore the access of fish species to Big Beaver Wetland, the season of the access, and the reservoir levels, including the historic access of fish to Big Beaver Wetland. **New comment provided on 06/23/2020:** The 20 year-old report does not consider the new variable, red side shiners. Adult resident trout and bull trout can obtain bigger sizes due to the explosion of red side shiner population. Larger fish can not only access and navigate the old fish barrier at the falls at Big Beaver Creek confluence easier, they can also increase predation on all life stages of frogs because of their large size. The reservoir has caused easier access by larger fish to the wetland and degraded the wetland habitat through the spread of reed canarygrass with the source population at the reservoir. Larger fish will bring different and possibly detrimental effects to	Bull trout have been documented in Big Beaver Creek, however it is unclear if these fish are occupying the same habitats as amphibians. Columbia spotted frog have been documented in Big Beaver Valley in extensive beaver-dammed wetlands as recently as the 90s which indicates continued presence of the species post construction of Ross Lake. There is no documentation of an effect of bull trout predation on Columbia spotted frog in these habitats. Regarding the documented presence of Westslope Cutthroat Trout (WCT) in Big Beaver Creek, WDFW has provided no evidence that amphibian populations using wetlands separate from the stream channel are affected. Holmes and Glesne (1999) reported a diverse amphibian community associated with the streams and wetlands in Big Beaver Valley. WDFW has also not established a Project effect. Smith and Anderson (1921) reported the presence of Cutthroat Trout during a reconnaissance of the Upper Skagit in 1920, decades prior to Ross Dam construction. The authors attributed the presence of this species

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				ecosystem and natural habitats upstream in Big Beaver Creek. WDFW recommends that you include Big Beaver Wetland in the study area.	to intentional stocking for sport fishing. Further, the presence of this fish species in Big Beaver Valley is not necessarily attributable to Project operations. WCT are infrequently caught in Ross Lake during gillnet surveys due to their relative scarcity in the Lake. Initial eDNA analysis of Ross Lake tributaries found WCT in Big Beaver, Ruby, and Lightning creeks. The majority of Ross Lake tributaries are either closed to fishing or managed as catch-and-release. The presence of WCT in those streams and their relatively low abundance in Ross Lake suggests that the tributaries, including Big Beaver Creek, are the likely sources of WCT and not immigration from Ross Lake. WDFW manages this population of WCT with a catch-and-release fishery, which indicates that WDFW, in coordination with the NPS, is actively managing WCT to ensure their persistence in the Big Beaver Valley. City Light would appreciate receiving information describing how City Light's operations have contributed to amphibian predation and WCT occurring in Big Beaver Creek wetlands. City Light is open to discussions about potential interactions between Ross Lake and Big Beaver Valley flora and fauna. **Response to comment provided on 06/23/2020:** The term "Big Beaver Wetland" does not accurately represent the complex of wetlands in Big Beaver Valley, which are not uniform,

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					and most are separated from Big Beaver Creek by 400-900 ft. The statement, "the reservoir has caused easier access by larger fish to the wetland and degraded the wetland habitat through the spread of reed canarygrass with the source population at the reservoir" is entirely speculative. It should also be noted that larger fish are not necessarily a greater threat to native amphibians than smaller fish and that the risk is only increased if fish are using the wetland sites where frogs occur.
32.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	Concur	See response to Comment #31.
33.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	More specifics on how this is being defined is needed.	See response to Comment #29. Types of areas to be evaluated are listed in the study plan and survey locations will be mapped and shared with TRREWG prior to fieldwork.
34.	Brock Applegate (WDFW)	05/10/2020	Section 2.5 Study Area	The locations should include Big Beaver Wetland for the effects above.	See response to Comment #26.
35.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	Concur	See response to Comment #26.
36.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	This is vague and leaves lots of wiggle room for misunderstanding.	Prior to designating survey sites, maps and summary findings of field reconnaissance will be presented to the TRREWG for review and discussion.
37.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.5 Study Area	If these areas are within the flood plain and channel migration corridor of the Skagit River they should be included.	See response to Comment #2
38.	Brock Applegate (WDFW)	05/10/2020	Section 2.5 Study Area	1st paragraph – Add: wetlands affected by ongoing Project operations,	Text revised to include information.

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39.	Emily Wirtz (Sauk-Suiattle Indian Tribe)	04/28/2020	Section 2.5 Study Area	SSIT has updated Tribal lands, more than what is shown on the map. We also have property along the southside of 530. Also, I believe Swinomish and Upper Skagit have more lands along Highway 20 than what is represented. Let me know if you would like updated properties from SSIT for future maps.	Thank you. City Light would appreciate receiving information on tribal lands within or adjacent to the FERC Project.
40.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.6 Methodology	Include randomized sub-sample field observations of the habitat identified in the desktop exercise	See response to Comment #12.
41.	Brock Applegate (WDFW)	05/10/2020	Section 2.6.1 Identify and Map Potentially Suitable Habitat	SCL should include western toad. **New comment provided on 06/23/2020:** Please map western toad breeding habitat throughout the project area, which includes transmission lines.	See response to Comment #5. Mapping will emphasize potentially suitable habitat for the spotted frog species, for which mapping criteria are available. Around the Project reservoirs mapping will also identify habitats that might support western toad breeding associated with broad, gradually sloped areas and depressions that hold water when reservoirs levels are below NMWSE (linkage to fish stranding study plan). The study will also create a final map showing locations of surveys, amphibians detected during surveys and by incidental observation, and associated habitats. **Response to comment provided on 06/23/2020:** Sites where evidence of western toad breeding is detected by surveys or incidental observations, and any current or historical records provided by WDFW or other verified sources will be mapped. As indicated, mapping along the transmission line ROW will note stream and wetland categories, which

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					can be used to indicate potential western toad breeding habitat and development of BMPs protective of these locations. City Light is not aware of mapping criteria with which to accurately predict "western toad breeding habitat" from aerial imagery or other remote sources. As illustrated by the terminology in the comments, City Light is justifiably concerned that maps of broadly defined potential habitat would be misrepresented as "western toad breeding habitat."
42.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6 Methodology	The Methods need more detail. NPS requests that Methods be detailed enough that a uniformed party could replicate the study. You propose a number of different protocols below (VES, egg mass, dipnets, traps, and WDFW Oviposition) and it is unclear when and where each will be utilized. Additionally, it is uncertain what the level of effort will be. The proposed study lacks a description of analysis methods. How will occupancy by estimated and modeled? How will imperfect detection be accounted for?	The study report will fully document surveys methods performed at each site, as well as other details pertinent to interpreting results (e.g., site and weather conditions, total search time, and number of traps). The use of multiple methods closely follows the "toolbox" approach described by Olson and Leonard (1997), which is appropriate for sampling sites where multiple species and multiple life stages may occur. As indicated in the study plan, survey methods at lowland sites will be limited to the WDFW egg mass survey protocol for Oregon spotted frog, if warranted by potential for Project effects and the presence of suitable habitat. Decisions regarding choice of aquatic funnel trapping versus intensive dip-netting is often governed by site conditions, including water depths, and both methods may be appropriate at some sites. Presentation of summary findings of the field reconnaissance prior to designating survey sites will include details on expected survey methods at each site.

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					This is not a modeling study. The study uses methods that are consistent with existing protocols for the objectives of the study. The results might inform development of PMEs that could incorporate statistically rigorous sampling and analyses (if warranted).
43.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6.1 Identify and Map Potentially Suitable Habitat	How is potentially suitable habitat going to be identified? What constitutes PSH? If this is going to be a GIS analysis there must be a quantitative component.	Section 2.3 describes features of suitable habitat for each species. Potentially suitable habitat consists of areas that have these features. GIS provides a platform to combine multiple data layers for visualization. As evident from most of data layers listed here, the intent is not to quantify habitat but to identify locations where the data, including aerial imagery and LiDAR, suggest habitat for target species occurs. For example, NWI data consists of polygons of wetland types and is not quantitative except if used to calculate acreages and distances between connected wetlands, which are considerations that may be pertinent to identifying potential suitable spotted frog habitat. The study will also create a final map showing locations of surveys, amphibians detected during surveys and by incidental observation, and associated habitats.
44.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6.3 Amphibian Surveys	Consider including a table of species, habitat, and timing on when you would expect of encounter them.	Survey timing will be influenced by elevation, weather conditions, and seasonal accessibility. Presentation of summary findings prior to designating survey sites will include details on expected survey methods and timing at each site, to the extent possible.
45.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6.3 Amphibian Surveys	Surveys should also include eDNA.	eDNA may not be effective for detecting Columbia spotted frog and has limitations where both spotted frog species occur (Ovaska

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					et al. 2019). However, City Light had added the use of eDNA to the study plan as follows: "In the event that spotted frog life stages are not found at sites associated with Project reservoirs with suitable breeding habitat, these sites or a representative sub-sample of these sites will be sampled for the presence of Columbia spotted frog and Oregon spotted frog eDNA."
46.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6.3 Amphibian Surveys	How will this [use of aquatic funnel traps] be determined?	As detailed in the same paragraph: "Decisions regarding use of traps will be based on a determination that trapping could provide substantially more information on amphibian use of a site or do so more efficiently than other means."
47.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.6.4 Identification and Handling of Amphibians	Cool site! Thanks.	Comment noted. Thank you.
48.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.6.4 Identification and Handling of Amphibians	eDNA could be used, BUT strict sample methodology should be developed to determine if enough replicates/samples are taken to ensure a sufficient detection rate/possibility.	Sampling methods for use of eDNA will follow those described by Ovaska et al. (2019), which provides guidance for the number of samples/site. See also response to Comment #45.
49.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.6.4 Identification and Handling of Amphibians	Changes in water level due to Project operations and associated impacts on habitat availability/productivity should be included as a product.	See response to Comment #13. The Study will present results of surveys and habitat assessment. Project effects will be assessed in the DLA by combining results of this study along with the Wetlands Assessment, Reservoir Fish Stranding and Trapping Risk Assessment, Reservoir Shoreline Erosion, and operations.

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50.	Brock Applegate (WDFW)	05/10/2020	Section 2.8 Schedule	6th bullet – Add: Initial Study (ISR) Add ISR Meeting 2022	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis.
51.	Emily Wirtz (Sauk-Suiattle Indian Tribe)	04/28/2020	Section 2.6.4 Identification and Handling of Amphibians	I'm curious whether eDNA could also be a method used at the wetland sites. Also, I think testing for the Chytrid fungus and making sure to follow protocols to ensure surveyors are not spreading Chytrid from site to site should be considered and potentially mentioned in the plan.	Thank you for your comment. We are proposing multiple standard methods to document amphibians. Depending on specific site conditions, the methods may include repeated visit visual encounter surveys, funnel traps, and DNA samples collected via swabs or eDNA analysis of water samples. See response to Comment #45. City Light has added text describing cleaning and disinfection protocols to prevent spread of chytrid.
52.	Ashley Rawhouser	5/13/2020	Section 2.8 Schedule	Concur	See response to Comment #51.

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53.	Ashley Rawhouser (NPS)	5/13/2020	Section 2.8 Schedule	One year of survey effort will not be sufficient and will bias the results towards non-detection.	The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations.
54.	Brock Applegate (WDFW)	05/10/2020	Section 3.1 References	Add: Nordstrom, N., and R. Milner. 1997. Columbia Spotted Frog. Pages 4-1 to 4-14 in E. M. Larsen, ed. Management recommendations for Washington's Priority Species, Volume III: Amphibians and Reptiles. Wash. Dept. Fish and Wildl., Olympia. Add: 1997. Oregon Spotted Frog. Pages 6-1 to 6-12 in E. M. Larsen, ed. Management recommendations for Washington's Priority Species, Volume III: Amphibians and Reptiles. Wash. Dept. Fish and Wildl., Olympia.	Thank you. These references have been added as well as noting them in the text in Section.2.2.
55.	Brock Applegate (WDFW)	06/22/2020	Section 1.3 Study Plan Development	Comment on: "The study is designed to address Terrestrial Resources Issue 20 (TE20 Columbia Spotted Frog Survey), and aspects of TE03 (Littoral Riparian Habitat) and FA09 (Littoral and Riparian Habitat)." Should we include Invasive Plants as well?	No. The sentence is referring to linkages from the original issue forms discussed in the 2019 process. It is true that information from multiple other studies, including invasive species, will be used along with amphibian survey results to assess habitat conditions for special-status species.
56.	Brock Applegate (WDFW)	06/22/2020	Section 1.3 Study Plan Development	Comment on: "WDFW postulated that the Project may reduce or degrade aquatic, littoral, and emergent vegetation associated with potential spotted frog habitat." Please add "… through the fluctuations of the reservoirs."	Edit made.

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57.	Brock Applegate (WDFW)	06/22/2020	Section 1.3 Study Plan Development	Comment on: "The study will also provide information on any other amphibians that are observed incidentally or during surveys, including western toad (or boreal toad *Anaxyrus boreas boreas*), a WDFW candidate species, and Oregon spotted frog (*Rana pretiosa*), a federal threatened and State endangered species, and native amphibians that do not have special status. As well, the study will report any detections (visual or auditory) of the non-native American bullfrog (*Lithobates catesbeianus*), a species which, while not documented in the Project Area yet, is expanding its range and has been found in nearby waterbodies." WDFW recommends that SCL document presence of all non-native amphibians. Possibilities of additional non-native amphibians increase as the surveys continue south along the transmission lines to Bothell.	We will document all native and non-native amphibians detected during the surveys or by incidental observations during other field work, which will include work along the transmission line ROW. A large portion of the transmission line ROW is located on private property and is surrounded by private property over which City Light has no authority or means of preventing the spread of non-native amphibians. Also, see response to Comment #6.
58.	Brock Applegate (WDFW)	06/22/2020	Section 1.3 Study Plan Development	Comment on: "The Reservoir Fish Stranding and Trapping Risk Assessment study will also identify potential habitats within drawdown zones on Ross, Diablo, and Gorge lakes that could be used by special-status amphibians." Please add "…and could strand and trap amphibians in different life stages."	Edit made.
59.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "The goals of this study are to: (1) identify areas of potentially suitable breeding habitat for the special-status amphibians, Columbia spotted frog and Oregon spotted frog, within the study area;…" Please add western toad to the list. If SCL wants to identify special status breeding habitats so that SCL can mitigate effects from the ongoing operations, the map must contain the breeding habitats for all special-status amphibians.	See our responses to Comments #5 and 41. Maps will depict locations with evidence of western toad breeding and sightings of post-metamorphic life stages, as well as wetland and stream classifications. All sites examined in the field will also be described in text. Based on the types of habitats that are shown to be used by western toads in the study area, reasonable conclusions regarding potential effects of Project operations can be deduced.

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60.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "…(3) document occurrences of a third special-status species, western toad, and the locations and types of habitats used around the Project reservoirs;…" How does this differ from the first goal? I don't understand why we can't just add western toad to the first goal.	See our responses to Comments #5 and 41. The species are treated differently in the study goals for several reasons. (1) Oregon spotted frog is federally listed, whereas the other species are not. (2) The spotted frog species are highly aquatic and associated with relatively large wetlands or wetland complexes with areas of permanent water, vegetated shallows, and aquatic connections, features usually detectable from aerial imagery and other remote sources. As such, identifying and mapping potential habitats is a realistic goal. In contrast, the western toad is largely terrestrial and may breed long distances from where found terrestrially. Potential breeding habitats include common and widespread aquatic features (e.g., ponds, lakes, and slow-moving streams), as well as common features that may be too small to be detected on aerial photographs (e.g., rain pools, small ditches, and tire ruts). However, most of this potential habitat, particularly in lowlands of western Washington, is not actually used, and even at sites where western toad occurs, only a small part of potential habitat may be used. (3) The potential for Project operations to affect amphibians associated with Project reservoirs differs greatly from potential effects elsewhere such as along the transmission line ROW where the Project has no effect on water levels and where development of BMPs protective of aquatic and wetland habitats does not require documenting amphibian species.

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61.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "…(3) document occurrences of a third special-status species, western toad, and the locations and types of habitats used around the Project reservoirs;…" We should replace "project reservoirs" with "project area."	No edit made. See our responses to Comments #41 and 60. As indicated, mapping in other areas within the Project Boundary, including along the transmission line ROW, will note stream and wetland categories, which can be used along with amphibian observation locations to indicate potential western toad breeding habitat and development of BMPs protective of these habitats. The potential for Project operations to affect amphibians associated with Project reservoirs differs greatly from potential effects elsewhere such as along the transmission line ROW.
62.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "Study results will provide information on special-status and other amphibian species use and habitats that will be combined with results of other studies (e.g., Wetlands Assessment, Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way , Reservoir Shoreline Erosion, Sediment Deposition in Reservoirs Affecting Resource Areas of Concern)…" Please include Fish stranding and Trapping Study Plan.	Edit made.
63.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "Develop a preliminary, working map of potentially suitable breeding habitat (i.e., habitats used for oviposition [egg-laying] and larval rearing) for special-status amphibians within the study area using existing, publicly available aerial imagery, wetland and soil maps, and vegetation data. Potential habitat will also be identified by the results of the Vegetation Mapping and Wetland Assessment studies and analyses of Light Detection and Ranging (LiDAR) data by the Reservoir Fish Stranding and Trapping Risk Assessment study. The preliminary map will indicate	See our responses to Comments #5, 41, 59, and 60.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				discernible wetlands and topographic depressions, as well as general areas, such as gently sloping shorelines, that might support special-status amphibian breeding. For this preliminary map habitat suitability will be broadly defined by reference to literature accounts that describe habitats successfully used by each special-status species." Will SCL include western toad on this map? I assume so, since WDFW has listed western toad as a State Candidate Species for listing. WDFW would like western toad breeding habitats included on the maps to warn of risks from project operations effects.	
64.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "Develop a preliminary, working map of potentially suitable breeding habitat (i.e., habitats used for oviposition [egg-laying] and larval rearing) for special-status amphibians within the study area using existing, publicly available aerial imagery, wetland and soil maps, and vegetation data. Potential habitat will also be identified by the results of the Vegetation Mapping and Wetland Assessment studies and analyses of Light Detection and Ranging (LiDAR) data by the Reservoir Fish Stranding and Trapping Risk Assessment study. The preliminary map will indicate discernible wetlands and topographic depressions, as well as general areas, such as gently sloping shorelines, that might support special-status amphibian breeding. For this preliminary map habitat suitability will be broadly defined by reference to literature accounts that describe habitats successfully used by each special-status species." I would envision that SCL would use this map to implement BMPs or future surveys, when maintenance projects, road construction, or herbicide/pesticides application would occur in the future. In addition, SCL	Thank you for your comment. City Light will use the study results to develop appropriate BMPs to protect wetlands, streams, and other sensitive habitats, or other PME measures, if warranted.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				should address any effects to amphibians due to ongoing operations, currently or in the future.	
65.	Brock Applegate (WDFW)	06/22/2020	Section 2.1 Study Goals and Objectives	Comment on: "Perform a special-status amphibian field survey in areas identified as potentially suitable habitat where there is activity related to Project O&M or at Project recreation facilities and where additional information is needed on species occurrence, relative abundance, and life history timing." Would this include western toad?	See our responses to Comments #5 and 41.
66.	Brock Applegate (WDFW)	06/22/2020	Section 2.5 Study Area	Comment on: "The wildlife mitigation lands are not included in the study area because no Project effects occur in these areas; in addition, previous surveys completed by City Light in 2011–2012 covered wetlands on the properties and found only one ranid species – northern red-legged frog." Although not caused by the Project directly, ownership of the project may cause the public to visit the mitigation lands. Bullfrogs and people, to some degree, come together. WDFW would recommend that SCL have these mitigation lands surveyed for bullfrogs so that we can manage for containment or eradication of them. WDFW would like this request for bull frog surveys recorded here so that they may accompany these surveys, when SCL has biologists mobilized around the project, or future surveys. SCL should address the possibility of bullfrogs because of their impact on other native amphibian species.	See response to Comment #27.
67.	Brock Applegate (WDFW)	06/22/2020	Section 2.5 Study Area	Comment on: "The wildlife mitigation lands are not included in the study area because no Project effects occur in these areas; in addition, previous surveys completed by City Light in 2011–2012 covered wetlands on the properties and found only one ranid species – northern red-legged frog."	See response to Comment #27.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				WDFW would prefer the same findings, which includes mitigation lands with only native amphibians. We appreciate the 2011/12 surveys, but the surveys happened 8-9 years ago. Conditions can change on the mitigation lands over the course of one season.	
68.	Brock Applegate (WDFW)	06/22/2020	Section 2.6.4 Identification and Handling of Amphibians	Comment on: "Areas examined during field reconnaissance for potentially suitable amphibian habitats;" WDFW recommends that SCL include suitable habitat for all special status frogs on the map, whether examined during field reconnaissance or not.	See our responses to Comments #5, 41, 59, and 60. Study report maps will show stream and wetland categories, which can be used to indicate potential habitats for special-status amphibians and development of BMPs protective of these habitats. It may not be appropriate to categorize habitats as "suitable" basely solely on remote data sources.
69.	Brock Applegate (WDFW)	06/23/2020	Section 2.8 Schedule	Comment on: "Final Report – March 2022" Please include the Final Initial Study Report (ISR) and the ISR Meeting. SCL will complete these activities in the schedule, so please include them.	Thank you for your comment. The schedule reflects the timeline for this study only, not the larger ILP process.

TR-09 BEAVER HABITAT ASSESSMENT PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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Attachment B	Skagit River Hydroelectric Project Beaver Sighting and Habitat Form
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List of Acronyms and Abbreviations

BIP .....Beaver Intrinsic Potential
City Light.....Seattle City Light
ELC.....Environmental Learning Center
FCC.....Flow Coordinating Committee
FERC.....Federal Energy Regulatory Commission
ft .....feet/foot
GIS .....Geographic Information System
GPS .....Global Positioning System
HPA.....Hydraulic Project Approval
HSI .....Habitat Suitability Index
ISR .....Initial Study Report
LiDAR.....Light Detection and Ranging
LP.....licensing participant
LWD .....large woody debris
NFCC .....Non-flow Coordinating Committee
NPS .....National Park Service
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
PSP.....Proposed Study Plan
RCW .....Revised Code of Washington
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....Resource Work Group
STI.....Stillaguamish Tribe of Indians
TRREWG.....Terrestrial Resources and Reservoir Erosion Work Group
U.S.C.....United States Code
USFS.....U.S. Forest Service
WAC .....Washington Administrative Code
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing. The PAD also includes an outline of the goals and objectives of this study.

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. This study plan reflects RWG discussion and study requests and comments submitted by LPs.

1.3 Study Plan Development

This Study Plan addresses Issue Form TE22 – Beaver Floodplains and Dams brought forward to the Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) on July 8, 2019 by the Upper Skagit Indian Tribe. The Upper Skagit Indian Tribe conducts annual maintenance, as needed, of the Newhalem and County Line Ponds, and Taylor, Powerline, and Illabot spawning channels. A sixth spawning channel – Park Slough – is maintained by NPS. All six of these off-channel Chum habitat sites were constructed as part of the City Light fisheries mitigation program under the current license. Upper Skagit Indian Tribe biologists have indicated that beaver (*Castor canadensis*) dams constructed near the outlets and at other locations of several of the artificial channels and ponds are causing episodic but sometimes significant impediments to Chum access and impediments for other aquatic organisms. The issue form submitted by the Upper Skagit Indian Tribe included three topics: (1) the Project operations may continue to affect beaver distribution in the study area; (2) beaver dams built at several of the constructed off-channel Chum Salmon habitat areas are adversely affecting fish access; and (3) evaluation and feasibility study for a beaver relocation project through the Project vicinity. The TRREWG discussed the form at the July 30, 2019 RWG meeting where City Light agreed to assess beaver conflicts at spawning channels, collect information on current distribution of beavers in the study area, and provide information useful for planning beaver relocations. The Steering Committee approved study of the issue at their September 4, 2019 meeting.

On April 10, 2020, City Light released the Beaver Habitat Assessment Draft Study Plan for LP review and comment. On May 6, 2020, the draft study plan was discussed at a Terrestrial Resources and Reservoir Erosion Work Group (TRREWG) meeting. City Light reviewed all comments received and released a revised version of the draft study plan on June 12, 2020. The revised draft was discussed on June 23, 2020 at a TRREWG meeting. Written comments were received from Washington Department of Fish and Wildlife (WDFW), Upper Skagit Indian Tribe, Sauk-Suiattle Indian Tribe, and U.S. Forest Service (USFS) and responded to in an attachment to this study plan. A Status Draft of the study plan was provided to LPs on August 6, 2020.

City Light is filing this study plan with FERC as part of its Proposed Study Plan (PSP), incorporating additional consultation prior to the filing date.

The Stillaguamish Tribe of Indians submitted a study request pertaining to beaver(STI-04 Beaver Project). This study plan addresses some of the elements identified in this study request, as explained in Section 6 of the PSP. Some elements of the study request involve management actions that will take place after the relicensing; information gathered in the study will be used to assess potential management actions, including beaver relocation, at the Chum channels during the next Project license.

While we do not know of any data that supports the contention of the Project affecting overall beaver distribution along the Skagit River, City Light recognizes that maximizing effectiveness of the constructed off-channel Chum habitats may require management actions that account for ongoing use by beavers. A study of the City Light Chum channels and beaver habitat suitability in

the Project vicinity is proposed to inform future management of the spawning channels. Measures to be considered include physical modifications to the ponds or active removal of beavers (Pollock et al. 2018). Another option that has been brought up by LPs is to relocate beavers from the spawning channels to other suitable locations to benefit ecological processes, salmon habitat, and climate change resiliency.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goals of this study are to characterize the ongoing beaver conflicts at the Project's Chum Salmon off-channel sites and characterize beaver habitat suitability in the study area.

The objectives are as follows:

- Evaluate beaver conflicts (depending on depths and velocities, dams can create pool steps too high or wide for adult salmon, particularly Chum Salmon) and assess hydrologic and geomorphologic issues that may adversely affect Chum Salmon and provide information that can be used to inform management at each of the City Light Chum off-channel habitat sites.
- Identify where beaver occur in the study area based on existing information and field observations during fish and wildlife relicensing studies.
- Map beaver habitat suitability of aquatic habitats in the study area based on morphological habitat, vegetation, and ownership/land use characteristics to provide information useful for potential future beaver relocations aimed at reducing Chum channel conflicts and enhance ecological functions at sites in the watershed.

2.2 Resource Management Goals

City Light's goal is to gain an understanding of the current conditions at the Chum off-channel sites and the issues caused by beaver activity and to assess overall beaver habitat potential in the within a 2-mile buffer of the Project, which includes the 100-year floodplain and segments of adjacent tributaries of the Skagit watershed. This information will be used to assess potential management actions at the Chum channels during the next Project license. It will also be used to assess potential operational changes that may benefit beaver and salmonid habitat.

The following sections summarize management goals and policies of agencies applicable to this study.

- National Park Service (NPS)

There are no NPS policies that relate specifically to beavers. However, the RLNRA General Management Plan (NPS 2012) addresses protection of natural resources and values related to the North Cascades ecosystem, wilderness, and cultural history within RLNRA. It stresses the need to factor in climate change and responses of ecosystem functions and processes in management decisions. Although not stated in the NPS plan, the role of beaver relates directly to these goals.

- U.S. Forest Service (USFS)

The Mount Baker-Snoqualmie National Forest Land and Resource Management Plan (1990, as amended) includes a Watershed, Wildlife, and Fisheries Emphasis in Riparian Areas goal: "To maintain or improve water quality and to produce various levels of potential habitat capability for various species of fish within designated riparian areas. Also maintain or enhance habitat for riparian associated wildlife species." Under Intensity 13D: Level III Anadromous, Potential

Resident Fish Habitat Capability, the standards and guidelines for the Wildlife and Fish Planning program element include: "Manage wetlands to protect all bogs, swamps, and beaver ponds."

- Washington Department of Fish and Wildlife (WDFW)

The beaver is classified by Washington State as a furbearer (Washington Administrative Code [WAC] 220-400-020). Recreational trapping is allowed November 1 to March 31 with a trapping license for beaver. A property owner may kill or trap beavers on their property if there is an immediate threat to personal property. In 2017, the regulations for beaver relocation (Revised Code of Washington [RCW] 77.32.585; attached to this study plan) were changed to allow for relocation on both sides of the Cascades with a permit from WDFW. Authorization via a WDFW permit is required to relocate beavers to non-federal property. To use beavers in restoration, landowners can request a relocation, per RCW 77.36.160.

A Hydraulic Project Approval (HPA) is required for any instream work, including removing or notching beaver dams as well as installing flow devices. WAC 220-660-230 addresses beaver dam management and required mitigation in HPAs.

Damage-related beaver removal can occur any time of year by the property owner or their designee. RCW 77.15.194 made it unlawful in Washington to use a body-gripping trap to capture any mammal for recreation or commerce in fur. Neck snares and unpadded, steel-jawed leg-hold traps are illegal with no exceptions. Allowable body-gripping traps require a Special Trapping Permit and are intended to be used with nuisance animals. Legal traps are cage or box traps and suitcase-type live traps, including Bailey and Comstock traps.

- Whatcom County

Whatcom County Critical Areas Regulations (Chapter 16.16.235) allows with notification, alteration or removal of beaver-built structures two years old or less; provided, that there is no adverse effect to wetland or river or stream functions, an HPA is obtained from WDFW (if required) prior to the maintenance activity, and the property owner provides a copy of the HPA to the County technical administrator as part of the written notification. Alteration or removal of beaver-built structures more than two years old is allowed, provided that the property owner can show that the beaver dam is harming or likely to harm the property, it has been demonstrated that beaver deceivers or auto leveler devices cannot eliminate adverse effects to property, effects to wetland, river, or stream functions are minimized and mitigation is provided to compensate for lost ecological value, an HPA is obtained from WDFW, and the HPA is provided to the County technical administrator.

- Skagit County

According to Skagit County Parks and Recreation Code 9.41.160, it is unlawful to disturb, deface, remove or destroy animal nesting areas including beaver dams in County Parks.

- Indian Tribes

The Upper Skagit Indian Tribe considers the beaver a keystone species for the Skagit River watershed and the Sauk-Suiattle Indian Tribe considers beaver to be an essential part of ecosystem health for the Sauk and Skagit Watersheds. The Upper Skagit Indian Tribe believes that healthy beaver populations are important for riverine and habitat, floodplain dynamics, large woody debris

(LWD), hydrology, salmonid and other aquatic dependent species and wishes to include beaver abundance and beaver habitat suitability in the assessment of Project hydrologic effects. Additionally, the Upper Skagit Indian Tribe seeks to understand effects to anadromous salmonids, including Coho salmon use of beaver ponds.

The Indian tribes have been working with City Light on beaver and off-channel mitigation projects during the current license and have advanced capacity and understanding on how to protect and enhance beaver's ecological interactions in the floodplain with salmon recovery efforts. The Indian tribes collaborate with local, state, and federal agencies and landowners to address beaver conflicts and enhance habitats for salmon throughout the watershed. The Tulalip Tribe has implemented many beaver relocations in the Snohomish River watershed, while the Stillaguamish Tribe has completed projects in the Stillaguamish River watershed. In the Suiattle River, the Sauk-Suiattle Indian Tribe and Stillaguamish Tribe have worked with the USFS on beaver management projects to benefit salmon.

2.3 Background and Existing Information

Beaver are widely recognized as important in maintaining high-quality diverse aquatic habitats for salmonids and other native biota, ecosystem health, and hydrologic connectivity and thermal conditions, especially in the face of climate change (Dittbrenner et al. 2018; Pollock et al. 2018). Pollock et al. (2004) found that increasing beaver populations may be effective in creating habitat for Coho Salmon in the Stillaguamish watershed. In many watersheds of Washington, beaver populations have been dramatically reduced from trapping and habitat removal. In the Skagit River watershed, Beechie et al. (2001) reported that beaver dams historically accounted for at least 8 percent of tributary channel length, particularly in the lower Skagit sub-basin but that diking, draining, and hydromodification has substantially reduced this habitat and habitat complexity. In the unregulated Stillaguamish River watershed, Pollock et al. (2004) found an overall reduction of 86 percent of beaver habitat compared to historic conditions.

While populations are reduced relative to pre-European settlement, beavers are anecdotally known to occur at many locations with suitable habitat on the Skagit River floodplain and along tributaries that are less affected by human development. As discussed previously, beavers routinely construct dams at several of the off-channel Chum habitat channels where the hyporheic flow from the river provides relatively stable water levels. The Upper Skagit Indian Tribe has employed annual, labor-intensive beaver dam removal in recent years to maintain Chum access at most of the channels. To alleviate adverse effects of beaver dams on water levels and fish access at Powerline Pond, a pond leveler was successfully installed through collaborative effort between City Light and the Upper Skagit Indian Tribe. The Upper Skagit Indian Tribe has also completed other non-lethal habitat management and lethal beaver removal at sites in the watershed and has partnered with NOAA to study fish passage and have had beaver experts provide consultation for the Chum channels (e.g., Hall and Shanahan 2009).

Another potential management tool that can sometimes be used to alleviate beaver conflicts is to trap and relocate beavers to other locations. Interest in re-establishing beaver populations to aid watershed restoration has led to a number of recent publications that describe approaches to evaluating habitat and implementing beaver relocation projects (e.g., Pollock et al. 2018; Dittbrenner et al. 2018; Tulalip Tribes 2015). A first step in conducting a relocation project is to

assess beaver habitat suitability. Dittbrenner et al. (2018) has developed and employed a Geographic Information System (GIS)-based model to rate the Beaver Intrinsic Potential (BIP) of stream segments in the Whatcom, Skagit, and Snohomish counties (among others) and evaluated the modeling in the Snohomish River basin. As one measure of model validity, they reported that 60 percent of stream segments in the Snohomish River basin with a high or moderate BIP had evidence of current or past beaver activity while no segments classified as low BIP habitat had any beaver sign. This model does not factor in land ownership and land use aspects, which are significant determinants of beaver population capacity in a given area.

Natural dispersal ability of beavers is common where degraded stream segments are restored allowing beavers from nearby areas to move in. A good example of this is the Upper Skagit Indian Tribe's restoration of Hansen Creek, a Skagit River tributary near Sedro-Woolley. Within five years after mechanical stream restoration, 600 feet (ft) of new beaver dams had been built along 17,000 ft of stream (MacFarlane et al. 2014).

2.4 Project Operations and Effects on Resources

Conflicts with beaver exist at some of the off-channel Chum channels constructed by City Light as fish mitigation under the current Project license. These include: Park Slough, Newhalem Pond, County Line Pond, Taylor Channel, Powerline Pond, and Illabot Channel. The Upper Skagit Indian Tribe has, in the past, routinely removed beaver dams from several of the channels to facilitate Chum Salmon access and egress. At Powerline Pond channel, a beaver deceiver installed near the pond's connection with the Skagit River has been effective in maintaining fish access. The Flow/Non-Flow Coordinating Committee (FCC/NFCC) is responsible for overseeing fisheries flow and habitat elements of the existing license and is discussing the future viability and management objectives for the Chum channels.

As reservoirs with large annual water level fluctuations preclude beaver use (Allen 1983), Ross Lake is not suitable habitat. Beavers could conceivably use Ross Lake to swim between tributary streams during summer months when the water level is typically near normal maximum water surface elevation. While Gorge Lake does not have large annual water levels fluctuations, most of the lake is in a canyon with very steep shorelines lacking deciduous shrubs and trees and is not high-quality beaver habitat. The upper end of Gorge Lake and portions of Diablo Lake that are outside of the canyon and have bordering deciduous trees could conceivably support beaver. Although there are no known beaver constructed dams, beavers are known to use the Diablo tailrace and riparian areas near the Diablo townsite.

There is no documentation that beaver distribution or abundance in the Skagit River and tributaries up and downstream of the dams are adversely affected by the Project. Beavers are common in many locations downriver of the Project, including on the Lucas, Barnaby, and Illabot wildlife mitigation lands and adjacent WDFW and The Nature Conservancy lands along the Skagit River, and on the Everett Creek wildlife area along the Sauk River. At many locations between Bacon Creek and the Sauk River, development and transportation infrastructure have contributed along with modified hydrology to reduce side- and off-channel habitats that can support beavers. Furthermore private landowners often remove beavers or their dams to protect private property.

2.5 Study Area

The beaver habitat assessment will cover the entire Project Boundary (Figure 2.5-1) plus a 2-mile buffer focusing on streams and other potential beaver habitat for the purpose of providing information for screening potential relocation sites. The beaver conflicts will be assessed in the general vicinity of the Chum Salmon spawning channels funded by City Light. This includes the Newhalem and County Line Ponds, Park Slough, and the Taylor, Powerline, and Illabot spawning channels (Figures 2.5-2 through 2.5-4). Beaver and beaver sign will be noted at sites visited as part of TR-01 Vegetation Mapping Study, TR-02 Wetland Assessment, GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study, and certain fisheries studies will include all of the Project Boundary plus up to half mile buffer, and the entire floodplain between Gorge Dam and the Sauk River.

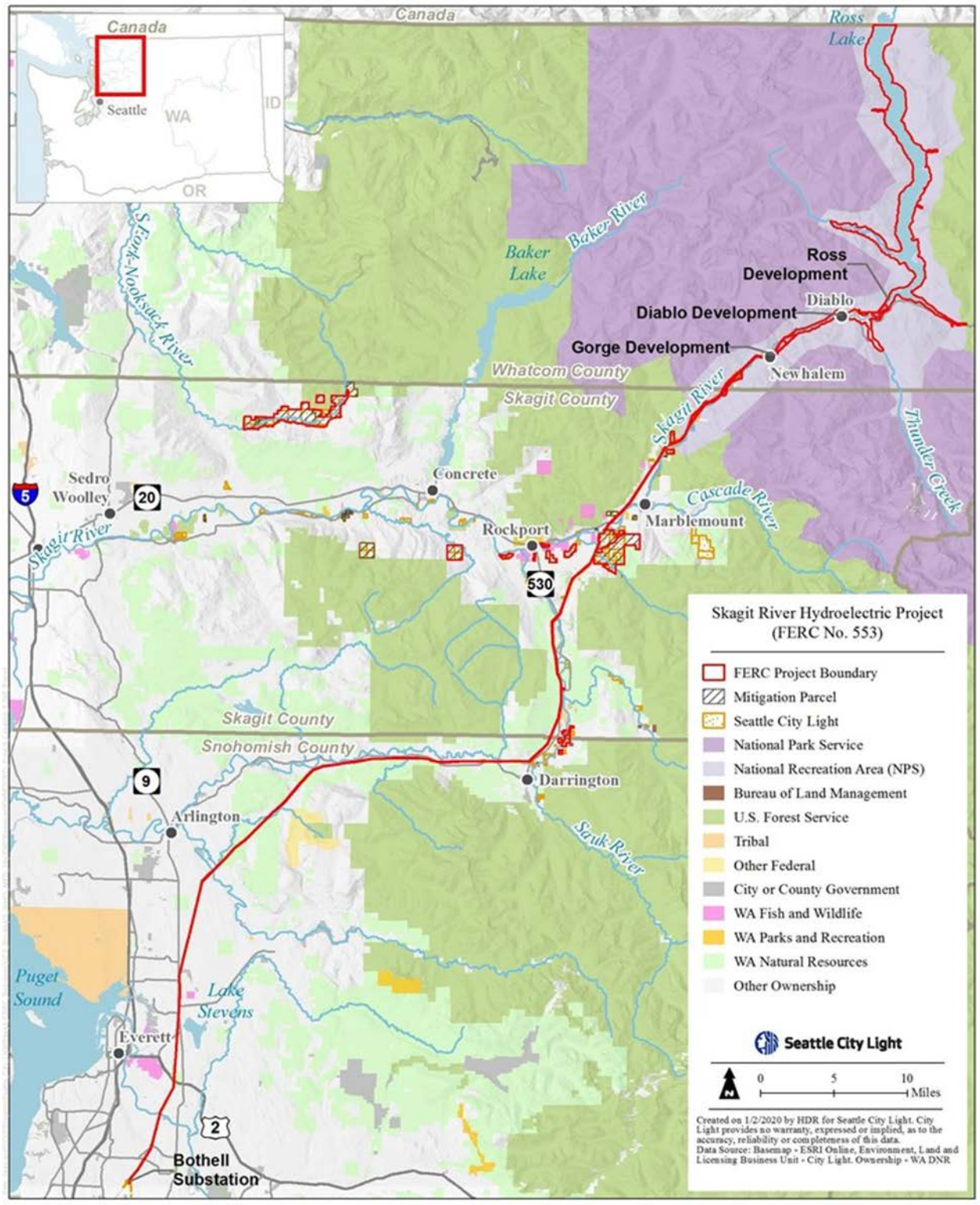


Figure 2.5-1. Location map of the Skagit River Project.

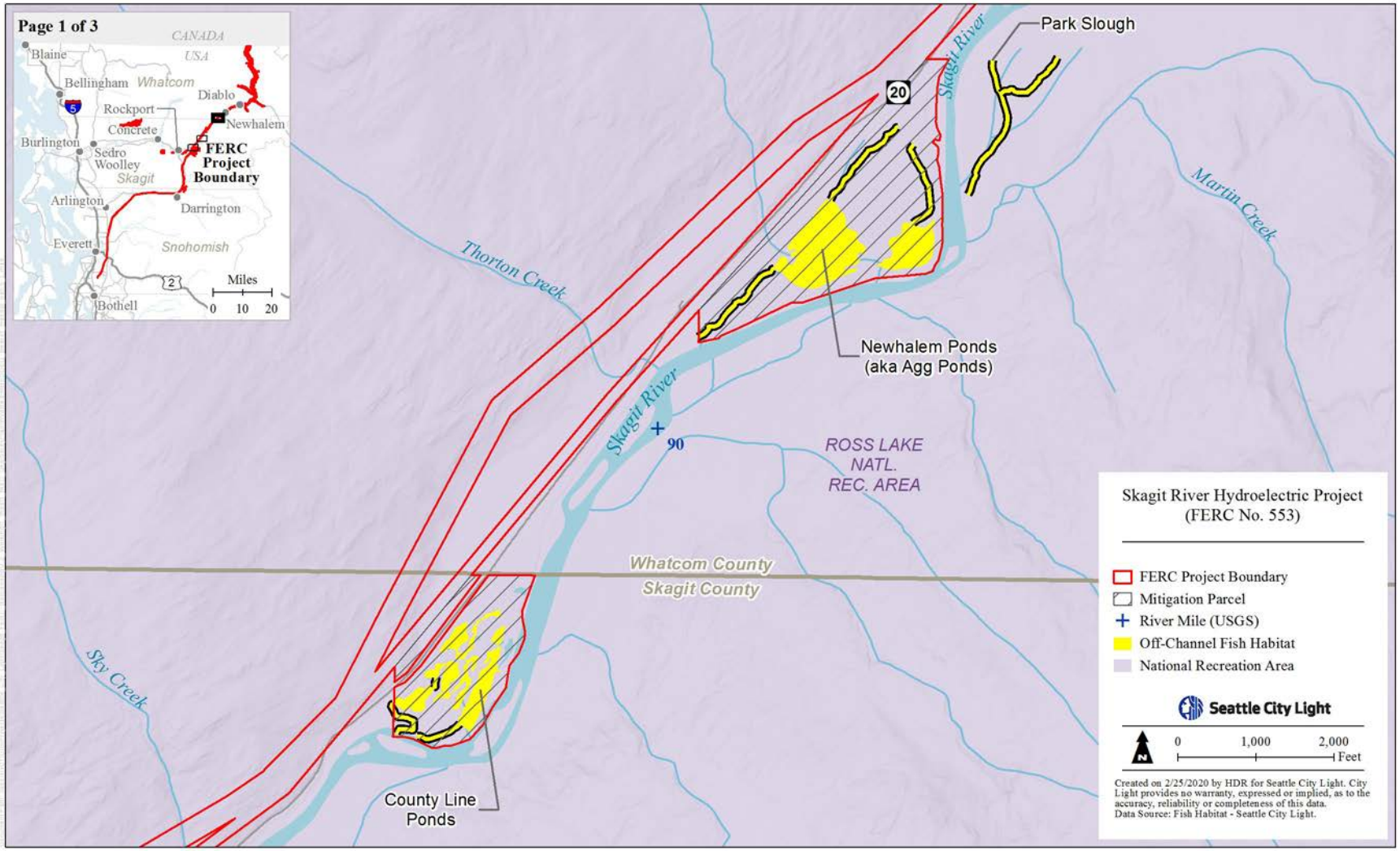


Figure 2.5-2. Chum Salmon spawning channels: Newhalem and County Line Ponds and Park Slough.

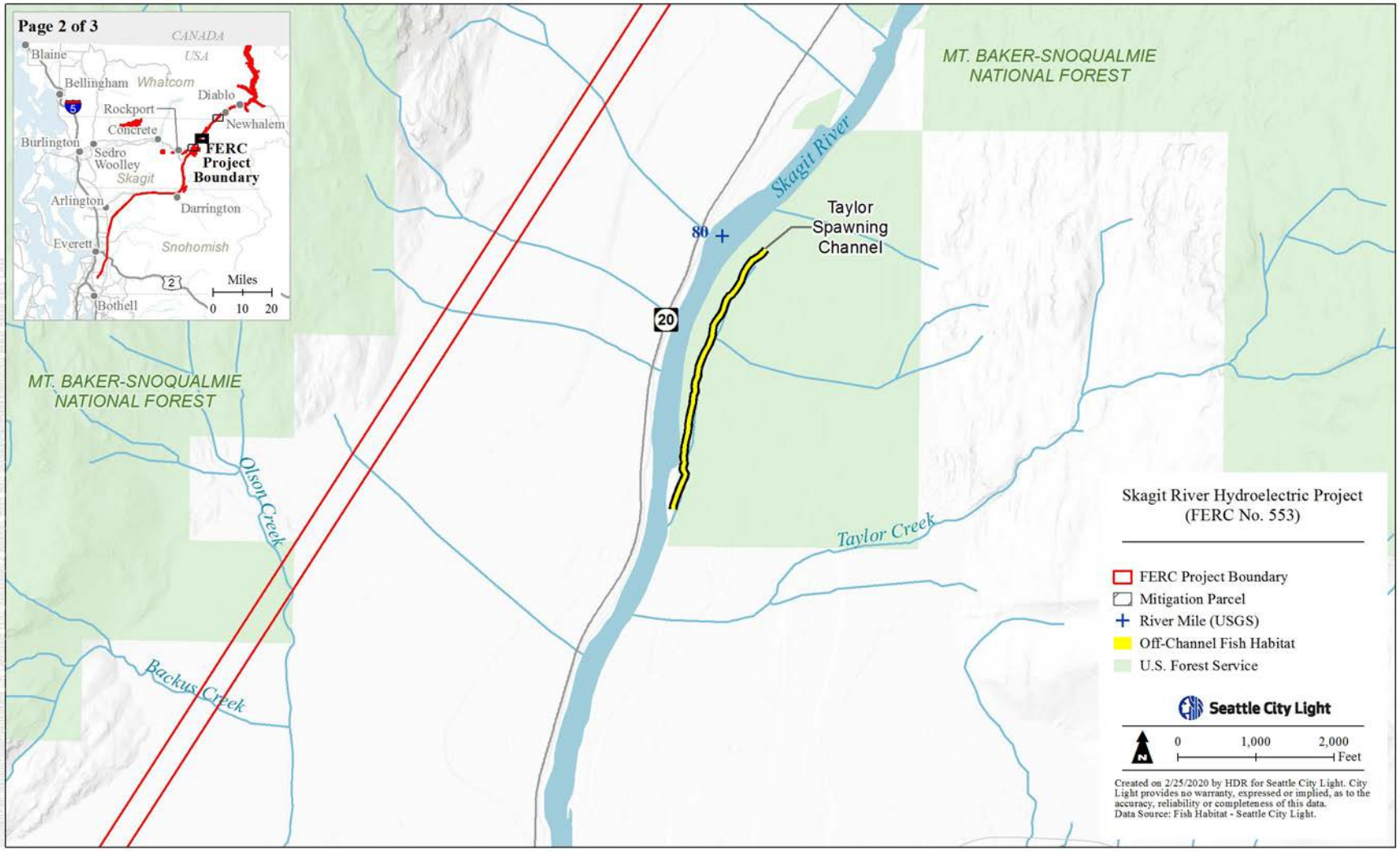


Figure 2.5-3. Chum Salmon spawning channels: Taylor spawning channel.

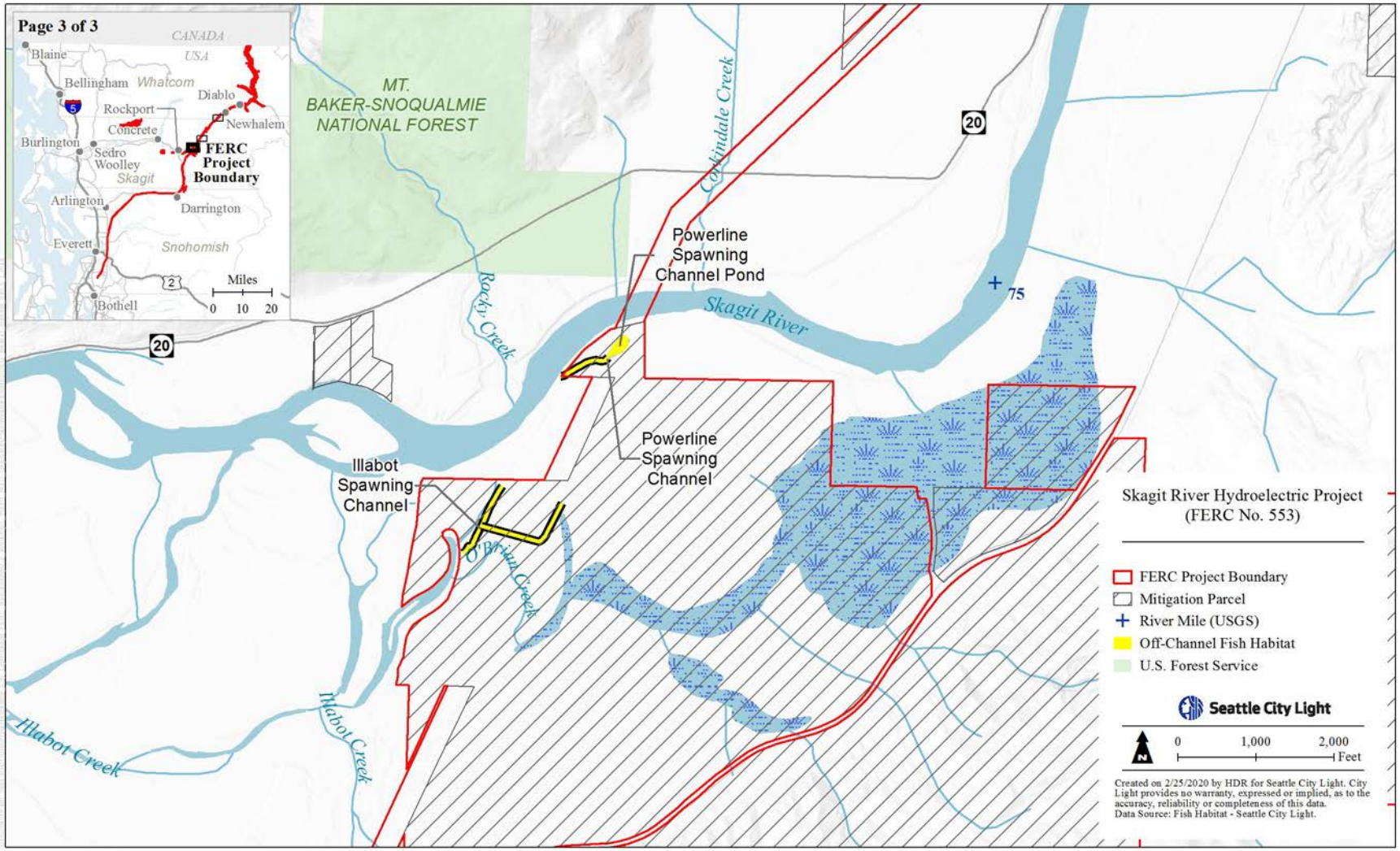


Figure 2.5-4. Chum Salmon spawning channels: Powerline and Illabot spawning channels.

2.6 Methodology

The following sections discuss methods to be used to conduct this assessment.

2.6.1 Evaluate Existing Conditions and Management Activities at Off-Channel Habitat Areas

The FCC/NFCC is responsible for overseeing fisheries flow and habitat elements of the existing license and is discussing the future viability and management objectives for the Chum channels. The degree to which existing channels are evaluated for beaver management options will be dependent on the outcome of that assessment.

For any channels that are deemed important to be maintained, the following evaluation will be conducted. Existing information on salmon use, beaver occurrence, and past management activities at each of the off-channel Chum habitat sites will be summarized. Wetland/riparian vegetation mapping and plant species occurrence data collected during the Vegetation Mapping and Wetland Assessment studies will be combined with Light Detection and Ranging (LiDAR) to map and describe morphological and habitat conditions at each channel. Past beaver dam locations will be mapped and described from Upper Skagit Indian Tribe and City Light observations. Available photos will be included to show conditions.

Experts in fluvial geomorphology, hydrology, beaver ecology, and floodplain ecology/restoration will conduct a site visit to the channels with interested LPs. The objectives of the site visit will be to document existing conditions and provide information that can be used to identify opportunities/constraints for physical modifications and vegetation management (e.g., planting conifers) to enhance functionality for salmon and reduce beaver conflicts. This assessment will consider instream flows to evaluate connectivity enhancements to keep any beaver dams and their relict bedforms passable. The expert team will draft a brief memo that summarizes their technical observations at each site.

2.6.2 Map Beaver Occurrence within the Project Boundary

To characterize existing distribution of beaver in the study area, City Light will summarize any information obtained from NPS, USFS, or other entities. All inactive and active beaver dams, concentrated beaver sign, or individual beavers observed during the vegetation mapping, wetland characterization, erosion, botanical, wildlife, and fisheries studies will be mapped with Global Positioning System (GPS). Terrestrial field teams will use a data form (attached to this study plan) to collect information on beaver and habitat sightings during fieldwork. Information will be entered into a GIS database and displayed on a map to show beaver occurrence in study area.

2.6.3 Beaver Habitat Assessment

According to MacFarlane et al. (2014), there are five primary habitat conditions necessary for beaver dam occurrence: 1) a perennial water source; 2) availability of forage and dam building materials (woody deciduous vegetation); 3) ability to build a dam at baseflow; 4) likelihood of dams to withstand a typical flood; and 5) likelihood that stream gradient would not limit or completely eliminate dam building by beaver. Over the years, there have been many variations of Habitat Suitability Index (HSI) models developed for beaver. These models provide a habitat value index based on presence of suitable beaver habitat characteristics such as water availability, vegetation composition, and structure in riparian and wetland communities. HSI models are

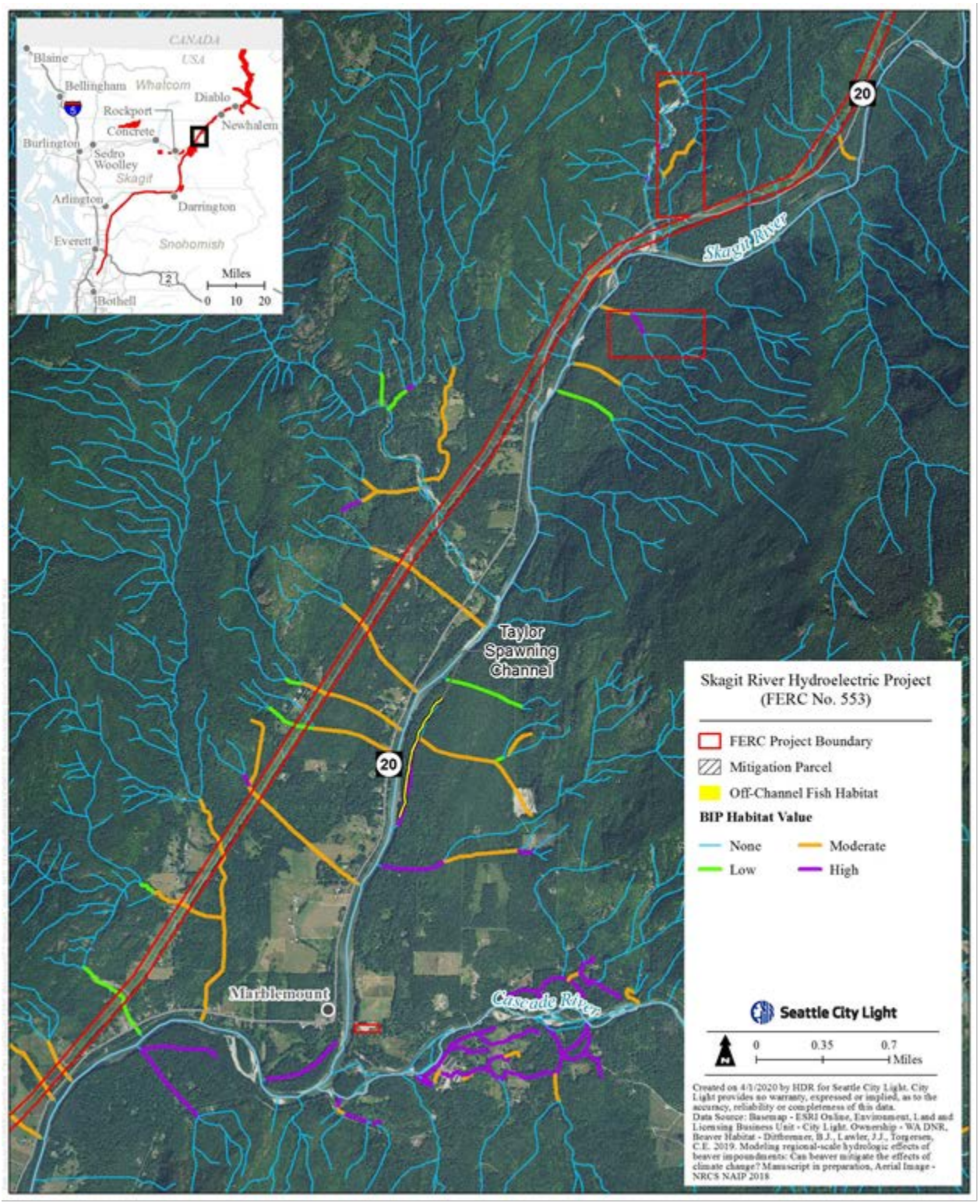
generally based on the assumption that absence equates to lower quality habitat; the models do not consider potential for beaver habitat development if beavers modify the landscape or if restoration actions or land-use management actions were taken to promote beaver occupancy. As described in Section 2.3 of this study plan, several authors (e.g., Pollock et al. 2018; Dittbrenner et al. 2018; Tulalip Tribes 2015) have utilized geomorphic characteristics to map BIP and to use the mapping results to select beaver relocation sites.

City Light has reviewed GIS data of modeled BIP mapping of stream segments in Whatcom, Skagit, and Snohomish counties provided by B. Dittbrenner, a local beaver expert with Beavers Northwest, whose research is mentioned above (Dittbrenner 2019a). The GIS data rates habitat potential based on a combination of hydrogeomorphic characteristics such as stream gradient, stream size, and size of the valley bottom (Dittbrenner et al. 2018). This current assessment assigns a BIP-score data ranking of 0-3, (BIP scores: 0 = no habitat value, 1 = low value, 2 = moderate, and 3 = high value) to each stream segment. Examples of the existing mapping are shown in Figures 2.6-1 and 2.6-2).

City Light will use the BIP mapping classifications (Dittbrenner 2019b) to characterize and assess stream segments within the study area. Remote sensing of aerial photography, LiDAR, and field observations will be used to verify and update parameter values in the BIP database for any segments that appear to be inaccurately characterized in the currently available dataset. A representative number of locations within the Project Boundary will be verified in the field. Changes will be tracked in the database and field verified, as appropriate. This effort will include consultation with expert staff from Beavers Northwest, as needed.

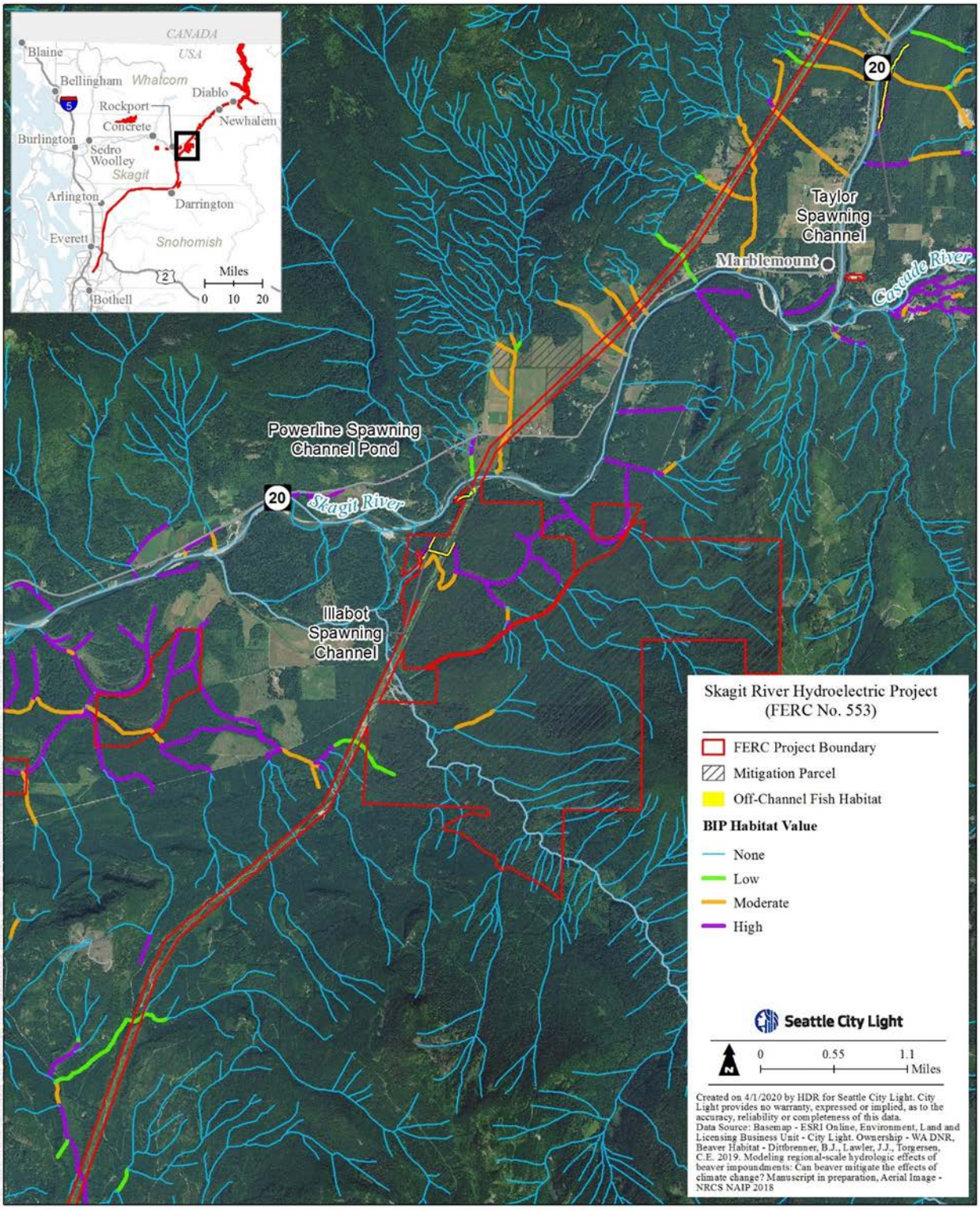
BIP mapping classification will be supplemented with vegetation suitability information from the results of the Vegetation Mapping and Wetland Assessment studies and review of aerial photography and LiDAR. This supplemental information will be used to qualitatively identify stream segments that have high beaver habitat value at a coarse level at areas within the Project Boundary and 0.5-mile buffer (i.e., within the study area for the Vegetation Mapping study). Desktop assessment of beaver habitat using the existing BIP mapping classification will cover a wider area to identify potentially suitable beaver habitat in the Project vicinity. At representative and accessible stream segments with high BIP scores within the Project Boundary, City Light will qualitatively identify those that have high beaver vegetation value based on published HSI model vegetation parameters for the area within 328 ft (100 m) of streams/wetlands (e.g., Allen 1983). These parameters will include: (1) tree canopy cover >50 percent; (2) >50 percent of trees being 1-6 in dbh; (3) >25 percent deciduous shrub canopy cover; (4) shrub height > 3.3 ft (1 m) tall; and (5) woody vegetation dominated by aspen, willow, cottonwood, or alder. Biologists will record whether the visited segments meet each of these criteria.

The BIP, vegetation habitat suitability, known beaver activity, and landownership mapping will then be analyzed in GIS to identify locations of higher quality overall beaver habitat relative to beaver occurrence in various segments of the study area. The information can then be used to screen beaver relocation potential at sites in the watershed deemed appropriate for habitat enhancement.



Source: Dittbrenner 2019b.

Figure 2.6-1. Beaver Intrinsic Potential near Newhalem and County Line Ponds.



Source: Dittbrenner 2019b.

Figure 2.6-2. Beaver Intrinsic Potential between Bacon Creek and Marblemount.

2.7 Consistency with Generally Accepted Scientific Practice

This assessment uses methods consistent with those used by experts in beaver ecology, fisheries, hydrology and restoration to evaluate options for modifying the off-channel salmon channels or pursuing other options for Chum habitat management. Analysis of beaver habitat suitability follows approaches used in recent beaver habitat modeling and published studies.

2.8 Schedule

- Channels Existing Conditions Assessment – April 2021
- Channel Site Visits and Field Data Collection – April 2021 to September 2021
- Incidental Observations of Beaver Sign in Field – April 2020 to June 2022
- BIP Map Review and Refinement – March 2021 to June 2021
- GIS Analyses – Fall/Winter 2021-2022
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $70,000.

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BEAVER HABITAT ASSESSMENT PROPOSED STUDY PLAN

ATTACHMENT A

RCW 77.32.585. RELEASE OF WILD BEAVERS

(1) The department shall permit the release of wild beavers on public and private lands with agreement from the property owner. (2) The department may limit the release of wild beavers to areas of the state where: (a) There is a low probability of released beavers becoming a nuisance or causing damage; (b) Conditions exist for released beavers to improve, maintain, or manage stream or riparian ecosystem functions; and (c) There is evidence of historic endemic beaver populations. (3) The department may condition the release of beaver to maximize the relocation's success and minimize risk. Factors that the department may condition include: (a) Stream gradient; (b) Sufficiency of the water supply; (c) Stream geomorphology; (d) Adequacy of a food source; (e) Proper site elevation and valley width; (f) Age of the beavers relocated; (g) Times of year for capture and relocation; (h) Requirements for the capture, handling, and transport of the live beavers; (i) Minimum and maximum numbers of beavers that can be relocated in one area; and (j) Requirements for the permit holder to initially provide supplemental food and lodge building materials. (4) The department may require: (a) Specific training for those involved with capture, handling, and release of beavers; and (b) The notification of any potentially affected adjacent landowners before permitting the release of wild beavers. (5) Nothing in this section creates any liability against the state or those releasing beavers nor authorizes any private right of action for any damages subsequently caused by beavers released pursuant to this section. (6) For the purposes of this section, "beaver" means the American beaver (*Castor canadensis*). (7) For the purposes of this section, beavers may only be released to carry out relocation: (a) Between two areas east of the crest of the Cascade mountains; or (b) between two areas west of the crest of the Cascade mountains. [2017 c 82 § 1; 2012 c 167 § 2.] NOTES: Finding—2012 c 167: "The legislature finds that beavers have historically played a significant role in maintaining the health of watersheds in the Pacific Northwest and act as key agents in riparian ecology. The live trapping and relocating of beavers has long been recognized as a beneficial wildlife management practice, and has been Beaver Management Technical Paper #2: Current Laws, Policies, and Practices King County Science and Technical Support Section F-2 September 2018 successfully utilized to restore and maintain stream ecosystems for over fifty years. The benefits of active beaver populations include reduced stream sedimentation, stream temperature moderation, higher dissolved oxygen levels, overall improved water quality, increased natural water storage capabilities within watersheds, and reduced stream velocities. These benefits improve and create habitat for many other species, including endangered salmon, river otters, sandhill cranes, trumpeter swans, and other riparian and aquatic species. Relocating beavers into their historic habitat provides a natural mechanism for improving the environmental conditions in Washington's riparian ecosystems without having to resort to governmental regulation or expensive publicly funded engineering projects." [2012 c 167 § 1.] Beaver Management Technical Paper #2: Current Laws, Policies, and Practices King County Science and Technical Support Section G-1 September 2018

SOP FOR MAINTENANCE BMPS IN SENSITIVE AREAS*:
BEAVER DAM MAINTENANCE

City of Seattle

TASK DESCRIPTION: Task # 607 (Inspection) & 608 (Maintenance) The periodic removal of loose sticks and debris from beaver dams that directly affect trash racks. Partial circumvention or full removal may also be needed when barriers inhibit fish migration or create a flooding potential.

PERMITS: A copy of the general Hydraulic Project Approval (HPA) for this activity is required if occurring in a riparian corridor and must be on site during the work.

RESTRICTIONS: Care must be taken when circumventing and modifying dams to prevent accumulated sediment from creating excessive turbidity. Dams are not to be removed unless removal is the stated objective in the HPA. In most cases the dam is being modified to minimize blockages and accumulations on trash racks and allow fish migration. Care must be taken to prevent turbidity during modifications.

EQUIPMENT: Hand tools - rakes, shovels, etc.

PROCEDURE: Approach the work situation carefully. Sticks and branches may be slick and a fall hazard exists. During periods of high flow there may be danger of drowning. Always perform this task with assistance. Avoid soil disturbance and vegetation removal whenever possible. When approaching the dam from the downstream side, visually check for stability before entering the streambed. Remove any debris from any downstream trash racks first. When working on the dam, several options may be available depending on your situation and the desired outcome.

Dam modification to prevent trash rack blockage:

This involves removing only the most recent unstable material from the dam or removing recent materials to get the dam back to a stable state. Working the top of the dam remove any loose materials, sticks and branches that are not adequately secured. All removal needs to happen gradually to prevent significant increase in flows that may cause turbidity. If removing a substantial portion of a dam, proceed in stages to allow the water levels to drop slowly. If removal will occur below the accumulated sediment line, utilize additional BMP's to prevent turbidity.

During certain times of year flow can be maintained by installing 4" pipes through the dam to allow water to pass. This is practical in younger dams without a lot of silt buildup. Avoid any water noise. Downstream ends of pipe should be submerged to prevent splashing. Water noise will trigger dam building.

Dam modification to allow for fish migration.

Locate the most accessible part of the dam. Create an opening at the top of the dam to increase flow in a concentrated area. Reposition the sticks and debris to create an aquatic corridor over the dam. If the difference in elevation between the creek bed and backwater is greater than 18", remove a portion of the upper dam to lower the backwater level, or elongate the corridor to keep slope grades to a minimum. Stabilize the corridor as much as possible to prevent blowout. Insure there are no sticks jutting into the corridor that may injure fish.

Dam modification for flood prevention and eventual breakup.

When Beaver build dams in areas where flooding and eventual dam blowout are inevitable, structural modification and controlled removal may be necessary. Dam removal must be approved before undertaking. WDFW would prefer that dams stay in place under most circumstances to create fish habitat. Take caution to allow water levels behind the dam to lower slowly to minimize turbidity. If no threat of downstream blockages exists, leave as much organic debris in the creek as possible.

- If significant vegetation has been disturbed (i.e., trampled or uprooted, and lots of exposed soil), contact Kevin Flanagan for site restoration guidance at 386-1802.

* The Standard Operating Procedure (SOP) detailed above is specific to the implementation of Best Management Practices (BMPs) for protecting sensitive areas and minimizing disturbance during routine maintenance activities. This is not meant to act as guidance on the mechanical aspects of the specified maintenance activity.

BEAVER HABITAT ASSESSMENT PROPOSED STUDY PLAN

ATTACHMENT B

SKAGIT RIVER HYDROELECTRIC PROJECT BEAVER SIGHTING AND HABITAT FORM

Skagit River Hydroelectric Project Beaver Sighting and Habitat Form

Date: **Site ID:** **Observer:**_____

GPS/Map Point No.:_____ **Subwatershed:**_____

Lat/Long Coordinates:_____ **Location Description** _____

Landowner (if known):

Observation(s): Beaver(s) No. adults/kits : Scat Dam Lodge Bank Den

Slide Food Cache Harvest Site

Age of Sign: Fresh Old

Stream Gradient: ≤3% 4-6% 7-9% ≥9%

Habitat Unit Size: Extensive stretch / Small isolated pocket

Aquatic width (ft):

Community Type: Stream or Wetland (circle one)

Dominant Vegetation: Herbaceous Shrub Forest

Dominant Trees/Shrub(s): willow alder cottonwood other deciduous Conifer

Tree Canopy Cover >50%?: Y / N

>50 percent of trees 1–6 inches dbh?: Y / N

>25 percent deciduous shrub canopy cover?: Y / N

Shrub height > 3.3 ft (1 m) tall?: Y / N

Herbaceous Food: Grasses and forbs abundant No Grass/Forbs Present

Photo number(s): _____

Conflicts:

Notes:

BEAVER HABITAT ASSESSMENT PROPOSED STUDY PLAN

ATTACHMENT C

CITY LIGHT RESPONSES TO LP COMMENTS ON THE STUDY PLAN

Table 1. City Light responses to LP comments on the study plan.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
1.	Brock Applegate (WDFW)	05/11/2020	Section 1.2 Relicensing Process	1st paragraph - Delete: effort Add: consultation	Change made in different location of sentence and paragraph. Text modified to include discussion and consultation.
2.	Brock Applegate (WDFW)	05/11/2020	Section 1.3 Study Plan Development	1st Paragraph – Add: (*Castor canadensis*)	Change made in different location. Name of issue form did not include beaver scientific name.
3.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 1.3 Study Plan Development	NPS performs the survey and monitoring work at Park slough	Thank you for the clarification. Text added to make that clear.
4.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 1.3 Study Plan Development	Beaver dam building has been episodic across all channels, and are located throughout each channel, they are not limited to the outlet of channels.	Thank you. Text modified to incorporate this information.
5.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 1.3 Study Plan Development	Other aquatic species are also blocked	Thank you. Text modified to incorporate this information.
6.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 1.3 Study Plan Development	(3) Evaluation and feasibility study for a beaver relocation project through the project area.	Information added.
7.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 1.3 Study Plan Development	This can be confidently inferred based on the overlap between known beaver habitat preferences and project-related impacts to floodplains. Beavers utilize low-gradient areas capable of supporting wetland habitats. As such, groundwater levels and the duration, extent, and timing of floodplain inundation affect the presence and quality of beaver habitat. Project-related flood control and power generation alter patterns of floodplain inundation; altered river hydrology and channel incision may lower the	Under current conditions, beaver appear to be well-distributed throughout the Skagit River floodplain in areas where altered land use or beaver removal is not occurring. The fact that the Chum channels and ponds as well as many sites on City Light mitigation lands have beaver-maintained wetlands is illustrative of beaver being well-distributed. The proposed study will document intrinsic beaver habitat potential within 2 mile of the Project Boundary and record beaver sign incidentally so there will be

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				groundwater table. We are requesting these impacts to beaver habitat be quantified. Other studies or available information will be used to understand how impaired beaver habitat reduces the quality and availability of off-channel salmonid habitats.	information beaver occurrence. The Wetland Assessment study and Skagit River Geomorphology Between Gorge Dam and the Sauk River study will provide information on wetlands on the Skagit River floodplain between the Gorge Powerhouse and the confluence of the Skagit and Sauk rivers. The planned update of the Wildlife Mitigation Lands Management Plan will incorporate beaver habitat maintenance along with fish and wildlife habitat and cultural resources protection.
8.	Brock Applegate (WDFW)	05/11/2020	Section 1.3 Study Plan Development	WDFW would postulate that the Project reduces migration between the bottom and the top of the Project.	Thank you for the comment. There are beaver above, throughout, and below the Project reservoirs so there is no demonstrated evidence that the Project reduces migration. City Light would appreciate receiving any information that supports the WDFW hypothesis from LPs.
9.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 1.3 Study Plan Development	In the last license study period (Envirosphere 1988) beaver were chosen as an evaluation species to represent riverine, riparian, and palustrine habitat types upstream of the dams. The 1988 study did not evaluate downstream project impacts on beaver or their habitat suitability, but the report highlighted significant impacts in the reservoir areas under post impoundment conditions- which are currently maintained due to project operations.	Thank you for your comment. The cited report selected beaver along with other target wildlife species to characterize habitat effects of the Project from the original reservoir inundation. The study results were used to develop the Wildlife Settlement Agreement signed by all parties that included habitat acquisition/ management, wildlife research, and NPS ecological monitoring funding to compensate for those effects.
10.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 1.3 Study Plan Development	Instream flows affect water levels and flow in the chum channels, being fed by hyporheic exchange, groundwater, or backwatering. It has been observed that during low Skagit mainstem flows the chum channel water levels drop to nearly zero and the altered bed of the chum	Thank you for the comment. The instream flow study will develop a hydraulic model of the Skagit mainstem from Gorge Powerhouse to the Sauk which will be used to simulate water levels in that reach. The

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				channels become impassable even after beavers are gone. Please link instream flow study to examine this relationship.	simulation results could be used to support evaluation of water levels in the Chum channels. There is an action item for the Flow Coordinating Committee/Non-Flow Coordinating Committee (FCC/NCC) to form a subgroup tasked with evaluating deficiencies in the Chum channels. Bringing these observations/data/reports to the FCC/NCC will be important as the subgroup and committee evaluates alternative actions for these channels.
11.	Brock Applegate (WDFW)	05/11/2020	Section 1.3 Study Plan Development	WDFW would prefer the relocation alternative, but SCL should address the ability of beaver to return to the same area after they move the beavers.	Thank you for the comment. City Light would appreciate receiving any information related to this topic from LPs. This conclusion assumes that parties agree that the Chum channels should be maintained for salmon and that no engineering alternatives are feasible. Please note that full relocation program would require much more intensive, and likely multiple, evaluations of proposed release sites that are selected from potential sites identified in this assessment. That intensive assessment would need to occur outside of the scope of this study plan, at a later time. City Light would be willing to cooperate with LPs and affected landowners if this is pursued. As there are beaver throughout the Skagit River floodplain, it is virtually certain that beavers from nearby areas will disperse and re-establish colonies at Chum channels. Relocation is an option that often is successful on a temporary basis and as part of a longer term management or monitoring approach; beaver will likely move throughout the Project vicinity and may return.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
12.	Shauna Hee (USFS)	05/10/2020	Section 2.1 Study Goals	Conflicts: Would be helpful to have the conflict described. Are incoming salmon not able to jump over the beaver dams? Is there a problem with insufficient stream pool depth for chum in summer early fall? The SOP for Beaver dam maintenance in the appendix has dam lowering if there is a difference of 18 inches? is that based on height fish are not able to breach?	Text edited to add details. The City of Seattle Standard Operating Procedure includes the 18-inch height as part of the general guidance for modifying beaver dams to maintain fish access. The height was based on WDFW information (see Comment #13). The SOP is included as example only and, as noted in the study plan and in the SOP, a HPA which can include more specific measures is required for instream work. The beaver dam modifications at the Chum channels have been completed under HPA obtained from WDFW.
13.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	Biologist have traditionally considered a 1.5-foot step upstream, a barrier to fish passage, especially for chum.	Thank you for the information. We have seen other maximum drops in fishways presented in literature. If WDFW or other LPs have current guidance on this topic, City Light would appreciate receiving it.
14.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.1 Study Goals and Objectives	This is a limited interpretation of the intended goal statement submitted by USIT; "The goals of this study are to characterize the ongoing beaver conflicts at the Projects' Chum channels, characterize beaver habitat suitability in the project area, and assess how operations impact the abundance, distribution and movement of beaver through the project area, and then assess feasibility of a relocation program.	At the July 30, 2019 TRREWG meeting we discussed the Issue Form. City Light agreed to assess the beaver conflict issues at the Project's Chum channels and conduct the general beaver occurrence and habitat mapping. However, City Light does not believe there is a documented Project effect on overall movement or distribution of beaver in the Skagit River watershed.
15.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.1 Study Goals and Objectives	Additional objectives: 1) Assess how the project has degraded available beaver habitat, including areas no longer suitable for beaver colonization. 2) Consider how changes to current operations (e.g. process flows, wood and sediment reintroduction) could support natural off-channel habitat formation and	See response to Comment #14. The Draft License Application (DLA) will evaluate proposed Project operations effects on side- and off-channel wetlands and fish habitat.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				reduce needs for beaver management.	
16.	Brock Applegate (WDFW)	05/11/2020	Section 2.1 Study Goals and Objectives	Should we analyze if these channels even increase chum habitat? Do chum produce in these channels? Can we manage other things more effectively to increase the chum population?	As part of the Chum channel evaluation, City Light is open to working with the LPs to assess channel efficacy. Depending on the outcome of this assessment, the need for additional beaver management at the sites could be unnecessary.
17.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.1 Study Goals and Objectives	Specific language here to identify relocation sites to enhance ecological function within the Project boundary would be useful [Comment highlights on 3 objectives for study.]	Bullet #3 text revised. Also see revised text in last paragraph of Section 2.6.3.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
18.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.1 Study Goals and Objectives	Reservoir seasonal elevation management and riverine flow fluctuations may limit beaver colonization in the floodplains areas adjacent to Skagit mainstem. We are looking to map existing suitable habitat then assess projects hydrologic operations that may reduce habitat suitability.	There is no indication that the beaver population along the Skagit River is adversely affected downriver of the Project. Beavers occupy numerous channels, tributaries, and sloughs. Beaver Intrinsic Potential (BIP) mapping will cover areas within 2 miles of the Project Boundary (this captures the entire floodplain and some adjacent lands between Newhalem and the Sauk River) so there will be a map of habitat suitability. The mapping and characterization of floodplain wetlands will be combined with modeling tools to describe inundation and connections under different flows. This will then be used in the DLA to assess effects of proposed operations.
19.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.2 Resource Management Goals	USIT considers beaver a keystone species. The Tribe would like to assess habitat suitability across project area (reservoirs, river and floodplains) compared to ongoing projects operations throughout the project area including the 100 year floodplain of the project. "Immediate watershed" has no geographic context.	Text revised to replace "immediate" with "…within a 2-mile buffer of the Project, which includes the 100-year floodplain and segments of adjacent tributaries of the Skagit" The study area captures all areas within the 100-year floodplain upriver of the Sauk and 2 miles of tributaries around the reservoirs.
20.	Brock Applegate (WDFW)	05/11/2020	Section 2.2 Resource	Do we have other management actions that can help chum?	Exploring options for managing Chum Salmon is a discussion well-suited for the Fish and Aquatics RWG. This study plan focuses on

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Management Goals		ongoing beaver conflicts at the off-channel sites. Other management actions for Chum Salmon not related to the beaver conflicts are outside the scope of this study.
21.	Shauna Hee (USFS)	05/10/2020	Section 2.2 Resource Management Goals	Add the MBSNF LRMP 1990, as amended, management goals and direction. Taylor Channel is on FS managed land and is outside of the project boundary.	Thank you. Information has been added to the text.
22.	Shauna Hee (USFS)	05/10/2020	Section 2.3 Background and Existing Information	Good to have the identifcation of where a beaver deceiver works and where it doesn't. What site conditions are favorable to deceiver success? What sites within the watershed has beaver dam removal occurred and where have deceivers have been utilized with success and failure? Please include descriptions.	Thank you for your comment. These are good questions but broader in scale than can be described in the study plan. This information will be taken into consideration when determining best management approaches. We refer you to the Beavers Northwest website (http://www.beaversnw.org/) and the Beaver Restoration Handbook (Pollock et al. (2018) for specific information.
23.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	Dams and associated altered flows are hydromodifications. For example, see National Management Measures to Control Nonpoint Source Pollution from Hydromodification (EPA, 2007).	Thank you for your comment.
24.	Rick Hartson (Upper Skagit Indian Tribe)	05/08/2020	Section 2.3 Background and Existing Information	Indeed, dams and regulated flows are not the only factor affecting beavers and their habitat. That does not preclude Seattle City Light from mitigating for impacts caused by the project.	Thank you for your comment.
25.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.3 Background and Existing Information	The USIT has also adjusted instream LWD, build beaver exclusionary fencing at culverts, planted riparian corridors and lethally executed beaver from their habitats. We have partnered with NOAA to study fish passage and have had several beaver experts provide consultation for the chum channels etc.	Thank you for the information. Text has been added. City Light would appreciate receiving the information from past projects and consultations with NOAA and beaver experts as it will clearly be useful for this study.
26.	Jon-Paul Shannahan	05/11/2020	Section 2.4 Project	1st paragraph – Add: and egress.	Thank you. Text revised.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
	(Upper Skagit Indian Tribe)		Operations and Effects on Resources	Delete: The Upper Skagit Indian Tribe biologists believe that pond leveler would not be effective at the other channels.	
27.	Shauna Hee (USFS)	05/10/2020	Section 2.4 Project Operations and Effects on Resources	Please provide the USFS with information pertaining to when and why dam removal occurred at Taylor Channel. Taylor Channel is located on USFS managed lands. No date, no beaver activity – past or present – is known at this site.	The degree of conflict at Taylor Channel has not be verified yet so text has been changed to indicate uncertainty. City Light will be compiling information on history of conflicts and maintenance activities as part of the study and will provide to USFS when available.
28.	Shauna Hee (USFS)	05/10/2020	Section 2.4 Project Operations and Effects on Resources	see comment above re: where and why deceivers work	See response to Comment #22.
29.	Brock Applegate (WDFW)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	WDFW would assume that the Project blocks or at least severely reduces beaver migration.	Thank you for the comment. City Light would appreciate receiving any information that supports this comment.
30.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.4 Project Operations and Effects on Resources	USIT is not implying the utility is solely responsible loss of beavers in the watershed. We are asking for an account of project related activities on the abundance and dispersal of a keystone species. On going project related activities include: Hydrologic surface level fluctuations limit beaver use of the area, with no downstream movement of sediment and LWD downstream in the Skagit below Gorge PH can cause impacts to floodplain inundation, no disturbance flows limits habitat forming processes including recolonization veg species in the riparian and floodplain habitats, noise, light, disturbance and infrastructure limit or impact beaver movement through the project area- by pass is currently a 3 mile barrier for	Thank you for your comment. City Light also recognizes the importance of beaver in river and wetland ecology. However, there is no evidence that beaver are not well distributed in the appropriate habitats in the floodplain or that the Project is creating a barrier. City Light would appreciate receiving any information that demonstrates how the Project limits beavers under current operations. City Light believes that the proposed study will provide useful information to (1) characterize the ongoing beaver conflicts at the Project's Chum Salmon off-channel sites and (2) characterize beaver habitat suitability in the study area so information is available if beaver

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				upstream and downstream movement of these species.	relocation is deemed appropriate. In addition, wetland characterization and instream flow modelling will provide information on connectivity of side and off-channel habitat for beaver and other fauna. A comprehensive resource effects analysis will be developed and integrated during the preparation of the Draft License Application (DLA). License participants will have an opportunity to consider effects of Project-related activities on beaver in their review of the DLA in the National Environmental Policy Act (NEPA) process. City Light has an interest in exploring, as part of a collaborative effort, discussions on beaver management in the watershed, but these discussions are outside the scope of this study plan.
31.	Shauna Hee (USFS)	05/10/2020	Section 2.5 Study Area	Why include the powerline corridor all the way to Bothell? Is relocation to those areas likely?	While relocations might be unlikely along the lower section of the transmission corridor, we proposed to include the area in the assessment in the event that other studies such as the Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way or Wetland Assessment reveal issues involving beaver habitat.
32.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	05/11/2020	Section 2.5 Study Area	Should include floodplain assessment	The mapping will capture beaver habitat on the entire Skagit River floodplain upstream of the confluence with the Sauk River.
33.	Shauna Hee (USFS)	05/10/2020	Section 2.6.1 Evaluate Existing Conditions and	Does existing information include past management actions to control beavers and/or manage vegetation at each of the sites?	Yes. Text has been revised

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Management Activities at Off-Channel Habitat Areas		
34.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Evaluate Existing Conditions and Management Activities at Off-Channel Habitat Areas	In addition to the wood portion of beaver dams, beavers pile up gravel as the base which becomes the substantial barrier at low water even after dams have been removed. This plan should link to instream flows to see if there is potential to keep the beaver dams and their relict bedforms passable during spawning.	Thank you for the comment. Instream flow modelling will be used to help assess channel habitat. Text has been revised.
35.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Evaluate Existing Conditions and Management Activities at Off-Channel Habitat Areas	Please include water temperature.	City Light is not aware of water quality problems under current conditions and would appreciate receiving any relevant information. City Light acknowledges ongoing discussions with the FCC/NCC in regards to these concerns.
36.	Curtis Clement (Upper Skagit Indian Tribe)	05/08/2020	Section 2.6.1 Evaluate Existing Conditions and Management Activities at Off-Channel Habitat Areas	Also to reduce eutrophication of the channels, which is a big problem at Illabot, and NewHalem ponds possibly due to nitrogen fixing vegetation or lack of flow to remove organic matter and keep temperatures low enough not to fill up with periphyton.	City Light is not aware of water quality problems under current conditions and would appreciate receiving any relevant information. City Light acknowledges ongoing discussions with the FCC/NCC in regards to these concerns.
37.	Shauna Hee (USFS)	05/10/2020	Section 2.6.1 Evaluate Existing Conditions and Management Activities at Off-Channel Habitat Areas	How will the channel be defined? Is there a buffer around the feature that will be used to characterize conditions? Can it be assumed that Taylor Channel will be included as a site in the Wetland Study that would receive field assessment?	The “channel” will include all of the connected and potentially connected channels, ponds, and depressions on the immediate floodplain and sufficient buffer to inform condition assessment. All five of the spawning channels, being routinely maintained, will be targeted for visits as part of the Wetland Assessment study.
38.	Shauna Hee (USFS)	05/10/2020	Section 2.6.1 Evaluate Existing	The USFS is an interested LP.	Thank you. We will coordinate with all LPs so that anyone who is interested can participate.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
			Conditions and Management Activities at Off-Channel Habitat Areas		
39.	Brian (uploaded by Jon-Paul Shannahan) (Upper Skagit Indian Tribe)	05/05/2020	Section 2.6.2 Map beaver Occurrence in Project Boundary	Would be useful to extend beaver occurrence to entire Skagit watershed to guide any re-location to areas that may be in need for some beaver activity.	BIP data can be provided for entire tri-county area (Whatcom, Skagit, and Snohomish counties) but City Light assessment will focus on the 2-mile buffer from Project Boundary.
40.	Brock Applegate (WDFW)	05/11/2020	Section 2.7 Consistency with Generally Accepted Scientific Practice	1st paragraph – Add: or pursuing other options for chum habitat management.	Text revised.
41.	Brock Applegate (WDFW)	05/11/2020	Section 2.8 Schedule	6th bullet – Add: Initial Study (ISR) Add ISR Meeting 2022	Thank you for the comment; City Light acknowledges the ILP milestones provided. The ILP will provide the opportunity for comment on the final report submitted in the ISR and discussed at the ISR meeting; if any components of the study goals and objectives are not met in the first year, or there are anomalous conditions, any party may propose additional work or request additional study per FERC ILP regulations. No changes were made to the schedule in the draft study plan as City Light intends to complete the study within one year and wants to be clear with FERC and LPs on the proposed schedule. City Light believes that it will be beneficial to all parties to have complete information from the studies as soon as possible to inform development of management proposals and cross resource analysis.

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
42.	Jon-Paul Shannahan (Upper Skagit Indian Tribe) Rick Hartson (Upper Skagit Indian Tribe)	07/16/2020	Section 2.2 Resource Management Goals	1st list – Add: ▪"To gain an understanding on how project operations have impacted beaver occupancy through the project area and floodplain, to better address operational alternatives for future programs ▪To assess the relationship between beaver occupancy and floodplain habitats used by rearing salmonids, such as Coho salmon use of off-channel ponds."	Bullets not added. City Light agreed to assess conflicts at Chum channels and collect information that will aid in describing current distribution of beavers and locations of suitable beaver habitat. This information will be available to inform potential future management actions at the Chum channels and partnerships to improve off-channel and tributary habitats.
43.	Jon-Paul Shannahan (Upper Skagit Indian Tribe)	07/16/2020	Section 2.2 Resource Management Goals	1st paragraph – Add: "It will also be used to assess potential operational changes that may benefit beaver and salmonid habitat. "	Edit accepted.
44.	Jon-Paul Shannahan (Upper Skagit Indian Tribe) Rick Hartson (Upper Skagit Indian Tribe) Emily Wirtz (Sauk-Suiattle Indian Tribe)	07/16/2020	Section 2.2 Resource Management Goals	Last paragraph – Add Tribe Goals: "The Upper Skagit Indian Tribe (USIT) considers the beaver a keystone species for the Skagit River watershed. The USIT believes that healthy beaver populations are important for riverine and habitat, floodplain dynamics, LWD, hydrology , and off-channel salmonid and other aquatic dependent species habitats and wishes to include beaver abundance and beaver habitat suitability in the assessment of Project hydrologic effects. Additionally, USIT seeks to understand effects to anadromous salmonids, including Coho salmon use of beaver bonds. The USIT have been working with SCL on beaver and off-channel mitigation projects during the last license, and have advanced	Edits accepted, with revision to reflect Sauk-Suiattle Indian Tribe comments that it too considers beaver to be an essential part of ecosystem health for the Sauk and Skagit Watersheds and to specify the following: "(1) It was mostly Tulalip on the Snohomish River effort, Stilly may have assisted some and also have done some beaver work on the Stillaguamish Watershed, (2) It was Stillaguamish and Sauk-Suiattle on the Suiattle Project, (3) that WDFW permit is not required for relocating beavers to USFS lands."

No.	Commenting Individual (Organization)	Date	Study Plan Section	Comment	Response
				capacity and understanding on how to protect and enhance beaver's ecological interactions in the floodplain with salmon recovery efforts. The tribes collaborate with local, state, and federal agencies and landowners to address beaver conflicts and enhance habitats for salmon throughout the watershed. The Stillaguamish Tribe and Tulalip Tribe have implemented many beaver relocations in the Snohomish River watershed. In the Suiattle River, these two tribes have worked with the USFS and the Sauk-Suiattle Tribe on beaver management projects to benefit salmon."	

TR-10 NORTHERN SPOTTED OWL HABITAT ANALYSIS PROPOSED STUDY PLAN

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553

Seattle City Light

December 2020
PSP

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List of Acronyms and Abbreviations

BMP .....best management practice
CBI.....Conservation Biology Institute
City Light.....Seattle City Light
dB.....decibels
ELC.....Environmental Learning Center
ESA.....Endangered Species Act
FERC.....Federal Energy Regulatory Commission
FIA .....Forest Inventory and Analysis
FR.....Federal Register
GIS .....Geographic Information System
LiDAR.....Light Detection and Ranging
LP.....licensing participant
MRLC .....Multi-Resolution Land Characteristics
NLCD.....National Land Cover Database
NPS .....National Park Service
NRCS .....National Resource Conservation Service
NRF.....nesting, roosting, and foraging
NSO.....northern spotted owl
NWFP .....Northwest Forest Plan
O&M.....operations and maintenance
PAD.....Pre-Application Document
Project .....Skagit River Hydroelectric Project
RLNRA.....Ross Lake National Recreation Area
RM .....river mile
RWG .....resource work group
U.S.C.....United States Code
USDA.....U.S. Department of Agriculture
USDI .....U.S. Department of the Interior
USFS.....U.S. Forest Service
USFWS .....U.S. Fish and Wildlife Service
WDFW.....Washington Department of Fish and Wildlife

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1.0 INTRODUCTION

1.1 General Description of the Project

The Skagit River Hydroelectric Project (Project), licensed to The City of Seattle, Washington, and operated through its publicly-owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. Power from the Project is transmitted via two 230-kilovolt powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation facilities, and several parcels of fish and wildlife mitigation lands.

Project generating facilities are all located in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at normal maximum water surface elevation. Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines cross Whatcom, Skagit, and Snohomish counties; the fish and wildlife mitigation lands are in the same counties.

The Project Boundary is extensive, spanning over 133 miles from the Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife mitigation lands and recreation facilities within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation maintains the Federal Energy Regulatory Commission's (FERC) jurisdiction "in the lands and waters within the Skagit River Hydroelectric Project," as well as hydrologic monitoring stations necessary for the proper operation of the Project (16 United States Code [U.S.C.] § 90d-4; Public Law 90-544. Sec. 505 dated October 2, 1968, as amended by Public Law 100-668. Sec. 202 dated November 16, 1988).

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on April 27, 2020 (City Light 2020). The PAD includes descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources and early consultation on potential resource issues to be addressed during the relicensing.

1.3 Study Plan Development

The northern spotted owl (*Strix occidentalis caurina*) is federally-listed as threatened under the Endangered Species Act (ESA) and State-listed as endangered in Washington State. Northern spotted owls (NSO) in the Western Cascades primarily utilize late successional mature and old-growth forests with large diameter coniferous trees, snags, downed wood, and a closed canopy with multiple canopy layers for nesting and roosting (Davis et al. 2016; Buchanan 2016). Foraging habitat for NSO is similar but may not contain suitable nesting structures to support successful breeding pairs (Sovern et al. 2015).

City Light is filing this Northern Spotted Owl Habitat Analysis Study Plan with FERC as part of its Proposed Study Plan (PSP). This study plan is in response to a study request made by the U.S. Fish and Wildlife Service (USFWS)(USFWS-19 Impact of the Operations of Skagit Hydroelectric Project (#553) on Northern Spotted Owl). In its study request, the USFWS requested more information on Project effects to NSO and whether NSO could successfully establish around Project reservoirs and mitigation lands. USFWS states if Project activities from operations are located near NSO nesting, roosting, or foraging (NRF) habitat, or tree clearing or other modifications to suitable habitat are planned, then there is potential for disturbing nesting NSO. While existing information does not a show a demonstrated effect of the Project on NSO populations, City Light has a mutual natural resource management interest in providing habitat information to inform potential NSO conservation measures and best management practices and has proposed this study in its PSP. This study plan addresses some of the elements identified in the study request, as explained in Section 6 of the PSP.

2.0 STUDY PLAN ELEMENTS

2.1 Study Goals and Objectives

The goal of this study is to identify and map potentially suitable NSO NRF habitat within the study area.

A NSO habitat suitability model was originally created by the Northwest Forest Plan's (NWFP) Effectiveness Monitoring Program in 2005 for the purposes of assessing trends of NSO populations and their habitat (Davis and Lint 2005). The NWFP Model has since been updated, based on the latest science and species location data (Davis et al. 2016). While the NWFP Model has been used to map suitable NSO habitat in its range and at regional scales, it has not been accurately applied at the local scale in the Skagit River watershed due to the lack of locally available NSO habitat and detection data. Therefore, a more detailed and refined map of suitable NSO habitat (if possible, splitting identified suitable habitat into 2 types: Nesting/Roosting and Foraging) is necessary to characterize baseline conditions, assess potential ongoing Project effects, and inform conservation measures under a new license.

2.2 Resource Management Goals

The NSO Habitat Analysis will inform City Light's long-term resource management and provide information to the following agencies with jurisdiction or interest in the species and habitat.

The Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), Indian tribes and other natural resource agencies have responsibility to implement specific laws associated with fish and wildlife resources. These include, but are not limited to, the Fish and Wildlife Coordination Act, the Endangered Species Act (ESA), the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, etc.).

- U.S. Fish and Wildlife Service (USFWS)

The objective of the USFWS Revised Recovery Plan for Northern Spotted Owls (USFWS 2011) is to support the recovery of NSO so that (1) populations are sufficiently large enough and distributed such that the species no longer requires listing under the ESA; (2) adequate habitat is available for NSO and will continue to exist to allow the species to persist without the protection of the ESA; and (3) the effects of threats have been reduced or eliminated such that NSO populations are stable or increasing and NSO are unlikely to become threatened again in the foreseeable future.

The resource management goals are to support the recovery of Northern Spotted Owl according to the USFWS Revised Recovery Plan. The USFWS Recovery Plan, Recovery Objectives are:

(1) Spotted owl populations are sufficiently large and distributed such that the species no longer requires listing under the ESA;

(2) Adequate habitat is available for spotted owls and will continue to exist to allow the species to persist without the protection of the ESA; and

(3) The effects of threats have been reduced or eliminated such that spotted owl populations are stable or increasing and spotted owls are unlikely to become threatened again in the foreseeable future.

- U.S. Forest Service (USFS)

One of the primary objectives of the NWFP was to provide adequate amounts of forest cover to sustain NSO (U.S. Department of Agriculture [USDA] and U.S. Department of the Interior [USDI] 1994), which included the protection of large blocks of late-successional forests and maturing younger forests to support healthy populations of breeding NSO pairs. The goal was to increase the amount of suitable habitat for NSO across its range.

- National Park Service (NPS)

The NSO is considered to be an at-risk species by the NPS within the North Cascades National Park. Preserving and maintaining the species and its habitats is a management priority for the park. NSO detections within the park have become increasingly rare and the number of NSO found in the park is difficult to quantify (Hoffman et al. 2015).

- Washington Department of Fish and Wildlife (WDFW)

The NSO was listed as endangered by the Washington State Fish and Wildlife Commission in 1988 (Buchanan 2016). While the NWFP has significantly reduced the amount of habitat loss for the species, the increasing competition from barred owls (*Strix varia*) has further reduced NSO populations. The species is now considered to be critically imperiled at the state level as population estimates have continued to decline.

2.3 Background and Existing Information

The NSO was listed as a federally threatened species on June 26, 1990 (55 Federal Register [FR] 26114) and a Washington State endangered species in 1988 (Buchanan 2016). The NSO was listed because of widespread loss of temperate old-growth forest habitat across its range and inadequacy of existing regulatory mechanisms to conserve the spotted owl (USFWS 2011). The range of this species is from southwestern British Columbia through western Washington, western Oregon, and the Klamath Mountains and Coast Ranges of northwestern California south to San Francisco Bay (55 FR 26114). Critical habitat for NSO was designated in 1992, revised in 2008, and again in 2012 (77 FR 71876).

The NSO is a nocturnal owl species and resident of structurally complex forests. It prefers late-successional mature and old-growth forest or forests with old-growth characteristics. Preferred nesting and roosting habitat include a multi-story forest containing a diversity of tree species, moderate to dense canopy cover (>60 percent) dominated by large trees with a high incidence of cavities or broken tops, sufficient open space below the canopy for flight, and an accumulation of woody debris on the ground (USFWS 2011). NSO usually nest in tree and snag cavities or in broken tops of large trees. They less frequently nest in mistletoe clumps and abandoned raptor and raven nests (Zeiner et al. 1990).

NSO are territorial, although home ranges of adjacent pairs can overlap. The size of the home range varies with geography. Along the Cascade Range, the estimated average home range size is

2,955 acres (USFWS 2011). Variability in home range size has been attributed to differences in local prey species. In the Cascade Range of Washington, NSO feed predominantly on flying squirrels (Hamer et al. 2001; USFWS 2011). However, NSO will feed on a variety of prey items, including small mammals, birds, amphibians, reptiles, and insects (Zeiner et al. 1990; USFWS 2011). Foraging habitat for NSO is similar to nesting and roosting habitat but may not contain suitable nesting structures to support successful breeding pairs (Sovern et al. 2015).

The NSO is a long-lived species, with a long reproductive life span. It is monogamous, but pairs do not necessarily breed every year. Breeding generally begins at 2 to 5 years of age. Following courtship, breeding may start as early as mid-February, and the female typically lays 1 to 4 eggs by late-March or April. The male delivers food to the female and the young while the female is brooding. Juvenile owls fledge in late-May or June; however, they still depend on food provided by their parents until about September (Zeiner et al. 1990; USFWS 2011).

NSO detection data within and immediately surrounding the North Cascades National Park Complex is limited (Hoffman et al. 2015). Survey efforts began in the early 1980s and have sporadically continued since that time (Siegel et al. 2012). A baseline NSO owl inventory was conducted by the park in the mid-1990s with 11 NSO activity centers detected, including 6 pairs (Kuntz and Christopherson 1996). Additional surveys were conducted by the Institute of Bird Populations between 2007 and 2010 (Siegel et al 2012), including follow-up surveys at the 11 NSO activity centers identified during the baseline inventory and additional surveys in the vicinity of reservoirs. The study indicated locations of five historical spotted owl activity centers, all 1 mi or farther from Project reservoirs (Deer Lick >2.5 mi from Ross Lake, Big Beaver Boundary >6 mi from Ross Lake, Pyramid Lake 1 mi from Diablo Lake/Colonial Creek Campground, Newhalem Creek >2 mi from Newhalem, and Little Devil/Stout Creek >3 mi from Newhalem). Surveys at each of these locations in 2009 and 2010 by Siegel et al. (2012) yielded a spotted owl response only at Newhalem Creek in 2009 (but not in 2010); the Newhalem Creek area was subsequently burned in the 2015 Goodell Creek Fire. An analysis of the NWFP Model was conducted for North Cascades National Park, comparing model results to known NSO nest sites in the park (Wilkerson and Siegel 2007). The analysis concluded that the NWFP Model performed relatively well for the park and the NWFP Model could be used as a reliable tool for land management decisions within the park.

City Light will review the following data sources to inform this study:

- Northwest Forest Plan—the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. (Davis and Lint 2005)
- Northwest Forest Plan Revised NSO Habitat Suitability Model (Davis et al. 2016)
- Conservation Biology Institute (CBI) North Cascades Old Growth Mapping (CBI 2020)
- Interpreting the Northwest Forest Plan's Northern Spotted Owl habitat suitability model for use in North Cascades National Park. The Institute for Bird Populations, Point Reyes Station, CA. (Wilkerson and Siegel 2007)
- Seattle City Light Skagit River LiDAR – 2018
- U.S. Geological Survey (USGS) Western Washington 3DEP LiDAR. 2016/2017. http://lidarportal.dnr.wa.gov/

2.4 Project Operations and Effects on Resources

The operation and maintenance (O&M) of the existing Project has limited potential to directly affect NSO habitat from (1) occasional cutting of hazard trees in forests adjacent to the transmission line or access roads, or (2) habitat management activities on mitigation lands. Another mechanism by which NSO may be affected is O&M activities or project-related recreation occurring close to active NSO nests which could disturb owls during the nesting season, if any such nests were to occur near Project facilities. Project-related noise disturbance could come from the operation of heavy equipment and tools, such as chainsaws, for maintenance of vegetation, structures, utilities, and roads near the dams, powerhouses, and transmission line corridor or during work on the mitigation lands. City Light boat use generates noise on the Project reservoirs. Some City Light boat activity occurs on Diablo Lake from operating the barge and crew ferry and on all three reservoirs from occasional research boat use and seasonal work boats used to maintain structures at the dams and collect floating driftwood. Most of the boat use on Ross Lake is related to small engine recreational boats and NPS management activities.

City Light periodically uses helicopters to inspect the transmission lines and towers. During these inspections the helicopter flies well over the tree tops and only hovers if potential structural problems are noted, which is rare. Project-related snow surveys, conducted by National Resource Conservation Service (NRCS) via helicopter for two days each month from the end of December through early May, also generate noise, which is most noticeable at take-off and landing in Newhalem and at the snow course stations, and during ascents and descents in the Gorge bypass reach area. Noise from helicopters has the potential to impact wildlife in and around the Newhalem area and in the Gorge bypass reach but the frequency of occurrence is low and intermittent and mostly outside of the nesting season.

2.5 Study Area

The study area will include the Project Boundary and also a 0.5-mile buffer surrounding the FERC Project Boundary (Figure 2.5-1).

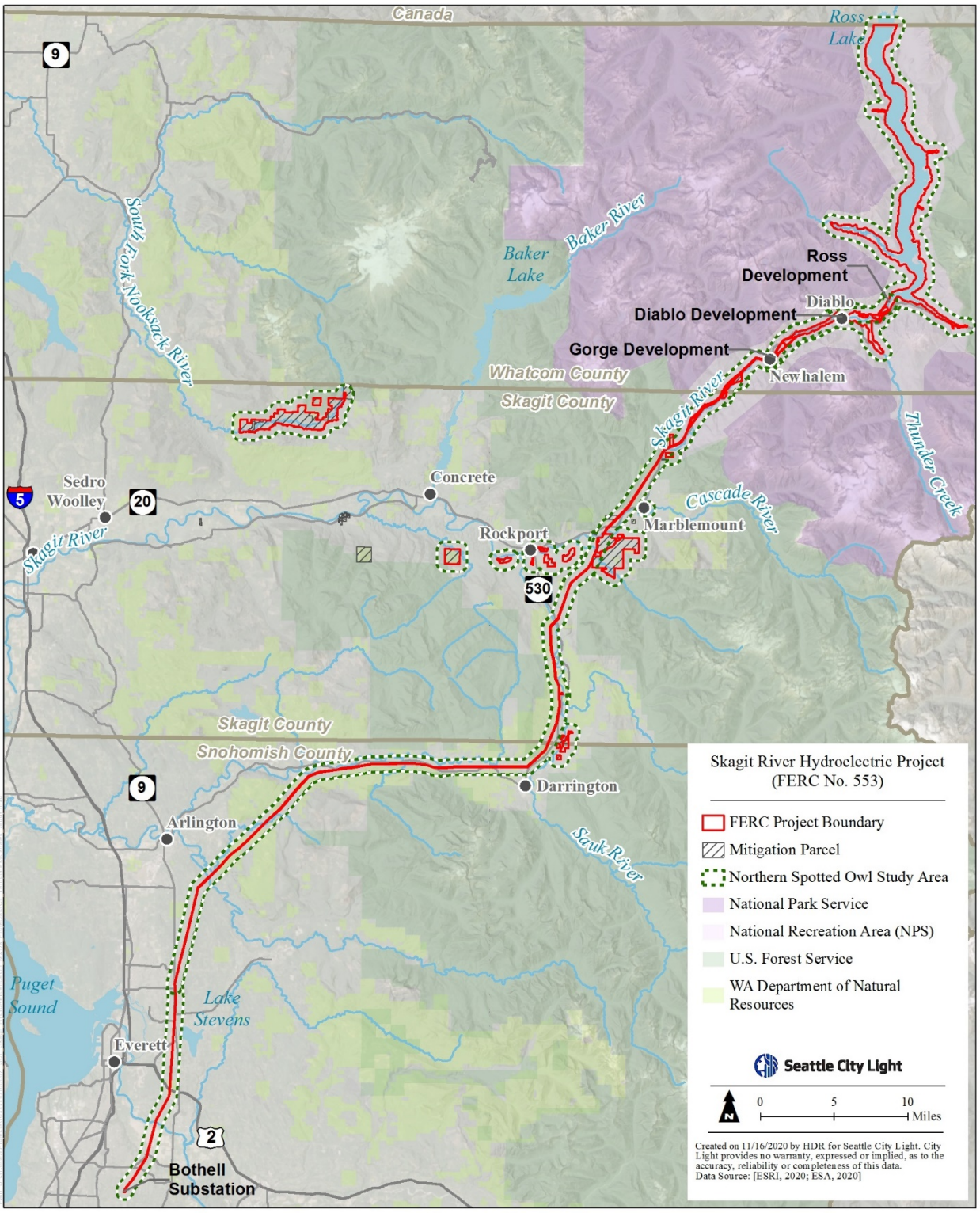

Figure 2.5-1. Overview of study area.

2.6 Methodology

The study will use available science and habitat models to identify potentially suitable NSO NRF habitat within the study area. The steps for conducting the study are detailed below.

2.6.1 Review Scientific Literature

Habitat parameters identified in the literature for NSO and available habitat models will be reviewed and summarized in tabular and narrative format. The types of information that will be reviewed include state and federal agency reports and management plans, previous Geographic Information System (GIS) NSO habitat mapping efforts and habitat models, existing Light Detection and Ranging (LiDAR) data, peer reviewed published literature, NPS and surrounding area's survey data, eBird records, and personal communications with current and former NPS, U.S. Forest Service (USFS), and WDFW staff and other relevant species experts.

2.6.2 Identify and Map Potentially Suitable Habitat

For the purposes of this study, City Light is considering suitable NSO habitat to be NRF habitat. Suitable NSO nesting and roosting habitat is generally defined as late successional mature and old-growth forests with large diameter coniferous trees, snags, downed wood, and a closed canopy (>60 percent canopy cover) with multiple canopy layers. Foraging habitat is often similar in structure to nesting and roosting habitat, though suitable foraging habitat can encompass a more diverse range of forest types such as younger forests with some component of residual large diameter conifer trees and snags (Forsman et al 2015; North et al. 1999).

Previous efforts by the Institute of Bird Populations in conjunction with NPS investigated the viability of developing a NSO habitat map for the North Cascades National Park but the lack of known NSO territories within the park precluded this model from being developed (Wilkerson and Siegel 2007). A larger and more robust NSO habitat suitability model, using data from NSO territories throughout the Pacific Northwest, was developed for the NWFP (Davis and Lint 2005). The NWFP Model produced vegetation maps that were developed using a combination of satellite imagery from various federal land agencies and Forest Inventory and Analysis (FIA)[1] plot data. FIA plots are forest inventory plots where a number of different forest inventory parameters for a specific location were collected and measured, such as tree height, species, canopy cover, canopy structure, downed woody debris, and snags. These vegetation maps were then analyzed using the habitat modeling software BioMapper (Hirzel et al. 2002) in combination with NSO detection data to create the NWFP Model for the range of the NSO. The seven habitat variables used for this modeling are: (1) quadratic mean diameter, which is the diameter at breast height of the dominant and codominant trees of an average basal area; (2) canopy cover of coniferous trees; (3) index of the product of conifer tree size and canopy cover; (4) canopy cover of deciduous trees; (5) an index of stand structure based on the number of vegetation-strike-team size classes within a 5x5 window (25 pixels = 3.9 ac square); (6) focal mean of discrete structure values within a 5x5 window; and (7) elevation from USGS digital elevation models.

[1] "The FIA Program collects, analyzes, and reports information on the status and trends of America's forests: how much forest exists, where it exists, who owns it, and how it is changing, as well as how the trees and other forest vegetation are growing and how much has died or has been removed in recent years." https://www.fia.fs.fed.us/about/about_us/

While the existing habitat map provides a generally good depiction of NSO habitat, refinements can be made using updated methods and information. Since the time Wilkerson and Siegel (2007) analyzed the original NWFP Model for use within North Cascades National Park, the NWFP Model has evolved based on the latest science and species detection information (Davis et al. 2016). The software MaxEnt (Phillips et al. 2020), is currently considered to be the software of choice for conducting presence-only species distribution modeling and has replaced the BioMapper software (Merow and Silander 2014). The NWFP Model has also refined the variables used for analysis to include: (1) diameter diversity index; (2) canopy cover of all conifers; (3) stand height; (4) mean conifer diameter; (5) density of large conifers; (6) stand age; and (7) forest species composition (Davis et al. 2016). Using the NWFP Model and the most up-to-date science and species detection information, a GIS map of potential suitable NSO NRF habitat will be developed for the study area.

Additional analysis using a combination of available LiDAR data will be used to produce a refined NSO habitat layer. LiDAR data was collected (2013–2018) for the entire Project Boundary. LiDAR is a remote sensing tool that can be used to describe the vertical structure of vegetation in a forested environment. When related to various forest structure variables associated with species-specific habitat features, LiDAR has been shown to accurately estimate the occupancy probability for species such as marbled murrelet, which share numerous nesting habitat features with NSO (Hagar et al. 2014). Recent research also suggests that LiDAR can be useful for identifying NSO habitat (Hagar et al. 2019), where maximum canopy height was determined to be the best predictor of NSO occupancy. Canopy cover, an important indicator of suitable NSO NRF habitat, can also be derived from LiDAR. This LiDAR data will be used to confirm the accuracy and reliability of the NSO habitat model developed above as well as to create a stand-alone NSO Suitable NRF habitat layer. If possible, nesting and roosting habitat will be mapped separately from foraging habitat. For the purposes of this analysis, foraging habitat includes all suitable nesting and roosting habitat along with younger forest stands that have the following three characteristics: (1) a canopy cover >60 percent; (2) containing some component of residual large diameter conifers and snags; and (3) within 1.8 miles of suitable nesting and roosting habitat.

CBI recently mapped old growth and late seral stage forests of the North Cascades (CBI 2020). The results from that mapping analysis will be combined in GIS with the data layers derived from the LiDAR analysis above to create a NSO Suitable NRF Habitat layer. Limited field verification during the TR-01 Vegetation Mapping Study and the TR-02 Wetland Assessment will provide additional refinement of the initial NSO habitat maps, providing information on the availability of suitable NSO habitat characteristics such as tree diameter and height, canopy cover, and canopy structure. If deemed necessary, using some of the methods outlined in the Vegetation Mapping Study, City Light will also conduct limited habitat assessments to verify the accuracy of the mapping of suitable NSO NRF habitat in areas where City Light may have activities that could potentially disturb nesting and roosting NSO. If possible, this effort will be coordinated in conjunction with the TR-05 Marbled Murrelet Study. City Light will use two biologists to sample and conduct a rapid assessment of representative sites (up to 6 days field effort) to verify accuracy of the mapping of NSO NRF habitat. A 25-meter radius plot will be conducted in each stand with the following information collected: forest species composition, conifer diameter, conifer tree height, canopy cover, canopy structure, and an assessment of flight access for NSO. At least five stands could be sampled per day or a total of ~30 stands during the week. This ground-truth information will be used to correct any inaccuracies in the final habitat model. If there are canopy

cover deficiencies in the NWFP or LiDAR models, we will also review an additional measure of canopy cover derived from the Multi-Resolution Land Characteristics (MRLC) Consortium, which produces the National Land Cover Database (NLCD).

The study will produce GIS layers showing NSO NRF habitat (possibly broken into NR vs. F) for the entire Project Boundary and 0.5-mile buffer derived from: (1) the updated NWFP Model; and (2) LiDAR analysis. The data will be presented in map format and summarized in a narrative. The results of the study will be used in the license application to assess Project effects and to inform development of NSO protection BMPs for O&M activities and new construction in or near NSO NRF habitat.

2.7 Consistency with Generally Accepted Scientific Practice

The study methods use a standard scientific approach by relying on documented occurrences of the species, a review of scientific literature and management guidelines, and a habitat assessment specific to western Washington using parameters identified in the scientific literature. The NWFP Model has been used to map habitat for a variety of federal projects that had the potential to impact NSO, including a recent pipeline development project in Oregon (USDA Forest Service 2018).

2.8 Schedule

- Literature Review – Spring 2021
- Habitat Mapping – Summer 2021
- Final Report (Initial Study Report [ISR]) – March 2022

2.9 Level of Effort and Cost

The initial estimate for implementation and reporting associated with this study is approximately $60,000.

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