FINAL LICENSE APPLICATION
EXHIBIT E

APPENDIX O

SKAGIT RIVER RIVERSCAPE ECOSYSTEM PLAN

RIVERSCAPE ECOSYSTEM PLAN
DRAFT

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

Seattle City Light

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List of Acronyms and Abbreviations

°C ....degrees Celsius
BACI ....before-after-control-impact
BMP ....best management practice
cfs ....cubic feet per second
City Light ....Seattle City Light
CMZ ....Channel Migration Zone
CoSD ....City of Seattle Datum
dbh ....diameter at breast height
EMAMP ....Ecosystem Monitoring and Adaptive Management Program
FERC ....Federal Energy Regulatory Commission
FLA ....final license application
FMP ....Flow Management Program
LiDAR ....light detection and ranging
NAVD88 ....North American Vertical Datum of 1988
NERC ....North American Electric Reliability Corporation
Non-Flow Program ....Aquatic Habitat Program
NPS ....National Park Service
O&M ....operations and maintenance
PDT ....Pacific Daylight Time
PME ....protection, mitigation and enhancement
PRM ....Project River Mile
Project ....Skagit River Hydroelectric Project
PST ....Pacific Standard Time
REP ....Riverscape Ecosystem Plan
Revised FSA ....Revised Fisheries Settlement Agreement
ROW ....right-of-way
RTK ....real-time kinematic positioning
SR ....State Route
SRCC ....Skagit Resource Coordination Committee
STJ ....(salmonid) stream-type juvenile
USGS .........................U.S. Geological Survey

WDFW......................Washington Department of Fish and Wildlife

1.0 INTRODUCTION

This document describes Seattle City Light's (City Light) proposed Riverscape Ecosystem Plan (REP) for the Skagit River Hydroelectric Project (Project or Skagit River Project), Federal Energy Regulatory Commission (FERC) No. 553. The REP consists of two programs: the Flow Management Program (FMP) and the Aquatic Habitat Program (Non-Flow Program). The goal of the REP is to describe the flow and non-flow measures developed to minimize the effects of Project operations on salmon and steelhead and enhance mainstem, side channel, and off-channel habitat downstream of Gorge Powerhouse and at stream crossings along the transmission line right-of-way (ROW).

City Light will integrate the efforts required under this REP with other license article obligations, including Fish Passage Program, Flood Risk Management Operations, and other license article obligations included in the new license. These obligations are described in the final license application (FLA) and are not included in this document; however, they, and other related license measures, are anticipated to be included within the scope of the Ecosystem Monitoring and Adaptive Management Program (EMAMP) discussed herein.

2.0 PURPOSE AND SCOPE OF THE PLAN

City Light proposes this REP to describe the flow and non-flow measures developed to minimize the effects of Project operations on salmon and steelhead and enhance mainstem, side channel, and off-channel habitat downstream of Gorge Powerhouse and at stream crossings along the transmission line ROW. The REP consists of two programs: the FMP and the Non-Flow Program.

2.1 Goals and Objectives

The goal of the REP is to describe the flow and non-flow measures developed to minimize the effects of Project operations on salmon and steelhead and enhance mainstem, side channel, and off-channel habitat downstream of Gorge Powerhouse and at stream crossings along the transmission line ROW.

The purpose of the FMP (integrated as part of the REP) is to describe the flows and ramping rate restrictions to minimize the effects of Project operations on salmon and steelhead and to provide the following benefits: (1) salmon spawning and redd protection; (2) salmon fry protection; (3) steelhead spawning and redd protection; (4) steelhead fry protection; (5) salmonid fry outmigration; and (6) salmonid stream-type juvenile (STJ) protection. It also describes proposed flow releases designed to promote geomorphic processes (i.e., process flows) that maintain aquatic, riparian, and floodplain habitats and increase the connectivity of side channels and off-channel habitats to the main channel.

The FMP builds off the existing Flow Plan of the Revised Fisheries Settlement Agreement (Revised FSA) implemented since 2013 (City Light 2011) by continuing flow management approaches that have been successful while also introducing new additional measures to benefit salmon and steelhead.

The purpose of the Non-Flow Program (integrated as part of this REP) is to guide management of mainstem, riparian, floodplain, side channel, and off-channel habitat enhancement measures downstream of Gorge Powerhouse and at stream crossings along the transmission line ROW with the primary purpose of improving the availability of these habitats and enhancing the ecosystem process that create and sustain them. The Non-Flow Program builds off the existing Anadromous and Resident Fish Non-Flow Plan (City Light 2011) by expanding upon the Habitat Development and Improvement Program while also introducing new measures to benefit aquatic habitats and ecosystem diversity and resiliency. Additionally, the Non-Flow Program includes measures to avoid, minimize, and mitigate impacts of Project operations to protect and enhance aquatic and habitat at transmission line stream crossings along the transmission line ROW and associated routes. Culvert replacements, wood augmentation, and projects to avoid, minimize, and mitigate interactions resulting from channel migration interactions with transmission line towers and other City Light infrastructure are included in the Non-Flow Program.

Terrestrial components of management of the transmission line ROW and associated roads including road maintenance, vegetation management and riparian restoration measures are included in the Roads, Trails, and Transmission Line Right-of-Way Erosion Management Plan, and Vegetation Management Plan, respectively.

The REP also lays out a comprehensive monitoring program to evaluate the effectiveness of the measures described within, identify adaptive management opportunities, and support compliance.

2.2 Geographic Area

The geographic scope of the REP is the Skagit River below Gorge Powerhouse, including aquatic habitat areas to be enhanced within the transmission line ROW and within the Skagit River below Gorge Powerhouse.

3.0 FLOW MANAGEMENT PROGRAM

The purpose of the FMP (integrated as part of the REP) is to describe the flows and ramping rate restrictions currently in place to minimize the effects of Project operations on salmon and steelhead and to provide the following benefits: (1) salmon spawning and redd protection; (2) salmon fry protection; (3) steelhead spawning and redd protection; (4) steelhead fry protection; (5) salmonid fry outmigration; and (6) salmonid STJ protection. It also describes proposed flow releases designed to promote geomorphic processes (i.e., process flows) that maintain aquatic, riparian habitats, and floodplain habitats and increase the connectivity of side channels and off-channel habitats to the main channel.

While the FMP flow measures and ramping rate restrictions are designed to provide protection for all anadromous and resident species, they specifically target protections for the mainstem spawning species:

- Chinook Salmon (*Oncorhynchus tshawytscha*);
- Pink Salmon *(O. gorbuscha)*;
- Chum Salmon *(O. keta)*; and
- Steelhead *(O. mykiss)*.

Flow measures are tailored to be protective for specific life stages of each species:

- *Spawning Flows* are implemented to limit maximum flow levels during the Spawning Period, and thereby minimize redd building in areas along the river margin exposed by daily load-following generation.
- *Incubation Flows* provide minimum flow levels throughout the incubation period so that redds are adequately inundated from the onset of spawning until the fry emerge.
- *Fry Protection* is implemented by providing for minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds.
- *STJ Protection* exclusively targets stream-type juvenile life histories of Chinook Salmon, steelhead, and other salmonids that exhibit prolonged freshwater residence. This measure establishes down-ramp rates to protect STJ from stranding and to minimize local displacement from foraging habitats. Down-ramp rates are limited to < 3,000 cubic feet per second (cfs) per hour from October 16 to December 31 each year.

3.1 Instream Flow Provisions by Species

3.1.1 Chinook Salmon

3.1.1.1 Spawning Flows

For the purposes of the FMP, the Spawning Period for Chinook Salmon extends from August 20 to October 15. During this period, a maximum Daily Spawning Flow of 4,500 cfs will be maintained to help prevent dewatering of redds during subsequent flow conditions. Two exceptions to this rule may occur: (1) flows may be higher during the Spawning Period if flow forecasts suggest that there will be a sufficient volume of water available to also provide higher flows during the subsequent Incubation Period; and (2) flows may also be higher during the Spawning Period when high flow events result in uncontrollable flow conditions.

3.1.1.2 Incubation Flows

Incubation Flows are intended to provide minimum flow conditions during the Incubation Period so that redds remain adequately inundated until fry emerge. For Chinook Salmon, the Incubation Period begins on August 20, simultaneously with the beginning of the Spawning Period, and extends until April 30. The Incubation Period is further separated into the following three segments during which different instantaneous minimum incubation flows are implemented.

- *August 20 – 29*: During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned Spawning Flows are the flows targeted for spawning during a given month in City Light's monthly operating plan.
- *August 30 – October 15*: During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources.[1]
- *October 16 – April 30:* During the remainder of the Incubation Period, incubation flows will be based on the Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during the entire Spawning Period (August 20 – October 15).

Exceptions to these minimum incubation flows may occur when higher minimum flows are required for protection of other species and life stages. During such instances, City Light will provide the highest of the competing minimum flow requirements indicated for any particular day. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the Skagit Resource Coordinating Committee (SRCC). Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC.

3.1.1.3 Fry Protection

Protection for Chinook Salmon fry is provided by implementing minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds. For Chinook Salmon, the Fry Protection Period extends from January 1 through May 31. During this period, the Downramp Amplitude will not exceed 3,000 cfs from January 1 through January 31 and 4,000 cfs from February 1 through May 31. Downramp Amplitude is defined as the difference between the highest and subsequent

[1] I.e., flood risk management, spill, avoiding Firm Load curtailment, high Sidestream Inflow, or Process Flows.

lowest Newhalem gage readings during any consecutive 24-hour period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam.

Restrictions on the maximum downramping rates during the Fry Protection Period are differentiated between daytime and nighttime periods. During the daytime, downramping is not allowed when the Predicted Marblemount Flow is 4,700 cfs or less. When the Predicted Marblemount Flow is greater than 4,700 cfs, downramping is allowed at a rate of up to 1,500 cfs/hour. During nighttime, downramping is allowed at a rate of up to 3,000 cfs/hour regardless of river flow conditions. The daytime period is defined here as beginning 6.5 hours before official sunrise and ending at official sunset (Pacific Standard Time [PST] or Pacific Daylight Time [PDT]), while the nighttime period is defined as the remaining portion of a given 24-hour period.

To maintain inundation of various fry rearing habitats, a minimum flow at the Newhalem gage will be maintained that is the higher of either:

(1) The flow resulting in a Predicted Marblemount Flow of at least 3,000 cfs; or

(2) The monthly flows established for fry protection as shown in Table 3.1-1.

However, City Light will not be required to release flows exceeding 2,600 cfs (as measured at Newhalem gage) for the purposes of salmon fry protection.

3.1.1.4 STJ Protection

Protection for STJ is provided by restricting downramping rates to minimize stranding as well as displacement from rearing habitats. During the STJ Protection Period, which extends from October 16 to December 31, downramping rates will be limited to less than 3,000 cfs/hour, irrespective of time-of-day or river flow conditions.

Table 3.1-1. Fry protection flows at Newhalem Gage.

Month	Minimum Instantaneous Flow (cfs)
January	**
February	1,800
March	1,800
April	1,800
May	1,500
June	1,500
July	1,500
August	2,000*
September	1,500
October	1,500
November	**
December	**

* Minimum flow may be reduced to 1,500 cfs when Natural Flow on the Inflow Day is less than 2,300 cfs. See Sections 3.2.1.1 and 3.2.1.2 below.

** Minimum flows in these months are determined by incubation flow requirements.

Table 3.1-2 provides a graphical illustration of Chinook Salmon flow protection periods by life stage.

Table 3.1-2. Chinook Salmon flow protection periods by life stage.

Flow Protection Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning												
Incubation[1]												
Fry												
STJ												

1 The incubation flow protection period has three components distinguished above by shading: the first 10 days of the Spawning Period (dark); the subsequent portion of the Spawning Period (moderate); and after the Spawning Period (light).

3.1.2 Pink Salmon

3.1.2.1 Spawning Flows

For the purposes of the FMP, the Spawning Period for Pink Salmon extends from September 12 to October 31, exclusively during odd numbered years. During this period, a maximum Daily Spawning Flow of 4,000 cfs will be maintained to help prevent dewatering of redds during subsequent flow conditions. Two exceptions to this rule may occur: (1) flows may be higher during the Spawning Period if flow forecasts suggest that there will be a sufficient volume of water available to also provide higher flows during the subsequent Incubation Period; and (2) flows may also be higher during the Spawning Period when high flow events result in uncontrollable flow conditions.

3.1.2.2 Incubation Flows

Incubation Flows are intended to provide minimum flow conditions during the Incubation Period so that redds remain adequately inundated until fry emerge. For Pink Salmon, the Incubation Period begins on September 12, simultaneously with the beginning of the Spawning Period, and extends until April 30. The Incubation Period is further separated into the following three segments during which different instantaneous minimum incubation flows are implemented.

- *September 12 – 21*: During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned Spawning Flows are the flows targeted for spawning during a given month in City Light's monthly operating plan.
- *September 22 – October 31*: During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources.[2]

2 I.e., flood risk management, spill, avoiding Firm Load curtailment, high Sidestream Inflow, or Process Flows.

- *November 1 – April 30:* During the remainder of the Incubation Period, incubation flows will be based on the Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during the entire Spawning Period (September 12 – October 31).

Exceptions to these minimum incubation flows may occur when higher minimum flows are required for protection of other species and life stages. During such instances, City Light will provide the highest of the competing minimum flow requirements indicated for any particular day. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC.

3.1.2.3 Fry Protection

Protection for Pink Salmon fry is provided by implementing minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds. For Pink Salmon, the Fry Protection Period extends from January 1 through May 31. During this period, the Downramp Amplitude will not exceed 3,000 cfs from January 1 through January 31 and 4,000 cfs from February 1 through May 31. Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hour period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam.

Restrictions on the maximum downramping rates during the Fry Protection Period are differentiated between daytime and nighttime periods. During the daytime, downramping is not allowed when the Predicted Marblemount Flow is 4,700 cfs or less. When the Predicted Marblemount Flow is greater than 4,700 cfs, downramping is allowed at a rate of up to 1,500 cfs/hour. During nighttime, downramping is allowed at a rate of up to 3,000 cfs/hour regardless of river flow conditions. The daytime period is defined here as beginning 6.5 hours before official sunrise and ending at official sunset (PST or PDT), while the nighttime period is defined as the remaining portion of a given 24-hour period.

To maintain inundation of various fry rearing habitats, a minimum flow at the Newhalem gage will be maintained that is the higher of either:

(1) The flow resulting in a Predicted Marblemount Flow of at least 3,000 cfs; or

(2) The monthly flows established for fry protection as shown in Table 3.1-1.

However, City Light will not be required to release flows exceeding 2,600 cfs (as measured at Newhalem gage) for the purposes of salmon fry protection.

Table 3.1-3 provides a graphical illustration of Pink Salmon flow protection periods by life stage.

Table 3.1-3. Pink Salmon flow protection periods by life stage.

Flow Protection Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning												
Incubation[1]												
Fry												

1 The incubation flow protection period has three components distinguished above by shading: the first 10 days of the Spawning Period (dark); the subsequent portion of the Spawning Period (moderate); and after the Spawning Period (light).

3.1.3 Chum Salmon

3.1.3.1 Spawning Flows

For the purposes of the FMP, the Spawning Period for Chum Salmon extends from November 1 to January 6. During this period, a maximum Daily Spawning Flow of 4,600 cfs will be maintained to help prevent dewatering of redds during subsequent flow conditions. Two exceptions to this rule may occur: (1) flows may be higher during the Spawning Period if flow forecasts suggest that there will be a sufficient volume of water available to also provide higher flows during the subsequent Incubation Period; and (2) flows may also be higher during the Spawning Period when high flow events result in uncontrollable flow conditions.

3.1.3.2 Incubation Flows

Incubation Flows are intended to provide minimum flow conditions during the Incubation Period so that redds remain adequately inundated until fry emerge. For Chum Salmon, the Incubation Period begins on November 1, simultaneously with the beginning of the Spawning Period, and extends until May 31. The Incubation Period is further separated into the following three segments during which different instantaneous minimum incubation flows are implemented.

- *November 1 – 9*: During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned Spawning Flows are the flows targeted for spawning during a given month in City Light's monthly operating plan.
- *November 10 – January 6*: During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources.[3]
- *January 7 – May 31:* During the remainder of the Incubation Period, incubation flows will be based on the Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during the entire Spawning Period (November 1 – January 6).

3 I.e., flood risk management, spill, avoiding Firm Load curtailment, high Sidestream Inflow, or Process Flows.

Exceptions to these minimum incubation flows may occur when higher minimum flows are required for protection of other species and life stages. During such instances, City Light will provide the highest of the competing minimum flow requirements indicated for any particular day. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC.

3.1.3.3 Fry Protection

Protection for Chum Salmon fry is provided by implementing minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds. For Chum Salmon, the Fry Protection Period extends from January 1 through May 31. During this period, the Downramp Amplitude will not exceed 3,000 cfs from January 1 through January 31 and 4,000 cfs from February 1 through May 31. Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hour period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam.

Restrictions on the maximum downramping rates during the Fry Protection Period are differentiated between daytime and nighttime periods. During the daytime, downramping is not allowed when the Predicted Marblemount Flow is 4,700 cfs or less. When the Predicted Marblemount Flow is greater than 4,700 cfs, downramping is allowed at a rate of up to 1,500 cfs /hour. During nighttime, downramping is allowed at a rate of up to 3,000 cfs/hour regardless of river flow conditions. The daytime period is defined here as beginning 6.5 hours before official sunrise and ending at official sunset (PST or PDT), while the nighttime period is defined as the remaining portion of a given 24-hour period.

To maintain inundation of various fry rearing habitats, a minimum flow at the Newhalem gage will be maintained that is the higher of either:

(1) The flow resulting in a Predicted Marblemount Flow of at least 3,000 cfs; or

(2) The monthly flows established for fry protection as shown in Table 3.1-1.

However, City Light will not be required to release flows exceeding 2,600 cfs (as measured at Newhalem gage) for the purposes of salmon fry protection.

Table 3.1-4 provides a graphical illustration of Chum Salmon flow protection periods by life stage.

Table 3.1-4. Chum Salmon flow protection periods by life stage.

Flow Protection Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning												
Incubation[1]												
Fry												

1 The incubation flow protection period has three components distinguished above by shading: the first 10 days of the Spawning Period (dark); the subsequent portion of the Spawning Period (moderate); and after the Spawning Period (light).

3.1.4 Steelhead

3.1.4.1 Spawning Flows

In contrast to fall-spawning salmon species, Skagit River steelhead spawn during the spring over a more protracted period. For the purposes of the FMP, the Spawning Period for steelhead extends from March 15 to June 15. However, given the longer duration of this period, the expected interval between fertilization and fry emergence, and the nature of the springtime Skagit River hydrograph, the Spawning Period for steelhead is divided into three subperiods: March 15 to 31 (March spawners), April 1 to 30 (April spawners), and May 1 to June 15 (May/June spawners). Steelhead spawning during these subperiods will be considered separate spawning groups for which specific incubation flows (magnitude and duration) are determined.

Like flow operations for salmon spawning, steelhead spawning flows will be managed to minimize redd building in areas along the river margins that would be at risk of exposure during daily fluctuations in generation and that minimum flows are subsequently maintained during incubation so that redds remain submerged until fry emergence. However, unique to steelhead, Planned Spawning Flows will be derived based on a Spawning Control Curve that incorporates forecasted hydrologic conditions established prior to the Spawning Period and is adjusted throughout the Spawning Period as prevailing conditions change. The Spawning Control Curve is described in detail in Appendix E (Shaping of Flows During Steelhead Spawning). The output from the Spawning Control Curve represents the maximum Planned Spawning Flows for each subperiod. In addition, the Maximum Planned Spawning Flow for each subperiod (as measured at the Newhalem gage) is further limited as follows: 5,000 cfs for March steelhead, 5,000 for April steelhead, and 4,000 cfs for May/June steelhead. Flows may be higher during the Spawning Period if flow forecasts suggest that there will be a sufficient volume of water available to also provide the appropriate flows during the subsequent Incubation Period. Flows may also be higher during the Spawning Period when high flow events result in uncontrollable flow conditions.

3.1.4.2 Incubation Flows

Incubation Flows are intended to provide minimum flow conditions during the Incubation Period for each subgroup so that redds remain inundated until fry emerge. For March steelhead, the Incubation Period begins on March 15, simultaneously with the beginning of the Spawning Period, and extends through June 30. For April steelhead, the Incubation Period is from April 1 through July 31, and from May 1 through July 31 for May/June steelhead. The Incubation Period for each subgroup is further separated into the following three segments during which different instantaneous minimum incubation flows are implemented. Specific dates for each incubation segment are shown in Table 3.1-5.

- *First 10 Days of Each Spawning Subperiod*. During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned Spawning Flows are the flows targeted for spawning during a given month in City Light's monthly operating plan.
- *Remaining Days of Each Spawning Subperiod*. During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources.[4]
- *Following Each Spawning Subperiod.* During the remainder of the Incubation Period, incubation flows will be based on the Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during that spawning subperiod.

Exceptions to these minimum incubation flows may occur when higher minimum flows are required for protection of other species and life stages. During such instances, City Light will provide the highest of the competing minimum flow requirements indicated for any particular day. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC.

3.1.4.3 Fry Protection

Protection for fry is provided by implementing minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds. Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hour period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam. For steelhead, the Fry Protection Period extends from June 1 through October 15. During this period, the Downramp Amplitude will not exceed 3,000 cfs. An exception to this rule is that when the Project is operating under established Flow Insufficiency conditions in August, the Downramp Amplitude will not exceed 500 cfs. In addition, when flow at the Newhalem gage is 4,000 cfs or less, Downramp Amplitude will be further limited in accordance with Table 3.1-6.

Restrictions on the maximum downramping rates during the Steelhead Fry Protection Period are differentiated based on flow at the Newhalem gage. When Newhalem Instantaneous Flow is 4,000

[4] I.e., flood risk management, spill, avoiding Firm Load curtailment, high Sidestream Inflow, or Process Flows.

cfs or less, downramping will be allowed up to 500 cfs/hour. When Newhalem Instantaneous Flow is greater than 4,000 cfs, downramping will be allowed up to 1,000 cfs/hour.

To maintain inundation of steelhead fry rearing habitats, a minimum flow at the Newhalem gage will be maintained that is the higher of either:

(1) The monthly flows established for protection of both salmon and steelhead fry as shown in Table 3.1-1; or

(2) The Steelhead Incubation Flows developed as described above.

However, when Natural Flow at the Newhalem gage is less than 2,300 cfs, the minimum flow for August may be reduced to 1,500 cfs.

3.1.4.4 STJ Protection

STJ protection is provided by restricting downramping rates to minimize stranding as well as displacement from rearing habitats. During the STJ Protection Period, which extends from October 16 to December 31, downramping rates will be limited to less than 3,000 cfs/hour, irrespective of time-of-day.

Table 3.1-5. Steelhead flow protection periods by life stage.

Flow Protection Period[1]		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning	March Steelhead												
	April Steelhead												
	May/June Steelhead												
Incubation[2]	March Steelhead												
	April Steelhead												
	May/June Steelhead												
Fry													
STJ													

1 For the purposes of spawning and incubation flows, steelhead are separated into three subperiods based on the month in which they spawn.

2 The incubation flow protection period has three components distinguished above by shading: the first 10 days of the Spawning Period (dark); the subsequent portion of the Spawning Period (moderate); and after the Spawning Period (light).

Table 3.1-6. Allowable Downramp Amplitude during steelhead fry protection period.

Month	Maximum Daily 24-hour Amplitude (cfs)	Portion of Amplitude When Newhalem Gage <4,000 cfs (cfs)
June 1 or Alternative Start Date to June 30	3,000	2,000
July	3,000	2,000
August	3,000*	2,000*
September	3,000	2,500
October 1 to 15 or Alternative End Date	3,000	2,500

* Limited to 500 cfs per day when Flow Insufficiency provisions are in effect.

3.2 Measures Beyond Required Operation

City Light targets providing spawning and redd, incubation, fry, and STJ protection each year; however, conditions may arise, especially when uncontrollable flow events occur, where protection is not possible. In these cases, certain action may be taken, such as augmenting minimum flows or reducing daily average flows. The specific actions to be taken shall be cooperatively developed with the SRCC considering operating constraints, system flexibility, and potential impacts upon all anadromous species and life stages.

City Light will develop proposed actions to protect fish in the mainstem Skagit River based on the best available options identified at the end of the spawning season for each species (or spawning group in the case of steelhead) or whenever uncontrollable flow events occur during the spawning, incubation, and rearing periods. City Light will present the proposal to the SRCC for review and discussion in an effort to reach consensus on a plan of action.

3.2.1 Flow Insufficiency

Flow Insufficiency shall mean water conditions during a month or months characterized by abnormally low precipitation and sidestream runoff that has the potential to result in a failure to maintain target Ross Lake elevations or draw Ross Lake elevations down to the minimum usable pool (i.e., 1,480.76 feet North American Vertical Datum of 1988 [NAVD88]; 1,474.5 feet City of Seattle Datum [CoSD]) if operations continue to draft at the rate determined by minimum required flows. Months which are characterized by any of the flow insufficiency criteria in Section 3.2.1.1 (Determination of Flow Insufficiency) shall be considered Insufficient Months.

3.2.1.1 Determination of Flow Insufficiency

An Insufficient Month shall be deemed to occur when any one of the following criteria are met:

- **Criterion 1**: When discharge of the required minimum flows at the Newhalem gage, plus 300 cfs, combined with the forecasted inflow to Ross Lake (which is exceeded with 95 percent confidence) results in Ross Lake drafting to the minimum usable pool. A sample calculation is shown in Appendix L (Miscellaneous Calculations).

- **Criterion 2**: When discharge of the required minimum flows at the Newhalem gage, plus 300 cfs, combined with the forecasted inflow to Ross Lake (which is exceeded with 95 percent confidence) results in Ross Lake drafting to the minimum usable pool. An example is shown in Appendix L (Miscellaneous Calculations).
- **Criterion 3**: When Natural Flow at the Newhalem gage on any Inflow Day in August is less than 2,300 cfs. An example is shown in Appendix L (Miscellaneous Calculations).

3.2.1.2 Response to Flow Insufficiency

At the earliest possible time after flow insufficiency has been determined, City Light will notify the SRCC of the need to meet to discuss the flow insufficiency problem and proposed action alternatives. Alternatives for action shall include but not be limited to the following: (1) reduced requirements for minimum instream flows for some or all succeeding months in which the condition of flow insufficiency persists; and (2) no action, which could potentially lead to reduced Newhalem gage flows (to a level equal to Natural Flow) or Project load curtailment.

If a course of action is not achieved within two weeks of the date City Light notifies SRCC of a condition of Flow Insufficiency, City Light will take the following actions.

For Criteria 1 and 2, City Light will reduce each month's minimum flow proportionally to the extent necessary to remove the Flow Insufficiency provided, however, that the result of such reductions will be flows no less than the lesser of Natural Flow or 1,000 cfs (as measured at the Newhalem gage). Proportional reduction of minimum flows shall be implemented as follows. City Light will:

(1) Notify SRCC representatives of its intent to implement proportional flow reductions;

(2) Calculate the total volume of flow (flow deficit) that is required to remove Flow Insufficiency (i.e., to keep Ross Lake from drafting to the minimum usable pool), or to enable refilling Ross Lake to a minimum elevation of 1,600.76 feet NAVD88 (1,594.5 feet CoSD) by July 31 based on either the 50 percent exceedance flow or mean streamflow forecast;

(3) Divide the total flow deficit among the months during the entire period from the current date to the date when the City Light predicts that Ross Lake will be drafted to the minimum usable pool or to an elevation where the 50 percent exceedance flow forecast cannot be regulated in such a way that achieves Ross Lake reaching a minimum elevation of 1,600.76 feet NAVD88 (1,594.5 feet CoSD) by July 31—flows are divided proportionally according to each month's normal minimum flow; and

(4) Either reduce the monthly minimum flows according to each months' proportion of the flow deficit, or preferably reduce the monthly minimum flows according to an alternative schedule recommended by the SRCC which will accomplish the same result (i.e., remove Flow Insufficiency within the same time frame).

For Criterion 3, City Light will reduce minimum flows in August in conformance with Section 3.1.4.3 (Steelhead Fry Protection).

During months when minimum flows are reduced due to Flow Insufficiency, the Flow Insufficiency conditions will be reassessed weekly for Criteria 1 and 2 and reassessed daily for Criterion 3. When reassessment confirms that Flow Insufficiency criteria are no longer met, City Light will resume the monthly minimum flows.

3.2.1.3 Inflow Flow Forecasting

City Light utilizes several flow forecasting techniques to develop projected inflows and these forecasting methods are expected to evolve over time. Accordingly, City Light will make the assumptions and methods of each particular forecast available to SRCC at the time the flow forecast is made. City Light will also regularly evaluate natural inflow and natural sidestream “Forecast Skill” used as input to forecast models for planning regulated discharge flow from the Project’s powerhouses. Forecast Skill is defined as the relative improvement (i.e., reduction) in forecast error, as compared to a simple, but reasonable, baseline forecast. An example of a baseline inflow (or natural sidestream) forecast for monthly flow models would be to use recent historical monthly averages as the expectation of future monthly average flows. When creating forecasts of regulated discharge flow, City Light will give the highest weighting to forecasts that demonstrate the highest statistical Forecast Skill. When forecasting for shorter horizons, such as creating an hourly forecast for the next 24 hours, the standard baseline forecast would use the previous completed hour projected into the future for the duration of the forecast period. See Appendix N (Forecast Verification) for further description and examples of calculating Forecast Skill.

3.2.2 Limitations to Flow Management Capabilities

There are some circumstances (described below) where this management plan will be limited due to City Light’s inability to react to or control the flows or operating factors that affect fish.

3.2.2.1 Emergency Conditions

Nothing in this FMP will constrain City Light from taking appropriate action to respond to an emergency condition which includes but is not limited to a cause or event of Force Majeure. An emergency condition may include mechanical or electrical failure or deficiencies of power necessary to serve Firm Load where there are no other viable options available, including power purchases from other sources. As soon as possible after the end of an emergency condition, City Light will return to an operation schedule in line with this FMP. City Light may be liable and responsible for certain emergency conditions that do not constitute Force Majeure.

3.2.2.2 Force Majeure

City Light shall not be liable or responsible for failure to perform or for delay in performance due to any cause or event or circumstance of Force Majeure. For purposes of this FMP, Force Majeure is any cause or event beyond City Light's reasonable control. This may include but is not limited to fire, flood, mechanical failure, or accidents that could not reasonably have been avoided by City Light, strike or other labor disruption, act of God, act of any governmental authority or of the Parties, embargo, fuel or energy unavailability (ancillary to, but not including, basic power generation), wrecks or unavoidable delays in transportation, and inability to obtain necessary labor, materials, or manufacturing facilities from generally recognized sources in the applicable industry, or communications systems breakdowns, or for any other reason beyond City Light's control. City

Light shall make all reasonable efforts to resume an operation schedule in line with this FMP promptly once the Force Majeure is eliminated.

3.2.2.3 Uncontrolled Flow Measures

The limitations on storage capacity in Gorge and Diablo lakes mean that Ross Dam is the only effective point of control for downstream flows, when considering bulk flows over time periods greater than a day. Nevertheless, there are conditions under which control of downstream flows is not possible even at Ross Dam. City Light will provide for flows protecting fish only so far as it can control the downstream flows. Therefore, the portion of the total daily flow which occurs under the conditions of flood risk management or spill avoidance, load curtailment avoidance, and high Sidestream Inflow shall be considered uncontrolled flow and will be excluded from the calculation of Season Spawning Flow.

Flood Risk Management Measures or Spill Avoidance

City Light will not be responsible for flow which is released due to actions of the U.S. Army Corps of Engineers or due to reasonable actions taken to avoid exceeding the Flood Risk Management Rule Curve or full pool. In its annual compliance report, City Light will provide information upon which a decision to exercise this clause was made. A sample calculation is shown in Appendix A (Calculation of Daily and Seasonal Spawning Flows for Salmon and Steelhead).

Load Curtailment Avoidance

City Light will not be responsible for flow which is released when there are no other viable options available other than Firm Load Curtailment, including purchase of power from other sources. This section is not intended to permit flow releases to meet the generation requirements resulting from an increase in Firm Load growth after the execution of this FMP. For the purpose of this FMP, Firm Load shall mean the minimum amount of power which City Light is obligated to provide from a combination of generation and contract resources for the use of its customers. A sample calculation is shown in Appendix A (Calculation of Daily and Seasonal Spawning Flows for Salmon and Steelhead).

High Sidestream Inflow

City Light will not be responsible for that portion of flow which is released due to Sidestream Inflow greater than 3,500 cfs during the Chinook Salmon Spawning Period, 2,500 cfs during the Pink Salmon Spawning Period, 3,000 cfs during the Chum Salmon Spawning Period, or due to Sidestream Inflow which is greater than the current Spawning Control Flow for the Steelhead Spawning Period minus 500 cfs. The Sidestream Inflow values shall be considered Threshold Sidestream Inflows for the purpose of calculating Daily Spawning Flows. Sample calculations are shown in Appendix A (Calculation of Daily and Seasonal Spawning Flows for Salmon and Steelhead).

3.2.3 Operating Considerations

3.2.3.1 Scheduling Procedures

General Principles

Schedules of hourly generation during each calendar day are prepared in advance on the preceding Power Scheduling Day. Actual generation may deviate from the scheduled generation due to power system and streamflow conditions that were not anticipated when schedules were prepared on the Power Scheduling Day. Whenever an instrument reading affecting fish flow compliance appears to be erroneous, the power scheduler shall use the last reliable instrument reading available for the purpose of preparing the next generation schedule or an extrapolation based on relationships previously established using available historical data; the method chosen is left to the power scheduler's best judgment and available resources. Malfunctions of instruments affecting fish flow compliance for a period longer than 24 hours will be promptly reported to the SRCC to make a determination of appropriate action.

When changes in operating constraints occur from one day to the next (such as from the end of one month to the beginning of another), the changes must not occur prior to 0001 hours on the day such changes are supposed to be in effect.

Scheduling Generation

When scheduling power generation for the succeeding calendar day, power schedulers shall use best available forecasts, or assume that Tributary Inflow is the same as on the Inflow Day; the method chosen is left to the power scheduler's best judgment and available resources. Further, they shall calculate the Predicted Marblemount Flow as the planned discharge flow from Gorge Powerhouse plus expected natural sidestream flow between Gorge Powerhouse and the Marblemount gage. The expected natural sidestream flow between Gorge Powerhouse and the Marblemount gage shall be determined by a forecast of natural sidestream flow that has been shown to demonstrate Forecast Skill at the applicable forecast horizon where the baseline forecast is calculated as total flow at the Newhalem gage plus the Tributary Inflow that occurred on the Inflow Day. If no such skillful forecast is available, the baseline forecast shall be used to plan Gorge Powerhouse releases accordingly; see Appendix N (Forecast Verification) for further description and examples of calculating Forecast Skill.

3.2.3.2 Operating to Meet the Schedule

Normal Conditions

Ramp rates, which are expressed in cfs/hour,[5] shall be treated as instantaneous constraints and ramping shall be accomplished in as uniform a rate as practical over the hour.

[5] City Light anticipates that ramping rates will be expressed in terms of inches per hour (inches/hour) in consultation with the Washington Department of Ecology as part of the Project's Section 401 Water Quality Certification process (required as part of the FERC relicensing effort).

Table 3.2-1. Combined flow protection periods by species and life stage.

Flow Protection Period[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Chinook Salmon											
Spawning												
Incubation												
Fry												
STJ												
Flow Protection Period	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Pink Salmon											
Spawning												
Incubation												
Fry												
Flow Protection Period	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Chum Salmon											
Spawning												
Incubation												
Fry												
Flow Protection Period[2]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Steelhead											
Spawning – March Steelhead												
Spawning – April Steelhead												
Spawning – May/June Steelhead												
Incubation[2] – March Steelhead												
Incubation[2] – April Steelhead												
Incubation[2] – May/June Steelhead												
Fry												
STJ												

1 The incubation flow protection period has four components distinguished above by color: the Spawning Period (red), the Incubation Period (Black/Grey), and the Fry Protection Period (Blue), and the STJ Protection Period (Green).

2 For the purposes of spawning and incubation flows, Steelhead are separated into three subperiods based on the month in which they spawn.

Table 3.2-2. Summary of annual flow management actions for the Project by date from January 1 to December 31.

Date	Flow Management Action
January 1	Start Salmon Fry Protection
January 6	End Chum Spawning
	End Chum Incubation 2
January 7	Start Chum Incubation 3
March 15	Start Steelhead-March Spawning
	Start Steelhead-March Incubation 1
March 25	End Steelhead-March Incubation 1
March 26	Start Steelhead-March Incubation 2
March 31	End Steelhead-March Spawning
	End Steelhead-March Incubation 2
April 1	Start Steelhead-April Spawning
	Start Steelhead-April Incubation 1
	Start Steelhead-March Incubation 3
April 11	End Steelhead-April Incubation 1
April 12	Start Steelhead-April Incubation 2
April 30	End Chinook Incubation 3
	End Pink Incubation 3
	End Steelhead-April Spawning
	End Steelhead-April Incubation 2
May 1	Start Steelhead-April Incubation 3
	Start Steelhead-May/June Spawning
	Start Steelhead-May/June Incubation 1
	End Steelhead-May/June Incubation 2
May 2	Start Steelhead-May/June Incubation 3
May 11	End Steelhead-May/June Incubation 1
May 12	Start Steelhead-May/June Incubation 2
May 31	End Chum Incubation 3
	End Salmon Fry Protection
June 1	Start Steelhead Fry Protection
June 15	End Steelhead-May/June Spawning
June 30	End Steelhead-March Incubation 3
July 31	End Steelhead-April Incubation 3
	End Steelhead-May/June Incubation 3

Date	Flow Management Action
August 20	Start Chinook Spawning
	Start Chinook Incubation 1
August 30	End Chinook Incubation 1
August 31	Start Chinook Incubation 2
September 12	Start Pink Spawning
	Start Pink Incubation 1
September 22	End Pink Incubation 1
September 23	Start Pink Incubation 2
October 15	End Chinook Spawning
	End Chinook Incubation 2
	End Steelhead Fry Protection
October 16	Start Chinook Incubation 3
October 16	Start Chinook/Steelhead STJ Protection
October 31	End Pink Spawning
	End Pink Incubation 2
November 1	Start Chum Spawning
	Start Chum Incubation 1
	Start Pink Incubation 3
November 11	End Chum Incubation 1
November 12	Start Chum Incubation 2
December 31	End Chinook/Steelhead STJ Protection

3.3 Process Flow Releases

Process flows are flows necessary to promote connectivity to side- and off-channel fish habitat and improve gravel quality for spawning and incubation by providing flushing flows and to promote geomorphic processes and mobilize sediment (channel maintenance flows).

3.3.1 Flushing and Connectivity Flows

No less than two times per year (if not already provided by Project operation requirements or flood risk management protocols), City Light will release water from the Project to ensure flows of not less than 5,734 cfs and not more than 7,440 cfs as measured at the Newhalem gage for a period of 48 hours. The purpose of the release will be to promote connectivity to side- and off-channel fish habitat and improve gravel quality for spawning and incubation by providing flushing flows. Releases, which would be subject to the conditions identified below, would likely occur around the following approximate dates: April 1, April 15, and May 1. The timing of these flow releases will be coordinated with the SRCC and will be adaptively managed to promote connectivity and improve gravel quality.

3.3.2 Channel Maintenance Flows

No less than once every five (5) years and no more than once every two (2) years, City Light will release water from the Project to achieve a target flow of 26,400 cfs as measured at the Newhalem gage for a period of 24 hours to promote geomorphic processes and mobilize sediment (provide channel maintenance flows). These flow releases are subject to the conditions below and will be released in coordination with the SRCC. Initial releases of the channel maintenance flows will evaluate safety (both dam safety and downstream flood risk management) and may result in modifications to the release (timing, duration, and magnitude) of channel maintenance flows in order to adhere to the conditions described below.

3.3.3 Conditions for Process Flow Releases

City Light will coordinate with the SRCC to release process flows under the following conditions:

- City Light's process flows releases are subject to having adequate runoff to refill Ross Lake in order to maintain its ability to provide for anadromous fisheries protection flows, recreation, and firm power generation needs. City Light will rely upon forecasts to determine whether the projected refill will maintain or exceed Ross Lake target elevations identified in the Annual Flow Plan Forecast after process flow releases. Modification to the timing, duration, and magnitude of the process flow releases can be adaptively managed subject to the approval of the SRCC.
- City Light's process flow releases will be planned to avoid flooding (to the extent possible) of the Skagit River, which is currently defined[6] for purposes of this protection, mitigation and enhancement (PME) measure as exceeding the National Weather Service threshold of 28 feet (approximately 62,500 cfs) at the U.S. Geological Survey (USGS) Skagit River flow gaging station near Concrete, Washington.
- City Light's process flow releases are subject to complying with dam safety requirements and other regulatory conditions (e.g., Section 401 Water Quality Certificate conditions).
- City Light's process flow releases will not be subject to the FMP down-ramp amplitude requirements. City Light will rely upon a 1,000 cfs/hour downramping rate (unless modified as a result of field monitoring and in coordination with the SRCC) for process flow releases.
- The magnitude, duration, timing, and frequency of the process flow components may be achieved through any combination of controlled and uncontrolled flow releases (i.e., Gorge Powerhouse discharge, Gorge Dam spill, and accretion flow).

3.4 Annual Flow Plan Forecast

This section will further describe the development and implementation of an Annual Flow Plan Forecast. The Annual Flow Plan Forecast will be developed no later than March 15 each year, prior to initiation of the spring refill, and will consider instream flows necessary for steelhead spawning and incubation, identify existing and projected hydrological conditions, and projections

[6] Release of process flows may identify flooding considerations beyond the criteria listed in Section 3.3.3. If such instances are identified, this provision may be modified accordingly.

for timing associated with refilling Ross Lake to inform management of the Summer Variable Reservoir Operations Zone.

City Light will provide the SRCC the forecast and coordinate on the release (timing, magnitude, and duration) of process flows and management of Ross Lake elevations within the Summer Operational Zone in consideration of the flows necessary to meet compliance obligations related to downstream flows and Ross Lake water surface elevations.

4.0 AQUATIC HABITAT PROGRAM (NON-FLOW PROGRAM)

As described above, the Non-Flow Program is intended to guide management on mainstem, riparian, floodplain, side channel, and off-channel habitat enhancement measures downstream of Gorge Powerhouse and at stream crossing along the transmission line ROW, with the primary purpose of improving the availability of these habitats and enhancing the ecosystem processes that create and sustain them. The Non-Flow Program builds off the existing Anadromous and Resident Fish Non-Flow Plan (City Light 2011) by expanding upon the Habitat Development and Improvement Program while also introducing new measures to benefit aquatic habitat. Where proposed project sites are located on mitigation lands, these efforts will be coordinated and aligned with objectives in the Fish and Wildlife Mitigation Lands Management Plan (City Light 2023a) and in consultation with the SRCC, as these sites also provide critical habitat for wildlife.

4.1 Mainstem Habitat Measures

This section describes proposed restoration of subreaches with high restoration potential identified based on their geomorphic characteristics, potential for functional uplift, and a preliminary assessment of feasibility. These projects will be designed and sequenced with process flows to achieve desired habitat improvements. Process flows harness the river to perform geomorphic work. Projects in the Non-Flow Program complement the flow program by guiding fluvial energy to achieve desired outcomes at specific locations on a reach scale, working within the constraints of a managed system to achieve desired outcomes, and encouraging reactivation of side channel features over shorter timeframes. Wood augmentation measures, focused on log jams/structures to promote island formation and floodplain connectivity, are incorporated into this section and each of the subreach restoration projects. The sites also include constructed blind side channels, some of which will be fully connected to the river and others that may be refreshed or expanded to support Chum spawning or other biological objectives. All constructed Chum channel will be evaluated for current function, maintenance needs, and additional enhancement opportunities in collaboration with the SRCC and the partner organizations that implement previous projects on site to determine appropriate next steps. Decisions regarding which channels to connect at an inlet shall be made in collaboration with and approval by the SRCC and as approved by FERC, as necessary.

Each of these subreaches has the potential for improving rearing habitat for juvenile salmonids, spawning habitat for Chum Salmon, connectivity with floodplain features, and dynamic interactions to refresh, enhance, and sustain off-channel habitat. Many of the existing constructed habitat features within these sites have declined in functionality, mostly due to discontinuity with river processes. Restoration actions at these sites may include placement of engineered log jams; enhancement of existing log jams to increase their function and longevity; wood post arrays; tipping and winching of riparian trees to use as key pieces; wood enhancement within side channels; excavation of side channel inlets or outlets of natural side channel and constructed blind channels; excavation of constructed blind channels to remove accumulated fines; removal of encroaching vegetation at side channel inlets; removal of berms; placement of gravel; and riparian restoration. Locations, size, type, and number of features (such as engineered log jams and breaches shown in figures) are conceptual and will be refined to best meet project objectives in consultation with the SRCC during implementation planning and design. If unforeseen site constraints are identified during implementation and design, or unforeseen opportunities are noted, City Light may recommend adjustments to projects (including location and scope) to best meet the objectives of the mainstem habitat measures, in collaboration with the SRCC and, if necessary, as approved by FERC. For example, if access is denied for construction or cultural sites identified, then the SRCC could approve completion of another project of comparable scale and benefits in lieu of implementing the projects identified below to be implemented in the first ten (10) years.

In addition to these projects to be implemented in the first ten (10) years of the license, City Light proposes the establishment of two Estuary and Watershed Aquatic Habitat Enhancement Accounts to provide for additional aquatic habitat enhancement projects. The implementation of these additional enhancement projects would begin in year 15 of the new license. The overarching goal of these aquatic habitat enhancement projects will be to restore ecosystem processes and habitat for native fish and other aquatic biota.

4.1.1 Park Slough Subreach

The Park Slough subreach of reach 2B is located downstream of Goodell Creek between Project River Mile (PRM) 91.5 and 92.4. Reach 2B is a response reach with the potential to support an anastomosing channel planform. The current channel pattern has split flow around a small island between PRM 92.0 and 92.2 and is otherwise single-threaded. The channel is inset within alluvial terraces that are rarely connected with overbank flows under the current flow regime. Mainstem habitat is primarily comprised of glide, riffle, and run habitat with few pool features. There are no stable logjams in the subreach. Wood recruitment from bank erosion is limited by low rates of channel migration and wood loading is primarily from tributary channel sources.

Park Slough is located in North Cascades National Park and the adjacent property along the opposite bank is owned by City Light. Park Slough is a blind side channel along the left bank terrace that was constructed in the 1990s to support Chum spawning. The slough channel has a Y-shaped pattern with two groundwater-fed channels, each 20- to 30-feet in width, that merge and follow the flow path of a relict channel feature that joins with the Skagit River across from Newhalem Agg Ponds. The total channel length is approximately 2,900 feet with an area of approximately 71,000 square feet.

The outlet to Park Slough is connected but filled with sand deposited from river backwatering. Upstream of the outlet the channel is a series of constructed pools and riffles with placed spawning gravel and several beaver dams. The channel has been silting in over time, particularly above the beaver dams, reducing its spawning habitat function. In its current condition, it still provides rearing habitat function due to slow velocities, cold groundwater inputs, and cover from large wood and overhanging vegetation, but as it fills in with sand, silt, and organics, rearing habitat suitability will likely continue to decline.

Habitat enhancement objectives for the Park Slough subreach include:[7]

- Increased rearing habitat area and length;
- Increased connectivity and access for fish;

[7] Quantifiable and measurable habitat enhancement objectives will be developed during implementation planning.

- Increase functionality of Chum-spawning habitat;
- Increased flushing flows to remove fine sediment;
- Increased sustainability of off-channel rearing habitats; and
- Increased quantity of stable log jams that form pools, create velocity refuge, provide edge habitat and cover, capture wood, and split flow to support development of side channels.

The west branch of Park Slough follows the path of a relict side-channel and has an orientation suitable for a sustainable[8] upstream connection. The project concept involves excavation of an inlet channel to connect one or both of the branches of Park Slough with the main channel (Figure 4.1-1). Several engineered log structures could be installed near the inlet to split flow, raise local water surface elevations to sustain the connection, and form mainstem pools. Wood structures may include a bar apex jam at the head of forested island in the vicinity of the inlet connection, an additional jam or jams along the left bank at the channel inlet(s), and wood structures to create roughness and cover within the side channel. Log structures in this reach would potentially capture and retain additional mobile wood recruited from Goodell Creek, a significant source of large wood recruitment to the Skagit River. If either the east or west branch of Park Slough is left as a blind side channel (a determination to be made in consultation with the SRCC) it could be refreshed to remove fine sediment that has accumulated over the last 25 years. Trees removed during construction of the inlet channel would be used in wood structures and excavated alluvium placed on mainstem channel bars or stockpiled on site for input to the mainstem in association with a process flow release.

[8] Sustainable in the context of a dynamic fluvial system; channel evolution is a natural process.

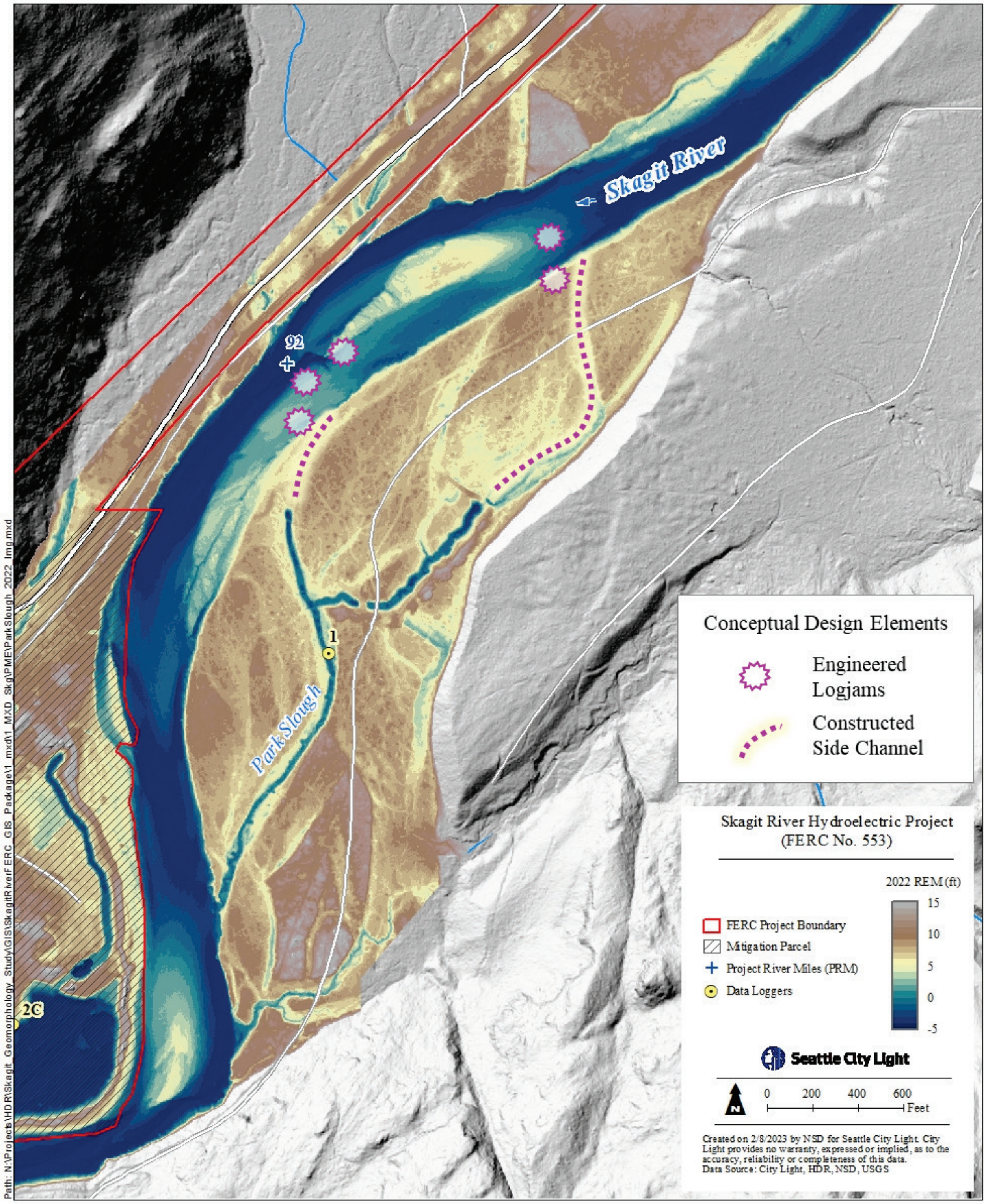

Figure 4.1-1. **Conceptual design opportunities in the Park Slough Subreach.**

4.1.2 Newhalem Ponds (Agg Ponds) Subreach

The Newhalem Agg Ponds subreach is located between PRM 90.6 and 91.8 within Reach 2B and is directly downstream of the Park Slough subreach. The channel is inset within alluvial terraces that are rarely connected with overbank flows under the current flow regime. There is an existing seasonally active side channel, approximately 40-feet wide and 600-feet long, that splits around a forested island just upstream of the Agg Ponds near PRM 91.7. A second island is developing within the channel at PRM 91.4 immediately adjacent to the eastern Agg Pond and just downstream of Park Slough. The main channel is characterized by a lack of large wood, and stable log jams and wood recruitment processes are limited by reductions in the rate of bank erosion and channel migration.

The Agg Ponds complex includes a series of constructed, groundwater-fed side channels and off-channel ponds that were excavated within the alluvial terrace and connect to the main channel just upstream of the confluence with Thornton Creek. The ponds were originally created to mine gravel as aggregate for construction of Project facilities and State Route (SR) 20 and have since been managed to provide off-channel spawning and rearing habitat for salmon. The ponds have aquatic vegetation around the shoreline and open deepwater in the center. The lower (outlet) channel connecting the larger pond to the Skagit River has patches of spawning gravel that appear to be functioning, but the upper channels above the ponds are filled with aquatic vegetation and a veneer of fine sediment and organics. The groundwater channels draining into the ponds maintain cool water temperatures year-round. Monitoring locations within the ponds; however, show periods of elevated water temperature between late-July and early-September with maximum water temperature near 20°C.

Habitat enhancement objectives for the Agg Ponds subreach include:

- Increased rearing habitat area and length;
- Increased connectivity and access for fish;
- Increase functionality of Chum-spawning habitat.
- Increased conveyance through ponds;
- Moderate summer water temperatures; and
- Increased quantity of stable logjams that form pools and split flow to support development of side channels.

Conceptual design opportunities for this subreach include placement of engineered log structures to stabilize forested islands and maintain split flow into existing side channels near PRM 91.4 and 91.7 (Figure 4.1-2). A portion of the narrow island upstream of the Agg Ponds at PRM 91.7 eroded during the November 2021 flood and the upper section of the side channel is now incorporated into a shallow riffle of the mainstem channel. Addition of a bar apex log jam near the upstream end of the island would form a stable hard point to maintain the flow split and enhance connectivity with the side channel, which is seasonally dry. Additional wood structures around the island and in the side channel would enhance cover and increase length and quality of edge habitat within the subreach.

The groundwater-fed channels currently draining into the Agg Ponds are separated from the main channel by a berm that limits floodplain connectivity. The proposed concept includes a breach in the berm and excavation of a channel connecting the side channel near PRM 91.7 with the Agg Ponds complex through an inlet. The project could integrate this connection with the previously described side channel enhancement at PRM 91.7 and direct flow from the existing side channel into the constructed channel draining to the eastern pond. Engineered log structures within the side channel would aid in deflecting flow toward the new connector channel and increase flow entering the Agg Ponds complex. There is an access road that follows a berm separating the two main pond areas and a culvert connects the ponds on either side. Replacing the culvert would enhance connectivity and reduce maintenance issues created by beaver activity, while maintaining access to the boat ramp. An additional opportunity exists within the Agg Ponds subreach to install engineered log structures upstream of the existing island near PRM 91.4 that would stabilize the island and promote development of mature forest vegetation to provide future sources of large wood. Other opportunities[9] include refreshing the blind channel closest to SR 20 and potentially restoring a portion of the City Light storage area if a suitable alternative location is identified.

An important design consideration to be evaluated during implementation planning would be impacts of proposed connections and the potential for a channel avulsion to the relatively deep ponds on sediment transport downstream. A phased approach that allows smaller-grained sediment to accumulate in the ponds before removing additional sections of the berm to increase floodplain connectivity may be warranted. Additional sections of the berm could be breached through tree tipping or mechanical removal once channel elevations equalize.

[9] This site provides habitat for the western toad. Any alterations to this channel will be considered in consultation with the SRCC.

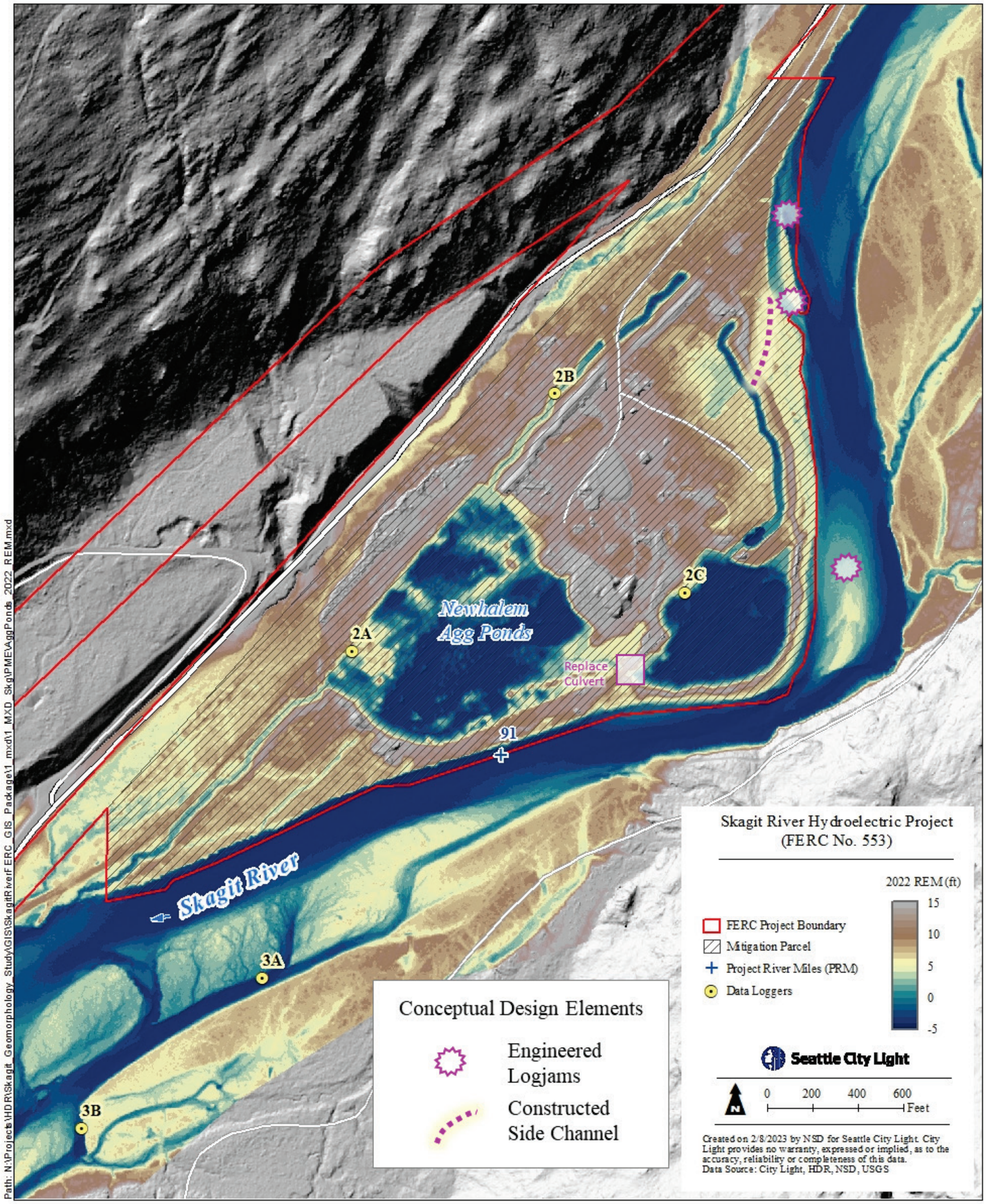

Figure 4.1-2. Conceptual design opportunities in the Agg Ponds Subreach.

4.1.3 County Line Ponds Subreach

The County Line Ponds subreach is located between PRM 89.2 and 89.9 at the bottom end of Reach 2B. The County Line Ponds complex is a mitigation parcel owned by City Light and the surrounding area is part of North Cascades National Park. The ponds were originally created to mine gravel aggregate for construction of the dams and other facilities and have since been managed to provide off-channel spawning and rearing habitat for salmon as well as other wildlife habitat functions The boundary between Whatcom County and Skagit County crosses the Skagit River just upstream of the ponds. The channel is inset within alluvial terraces that are rarely connected with overbank flows under the current flow regime. The main channel is characterized by a lack of large wood, and stable log jams and wood recruitment processes are limited by reductions in the rate of bank erosion and channel migration.

Within the County Line Ponds complex there are three side channels and two ponds that are perennially connected to the river and a series of ponds that are less connected. The pond complex closer to SR 20 drains through a constructed outlet channel at the south end that joins with the main channel near PRM 89.2. Beaver dams impound the upper section of the outlet channel and influence water levels in the pond. The lower segments of the outlet channel go dry during the summer. The easternmost pond closest to the river is connected with the main channel via a small breach through the berm that separates the pond from the river. The main channel splits to form secondary channels around a series of small, vegetated islands adjacent to the County Line Ponds. The largest of the side channels flows parallel to the berm along the eastern-most pond.

Habitat enhancement objectives for the County Line Ponds subreach include:

- Use large wood structures to maintain and enhance the anabranching channel form, channel complexity, and cover;
- Increase complex edge habitat;
- Increase connectivity of flow between channel and ponds through levee breaches;
- Increase rearing habitat area and length; and
- Increase functionality for Chum spawning.

Conceptual design opportunities for the County Line Ponds subreach include project actions to install stable wood jams and increase connectivity with off-channel habitat in the ponds complex (Figure 4.1-3). An array of engineered logjams would support stabilization of vegetated bars to promote development of mature riparian vegetation and future sources of wood recruitment. Addition of stable logjams in the subreach will deflect additional flow toward the existing side channel that flows along the berm adjacent to the eastern-most pond. The berm will be breached in targeted locations to further enhance connectivity and access for fish.

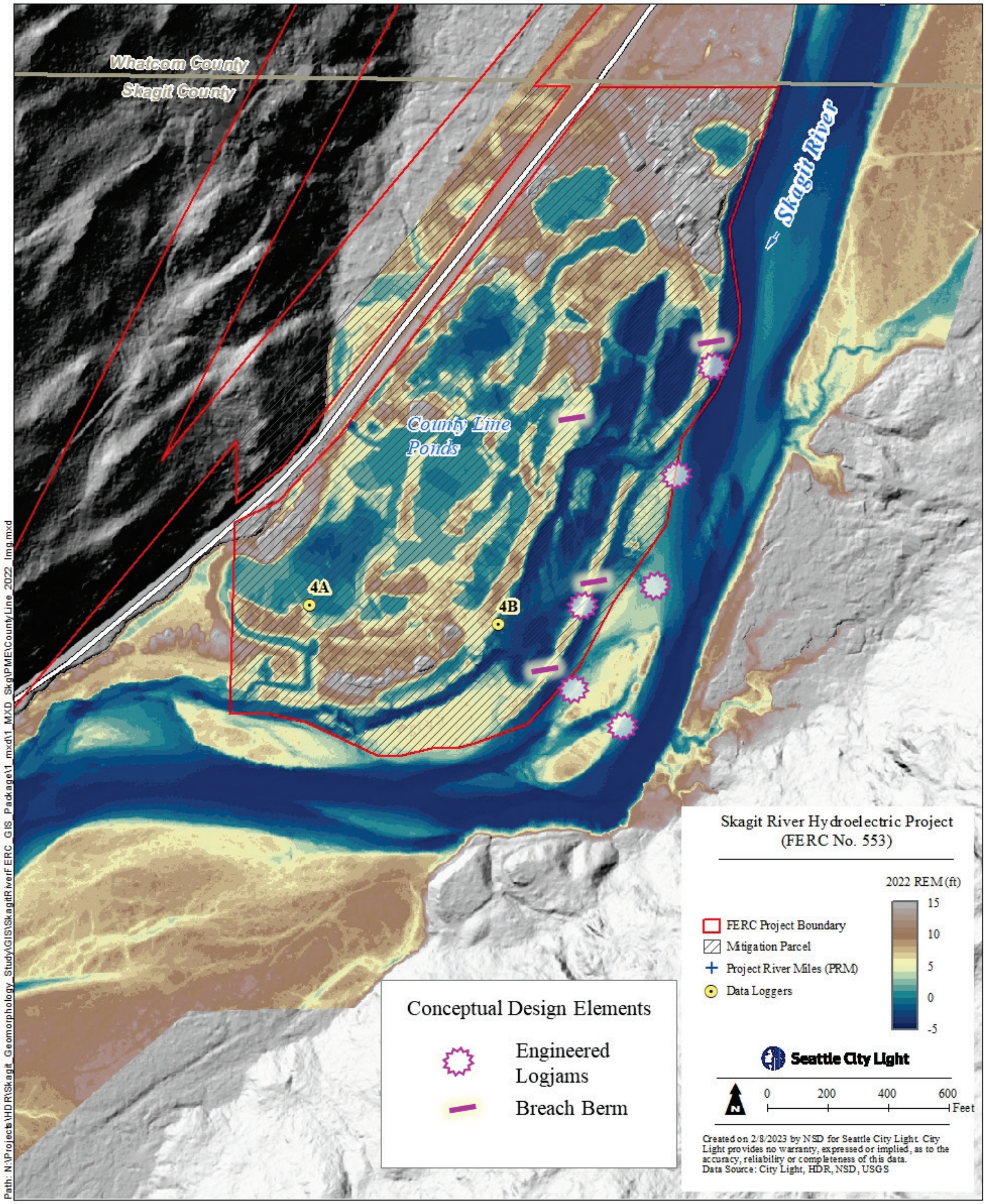

Figure 4.1-3. Conceptual design opportunities in the County Line Ponds Subreach.

4.1.4 Taylor Side Channel Subreach

The Taylor Side Channel Subreach is located between PRM 79.7 and 80.5 within Reach 5A upstream of the Cascade River near Marblemount. The Skagit River has a single-thread pattern and is inset within alluvial terraces that are rarely connected with overbank flows under the current flow regime through this reach. The Taylor Side Channel is a blind spawning channel constructed in the 1990s. The channel is connected most of the year and groundwater fed as evidenced by a subsurface inlet and is a cold water refugia in the summer. The lower section of Taylor channel has several log jams and two beaver dams creating relatively deep pools (at least 2 feet deep). The upper section was consistently 1.5 to 3 feet deep during August. The protected slow water and fish cover provide juvenile salmonid rearing habitat. Spawning habitat with suitable gravel substrate is still functional in some locations of the side channel while other areas are covered in a veneer of fine sediment.

Habitat enhancement objectives for the Taylor Side Channel Subreach include:

- Increase flushing flows to remove fine sediment;
- Increase sustainability of off-channel rearing habitats;
- Increase functionality of channels for Chum spawning;
- Increase connectivity and access for fish;
- Increase rearing habitat area and length; and
- Increase structure and cover through additional wood placement.

Conceptual design opportunities for the Taylor Side Channel Subreach include project actions to install stable wood jams and excavate connecting channels to deflect additional flow from the main channel into upper segments of Taylor Side Channel (Figure 4.1-4). Decisions regarding whether to create one or more upstream connections or alternatively refresh one or more of the channels will be made in consultation with the SRCC. Engineered large wood structures along the left bank would provide additional geomorphic function to form pools and split flows to promote connectivity with the side channel.

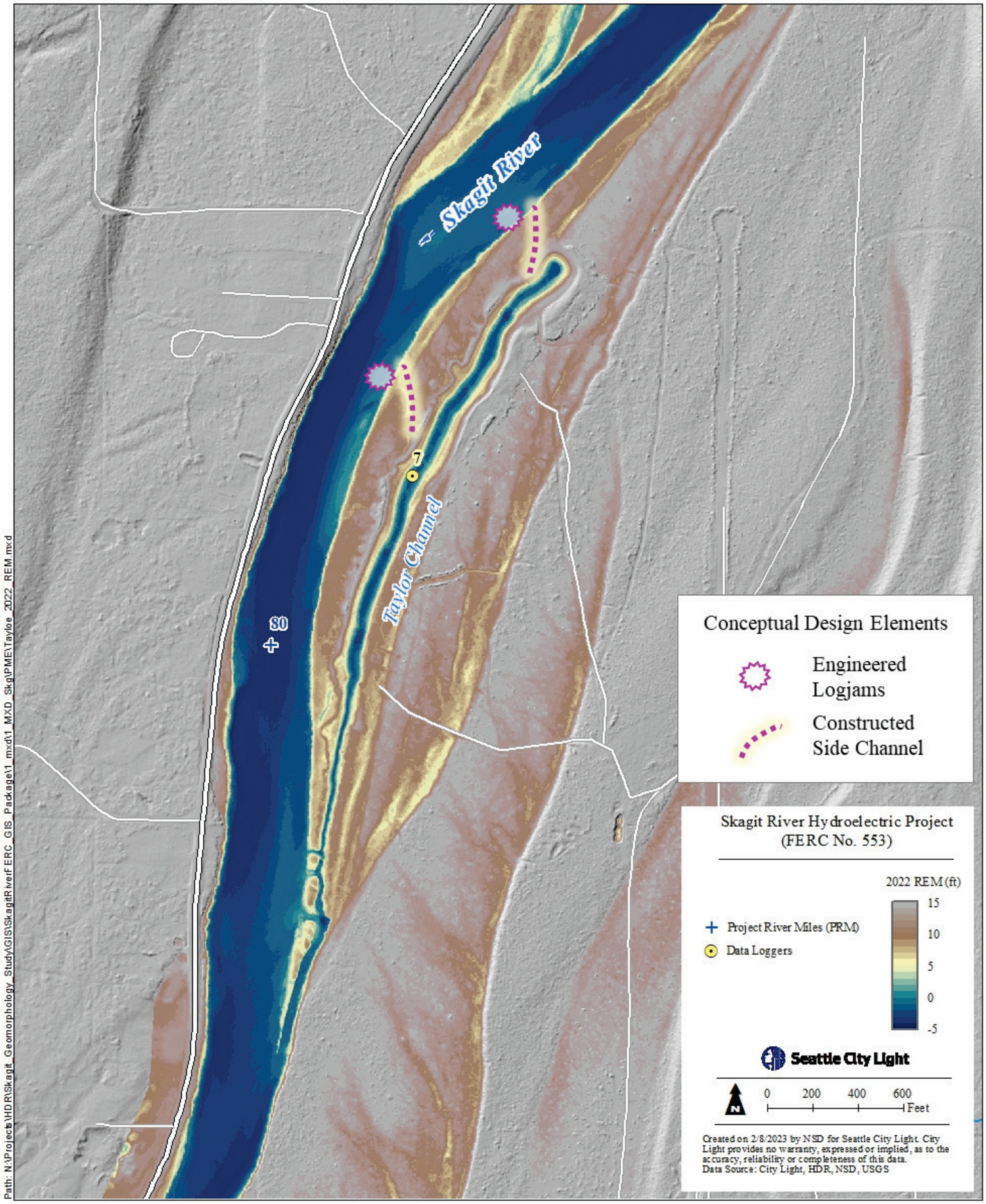

Figure 4.1-4. Conceptual design opportunities in the Taylor Side Channel Subreach.

4.1.5 Illabot and Powerline Sites

Illabot and Powerline constructed blind channels were developed to provide stable spawning habitat for Chum Salmon. They also provide off-channel rearing and refuge for other salmonid species. These sites have accumulated fine sediment and organic matter and their function and fish use has declined. Constraints at these sites limit opportunities for inlet connections as proposed in the subreaches above. The proposed treatment at these sites is to restore them to as-built conditions, modified as necessary to best meet objectives in consultation with the SRCC.

4.1.6 Estuary and Watershed Aquatic Habitat Enhancement Accounts

As part of the Skagit River REP Non-Flow Program, City Light proposes the establishment of two Aquatic Habitat Enhancement Accounts to provide for additional aquatic habitat enhancement projects. The implementation of these additional enhancement projects would begin in year 15 of the new license.

- Estuary Enhancement Account: City Light will deposit $15 million in this account. City Light will use funds from this account exclusively for enhancement projects in the Skagit River estuary.
- Watershed Enhancement Account: City Light will deposit $5 million in this account. City Light will use funds from this account for enhancement projects located throughout the Skagit River watershed and its tributaries (including the Sauk River).

The overarching goal of these aquatic habitat enhancement projects will be to restore ecosystem processes and habitat for native fish and other aquatic biota. The objectives are as follows:

- Identify additional opportunities and constraints to achieving the stated goal within the Project area, both large and small.
- Engage with Tribes, local landowners, and jurisdictions to identify priorities and support existing comprehensive efforts to achieve aquatic habitat restoration.
- Build partnerships and community support to implement additional reach-scale projects.
- Complete conceptual designs, cost estimates, and achievable schedules for restoration projects.
- Develop a prioritized list of actions.

City Light will use the funds from each of the Aquatic Habitat Enhancement Accounts for implementation of habitat enhancement projects. Funding will be guided by the SRCC and may include restoration projects, maintenance projects, and land acquisitions.

4.2 Aquatic Habitat in Transmission Line Right-Of-Way

The transmission line ROW and associated Project Routes[10] extends from Newhalem to Bothell via the Skagit, Sauk, and North Fork Stillaguamish River valleys. The proposed scope of measures include fish passage barriers at stream crossings on Project Routes, interactions between channel migration and Project facilities, and aquatic habitat at transmission line stream crossings. It does not include non-Project Routes and associated infrastructure impacts, which are the responsibility of the landowner. Road maintenance and vegetation management in the transmission line ROW are included in the Roads, Trails, and Transmission Line Right-of-Way Erosion Management Plan (City Light 2023b) and the Vegetation Management Plan (City Light 2023c), respectively. Where elements of these programs overlap, they are referenced and will be coordinated with the SRCC. The following measures will also be coordinated with the Fish and Wildlife Mitigation Land Management Plan (City Light 2023a) at Illabot Creek and any other sites that may include mitigation lands.

4.2.1 Passage Barriers on Project Route Stream Crossings

Fish passage barriers at stream crossing structures along Project Routes will be identified and prioritized for improvement. Identification and an initial prioritization of fish passage barriers at stream crossing structures has been completed and summarized in the GE-02 Erosion and Geologic Hazards at Project Facilities and Transmission Line Right-Of-Way Study (GE-02 Erosion and Geologic Hazards Study; City Light 2023d). A more detailed prioritization, which includes field verification, is described below.

4.2.1.1 Prioritization and Planning

Initial Prioritization

All culverts, bridges and fords on Project Routes were evaluated for physical condition in accordance with the Washington Department of Fish and Wildlife (WDFW) Fish Passage Inventory, Assessment and Prioritization Manual (WDFW 2019) as described in the GE-02 Erosion and Geologic Hazards Study (City Light 2023d). The assessment identifies 19 structures that are less than 100 percent passable on Project Routes:

- 12 culverts (0 percent passable);
- 2 culverts and 1 bridge (33 percent passable);
- 3 culverts (67 percent passable); and
- 1 unknown.

Of these structures, five culverts and one bridge block or restrict access to "significant" habitat defined as greater than 200 meters of stream meeting fish bearing criteria (Table 4.2-1)—this definition is consistent with Washington State's culvert prioritization. Upstream potential fish

[10] As part of the FLA, City Light conducted an extensive roads and trails ("routes") inventory to review and document all routes used to access the Project, including those through the transmission line ROW. As part of this effort, City Light distinguished between routes considered "Project Routes" (maintained by City Light and exclusively used by City Light for Project purposes), and "Non-Project Routes" (may or may not be maintained by City Light and not exclusively used by City Light [i.e., shared use]). The detailed information gathered as part of the inventory is presented in the FLA as part of Exhibit E Section 4.2.6.

habitat was estimated by compiling potential stream lengths, areas, and gradients using available data and remote sensing techniques. A field assessment of potential upstream fish habitat will be completed, as described below, to confirm and prioritize stream crossing structure replacement or removal in consultation with the SRCC.

Table 4.2-1. Project route stream crossings identified as full or partial barriers with greater than 200 meters of fish habitat upstream as determined in the Phase 1 assessment.

Site ID	Structure ID	Type of Structure	Percent Passable	Fish Species[1]	HUC Basin Name
FC1060	C1045	Culvert	67	Unknown	Jim Creek
FC1062	C1050	Culvert	0	CO,CK,CH,PK,SH,CT	Jim Creek
FC1091	C1076	Culvert	0	Unknown	French Creek
FC1101	C1087	Culvert	0	CO,CK,CH,PK,CT,SH	Prairie Creek
FC1106	C1092	Culvert	0	Unknown	Sauk River
FB1100	B1005	Bridge	33	PK,CK,SH,CH,CT,CO	Prairie Creek

1 Chinook (CK); Chum (CH); Coho (CO); Pink (PK); steelhead (SH); Cutthroat (CT).

Field Verification of Upstream Aquatic Habitat

A field verification of potential aquatic habitat upstream from the stream crossing structures identified during relicensing studies (GE-02 Erosion and Geologic Hazards Study) will include the application of the Reduced Sample Full Survey (Fish Passage Inventory, Assessment, and Prioritization Manual; WDFW 2019) or equivalent field verification methods agreed to in consultation with the SRCC. The field verification will be applied to sites identified in Section 4.2.1.1 above, where it has not already been completed during implementation planning. Site survey on private property is subject to landowner approval. In the absence of landowner approval, City Light will field survey accessible areas only. Results will be used to sequence within priority groups and make adjustment as needed in consultation with SRCC. Sites with less than 200 meters of habitat as identified through the desktop exercise will also be field verified as to the length of blocked habitat; if potentially accessible suitable habitat exceeds 200 meters, they will be included in the Reduced Sample Full Survey field assessment. Field verification work will commence within two (2) years of license issuance.

4.2.1.2 Implementation of Passage Improvement Actions

Upon completion of the planning and prioritization process by the end of License Year 2, City Light will implement the identified passage improvement projects over three periods and associated priority groups:

- **Group A:** Culverts and other structures that block over 200 meters of anadromous fish habitat will be replaced or removed by License Year 5.
- **Group B:** Culverts and other structures that block over 200 meters of resident fish habitat will be replaced or removed by License Year 12.
- **Group C:** Culverts and other structures on non-fish bearing streams and fish bearing streams with less than 200 meters of habitat upstream will be replaced at end of usable life or as part of road maintenance or road segment upgrades (prior to end of usable life) throughout the term

of the license. A subset of these may not make sense to replace with a much larger culvert if it will require a substantial amount of additional road fill to meet required clearance above a larger replacement culvert. In such cases where project impacts may exceed benefits, the determination of whether or not to proceed with a marginal project will be determined in consultation with the SRCC.

Improvement projects will be consistent with the WDFW Water Crossing Design Guidelines (Barnard et al. 2013) and any future updates of this document. Improvement projects on properties not owned by City Light are subject to landowner approval and easement agreements.

4.2.2 Channel Migration Areas near Project Infrastructure

Channel migration zones (CMZ) have been delineated for 22 stream reaches in the Project Boundary as part of the GE-02 Erosion and Geologic Hazards Study (City Light 2023d). Ten of these areas have transmission line towers or Project features within the mapped CMZ. This section of the management plan describes how City Light will protect Project features, Project Routes, aquatic and riparian habitats, and river processes at locations within CMZs through proactive planning, monitoring, and implementation of site-specific measures.

4.2.2.1 Prioritization and Planning

City Light will continue to identify and monitor existing and potential channel migration and fluvial hazards including bank erosion, bank instability, avulsion, aggradation, incision, headcutting, scour, and deposition with existing or potential future interaction with Project facilities. Ten streams were identified in the GE-02 Erosion and Geologic Hazards Study with existing or potential for future (50-year) channel migration interaction with Project facilities (Ladder Creek, Goodell Creek, Damnation Creek, Bacon Creek, Diobsud Creek, Skagit Crossing near Corkindale, Illabot Creek, Sauk River, Squire Creek, and Montague Creek) and other streams may be identified in the future with potential for channel migration or fluvial hazard interaction with Project facilities (see Table 4.2-2). Identification and monitoring of these hazards will occur by operations staff as part of routine operations and maintenance (O&M) activities, and during periodic inspections or assessments of Project facilities. Targeted monitoring using light detection and ranging (LiDAR) and aerial photos will be implemented at the nine streams identified for existing or future potential channel migration hazards and at other streams identified in the future with channel migration or other fluvial hazards annually and following major flood events.

Because these channel migration and fluvial hazards typically develop rapidly during high-flow events, immediate emergency intervention mitigation measures may be required to protect or restore integrity to Project facilities or to address public/personnel safety. In these situations, emergency intervention measures will be maintained until the long-term mitigation can be determined and implemented (which may include removal, replacement, modification, or retention of the emergency mitigation measures as appropriate). In consultation with regulatory/local governing agencies and Indian Tribes with established treaty rights, the adverse impacts on natural and cultural resources resulting from the emergency intervention will be evaluated and the appropriate mitigation of the resource impacts will be implemented with the long-term hazard mitigation measures.

Site Specific Measures

City Light will develop an implementation plan by License Year 5 for Project features within mapped CMZs to reduce risk to infrastructure and need for emergency actions. All actions will be designed to result in a net increase in habitat quantity and quality. In addition to monitoring at these sites, potential treatments to be determined on a site-specific basis to meet objectives may include engineered log jams and log cribs to deflect and split flow, wood pile arrays, bioengineered bank treatments, integration of wood and plants into rockery, and where feasible and necessary, relocating transmission towers.

Table 4.2-2. Identified streams crossings in the Project Boundary with the potential for channel migration interactions with Project facilities and proposed monitoring and site-specific measures.

Stream	Channel Migration Issue	Relative Risk	Proposed Action[1,2]
Ladder Creek	Bank erosion at one location along the right bank was observed to be threatening the integrity of the wooden fence near the historic pools that are part of the Ladder Creek trail and historic area.	Medium	Monitor annually and after major flood events. Site evaluation and proactive plan.
Goodell Creek	Alluvial fan. Towers located in swale with potential for avulsion, particularly if berm protecting campground and National Park Service (NPS) road fails. Both of these towers have raised concrete bases, suggesting they were designed with future flooding or channel change in mind.	Medium	Monitor annually and after major flood events. Site evaluation and proactive plan. Add additional bank protection around base of towers (two) in swale. Construct two engineered log structures in Goodell Creek to reduce risk of an avulsion and improve pool area and cover.
Damnation Creek	Alluvial fan. Tower located near side channel with risk of channel avulsion. While mapped as low risk, moved into the medium category based on evidence of flow and aggradation following November 2021 flood.	Medium	Monitoring annually and after major flood events. Site evaluation and proactive plan. Place up to two engineered log structures to reduce risk of avulsion and associated impacts to tower, while increasing pool area and cover in the reach.
Bacon Creek	Alluvial fan. Left bank tower on edge of the CMZ. Low risk of future interaction due to SR 20 bridge constriction upstream of ROW.	Low	Monitor annually and after major flood events.
Diobsud Creek	Bank erosion along left bank in close proximity to tower.	High	Monitor annually and after major flood events. Site evaluation and placement of four engineered log structures to protect tower and increase habitat quantity and quality in reach. Measure may include vegetated rockery bank protection.
Skagit River - Corkindale	Bank erosion along the right bank. Monopoles on right bank	Medium	Monitor annually and after major flood events. Site evaluation and proactive plan.

Stream	Channel Migration Issue	Relative Risk	Proposed Action[1,2]
	and traditional towers along the left bank. The towers closest to the channel along the left bank of the Skagit River are most at risk.		
Illabot Creek	Alluvial fan. Towers protected in place. Low risk under current protections which include levees.	Low	Monitor annually and after major flood events. Site evaluation and proactive plan. As part of evaluation, examine options for additional habitat enhancement. Habitat enhancement measures may include up to 3 additional log structures within or adjacent to the ROW, with a primary goal of enhancing or extending the existing restoration project to increase the quantity and quality of habitat.
Sauk River	Channel migration into glacial deposits at three locations along left bank. Channel avulsed in 2021 toward the east side of the valley, abandoning the channel downstream of Rinker Creek.	Moderate	Monitor annually and after major flood events. Site evaluation and proactive plan.
Squire Creek	Tower in close proximity to channel. Very slow migration and bank erosion.	Low	Monitor annually and after major flood events. Site evaluation and proactive plan. Restoration measures could include a large wood structure to redirect flow and riparian planting.
Montague Creek	Towers in close proximity to channel. Creek follows powerline corridor. Channelized and stable. One tower at high risk due to unstable geology.	High	Monitor annually and after major flood events. Site evaluation and proactive plan to address slump (potential measures could include a retaining wall, toe protection, and improved drainage) along confined section of Montague Creek near tower.

1 Proposed actions are preliminary and may be revised during implementation planning.
2 Initial concept; project details to be developed in the monitoring and implementation plan.

Emergency Channel Migration Zone Protocols

It is City Light's intent to proactively address and monitor CMZ/Project feature interactions as described above. However, emergency measures may be necessary despite these actions. City Light will develop programmatic emergency channel migration protocols by License Year 1 that includes best practices for addressing emergency actions related to channel migration that avoid where possible, minimize and mitigate for impacts to aquatic species, aquatic and riparian habitat, and river processes at all sites with ongoing or potential interactions between channel migration and transmission line towers or other City Light infrastructure. Emergency actions and best management practices shall also apply to other sites with interactions between Project facilities and aquatic resources (e.g., Hollywood levee, Ladder Creek).

4.2.2.2 Implementation

Upon completion of the planning and prioritization process, City Light will design, permit, and implement site-specific measures identified in the plan. The three most urgent sites for mitigating risk to infrastructure as determined by City Light in consultation with the SRCC shall be implemented by License Year 6. Measures at three additional sites shall be implemented by License Year 11. Triggers associated with monitoring results within the adaptive management framework may accelerate implementation schedules or lead to project implementation at additional sites.

4.2.3 Aquatic and Riparian Habitat at Transmission ROW Stream Crossings

Road maintenance and vegetation management activities associated with the transmission ROW impact vegetation composition, structure and function, terrestrial habitat, and aquatic habitat at stream crossings. Road maintenance and vegetation management best management practices (BMP) and programmatic actions are described in the Roads, Trails, and Transmission Line Right-of-Way Erosion Management Plan (City Light 2023b) and the Vegetation Management Plan (City Light 2023c), respectively. In addition to the BMPs and programmatic actions described in these plans, City Light will also mitigate for Project effects on wood loading through additional programmatic actions and wood augmentation.

Reduced wood loading to streams is the primary effect of ROW management on aquatic habitat. ROW stream segments have lower wood loading on average than non-ROW stream segments. Clearing, development, and hydromodification on private property and impacts from state highways and roads that are not Project Routes also affect relative wood loading.

4.2.3.1 Programmatic Actions

Programmatic actions are described in the draft Roads, Trails, and Transmission Line Right-of-Way Erosion Management Plan (City Light 2023b) and draft Vegetation Management Plan (City Light 2023c). Example BMPs include (and are not limited to):

- Use height zonation mapping to maximize retention of native riparian trees and shrubs.
- Apply integrated weed management practices to control invasives and to replace invasives and non-compatible native plant species to improve riparian areas.
- Place and position wood debris from trees that need to be cut to achieve North American Electric Reliability Corporation (NERC) compliance in small streams.
- Work collaboratively with other jurisdictions to control unauthorized motor vehicle access to Project Routes where feasible.
- Decommission redundant and unnecessary access routes.
- Revegetate and use bioengineering approaches to treat areas of erosion.

4.2.3.2 Wood Augmentation in ROW streams

City Light will add 500 pieces of large wood >15-feet length and 12-inches diameter at breast height (dbh) at ROW stream crossings or alternative locations as approved by the SRCC. One-third of the pieces shall be >25-feet length and 18-inches dbh with rootwad. Subject to approval by the SRCC, adjustments to wood number and sizing may be revised consistent with total wood volumes (i.e., 25-feet length and 10-inches dbh instead of 15-feet length and 12-inches dbh) to meet design specifications and align with available large wood. Wood for projects may include trees removed as part of ROW management, trees tipping/thinning from adjacent riparian areas on public land consistent with silvicultural management objectives, and logs obtained from off-site.

Within one (1) year of License issuance and in consultation with the SRCC, City Light will propose subbasin/ecological zone targets (percent of total augmentation distributed among the subbasin) and treatment locations (stream segments with a high potential for functional uplift). Targets are subbasin specific rather than stream specific to maintain flexibility to concentrate wood placement and focus interventions based on geomorphic conditions (e.g., alluvial reaches), specific opportunities (e.g., engagement of a side channel), and limiting factors analysis (e.g., Chinook or steelhead habitat, rearing), rather than generic wood loading targets for each ROW stream reach. For instance, in the Stillaguamish River basin there is interest to align wood augmentation sites with wood debris targets identified in the Chinook Recovery Plan update (Stillaguamish Watershed Council, 2016). This could include a financial contribution to projects in the Stillaguamish mainstem and large Chinook-bearing streams in lieu of wood placement in smaller ROW stream segments. In the Skagit River basin, there is a desire to start with assumption of in-place, in-kind targets. Adjustments may be made in consultation with and approval by the SRCC and may include the placement of additional wood beyond mitigation requirements at the stream crossings with channel migration identified in Table 4.2-2, and wood added as part of fish passage improvement projects.

Subbasin/ecological zones include:

- Skagit tributaries upstream of Bacon Creek;
- Skagit tributaries downstream of Bacon Creek to Sauk River;
- Sauk tributaries;
- NF Stillaguamish tributaries;
- SF Stillaguamish tributaries; and
- Snohomish tributaries.

4.2.3.3 Implementation

Wood augmentation will occur on the agreed upon schedule at tributary stream crossings or aggregated sites within subbasin/ecological zones by License Year 10.

5.0 MONITORING, REPORTING, AND COMMUNICATIONS

5.1 Monitoring Overview

In support of REP activities and the Skagit River ecosystem overall, City Light shall conduct a multi-faceted monitoring program that includes compliance, performance, and ecosystem outcome monitoring (e.g., biological effectiveness, etc.) as described below.

5.1.1 Flow Management Program Field Monitoring

Several field monitoring procedures will be conducted throughout the duration of this management plan. In particular, the starting and ending dates of salmon and steelhead spawning may be monitored each year as described in Appendix J (Alternative Salmon and Steelhead Spawning Periods). Annual monitoring may also be used to identify when the Steelhead Fry Protection Period begins and/or ends. Fry stranding surveys may be conducted during the peak fry vulnerability periods to monitor fry stranding levels. All field monitoring studies will be developed in consultation with the SRCC and will be conducted by a monitoring team composed of at least one representative of City Light and at least one representative of another partner agency participating in the SRCC.

5.1.1.1 Salmon and Steelhead Spawning Start and End Dates

This management plan specifies default start and end dates for salmon and steelhead spawning. City Light may elect to conduct annual surveys that will provide site specific data required to either delay the start or advance the end dates according to criteria listed in Appendix J (Alternative Salmon and Steelhead Spawning Periods). Surveys will be conducted as needed at index locations and/or reaches predetermined by the SRCC. These surveys will be conducted by City Light, in consultation with the SRCC, acting through a Field Monitoring team as described in Appendix J.

Redd protection measures will be implemented in the case of start date or maintained in the case of end date on the default dates unless the surveys indicate that spawning activity (according to evidence described in Appendix J) has begun or ceased, respectively. If survey observations are determined to be unreliable, the default dates shall determine the start or end of redd protection measures.

5.1.1.2 Steelhead Fry Protection Period Start and End Dates

This management plan specifies that the default start and end dates for the Steelhead Fry Protection Period shall be June 1 and October 15, respectively. However, annual monitoring efforts may be used to identify alternate Steelhead Fry Protection Period start and end dates. This monitoring procedure is described in Appendix K (Alternative Steelhead Fry Protection Periods).

5.1.1.3 Fry Stranding Surveys

Following this management plan, fry stranding surveys will be conducted annually for a period of no less than three (3) years to monitor the effectiveness of the fry protection measures implemented. These surveys will be conducted during the peak vulnerability periods for both salmon and steelhead fry. Steelhead fry surveys will be conducted between August 1 and August

31, and salmon fry surveys will be conducted between March 15 and April 15, unless the SRCC agrees otherwise.

Surveys will be completed during the steelhead survey period by the Field Monitoring team in coordination with the SRCC. Surveys will be completed during the salmon survey period by the Field Monitoring team. The surveys, which will record species, locations, and numbers of stranded fry, will be conducted on 300-foot sections of exposed river bars between the high and low water lines of a Downramp Event. The results of surveys will be presented to SRCC for review and discussion. After three (3) years of annual surveys, the SRCC may agree to continue surveys at annual intervals or otherwise.

5.1.2 Flow Management Program Compliance Monitoring

The flow levels specified in this management plan will be measured at USGS gages, which have certain inherent ranges of accuracy. For the purposes of this management plan, operations will be determined based on real time gage readings which will be recorded by City Light.

City Light will prepare an Annual FMP Compliance Report to demonstrate compliance with the instream flows and operating restrictions embodied in this management plan. The reporting period shall be February 1 to January 31. The report shall be sent to the SRCC and to FERC within 120 days of the end of the reporting period. The report may include (but may not be limited to) the following:

(1) Minimum flows recorded at Newhalem gage;

(2) Hourly ramping rates during Salmon and Steelhead Fry Protection Periods;

(3) Hourly ramping rates during the STJ Protection Period;

(4) Daily Predicted Marblemount Flows during the Salmon Fry Protection Period;

(5) Mean Daily Tributary Inflow;

(6) Daily total Downramp Amplitude and portion of amplitude that occurred at Newhalem gage flows less than 4,000 cfs during Salmon and Steelhead Fry Protection Periods;

(7) Daily required instantaneous incubation flows based on Appendix C (Salmon Spawning/Incubation Flow Tables) and Appendix G (Steelhead Spawning/Incubation Flow Tables);

(8) The Season Spawning Flow or spawning flows calculated to date for each salmon species or steelhead spawning group;

(9) Documentation and explanation of any flow violations;

(10) Calculated Daily Spawning Flows;

(11) Planned Spawning Flow for each species spawning or incubating during the reporting period;

(12) List of daily flows calculated from the Spawning Control Curve for steelhead;

(13) Documentation of any decision to exercise a limitations clause (per Section 3.2.2), including consultations with the SRCC;

(14) Documentation of any emergencies that caused deviation from this management plan;

(15) Summary list of the SRCC actions during the reporting period;

(16) Daily fry protection flows as listed in Appendix I (Fry Protection Flows at Newhalem gage); and

(17) Applicable Minimum Flows for the reporting period.

5.1.3 Process Flow Monitoring

Compliance Monitoring – Document the timing, magnitude, and duration of flows released from the Project and the rationale for decisions made regarding flow release as part of the Annual Compliance Report.

Flood Monitoring – Collect high water mark data following process flow releases. Evaluate effects at locations of vulnerable infrastructure.

Geomorphic Work Performance Monitoring – As approved by the SRCC, City Light will use topobathymetric LiDAR to evaluate changes in channel dimensions and planform, channel migration rates, areas of bed mobilization, changes in channel planform (deposition and incision), and wood recruitment. Field surveys will include scour monitoring at redd locations and substrate mapping within reference reaches. Changes in wood loading within reference reaches will be evaluated through remote sensing techniques.

Research and Biological Effectiveness Monitoring – Monitoring completed by City Light as part of a collaborative efforts to advance scientific understanding of fish population dynamics and inform structured decision-making will be described in the EMAMP. Population monitoring studies may be designed to inform scientific understanding of tradeoffs and relative benefits between life history stages, strategies, and species from flow releases of a given magnitude and frequency at a given time of year. A sediment augmentation pilot in the context of a process flow release could involve placement of sediment from side-channel excavation on river bars.

5.1.4 FMP Research and Biological Effectiveness Monitoring

Monitoring completed by City Light as part of collaborative efforts to advance scientific understanding of fish populations and inform structured decision-making will be described in the EMAMP. The EMAMP may provide for biological research and monitoring to be implemented in collaboration with the SRCC. Biological monitoring may include population modeling, smolt traps, and other agreed-upon monitoring actions. Biological project effectiveness monitoring may follow a before-after-control-impact (BACI) design within a hypothesis-driven framework centered on research questions as described in the EMAMP.

5.1.5 Non-Flow Program Compliance Monitoring

Mainstem Habitat Mitigation and Enhancement – Compliance monitoring for side channel and off-channel habitat reconnection and wood installation would include as-builts documenting the grading extent, channel form, wood structure location, implementation, and specifications (i.e., piece count and sizes, depth of pile installation, ballast requirements in place) within a year of project completion. Photo points or drone footage before and after construction will also be used to document project implementation.

Transmission Line ROW Aquatic Habitat Mitigation and Enhancement – For Project route stream crossings passage improvement projects, CMZ stream crossing enhancement and mitigation projects, and wood augmentation, compliance monitoring per designs and approved changes as documented in as-builts will be completed within a year of implementation. Photo points or drone footage before and after construction will also be used to document project implementation.

5.1.6 Non-Flow Program Physical Habitat Performance Monitoring

Mainstem Habitat Mitigation and Enhancement – Baseline topobathymetric data will be collected along the mainstem Skagit River during implementation planning and at 5-year intervals throughout the term of the license. Topobathymetric LiDAR will be used both for project physical habitat performance monitoring within restoration subreaches and to evaluate geomorphic changes from process flow releases (Section 5.1.3) to be implemented through a structured decision-making adaptive management framework (EMAMP). Because implementation within restoration subreaches will occur over several years, baseline data may be collected from 1 to 4 years prior to implementation. If a flow of greater than 10-year recurrence interval occurs after the baseline collection but before implementation, additional LiDAR or field survey data may be collected within select subreaches prior to construction, if necessary.

Physical habitat performance monitoring for each project site would include the following elements to establish a baseline and evaluate change in function over time:

- Topography – Landscape level assessments will be completed using topobathymetric LiDAR at 5-year intervals and following flow events above the 10-year recurrence interval. Drone flights and field survey with real-time kinematic positioning (RTK) may be used to supplement LiDAR and to evaluate near-term changes following restoration intervention and peak flow events.
- Edge habitat – Use LiDAR to evaluate changes in edge habitat length and LiDAR and field data collection to characterize changes in edge habitat width and cover.
- Channel engagement – Level loggers (one per side channel/off-channel network) will be installed to document changes in the level of connection and inflow at each monitoring location. Level loggers will be left in place and downloaded as needed for five (5) years following construction. Some loggers may be left in place for a longer period as part of EMAMP. At side channel inlets, cameras (set to take photos at intervals) will be installed to gather additional information on the flows at which channels become engaged. Cameras will also be downloaded annually for five (5) years following construction.
- Pools – Number and depth of pools (primary, backwater, side-channel) will be spatially documented using field and/or remote sensing techniques, where feasible given site conditions and available technology (baseline, Year 1, 5, 10).[11]
- Large wood – Log jams (natural and constructed) and individual pieces meeting minimum size criteria will be tallied within size bins and spatially recorded. Presence/absence of rootwads will also be noted (baseline, Year 1, 5, 10). Observations of changes in jam features will be noted.

[11] Monitoring may be adjusted to align longer term monitoring efforts for similar types of projects for efficient evaluation and reporting.

- Substrate – Pebble counts, visual assessment of (dominant/subdominant) and facies mapping will be completed (baseline, Year 1, 5, 10) including at side channel inlets and outlets.

Transmission Line ROW Aquatic Habitat Mitigation and Enhancement:

- Stream Crossing Passage Improvement Projects
  - Complete visual inspection annually and after major flood events to inform routine maintenance activities. Take annual photo of upstream and downstream end of culvert. Flag problem sites for further evaluation by the SRCC where issues have developed that cannot be addressed with routine maintenance BMPs. For example, if a culvert becomes perched and no longer meets design criteria, then it will be discussed with the SRCC and City Light will propose a plan and schedule to address it.
- Habitat and River Process Improvements near Project Infrastructure
  - Inspect sites with ongoing or potential CMZ/tower interactions annually and after major flood events.
  - Establish remote sensing-based monitoring protocol for Diobsud Creek, Bacon Creek, Goodell Creek, Skagit River, Sauk River, Squire Creek, and other sites as identified to track channel migration rates within reaches with channel migration in close proximity to transmission towers.
  - Collect topographic survey, pools, large wood, substrate data as described above (include bank erosion and modification data).
- Wood Augmentation at ROW Stream Crossings
  - Large wood – Log jams (natural and constructed) and individual pieces meeting minimum size criteria will be tallied within size bins and spatially documented. Presence/absence of rootwads will also be noted (baseline, Year 1, 5, 10). Observations of changes in jam features will be noted.

5.1.7 Non-Flow Program Research and Biological Effectiveness Monitoring

Monitoring completed by City Light as part of collaborative efforts to advance scientific understanding of fish populations and inform structured decision-making will be described in the EMAMP. In addition to the physical habitat metrics described above, the EMAMP may provide for biological research and monitoring to be implemented at select habitat mitigation and enhancement sites identified in collaboration with the SRCC. Biological monitoring may include snorkel surveys, redd surveys, weir trap, electrofishing, mark and recapture, and benthic sampling within reference reaches. Biological project effectiveness monitoring may follow a BACI design within a hypothesis-driven framework centered on research questions (e.g., is Chum Salmon spawning higher in blind side channels or side channels with an upstream and downstream connection; what are the densities, growth rates and survival of Chinook Salmon sub-yearling parr and yearling smolts in various types of off-channel habitat).

5.1.8 Management Actions and Adaptive Management

Based on results of performance monitoring, design adjustments, and maintenance activities may be warranted. Details of the evaluation and adjustment process and associated triggers and schedule will be developed in consultation with the SRCC. Data collected according to the protocols outlined in the REP will be applied in the context of the EMAMP, as appropriate (determinations regarding which data are applicable, and how they are to be used, will be made in consultation with the SRCC).

5.2 Implementation and Monitoring Schedule

Implementation of the REP will begin upon license issuance and continue through the license term. The schedule for specific measures is shown in Table 5.2-1 for FMP-related activities and Table 5.2-2 for Non-Flow Program-related activities.

Table 5.2-1. Timeline for Riverscape Ecosystem Plan activities – FMP.

Timeline	Protection and Enhancement Monitoring Activity
Annually (as requested as approved by the SRCC)	Conduct monitoring of starting and ending dates of salmon and steelhead spawning.
Annually (as requested as approved by the SRCC)	Conduct redd protection surveys.
Annually (as requested as approved by the SRCC)	Conduct monitoring to identify when the Steelhead Fry Protection Period begins and ends.
Annually or License Years 1-3 (minimum)	Conduct fry stranding surveys.
Annually	Provide Annual Flow Plan Forecast to the SRCC.
No less than two times per year	Release flushing and connectivity flows (if not already provided by Project operation requirements or flood risk management protocols).
No less than once every five (5) years and no more than once every two (2) years	Release channel maintenance flows (if not already provided by Project operation requirements or flood risk management protocols).
Annually	Compile and file Annual FMP Compliance Report with FERC.

Table 5.2-2. Timeline for Riverscape Ecosystem Plan activities – Non-Flow Program.

Timeline	Protection and Enhancement Monitoring Activity
Mainstem Habitat Measures	
Within ten (10) years of license issuance	Implement restoration of subreaches with high restoration potential (Park Slough, Newhalem Ponds (Agg Ponds), County Line Ponds, Taylor Side Channel, Illabot, and Powerline sites).
Within eleven (11) years of license issuance	Compliance monitoring including as-builts required within one (1) year of installation.
Within fifteen (15) years of license issuance	Initiate additional habitat enhancement measures as part of the Estuary and Watershed Aquatic Habitat Enhancement Accounts.
Aquatic Habitat in Transmission Line Right-of-Way	
Within two (2) years of license issuance	Commence field verification of upstream aquatic habitat.
Within two (2) years of license issuance	Planning and prioritization of passage improvement actions.
Within five (5) years of license issuance	Removal or replacement of culverts and other structures that block over 200 meters of anadromous fish habitat (Group A of passage improvement actions).
Within twelve (12) years of license issuance	Removal or replacement of culverts and other structures that block over 200 meters of resident fish habitat (Group B of passage improvement actions).
Year 13 – license expiration	Replacement of culverts and other structures on non-fish bearing streams and fish bearing streams with less than 200 meters of habitat at the end of usable life or as part of road maintenance and upgrades (Group C of passage improvement actions).
Channel Migration Areas near Project Infrastructure	
Within one (1) year of license issuance	Develop programmatic emergency channel migration protocols.
Within five (5) years of license issuance	Develop an implementation plan for Project features within mapped CMZ to reduce risk to infrastructure and need for emergency actions.
Within six (6) years of license issuance	Commence site-specific measures related to three most urgent sites for mitigating risk to infrastructure as determined by City Light (in consultation with the SRCC).
Within twelve (12) years of license issuance	Commence site-specific measures related to three additional sites for mitigating risk to infrastructure as determined by City Light (in consultation with the SRCC).
Aquatic and Riparian Habitat at Transmission ROW Stream Crossings	
Within ten (10) years of license issuance	Commence wood augmentation on the agreed upon schedule at tributary stream crossings or aggregated sites within subbasin / ecological zones.

6.0 DEFINITIONS

Daily Spawning Flow

Shall mean the actual average daily flow at the Newhalem gage minus the portion of flow due to flood risk management, spill, avoiding Firm Load curtailment, high Sidestream Inflow, or Process Flows. A sample calculation is shown in Appendix A (Calculation of Daily and Seasonal Spawning Flows for Salmon and Steelhead).

Downramp Amplitude

Shall mean the difference between the highest Newhalem gage reading and the subsequent lowest Newhalem gage reading during any consecutive 24-hour period due to a flow reduction at Gorge Powerhouse and/or at Gorge Dam, which is calculated as shown in Appendix L (Miscellaneous Calculations).

Downramp Event

Shall mean a reduction in flow at the Newhalem gage due to a controlled reduction in generation and/or spill at Gorge Powerhouse or Gorge Dam at a rate exceeding 300 cfs for one hour, or which exceeds a total reduction in flow of 300 cfs over two or more consecutive hours. Downramp rate is calculated in units of cfs per hour[12] as the difference in average flow at the Newhalem gage between one hour and the next.

Firm Load

Shall mean the minimum amount of power which City Light is obligated to provide from a combination of generation and contract resources for the use of its customers.

Forecast Skill

Forecast Skill is defined as the relative improvement (i.e., reduction) in forecast error, as compared to a simple, but reasonable, baseline forecast. Can also be referred to as a skillful forecast.

Inflow Day

Shall mean the last calendar day preceding a Power Scheduling Day for which data are available to calculate inflow conditions.

Insufficient Month

Shall mean a month for which it is determined that there is insufficient stream flow to meet both minimum flows and other constraints.

[12] City Light anticipates that ramping rates will be expressed in terms of inches/hour in consultation with the Washington Department of Ecology as part of the Project's Section 401 Water Quality Certification process (required as part of the FERC relicensing effort).

Marblemount Gage

Shall mean the Skagit River at Marblemount, Washington flow gaging station (USGS Station Number 1218100).

Maximum Spawning Flow

Shall mean an average daily flow measured at the Newhalem gage and the highest average daily flow that City Light can release during the salmon and steelhead spawning season without exceeding the current Spawning Control Curve (refer to Appendix E Shaping of Flows During Steelhead Spawning).

Natural Flow

Shall mean the flow which represents the average daily flow which would occur without the Skagit River Hydroelectric Project in place, which is calculated as shown in Appendix L (Miscellaneous Calculations).

Newhalem Gage

Shall mean the Skagit River at Newhalem, Washington flow gaging station (USGS Station Number 12178000).

Historic Percent Exceedance Flow

Shall mean the flow calculated from historical flow records that represents the flow which is exceeded with a specific probability frequency. For example, the “50 percent exceedance flow” (or P50) means 50 percent of the historical flows are higher than this value and 50 percent of the historic flows are lower.

Planned Spawning Flow

Shall mean the average daily flow included in the monthly operating plan of City Light as the target flow for spawning during a particular month.

Power Scheduling Day

Shall mean any day in which power schedulers at City Light's Power Control Center prepare generation schedules for the following day(s).

Predicted Marblemount Flow

Shall mean the sum of the planned total discharge from Gorge Powerhouse and Gorge Dam (i.e., spill) during the target day, the forecast natural sidestream flow between Gorge Dam and the Newhalem gage, and the forecast Tributary Inflow (between Newhalem and Marblemount). In the absence of reliable sidestream and Tributary Inflow forecasts, the sum of the most recent observed daily average instantaneous natural sidestream flow between Gorge Dam and the Newhalem gage for a given calendar day, the Tributary Inflow for the corresponding Inflow Day, and the daily average Tributary Inflow can be added to the planned Gorge Powerhouse discharge for the target day in order to obtain the Predicted Marblemount Flow. An example calculation for when a skillful forecast of total natural sidestream flow is unavailable and the Tributary Inflow for the corresponding Inflow Day must be used for planning purposes is shown in Appendix L, Part 3.

Redd

Shall mean the gravel nest in which salmon or steelhead lay their eggs.

Season Spawning Flow

Shall mean the flow at the Newhalem gage that determines incubation flows based on spawning conditions over the entire Spawning Period of a salmon species or steelhead spawning group. Sample calculations are shown in Appendix A (Calculation of Daily and Seasonal Spawning Flows for Salmon and Steelhead).

Sidestream Inflow

Shall mean the inflow from tributaries between Ross Dam and the Newhalem gage.

Spawning Control Flow

Shall mean the planned spawning flow for steelhead based on forecasted conditions prior to and during the Spawning Period which is determined as shown in Appendix E (Shaping of Flows During Steelhead Spawning).

Spawning Period

Shall mean the planned start and end dates associated with spawning activity for salmonid species. The planned start and end dates are species specific and may be adjusted each year based on field monitoring/observations.

Threshold Sidestream Inflow

Shall mean the inflow between Ross Dam and the Newhalem gage which is beyond City Light's reasonable means to control and shall be defined as 3,500 cfs during the Chinook Salmon Spawning Period, 2,500 cfs during the Pink Salmon Spawning Period, 3,000 cfs during the Chum Salmon Spawning Period, or the Spawning Control Flow minus 500 cfs during the Steelhead Spawning Period.

Tributary Inflow

Shall mean the inflow from tributaries between the Newhalem gage and the Marblemount gage calculated as the mean daily flow at Marblemount gage minus the mean daily flow at Newhalem gage on the same calendar day. A sample calculation is included in Appendix L (Miscellaneous Calculations).

7.0 REFERENCES

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RIVERSCAPE ECOSYSTEM PLAN

APPENDIX A

CALCULATION OF DAILY AND SEASONAL SPAWNING FLOWS FOR SALMON AND STEELHEAD

1.0 GENERAL CALCULATION OF DAILY SPAWNING FLOW

Mean Daily Spawning Flows for salmon and steelhead shall be calculated as follows:

DSF = ANF - MAX (RDF, RDL) - MAX (SS - TSS, 0)

where:

- DSF = Mean Daily Spawning Flow.[1]
- ANF = Actual average daily flow at Newhalem gage.
- RDF = Mean daily Ross Dam discharge for flood risk mitigation, which shall be calculated as the average amount released throughout the day to avoid exceeding the Flood Risk Management Rule Curve or spilling (equal to inflow to Ross Lake from the moment that the Flood Risk Management Rule Curve or spill point is reached).
- RDL = Mean daily Ross Dam Discharge to serve Firm Load,[1] which shall mean the average amount released to avoid curtailing firm load beyond the Maximum Spawning Flow[1] (Section 3.2.2.3).
- SS = Mean Daily Sidestream Inflow[1] from Ross Dam to Newhalem gage.
- TSS = Threshold Sidestream Inflow.[1]

Sample calculations are provided in Appendix A Section 1.1 – 1.4 below:

1.1 Normal Conditions

Assumptions: Assume that you are calculating the flow for a Pink Salmon spawning day during which no water is released from Ross Lake for flood risk mitigation or to avoid curtailing Firm Load, and there is no high Sidestream Inflow.

- RDF = 0
- RDL = 0
- SS = 900 cfs
- TSS = 2,500
- ANF = 3,500 cfs

Calculations:

DSF = 3,500 - 0 - (0) = 3,500 cfs

Conclusion: the Daily Spawning Flow is calculated as 3,500 cfs for that day.

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1 Defined in Section 6 (Definition) of the Riverscape Ecosystem Plan (REP).

1.2 Flood Risk Management Measures or Spill Avoidance

"City Light will not be responsible for flow which is released due to actions of the U.S. Army Corps of Engineers or due to reasonable actions taken to avoid exceeding the Flood Risk Management Rule Curve or full pool." (Section 3.2.2.3).

Assumptions: Assume that you are calculating the flow for a Chum Salmon spawning day during which a flood risk mitigation release was required. Ross Lake elevation is near full or Flood Risk Management Rule Curve.

- RDF = 6,000 cfs
- RDL = 0
- SS = 3,000 cfs
- TSS = 3,000 cfs
- ANF = 9,000 cfs

Calculations:

DSF = 9,000 - 6,000 - (0) = 3,000 cfs

Conclusion: the Daily Spawning Flow is calculated as 3,000 cfs for that day.

1.3 Load Curtailment Avoidance

"City Light will not be responsible for flow which is released when there are no other viable options available other than Firm Load Curtailment, including purchase of power from other sources. This section is not intended to permit flow releases to meet the generation requirements resulting from an increase in Firm Load growth after the execution of this FMP. For the purpose of this FMP, Firm Load shall mean the minimum amount of power which City Light is obligated to provide from a combination of generation and contract resources for the use of its customers." (Section 3.2.2.3).

Assumptions: A power scheduler is calculating the spawning flow for a Pink Salmon spawning day during which heating loads in Seattle are expected to be very high due to effects of an arctic air mass in the area. The Seattle generating system is operating at maximum capacity. No secondary, exchange, or stored energy is available for acquisition and all firm contract rights are being exercised. Increased generation at the Skagit River Project is required to meet the load without curtailing power supplies to some firm power customers. City Light can voluntarily increase flows at Newhalem up to the Maximum Spawning Flow which for Pink Salmon is 4,000 cfs. Since the Sidestream Inflow is 2,500 cfs, 4,000 – 2,500 = 1,500 cfs is within the City Light's control. Therefore RDL = 5,500 – 1,500 = 4,000 cfs.

- Actual Ross Discharge = 5,500 cfs
- RDF = 0
- RDL = 4,000
- SS = 2,500 cfs
- TSS = 2,500 cfs
- ANF = 8,000 cfs

Calculations:

DSF = 8,000 - 4,000 - 0 = 4,000 cfs

Conclusion: the Daily Spawning Flow is calculated as 4,000 cfs for that day.

1.4 Sidestream Inflow Greater than the Threshold Sidestream Inflow

"City Light will not be responsible for that portion of flow which is released due to Sidestream Inflow greater than 3,500 cfs during the Chinook Salmon Spawning Period, 2,500 cfs during the Pink Salmon Spawning Period, 3,000 cfs during the Chum Salmon Spawning Period, or due to Sidestream Inflow which is greater than the current Spawning Control Flow for the Steelhead Spawning Period minus 500 cfs. The Sidestream Inflow values shall be considered Threshold Sidestream Inflows for the purpose of calculating Daily Spawning Flows." (Section 3.2.2.3).

Assumptions: Assume that you are calculating the flow for a Pink Salmon spawning day during which no water is released for flood risk mitigation or for meeting a firm load requirement.

- RDF = 0
- RDL = 0
- SS = 5,500 cfs
- TSS = 2,500 cfs
- ANF = 6,000 cfs

Calculations:

DSF = 6,000 - 0 - (5,500 - 2,500) = 3,000 cfs

Conclusion: The Daily Spawning Flow is calculated as 3,000 cfs for that day.

2.0 SEASON SPAWNING FLOW FOR SALMON

"Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during the entire Spawning Period. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1).

A sample calculation follows:

Suppose that spawning flow is based on the ten highest days in a 50-day Spawning Period. In the Year X, City Light planned a Pink Salmon average Daily Spawning Flow of 3,500 cfs or less. The fish actually spawned over a 50-day period at the following average Daily Spawning Flow. Days marked with an asterisk are characterized by high Sidestream Inflow conditions beyond City Light's means of control (see Sidestream Inflow, above). The Daily Spawning Flow calculated for those days excludes the effect of Sidestream Inflow beyond the threshold of 2,500 cfs.

Table A-1. Daily Spawning Flows at Newhalem gage (cfs) (Sept 12-Oct 21, Year X).

Day	cfs	Day	cfs	Day	cfs
Day 1	3,021	Day 19*	**3,400**	Day 37	2,657
Day 2	3,202	Day 20	**3,389**	Day 38	2,678
Day 3	3,105	Day 21	3,107	Day 39	2,790
Day 4	3,220	Day 22	3,025	Day 40	2,899
Day 5	3,305	Day 23	2,987	Day 41	2,869
Day 6	3,011	Day 24	2,807	Day 42	2,765
Day 7	3,232	Day 25	2,524	Day 43	2,876
Day 8	3,111	Day 26	2,789	Day 44	2,975
Day 9	2,993	Day 27	2,987	Day 45	3,081
Day 10	3,002	Day 28	3,154	Day 46	3,110
Day 11	3,209	Day 29	3,218	Day 47	3,265
Day 12	**3,403**	Day 30	3,212	Day 48	3,350
Day 13	**3,577**	Day 31	3,290	Day 49	**3,449**
Day 14	**3,598**	Day 32	3,110	Day 50	3,354
Day 15	**3,899**	Day 33	3,009		
Day 16*	**3,555**	Day 34	3,005		
Day 17*	**3,600**	Day 35	2,998		
Day 18*	**3,450**	Day 36	2,780		

Calculations:

The average of the ten highest Daily Spawning Flows (3899, 3577, 3598, 3600, 3555, 3450, 3403, 3400, 3449, and 3389) is 3,532 cfs.

This is the Season Spawning Flow for Pink Salmon in the Year X.

Action: Referring to the nearest Season Spawning Flow listed in Table C-2, Appendix C (Salmon Spawning/Incubation Flow Tables), the power scheduler determines the minimum requirements for incubation flow:

November	2,200 cfs	February	2,500 cfs
December	2,600 cfs	March	2,300 cfs
January	2,600 cfs	April	2,400 cfs

3.0 SEASON SPAWNING FLOW FOR STEELHEAD

"Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during that spawning subperiod. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1.3).

A sample calculation follows:

The spawning flow in April is based on the ten highest days in a 30-day Spawning Period. While City Light planned to release flows at Gorge Powerhouse in April based on the Spawning Control Curve as outlined in Appendix E, incubation flows are based on actual spawning flows. Suppose the April Spawning Control Curve showed 4,500 cfs. The fish actually spawned over a 30-day period at the following average Daily Spawning Flow. Days marked with an asterisk are characterized by high Sidestream Inflow conditions beyond City Light's means of control (see Sidestream Inflow above). The Daily Spawning Flow calculated for those days excludes the effect of Sidestream Inflow beyond the threshold which is based on the Spawning Control Flow minus 500 cfs (2,500 cfs for this case).

Table A-2. Daily Spawning Flows at Newhalem Gage in CFS (April, Year X).

Day	cfs	Day	cfs
Day 1	4,021	Day 16	3,789
Day 2	4,202	Day 17	3,987
Day 3	4,105	Day 18	4,154
Day 4	4,220	Day 19	4,218
Day 5	**4,350**	Day 20	4,212
Day 6	4,011	Day 21	**4,290**
Day 7	4,232	Day 22	4,110
Day 8	4,111	Day 23	4,009
Day 9	**4,693**	Day 24	4,005
Day 10*	**4,500**	Day 25	3,998
Day 11*	**4,500**	Day 26	4,280
Day 12*	**4,500**	Day 27	**4,290**
Day 13	**4,577**	Day 28	**4,478**
Day 14	4,245	Day 29	**4,450**
Day 15	3,899	Day 30	4,199

Calculations:

The average of the ten highest Daily Spawning Flows (4,693; 4,577; 4,500; 4,500; 4,500; 4,478; 4,450; 4,350; 4,290; and 4,290) is 4,463 cfs.

This is the Season Spawning Flow for April steelhead in the Year X.

Action: Referring to the nearest Season Spawning Flow (4,500 cfs) listed in Table G-2, Appendix G (Steelhead Spawning/Incubation Flow Tables), the power scheduler determines the minimum requirements for incubation flow:

April	1,800 cfs	Newhalem gage
May	2,200 cfs	Newhalem gage
June	4,059 cfs	Predicted Marblemount Flow
July	3,793 cfs	Predicted Marblemount Flow

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX B

SALMON SPAWNING/INCUBATION EXAMPLES

1.0 SALMON INCUBATION FLOW – DURING SPAWNING (FIRST TEN DAYS)

"During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned Spawning Flows are the flows targeted for spawning during a given month in City Light's monthly operating plan." (Section 3.1.1).

Assumptions:

- The power scheduler is preparing a schedule for September 19 on September 18.
- Chinook Salmon spawning is ongoing.
- Calculated Spawning Flow for Chinook Salmon through September 18 = 4,000 cfs.
- Pink Salmon are spawning for the second day.
- The Planned Spawning Flow = 3,300 cfs.

Calculation:

The required incubation flow for Pink Salmon based on the Planned Spawning Flow is obtained from Table C-2, Appendix C, and for the month of September is 1,900 cfs. The required incubation flow for Chinook Salmon based on the calculated spawning flow is 1,500 cfs.

Action: The higher required incubation flow takes precedence; therefore the power scheduler must schedule a flow of at least 1,900 cfs for each hour of September 19.

2.0 SALMON INCUBATION FLOW - DURING SPAWNING (AFTER FIRST TEN DAYS)

"During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1.1).

Assumptions:

- The power scheduler is preparing a schedule for October 4 on October 3.
- Chinook Salmon spawning is ongoing.
- Calculated Spawning Flow for Chinook Salmon through October 3 = 4,000 cfs.
- Pink Salmon spawned on October 2 for the fifteenth day.
- Daily Spawning Flows through October 2 = 3,011; 3,124; 3,190; 3,012; 2,991; 2,725; 2,601; 2,788; 2,790; 2,897; 2,993; 3,110; 3,007; 3,101; and 2,868 cfs.

Calculation:

The spawning flow for Pinks calculated as the ten highest Daily Spawning Flows through the last Inflow Day is 3,044 cfs. Thus, the required incubation flow for Pink Salmon which is obtained from Table C-2, Appendix C, is 1,700 cfs. The required incubation flow for Chinook Salmon based on the calculated spawning flow is 1,500 cfs.

Action: The higher required incubation flow takes precedence; therefore the power scheduler must schedule a flow of at least 1,700 cfs for each hour of October 4.

3.0 SALMON INCUBATION FLOW - AFTER SPAWNING

"During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1.1).

Assumptions:

- A power scheduler is preparing a schedule for November 4 on November 3.
- Chinook Salmon spawning ended October 15.
- Season Spawning Flow for Chinook Salmon = 4,000 cfs.
- Pink Salmon spawning ended October 31.
- Season Spawning Flow for Pink Salmon = 3,500 cfs.
- Chum Salmon have not begun to spawn.

Calculation:

The required incubation flow for the next day based on the Season Spawning Flows are obtained from Appendix C for Chinook and Pink salmon. The required incubation flows for Chinook and Pink salmon during the month of November should be 1,100 and 2,200 cfs, respectively.

Action: The higher required incubation flow takes precedence, therefore the power scheduler must schedule a flow of at least 2,200 cfs for each hour of the day on November 4.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX C

SALMON SPAWNING/INCUBATION FLOW TABLES

Table C-1. Chinook Salmon.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)								
	Aug*	Sep*	Oct	Nov	Dec	Jan	Feb	Mar	Apr
2,000	**2,000**	**1,500**	**1,500**	**1,000**	**1,000**	**1,000**	**1,800**	**1,800**	**1,800**
2,100	**2,000**	**1,500**	**1,500**	**1,000**	**1,000**	**1,000**	**1,800**	**1,800**	**1,800**
2,200	**2,000**	**1,500**	**1,500**	**1,000**	**1,000**	**1,000**	**1,800**	**1,800**	**1,800**
2,300	**2,000**	**1,500**	**1,500**	**1,000**	**1,100**	**1,100**	**1,800**	**1,800**	**1,800**
2,400	**2,000**	**1,500**	**1,500**	**1,000**	**1,100**	**1,100**	**1,800**	**1,800**	**1,800**
2,500	**2,000**	**1,500**	**1,500**	**1,000**	**1,200**	**1,200**	**1,800**	**1,800**	**1,800**
2,600	**2,000**	**1,500**	**1,500**	**1,000**	**1,300**	**1,300**	**1,800**	**1,800**	**1,800**
2,700	**2,000**	**1,500**	**1,500**	**1,000**	**1,300**	**1,300**	**1,800**	**1,800**	**1,800**
2,800	**2,000**	**1,500**	**1,500**	**1,000**	**1,400**	**1,400**	**1,800**	**1,800**	**1,800**
2,900	**2,000**	**1,500**	**1,500**	**1,000**	**1,400**	**1,400**	**1,800**	**1,800**	**1,800**
3,000	**2,000**	**1,500**	**1,500**	**1,000**	**1,400**	**1,400**	**1,800**	**1,800**	**1,800**
3,100	**2,000**	**1,500**	**1,500**	**1,000**	**1,500**	**1,500**	**1,800**	**1,800**	**1,800**
3,200	**2,000**	**1,500**	**1,500**	**1,000**	**1,500**	**1,500**	**1,800**	**1,800**	**1,800**
3,300	**2,000**	**1,500**	**1,500**	**1,000**	**1,600**	**1,800**	**1,800**	**1,800**	**1,800**
3,400	**2,000**	**1,500**	**1,500**	**1,000**	**1,700**	**1,700**	**1,800**	**1,800**	**1,800**
3,500	**2,000**	**1,500**	**1,500**	**1,000**	**1,700**	**1,700**	**1,800**	**1,800**	**1,800**
3,600	**2,000**	**1,500**	**1,500**	**1,000**	**1,800**	**1,800**	**1,800**	**1,800**	**1,800**
3,700	**2,000**	**1,500**	**1,500**	**1,000**	**1,800**	**1,800**	**1,800**	**1,800**	**1,800**
3,800	**2,000**	**1,500**	**1,500**	**1,000**	**1,800**	**1,800**	**1,800**	**1,800**	**1,800**
3,900	**2,000**	**1,500**	**1,500**	**1,100**	**1,900**	**1,900**	**1,800**	**1,800**	**1,800**
4,000	**2,000**	**1,500**	**1,500**	**1,100**	**2,000**	**2,000**	**1,800**	**1,800**	**1,800**
4,100	**2,000**	**1,500**	**1,500**	**1,100**	**2,100**	**2,100**	**1,900**	**1,800**	**1,800**
4,200	**2,000**	**1,500**	**1,500**	**1,200**	**2,100**	**2,100**	**1,900**	**1,800**	**1,800**
4,300	**2,000**	**1,500**	**1,500**	**1,200**	**2,200**	**2,200**	**2,100**	**1,900**	**1,900**
4,400	**2,000**	**1,500**	**1,500**	**1,200**	**2,300**	**2,300**	**2,100**	**2,000**	**1,900**
4,500	**2,000**	**1,500**	**1,500**	**1,300**	**2,300**	**2,300**	**2,200**	**2,100**	**2,000**
4,600	2,000	1,500	1,500	1,300	2,400	2,400	2,200	2,100	2,000
4,700	2,000	1,500	1,500	1,300	2,500	2,500	2,300	2,200	2,100
4,800	2,000	1,500	1,500	1,300	2,500	2,500	2,400	2,200	2,200
4,900	2,000	1,500	1,500	1,400	2,500	2,500	2,400	2,200	2,200
5,000	2,000	1,500	1,500	1,500	2,600	2,600	2,400	2300	2,200
5,100	2,000	1,500	1,600	1,500	2,600	2,600	2,500	2,300	2,300
5,200	2,000	1,500	1,800	1,600	2,700	2,700	2,500	2,400	2,400
5,300	2,000	1,500	1,800	1,700	2,700	2,700	2,600	2,500	2,400
5,400	2,000	1,600	1,900	1,800	2,700	2,700	2,600	2,500	2,500
5,500	2,000	1,700	1,900	1,900	2,700	2,700	2,600	2,500	2,500
5,600	2,000	1,800	2,000	1,900	2,900	2,900	2,600	2,600	2,500

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)								
	Aug*	**Sep***	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
5,700	2000	1,800	2,000	2,000	3,100	3,100	2,900	2,800	2,700
5,800	2000	1,900	2,000	2,000	3,100	3,100	2,900	2,800	2,700
5,900	2000	1,900	2,100	2,000	3,100	3,100	3,000	3,000	2,900
6,000	2000	1,900	2,100	2,000	3,100	3,100	3,000	3,000	2,900
6,100	2000	2,000	2,100	2,100	3,100	3,100	3,000	3,000	2,900
6,200	2000	2,000	2,100	2,100	3,200	3,200	3,100	3,000	2,900
6,300	2000	2,000	2,400	2,300	3,400	3,400	3,100	3,000	2,900
6,400	2100	2,000	2,400	2,400	3,400	3,400	3,200	3,000	2,900
6,500	2100	2,200	2,400	2,400	3,500	3,500	3,300	3,100	3,000
6,600	2200	2,300	2,600	2,500	3,700	3,700	3,400	3,200	3,100
6,700	2200	2,300	2,700	2,500	4,000	4,000	3,600	3,300	3,100
6,800	2500	2,300	2,800	2,600	4,000	4,000	3,800	3,500	3,100
6,900	2500	2,400	2,800	2,700	4,000	4,000	3,800	3,700	3,600
7,000	2500	2,600	2,800	2,700	4,100	4,100	3,900	3,900	3,800

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

Table C-2. Pink Salmon.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)							
	Sep*	Oct	Nov	Dec	Jan	Feb	Mar	Apr
2,000	**1,500**	**1,500**	**1,200**	**1,400**	**1,300**	**1,900**	**1,800**	**1,800**
2,100	**1,500**	**1,500**	**1,200**	**1,600**	**1,600**	**1,900**	**1,800**	**1,800**
2,200	**1,500**	**1,500**	**1,400**	**1,600**	**1,600**	**1,900**	**1,900**	**1,800**
2,300	**1,500**	**1,500**	**1,400**	**1,800**	**1,800**	**1,900**	**1,900**	**1,800**
2,400	**1,500**	**1,500**	**1,400**	**1,800**	**1,800**	**1,900**	**1,900**	**1,800**
2,500	**1,500**	**1,500**	**1,400**	**1,800**	**1,800**	**1,900**	**1,900**	**1,800**
2,600	**1,500**	**1,500**	**1,400**	**1,800**	**1,900**	**1,900**	**1,900**	**1,800**
2,700	**1,500**	**1,600**	**1,400**	**1,900**	**1,900**	**1,900**	**1,900**	**1,800**
2,800	**1,500**	**1,700**	**1,400**	**1,900**	**1,900**	**1,900**	**1,900**	**1,900**
2,900	**1,500**	**1,700**	**1,400**	**1,900**	**1,900**	**1,900**	**1,900**	**1,900**
3,000	**1,500**	**1,700**	**1,500**	**1,900**	**1,900**	**1,900**	**1,900**	**1,900**
3,100	**1,500**	**1,700**	**1,600**	**2,100**	**2,200**	**1,900**	**1,900**	**1,900**
3,200	**1,500**	**1,700**	**1,700**	**2,300**	**2,300**	**2,100**	**2,000**	**2,000**
3,300	**1,900**	**1,800**	**1,900**	**2,500**	**2,400**	**2,200**	**2,200**	**2,200**
3,400	**1,900**	**1,800**	**2,100**	**2,600**	**2,600**	**2,500**	**2,300**	**2,400**
3,500	**2,000**	**2,100**	**2,200**	**2,600**	**2,600**	**2,500**	**2,300**	**2,400**
3,600	**2,100**	**2,100**	**2,200**	**2,600**	**2,700**	**2,600**	**2,400**	**2,400**
3,700	**2,100**	**2,100**	**2,200**	**2,700**	**2,700**	**2,700**	**2,500**	**2,500**
3,800	**2,100**	**2,200**	**2,200**	**2,800**	**2,800**	**2,700**	**2,500**	**2,600**
3,900	**2,200**	**2,200**	**2,200**	**2,800**	**2,800**	**2,700**	**2,600**	**2,600**
4,000	**2,200**	**2,200**	**2,300**	**2,800**	**2,800**	**2,700**	**2,600**	**2,600**
4,100	2,200	2,200	2,300	2,800	2,800	2,700	2,600	2,600
4,200	2,200	2,300	2,300	2,800	2,800	2,700	2,700	2,600
4,300	2,300	2,300	2,400	3,100	3,200	2,900	2,800	2,600
4,400	2,300	2,300	2,500	3,100	3,200	2,900	3,000	2,900
4,500	2,400	2,500	2,600	3,100	3,200	3,000	3,000	3,000
4,600	2,400	2,500	2,600	3,100	3,200	3,000	3,000	3,000
4,700	2,600	2,500	2,600	3,100	3,200	3,000	3,100	3,000
4,800	2,600	2,500	2,700	3,500	3,400	3,100	3,100	3,000
4,900	2,600	2,500	2,700	3,500	3,500	3,300	3,200	3,000
5,000	2,600	2,700	2,700	3,500	3,500	3,300	3,200	3,000
5,100	2,700	2,700	2,800	3,600	3,600	3,400	3,200	3,000
5,200	2,700	2,700	2,800	3,600	3,600	3,400	3,300	3,100
5,300	2,900	2,800	3,100	3,700	3,800	3,600	3,600	3,500
5,400	3,100	3,200	3,200	4,200	4,100	4,100	4,000	4,000
5,500	3,200	3,200	3,300	4,200	4,100	4,100	4,000	4,000
5,600	3,200	3,200	3,300	4,200	4,100	4,100	4,000	4,000

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)							
	Sep*	Oct	Nov	Dec	Jan	Feb	Mar	Apr
5,700	3,200	3,200	3,300	4,200	4,200	4,100	4,000	4,000
5,800	3,200	3,200	3,300	4,200	4,200	4,100	4,000	4,000
5,900	3,200	3,300	3,400	4,200	4,200	4,100	4,000	4,000
6,000	3,200	3,300	3,400	4,200	4,200	4,100	4,100	4,000
6,100	3,300	3,300	3,400	4,200	4,200	4,100	4,100	4,000
6,200	3,300	3,300	3,400	4,200	4,300	4,100	4,100	4,000
6,300	3,300	3,300	3,400	4,300	4,300	4,200	4,200	4,100
6,400	3,400	3,400	3,500	4,300	4,300	4,200	4,200	4,100
6,500	3,400	3,400	3,500	4,300	4,300	4,200	4,200	4,100
6,600	3,500	3,800	3,700	4,300	4,300	4,200	4,200	4,100
6,700	3,700	3,800	3,700	4,300	4,300	4,200	4,200	4,100
6,800	3,700	3,800	3,800	5,000	5,000	5,000	4,300	4,100
6,900	3,700	4,000	4,100	5,000	5,000	5,000	5,000	4,600
7,000	4,100	4,100	4,200	5,100	5,100	5,000	5,000	4,900

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

Table C-3. Chum Salmon.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)						
	Nov*	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
3,000	**2,100**	**1,800**	**1,500**	**1,800**	**1,800**	**2,100**	**1,500**
3,100	**2,100**	**1,800**	**1,500**	**1,800**	**1,800**	**2,100**	**1,500**
3,200	**2,200**	**1,800**	**1,500**	**1,800**	**1,800**	**2,100**	**1,500**
3,300	**2,200**	**1,800**	**1,500**	**1,800**	**1,800**	**2,100**	**1,500**
3,400	**2,200**	**1,800**	**1,800**	**1,800**	**2,100**	**2,100**	**1,500**
3,500	**2,200**	**1,800**	**2,200**	**1,800**	**2,100**	**2,100**	**1,500**
3,600	**2,200**	**1,800**	**2,200**	**1,800**	**2,100**	**2,100**	**1,500**
3,700	**2,200**	**1,800**	**2,200**	**1,800**	**2,200**	**2,100**	**1,500**
3,800	**2,200**	**1,800**	**2,200**	**1,800**	**2,200**	**2,100**	**1,500**
3,900	**2,200**	**1,800**	**2,200**	**1,800**	**2,200**	**2,100**	**1,500**
4,000	**2,200**	**1,800**	**2,200**	**1,800**	**2,200**	**2,100**	**1,500**
4,100	**2,200**	**1,800**	**2,200**	**1,900**	**2,300**	**2,200**	**1,500**
4,200	**2,200**	**1,800**	**2,300**	**1,900**	**2,300**	**2,200**	**1,500**
4,300	**2,200**	**1,900**	**2,400**	**1,900**	**2,300**	**2,200**	**1,500**
4,400	**2,200**	**1,900**	**2,400**	**1,900**	**2,300**	**2,200**	**1,500**
4,500	**2,200**	**2,100**	**2,400**	**2,000**	**2,300**	**2,300**	**1,600**
4,600	**2,200**	**2,100**	**2,600**	**2,300**	**2,600**	**2,500**	**1,600**
4,700	2,200	2,100	2,800	2,500	2,800	2,600	1,700
4,800	2,200	2,100	2,900	2,600	2,800	2,600	1,800
4,900	2,400	2,200	3,000	2,600	2,900	2,800	1,900
5,000	2,600	2,200	3,000	2,600	2,900	2,800	1,900
5,100	2,600	2,500	3,000	2,600	3,000	2,800	1,900
5,200	2,600	2,500	3,000	2,600	3,000	2,900	1,900
5,300	2,600	2,500	3,000	2,600	3,100	3,000	2,100
5,400	2,800	2,500	3,200	2,800	3,300	3,100	2,100
5,500	2,900	2,500	3,200	2,800	3,300	3,100	2,200
5,600	3,000	2,500	3,200	2,800	3,300	3,100	2,200
5,700	3,000	2,600	3,200	3,000	3,500	3,300	2,300
5,800	3,000	2,700	3,400	3,000	3,500	3,300	2,400
5,900	3,300	2,800	3,400	3,000	3,500	3,300	2,500
6,000	3,400	3,100	3,400	3,000	3,500	3,300	2,700
6,100	3,500	3,200	3,500	3,000	3,700	3,600	2,900
6,200	3,500	3,200	3,500	3,300	3,900	3,700	2,900
6,300	3,800	3,200	4,100	3,700	4,000	4,000	3,000
6,400	4,000	3,300	4,100	3,700	4,000	4,000	3,300
6,500	4,200	3,300	4,100	3,700	4,100	4,100	3,500
6,600	4,200	3,800	4,100	3,800	4,400	4,300	3,600
6,700	4,300	3,800	4,200	3,800	4,400	4,300	3,600

Season Spawning Flow (cfs)	**Minimum Instantaneous Incubation Flow (cfs)**						
	Nov*	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
6,800	4,600	3,900	4,200	4,100	4,700	4,500	3,700
6,900	4,600	4,000	4,700	4,200	4,800	4,500	3,700
7,000	4,600	4,000	4,700	4,200	4,800	4,500	3,800

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX D

SALMON FRY PROTECTION EXAMPLES

1.0 SALMON FRY PROTECTION FLOW

"Protection for Chinook Salmon fry is provided by implementing minimum flow requirements and restrictions on downramp conditions (amplitude and rate) to minimize the risk of fry stranding during the period when fry are emerging from redds. For Chinook Salmon, the Fry Protection Period extends from January 1 through May 31. During this period, the Downramp Amplitude will not exceed 3,000 cfs from January 1 through January 31 and 4,000 cfs from February 1 through May 31." (Section 3.1.1.3).

Assumptions:

- A power scheduler is preparing a schedule for a Thursday on a Wednesday in April.
- Required minimum Predicted Marblemount Flow = 3,000 cfs.
- Required fry protection flow at Newhalem gage = 1,800 cfs.
- Required incubation flow at Newhalem gage = 1,900 cfs.
- Tributary Inflow on Inflow Day (Tuesday) = 300 cfs.
- Maximum required fry protection flow at Newhalem gage = 2,600 cfs.

Calculation:

- Minimum Flow at Newhalem plus Tributary Inflow = 1,900 + 300 = 2,200 cfs.
- Minimum Flow needed to achieve 3,000 cfs Predicted Marblemount Flow = 3,000 - 300 = 2,700 cfs.

Action: A release of the minimum required incubation flow (1,900 cfs) plus Tributary Inflow would result in a Predicted Marblemount Flow which is 700 cfs short of the required 3,000 cfs. However, the amount of Newhalem flow required to provide a Predicted Marblemount flow of 3,000 (2,700 cfs) is greater than 2,600 cfs, so generation schedules will be prepared such that a minimum flow of at least 2,600 cfs is provided for each hour on Thursday.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX E

SHAPING OF FLOWS DURING STEELHEAD SPAWNING

1.0 OBJECTIVES

The basic objective of intentional shaping, or redistributing, the spawning flows during steelhead spawning is to provide relatively uniform spawning and incubation conditions for steelhead throughout the Steelhead Spawning Period. Also, incubation flows are selected that protect redds without jeopardizing refill nor causing avoidable spill. Shaping the flows requires recognition that the Tributary Inflow is less in the earlier part of the Steelhead Spawning Period (March) than at the end of the Steelhead Spawning Period (June). Also, the greatest proportion of wild steelhead spawning occurs in the middle of the Steelhead Spawning Period, April and May. To achieve uniform flow at Marblemount, Daily Spawning Flows at the Newhalem gage will be kept as low as is consistent with actual available reservoir storage and sidestream flows below Ross Lake during periods of high Tributary Inflow and peak spawning (i.e., April and May).

Note that for all historical inflow volumes (from both liquid precipitation and snowmelt runoff) to-date during the whole of the Steelhead Spawning Period have been greater than the maximum volumes allowed to be released during the Steelhead Spawning Period, requiring the excess water to be stored in Ross Lake, and consequently that Ross Lake must be drafted in the prior winter. The requirement to absorb excess water in Ross Lake aids the effort to refill Ross Lake by July 31; however, as maximum and minimum flows must also be respected throughout the Steelhead Spawning Period, this interaction of objectives requires the winter draft of Ross Lake to be planned carefully, based on the best forecasts available, and with consideration of forecast uncertainty if possible, such that the expected excess volume of water beyond planned releases during the Steelhead Spawning Period that must be absorbed into Ross Lake is equal to the volume drafted from Ross Lake the previous winter.

2.0 OPERATING PRINCIPLES

Shaping discharge from Gorge Powerhouse in order to maintain uniform (i.e., flat) flows must be planned with consideration of the expected sum of sidestream flows between Gorge Powerhouse and the Marblemount gage. This roughly reverses the trend of Tributary Inflow and helps achieve the goal of uniform spawning and incubation conditions for steelhead throughout the Spawning Period. The actual spawning flows that are created in each of the spawning months by this shaping effort are later compared to the Steelhead Spawning/Incubation Flow Tables (Appendix G) to determine the required incubation flow for each month.

3.0 METHODOLOGY

Monthly Planned Spawning Flows shall be calculated in advance of the Steelhead Spawning Period and adjusted each week, or more frequently as needed, during the period based on the following criteria:

(1) current runoff volume forecast;

(2) maximum capability (output) of Gorge Powerhouse;

(3) refill requirements; and

(4) storage ability of Ross Lake.

In advance of the start of Steelhead Spawning Period, these Planned Spawning Flows are defined by the Spawning Control Curve, the basic planning tool in this shaping process. The actual Daily Spawning Flows are influenced by two additional criteria: actual runoff (timing and volume) and daily adherence to physical limitations. Further, Monthly Planned Spawning Flows shall be limited to the maximums provided in Section 3.1.4.1.

The Spawning Control Curve is a set of Planned Spawning Flows that are derived by solving an equation that includes three variables: (1) forecast total runoff into Ross Lake; (2) forecast storage available in Ross Lake; and (3) monthly flows that sum to the total volume. In general terms, the water that will create Spawning Flows is the difference between the water that runs off into Ross Lake and the available storage at Ross Lake. Sidestream Inflow is also a factor, and the equation takes that into account by shaping forecast flows at Gorge Powerhouse using available Ross Lake storage. Actual Sidestream Inflow may produce minor variations.

More specifically, the entire volume of runoff at Gorge from March 1 to June 30 is divided among the months that constitute the forecast period, namely March, April, May, and June. Each monthly flow in the equation is expressed in terms of the flow in May (X), the month of highest expected Tributary Inflow. Forecast average Tributary Inflow in March is typically lower than in May and is represented by T_{Mar}, so the Planned Spawning Flow in March should be $X + T_{Mar}$ cfs. Tributary Inflow in April is also typically lower than in May, and the Planned Spawning Flow in April should be $X + T_{Apr}$ cfs. Tributary Inflow in the first half of June is typically about the same as in May, and June 1st – 15th Planned Spawning Flows are denoted as T_{Jun}.

Finally, it was assumed that a discharge flow of Y cfs at the Newhalem gage would be planned to be equal to the midpoint between the maximum discharge flow from Gorge Powerhouse without spilling (taking planned unit outages into consideration) plus predicted natural sidestreams between Gorge Powerhouse and Newhalem, and the minimum discharge flow at Ross Lake plus the forecast Sidestream Inflow, for the June 15th - 30th period, independent of X. Planning for a discharge at the midpoint of the allowed possible range maximizes flexibility and opportunity for later correction, in light of significant forecast uncertainty when planning flows in the months-ahead time frame.

Expressed as an equation, the sum of expected volume flows in March, April, May, and June is set equal to the total volume of forecast runoff (measured in volume terms of second-foot-days or SFD), less the total amount of forecast storage in Ross Lake.

That is, March + April + May + June average flows = forecast runoff - forecast storage.

In algebraic terms:

$[(X+T_{Mar})*31 \text{ days}] + [(X+T_{Apr})*30 \text{ days}] + [X*31 \text{ days}] + [X*15 \text{ days} + Y*15 \text{ days}] = VF - VS$, equation (1)

where:

- VF = forecasted runoff in Ross Lake from March 1 to June 30.
- VS = storage available in Ross Lake from March 1 to June 30.

For example, suppose the March 1 elevation in Ross Lake is actually measured at 1,535 feet City of Seattle datum (CoSD) and the June 30 elevation is forecasted to be 1,595 feet CoSD, then VS is 60 feet, which is approximately 296,000 SFD when converted to volume terms. Suppose also that the expected March Tributary Inflows are 1,500 cfs lower than those expected in May, expected April Tributary Inflows are 1,000 cfs lower than those expected in May, expected June 1 to June 15 Tributary Inflows are expected to be about equal to those expected in May, and the planned June 16 to June 30 flows at Newhalem are Y=6,000 cfs. Then the Spawning Control Curve equation is solved as follows:

[Left side of equation (1)] = VF - 296,000

Multiplying out and collecting terms,

$107X + 166{,}500 = VF - 296{,}000$

Solving for X,

$X = (VF - 296{,}000 - 166{,}500) / 107$

Assume further that based on snow surveys and historical data that the runoff forecast, VF, for the sample year is 730,000 SFD. Then, the equation above is solved giving X = 2,500 cfs.

Therefore, the Planned Spawning Flows in the forecast period are:

March = X + 1,500 = 4,000 cfs

April = X + 1,000 = 3,500 cfs

May = X = 2,500 cfs

June 1-15 = X = 2,500 cfs

In summary, the Spawning Control Curve for this sample year for the period March 1 to June 15 is determined by (a) the set of monthly average forecasted flows, (b) total forecasted runoff, and (c) forecasted storage in Ross Lake.

The flows that constitute the Spawning Control Curve are recalculated at least monthly as runoff forecasts are updated, and a new set of spawning flows are derived. Plant operators at the Skagit River Project will then endeavor to operate the Project such that the spawning flows, as measured at the Marblemount gage, will be as uniform as possible through the Steelhead Spawning Period.

Occasionally, however, things do not go as planned. For example, severe weather conditions or the lack of perfect foresight may require Planned Spawning Flows to differ from the Spawning Control Curve. To minimize the impact of forecast uncertainty, the Spawning Control Curve should therefore be updated regularly leading up to and throughout the Steelhead Spawning Period. Just before steelhead spawning begins on March 15, a final Spawning Control Curve should be calculated using the 50 percent exceedance (P50) natural inflow and sidestream forecasts, resulting in a target value of total Marblemount flow, to be maintained as uniformly as possible throughout the Steelhead Spawning Period. That Marblemount flow should be targeted and maintained as uniformly as possible through the end of March. At the start of April, the average total flow at the Marblemount gage from March 15 to March 30 should be considered the established target Marblemount flow for the remainder of the Steelhead Spawning Period.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX F

STEELHEAD INCUBATION FLOW EXAMPLES

1.0 STEELHEAD INCUBATION FLOW - DURING SPAWNING (EARLY SUBPERIOD)

"During the first 10 days of the Spawning Period, which also represent the first 10 days of the Incubation Period, incubation flows will be based on the Planned Spawning Flow. Planned spawning flows are the flows targeted for spawning during a given month in City Light's monthly operating plan." (Section 3.1.4.2).

Assumptions:

- The power scheduler is preparing a schedule for April 3 on April 2.
- Season Spawning Flow for March steelhead = 5,000 cfs.
- April steelhead are spawning for the third day.
- The Planned Spawning Flow for April steelhead = 4,500 cfs.
- The required fry protection flow for salmon = 1,800 cfs.

Procedure: The required incubation flow for early April spawners based on the Planned Spawning Flow is obtained from Table G-2, Appendix G, and for April 3 is 1,800 cfs. The required incubation flow for March steelhead incubating in April based on the Season Spawning Flow (from Table G-1) is 2,000 cfs.

Action: The higher of the incubation (2,000 cfs) or fry protection flows (1,800 cfs) takes precedence. Of the two incubation flows (1,800 and 2,000 cfs), the higher required incubation flow takes precedence, therefore the power scheduler must schedule a flow of at least 2,000 cfs for each hour of April 3.

2.0 STEELHEAD INCUBATION FLOW - DURING SPAWNING (MID- SUBPERIOD)

"During the remainder of the Spawning Period, incubation flows will be based on the average of the ten highest Daily Spawning Flows that have occurred during the Spawning Period up to that day. Daily Spawning Flows are calculated as the actual average daily flow at the Newhalem gage minus the portion of flow attributed to other sources. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1.4.2).

Assumptions:

- The power scheduler is preparing a schedule for April 15 on April 14.
- Season Spawning Flow for March steelhead = 5,000 cfs.
- April steelhead spawned on April 13 for the thirteenth day.
- Daily Spawning Flows through April 13 = **5,011; 5,024; 4,990; 5,012; 4,910; 4,870;** 4,650; **4,690;** 4,450; **5,010; 5,007; 5,101;** and 4,468 cfs.
- The required fry protection flow for salmon = 1,800 cfs.

Procedure: The spawning flow for April steelhead calculated as the ten highest Daily Spawning Flows through the last Inflow Day is 4,962 cfs. Thus, the required incubation flow for April steelhead which is obtained from Table G-2, Appendix G, is 1,800 cfs. The required incubation flow for March steelhead based on the Season Spawning Flow (from Table G-1) is 2,000 cfs.

Action: The higher of the incubation or fry protection flows takes precedence. The higher required incubation flow takes precedence over the lower incubation flow, therefore the power scheduler must schedule a flow of at least 2,000 cfs for each hour of April 15.

3.0 STEELHEAD INCUBATION FLOW - AFTER SPAWNING

"During the remainder of the Incubation Period, incubation flows will be based on the Season Spawning Flow which is calculated as the average of the ten highest Daily Spawning Flows at the Newhalem gage observed during that spawning subperiod. City Light may determine that basing the incubation flows on the ten highest Daily Spawning Flows could result in an incubation flow that is higher than desirable. Since the main purpose of incubation flows is to keep redds inundated during the incubation period, City Light may use an adaptive management approach to evaluate the sensitivity and effectiveness of using the ten highest Daily Spawning Flows versus an alternative approach if approved by the SRCC. Additionally, City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC." (Section 3.1.4.2).

Assumptions:

- The power scheduler is preparing a schedule for a day in late June.
- Season Spawning Flow for March steelhead = 5,000 cfs.
- Season Spawning Flow for April steelhead = 4,000 cfs.
- Season Spawning Flow for May - June 15 steelhead = 3,500 cfs.
- The required fry protection flow for salmon = none.
- The required fry protection flow for steelhead = 1,500 cfs.
- Tributary Inflow on last Inflow Day = 2,100 cfs.

Procedure: The required incubation flows for March, April, and May - June 15 steelhead which are obtained from Tables G-1, G-2, and G-3 in Appendix G are 3,859; 4,059; and 4,560 cfs (Predicted Marblemount Flow), respectively, during the incubation month of June. Based on Tributary Inflow on the Inflow Day (2,100 cfs), these flows correspond to Newhalem gage flows of 1,759; 1,959; and 2,460 cfs, respectively.

Action: When scheduling minimum daily flows, the higher of the incubation or fry protection flows takes precedence. In this case the highest required incubation flow (4,560 cfs, Predicted Marblemount Flow, which corresponds to 2,460 cfs at Newhalem based on the last Inflow Day's Tributary Inflow) takes precedence over the lower fry protection flow that is measured at Newhalem gage (1,500 cfs). Therefore the power scheduler must schedule an instantaneous flow of at least 2,460 cfs at the Newhalem gage for each hour of the day in June being scheduled.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX G

STEELHEAD SPAWNING/INCUBATION FLOW TABLES

Table G-1. March steelhead.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)			
	Mar*	Apr	May	Jun
3,000	1,800	1,800	1,500	3,859
3,100	1,800	1,800	1,500	3,859
3,200	1,800	1,800	1,500	3,859
3,300	1,800	1,800	1,500	3,859
3,400	1,800	1,800	1,500	3,859
3,500	**1,800**	**1,800**	**1,700**	**3,859**
3,600	**1,800**	**1,800**	**1,700**	**3,859**
3,700	**1,800**	**1,800**	**1,700**	**3,859**
3,800	**1,800**	**1,800**	**1,700**	**3,859**
3,900	**1,800**	**1,800**	**1,700**	**3,859**
4,000	**1,800**	**1,800**	**1,700**	**3,859**
4,100	**1,800**	**1,800**	**1,700**	**3,859**
4,200	**1,800**	**1,800**	**1,700**	**3,859**
4,300	**1,800**	**1,800**	**1,800**	**3,859**
4,400	**1,800**	**1,800**	**1,900**	**3,859**
4,500	**1,800**	**1,800**	**1,900**	**3,859**
4,600	**1,800**	**1,900**	**1,900**	**3,859**
4,700	**1,800**	**1,900**	**1,900**	**3,859**
4,800	**1,800**	**1,900**	**1,900**	**3,859**
4,900	**1,800**	**2,000**	**1,900**	**3,859**
5,000	**1,800**	**2,000**	**1,900**	**3,859**
5,100	1,800	2,100	1,900	3,859
5,200	1,800	2,100	1,900	3,859
5,300	1,800	2,100	1,900	3,859
5,400	1,800	2,100	1,900	3,859
5,500	1,800	2,100	1,900	3,859
5,600	1,900	2,300	2,100	3,859
5,700	1,900	2,300	2,100	3,859
5,800	1,900	2,300	2,100	3,859
5,900	1,900	2,300	2,100	3,959
6,000	1,900	2,300	2,100	4,059
6,100	2,200	2,500	2,300	4,159
6,200	2,200	2,500	2,400	4,259
6,300	2,300	2,500	2,500	4,359
6,400	2,400	2,600	2,500	4,359
6,500	2,400	2,600	2,600	4,559

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

\# Predicted Marblemount Flow.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

Table G-2. April steelhead.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)			
	Apr*	May	Jun#	Jul#
1,000	1,000	1,000	2,369	2,035
1,100	1,000	1,000	2,469	2,135
1,200	1,100	1,000	2,569	2,235
1,300	1,200	1,000	2,669	2,335
1,400	1,300	1,000	2,769	2,435
1,500	1,400	1,000	2,535	2,535
1,600	1,500	1,100	2,969	2,635
1,700	1,600	1,200	3,069	2,735
1,800	1,700	1,300	3,169	2,835
1,900	1,800	1,400	3,269	2,935
2,000	1,800	1,500	3,369	3,035
2,100	1,800	1,500	3,469	3,135
2,200	1,800	1,600	3,569	3,235
2,300	1,800	1,700	3,669	3,335
2,400	1,800	1,800	3,769	3,435
2,500	1,800	1,900	3,869	3,535
2,600	1,800	1,900	3,869	3,535
2,700	1,800	2,000	3,869	3,535
2,800	1,800	2,000	3,969	3,635
2,900	1,800	2,100	3,969	3,635
3,000	1,800	1,500	3,859	3,193
3,100	1,800	1,700	3,859	3,493
3,200	1,800	1,900	3,859	3,493
3,300	1,800	1,900	3,859	3,493
3,400	1,800	1,900	3,959	3,593
3,500	**1,800**	**1,900**	**4,059**	**3,593**
3,600	**1,800**	**1,900**	**4,059**	**3,693**
3,700	**1,800**	**1,900**	**4,059**	**3,693**
3,800	**1,800**	**1,900**	**4,059**	**3,693**
3,900	**1,800**	**1,900**	**4,059**	**3,693**
4,000	**1,800**	**2,000**	**4,059**	**3,693**
4,100	**1,800**	**2,100**	**4,059**	**3,793**
4,200	**1,800**	**2,100**	**4,059**	**3,793**
4,300	**1,800**	**2,200**	**4,059**	**3,793**
4,400	**1,800**	**2,200**	**4,059**	**3,793**
4,500	**1,800**	**2,200**	**4,059**	**3,793**
4,600	**1,800**	**2,200**	**4,059**	**3,793**
4,700	**1,800**	**2,200**	**4,059**	**3,793**
4,800	**1,800**	**2,200**	**4,059**	**3,793**
4,900	**1,800**	**2,200**	**4,059**	**3,793**
5,000	**1,800**	**2,200**	**4,059**	**3,793**
5,100	1,900	2,200	4,059	3,793
5,200	1,900	2,200	4,059	3,793
5,300	1,900	2,300	4,059	3,793
5,400	1,900	2,300	4,059	3,793
5,500	1,900	2,300	4,059	3,793
5,600	2,100	2,400	4,259	3,793
5,700	2,200	2,400	4,359	3,793
5,800	2,400	2,400	4,359	3,793
5,900	2,500	2,500	4,559	3,793
6,000	2,500	2,600	4,659	3,793
6,100	2,500	2,600	4,659	3,793
6,200	2,500	2,600	4,659	3,793
6,300	2,500	2,600	4,659	3,793

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)			
	Apr*	May	Jun#	Jul#
6,400	2,500	2,600	4,659	3,793
6,500	2,500	2,600	4,659	3,793

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

\# Predicted Marblemount Flow.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

Table G-3. May-June 15 steelhead.

Season Spawning Flow (cfs)	Minimum Instantaneous Incubation Flow (cfs)		
	May*	Jun*#	Jul#
2,000	1,500	4,160	3,093
2,100	1,500	4,160	3,093
2,200	1,500	4,160	3,093
2,300	1,500	4,160	3,193
2,400	1,500	4,160	3,193
2,500	1,500	4,160	3,293
2,600	1,500	4,160	3,293
2,700	1,500	4,160	3,293
2,800	1,500	4,160	3,693
2,900	1,500	4,160	3,793
3,000	**1,500**	**4,360**	**3,793**
3,100	**1,500**	**4,560**	**3,793**
3,200	**1,500**	**4,560**	**3,793**
3,300	**1,500**	**4,560**	**3,793**
3,400	**1,500**	**4,560**	**3,793**
3,500	**1,500**	**4,560**	**3,793**
3,600	**1,500**	**4,660**	**3,793**
3,700	**1,500**	**4,660**	**3,793**
3,800	**1,500**	**4,660**	**3,793**
3,900	**1,500**	**4,660**	**3,793**
4,000	**1,500**	**4,660**	**3,793**
4,100	1,500	4,660	3,793
4,200	1,500	4,660	3,793
4,300	1,500	4,660	3,793
4,400	1,500	4,660	3,793
4,500	1,500	4,660	3,793
4,600	1,500	4,660	3,793
4,700	1,500	4,660	3,793
4,800	1,500	4,660	3,793
4,900	1,500	4,660	3,793
5,000	1,500	4,660	3,793
5,100	1,800	4,660	3,793
5,200	1,800	4,660	3,793
5,300	2,000	4,660	3,793
5,400	2,100	4,660	3,793
5,500	2,100	4,660	3,793
5,600	2,100	4,660	3,793
5,700	2,100	4,660	3,793
5,800	2,100	4,660	3,793
5,900	2,100	4,660	3,793
6,000	2,100	4,660	3,793
6,100	2,100	4,660	3,793
6,200	2,100	4,660	3,793
6,300	2,100	4,660	3,793
6,400	2,100	4,660	3,793
6,500	2,100	4,660	3,793
6,600	2,200	4,681	3,908
6,700	2,200	4,681	3,908
6,800	2,200	4,681	3,908
6,900	2,200	4,681	3,908
7,000	2,200	4,681	3,908
7,100	2,200	4,681	3,908

Most likely spawning flows in **bold** lettering.

* Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90

percent EP during incubation.

Predicted Marblemount Flow.

Note: City Light may use an adaptive management approach to evaluate the efficacy of the Spawning and Incubation Flow Tables over the term of the new license. Modifications may be made as approved by the SRCC.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX H

STEELHEAD FRY PROTECTION EXAMPLES

1.0 DOWNRAMP AMPLITUDE DURING STEELHEAD FRY PROTECTION PERIOD - NORMAL CONDITIONS

"Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hr period due to a flow reduction at Gorge Powerplant and/or Gorge Dam. For steelhead, the Fry Protection Period extends from June 1 through October 15. During this period, the Downramp Amplitude will not exceed 3,000 cfs." (Section 3.1.4.3).

Assumptions:

- A power scheduler is preparing a schedule for July 10 on July 9.
- Natural Flow on Inflow Day (July 8) = 3,500 cfs.
- Fry Protection Flow requirement = 1,500 cfs.
- Maximum 24-hr Downramp Amplitude = 3,000 cfs.
- Maximum Downramp Amplitude Below 4,000 cfs at Newhalem gage = 2,000 cfs.
- March steelhead incubation has ended.
- Season Spawning Flow for April steelhead = 3,500 cfs.
- Season Spawning Flow for May - June 15 steelhead = 3,000 cfs.
- Tributary Inflow on the last Inflow Day = 2,293 cfs.

Procedure: The required incubation flows for April and May - June 15 steelhead, which are obtained from Tables G-2 and G-3 in Appendix G are 3,593 and 3,793 cfs (Predicted Marblemount Flow). Based on Tributary Inflow on the last Inflow Day (2,293 cfs), these flows correspond to Newhalem gage flows of 1,300 cfs and 1,500 cfs, respectively. The highest required incubation flow (1,500 cfs) is no larger than the fry protection flow requirement (1,500 cfs). Also, the power scheduler determines that a minimum flow of 1,500 cfs is an adequate flow in the low demand hours. Hence, the maximum Downramp Amplitude below 4,000 cfs at Newhalem gage (2,000 cfs) plus the minimum (1,500 cfs) provides the upper limit of fluctuation (i.e., the maximum flow of the 24-hr period: 2,000 cfs + 1,500 cfs = 3,500 cfs).

Action: The scheduler then must schedule hourly generation such that the minimum (1,500 cfs) and maximum (3,500 cfs) flow bounds are adhered to while reducing generation during a 24-hr period. The maximum Downramp Amplitude of 3,000 cfs cannot be achieved under these conditions. The scheduler must also make sure that reductions in generation that continue past midnight from one day to another do not result in 24-hr Downramp Amplitudes that exceed the maximum.

2.0 DOWNRAMP AMPLITUDE DURING STEELHEAD FRY PROTECTION PERIOD - NORMAL CONDITIONS (AUGUST)

"Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hr period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam. For steelhead, the Fry Protection Period extends from June 1 through October 15. During this period, the Downramp Amplitude will not exceed 3,000 cfs. An exception to this rule is that when the Project is operating under established Flow Insufficiency conditions in August, the Downramp Amplitude will not exceed 500 cfs." (Section 3.1.4.3).

Assumptions:

- A power scheduler is preparing a schedule for August 10 on August 9.
- Natural Flow on Inflow Day (August 8) = 3,500 cfs.
- Fry Protection Flow requirement = 2,000 cfs.
- Maximum 24-hr Downramp Amplitude = 3,000 cfs.

Procedure: The power scheduler determines that the minimum flow (2,000 cfs) is an adequate flow in the low demand hours. Hence, the minimum (2,000 cfs) plus the maximum Downramp Amplitude (3,000 cfs) provides the maximum peak of the day (2,000 cfs + 3,000 cfs = 5,000 cfs).

Action: The scheduler then must schedule hourly generation such that the minimum (2,000 cfs) and maximum (5,000 cfs) flow bounds are adhered to while reducing generation during a 24-hr period. The scheduler must also make sure that reductions in generation that continue past midnight from one day to another do not result in 24-hr Downramp Amplitudes that exceed the maximum.

3.0 DOWNRAMP AMPLITUDE DURING STEELHEAD FRY PROTECTION PERIOD – INSUFFICIENT MONTHS (AUGUST)

"Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hr period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam. For steelhead, the Fry Protection Period extends from June 1 through October 15. During this period, the Downramp Amplitude will not exceed 3,000 cfs. An exception to this rule is that when the Project is operating under established Flow Insufficiency conditions in August, the Downramp Amplitude will not exceed 500 cfs. Restrictions on the maximum downramping rates during the Steelhead Fry Protection Period are differentiated based on flow at the Newhalem gage. When Newhalem Instantaneous Flow is 4,000 cfs or less, downramping will be allowed up to 500 cfs/hr. When Newhalem Instantaneous Flow is greater than 4,000 cfs, downramping will be allowed up to 1,000 cfs/hr. However, when Natural Flow at the Newhalem gage is less than 2,300 cfs, the minimum flow for August may be reduced to 1,500 cfs." (Section 3.1.4.3).

Assumptions:

- A power scheduler is preparing a schedule for August 10 on August 9.
- Natural Flow on Inflow Day (August 8) = 1,500 cfs.
- Flow Insufficiency Provisions are in effect, because the Natural Flow at the Newhalem gage is less than 2,300 cfs.
- Fry Protection Flow requirement = 1,500 cfs.
- Maximum 24-hr Downramp Amplitude = 500 cfs.

Procedure: The power scheduler decides that the minimum flow (1,500 cfs) will be the desirable flow in the low demand hours. Hence, the minimum (1,500 cfs) plus the maximum Downramp Amplitude (500 cfs) provides the maximum peak of the day (1,500 cfs + 500 cfs = 2,000 cfs).

Action: The scheduler then must schedule hourly generation such that the minimum (1,500 cfs) and maximum (2,000 cfs) flow bounds are not exceeded while reducing generation during a 24-hr period. The scheduler must also make sure that reductions in generation that continue past midnight from one day to another do not result in 24-hr Downramp Amplitudes that exceed the maximum.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX I

FRY PROTECTION FLOWS AT NEWHALEM GAGE

Table I-1. Fry protection flows at Newhalem gage.

Months	Minimum Instantaneous Flow (cfs)
January	**
February	1,800
March	1,800
April	1,800
May	1,500
June	1,500
July	1,500
August	2,000*
September	1,500
October	1,500
November	**
December	**

* Minimum flow may be reduced to 1,500 cfs when Natural Flow on the Inflow Day is less than 2,300 cfs (Section 3.1.1.4).

** Minimum flows in these months are determined by incubation flow requirements.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX J

ALTERNATIVE SALMON AND STEELHEAD SPAWNING PERIODS

1.0 ALTERNATIVE SALMON AND STEELHEAD SPAWNING PERIODS

In any year, City Light may elect to conduct surveys to monitor the actual start and end dates of the Spawning Periods of each salmon species and steelhead. For any particular season, monitoring may result in delaying the start or advancing the end dates of the Spawning Period of a particular salmon species and/or steelhead during which operational constraints are imposed to protect spawning fish. The monitoring program will be developed by the SRCC composed of at least one representative of City Light and at least one representative of another SRCC party. The monitoring program must be approved by SRCC and shall be conducted by the monitoring team.

Whenever disputes arise concerning interpretation of field observations or other data pertaining to the alternative start or end date, which the SRCC cannot resolve in a timely fashion, the default date shall prevail, or, if the default start date has passed, City Light shall implement spawning/incubation flow restrictions on the day following the next Power Scheduling Day.

2.0 START OF SPAWNING PERIODS

The start of spawning may be determined by field monitoring that ascertains the presence of spawning fish or redds. The SRCC shall agree on certain reaches of river to be observed on a daily basis beginning at least two days prior to the default spawning start dates of each species. Default start dates and criteria for evidence of onset of spawning are as follows:

Table J-1. Spawning Start Date by Species.

Species	Evidence of Spawning	Default Start Date
Steelhead	Observed behavior or redd construction	March 15
Chinook	Observed behavior or redd construction	August 20
Pink	Observed behavior or redd construction	September 12
Chum	Observed behavior or redd construction	November 1

3.0 END OF SPAWNING PERIODS

The end of spawning may be determined by field monitoring that ascertains the absence of fish spawning. The SRCC shall agree on certain reaches of river to be observed on a daily basis beginning any number of days prior to the default spawning end dates of each species. Default end dates and evidence of cessation of spawning are as follows:

Table J-2. Spawning End Date by Species.

Species	Evidence of Cessation of Spawning	Default End Date
Steelhead	No observed behavior	June 15
Chinook	No observed behavior	October 15
Pink	No observed behavior	October 31
Chum	No observed behavior	January 6

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX K

ALTERNATIVE STEELHEAD FRY PROTECTION PERIOD

1.0 ALTERNATIVE STEELHEAD FRY PROTECTION PERIOD

The default Start and End dates for the Steelhead Fry Protection Period shall be June 1 and October 15, respectively, unless the SRCC agrees to alternative start and end dates for fry protection restrictions. Alternative Start and End dates shall be based on field monitoring or the Start Date may be based on the use of adaptive management. City Light may apply adjustments to the default Spawning Flows and Incubation Flows based on monitoring of conditions and observed periodicity if approved by the SRCC.

2.0 FIELD MONITORING

Field monitoring of steelhead fry presence shall be performed initially to determine the start of emergence and the end of the period during which steelhead fry are vulnerable to stranding. Field monitoring plans must be approved by the SRCC. Eventually, the Start Date may be determined as the first day that emerged fry are captured in steelhead redd caps or via some other mutually agreeable sampling method.

2.1 Start Date

The Start Date shall be either June 1 or a later date based upon field surveys and as agreed to by the SRCC. A field crew comprised of one monitoring representative from City Light and at least one from the SRCC shall select appropriate habitat to sample within those reaches according to flow conditions.

2.2 End Date

The End Date shall be either October 15 or an earlier date based upon field surveys and as agreed to by the SRCC. A field crew comprised of one monitoring representative from City Light and at least one from the SRCC shall select appropriate habitat to sample within those reaches according to flow conditions.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX L

MISCELLANEOUS CALCULATIONS

1.0 DOWNRAMP AMPLITUDE

Downramp Amplitude:

"Downramp Amplitude is defined as the difference between the highest and subsequent lowest Newhalem gage readings during any consecutive 24-hr period due to a flow reduction at Gorge Powerhouse and/or Gorge Dam." (Section 3.1).

Assumptions:

- On Day X, a peak of 7,000 cfs occurred at hour 1030.
- On the following day, a low flow of 3,000 cfs occurred at hour 0430.

Calculation:

Subtract the highest and lowest flows in a 24-hr period: 7,000 cfs - 3,000 cfs = 4,000 cfs.

Conclusion: The Downramp Amplitude for Day X is 4,000 cfs.

2.0 NATURAL FLOW

Natural Flow:

"Shall mean the flow which represents the average daily flow which would occur without the Skagit Project in place." (Section 6.0 Definitions).

Natural Flow is calculated as the sum of inflow into Ross Lake and the total sidestreams above Newhalem gage.

Assumptions:

- A power scheduler calculates the inflow into Ross Lake = 1,851 cfs and the natural sidestreams above Newhalem gage = 849 cfs.

Calculation:

Natural Flow at Newhalem gage = 1,851 cfs + 849 cfs = 2,700 cfs.

Conclusion: The Natural Flow at Newhalem gage on the Inflow Day is calculated as 2,700 cfs.

3.0 PREDICTED MARBLEMOUNT FLOW

Predicted Marblemount Flow:

"Shall mean the sum of the planned total discharge from Gorge Powerhouse and Gorge Dam (i.e., spill) during the target day, the forecast natural sidestream flow between Gorge Dam and the Newhalem gage, and the forecast Tributary Inflow (between Newhalem and Marblemount). In the absence of reliable sidestream and Tributary Inflow forecasts, the sum of the most recent observed daily average instantaneous natural sidestream flow between Gorge Dam and the Newhalem gage for a given calendar day, the Tributary Inflow for the corresponding Inflow Day, and the daily average Tributary Inflow can be added to the planned Gorge Powerhouse discharge for the target day in order to obtain the Predicted Marblemount Flow." (Section 6.0 Definitions).

Assumptions:

- A power scheduler is preparing a schedule for Thursday on a Wednesday in April.
- Required minimum Predicted Marblemount Flow = 3,000 cfs.
- Required Fry Protection Flow at Newhalem gage = 1,800 cfs.
- Required Incubation Flow at Newhalem gage = 1,800 cfs.
- Mean daily Tributary Inflow on Inflow Day (Tuesday) = 1,100 cfs.

Calculation:

Predicted Marblemount Flow for Thursday = 1,800 cfs + 1,100 cfs = 2,900 cfs.

Action: 2,900 cfs is 100 cfs less than the required 3,000 cfs, so the generation schedules will be made such that a minimum flow of at least 1,900 cfs is provided at Newhalem gage for each hour on Thursday.

4.0 TRIBUTARY INFLOW

Tributary Inflow:

"Shall mean the inflow from tributaries between the Newhalem gage and the Marblemount gage calculated as the mean daily flow at Marblemount gage minus the mean daily flow at Newhalem gage on the same calendar day." (Section 6.0 Definitions).

Assumptions:

- Mean daily flow at Marblemount gage = 6,000 cfs.
- Mean daily flow at Newhalem gage = 3,400 cfs.

Calculation:

Tributary Inflow = 6,000 – 3,400 = 2,600 cfs.

Conclusion: The Tributary Inflow is 2,600 cfs for the Inflow Day.

5.0 FLOW INSUFFICIENCY – CRITERION 1

"When discharge of the required minimum flows at the Newhalem gage, plus 300 cfs, combined with the forecasted inflow to Ross Lake which is exceeded with 95 percent confidence and the current reservoir volume results in Ross Lake drafting to the minimum useable pool." (Section 3.2.1.1).

An example of how this criterion will be determined is:

Assumptions:

Spawning conditions for Chinook, Pink and Chum salmon resulted in minimum flows for February, March, and April of 2,500 cfs; 2,400 cfs; and 2,400 cfs, respectively for incubation. Volume in storage at Ross Lake on January 31 is 63,900 SFD (this corresponds to an elevation of 1,505 feet CoSD, which would be caused by abnormally low winter runoff.) City Light provides forecast flows for February and March, with documentation to the SRCC, that shows 95 percent confidence forecast inflow into Ross Lake is 800 cfs in both February and March with 200 cfs Sidestream Inflow between Ross Lake and Newhalem gage. The forecast for April is 3,500 cfs, with 800 cfs Sidestream Inflow. The calculations are:

Ross Volume

	Start	63,900	SFD
+	February Inflow	22,400	= 800 cfs x 28 days
-	Ross Minimum Volume	- 72,800	= (2,500 + 300 – 200) cfs x 28 days
	February 28 Volume	13,500	= elevation 1,481 ft CoSD – no problem yet
+	March Inflow	24,800	= 800 cfs x 31 days
-	Ross Minimum	- 77,500	= (2,400 +300 – 200) cfs x 31 days
	March 31 Volume	-39,200	= below minimum usable pool (elev < 1,474.5 ft CoSD) –problem
+	April Inflow	105,000	= (2,400 +300 – 800) cfs x 30 days
-	Ross Minimum	-57,000	= (2,400 +300 – 800) cfs x 30 days
	April 30 volume	8,800	= above minimum usable pool (elev > 1,474.5 ft CoSD) – no problem

This calculation would set February and March as insufficient months. This would call for a quick meeting of the SRCC to determine the best course of action. Absent consensus agreement, City Light would reduce minimum flows in February and March by equal percentages (pro-rata reduction) until the March 31 volume is just enough above zero to meet minimum flows in April.

In this example a 27 percent reduction in minimum flow will achieve sufficiency. The new February minimum would be 1,825 cfs and March would be 1,752 cfs.

This procedure would leave Ross Lake below the minimum usable pool elevation at the end of March (i.e., 1,474.5 feet CoSD). If spring runoff was expected to be normal, this would be no problem. However, the action City Light would recommend would be to reduce minimum flows so that February and March would be lower still, to protect against a continuation of 1,000 cfs natural flow at the Newhalem gage with Ross Lake below the minimum usable pool elevation.

Note that this example was picked for illustrative purposes and to demonstrate the calculation technique. In practice, this calculation would be done each month through July 31 so that an early warning could be given. Also note that in this circumstance something must be done as Ross Lake cannot physically release enough water to maintain minimum flows.

6.0 FLOW INSUFFICIENCY - CRITERION 2

"When discharge of the required minimum flows at the Newhalem gage, plus 300 cfs, combined with the forecasted inflow to Ross Lake (which is exceeded with 95 percent confidence) results in Ross Lake drafting to the minimum usable pool." (Section 3.2.1.1)

An example of how this criterion is determined is:

Assumptions:

Previous spawning conditions produce required incubation flows in May, June, and July of 1,700 cfs; 1,300 cfs; and 1,700 cfs, respectively. Ross Lake begins May at 1,500 feet CoSD, which is a volume of 60,000 SFD. The 95 percent confidence inflow to Ross Lake is 5,500 cfs in May, 5,000 cfs in June, and 4,000 cfs in July. Sidestream Inflow between Ross Lake and the Newhalem gage is 1,700 cfs; 2,000 cfs; and 1,200 cfs in May, June and July, respectively (90 percent confidence).

Ross Volume

	Start	60,000	SFD
+	May inflow	170,500	= 5,500 cfs x 31 days
-	Ross Minimum volume	-9,300	= (1,700 + 300 – 1,700) cfs x 31 days
	May 31 Volume	221,200	
+	June inflow	150,000	= 5,000 cfs x 30 days
-	Minimum	0	= (1,300 + 300 – 2,000) cfs x 30 days (Minimum is zero because there is more Sidestream Inflow [2,000 cfs] than needed to maintain minimum flow.)
	June 30 value	371,200	
+	July inflow	124,000	= 4,000 cfs x 31 days
-	Minimum	-24,800	= (1,700 + 300 – 1,200) cfs x 31 days
	July 31 value	470,400	= below full (full is 530,000 SFD)
	Full	-530,000	
	Deficit	-59,600	SFD

This calculation would set May, June, and July as insufficient months since Ross Lake does not refill. This would call for a meeting of the SRCC to determine the best course of action. Absent consensus, City Light would reduce minimum flows in May, June, and July by equal percentages (pro-rata) so that Ross Lake can refill. In this example a reduction of 20 percent in May and July would achieve sufficiency (no additional reduction is needed in June because the minimum required release from Ross Lake is already zero). The new minimum at Newhalem for May, June, and July would be 1,360 cfs; 1,300 cfs; and 1,360 cfs, respectively.

It is important to take into consideration that forecast uncertainty increases with forecast horizon, and seasonal (monthly) forecasts will likely not have skill more than a few months ahead, so at times this situation may be difficult to foresee with confidence with more than a few months' warning. However, the SRCC should be kept apprised whenever risk of flow insufficiency is significant, which will give them an opportunity to spread the reduction in flows over more months, alleviating the impact on any given month.

7.0 FLOW INSUFFICIENCY - CRITERION 3

"When Natural Flow at the Newhalem gage on any Inflow Day in August is less than 2,300 cfs." (Section 3.2.1.1).

Assumptions:

The power scheduler is preparing a schedule for Wednesday on a Tuesday in August. Natural Flow at the Newhalem gage on the Inflow Day is 1,800 cfs. The Fry Protection Flow requirement is 2,000 cfs.

Action: The power schedulers may drop the flow to as low as 1,500 cfs, subject to the hourly downramp rate of 500 cfs/hr (daytime or nighttime) for all days in which the minimum flow is below 2,000 cfs. The schedule for Wednesday may show a minimum flow as low as 1,500 cfs. Since the downramp rate for steelhead fry protection is 500 cfs/hr, the minimum flow could start at 0100 hrs on Wednesday, with no further downramps for the day.

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX M

TRIBUTARY PERCENT EXCEEDANCE FLOW BETWEEN NEWHALEM AND MARBLEMOUNT

1.0 TRIBUTARY PERCENT EXCEEDANCE FLOW BETWEEN NEWHALEM AND MARBLEMOUNT

Table M-1. Tributary Percent Exceedance Flow between Newhalem and Marblemount.

Month	50 Percent Exceedance Flow (cfs)	90 Percent Exceedance Flow (cfs)
January	1,164	684
February	1,533	853
March	1,450	1,044
April	1,504	1,111
May	2,530	1,742
June	2,763	2,084
July	2,174	1,223
August	1,093	644
September	975	617
October	968	611
November	1,781	742
December	1,537	656

RIVERSCAPE ECOSYSTEM PLAN

APPENDIX N

FORECAST VERIFICATION

1.0 DEFINITIONS

The forecast period is the start date or time of the forecast through the end date or time of the forecast.

The forecast target period is the period of time for which the forecast value is valid. For example a forecast for the monthly average streamflow in May, the month of May is the forecast target period.

A seasonal forecast is a forecast of monthly average values.

A forecast horizon is the number of full forecast periods between when the forecast is created, and the target forecast period. For example, for a seasonal forecast created in mid-January, with forecast values valid in February, March, and April, the forecast value for February has a zero-month horizon, the forecast value for March has a one-month horizon, and the forecast value for April has a two-month horizon. Another single time series forecast for the same target months created at the end of January for the next three calendar months ahead would be considered to have the same forecast horizons. If a subsequent forecast for March and April were created in February, the forecast value for March would then have a zero-month horizon, and April's forecast value would have a one-month horizon. The same applies regardless of forecast time resolution, such as for hourly, daily, or yearly forecasts.

2.0 BASELINE FORECASTS

Baseline forecasts are simplistic forecasts that do not take any specialized knowledge to produce. Baseline forecasts are used as benchmarks for forecasts produced by more complex models. If a forecast produced from a more complex model cannot perform better, on average, than a simple baseline forecast, it is said to not have forecast skill; in this case, planners would be better off using a baseline forecast. The intuition here is that more complex forecast models, such as a linear regression or a neural network, should be able to demonstrate skill over a simple baseline forecast.

When forecasting at small forecast time resolutions (such as hour-averages) for small horizons (such as 0 to 10 hours ahead), a typical method of generating a baseline forecast is to use the most recent observed value at the same time resolution, and project that forward into the future over your forecast period. This particular type of baseline forecast is called a "persistence" forecast.

When forecasting at larger forecast time resolutions (such as month-averages) for longer horizons (such as 1 to 10 days ahead), a typical method of generating a baseline forecast is to simply substitute historical averages from the same historical period. For example, for monthly averages spanning a forecast period from 1 to 12 months ahead, a typical method of generating a baseline forecast is to simply use historical monthly averages from a recent period in history (for example, the last 30 years). This is typically called a "climatology" forecast.

3.0 FORECAST SKILL

Particularly for weather, or weather-driven forecasts like streamflow forecasts, it is important for planners to determine and monitor forecast skill, so that they can revert back to a baseline forecast once the more complex forecast model does not show skill.

3.1 Forecast Error

The final version of the REP FMP will include discussion on typical forecast error metrics.

3.2 Deterministic Forecast Skill

The final version of the REP FMP will include discussion on deterministic forecast skill.

3.3 Probabilistic Forecast Skill

Probabilistic forecasts generate a full probability distribution for each forecast target period, rather than just a single value. Probabilistic forecast exceedance values (P values, such as P10 or P90), or equivalent forecast quantiles (such as 90^{th} or 10^{th} percentiles) can also be evaluated for skill. In this case a reasonable probabilistic baseline forecast would be to use the historical empirical distribution of forecast values for each forecast target period.

The final version of the REP FMP will include discussion on typical probabilistic forecast skill metrics.

3.4 Example Calculations

The final version of the REP FMP will include example calculations of Forecast Skill.