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VIA ELECTRONIC FILING

March 8, 2023

KIMBERLY D. BOSE SECRETARY FEDERAL ENERGY REGULATORY COMMISSION 888 FIRST STREET, NE WASHINGTON, DC 20426

Re: Skagit River Hydroelectric Project, FERC Project No. 553-235 – Filing of Updated Study Report

Dear Secretary Bose:

In accordance with the Federal Energy Regulatory Commission's (FERC or Commission) regulations at 18 C.F.R. § 5.15(f), the City of Seattle, Washington, through its City Light Department (City Light), hereby files with the Commission its Updated Study Report (USR) for the relicensing of the Skagit River Hydroelectric Project (FERC Project No. 553) (Project).

The Project is located in the upper Skagit River Watershed. The Skagit River Watershed is within the traditional territory of several Indian Tribes and Canadian First Nations. The watershed and surrounding ecosystem support vital runs of anadromous fish that are key to the cultural, spiritual, and economic health of Indian Tribes. These anadromous fish, especially Chinook Salmon, are also important to other area residents, endangered Southern Resident Orca whales, and the entire Puget Sound ecosystem. Recognizing this, the City of Seattle has embraced an ecosystem approach under which it looks beyond what is strictly required under the FERC study criteria and has focused its relicensing studies to inform decisions on operating the Project over the next 40-50 years.

The Project consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities. The Project also includes two City Light-owned towns, the North Cascades Environmental Learning Center, several recreation facilities, and several thousand acres of fish and wildlife mitigation lands. The three Skagit generating developments are hydraulically coordinated to act as a single project and supply approximately 20 percent of City Light's power requirements. The Project also plays an important role in the regional energy market by integrating renewable resources and providing generation reserves.

The current license for the Project expires on April 30, 2025. In January 2019, City Light began a voluntary Study Plan Development Process with resource agencies, Indian Tribes, Canadian First Nations, and other interested parties (collectively, licensing participants or LPs) in advance of the

formal relicensing process to identify resource issues that warrant study during relicensing. City Light filed a Notice of Intent to relicense the Project and Pre-Application Document (PAD) on April 27, 2020. Following the filing of its PAD, City Light continued meeting with LPs to discuss studies necessary to inform the relicensing process. City Light filed the Proposed Study Plan (PSP) on December 8, 2020. The PSP included a suite of 28 relicensing studies and responded to study requests from LPs. After extensive PSP meetings and careful review of LP comments on the PSP, City Light significantly expanded and modified its PSP in the Revised Study Plan (RSP) filed on April 7, 2021, which included a proposed suite of 33 relicensing studies. Following filing of the RSP, City Light continued to work with LPs to attempt to resolve outstanding areas of disagreement regarding the proposed studies. On June 9, 2021, City Light filed a "Notice of Certain Agreements on Study Plans for the Skagit Relicensing" (June 9, 2021 Notice) detailing additional modifications to the RSP that were agreed to between City Light and supporting LPs. FERC issued its study plan determination on July 16, 2021, approving with modifications City Light's RSP. No study disputes were filed with FERC.

The enclosed USR builds on the Initial Study Report (ISR), which City Light filed with the Commission on March 8, 2022. City Light held ISR meetings on March 21-23, 2022, and filed an ISR meeting summary on April 7, 2022. A number of LPs filed comments on the ISR and meeting summary, including requests for study modifications and new studies. On August 8, 2022, the Director of the Office of Energy Projects issued a Determination on Requests for Study Modifications adopting one requested study modification in full and one in part and declining to approve the remaining modifications and requests for new studies.

This USR contains a complete reporting of all studies undertaken in the relicensing effort. Except as described below, City Light has now completed the Commission-approved study plan for the relicensing of the Project. Several studies will not be completed until after the filing of the Final License Application in April 2023. These include:

- CR-04 Inventory of Historic Properties with Traditional Cultural Significance Study: Ethnographers contracted by the Indian Tribes and Canadian First Nations continue to gather data and information, document and evaluate historic properties with traditional cultural significance, evaluate Project effects, and complete their reporting. The final study report(s) will be filed with FERC, in agreement with predetermined protocols for privileged information, once National Historic Preservation Act Section 106 consultation has been completed for the study report(s) (expected by May 2024).
- GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study: The GE-04 study is substantially complete. However, the 2D mobile bed HEC-RAS sediment transport model added in the June 9, 2021 Notice remains under development. City Light expects to file the 2D Mobile Bed HEC-RAS Model Development Report with FERC by the end of Q2 2023. This model is not critical for development of an effects analysis but will provide additional information that will help inform adaptive management.

 RA-02 Gorge Bypass Reach Safety and Whitewater Boating Study: The RA-02 study is substantially complete. However, the level 3 multiple flow evaluation has been delayed due to safety concerns, and is tentatively scheduled for Summer 2023. City Light expects to file with FERC the Level 3 Multiple Flow Evaluation Results and Findings Technical Memorandum by the end of Q3 2023.

Certain of the cultural resource study reports and Attachment D to the TR-03 study included in this USR contain sensitive and confidential cultural resource information and are filed with the Commission as privileged. These documents have been labeled as CUI//PRIV—PRIVILEGED—DO NOT RELEASE.

Pursuant to 18 C.F.R. § 5.15(c)(2), within 15 days of filing this USR, City Light will hold public USR meetings with LPs and Commission staff to discuss the study results. The USR meetings will be held virtually via Webex on March 20 and March 21, 2023. An agenda and instructions for joining the meetings is attached.

Within 15 days following the USR meetings, City Light will file meeting summaries with the Commission. Within 30 days of City Light's filing of the USR meeting summaries, stakeholders may file any disagreements with the meeting summaries, as well as any recommendations and associated justification for proposed modifications to ongoing studies or requests for new studies.

In addition to filing the USR with the Commission, City Light will share the USR with LPs and other stakeholders by posting the documents on City Light's Skagit Relicensing Public Documents Library web page at <u>http://www.seattle.gov/light/skagit/Relicensing/default.htm</u>.

City Light looks forward to continued collaboration with LPs and FERC staff in further developing its relicensing proposal. If there are any questions regarding this filing, please contact me by phone at (206) 304-1210 or by email at <u>Chris.Townsend@seattle.gov</u>.

Sincerely,

Chris Townsend (Mar 6, 2023 13:47 PST)

Chris Townsend Director, Natural Resources and Hydro Licensing Seattle City Light

Enclosures

cc: Distribution List (attached)



Skagit River Hydroelectric Project Updated Study Report (USR) Meeting Schedule

	<u> Monday, March 20 <i>9:00 am – 4:30 pm</i></u>	<u> Tuesday, March 21 <i>9:00 am – 4:30 pm</i></u>		
Time (PDT)	Zoom Meeting Link: LINKED HERE Meeting ID: 886 4548 3405 Passcode: 273238 Dial-in: +1 253 205 0468 US	Zoom Meeting Link: LINKED HERE Meeting ID: 886 4548 3405 Passcode: 273238 Dial-in: +1 253 205 0468 US		
Morning Session	 Welcome and Introductions <u>Studies:</u> FA-01a Water Quality Monitoring Study FA-01b Water Quality Model Development Study FA-02 Instream Flow Model Development Study FA-03 Reservoir Fish Stranding and Trapping Risk Assessment FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study 	 Welcome and Introductions <u>Studies:</u> OM-01 Operations Model Study FA-04 Fish Passage Technical Studies Program GE-01 Reservoir Shoreline Erosion GE-03 Affecting Resource Areas of Concern RA-01 Recreation Use and Facility Assessment RA-02 Gorge Bypass Reach Safety and Whitewater Boating Study 		
Break	12:00 – 12:45 : Lunch Break	12:00 – 12:45 : Lunch Break		
Afternoon Session	 Welcome and Introductions <u>Studies:</u> FA-06 Reservoir Native Fish Genetics Baseline FA-07 Reservoir Tributary Habitat Assessment GE-02 Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-of-Way GE-04 Geomorphology Between Gorge Dam & Sauk River SY-01 Synthesis and Integration of Available Information on Resources in the Lower Skagit River 	 Welcome and Introductions <u>Studies:</u> RA-04 Project Sound Assessment RA-05 Lower Skagit River Recreation Flow Study TR-03 Rare, Threatened, and Endangered Plants Study TR-04 Invasive Plants Study TR-08 Special-status Amphibian Study TR-09 Beaver Habitat Assessment CR-02 Cultural Resources Survey Summary Report CR-04 Inventory of Historic Properties with Traditional Cultural Significance Study 		

The intent of the Skagit Relicensing USR meetings is for City Light to provide a final update on all technical studies that have been implemented. Presentations will outline study goals, objectives, methods, results, and variances. The USR reports will be filed with FERC on March 8, 2023, and available to the public via <u>FERC's eLibrary</u>.

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UPDATED STUDY REPORT

SKAGIT RIVER HYDROELECTRIC PROJECT FERC NO. 553





March 2023

				TABLE OF CONTENTS	
Sectio	on No.			Description	Page No.
Fyon	utivo Su	mmann			1
LXect		mmary			L
1.0	Intro	luction	and Back	ground	
	1.1	Project	t Descript	ion	
		1.1.1	Project L	ocation	
		1.1.2	Project F	acilities	
			1.1.2.1	Ross Development	
			1.1.2.2	Diablo Development	
			1.1.2.3	Gorge Development	
			1.1.2.4	Transmission	
			1.1.2.5	Recreation Facilities	
			1.1.2.6	Fish and Wildlife Mitigation Lands	
			1.1.2.7	Project Boundary	
		1.1.3	Operatio	ns	
			1.1.3.1	Ross Development	
			1.1.3.2	Diablo Development	1-11
			1.1.3.3	Gorge Development	1-11
	1.2	Overvi	ew of the	Integrated Licensing Process (ILP)	
		1.2.1	Initiation	of the ILP	
		1.2.2	ILP Proc	ess Plan and Schedule	
		1.2.3	NOI and	PAD	
		1.2.4	Commer	cement of Relicensing and Environmental Scoping .	1-15
		1.2.5	PAD and	SD1 Comments and Study Requests	1-15
	1.2.6 PSP		1-15		
		1.2.7	PSP Mee	eting	1-16
		1.2.8	Commer	ts on the PSP	1-16
		1.2.9	RSP		1-16
		1.2.10	Commer	ts on the RSP	1-16
		1.2.11	June 9, 2	021 Notice	1-17
		1.2.12	SPD and	Study Disputes	1-17
		1.2.13	Study Re	porting and Study Plan Modification	1-17
		1.2.14	ISR Mee	ting and Comments	1-18
		1.2.15	DLA		
		1.2.16	Commer	ts on the DLA	
		1.2.17	USR Me	eting and Comments	
		1.2.18	FLA		1-18

2.0	Relicensing Studies and Ongoing Data Collection Activities			2-1
	2.1	Relice	ensing Studies	2-1
	2.2	Additi		
		2.2.1	Hydrology Datasets, Newhalem to Mount Vernon	
		2.2.2	Littoral Habitat Analysis	
	2.3	Ongoing and Future Data Collection Activities		
		2.3.1	Landform Mapping	2-4
		2.3.2	Food Web Study	
3.0	Status	of Ska	git Relicensing Collaborative Process	3-1
	3.1	Collab	poration with LPs to Date	
4.0	Refere	ences		4-1

List of Figures		
Figure No.	Description	Page No.
Figure 1.1-1.	Location map of the Skagit River Project	

List of Tables

Table No.	Description	Page No.
Table 1.2-1.	ILP milestones for the Skagit River Project through filing of the Final	
	License Application (FLA).	1-12
Table 2.1-1.	Summary of study reports	
Table 1.	USGS RM and PRM system crosswalk	1

List of Appendices

Appendix AProject InformationAppendix BHydrology Datasets, Newhalem to Mount VernonAppendix CList of Meeting and Organizations Participating in the Work Groups, Technical
Steering Committee, Advisory Roundtable, and Partners' Committee MeetingsAppendix DStudy Reports

1-D	one-dimensional
2-D	two-dimensional
CFR	Code of Federal Regulations
City Light	Seattle City Light
CoSD	City of Seattle datum
COVID-19	Novel Coronavirus
DLA	Draft License Application
Ecology	Washington State Department of Ecology
ELC	Environmental Learning Center
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FSA	Fisheries Settlement Agreement
GIS	geographic information system
GPS	Global Positioning System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HWM	high water marks
IHA	Indicators of Hydraulic Alteration
ILP	Integrated Licensing Process
ISR	Initial Study Report
June 9, 2021 Notice	June 9, 2021 Notice of Certain Agreements on Study Plans for the Skagit Relicensing
kV	kilovolt
LiDAR	Light Detection and Ranging
LP	licensing participant
MW	megawatts
NAVD 88	North American Vertical Datum of 1988
NGO	non-governmental organization
NGS	National Geodic Survey
Nlaka'pamux Nation	Coalition of Bands of the Nlaka'pamux Nation
NMFS	National Marine Fisheries Service
NOI	Notice of Intent

NPS	National Park Service
NSO	northern spotted owl
PAD	Pre-Application Document
PME	protection, mitigation, and enhancement
PRM	Project River Mile
Project	Skagit River Hydroelectric Project
PSP	Proposed Study Plan
RLNRA	Ross Lake National Recreation Area
RM	river mile
ROW	right-of-way
RSP	Revised Study Plan
RTE	rare, threatened, and endangered
SD1	Scoping Document 1
SD2	Scoping Document 2
SPD	Study Plan Determination
SPU	Seattle Public Utilities
SR	State Route
USACE	U.S. Army Corps of Engineers
U.S.C	United States Code
UBCRM	University of British Columbia Regime Model
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USR	Updated Study Report

EXECUTIVE SUMMARY

The Skagit River Hydroelectric Project (Skagit River Project or Project) is located in the upper Skagit River Watershed. The Skagit River Watershed is within the traditional territory of several Indian Tribes and Canadian First Nations. The watershed and surrounding ecosystem support vital runs of anadromous fish that are key to the cultural, spiritual, and economic health of Indian Tribes. These anadromous fish, especially Chinook Salmon, are also important to other area residents, endangered Southern Resident Orca whales, and the entire Puget Sound ecosystem. Recognizing this, the City of Seattle has embraced an ecosystem approach wherein it looks beyond what is strictly required under the Federal Energy Regulatory Commission (FERC or Commission) study criteria and has focused its relicensing studies to inform decisions on operating the Project over the next 40-50 years.

The City of Seattle, through its City Light Department (City Light), is the licensee of the existing 700-megawatt (MW) Skagit River Project. The Project is located within the North Cascades National Park Complex and portions of Whatcom, Skagit, and Snohomish counties, Washington. The Project consists of three power generating developments on the Skagit River—Ross, Diablo, and Gorge—and associated lands and facilities. The Project was originally licensed in 1927 by FERC's predecessor agency, the Federal Power Commission. The Project was developed over a 42-year period, beginning with the construction of Gorge Powerhouse and a timber-crib dam in 1919, and finishing with the completion of the existing concrete-arch dam at the Gorge Development in 1961.

The 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. Approximately one mile of Ross Lake, the upper-most Project reservoir, is in British Columbia and is part of the Skagit Valley Provincial Park. The roughly 60-mile stretch of the Skagit River several miles downstream of the Project is designated as a Wild and Scenic River and is managed by the U.S. Forest Service (USFS).

The three Skagit generating developments are hydraulically coordinated to act as a single project and supply approximately 20 percent of City Light's power requirements. The operational priorities for the Project are flood risk management, downstream fish protection, recreation, and power production. The Project also plays an important role in the regional energy market by integrating renewable resources and providing generation reserves.

Regionally, the Skagit River is a critically important resource. It is one of the largest rivers in Washington State and the only Puget Sound river that supports all five native salmonid species. It provides spawning, incubation, and rearing habitat for three federally listed threatened fish species—Chinook Salmon, steelhead, and Bull Trout—and is well-known for the large numbers of bald eagles that winter along the river and in its floodplain. The floodplain along the lower Skagit River contains rich agricultural land and supports thousands of migrating waterfowl and raptors.

The existing license for the Skagit River Project was issued May 16, 1995 and will expire on April 30, 2025. City Light is utilizing FERC's Integrated Licensing Process (ILP) to prepare its license application. The Federal Power Act requires City Light to file its new license application with FERC by April 30, 2023.

City Light initiated the relicensing by filing a Notice of Intent (NOI) and Pre-Application Document (PAD) with the Commission on April 27, 2020. The PAD proposed 24 studies developed by City Light in consultation with licensing participants (LP) through a voluntary Study Plan Development Process. On June 26, 2020, FERC issued public notice of City Light's NOI and PAD, which kicked off the formal licensing proceeding and started the public comment period on the PAD. Concurrently, FERC issued Scoping Document 1 (SD1) to outline the subject areas to be addressed in its environmental analysis of the Project pursuant to the National Environmental Policy Act. Due to the Novel Coronavirus (COVID-19) pandemic, FERC waived public scoping meetings and a site visit, and solicited written comments, recommendations, and information on SD1. Based on comments filed with the Commission in response to the PAD and SD1, and LP study requests, the Commission revised SD1 by issuing Scoping Document 2 (SD2) on December 4, 2020.

City Light filed the Proposed Study Plan (PSP) on December 8, 2020. The PSP included a suite of 28 relicensing studies and responded to study requests from LPs. As required by FERC's ILP regulations at 18 Code of Federal Regulations (CFR) § 5.11(e), City Light held study plan meetings to discuss the PSP on January 6, and 12-14, 2021. These meetings were used to present the background, concepts, and studies described in the PSP and receive feedback from the LPs. In addition, City Light hosted ten additional topic-based meetings and several one-on-one meetings with LPs in late January through April 2021 which were aimed at resolving outstanding differences between City Light's proposed studies and LPs' study requests.

Following the PSP meetings and after careful review of LP comments on the PSP, City Light reevaluated its position with respect to relicensing studies, reassessed its longstanding relationships with LPs, and decided to prioritize its efforts toward resolving outstanding differences concerning the proposed studies. City Light decided to significantly expand and modify its PSP in the Revised Study Plan (RSP) to demonstrate its commitment to working with LPs to accommodate their interests and information needs. Following filing of the RSP, City Light continued to work with LPs to attempt to resolve outstanding areas of disagreement regarding the proposed studies. On June 9, 2021, City Light filed a "Notice of Certain Agreements on Study Plans for the Skagit Relicensing" (June 9, 2021 Notice)¹ detailing additional modifications to the RSP agreed to between City Light and supporting LPs (which include the Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, National Marine Fisheries Service [NMFS], NPS, U.S. Fish and Wildlife Service, Washington State Department of Ecology [Ecology], and Washington Department of Fish and Wildlife). FERC subsequently issued its Study Plan Determination (SPD) on July 16, 2021, approving with modifications City Light's RSP. No study disputes were filed with FERC.

¹ Referred to by FERC in its July 16, 2021 Study Plan Determination as the "updated RSP."

City Light filed its Initial Study Report (ISR) on March 8, 2022, held ISR meetings March 21-23, 2022, and filed an ISR meeting summary on April 7, 2022. A number of LPs filed comments on the ISR and meeting summary, including requests for study modifications and new studies. On August 8, 2022, the Director of the Office of Energy Projects issued a Determination on Requests for Study Modifications adopting one requested study modification in full and one in part and declining to approve the remaining modifications and requests for new studies.

This USR contains a complete reporting of all studies undertaken in the relicensing effort. Except as described below, City Light has now completed the Commission-approved study plan for the relicensing of the Project. Components of three studies will not be completed until after the filing of the Final License Application in April 2023. These include:

- CR-04 Inventory of Historic Properties with Traditional Cultural Significance Study: Ethnographers contracted by the Indian Tribes and Canadian First Nations continue to gather data and information, document and evaluate historic properties with traditional cultural significance, evaluate Project effects, and complete their reporting. The final study report(s) will be filed with FERC, in agreement with predetermined protocols for privileged information, once National Historic Preservation Act Section 106 consultation has been completed for the study report(s) (expected by May 2024).
- GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study: The GE-04 study is substantially complete. However, the 2D mobile bed HEC-RAS sediment transport model added in the June 9, 2021 Notice remains under development. City Light expects to file the 2D Mobile Bed HEC-RAS Model Development Report with FERC by Q2 2023. This model is not critical for development of an effects analysis, but will provide additional information that will help inform adaptive management throughout the term of the new license.
- RA-02 Gorge Bypass Reach Safety and Whitewater Boating Study: The RA-02 study is substantially complete. However, the level 3 multiple flow evaluation was delayed due to safety concerns, and is tentatively scheduled for Q3 2023. City Light expects to file with FERC the Level 3 Multiple Flow Evaluation Results and Findings Technical Memorandum by the end of Q3 2023.

The results of the studies included in this USR will be comprehensively analyzed together with other relevant available information, including that from the PAD, in order to evaluate the environmental effects of the Project proposal to be described in the license application. The license application will also include a description of any anticipated environmental impacts of continued operation of the Project, the incremental impact of any proposed equipment and/or capacity upgrades or redevelopment of Project works, implementation of PME measures, and any other proposed changes in Project operation. City Light will present a Project proposal in its Final License Application to be filed with FERC no later than April 30, 2023. Further, City Light continues to engage LPs regarding PME measures that will be proposed to be included in the new license.

1.0 INTRODUCTION AND BACKGROUND

The Skagit River Hydroelectric Project (Skagit River Project or Project), owned and operated by the City of Seattle, through its City Light Department (City Light), is licensed by the Federal Energy Regulatory Commission (FERC or Commission) as Project No. 553. The existing license for the Skagit River Project was issued May 16, 1995 and will expire on April 30, 2025. In accordance with FERC regulations, City Light notified FERC on April 27, 2020 that it intends to apply for a new license for the Project. The Federal Power Act requires City Light to file its new license application with FERC by April 30, 2023.

In accordance with FERC regulations at 18 Code of Federal Regulations (CFR) Part 5, City Light is utilizing FERC's Integrated Licensing Process (ILP) for preparing its license application. This Updated Study Report (USR) is being filed with FERC pursuant to 18 CFR § 5.15(f) and the Process Plan and Schedule referenced in FERC's June 14, 2021 letter regarding Filing of Updated Revised Study Plan (see Table 1.2-1 in this USR). Notification of availability of this USR is also being distributed to state and federal agencies, Indian Tribes, Canadian First Nations, non-governmental organizations (NGO), and other interested parties (collectively, licensing participants [LP]).

1.1 **Project Description**

1.1.1 Project Location

The Skagit River Project is located in northern Washington State, across Whatcom, Skagit and Snohomish counties, and consists of three power generating developments on the Skagit River—Ross, Diablo, and Gorge—and associated lands and facilities (Figure 1.1-1). The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between Project River Miles (PRM) 94.5 and 127.9 (U.S. Geological Survey [USGS] river mile [RM] 94 and 127).² The Project has a total authorized installed capacity of 700.27 megawatts (MW).³ Power from the Project is transmitted via two 230-kilovolt (kV) 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 (Newhalem and Diablo), the North Cascades Environmental Learning Center (ELC), several recreation facilities, and several thousand acres of fish and wildlife mitigation lands.

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,

² City Light has developed a standard Project centerline and river mile system to be used throughout the relicensing process, including the study program, to replace the outdated USGS RM system. Given the long-standing use of the USGS RM system, both it and the PRM system are provided throughout this document. For further details see Appendix A of this USR.

³ Authorized installed capacity values presented herein are those approved by the February 2, 2021 Order Amending License, Approving Revised Exhibits K and M, and Revising Annual Charges (174 FERC ¶ 62,066).

Diablo, and Gorge lakes." The legislation maintains FERC's 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).



Figure 1.1-1. Location map of the Skagit River Project.

1.1.2 Project Facilities

1.1.2.1 Ross Development

The Ross Development is the furthest upstream of the three Skagit River Project developments; the powerhouse and nearby dam are about 11 miles north of Newhalem. Most of the water used for Skagit River Project power generation originates in high mountain basins surrounding Ross Lake and upstream along the Skagit River in British Columbia. The Ross Development is relatively inaccessible, especially by vehicle. The Ross Powerhouse is typically accessed via Diablo Lake. An approximately 1.5-mile-long gravel road (Haul Road) connects the powerhouse to the dam and reservoir and is used by vehicles barged up Diablo Lake by City Light. The powerhouse, dam and reservoir are also accessible by foot via several trails:

- Ross Dam Trail, which is one mile long and drops 700 feet from a parking lot along State Route (SR) 20 at milepost 134 to the Haul Road, which then connects to the powerhouse, dam, and reservoir;
- Happy Panther Trail, which starts from the East Bank Trailhead along SR 20 at MP 138 and runs for 6 miles along Ruby Arm to the Ross Dam Trail and Haul Road; and
- Diablo Lake Trail, which starts at the parking lot near the ELC, runs for nearly 4 miles along the north side of the lake, crosses a suspension bridge, and ends near Ross Powerhouse and the start of the Haul Road.

The three trails and the Haul Road are open to pedestrian access by the public. The only vehicle access (other than the Haul Road) to the reservoir is via a 40-mile-long gravel road from Hope, British Columbia, to Hozomeen at the very north end of the reservoir. The boat ramps at Hozomeen provide the only public launches for motorized boats.

Ross Powerhouse is about 1,100 feet downstream of Ross Dam, on the left bank at the eastern end of Diablo Lake. There are four Westinghouse generating units (Units 41, 42, 43, and 44), each with a nameplate rating of 112.5 MW. Units 42, 43, and 44 each have an authorized installed capacity of 91.875 MW, and Unit 41 has an authorized installed capacity of 76.875 MW, for a total authorized installed capacity of 352.5 MW at the development. Two concrete-lined power tunnels deliver water from the reservoir to four penstocks and into the powerhouse. There is no surge tank. Diablo Lake backs up to the base of Ross Dam and there is no bypass reach or section of free-flowing river between the two developments.

Ross Dam is immediately upstream of Ross Powerhouse at PRM 105.7 (USGS RM 105.1). At 540 feet from bedrock to crest, it is the highest of the three Project dams. The intake structure is on the left side of the dam (facing downstream). The dam has two spillways—one on each side and each with six gates operated by an electric hoist. Two of the spillway gates can be controlled remotely; the others are operated locally at the dam. In addition to the spillways, Ross Dam has two concrete lined power tunnel intake structures, two butterfly valves at the 1,346.2-foot North American

Vertical Datum of 1988 (NAVD 88) (1,340-foot City of Seattle datum [CoSD]) level⁴ and two hollow jet valves near the right bank at 1,275.2 and 1,260.2 feet NAVD 88 (1,269 and 1,254 feet CoSD). The two sets of valves can be opened to evacuate the reservoir once water levels drop below the level of the spillway gates. On the top of the dam, a shed houses two hoists, one for each of the broome gates that close off the six-foot-diameter water supply pipes to the hollow jet valve. There is also a gantry crane used to raise and lower the broome gates that isolate the six-foot conduits for the butterfly valves. The road on top of the dam is used by City Light and NPS vehicles and is open to pedestrian use by the public.

At nearly 23 miles long, Ross Lake is the largest reservoir in western Washington. It extends into Canada approximately another 1 mile (24 miles total), with about 500 acres in British Columbia. The reservoir has a surface area of 11,725 acres and storage volume of 1,432,000 acre-feet at the normal maximum water surface elevation of 1,608.76 feet NAVD 88 (1,602.5 feet CoSD).

1.1.2.2 Diablo Development

The Diablo Development is between the Ross and Gorge developments and in addition to generating power it reregulates flows between the other two developments. The powerhouse is on the north side of the Skagit River in the town of Diablo, about 4,000 feet downstream from Diablo Dam. Water from the reservoir to the powerhouse is conveyed by a single concrete lined tunnel for 1,900 feet that leads to three steel-lined penstocks. There is a surge tank located near the downstream end of the tunnel, uphill from the powerhouse. Diablo powerhouse, dam, and reservoir are all accessible by SR 20 and/or short access roads off this highway.

Diablo Powerhouse holds two Westinghouse generators (Units 31 and 32) and each has a nameplate rating of 90 MW and authorized installed capacity of 78.035 MW. There are also two smaller, house-unit generators (Units 35 and 36), each with nameplate ratings and authorized installed capacities of 1.2 MW. Total authorized installed capacity at the development is 158.47 MW. A reinforced-concrete tailrace on the westerly edge of the powerhouse also serves to support transformers, a switching apparatus, and a crossing for a single-lane road.

Diablo Dam is located at PRM 101.6 (USGS RM 101.2), about five miles upstream of Gorge Dam and four miles downstream of Ross Dam. The concrete arch dam is 389 feet from bedrock to crest and has two spillways, one on each side, and a total of 19 spillway gates—7 on the south spillway and 12 on the north. The three southern-most gates are automated via an electric hoist that can be locally or remotely operated. The remaining 16 gates are controlled locally at the dam using the "mule," an electric motor-driven hydraulic hoist that consists of two hydraulic cylinders to open or close the associated spillway gate. The mule runs on rails along the road on top of the dam and is positioned over the desired gate. The lifting chains for the gates are accessed below the deck plates on the dam. A valve house on the face of the dam has four outlets—three butterfly valves that can evacuate water from the reservoir at levels below the spillway gates and one Larner Johnson valve that is not used at elevation 1,050.65 feet NAVD 88 (1,044 feet CoSD). There are

⁴ City Light is in the process of converting Project information from its older vertical elevation datum (CoSD) to the more current and standardized elevation datum (NAVD 88). As such, elevations are provided relative to both data throughout this USR. The conversion factor between CoSD and NAVD 88 varies depending on location. A table converting elevation values of common benchmarks, staff gages, and key Project features from CoSD to NAVD 88 and a map of the same features are appended to this USR (Appendix A), both of which have been updated since the Pre-Application Document (PAD).

two bifurcated intakes at the dam but only one is in use, as the second intake was for planned future expansion of the powerhouse and a second tunnel, which were never constructed. The crest of the dam also serves as a road that provides access to a boat house and other marine facilities and the ELC. The road across the dam is open to the public from 7am to 5pm.

Diablo Lake has a surface area of about 905 acres and gross storage of 88,800 acre-feet at a normal maximum water surface elevation of 1,211.36 feet NAVD 88 (1,205 feet CoSD). Debris booms near the dam keep floating wood and boats away from the intakes and spillway gates; other booms delineate restricted boat use and operational areas on the reservoir.

There is no bypass reach or riverine section between Diablo Dam and Powerhouse. Hydraulic conditions in this area are controlled by the existence of a gravel/cobble bar located at the confluence of Stetattle Creek with Gorge Lake and by the orientation of Diablo Powerhouse outflows. Under normal operations, the reach between Diablo Dam and Powerhouse is watered and hydraulically connected to the upper end of Gorge Lake.

1.1.2.3 Gorge Development

Gorge Powerhouse is on the left bank (facing downstream) of the Skagit River just upstream of the town of Newhalem and can be reached via SR 20 by vehicle bridge across the river or by a nearby suspension foot bridge. Both bridges are open to pedestrian access by the public. There are four Westinghouse generating units (Units 21, 22, 23, and 24). Units 21 and 22 each have a nameplate rating of 36.86 MW and authorized installed capacity of 31.5 MW; Unit 23 has a nameplate rating of 36.86 MW and authorized installed capacity of 30.2 MW. Unit 24 is significantly larger, with a nameplate rating of 97 MW and an authorized installed capacity of 96.1 MW. Total authorized installed capacity at the development is 189.3 MW.

In addition to generating power, Gorge Powerhouse is responsible for regulating flows to the river downstream of the Project for fish protection, as stipulated by the current Project license. Units 21, 22, and 23 are each connected to steel-lined penstocks through 10-foot-diameter, biplane-type butterfly valves equipped with relief valves, which will discharge a maximum of 65 percent of the turbine flow at full-load rejection. Equipment has also been installed to allow these valves to open and stay open for any required period to maintain fish flows after a plant load rejection/shutdown. Unit 24 is connected to the steel-lined penstock through a 15-foot-diameter butterfly valve.

Water from Gorge Lake is conveyed via an intake structure in Gorge Dam into an 11,000-footlong concrete lined power tunnel to the powerhouse. The power tunnel passes through the solid rock slope that is adjacent to the Skagit River and then splits into four penstocks. A surge tank and riser with restricted orifice is located at the lower end of the tunnel. There are also two adits that provide access to the power tunnel—one about halfway at Devil's Elbow and the other near Gorge Powerhouse. The current Skagit River Project license includes a second power tunnel at the Gorge Development which has not yet been constructed.⁵

Gorge Dam, located at PRM 97.2 (USGS RM 96.6), is about 2.5 miles upstream of Gorge Powerhouse and 4 miles downstream from Diablo Dam near Gorge Creek. It is accessed by a short

⁵ A second power tunnel at the Gorge Development was authorized in a license amendment issued by FERC on July 17, 2013 (144 FERC ¶ 62,044).

gravel road off SR 20 and not open to public vehicles. The dam is a combination concrete arch and gravity structure that rises 300 feet from bedrock to crest. There are two spillways with gates that are operated by an electric hoist on top of the dam. One gate can be remotely controlled to a limited height; the other must be opened and closed locally at the dam. Training walls on either side of the spillway direct water into the river channel downstream. Two outlet valves on the face of the dam at elevation 770.3 feet NAVD 88 (764 feet CoSD) can be used to evacuate water from Gorge Lake below the spill gate level. There is a log chute that allows floating woody debris to be passed downstream of the Project.

Gorge Lake is 4.5 miles long and extends upstream to the base of Diablo Dam. At the normal maximum water surface elevation of 881.51 feet NAVD 88 (875 feet CoSD), the lake has a surface area of 235 acres and gross storage of 8,200 acre-feet. During normal operations, water from Gorge Dam is conveyed to the Powerhouse via the 11,000-foot-long power tunnel, creating a 2.5-mile-long bypass reach of the Skagit River between the dam and the powerhouse. This reach serves as the active spillway for Gorge Dam. Almost the entire Gorge bypass reach and the reservoir are bordered by SR 20.

1.1.2.4 Transmission

The Project Boundary includes approximately 351.83 circuit miles of primary transmission lines connecting the Project to the bulk electrical grid. The lines terminate at Bothell Substation, just north of Seattle in Snohomish County; the substation is located partially within the Project Boundary. The other substation associated with the lines is North Mountain, outside of the town of Darrington, which is jointly owned by City Light and Snohomish Public Utility District and began operations in 1991. This substation gives City Light the ability to interconnect with other utilities to balance regional supply and demand, if needed. The North Mountain Substation is not a Project facility and is not within the Project Boundary.

The Project transmission lines are primarily on double-circuit steel lattice towers, although a few towers have been replaced with monopoles. From Ross Powerhouse to Bothell Substation, the right-of-way (ROW) is approximately 100 miles long and ranges from 150 to 400 feet wide. The various components of this system are described below:

- From Ross Powerhouse, two 230-kV transmission lines (R1 and R2) run for about 3.8 miles along the west side of Diablo Lake, down the hillside past Diablo Dam to Diablo Switchyard.
- The 230-kV Diablo Switchyard is adjacent to Diablo Powerhouse and serves to connect the Ross, Diablo, and Gorge developments into the Skagit transmission system. The R1 and R2 lines from Ross terminate at the switchyard.
- From Diablo Switchyard, one 230-kV line (D4) runs for 5.8 miles and terminates at Gorge Switchyard, located just across the river from Gorge Powerhouse. The other three lines (D1, D2, and D3) run 87.5 miles to the Bothell Switching Substation.
- From the Gorge Switchyard, a single 230-kV line (GO-NM) runs 36.8 miles to the North Mountain Substation.
- From there, the NM-SN line extends for 40.6 miles to Bonneville Power Administration's Snohomish Substation and then another 7.6 miles to Bothell as SN-BO#1.

From Gorge Switchyard to North Mountain Substation, the D1, D2, D3, and GO-NM lines are mostly within the same right-of-way (ROW), although there are a few sections where the ROW splits, with two lines in each, due to topographical constraints. At the North Mountain Substation, the NN-SN line joins the three lines originating at Diablo (D1, D2 and D3) and runs in the same ROW. Similarly, the SN-BO#1 line joins the ROW from the Snohomish Substation to Bothell. From Ross Powerhouse to Bothell Substation, the ROW is approximately 100 miles long and ranges from 150 to 400 feet wide.

1.1.2.5 Recreation Facilities

City Light operates and maintains several educational, recreation, and interpretive facilities at the Project, including:

- (1) North Cascades Environmental Learning Center;
- (2) Skagit Tour Dock;
- (3) Diablo Dam Parking Area;
- (4) West Ferry Landing;
- (5) East Ferry Landing;
- (6) Ross Lodge Picnic Shelter;
- (7) Gorge Lake Boat Launch;
- (8) Ladder Creek Falls Trail and Gardens;
- (9) Trail of the Cedars;
- (10) Gorge Powerhouse Visitor Gallery;
- (11) Gorge Powerhouse Parking Area;
- (12) Skagit Information Center and restrooms;
- (13) Gorge Inn Museum;
- (14) Newhalem Picnic Sites;
- (15) Newhalem Parking Areas and complimentary vehicle charging station;
- (16) Newhalem Interpretive Displays; and
- (17) Newhalem Playground.
1.1.2.6 Fish and Wildlife Mitigation Lands

City Light owns multiple parcels of lands in the Skagit, Sauk, and South Fork Nooksack watersheds managed for wildlife and fish habitat, totaling approximately 10,804 acres. All of the fish and wildlife mitigation lands are within the current Project Boundary.⁶

1.1.2.7 Project Boundary

The Skagit River Project Boundary is located in the traditional territory of several Indian Tribes and Canadian First Nations and encompasses 32,773 acres and includes all Project facilities, including the dams, powerhouses, reservoirs, power tunnels, switchyards, transmission lines, and the towns of Newhalem and Diablo, as well as all fish and wildlife mitigation lands and Project recreation sites. It terminates in Washington State, at the U.S.-Canada border, and thus does not include the lands and waters around and within Ross Lake in Canada. Most of the City Light-owned fish and wildlife mitigation lands, as well as the U.S. Forest Service (USFS)-managed Marblemount and Sauk River boat launches, are non-continuous features within the Project Boundary and are mapped as "islands."

The Skagit River Project encompasses 19,233.51 acres of federal lands administered by the NPS and USFS—19,007.01 acres that are non-transmission related, and 226.5 acres in the transmission line ROW.⁷ The Project Boundary along Diablo and Gorge lakes extends about 200 feet (horizontal measurement) beyond the normal maximum water surface elevation. For Ross Lake, the Project Boundary was established to accommodate potential future development subject to the High Ross Treaty.⁸ As a result, the Project Boundary around Ross Lake includes significant reaches of several of the major tributaries above the current normal maximum water surface elevation, including Big Beaver, Little Beaver, Lightning, and Ruby creeks. While included within the Project Boundary, lands associated with the inundation zone of High Ross (5,213.78 acres)⁹ are not impacted by Project operations.

In compliance with Article 201 of the FERC license, City Light pays reasonable annual charges for recompensing the United States for the use, occupancy, and enjoyment of its lands by hydropower licensees. Annual charges for the use of government lands are payable in advance and are based on an annual schedule of per-acre rental fees. For 2022 the total fee levied for the Skagit Project was \$3,976,199.91 based on the Whatcom County rate of \$297.60 per acre applied to 13,371.53 qualifying acres.

⁶ In 2020, City Light amended the Project Boundary to include additional fish and wildlife mitigation lands that were recently acquired under ongoing implementation of the existing license (April 1, 2020 request to amend Exhibit K, as modified in its August 19, 2020 Response to FERC's May 21, 2020 Additional Information Request). Project Boundary acreage values presented herein are those approved by the February 2, 2021 Order Amending License, Approving Revised Exhibits K and M, and Revising Annual Charges (174 FERC ¶ 62,066).

⁷ In response to FERC's May 21, 2020 Additional Information Request, City Light submitted revised Exhibits K and M, which included updated federal lands values. Federal land acreage values presented herein are those approved by the February 2, 2021 Order Amending License, Approving Revised Exhibits K and M, and Revising Annual Charges (174 FERC ¶ 62,066).

⁸ Plans to raise the height of Ross Dam by 125 feet, approved by the Federal Power Commission in 1977, were suspended with the signing of the High Ross Treaty in 1984.

⁹ Per February 2, 2021 Order Amending License, Approving Revised Exhibits K and M, and Revising Annual Charges (174 FERC ¶ 62,066).

1.1.3 Operations

The three Project developments are hydraulically coordinated to operate as a single project. Project operation under the existing license is designed to meet and prioritize four objectives: (1) flood risk management; (2) salmon and steelhead protection flows downstream of Gorge Powerhouse; (3) recreation; and (4) power generation. To achieve these goals, City Light must adhere to specific license requirements for Ross Lake levels and for streamflows and ramping rates downstream of Gorge Powerhouse. This section describes typical current operations and does not describe variations due to extreme weather events such as heat waves and intense rain events.

1.1.3.1 Ross Development

Ross Lake, the impoundment created by Ross Dam, is the largest of the three Project reservoirs with a useable storage capacity of 1,063,000 acre-feet. If needed, the reservoir can be surcharged by 5.5 feet to the top of the spillway gates to absorb an additional 69,000 acre-feet (U.S. Army Corps of Engineers [USACE] 2002). City Light operates Ross Lake to provide storage for downstream flood risk management; downstream fish protection; recreation at the lake; and power production.

Under existing operations, Ross Lake is drawn down on a yearly basis during winter to capture flows from spring runoff and to provide for downstream flood risk management. The drawdown typically begins after Labor Day and continues until the lake reaches its lowest level in late March or early April. Article 301 of the current license requires City Light to draw down Ross Lake to a level that provides 60,000 acre-feet of storage for flood risk management by November 15 and 120,000 acre-feet by December 1, and to maintain this available storage through March 15.

Ross Lake levels are also managed to meet recreational needs, including access to 19 boat-in campsites with docks and pit toilets managed by NPS, during the summer months. The current license requires City Light to fill Ross Lake as soon as possible after April 15, achieve normal maximum water surface elevation depth by July 31, and to maintain this available storage through March 15. City Light must also comply with Details of Regulation for Use of Storage Allocated for Flood Control in Ross Reservoir, Skagit River, WA (USACE 1967), which is incorporated into the Project license by reference. This document was updated in 2002 and provides the current guidance for Project operations for flood risk management.

Ross Lake water surface elevation is also managed to meet recreational needs during the summer months. Article 403 of the current license requires City Light to fill Ross Lake as soon as possible after April 15, achieve normal maximum water surface elevation depth by July 31, and maintain normal maximum water surface elevation depth through Labor Day.

City Light typically operates the Ross Powerhouse continuously to pass flow downstream, although it occasionally increases and decreases generation for short periods to help meet load-following demand or other Project purposes. Spills over Ross Dam are infrequent (relative to Diablo and Gorge developments) due to the large reservoir storage capacity. Spill is typically associated with gate testing and is usually short in duration and averages only a few cubic feet per second of flow per event.

1.1.3.2 Diablo Development

The Diablo Development is operated primarily to regulate flow between the Ross and Gorge developments. Under normal operation, the reservoir level typically fluctuates between 4 and 5 feet per day. Because of its limited useable storage (6,200 acre-feet) relative to Ross Lake, the reservoir cannot absorb large fluctuations in flow under normal operations. Therefore, the Diablo Development spills much more frequently than the Ross Development, averaging about 62 days of spill per year. Spill can occur any time inflow to the reservoir exceeds plant capacity, typically during periods of high runoff. Diablo Dam also spills when the powerhouse units are offline or additional flow is needed to meet fish protection flows downstream of the Gorge Powerhouse.

Like the Ross Powerhouse, City Light typically operates the Diablo Powerhouse continuously to pass flow downstream, although it occasionally increases and decreases generation for short periods to help meet load-following demand or other Project purposes.

1.1.3.3 Gorge Development

The Gorge Development is operated primarily to regulate flows downstream of the powerhouse for salmon and steelhead protection in the upper Skagit River. The fish protection flow requirements are specified in the Revised Fisheries Settlement Agreement (FSA) Flow Plan that was developed in collaboration with Indian Tribes and regulatory agencies and that was approved by a July 17, 2013 Commission order amending license. The fish protection flows are generally designed to: (1) limit maximum flows when salmon and steelhead are spawning to prevent redd building along the margins of the river where they could be subject to flow fluctuations or dewatering if flows are reduced; (2) maintain minimum flows throughout the incubation period to prevent desiccation of redds; and (3) limit ramping to protect sensitive life stages of salmon and steelhead from rapid increases or decreases in river flows.

To comply with the requirements of the FSA Flow Plan, City Light operates Gorge Lake and Powerhouse in coordination with Ross and Diablo lakes to provide a continuous, stable flow regime in the upper Skagit River with minimum and maximum flows into the mainstem Skagit River downstream of Gorge Powerhouse as outlined in the FSA. Reservoir fluctuations are limited to about 3 to 5 feet and City Light does not typically operate the powerhouse to meet load-following demand.

The Gorge Development creates a 2.5-mile-long bypass reach of the Skagit River between the dam and powerhouse. There are no minimum or maximum flow requirements or ramping rates in the current Project license for the Gorge bypass reach. Therefore, except during spill events at Gorge Dam, bypass reach flow is limited to accretion flow, spillway-gate seepage, tributary input, and precipitation runoff.

Spill at Gorge Dam into the 2.5-mile-long Gorge bypass reach occurs any time that inflow exceeds the generating capacity of the powerhouse, or if additional flow is needed to meet fisheries protection flows in the upper Skagit River. These spill events typically occur between 9 and 56 days per year.

1.2 Overview of the Integrated Licensing Process (ILP)

1.2.1 Initiation of the ILP

Pursuant to 18 CFR § 5.5(a), City Light filed a Notice of Intent (NOI) to relicense the Project and a Pre-Application Document (PAD; City Light 2020a) with FERC on April 27, 2020. Copies of the NOI, PAD, and other relicensing filings can be accessed through FERC's e-library (<u>www.ferc.gov/docs-filing/elibrary.asp</u>) or the Skagit Relicensing Public Document Library on City Light's website (<u>http://www.seattle.gov/light/skagit/Relicensing/default.htm</u>).

1.2.2 ILP Process Plan and Schedule

Following City Light's filing of its NOI and PAD, several parties requested a modification of the ILP process plan and schedule presented in the PAD. FERC granted the extension request, in part, on June 25, 2020, in light of extenuating circumstances of the Novel Coronavirus (COVID-19) pandemic on LP participation in the study planning phase of the ILP. As a result, FERC issued a modified ILP Process Plan and Schedule waiving the timing requirements of 18 CFR §§ 5.10, 5.11, 5.12, and 5.13, extending the due dates for each milestone up to the Director's Study Plan Determination (SPD) by 60 days, and maintaining the original deadlines for the Initial Study Report (ISR) of March 8, 2022, and this USR of March 8, 2023.

In addition, in response to various LP requests for extension of time to comment on the Revised Study Plan (RSP)¹⁰ and City Light's June 9, 2021 filing of its "Notice of Certain Agreements on Study Plans for the Skagit Relicensing" (June 9, 2021 Notice),¹¹ FERC subsequently issued modified ILP Process Plans and Schedules in letters dated April 6, May 17, and June 14, 2021. Table 1.2-1 details the current Process Plan and Schedule as established by FERC.

Significant Pre-filing Milestones	Responsible Party	Timeframe	Date ¹	FERC Regulation
Filing of Notice of Intent (NOI) and Pre- Application Document (PAD)	City Light	As early as 5.5 years, but no later than 5 years prior to license expiration	4/27/2020	18 CFR §5.5 and §5.6
Initial Tribal Consultation Meeting(s)	FERC	No later than 30 days after filing NOI and PAD	5/27/2020	18 CFR §5.7
Notice of NOI/PAD and Issuance of Scoping Document 1 (SD1)	FERC	Within 60 days of filing NOI and PAD	6/26/2020	18 CFR §5.8
Scoping Meeting/Site Visit	FERC	Within 30 days of NOI/PAD notice and issuance of SD1	N/A Waived ²	18 CFR §5.8(b)(viii)
Comments on PAD, SD1, and Study Requests	FERC, LPs	Within 60 days of NOI/PAD notice and issuance of SD1	10/24/2020	18 CFR §5.9

Table 1.2-1.ILP milestones for the Skagit River Project through filing of the Final License
Application (FLA).

¹⁰ Swinomish Indian Tribal Community letter dated April 2, 2021 (supported by Washington Department of Ecology [Ecology] and City Light in letters dated April 5 and 6, 2021, respectively), and the Coalition of Bands of the Nlaka'pamux Nation in letter dated May 12, 2021.

¹¹ Referred to by FERC in its July 16, 2021 SPD as the "updated RSP."

Significant Pre-filing Milestones	Responsible Party	Timeframe	Date ¹	FERC Regulation
Issuance of Scoping Document 2 (SD2), if necessary	FERC	Within 45 days of deadline for filing comments on SD1	12/8/2020	18 CFR §5.10
File Proposed Study Plan (PSP)	City Light	Within 45 days of deadline for filing comments on PAD	12/8/2020	18 CFR §5.11(a)
Study Plan Meeting(s)	City Light	Initial meeting to be held within 30 days of filing PSP	1/7/2021	18 CFR §5.11(e)
Comments on PSP	FERC, LPs	Within 90 days after PSP is filed	3/8/2021	18 CFR §5.12
File Revised Study Plan (RSP)	City Light	Within 30 days of deadline for comments on PSP	4/7/2021	18 CFR §5.13(a)
Comments on RSP	All LPs, except the Coalition of Bands of the Nlaka'pamux Nation	Within 15 days following RSP	5/6/2021 ³	18 CFR §5.13(b)
	the Coalition of Bands of the Nlaka'pamux Nation		6/1/20214	
File Updated RSP	City Light		6/9/20215	18 CFR §5.13(a)
Comments on Updated RSP	LPs	Within 15 days of FERC's letter on Updated RSP	6/29/20215	18 CFR §5.13(b)
Issuance of Study Plan Determination (SPD)	FERC	Within 30 days of RSP	7/16/2021 ^{5,6}	18 CFR§ 5.13(c)
Conduct First Season of Studies	City Light		2021	18 CFR §5.15(a)
Initial Study Report (ISR)	City Light	Pursuant to the Commission- approved study plan and schedule provided in §5.13 or no later than 1 year after Commission approval of the study plan	3/8/2022	18 CFR §5.15(c)(1)
ISR meeting	City Light and LPs	Within 15 days of filing the ISR	3/23/2022	18 CFR §5.15(c)(2)
File ISR Meeting Summary	City Light	Within 15 days of study results meeting	4/7/2022	18 CFR §5.15(c)(3)
File Meeting Summary disagreements ⁷	LPs	Within 30 days of study results Meeting Summary	5/7/2022	18 CFR §5.15(c)(4)
File responses to Meeting Summary disagreements	City Light	Within 30 days of filing Meeting Summary disagreements	6/6/2022	18 CFR §5.15(c)(5)
Study Dispute Determination	FERC	Within 30 days of filing responses to disagreements	7/6/2022	18 CFR §5.15(c)(6)

Significant Pre-filing Milestones	Responsible Party	Timeframe	Date ¹	FERC Regulation
Conduct Second Season of Studies	City Light		2022	18 CFR §5.15(a)
File Draft License Application (DLA)	City Light	No later than 150 days prior to the deadline for filing a new or subsequent license application	11/30/2022	18 CFR §5.16 (a)-(c)
Comments on DLA	LPs	Within 90 days of filing DLA	2/28/2023	18 CFR §5.16(e)
File Updated Study Report (USR)	City Light	Pursuant to the Commission- approved study plan and schedule provided in §5.13 or no later than 2 years after Commission approval	3/8/2023	18 CFR §5.15(f)
USR meeting	City Light and LPs	Within 15 days of USR	3/23/2023	18 CFR §5.15(f)
File USR Meeting Summary	City Light	Within 15 days of USR meeting	4/7/2023	18 CFR §5.15(f)
File Meeting Summary Disagreements ⁷	LPs	Within 30 days of study results meeting summary	5/7/2023	18 CFR §5.15(f)
File Responses to Meeting Summary Disagreements	City Light	Within 30 days of filing meeting summary disagreements	6/6/2023	18 CFR §5.15(f)(5)
Study Dispute Determination	FERC	Within 30 days of filing responses to disagreements	7/6/2023	18 CFR §5.15(f)
File Final License Application (FLA)	City Light	No later than 24 months before the existing license expires	4/30/2023	18 CFR §5.17

1 If the due date falls on a weekend or holiday, the deadline is the following business day.

2 Due to the proclamation declaring a National Emergency concerning COVID-19, issued by the President on March 13, 2020, FERC waived § 5.8(b)(viii) of its regulations and did not conduct a public scoping meeting.

3 As amended by the Commission's letter dated April 6, 2021, LPs had until May 6, 2021 (an additional 14 days) to file comments on the RSP.

4 As amended by the Commission's letter dated May 17, 2021, the Coalition of Bands of the Nlaka'pamux Nation had until June 1, 2021 (an additional 15 days from the date of FERC's letter) to file comments on the RSP.

5 As amended by the Commission's letter dated June 14, 2021, LPs had until June 29, 2021 (15 days from the date of FERC's letter) to file comments on the Updated RSP, after which the Commission was to issue its SPD by July 14, 2021, and mandatory conditioning agencies were to file any study disputes by August 3, 2021. No study disputes were filed. Deadlines for milestones beyond issuance of the SPD remain unchanged.

6 FERC issued its SPD on July 16, 2021, shifting the deadlines for the study dispute steps by two days.

7 Shaded actions are not necessary if there are no study or meeting summary disputes.

1.2.3 NOI and PAD

City Light filed a NOI and PAD with the Commission on April 27, 2020 (City Light 2020a). The PAD serves as the first document in a phased process to provide the information necessary to both review existing conditions and inform development of a comprehensive proposal for Project operations, including protection, mitigation, and enhancement (PME) measures, over the term of the new license. The PAD also provides a preliminary assessment of known Project effects and proposed PME measures that may be implemented as a starting point for discussions with LPs. The PAD outlined goals and objectives of 24 studies that have since been further developed and expanded to 33 studies as presented in the RSP, ISR, and this USR.

1.2.4 Commencement of Relicensing and Environmental Scoping

On June 26, 2020, FERC issued public notice of the PAD and NOI and commencement of the relicensing pre-filing process, which kicked off the formal licensing proceeding and started the public comment period on the PAD. FERC's June 26, 2020 notice also designated City Light as FERC's non-federal representative for carrying out informal consultation pursuant to Section 7 of the Endangered Species Act and to fulfill its responsibilities under Section 106 of the National Historic Preservation Act. In addition, the notice requested that LPs provide comments regarding the PAD and provide study requests. Concurrently, FERC issued Scoping Document 1 (SD1) to outline the subject areas to be addressed in its environmental analysis of the Project pursuant to the National Environmental Policy Act.

Due to the proclamation declaring a National Emergency concerning COVID-19, issued by the President on March 13, 2020, FERC waived 18 CFR § 5.8(b)(viii) and notified the public that it does not intend to conduct a public scoping meeting or site visit to the Skagit River Project. Instead, FERC solicited written comments, recommendations, and information, on the SD1. If needed, a site visit may be held later in the study process.

On December 4, 2020, FERC issued its Scoping Document 2 (SD2) for the relicensing of the Project.

1.2.5 PAD and SD1 Comments and Study Requests

Pursuant to the current Process Plan and Schedule (Table 1.2-1), comments on the PAD and SD1 and study requests were due to FERC by October 24, 2020. LP comments on the PAD and comments and additional information received from continuing consultation with LPs were considered and incorporated, as appropriate, into Exhibit E of. the Draft License Application (DLA; City Light 2022b).

1.2.6 PSP

In accordance with 18 CFR § 5.11(a) and pursuant to the current Process Plan and Schedule (Table 1.2-1), and building upon the existing information identified and summarized in the PAD and informed by the over 60 work group meetings held prior to filing of the Proposed Study Plan (PSP), City Light filed its PSP within 45 days after the deadline for filing comments on the PAD and SD1 and study requests, on December 8, 2020 (City Light 2020b).

1.2.7 PSP Meeting

In accordance with 18 CFR § 5.11(e) and pursuant to the current Process Plan and Schedule (Table 1.2-1), City Light was required to hold a Study Plan Meeting(s) within 30 days after the deadline for filing the PSP (no later than January 7, 2021). The purpose of the meeting is to clarify the intent and content of City Light's PSP and identify any outstanding issues or information needed with respect to the proposed studies. City Light held four days of meetings on January 6 and 12-14, 2021. Due to the COVID-19 public health emergency, the meetings were held virtually. The background, concepts, and studies described in the PSP were presented during the Study Plan Meetings.

In addition, City Light hosted ten additional topic-based meetings in late January through February 2021, in coordination with LPs and aimed at resolving outstanding differences between City Light's proposed studies and LPs' study requests. The agenda for those meetings were developed by the LPs at their request. In response to feedback on the PSP received during the 14 meetings with the LPs in January and early February 2021, City Light developed 15 issue resolution forms proposing compromises and providing additional information and modifications to a number of study requests, and circulated them to the LPs prior to the deadline for PSP comments. The commitments reflected in these issue resolution forms were incorporated into the RSP (City Light 2021).

1.2.8 Comments on the PSP

In accordance with 18 CFR § 5.12 and pursuant to the current Process Plan and Schedule (Table 1.2-1), comments on City Light's PSP, including any revised information or study requests, were due to FERC within 90 days of the PSP being filed (no later than March 8, 2021). Commentors were requested to include an explanation of any study plan concerns and any agreements reached with City Light regarding those concerns. Proposed modifications to the PSP were requested to address the requisite Study Criteria as described in Section 4 of the RSP. See Appendix C of the RSP for a list of PSP comment letters provided by LPs (City Light 2021).

1.2.9 RSP

In accordance with 18 CFR § 5.13(a) and pursuant to the current Process Plan and Schedule (Table 1.2-1), City Light filed its RSP within 30 days of the due date for comments on the PSP, on April 7, 2021 (City Light 2021). The RSP specifically addressed all comments received on the PSP. The RSP also included a description of the efforts made to resolve differences over study requests. For any requested study not adopted in full or in part in the RSP, City Light provided the rationale for its decision based on FERC Study Criteria.

1.2.10 Comments on the RSP

In accordance with 18 CFR § 5.13(b), comments on City Light's RSP, including any revised information or study requests, were due to FERC within 15 days of the RSP being filed (no later than April 22, 2021). On April 2, 2021, prior to City Light's filing of its RSP, the Swinomish Indian Tribal Community requested a modification of the ILP process plan and schedule to extend the RSP comment period by 14 days, supported by the Washington State Department of Ecology (Ecology) and City Light in letters dated April 5 and 6, 2021, respectively. FERC granted the extension request on April 6, 2021, extending the comment deadline to May 6, 2021, and

modifying subsequent steps through the study dispute process in the Process Plan and Schedule accordingly.

Subsequently, on May 12, 2021, the Coalition of Bands of the Nlaka'pamux Nation (Nlaka'pamux Nation) requested an additional extension for RSP comments after the Nlaka'pamux Nation recently became aware of the Skagit River Project relicensing process, which FERC granted in a letter dated May 17, 2021, extending the comment deadline for the Nlaka'pamux Nation to June 1, 2021.

A total of 19 comment letters from federal and state agencies, Indian Tribes, Canadian First Nations, NGOs, and other LPs were filed with FERC. Comment letters and all documents filed with FERC can be accessed through FERC's eLibrary (www.ferc.gov/docs-filing/elibrary.asp) by searching under Docket P-553-235.

1.2.11 June 9, 2021 Notice

Following filing of the RSP, City Light continued to work with LPs to attempt to resolve outstanding areas of disagreement regarding the proposed studies. The ongoing discussions resulted in the filing of the "Notice of Certain Agreements on Study Plans for the Skagit Relicensing" with FERC on June 9, 2021. Updates on the resolution of commitments described in the June 9, 2021 Notice are provided in applicable study reports filed with this USR.

1.2.12 SPD and Study Disputes

In accordance with 18 CFR § 5.13(c), FERC issued the SPD on July 16, 2021, approving with modifications City Light's RSP (filed April 7, 2021). No study disputes were filed.

1.2.13 Study Reporting and Study Plan Modification

Following the issuance of FERC's SPD, and as required by 18 CFR § 5.15, City Light continued to engage with LPs in work group meetings to provide progress updates on study implementation. In addition, the work group meetings provided the venue to collaboratively refine the scope, methods, and implementation of the relicensing studies as described in the June 9, 2021 Notice. City Light agreed to significant modifications to some study plans at the request of LPs, which are described in relevant study reports filed with the ISR (City Light 2022a) and this USR.

In accordance with 18 CFR § 5.15(c)(1) and (2) and (f), and pursuant to the current Process Plan and Schedule (Table 1.2-1), at the conclusion of each study season City Light is to file an ISR and USR and hold a meeting with LPs and FERC staff to discuss the initial and updated study results (ISR meeting and USR meeting), respectively. Accordingly, City Light filed its ISR on March 8, 2022 (City Light 2022a) and is filing this USR (due by March 8, 2023) pursuant to FERC regulations. City Light submits all study documents that must be filed with FERC via FERC's elibrary system (www.ferc.gov/docs-filing/elibrary.asp) as well as through the Skagit Relicensing Public Document Library on City Light's website (<u>https://www.seattle.gov/light/skagit/ Relicensing/default.htm</u>).

1.2.14 ISR Meeting and Comments

In accordance with 18 CFR §5.15(c)(2), City Light held three days of ISR Meeting(s) on March 21-23, 2022. The purpose of the meeting is to discuss the study results and City Light's and/or LPs' proposals, if any, to modify the study plan in light of the progress of the study plan and data collected. Due to the COVID-19 public health emergency, the meetings were held virtually.

Following the ISR Meetings, the FERC ILP regulations provide the opportunity for City Light and/or LPs to request modifications to the study plan in light of progress of the study program and results to date, either as part of City Light's ISR Meeting Summary (due 15 days after the meetings, by April 7, 2022; 18 CFR § 5.15(c)(3)) or if LPs file Disagreements/Requests to Amend Study Plan (due 30 days after filing of the ISR Meeting Summary, by May 7, 2022; 18 CFR § 5.15(c)(4)). A total of 14 comment letters from federal and state agencies, Indian Tribes, Canadian First Nations, NGOs, and other LPs were filed with FERC. City Light filed a response to ISR comments on June 6, 2022. FERC issued a Determination on Requests for Study Modifications on August 8, 2022, adopting one requested study modification, adopting one study modification in part, and declining to approve the remaining requested modifications.

1.2.15 DLA

In accordance with 18 CFR § 5.16(a)-(c), City Light filed its DLA with FERC no later than 150 days prior to the deadline for filing a new license application, on November 30, 2022 (City Light 2022b).

1.2.16 Comments on the DLA

In accordance with 18 CFR § 5.16(e), comments on City Light's DLA were due to FERC within 90 days of the DLA being filed (no later than February 28, 2023). A total of 18 comment letters from federal and state agencies, Indian Tribes, Canadian First Nations, NGOs, and other LPs were filed with FERC. A summary of DLA comments received and City Light's responses thereto will be provided in the FLA.

1.2.17 USR Meeting and Comments

In accordance with 18 CFR § 5.15(c)(2), City Light is to hold the USR Meeting(s) within 15 days after the deadline for filing the USR (no later than March 23, 2023). City Light has scheduled the meetings for March 21-22, 2023. The meetings will be held virtually; the agenda is included with this USR filing.

1.2.18 FLA

In accordance with 18 CFR § 5.17, City Light will file its FLA with FERC no later than 24 months before the current Project license expires on April 30, 2023.

2.0 RELICENSING STUDIES AND ONGOING DATA COLLECTION ACTIVITIES

2.1 Relicensing Studies

This USR includes reports for 31 of the 33 relicensing studies. Table 2.1-1 lists the studies and identifies the type of report based on the status of completion of the study. As noted in the table, the final CR-01 Cultural Resources Data Synthesis report has already been filed with FERC, and the final CR-03 Gorge Bypass Reach Cultural Resources Survey will be filed with FERC following the conclusion of Section 106 consultation.

	Study Number and Title	Study and Reporting Status
1.	CR-01 Cultural Resources Data Synthesis	Complete. Filed with FERC at conclusion of Section 106 consultation.
	Traditional Cultural Property Synthesis Study (Part 1)	December 2020
	Cultural Resources Data Synthesis, Archaeological Resources (Part 2)	October 2022
	Cultural Resources Data Synthesis, Public Summary and Historic Built Environment Resources (Part 3)	October 2022
2.	CR-02 Cultural Resources Survey	Complete. Filed with USR. (Conclusion of Section 106 consultation to follow.)
3.	CR-03 Gorge Bypass Reach Cultural Resources Survey (Bypass Cultural Resources Survey)	Complete. Draft study report filed with ISR. (A final study report will be filed with FERC at conclusion of NHPA Section 106 consultation.)
4.	CR-04 Inventory of Historic Properties with Traditional Cultural Significance Study (Properties with Traditional Cultural Significance Study)	Progress Report. Filed with USR. (Study ongoing; Section 106 consultation to follow)
5.	FA-01a Water Quality Monitoring Study (WQ Monitoring Study)	Complete. ¹ Filed with USR.
	FA-01b Water Quality Model Development Study (WQ Model Development Study)	Complete. ² Filed with USR.
6.	FA-02 Instream Flow Model Development Study	Complete. Filed with USR.
7.	FA-03 Reservoir Fish Stranding and Trapping Risk Assessment (Stranding and Trapping Assessment)	Complete. Filed with USR.
8.	FA-04 Fish Passage Technical Studies Program (Fish Passage Study)	Complete. Filed with USR.
9.	FA-05 Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study (Bypass Instream Flow Model Development Study)	Complete. Filed with USR.
10.	FA-06 Reservoir Native Fish Genetics Baseline Study (Reservoir Fish Genetics Study)	Complete. Filed with USR.
11.	FA-07 Reservoir Tributary Habitat Assessment	Complete. Filed with USR.
12.	FA-08 Fish Entrainment Study	Complete. Filed with USR. ³

Table 2.1-1.Summary of study reports.

	Study Number and Title	Study and Reporting Status
13.	GE-01 Reservoir Shoreline Erosion Study	Complete. Filed with USR.
14.	GE-02 Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way Study (Erosion and Geologic Hazards Study)	Complete. Filed with USR.
15.	GE-03 Sediment Deposition in Reservoirs Affecting Resource Areas of Concern Study (Sediment Deposition Study)	Complete. Filed with USR.
16.	GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study (Geomorphology Study)	Substantially Complete. ⁴ Filed with USR.
17.	OM-01 Operations Model Study	Complete. Filed with USR.
18.	RA-01 Recreation Use and Facility Assessment (Recreation Assessment)	Complete. Filed with USR.
19.	RA-02 Gorge Bypass Reach Safety and Whitewater Boating Study (Bypass Safety and Whitewater Boating Study)	Substantially Complete. ⁵ Filed with USR.
20.	RA-03 Project Facility Lighting Inventory	Complete. Filed with USR. ³
21.	RA-04 Project Sound Assessment	Complete. Filed with USR.
22.	RA-05 Lower Skagit River Recreation Flow Study (Recreation Flow Study)	Complete. Filed with USR.
23.	SY-01 Synthesis and Integration of Available Information on Resources in the Lower Skagit River (Synthesis Study)	Complete. Filed with USR.
24.	TR-01 Vegetation Mapping Study	Complete. Filed with USR. ³
25.	TR-02 Wetland Assessment	Complete. Filed with USR. ³
26.	TR-03 Rare, Threatened, and Endangered Plants Study (RTE Plants Study)	Complete. Filed with USR.
27.	TR-04 Invasive Plants Study	Complete. Filed with USR.
28.	TR-05 Marbled Murrelet Study	Complete. Filed with USR. ³
29.	TR-06 Golden Eagle Habitat Analysis	Complete. Filed with USR. ³
30.	TR-07 Northern Goshawk Habitat Analysis	Complete. Filed with USR. ³
31.	TR-08 Special-status Amphibian Study	Complete. Filed with USR.
32.	TR-09 Beaver Habitat Assessment	Complete. Filed with USR.
33.	TR-10 Northern Spotted Owl Habitat Analysis (NSO Habitat Analysis)	Complete. Filed with USR. ³

1 In order to meet commitments in the June 9, 2021 Notice related to FA-01a, water quality data will be collected through May 2023 with an addendum reporting on this data collection to be provided to LPs and filed with FERC in October 2023 (to allow for lab processing and QAQC of all additional data).

2 In order to meet commitments in the June 9, 2021 Notice related to FA-01b, the CE-QUALW2 modeling tool will be expanded to include additional water quality measures beyond temperature and a calibration and validation report will be provided to LPs and filed with FERC in Q2 2023. The water quality model is not critical for development of an effects analysis, but will provide additional information that will help inform future adaptive management.

3 Report was substantively complete with ISR. Final report provided with USR for completeness.

4 In order to meet commitments in the June 9, 2021 Notice related to GE-04, development of the two-dimensional mobile bed model is ongoing and a technical memorandum describing development and calibration of the model will be provided to LPs and filed with FERC in Q2 2023. This model is not critical for development of an effects analysis but will provide additional information that will help inform future adaptive management.

5 Phase 3 of RA-02 to be completed in Q3 2023 as described in study report.

2.2 Additional Technical Information

In addition to the relicensing studies, several additional technical memos were appended to the ISR, including a water level assessment completed between Diablo Dam and Diablo Powerhouse and a memorandum related to Woody Debris Management. An additional technical memorandum summarizing hydrology datasets (Appendix B) was produced to support several relicensing studies and is appended to this USR. Other ongoing data gathering efforts that may inform the license application are summarized below.

2.2.1 Hydrology Datasets, Newhalem to Mount Vernon

In order to support analysis in serval relicensing studies, hourly and daily time series datasets, flood frequency estimates, and flow duration curves for multiple Skagit River tributaries and mainstem locations between Newhalem, Washington, and Mount Vernon, Washington were developed. A technical memorandum describing the methods used to develop these datasets is included as Appendix B.

2.2.2 Littoral Habitat Analysis

As part of the June 9, 2021 Notice, and required in FERC's SPD, City Light agreed to conduct a GIS assessment of habitat in the reservoir littoral and varial zones. In fulfillment of this requirement, a Reservoir Littoral Habitat Evaluation technical memorandum was filed with FERC on June 15, 2022. The purpose of this evaluation was to estimate the areal extent of littoral zone habitat around each of Ross, Diablo, and Gorge lakes and to evaluate the relationship between the extent of the littoral zone and reservoir water surface elevation for each. The technical memorandum summarized the methods used and results of a GIS assessment of littoral zone habitat at different reservoir drawdown levels for each Project reservoir.

2.3 Ongoing and Future Data Collection Activities

City Light continues to collect, evaluate, and provide to LPs resource monitoring information from the Project in accordance with the terms of its current license. These study and information gathering activities are summarized in the following reports:

- Annual Project Expenditures Statement (April).
- Semi-annual Flow Compliance Report (April and October).
- Annual Non-flow Program Report (July).
- Steelhead Program.
- Chinook Research Program.
- Off-Channel Chum Habitat Development and Improvement Program.
- Diablo and Gorge Lake Fisheries.
- Erosion Control Report (every 2 years; May).
- Wildlife Report (every 5 years; April).
- Archaeological Report (every 5 years; May).
- Historical Report (every 5 years; May).

Further, through discussions with LPs in early study plan development and in response to comments received on the PSP, City Light and LPs identified several information-gathering activities related to implementation of current license requirements that, while not included in the RSP, will inform current resource management activities and provide information relevant to the relicensing process and future management plans:

- Erosion monitoring at cultural resources sites around Ross Lake City Light has contracted with NPS to conduct a geomorphology investigation and map erosion patterns in Ross Lake to aid in cultural resources protection. Through this effort, City Light and NPS are coordinating to update archaeological monitoring techniques and this new data will be used to improve efficacy of monitoring and help prioritize recommendations for stabilization of historic properties.
- Sediment deposition and management of historic properties In response to NPS comments on the PSP, City Light collected information at five locations in Ross Lake suggested for study by the NPS in their comments to the scope of the GE-03 Sediment Deposition Study. Data collected at these five additional sites will inform historic properties management and data collection will be done in coordination with archaeological monitoring. City Light has also expanded its existing partnership with NPS to include erosion evaluation and monitoring at cultural sites on Ross Lake as part of implementation of the Archaeological Resources Mitigation and Management Plan in 2022 and 2023. The data collected from this effort will be used to inform management actions under the current license and will be integrated into the Historic Properties Management Plan under the new license.
- Reed canary grass control City Light and NPS are partnering on an inventory of known occurrences of reed canary grass and exploring treatment options.
- Recording observations of invasive bullfrogs NPS, BC Parks, and City Light are collaborating on documenting bullfrog occurrences. Distribution information on bullfrogs may inform future partnership management actions.

2.3.1 Landform Mapping

The Memorandum of Agreement with NPS for the Landform Mapping Study is appended to the PAD (City Light 2020a). This study will provide a baseline map of land and channel forms within the channel migration zone of the Skagit River and will inform the GE-02 Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way Study and the GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study (Geomorphology Study). Landforms have been mapped by National Park Service (NPS) for areas within Ross Lake National Recreation Area (RLNRA) (Riedel et al. 2012) and draft landform mapping has been developed by NPS for the Skagit River valley from Gorge Dam to Hamilton (Riedel et al. 2020; Riedel et al. 2022); these draft landform maps were used to inform the studies in this USR.

2.3.2 Food Web Study

During 2017-2018, City Light and the Skagit River Project Non-Flow Plan Coordinating Committee determined that an evaluation was needed to assess an observed demographic shift and apparent recruitment limitations in the Ross Lake Rainbow Trout population, thought to be related

to the introduction of Redside Shiners¹² to the Project reservoirs. In 2018, City Light agreed to fund a comprehensive food web assessment. At City Light's request, the USGS developed a scope of work for a comprehensive study, i.e., Factors Limiting Native Salmonids above Skagit River Dams ("Food Web Study").

The goal of the Food Web Study is to identify and quantify factors that limit recruitment or production of native adfluvial salmonids in Project reservoirs and associated tributaries. The implementation of this study began in 2019 and field work was completed in 2022.

The FA-07 Reservoir Tributary Habitat Assessment study report includes a summary of relevant preliminary results from the Food Web Study. Several publications addressing findings from the Food Web Study are underway by USGS and include information on the application of intrinsic potential models for evaluating salmon introduction into mainstem and tributary habitats upstream of the Skagit River dams, bioenergic growth performance of rainbow trout in the Project reservoirs, carrying capacity of the reservoirs following the invasion of redside shiner and response and impacts by piscivory by native salmonids.

¹² Redside Shiners are members of the minnow family and are not native to the Upper Skagit River where they have been observed since approximately 2004.

3.0 STATUS OF SKAGIT RELICENSING COLLABORATIVE PROCESS

3.1 Collaboration with LPs to Date

In January 2019, City Light began a voluntary Study Plan Development Process with LPs in preparation for initiating the relicensing process. The purpose of this early process was to provide a forum, structure, and additional time for discussion with LPs with the goal of identifying resource issues that may warrant study during relicensing. These discussions resulted in the development of a suite of issues and associated studies included in the PAD (City Light 2020a).

Following filing of its PAD, City Light continued meeting with LPs and provided early drafts of study plans for comment and discussion of studies necessary to inform the relicensing process. The proposed study plans in the PSP included documentation of comments received on these early drafts and City Light's responses, as well as responses to study requests filed with FERC by October 24, 2020.

After filing the PSP, City Light held the requisite PSP Meetings (January 6 and 12-14, 2021) followed by ten topic-based discussion meetings (January 26 and 28, and February 2, 4, 9, 11, 16, 18, 23, and 25, 2021) to continue efforts to resolve outstanding differences between City Light's proposed studies and LP study requests. In response to feedback received during the fourteen PSP Meetings with the LPs, City Light developed and circulated 15 issue resolution forms proposing compromises and providing additional information and modifications to its proposed studies in an effort to resolve differences over study requests.

Following the PSP meetings and after careful review of LP comments on the PSP, City Light and the LPs agreed to a collaborative process to focus on study implementation and collaboration regarding June 9, 2021 Notice commitments. Under this structure, City Light and the LPs have organized themselves into the following groups:

- Partners' Committee;
- Advisory Roundtable;
- Technical Steering Committee;
- Cultural Resources Work Group;
- Fish Passage Work Group;
- Flows Work Group;
- Geomorphology Work Group;
- Integration/Roadmap Small Work Group;
- Operations Model Work Group;
- Recreation Work Group;
- Reservoir Work Group;
- Synthesis Study Work Group;

- Terrestrial Work Group; and
- Water Quality Work Group.

In addition, other work groups have been developed and meet on an as needed basis as identified in the RSP and as requested by LPs to coordinate regarding study implementation. These work groups, or sub-groups, consist of (but are not limited to):

- Fish Passage Agency Work Session; and
- Habitat Suitability Criteria Technical Group.

Nearly 50 organizations have participated in over 190 collaborative process discussions to date. Appendix C provides a list of meetings and organizations that participated in meetings through February 2023.

4.0 **REFERENCES**

- Riedel, J., S. Sarrantonio, K. Ladig, and M. Larabee. 2020. DRAFT Skagit River geomorphology inventory report: Part I Gorge Dam to Sauk River. Report prepared by the U.S. National Park Service for Seattle City Light. Draft of December 2020.
- Riedel, J., S. Sarrantonio, G. Seixas, and J. Chan. 2022. DRAFT Skagit River geomorphology inventory report: Part II Middle Skagit valley from Sauk River to Hamilton. Report prepared for Seattle City Light. Draft of Fall 2022.
- Seattle City Light (City Light). 2020a. Pre-Application Document (PAD) for the Skagit River Hydroelectric Project, FERC Project No. 553. April 2020.
- . 2020b. Proposed Study Plan (PSP) for the Skagit River Hydroelectric Project, FERC Project No. 553. December 2020.
- _____. 2021. Revised Study Plan (RSP) for the Skagit River Hydroelectric Project, FERC Project No. 553. April 2021.
- . 2022a. Initial Study Report (ISR) for the Skagit River Hydroelectric Project, FERC Project No. 553. March 2022.
- . 2022b. Draft License Application (DLA) for the Skagit River Hydroelectric Project, FERC Project No. 553. November 2022.
- United States Army Corps of Engineers (USACE). 1967. Details of Regulation for Use of Storage Allocated for Flood Control in Ross Reservoir, Skagit River, WA. May 1967.
 - . 2002. Skagit River Project, Water Control Manual. June 2002.

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UPDATED STUDY REPORT

APPENDICES

UPDATED STUDY REPORT

APPENDIX A

PROJECT INFORMATION

APPENDIX A. PROJECT INFORMATION

City Light has established a standard Project centerline and PRM for use throughout the Skagit River Project relicensing process. The common and static RM system will allow for study data and information to be collected, organized, analyzed, and shared in a consistent and standardized manner. The Project centerline extent is from the mouth of the mainstem Skagit River in Skagit Bay to approximately 5 miles upstream from the Canadian border. The centerline was delineated based on a combination of various available information sources: riverbed topography from recent bathymetric LiDAR data, ESRI World and Google Earth aerial imagery, and the U.S. Army Corps of Engineers' Skagit and Baker Projects Corps Water Management System.

Table 1 provides a cross-reference of USGS RM and PRM values for common Project and riverine features.

Project Component	USGS River Mile (RM) ¹	Project River Mile (PRM)
Sauk River confluence with the Skagit River	66.6	66.7
Marblemount (town)	78	78.3
Marblemount USGS gage 12181000	78.7	79
Newhalem USGS gage 12178000	93.6	94.2
Newhalem (town)	94	94.5
Gorge Powerhouse	942	94.7
Gorge Dam	96.6	97.2
Upstream end of Gorge Lake	99.8	100.4
Diablo (town)	100	100.6
Diablo Powerhouse	100.2	100.8
Diablo Dam	101.2	101.6
Upstream end of Diablo Lake	105	105.6
Ross Powerhouse	104.9	105.5
Ross Dam	105.1	105.7
Upstream end of Ross Lake in U.S.	127	127.9

Table 1.USGS RM and PRM system crosswalk.

1 River miles are approximate.

SKAGIT RIVER PROJECT ELEVATION TRANSFORMATION TABLE

City Light As-Built to NAVD 88 Datum Last Revised 10/8/2020

Seattle Public Utilities (SPU) was tasked to densify the elevations on the Skagit River Hydroelectric Project from the established NAVD 88 benchmarks that was done in 2015 for the Height Modernization. These benchmarks were published by the NGS (National Geodic Survey). SPU used these published benchmarks to establish NAVD 88 elevations on a number of existing City Light benchmarks, staff gages, and elevations of powerhouses and top of dam elevations to obtain a comparison between the existing City of Seattle datum (CoSD) elevations from as-built drawings and the NAVD 88 datum. Below is the comparison of elevations of these items at each site on the Skagit River Hydroelectric Project.

Notes:

- (1) All elevations are in U.S. Survey Feet.
- (2) Refer to Geodetic Control Tables for each of the below networks.
- (3) No guarantees are made for adjustment of feature elevations not listed in this table and additional survey may be required to determine current elevation of the feature in question.
- (4) Above features are not to be used for survey control. All surveys shall use NGS benchmarks shown on Drawings D-44743 through D-44746.

PtNo / Station	Control Network and Feature	Reference	As-Built CoSD El. (feet)	Surveyed El. in NAVD-88 (feet)	Delta (feet)	Notes
Newhalen	1					
910	Gorge Powerhouse Finish Floor	D-44944	515.75	521.97	+6.22	
911	Gorge Powerhouse Tailrace Staff Gage (Physical)	Physical Gage	501.00	507.34	+6.34	Survey is to physical gage.
912	Gorge Powerhouse Tailrace Staff Gage (Electronic)	Electronic Reading	492.02	498.50	+6.48	SPU Survey indicates Water El. 498.5 ft NAVD-88 at 1:19 PM on 9/30/2019. Lake water surface elevation electronically recorded at 492.02 ft City Light per PI data from Don Tinker.

PtNo /	Control Network		As-Built CoSD EL	Surveyed El. in NAVD-88		
Station	and Feature	Reference	(feet)	(feet)	Delta (feet)	Notes
905	Newhalem Skagit River Gage USGS Gage 12178000	Physical Gage USGS 12178000	488.00	494.20	+6.20	Datum of Gage is 407.7 ft above NAVD-88. 3 measurements made at 488.0 ft, 484.0 ft on gage, and benchmark on river gage building resulting in deltas of 6.20, 6.21, and 6.20 ft, respectively. 6.20 ft selected.
Gorge Da	m				1	
1002	Top of Gorge Dam	D-49941	880.67	886.97	+6.30	SCL brass disc in concrete 2.5 ft east of D/S parapet wall.
GWTR	Gorge Lake Staff Gage	Electronic Reading USGS 12177700	871.26	877.77	+6.51	Datum of Gage is 6.51 feet above NAVD-88. 871.26 is electronic reading from powerhouse. Physical gage matched reading as of 5/21/2018.
Diablo (Po	owerhouse/Hollywoo	d Townsite)				
2030	Diablo Powerhouse	RR Map El., FB 49A, PG10	892.39	898.77	+6.38	Finish floor elevation surveyed 897.42 (+6.42 ft). 6.38 feet selected based on brass cap.
WTR	Diablo Tailrace Elevation	Electronic Reading	876.22	882.48	+6.26	El. 876.22 is electronic reading from powerhouse. Physical gage matched (+6.30).
2027	Stetattle Creek Bridge	RR Map	890.78	897.16	+6.38	Based off of SCL Survey Field Book 49A, Page 9 using the Railroad (RR) Map Elevation.
Diablo Da	m					
3008	Top of Dam (0+00 level pegging station)	D-44947	1218.00	1224.72	+6.72	Use +6.65 for Diablo Dam.
3009	Top of Dam (2+00 level pegging station)	D-44947	1218.00	1224.59	+6.59	Use +6.65 for Diablo Dam.

PtNo / Station	Control Network and Feature	Reference	As-Built CoSD El. (feet)	Surveyed El. in NAVD-88 (feet)	Delta (feet)	Notes
3007	SCL Benchmark NE end of bathrooms	Benchmark	1219.69	1226.01	+6.32	
3011	Diablo Lake Staff Gage (physical)	Physical Gage	1209.00	1215.37	+6.37	Upper panel replaced September 2020 and surveyed again by SPU 9/29/20.
3012	Diablo Lake Staff Gage (electronic)	Electronic Reading	1201.20	1207.56	+6.36	SPU Survey indicates Water El. 1207.56 ft NAVD-88 at 12:20 PM on 10/01/2019. Lake water surface elevation electronically recorded at 1201.20 ft SCL per PI data from Don Tinker.
	Diablo Intake	D-16717	1208.00			As surveyed on 9/29/20 by SPU, matched with staff gage (within a couple hundredths, actual value forthcoming in SPU report).
	Diablo Surge Tank					Placeholder - estimate of conversion values forthcoming in following SPU report.
Ross Dam	(and Powerhouse)					
4009	Top of Dam at toe of D/S parapet wall	D-44952	1615.25	1621.45	+6.20	Upstream wall also had delta of +6.20 ft.
4017	Ross Powerhouse Finish Floor	D-44954	1236.50	1242.65	+6.15	
4011	Ross Lake Staff Gage	Physical Gage	1615.10	1621.36	+6.26	Survey is to physical gage. Electronic gage not verified and reportedly fluctuates.
4015	Ross Powerhouse Tailrace Staff Gage	Physical Gage	1205.00	1210.96	+5.96	Survey is to physical staff gage.

PtNo / Station	Control Network and Feature	Reference	As-Built CoSD El. (feet)	Surveyed El. in NAVD-88 (feet)	Delta (feet)	Notes
4016	Ross Powerhouse Tailrace Staff Gage	Electronic Reading	1203.71	1209.67	+5.96	SPU Survey indicates Water El. El.1209.67 ft NAVD88 at 11:06 AM on 10/03/2019. Tailrace water surface elevation electronically recorded to be 1203.67 ft City Light per PI data from D. Tinker. B. Vavrek verified that powerhouse reading matched with Operator Bob See and PI data per D. Tinker 9/28/20 @ 2:08 PM (1200.38 visual, 1200.38 powerhouse, ~1200.36 PI). Value matched to physical gage based on powerhouse reading and visual water level matching within 0.01 ft.

PLEASE NOTE:

1. All elevations are in US Survey Feet.

2. Refer to Geodetic Control Tables for each network.

3. Please contact SCL Technical Resources or SPU Surver for a densification in an area not referenced in this map.

4. All surveys shall use NGS benchmarks shown on Drawings D-44743 through D-44746.

5. Refer to 'Skagit Project Elevation Transformation Table' Rev. 10/08/2020 for Datum Conversion details. The following equation is used to convert between the City of Seattle (COS) Datum and NAVD-88 Datum:

COS Datum Elevation + Delta = NAVD-88.

6. No guarantees are made for adjustment of feature elevations not listed in above table and additional survey may be required to determine current elevation of the feature in question.

7. The survey reading for physical gage(s) was taken at a mark on the physical gage(s) and should NOT be used for the actual water surface elevation. As of 10/08/2020, SCL has not surveyed any water surface elevations. Point No. 902 AVD-88 Elev = 490.855' o Convravailable Point No. 903 AVD-88 Elev = 507.378 No Convr a vailable Goodell Cree Point No. 901 NAVD-88 Elev = 504.609' No Convr a vailable whalem NAVD-88 Survey Elevations Seattle City Light Newhalem and vicinity 1:5,500 500 1,000

All elevations in this map are current as of October 8, 2020.

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All elevations in this map are current as of October 8, 2020.

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UPDATED STUDY REPORT

APPENDIX B

HYDROLOGY DATASETS, NEWHALEM TO MOUNT VERNON



MEMORANDUM

То:	Seattle City Light Date:	March 2023
	NHC Ref. No.	2003536
From:	Chad Drake, Rachel Hay, Derek Stuart, Malcolm Leytham – NHC	
Re:	Hydrology Datasets, Newhalem to Mount Vernon	

1.0 INTRODUCTION

Seattle City Light (City Light) owns and operates the Skagit Hydroelectric Project (Project). As part of the Federal Energy Regulatory Commission (FERC) relicensing, multiple studies being conducted by City Light have need for flow hydrology for the mainstem Skagit River and its tributaries at and downstream of Newhalem, Washington. These studies include the FA-01b Water Quality Model Development Study (City Light 2023a), FA-02 Instream Flow Model Development Study (City Light 2023a), and GE-04 Skagit River Geomorphology Between Gorge Dam and the Sauk River Study (GE-04 Geomorphology Study; City Light 2023c). This memorandum describes the development of hourly and daily flow time series (datasets), flood frequency estimates, and flow duration curves for multiple Skagit River tributaries and mainstem locations between Newhalem, Washington, and Mount Vernon, Washington.

2.0 STUDY AREA AND HYDROLOGIC DELIVERABLES

The study area for the hydrologic analysis encompasses over 1,900 square miles of the Skagit River Basin and 77 miles of the mainstem Skagit River between Newhalem (Project River Mile [PRM] 94.3) and Mount Vernon (PRM 17.1). The hydrology datasets developed include:

- Historical hourly and daily flows (October 1, 1987 May 31, 2022) based on U.S. Geological Survey (USGS) streamflow records, which reflect regulated flow conditions on the Skagit River mainstem stemming from the Skagit River and Baker River Hydroelectric Projects. All Skagit River tributary flows below Newhalem, except the Baker River, are unregulated.
- Naturalized daily flows (January 1, 1988 December 31, 2020), which are intended to remove the effects of storage and operations stemming from the Skagit River Hydroelectric Project only. All tributary flows below Newhalem, including the regulated flows on the Baker River resulting from the Baker River Hydroelectric Project, are treated as identical under historical and naturalized conditions.



- Flood frequency estimates for select Skagit River tributaries and mainstem locations at and below Newhalem for historical and naturalized conditions.
- Daily flow duration curves for historical and naturalized conditions.

Some or all of these hydrology datasets were developed for a total of 17 tributaries to the Skagit River, 13 subbasins comprising one or more tributaries and local inflow areas,¹ and four mainstem locations corresponding to the Newhalem, Marblemount, Concrete, and Mount Vernon USGS streamflow gages. The study area and analysis locations are shown in Figure 1 and listed in Table 1.

¹ Local inflow areas are defined as areas contributing flow to the Skagit River that do not belong to a defined tributary basin.




Figure 1. Study area for hydrology datasets between Newhalem and Mount Vernon in the Skagit River Basin.



No.	PRM	Area or Location of Interest	Drainage Area (square miles)
Skagit	River Tributaries		
1	93.8	Newhalem Creek ¹	28.1
2	93.3	Goodell Creek	38.9
3	88.0	Damnation Creek	5.2
4	85.5	Alma Creek	8.4
5	84.4	Copper Creek	4.0
6	83.2	Bacon Creek ¹	51.2
7	81.0	Diobsud Creek	26.6
8	77.2	Cascade River ¹	185.4
9	74.3	Olson Creek	6.6
10	74.3	Corkindale Creek	5.0
11	73.8	Rocky Creek	10.2
12	73.0	Illabot Creek	43.0
13	66.8	Sauk River ¹	732.8
14	58.4	Jackman Creek	24.4
15	56.8	Baker River ¹	299.2
16	47.8	Finney Creek	53.9
17	35.5	Day Creek	34.8
Skagit	River Subbasins		
1	93.3	Goodell and Martin Creeks	42.1
2	90.5	Thornton and Babcock Creeks	9.7
3	88.0	Sky and Damnation Creeks	20.1
4	84.4	Copper Creek	6.0
5	81.0	Diobsud and Taylor Creeks	35.8
6	74.3	Olson, Corkindale, and O'Brien Creeks	19.5
7	73.8	Rocky Creek	10.9
8	73.0	Illabot Creek	47.3
9	70.8	Sutter and Barr Creeks	4.0
10	67.8	Sauk Mountain and Barnaby Sloughs	14.5
11	64.6	Miller and Aldon Creeks	18.2

Table 1. Analysis locations for hydrology datasets.



No.	PRM	Area or Location of Interest	Drainage Area (square miles)
12	58.4	Jackman Creek	27.9
13	47.8	Finney Creek	64.1
1	94.3	Newhalem ²	1,175
2	79.0	Marblemount ²	1,377
3	54.6	Concrete ²	2,740
4	17.1	Mount Vernon ²	3,092

1 Gaged tributary: Newhalem Creek (USGS 12178100), Bacon Creek (USGS 12179900), Cascade River (USGS 12182500), Sauk River (USGS 12189500), Baker River (USGS 12193400/12193500).

2 Gaged mainstem location: Newhalem (USGS 12178000), Marblemount (USGS 12181000), Concrete (USGS 12194000), Mount Vernon (USGS 12200500).

3.0 METHODOLOGY

Several approaches were considered for developing hourly flows for the areas of interest between Newhalem and Mount Vernon. These included: (A) manipulating historical streamflow observations in a similar manner to prior hydrology efforts within the Skagit River basin (i.e., U.S. Army Corps of Engineers [USACE] 2013) or those specific to the Project relicensing study as described in the USGS Based Hydrology Calculation Summary (HDR 2022; Appendix 1 of Attachment A to the OM-01 Operations Model Study Report [City Light 2023d]); (B) using simulated flows from existing Skagit River Basin DHSVM (Bandaragoda et al. 2015) or other hydrologic models; or (C) some combination of both. While the existing DHSVM hydrologic model of the Skagit River Basin is documented as being calibrated and allows for the relatively easy extraction of complete flow time series at locations of interest, significant effort would be required to develop/extend the gridded meteorological forcing datasets for the period of interest (October 1, 1987 – May 31, 2022) and then ensure the model calibration was still reasonable for the objectives of this study. For these reasons as well as the relative completeness of the available published streamflow observations and consistency with prior hydrology efforts for the relicensing study (HDR 2022), hourly flows were developed exclusively using published streamflow data.

3.1 Hourly Flow Time Series

3.1.1 Available Streamflow Data

Hourly flows were developed for the period October 1, 1987 – May 31, 2022, for the tributaries, subbasins, and mainstem locations shown in Figure 1 and listed in Table 1 using published USGS subdaily streamflow data. The hourly flows developed served as the basis for computing daily mean flows, flood frequency estimates, and flow duration curves. The USGS gages used to develop hourly flows for areas between Newhalem and Mount Vernon are summarized in Table 1.



Table 2.USGS streamflow gages on the Skagit River and its tributaries used to develop
hourly flows for areas between Newhalem and Mount Vernon.

Gage Name	Gage Number	Drainage Area (square miles) ¹	Annual Water Yield, Water Years 1988- 2021 (inches)	Sub-daily Period of Record Used
Skagit River Tributaries				
Newhalem Creek near Newhalem	12178100	26.8	89.5	10/1/1989-5/31/2022
Bacon Creek below Oakes Creek	12179900	49.8	123.1 ⁵	11/3/1998-5/31/2022
Cascade River at Marblemount	12182500	172	83.2 ⁵	6/7/2006-5/31/2022
Sauk River near Sauk	12189500	716	84.1	10/1/1989-5/31/2022
Baker River at Henry Thompson Bridge at Concrete ^{2,3}	12193400	299	122.3	10/1/2007-5/31/2022
Baker River at Concrete ^{2,3}	12193500	299	122.3	10/1/1987-4/30/2009
North Fork Stillaguamish River near Arlington ⁴	12167000	262	98.8	10/1/1989-5/31/2022
Skagit River Mainstem				
Skagit River at Newhalem ²	12178000	1,175	52.7	10/5/1987-5/31/2022
Skagit River at Marblemount ²	12181000	1,377	60.5	10/1/1987-5/31/2022
Skagit River near Concrete ²	12194000	2,740	75.0	10/1/1987-5/31/2022
Skagit River near Mount Vernon ²	12200500	3,092	73.1	10/1/1988-5/31/2022

1 Drainage areas derived from GIS and compared to USGS published values to ensure reasonableness.

2 USGS streamflow records affected by regulation.

3 The active (12193400) and inactive (12193500) Baker River gages are approximately 300 feet apart and were combined to generate a single streamflow record spanning October 1, 1987 – May 31, 2022.

4 Located outside the Skagit River Basin but used for developing tributary flows in the Lower Skagit River Basin, which is defined by Hydrologic Unit Code (HUC) 17110007 and begins downstream of the Baker River confluence near Concrete (PRM 56.8).

5 Water yield estimated for water years 1988-2021 based on the gage's available period of record and scaling of a nearby USGS gage with a complete record available for 1988-2021.

The USGS sub-daily ("Instantaneous") flow data were processed to generate complete hourly records with no data gaps following the methodology below:

- The USGS sub-daily flow data typically published in 5-minute, 15-minute, or hourly intervals were converted to hourly averages using end of hour notation.
- Gaps in the gaged hourly records of less than one day were filled using linear interpolation.
- Gaps in the gaged hourly records of more than one day were filled with published daily average flows from the same gage.



- The sub-daily flow record for Bacon Creek (USGS 12179900) does not begin until November 1998. An hourly flow record for October 1987 – November 1998 was synthesized using a flow differencing approach similar to that also used to estimate flows for ungaged areas between Newhalem and Marblemount (Section 3.1.3), the only difference being that a scaling factor based on both drainage area and water yield (rather than drainage area alone) was used to account for the considerably higher water yield in Bacon Creek compared to nearby Newhalem Creek. The drainage area scaling factor ($\frac{A_{target}}{\Delta A}$) in equation (2) below was replaced with one based on area and water yield ($\left[\frac{A_{target}}{\Delta A}\right] \left[\frac{Y_{target}}{\Delta Y}\right]$), where A_{target} and Y_{target} denote the drainage area and average annual water yield, respectively, of the target area (i.e. Bacon Creek), and ΔA and ΔY denote the area and average annual water yield, respectively, of the total ungaged area between Newhalem and Marblemount. This change increased the scaling factor for Bacon Creek from 0.295 to 0.337.
- The sub-daily flow record for the Cascade River (USGS 12182500) does not begin until June 2006. An hourly flow record for October 1987 June 2006 was synthesized using a regression equation developed for daily flows between the Cascade River and Sauk River USGS gages for the period October 1, 1928 January 13, 2022 (Q_{Cascade} = 0.2247Q_{Sauk} + 51.775, R² = 0.85). This regression equation was then applied to the Sauk River hourly flow observations to estimate hourly flows at the Cascade River USGS gage for the period October 1987 June 2006.
- As a result of improvements made to the low end of the Marblemount (USGS 12181000) stagedischarge rating curves,² gaged flows below 2,500 cfs were modestly increased dating back to October 2012. (For reference, flows below 2,500 cfs at the Marblemount gage accounted for 2.6 percent of the hourly record length between October 2012 and May 2021, and the USGS reported mean annual flow at Marblemount for water years 2013-2021 is 6,300 cfs.) The flow differencing approach used to estimate flows for ungaged areas between the Newhalem and Marblemount mainstem Skagit River gages yielded several periods of negative incremental flows. Investigation of these negative flows and ensuing discussions with USGS staff led to the examination of and subsequent revision to the low end of the Marblemount rating curves using the calibrated HEC-RAS Upper Skagit Hydraulic Model developed for the FA-02 Instream Flow Model Development Study. The change applied to a single Marblemount rating curve is shown in Figure 1 as an example of the approach. These adjustments had the effect of reducing, though not entirely eliminating, the number of periods with negative incremental flows since some negative flows were computed during relatively high flow conditions at Newhalem and Marblemount (well above 2,500 cfs). When the flow differencing calculation did produce negative incremental flows, the flows for the ungaged areas were set to zero.

² Eight rating curves were used by the USGS to develop time-series of flows between October 2012 and May 2022.





Figure 2. Example of the change applied to a single Marblemount (USGS 12181000) stagedischarge rating curve.

3.1.2 Gaged Tributaries

Hourly flows for the USGS gages on Newhalem Creek, Bacon Creek, Cascade River, Sauk River, and Baker River were scaled based on drainage area to estimate flows at the mouth of each tributary:

$$\boldsymbol{Q}_{target} = \left(\frac{A_{target}}{A_{trib,gage}}\right) \boldsymbol{Q}_{trib,gage} \tag{1}$$

- Q_{target} is the adjusted measured hourly flow (cfs) at the mouth of the gaged tributary;
- Q_{trib,gage} is the measured hourly flow (cfs) at the tributary gage;
- A_{target} is the drainage area (square miles) at the mouth of the gaged tributary; and
- *A*_{trib,gage} is the drainage area (square miles) at the tributary gage.

The drainage area scaling factors $\left(\frac{A_{target}}{A_{trib,gage}}\right)$ used to scale the observed flows from the gage location to the tributary mouth were 1.046 for Newhalem Creek, 1.027 for Bacon Creek, and 1.078 for the Cascade River. For the Sauk River and Baker River tributaries, the gaged hourly flows were used directly (drainage area scaling factors = 1) given the close proximity of the gage to the mouth with no significant tributary inflows below the gage.



3.1.3 Ungaged Areas Between Newhalem and Marblemount

Hourly flows for the ungaged tributaries/subbasins between Newhalem and Marblemount were developed by extending the flow differencing approach initially summarized in HDR (2022). HDR (2022) describes how daily flows were developed for the incremental area between Marblemount and Newhalem through subtraction of daily data from the bounding mainstem (Newhalem and Marblemount) and tributary (Newhalem and Bacon Creeks) flow gages. Several alternative approaches were evaluated for generating hourly flows for the ungaged areas of interest, including performing the flow differencing strictly with hourly data. However, the inherent challenges associated with estimating flow lag times that vary with discharge and the ensuing impacts on calculated negative incremental flows and flow discontinuities in the estimated time series necessitated the use of daily flow data for the flow differencing calculation. When negative incremental flows were calculated by the differencing calculation, the flows for the ungaged areas of interest were set to zero.

In a similar manner to HDR (2022), a flow differencing calculation was performed to first estimate the total ungaged daily flow between Newhalem and Marblemount using the daily flow time series for Marblemount, Newhalem, Newhalem Creek, and Bacon Creek. Marblemount daily flows were computed using the adjusted hourly flow record described in Section 3.1.1, and daily flows for Newhalem, Newhalem Creek, and Bacon Creek were computed from the hourly flow time series transposed (lagged) to Marblemount.³ This daily flow time series of total ungaged flow between Marblemount and Newhalem was then distributed to each ungaged tributary/subbasin based on drainage area. The daily flow time series estimated for each ungaged tributary/subbasin was converted to an hourly flow time series by normalizing it by the corresponding daily flows of a selected reference tributary gage, assigning this daily flow ratio to noon of each day, linearly interpolating between adjacent days to produce hourly flow ratios with minimal discontinuities, and then scaling this non-dimensional hourly time series by the hourly flows of the corresponding reference tributary gage. Finally, each estimated hourly flow time series was transposed in time from Marblemount to the mouth of the upstream area of interest. This approach is summarized in equation (2):

³ Average travel times between Skagit River mainstem locations were estimated using a 1-D HEC-RAS model under a range of steady-state flow conditions. The average travel times from Newhalem, the Newhalem Creek confluence, and the Bacon Creek confluence to Marblemount were estimated to be five hours, five hours, and one hour, respectively.

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$$Q_{target} = \left[\frac{\Delta Q\left(\frac{A_{target}}{\Delta A}\right)}{Q_{ref,daily}}\right]_{noon} Q_{ref}$$
(2)

- *Q_{target}* is the estimated hourly flow (cfs) for the ungaged area of interest between Newhalem and Marblemount;
- ΔQ is the total ungaged flow (cfs) between Newhalem and Marblemount computed from the subtraction of gaged daily flows, which were calculated from the hourly time series lagged to Marblemount (Q_{Marb} Q_{New} Q_{NewCr} Q_{BacCr});
- Q_{ref} is the hourly flow (cfs) of the reference tributary gage lagged to Marblemount and Q_{ref,daily} is the corresponding daily mean flow. Newhalem Creek was selected as the reference tributary gage because it had a more complete hourly record than Bacon Creek for the period 1988-2022;
- *AA* is the total ungaged area (square miles) between Newhalem and Marblemount (A_{Marb} A_{New} A_{NewCr} A_{BacCr});
- A_{target} is the drainage area (square miles) of the ungaged area of interest between Newhalem and Marblemount; and
- $\left[\frac{\Delta Q\left(\frac{A_{target}}{\Delta A}\right)}{Q_{ref,daily}}\right]_{noon}$ denotes that the daily flow ratio has been assigned to noon of each day and

linearly interpolated between days to generate an hourly time series of flow ratios.

The ungaged hourly flow time series were reviewed graphically to ensure reasonableness both in terms of hydrograph shape and flow magnitude. Additionally, the methodology was tested on the gaged tributaries. Figure 2 and Figure 3 show the measured hourly flows (adjusted to the mouth; equation [1]) versus the hourly flow estimates (equation [2]) for Newhalem Creek and Bacon Creek, respectively, during a high flow period in November 2021. While there are some discrepancies, the estimated hourly flows reasonably replicate the adjusted measured hourly flows at both locations. The Newhalem Creek hourly flow estimates underestimate the monthly runoff volume by 7 percent and overestimate the peak flow on November 15, 2021, by 2 percent.⁴ The Bacon Creek hourly flow estimates overestimate the monthly runoff volume by 4 percent while the measured and estimated peak flows on November 15, 2021, are within 1 percent.⁵ The relatively large differences between measured and estimated flow on the receding limb of the hydrographs (November 17-21, 2021) result from uncertainty in the incremental inflow between the mainstem Newhalem and Marblemount gages during that period when there were sustained large releases from the Project (i.e., flow at Newhalem in excess of 20,000 cfs). For example, the published average daily discharge for November 19, 2021, is 28,400 cfs and 29,800 cfs at

⁴ The USGS flow data for Newhalem Creek (12178100) for November 2021 is considered provisional and subject to change. Discharge quality ratings are unavailable.

⁵ The USGS flow data for Bacon Creek (12179900) for November 2021 has been approved and rated FAIR (95 percent of the daily discharge data are within 15 percent of the actual flow), except the period November 14-18 which are estimated and rated POOR (daily discharge data are greater than 15 percent different from the actual flow).



Newhalem and Marblemount respectively, for an incremental inflow between Newhalem and Marblemount of 1,400 cfs. Small errors in the published discharges at Newhalem and/or Marblemount can translate into a large difference, and hence uncertainty, in the estimated incremental inflow between the two gages.



Figure 3. Comparison of measured and estimated flows for Newhalem Creek.





Figure 4. Comparison of measured and estimated flows for Bacon Creek.

3.1.4 Ungaged Areas Between Marblemount and Mount Vernon

Through evaluation of multiple approaches for developing hourly flow time-series for the ungaged areas of interest downstream of Marblemount, it was determined that a simpler scaling of the hourly flows of selected reference tributary gage time-series provided better results than a flow differencing calculation between the flows reported at the Marblemount and Concrete USGS gages.⁶ The hourly flows of selected reference tributary gages were scaled to the target area based on drainage area and annual water yield:

⁶ The flow differencing approach between Marblemount and Concrete involves the subtraction of these two mainstem gages and the gages on three large tributaries (Cascade, Sauk, and Baker Rivers) that account for nearly 90 percent of the incremental area between Marblemount and Concrete. The relative uncertainties in the larger flows recorded on these bigger mainstem and tributary gages contributed in part to the difficulty in producing realistic flow estimates for the relatively small amount of ungaged area between Marblemount and Concrete using the flow differencing approach.



$$\boldsymbol{Q}_{target} = \left[\left(\frac{Y_{target}}{Y_{ref}} \right) \left(\frac{A_{target}}{A_{ref}} \right) \right] \boldsymbol{Q}_{ref}$$
(3)

- Q_{target} is the estimated hourly flow (cfs) for the ungaged area of interest downstream of Marblemount;
- Q_{ref} is the hourly flow (cfs) of the reference tributary gage (adjusted to the mouth);
- Y_{target} is the average annual water yield (inches; 1988-2021) of the ungaged area of interest estimated from flow differencing of gaged mean annual flows;
- Y_{ref} is the average annual water yield (inches; 1988-2021) of the reference tributary gage;
- A_{target} is the drainage area (square miles) of the ungaged area of interest between downstream of Marblemount; and
- *A_{ref}* is the drainage area (square miles) of the reference tributary gage (adjusted to the mouth).

Excluding the Finney Creek and Day Creek tributaries, Newhalem Creek was once again selected as the reference tributary gage for flow scaling for all ungaged areas downstream of Marblemount because it had the most complete hourly record. Hourly flow estimates for Finney Creek and Day Creek were developed based on scaling of the North Fork Stillaguamish River near Arlington gage (USGS 12167000), which the USACE found to be a better predictor of tributary inflows to the Lower Skagit River Basin (defined by HUC 17110007, which begins downstream of the Baker River confluence near Concrete [PRM 56.8]) in a 2013 flood risk management study (USACE 2013).

As an example, Figure 4 shows the hourly flow estimates for the Illabot Creek subbasin based on a drainage area and water yield scaling factor of 1.665 applied to the adjusted measured hourly flows for Newhalem Creek for November 2021. Note that there are no observed data from Illabot Creek to validate these flow estimates.







3.1.5 Mainstem Locations

Historical hourly flows along the Skagit River mainstem at Newhalem, Marblemount, Concrete, and Mount Vernon were developed from the respective USGS gage sub-daily records following the processing steps outlined in Section 3.1.1.⁷ As a proof of concept of the hydrology approach, which should theoretically reproduce the observed mainstem flows quite well, mainstem hourly flows were also calculated by routing the Newhalem hourly flow observations and subbasin/tributary hourly flow estimates through a HEC-HMS reach routing tool. Figure 5 shows the measured and calculated hourly flows at the Marblemount USGS gage during the high flow period in November 2021. In general, the calculated hourly flows closely match the observations. The calculated hourly flows overestimate the monthly runoff volume by 0.2 percent and the observed peak on November 15, 2021, by 10 percent.⁸

⁷ Naturalized hourly mainstem flows were not developed as only a naturalized daily flow record exists for Newhalem currently (HDR 2022).

⁸ The USGS flow data for Marblemount (12181000) for November 2021 has been approved and rated FAIR (95 percent of the daily discharge data are within 15 percent of the actual flow).





Figure 6. Measured and estimated flows for the Skagit River at Marblemount.

3.2 Daily Flow Time Series

Daily flows were calculated for both historical (October 1, 1987 – May 31, 2022) and naturalized (January 1, 1988 – December 31, 2020) conditions. The only difference between the historical and naturalized conditions is introduced through the Newhalem daily flow record that served as the upstream inflow boundary condition; the tributary flows, which included regulated Baker River flows, remained the same for both conditions. The historical Newhalem daily flows were determined by averaging the hourly observations, while the naturalized Newhalem daily flows were provided by HDR using the methodology described previously (HDR 2022). Mainstem flows for both conditions were developed by starting with the appropriate Newhalem daily flow record (historical or naturalized) and incrementally accumulating the daily flow records of the next downstream subbasin/tributary. No time shifts were applied to the daily data since the average travel time between Newhalem and Mount Vernon was estimated to be about one to two days.



3.3 Instantaneous Flood Frequency Estimates

Flood frequency estimates were made for both annual instantaneous peak and annual daily average maximum discharges. The following section describes the development of instantaneous flood frequency estimates. Daily flood frequency estimates are discussed in Section 3.4.

Instantaneous flood peak discharges corresponding to the 2-, 5-, 10-, 25-, 50-, and 100-year return periods were determined for the Skagit River mainstem locations at and below Newhalem through a combination of flood frequency analysis (FFA) and routing of synthetic flood hydrographs. All FFAs were performed using annual (water year: October 1 – September 30) peak discharges according to Bulletin 17C procedures⁹ incorporated into the most current version (2.2) of the USACE HEC-SSP software (USACE 2019). The routing of synthetic flood hydrographs was used to determine larger flood quantiles (25- to 100-year return periods) on the mainstem Skagit River for historical regulated conditions in a similar manner to that adopted by the USACE (USACE 2013).

USACE (2013) provides detailed discussion and analysis of Skagit River hydrology, focusing primarily on estimation of mainstem flood quantiles for both regulated and unregulated (i.e., naturalized) conditions downstream from Concrete. The USACE hydrologic analysis was conducted in support of the Skagit River Flood Risk Management Feasibility Study, the purpose of which was "to formulate and recommend a comprehensive flood risk management plan for the Skagit River floodplain that will reduce flood risk in Skagit County with a focus [in terms of flood risk reduction] on downstream of Sedro-Woolley" (USACE 2013).

The approaches used to develop the mainstem flood frequency estimates are summarized below.

3.3.1 Mainstem Instantaneous Flood Quantiles

Determining instantaneous flood quantiles on the mainstem Skagit River at the Newhalem, Marblemount, Concrete, and Mount Vernon USGS gages for both historical and naturalized conditions necessitated the use of FFA and routing of synthetic flood hydrographs based on the USACE methodology (2013). The adopted mainstem instantaneous flood quantiles for historical and naturalized conditions are summarized in Table 2.

3.3.1.1 Historical Conditions

Mainstem instantaneous flood quantiles for historical conditions were determined in a manner similar to that adopted by the USACE (USACE 2013), through a combination of flood frequency analysis applied to the observed record of peak flows and routing of synthetic flood hydrographs.

Estimation of mainstem Skagit River flood quantiles is complicated by several factors which influenced the USACE's approach to hydrologic analysis:

⁹ It should be noted that Bulletin 17C procedures do not technically apply to flood flows altered by regulation, and frequency analysis should be used cautiously in regulated watersheds.



- Seasonal variations in the amount of storage available for flood risk management at both the Skagit and Baker River Hydroelectric Projects.
- Variations over the period of available streamflow records in the amount of storage available for flood risk management at both the Skagit and Baker River Hydroelectric Projects.
- The occurrence of major floods in water years 1898, 1910, 1918 and 1922, for which peak flow estimates are available but which occurred prior to dam construction and prior to systematic collection of streamflow data.

The large events in 1898, 1910, 1918 and 1922, occurring under natural (i.e., unregulated) conditions, are reported to have a significant influence on estimates of Skagit River flood quantiles (USACE 2013), particularly at higher return periods. These large events were accounted for in the USACE analysis by using USGS-published estimates of peak flows from those events in the development of synthetic hydrographs of unregulated inflows to the Skagit River Basin for floods with return periods from 2- to 500-years. These inflow hydrographs were then routed through Ross Lake and Baker Lake assuming current flood risk management storage and operating policies using a spreadsheet flow routing model to produce synthetic regulated hydrographs at key mainstem locations.

The results from routing of synthetic hydrographs were used by the USACE to determine regulated mainstem peak flows for return periods of 10 years and greater. Regulated peak flows for return periods less than 10 years were determined through frequency analysis of the observed records of annual peak flows for the period 1956-2007 under the assumption that all regulated peak flows in that period reflected the effects of current (circa 2013) flood risk management operations. The USACE noted that the currently available flood risk management storage at Baker Lake did not become available until 1977, but their assessment was that regulated peak flows for the period 1956-1977 would not have changed significantly with current flood storage.

The focus of the USACE study was on mainstem flows at and downstream from Concrete. As such, USACE (2013) reports regulated mainstem flood quantiles at Concrete, Sedro-Woolley, and Mount Vernon only. However, synthetic regulated hydrographs are available at Newhalem and Marblemount by way of data from the spreadsheet flow routing models used by the USACE.

For the present study, peak flows for return periods of 25 years and greater were taken directly from the synthetic regulated hydrographs developed by USACE (2013). Peak flows for return periods of less than 25 years were determined through frequency analysis of the observed records of annual peak flows for the period water years 1977-2020 using Bulletin 17C procedures. This period (which differs from the period used in USACE [2013]) was selected for the following reasons:

- A longer record of peak flows is now available.
- The current amount of flood risk management storage at Baker Lake did not become available until 1977.
- Complete data for this period are available for all four long-term mainstem gages (Newhalem, Marblemount, Concrete and Mount Vernon). Data are not available at Marblemount from 1958-1975.



Adopted mainstem flood quantiles for historical conditions are shown in Table 2. Note that data from Sedro-Woolley are as reported by USACE (2013). Discharge data are not available at Sedro-Woolley; the quantiles reported for Sedro-Woolley are all based on USACE routing of synthetic hydrographs. These may overstate flood magnitude at low return periods to some extent because the routing of synthetic hydrographs assumes flood risk management storage amounts per current operations and does not account for incidental regulation of flood peaks.

3.3.1.2 Naturalized Conditions

Mainstem instantaneous flood quantiles for naturalized conditions at Concrete, Sedro-Woolley, and Mount Vernon were taken directly from the synthetic unregulated hydrographs developed by USACE (2013). USACE (2013) developed the unregulated flood quantiles at and downstream from Concrete using unregulated Baker River flow inputs. This is a key distinction from the current study, where naturalized conditions were defined as removing the effects of storage and operations stemming from the Skagit River Hydroelectric Project only. It is important to note this inconsistency between studies and recognize that the mainstem flood quantiles for naturalized conditions, as defined in this study, at Concrete, Sedro-Woolley, and Mount Vernon reported in Table 3 are likely overestimated to some degree.

Synthetic unregulated hydrographs were not available at Newhalem and Marblemount from the flow routing models used by the USACE. As a result, the flood quantiles for naturalized conditions at these two locations were determined through FFA using the unregulated daily flow records developed by HDR (2022) for the period water years 1988-2020. The annual peak daily discharges from these synthetic records were scaled by a factor of 1.18 to estimate peak instantaneous discharges for FFA. This scaling factor was determined by comparing concurrent peak daily and peak instantaneous flows prior to flow regulation by the Project (1930 and earlier was established as the pre-regulation period) at the Newhalem and Skagit River at Reflector Bar near Newhalem (inactive; USGS 12177000) USGS gages. Peak flow observations from 1898, 1909-1914, and 1921-1930 were also included in the Newhalem FFA. No peak flow observations were included in the Marblemount FFA for naturalized conditions since the systematic record did not begin until 1944.



Return Period (years)	Naturalized Newhalem ¹	Historical Newhalem ²	Naturalized Marblemount ³	Historical Marblemount ⁴	Naturalized Concrete ⁵	Historical Concrete ⁴	Naturalized Sedro- Woolley⁵	Historical Sedro- Woolley⁵	Naturalized Mount Vernon ⁵	Historical Mount Vernon⁴
2	26,400	13,000	38,700	24,800	77,300	74,200	80,500	80,500	76,400	68,600
5	37,500	19,400	56,300	36,200	120,500	106,600	125,600	105,200	110,500	94,300
10	45,200	24,300	70,200	44,800	153,300	129,300	159,400	133,000	142,600	111,900
25	55,400	33,300	90,700	55,700	201,200	165,300	211,700	169,800	169,900	149,800
50	63,300	36,800	108,200	63,800	229,300	189,100	235,000	197,400	210,200	167,600
100	71,500	46,600	127,700	75,600	272,400	225,900	280,100	235,700	236,400	206,500

Table 3.Instantaneous flood frequency estimates (cfs) for mainstem Skagit River locations between Newhalem and Mount Vernon
for historical and naturalized conditions.

Flood quantiles determined through FFA. Analysis period (56 peaks): observed peak discharges from 1898, 1909-1914, and 1921-1930; observed peak discharges estimated from Skagit River at Reflector Bar 1915-1920; synthetic peak discharges from 1988-2020 determined from the unregulated flow record provided by HDR (2022).

2 Flood quantiles determined through FFA of observed or estimated peak discharges for 2-10-year return periods (44 peaks: observed peak discharges from 1977-2013 and 2015-2020; peak discharge 2014 estimated from daily data) and routing of synthetic flood hydrographs for 25-100-year return periods (USACE, 2013).

3 Flood quantiles determined through FFA of synthetic peak discharges from 1988-2020 (33 peaks) determined from the unregulated flow record provided by HDR (2022).

4 Flood quantiles determined through FFA of observed peak discharges for 2-10-year return periods (44 peaks: 1977-2020) and routing of synthetic flood hydrographs for 25-100-year return periods (USACE 2013).

5 Flood quantiles taken directly from USACE (2013) based on routing of synthetic flood hydrographs.



3.4 Daily Flood Frequency Estimates

Daily flood peak discharges corresponding to the 2-, 5-, 10-, 25-, 50-, and 100-year return periods were determined for selected Skagit River tributaries and mainstem locations at and below Newhalem using a combination of synthetic daily average flows (Section 3.2), USGS historical gage data, and naturalized daily average flows for the Skagit River at Newhalem developed by HDR (HDR 2022). Analysis was conducted for both historical and naturalized conditions, based on a common period of record for water years 1988 through 2020. Use of a common period of record facilitates comparison of historical and naturalized flood quantiles. The period of record for analysis was dictated by the available record of naturalized flows at Newhalem. FFAs were again performed according to Bulletin 17C procedures incorporated into the most current version (2.2) of the USACE HEC-SSP software (USACE 2019).

3.4.1 Tributary Daily Flood Quantiles

Daily flood quantiles for the Skagit River tributaries below Newhalem listed in Table 1.¹⁰ were determined through FFA following Bulletin 17C procedures. The FFAs were performed with the annual daily average maximum discharges extracted from each tributary's synthetic daily time series (Section 3.2) for the period water years 1988-2020. The tributary flood quantiles are identical for both historical and naturalized conditions since the naturalized condition is intended to only remove the effects of storage and operations stemming from the Skagit River Hydroelectric Project. Daily flood quantiles for the Skagit River tributaries below Newhalem are summarized in Table A1, Appendix A.

3.4.2 Mainstem Daily Flood Quantiles

3.4.2.1 Historical Conditions

Mainstem daily flood quantiles for historical conditions were computed for 13 reaches between Newhalem and Sedro-Woolley, with each reach composed of one or more of the geomorphic reaches defined in the GE-04 Geomorphology Study (City Light 2023c). The results of the analysis, including definition of the reaches, are provided in Table A2 (Appendix A).

FFA for each reach was performed using the annual daily average maximum discharges for the period water years 1988-2020 extracted from either the synthetic historical daily average flow time series (Section 3.2) or from the historical mainstem USGS gage records for Newhalem (representing geomorphic reach 2A), Marblemount (geomorphic reach 5A), and Concrete (geomorphic reach 9A-B).

The synthetic daily flow time series do not account for peak flow attenuation and tend to overstate annual maximum daily flows where significant floodplain storage is available. This was evident in the reach between the Marblemount and Concrete USGS gages from a comparison of synthetic against observed peak flows at Concrete. Initial estimates of daily flood quantiles in this reach (encompassing geomorphic reaches 5B through 8C) were adjusted to account for attenuation, based subjectively on the

¹⁰ No FFA was performed for the Baker River since flood frequency estimates were not requested for this regulated tributary.



amount of floodplain storage, and to provide for reasonable variation in flood quantiles as one moves downstream from Marblemount to Concrete, where flood quantiles are reliably determined from gage records.

It is likely that peak flows are also attenuated in the reach between Concrete and Sedro-Woolley (geomorphic reaches 10 and 11). However, in the absence of observed discharge records at Sedro-Woolley there is no direct basis for estimating attenuation in this reach and no equivalent adjustments were made. The daily flood quantiles for geomorphic reaches 10 and 11 in Table A2 may thus be overstated to some extent.

3.4.2.2 Naturalized Conditions

Mainstem daily flood quantiles for naturalized conditions were computed for each of the 13 reaches between Newhalem and Sedro-Woolley in a similar manner to that followed for historical conditions.

FFA for each reach was performed using the annual maximum daily average discharges for the period water years 1988-2020 extracted from either the synthetic naturalized daily average flow time series (Section 3.2) or from naturalized flows records computed separately at the Newhalem, Marblemount and Concrete USGS gage locations, representing naturalized flows in geomorphic reaches 2A, 5A and 9A-B, respectively.

The naturalized daily average flows at Newhalem and Marblemount were provided by HDR (2022). The naturalized flow at Concrete was computed by adding the difference between the Concrete and Marblemount historical daily average flow to the naturalized Marblemount record.

As with the estimation of historical flood quantiles, initial estimates of daily naturalized flood quantiles in the reach from Marblemount to Concrete (encompassing geomorphic reaches 5B through 8C) were adjusted to account for attenuation, based subjectively on the amount of floodplain storage, and to provide for reasonable variation in flood quantiles as one moves downstream from Marblemount to Concrete.

The naturalized mainstem daily flood quantiles are provided in Table A3, Appendix A.

3.5 Flow Duration Analysis

Annual flow duration curves were calculated in HEC-SSP using daily discharge data for the period January 1, 1988 – December 31, 2020, for each tributary and mainstem flow time series for historical and naturalized conditions. The annual flow duration curve shows the percent of time that a daily flow is exceeded during this 1988-2020 period. Flows were determined for a range of exceedance probabilities from 1 to 99 percent. Flow duration results for the Skagit River tributaries and mainstem locations are tabulated in Tables A4, A5, and A6, Appendix A, and an example flow duration curve plot is provided below as Figure 6.





Figure 7. Daily flow duration curve computed for Goodell Creek for the period calendar years 1988-2020.

4.0 SUMMARY

Hourly flows were developed for the mainstem Skagit River and its tributaries between Newhalem and Mount Vernon for the period October 1, 1987 – May 31, 2022. The hourly flow methodology uses subdaily streamflow data from 11 USGS gages that were processed into complete, filled hourly time series. Hourly flows for gaged tributaries were developed by scaling the hourly observations based on drainage area to estimate flows at the mouth of each tributary. Hourly flows for ungaged tributaries were estimated using a combination of daily flow differencing and/or scaling the hourly flows of a reference tributary gage based on drainage area and/or annual water yield. Complete hourly records were developed at the Newhalem, Marblemount, Concrete, and Mount Vernon mainstem USGS gages. The tributary and mainstem hourly flows were used to compute daily flows for historical and naturalized conditions, determine flood frequency estimates, and compute daily flow duration curves for use in individual relicensing studies.



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APPENDIX A

FLOOD FREQUENCY ESTIMATES AND FLOW DURATION ANALYSIS



A.1 FLOOD FREQUENCY ESTIMATES

Daily flood quantiles were computed for Skagit River tributaries and mainstem locations at and below Newhalem for the period water years 1988-2020 (33 peaks) through flood frequency analysis according to Bulletin 17C procedures incorporated into the HEC-SSP Version 2.2 Software (USACE 2019).

		Project River	Drainage Area (square						
No.	Tributary	Mile	miles)	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
1	Newhalem Creek	93.8	28.1	1,360	1,950	2,360	2,900	3,320	3,760
2	Goodell Creek	93.3	38.9	2,180	3,220	4,020	5,160	6,100	7,140
3	Damnation Creek	88.0	5.2	290	420	530	680	810	940
4	Alma Creek	85.5	8.4	460	680	850	1,090	1,290	1,520
5	Copper Creek	84.4	4.0	220	330	410	530	630	730
6	Bacon Creek	83.2	51.2	3,640	5,850	7,510	9,820	11,680	13,650
7	Diobsud Creek	81.0	26.6	1,450	2,140	2,670	3,440	4,090	4,800
8	Cascade River	77.2	185.4	6,560	9,920	12,470	16,080	19,050	22,270
9	Olson Creek	74.3	6.6	300	430	530	650	740	840
10	Corkindale Creek	74.3	5.0	230	330	400	490	560	630
11	Rocky Creek	73.8	10.2	470	670	810	990	1,140	1,290
12	Illabot Creek	73.0	43.0	1,970	2,820	3,410	4,190	4,800	5,430
13	Sauk River	66.8	732.8	27,120	40,590	50,310	63,410	73,740	84,560
14	Jackman Creek	58.4	24.4	1,120	1,600	1,940	2,380	2,730	3,080
15	Baker River	56.8	299.2			Not requeste	ed/computed		
16	Finney Creek	47.8	53.9	3,070	4,180	4,890	5,770	6,410	7,030
17	Day Creek	35.5	34.8	2,610	3,560	4,160	4,900	5,450	5,980

Table A.1.	Daily flood frequency estimates (cfs) for Skagit River tributaries below Newhalem, water years 1988-2020.



Geomorphic Reach	Reach Extents	Project River Mile	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
2A	Newhalem	94.3	11,200	17,200	21,900	28,800	34,700	41,300
2B-3A	[Newhalem - Sky Ck)	88.7	13,800	20,300	25,200	32,100	37,900	44,200
3A	[Sky Ck-Damnation Ck)	88.1	14,000	20,400	25,300	32,300	38,100	44,500
4	[Damnation Ck - Bacon Ck)	83.3	15,000	21,800	27,000	34,300	40,400	47,000
3B	[Bacon Ck - Diobsud Ck)	81.1	18,200	26,600	32,800	41,700	49,000	56,800
5A	[Diobsud Ck - Marblemount]	79.0	19,600	28,600	35,400	44,900	52,700	61,100
5B	(Marblemount - Illabot Ck)	73.7	25,800	37,700	46,500	58,600	68,400	78,900
6-7A	[Illabot Ck - Sauk R)	67.0	25,700	36,700	44,500	55,000	63,300	72,000
7B-8B	[Sauk R - Jackman Ck)	60.8	50,900	74,400	91,500	114,900	133,700	153,400
8C	[Jackman Ck - Baker R)	56.9	52,300	76,300	93,600	117,300	136,200	156,100
9А-В	[Baker R - Concrete]	54.6	58,400	84,800	103,900	130,100	151,000	173,000
10	(Concrete - Day Ck)	36	64,900	93,500	113,500	139,700	160,000	180,800
11	[Day Ck - Sedro-Woolley]	23.3	69,900	100,200	120,800	147,200	167,100	187,200

Table A.2.Daily flood frequency estimates (cfs) for mainstem Skagit River locations at and below Newhalem for historical
conditions, water years 1988-2020.

Notes:

1 Reaches are inclusive of upstream tributary ("[") and exclusive of downstream tributary (")").



Geomorphic Reach	Reach Extents	Project River Mile	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
2A	Newhalem	94.3	23,300	33,200	41,000	52,200	61,700	72,100
2B-3A	[Newhalem - Sky Ck)	88.7	26,800	38,300	47,200	60,400	71,500	83,900
3A	[Sky Ck-Damnation Ck)	88.1	26,900	38,400	47,500	60,700	71,900	84,400
4	[Damnation Ck - Bacon Ck)	83.3	28,000	40,100	49,600	63,500	75,300	88,500
3B	[Bacon Ck - Diobsud Ck)	81.1	31,300	45,000	55,900	71,800	85,200	100,300
5A	[Diobsud Ck - Marblemount]	79.0	32,800	47,700	59,500	76,900	91,700	108,200
5B	(Marblemount - Illabot Ck)	73.7	39,200	56,800	70,500	90,300	107,200	125,800
6-7A	[Illabot Ck - Sauk R)	67.0	38,200	54,500	67,000	85,000	99,900	116,100
7B-8B	[Sauk R - Jackman Ck)	60.8	64,200	93,200	114,800	145,200	169,700	196,200
8C	[Jackman Ck - Baker R)	56.9	65,300	94,700	116,700	147,500	172,600	199,500
9A-B	[Baker R - Concrete]	54.6	70,900	102,500	126,600	160,900	189,300	220,300
10	(Concrete - Day Ck)	36	76,500	110,400	135,800	171,400	200,600	232,100
11	[Day Ck - Sedro-Woolley]	23.3	81,300	117,000	143,100	179,200	208,200	239,100

Table A.3.Daily flood frequency estimates (cfs) for mainstem Skagit River locations at and below Newhalem for naturalized
conditions, water years 1988-2020.

Notes:

1 Reaches are inclusive of upstream tributary ("[") and exclusive of downstream tributary (")").



A.2 Flow Duration Analysis

Daily flow duration results were computed for Skagit River tributaries and mainstem locations at and below Newhalem for the period calendar years 1988-2020 using HEC-SSP Version 2.2 Software (USACE 2019).

				Percent of Time Exceeded									
No.	Tributary	Project River Mile	Drainage Area (square miles)	99%	95%	90%	75%	50%	25%	10%	5%	2%	1%
1	Newhalem Creek	93.8	28.1	28	41	50	75	131	240	385	495	677	883
2	Goodell Creek	93.3	38.9	0	22	53	120	236	392	580	738	1,027	1,358
3	Damnation Creek	88.0	5.2	0	3	7	16	31	52	77	98	136	179
4	Alma Creek	85.5	8.4	0	5	12	26	51	84	125	159	220	286
5	Copper Creek	84.4	4.0	0	2	6	12	25	41	60	77	106	138
6	Bacon Creek	83.2	51.2	77	115	144	223	362	596	891	1,119	1,576	2,136
7	Diobsud Creek	81.0	26.6	0	14	36	82	163	270	399	506	702	903
8	Cascade River	77.2	185.4	252	336	401	552	862	1,416	2,175	2,753	3,686	4,542
9	Olson Creek	74.3	6.6	6	9	11	17	29	53	86	110	151	197
10	Corkindale Creek	74.3	5.0	5	7	8	13	22	40	65	83	114	149
11	Rocky Creek	73.8	10.2	10	14	17	26	45	82	132	170	232	302
12	Illabot Creek	73.0	43.0	41	59	73	109	189	346	556	716	978	1,277
13	Sauk River	66.8	732.8	889	1,190	1,452	2,142	3,416	5,586	8,393	10,520	14,122	17,831
14	Jackman Creek	58.4	24.4	23	33	41	62	107	197	316	406	555	725
15	Baker River	56.8	299.2	82	122	293	1,473	2,754	3,812	4,300	4,883	6,323	8,460
16	Finney Creek	47.8	53.9	29	38	49	102	225	376	623	871	1,422	1,938
17	Day Creek	35.5	34.8	25	33	41	87	191	320	530	740	1,209	1,648

Table A.4.Daily flow duration results (cfs) for Skagit River tributaries below Newhalem, calendar years 1988-2020.



	Percent of Time Exceede								led	ed					
Geomorphic Reach	Reach Extents	Project River Mile	99%	95%	90%	75%	50%	25%	10%	5%	2%	1%			
2A	Newhalem	94.3	1,810	2,260	2,510	3,190	4,160	5,530	6,960	7,540	10,350	12,350			
2B-3A	[Newhalem - Sky Ck)	88.7	2,170	2,580	2,960	3,670	4,690	6,260	7,680	8,830	11,840	13,970			
3A	[Sky Ck-Damnation Ck)	88.1	2,180	2,590	2,970	3,680	4,710	6,290	7,720	8,880	11,870	14,090			
4	[Damnation Ck - Bacon Ck)	83.3	2,240	2,650	3,080	3,810	4,880	6,520	7,980	9,310	12,360	14,690			
3B	[Bacon Ck - Diobsud Ck)	81.1	2,360	2,860	3,310	4,150	5,320	7,120	8,710	10,420	13,500	16,370			
5A	[Diobsud Ck - Marblemount]	79.0	2,350	2,940	3,420	4,300	5,560	7,400	9,150	11,040	14,300	16,880			
5B	(Marblemount - Illabot Ck)	73.7	2,800	3,470	4,000	5,100	6,670	8,820	11,550	14,070	18,180	21,390			
6-7A	[Illabot Ck - Sauk R)	67.0	2,890	3,590	4,130	5,320	7,000	9,290	12,370	15,030	19,360	23,010			
7B-8B	[Sauk R - Jackman Ck)	60.8	4,050	4,990	5,740	7,730	10,710	14,920	20,890	25,710	32,890	40,960			
8C	[Jackman Ck - Baker R)	56.9	4,090	5,040	5,790	7,810	10,830	15,130	21,250	26,110	33,460	41,590			
9A-B	[Baker R - Concrete]	54.6	4,840	6,230	7,330	9,810	13,600	18,180	24,340	29,260	37,140	45,610			
10	(Concrete - Day Ck)	36	4,970	6,440	7,610	10,240	14,270	19,150	25,600	31,030	39,970	49,440			
11	[Day Ck - Sedro-Woolley]	23.3	5,050	6,570	7,790	10,520	14,740	19,880	26,560	32,370	42,050	52,470			

Table A.5.Daily flow duration results (cfs) for mainstem Skagit River locations at and below Newhalem for historical conditions,
calendar years 1988-2020.

Notes:

1 Reaches are inclusive of upstream tributary ("[") and exclusive of downstream tributary (")").



						Pe	rcent of Ti	me Exceed	led				
Geomorphic Reach	Reach Extents	Project River Mile	99%	95%	90%	75%	50%	25%	10%	5%	2%	1%	
2A	Newhalem	94.3	840	1,240	1,520	2,050	3,190	5,730	9,720	12,540	16,180	18,550	
2B-3A	[Newhalem - Sky Ck)	88.7	980	1,430	1,730	2,350	3,700	6,590	10,950	14,020	18,000	20,940	
3A	[Sky Ck-Damnation Ck)	88.1	990	1,440	1,740	2,360	3,720	6,620	10,990	14,080	18,050	21,010	
4	[Damnation Ck - Bacon Ck)	83.3	1,040	1,480	1,800	2,450	3,860	6,890	11,350	14,450	18,670	21,730	
3B	[Bacon Ck - Diobsud Ck)	81.1	1,150	1,630	1,980	2,700	4,250	7,520	12,300	15,650	20,240	23,380	
5A	[Diobsud Ck - Marblemount]	79.0	1,190	1,690	2,050	2,810	4,450	7,870	12,780	16,170	21,110	24,460	
5B	(Marblemount - Illabot Ck)	73.7	1,520	2,110	2,540	3,460	5,480	9,540	15,310	19,400	25,000	28,950	
6-7A	[Illabot Ck - Sauk R)	67.0	1,610	2,220	2,650	3,630	5,760	10,070	16,120	20,450	26,520	30,720	
7B-8B	[Sauk R - Jackman Ck)	60.8	2,610	3,530	4,230	5,890	9,370	15,890	24,630	31,090	39,970	49,670	
8C	[Jackman Ck - Baker R)	56.9	2,640	3,570	4,280	5,970	9,490	16,130	25,000	31,530	40,510	50,750	
9A-B	[Baker R - Concrete]	54.6	3,330	4,740	5,840	8,120	12,330	19,080	28,110	34,440	43,850	53,600	
10	(Concrete - Day Ck)	36	3,490	4,990	6,170	8,570	13,060	20,060	29,300	36,040	46,250	56,090	
11	[Day Ck - Sedro-Woolley]	23.3	3,580	5,120	6,370	8,890	13,590	20,780	30,160	37,320	48,110	58,560	

Table A.6.Daily flow duration results (cfs) for mainstem Skagit River locations at and below Newhalem for naturalized conditions,
calendar years 1988-2020.

Notes:

1. Reaches are inclusive of upstream tributary ("[") and exclusive of downstream tributary (")").

UPDATED STUDY REPORT

APPENDIX C

LIST OF MEETINGS AND ORGANIZATIONS PARTICIPATING IN THE WORK GROUPS, TECHNICAL STEERING COMMITTEE, ADVISORY ROUNDTABLE, AND PARTNERS' COMMITTEE MEETINGS

2019	2020	2021	2022	2023
2/12/19	1/23/20	3/26/21	1/12/22	1/4/23
4/17/19	3/12/20	6/30/21	1/26/22	
6/19/19	4/8/20	7/14/21	2/9/22	
9/4/19	5/20/20	7/28/21	2/23/22	
10/9/19	7/22/20	8/11/21	3/9/22	
11/6/19	11/10/20	8/25/21	4/6/22	
12/5/19		10/6/21	4/20/22	
		10/20/21	5/4/22	
		11/3/21	5/25/22	
		12/15/21	6/22/22	
			7/20/22	
			8/17/22	
			9/14/22	
			10/12/22	
			11/9/22	
			12/7/22	

Table E-1.List of Steering Committee and Partner Committee Meeting Dates.

Table E-2.List of Technical Steering Committee Meeting Dates.

2021	2022	2023
6/3/21	1/13/22	2/23/23
7/8/21	2/10/22	
9/9/21	4/14/22	
11/16/21	5/12/22	
12/9/21	6/9/22	
	9/8/22	

Table E-3.List of Advisory Roundtable Meeting Dates.

2021	2022
9/22/21	1/26/22
11/17/21	3/30/22

2019	2020	2021	2022	2023
1/29/19	3/19/20	4/14/21	2/23/22	1/5/23 (HPMP)
3/18/19	5/4/20		7/25/22	1/6/23 (HPMP)
5/21/19	6/22/20		9/26/22	1/11/23 (HPMP)
8/7/19	9/14/20		11/28/22	
10/16/19	11/16/20			

Table E-4. List of Cultural Resources Work Group Meeting Dates.

Table E-5.List of Fish & Aquatics Related Meeting Dates (Consisting of the Fish & Aquatics
Work Group, Flows Work Group, Reservoir Work Group, and Water Quality
Work Group).1

2019	2020	2021	2022	2023
1/29/19	3/31/20	4/28/21	1/18/22	1/30/23
3/18/19	5/5/20	5/17/21	1/25/22	
4/9/19	6/2/20	7/13/21	2/1/22	
5/20/19	6/24/20	7/14/21	2/9/22	
7/29/19	9/16/20	8/12/21	2/15/22	
	11/18/20	8/24/21	3/1/22	
		8/26/21	3/15/22	
		9/23/21	3/24/22	
		10/1/21	3/29/22	
		10/20/21	3/31/22	
		10/25/21	4/5/22	
		10/26/21	4/19/22	
		11/2/21	4/21/22	
		11/23/21	4/25/22	
		12/7/21	4/26/22	
		12/20/21	6/28/22	
		12/21/21	7/6/22	

1 Table is not inclusive of Habitat Suitability Criteria Workshops that occurred in 2021 and 2022. Please see the FA-02 Instream Flow Model Development Study Interim Study Report for meeting dates.

Table E-6.List of Fish Passage Meeting Dates.1

2019	2021	2022
10/3/19	7/15/21	2/24/22
10/30/19	9/23/21	8/30/22
	12/16/21	

1 Table is not inclusive of Agency Work Sessions that occurred in 2021 and 2022. Please see the FA-04 Fish Passage Technical Studies Program Interim Study Report for meeting dates.

2021	2022
12/7/21	1/13/22
12/15/21	2/10/22
	2/28/22
	3/28/22

Table E-7. List of Integration/Roadmap Small Work Group Meetings.

Table E-8.List of Geomorphology Work Group Meeting Dates.

2019	2021	2022
4/15/19	7/20/21	1/11/22
5/28/19	7/27/21	1/19/22
6/25/19	9/28/21	2/8/22
	10/12/21	4/12/22
	11/9/21	5/24/22

Table E-9.List of Operations Modeling Work Group Meeting Dates.

2021	2022
6/28/21	1/20/22
12/16/21	2/17/22
	3/17/22
	5/19/22
	6/16/22
	7/28/22
	8/25/22
	10/4/22

Table E-10.List of Recreation Work Group Meeting Dates.

2019	2020	2021	2022
1/29/19	3/24/20	9/2/21	2/8/22
3/18/19	5/7/20	11/4/21	3/3/22
5/22/19	6/25/20		
7/31/19	9/17/20		
	11/19/20		

2021	2022
12/15/21	4/28/22
	7/14/22
	8/11/22
	10/6/22
	11/23/22
	12/19/22

Table E-11.List of Synthesis Study Work Group Meeting Dates.

Table E-12.	List of Terrestrial	Work Group	Meeting Dates.
		1	

2019	2020	2021	2022
1/29/19	3/17/20	8/17/21	2/3/22
3/19/19	5/6/20	8/31/21	
5/21/19	6/23/20	9/23/21	
7/30/19	9/15/20	10/7/21	
10/15/19	11/17/20		

Table E-13.List of Topic-Based Issue Resolution Meeting Dates (to resolve differences
between LP study requests and City Light's proposed relicensing study program).

2021
1/26/21
1/28/21
2/2/21
2/4/21
2/9/21
2/11/21
2/16/21
5/26/21
5/27/21
5/28/21
6/1/21
6/2/21
6/4/21
6/7/21

Organization
Access Fund
American Canoe Association
American Rivers
American Whitewater
City of Mount Vernon
Confederated Tribes of the Colville Reservation
Lummi Nation
National Marine Fisheries Service
National Parks Conservation Association
Nlaka'pamux Nation Tribal Council
Nlaka'pamux Nation Bands Coalition
Nooksack Indian Tribe
North Cascades Conservation Council
North Cascades Institute
Samish Indian Nation
Sauk-Suiattle Indian Tribe
Skagit County
Skagit County Dike District Partnership
Skagit Drainage and Irrigation District Consortium
Skagit Environmental Endowment Commission
Skagit Fisheries Enhancement Group
Skagit River System Cooperative
Snohomish County
Snoqualmie Indian Tribe
Stillaguamish Tribe of Indians
S'ólh Téméxw Stewardship Alliance
Suquamish Tribe
Swinomish Indian Tribal Community
Trout Unlimited
U.S. Army Corps of Engineers
U.S. Bureau of Indian Affairs
U.S. Department of the Interior
U.S. Federal Energy Regulatory Commission
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Geological Survey
U.S. National Park Service
University of British Columbia
Upper Skagit Indian Tribe
Virginia Tech University

Table E-14.List of organizations participating in the relicensing meetings through February
2023.

Organization

Washington Climbers Coalition

Washington Department of Archaeology and Historic Preservation

Washington Department of Ecology

Washington Department of Fish and Wildlife

Washington State Parks and Recreation Commission

UPDATED STUDY REPORT

APPENDIX D

CITY LIGHT STUDY REPORTS