FISH MANAGEMENT PLAN

ENLOE HYDROELECTRIC PROJECT
(FERC PROJECT NO. 12569)

FEBRUARY 2012

(REVISED JULY 2012)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

amsl	above mean sea level
BLM	U.S. Bureau of Land Management
BMP	Best Management Practice
C	Celsius
CCT	Confederated Tribes of the Colville Reservation
cfs	cubic feet per second
District	Public Utility District No. 1 of Okanogan County
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
Falls	Similkameen Falls
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FMP	Fish Management Plan
fps	feet per second
FW	Fish Workgroup
FW	Fisheries workgroup
LWD	large woody debris
NMFS	National Marine Fisheries Service
OBEMP	Okanogan Basin Monitoring and Evaluation Project
Project	Enloe Hydroelectric Project
RM	river mile
TDG	Total dissolved gas
UCR	Upper Columbia River
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

This Fish Management Plan (FMP) is developed for compliance with the requirements of the Washington Department of Ecology Section 401 of the Clean Water Act (401 Certification). The FMP is provided in relation to the Enloe Hydroelectric Project (Project), FERC No. 12569, for Public Utility District No. 1 of Okanogan County (District). The FMP includes an overview of the physical structures associated with the Project (Section 2.1); a description of the fish species currently inhabiting the reservoir, bypass reach and downstream of Similkameen Falls (Section 2.2); a set of proposed management actions for the sustainability of fish species associated with the Project (Section 3); and the proposed monitoring and evaluation programs (Section 4). For detailed information on Project features, potential effects, and protection, mitigation and enhancement measures refer to the Final License Application for the Enloe Hydroelectric Project or FERC Project No. 12569 (FLA; District 2008).

The overall management goal of the FMP is to promote the sustainability of fish species affected by the Project. The general plan objectives are listed below. Reach-specific goals and objectives, by fish species groups, for Project-related effects to the Similkameen River are presented in Chapter 3.0.

1. Manage Project reservoir to minimize effects on reservoir fisheries.

2. Manage Project intake operations to minimize injury to resident fish species in the reservoir.

3. Manage tailrace operations to prevent fish access to the draft tube areas to minimize injury of adult anadromous fish.

4. Manage dam operations to provide minimum instream flows for native fish and other aquatic life in the bypass reach.

5. Manage dam operations to support anadromous spawning, rearing and migration downstream of Similkameen Falls.

6. Manage development, operation and maintenance of the side channel habitat enhancement project to provide cool water rearing habitat for juvenile salmonids (steelhead trout, Chinook salmon, and sockeye salmon) and resident fish during the summer to benefit native fish.

7. Manage gravel augmentation to supplement gravel supplies and augment salmonid spawning habitat in the mainstem Similkameen River.

8. Develop a monitoring and evaluation program that includes an adaptive management component.

The reason for developing a FMP for the Project is to ensure that the fisheries resources are fully protected, mitigated or enhanced, as specified in the Washington State Department of Ecology (Ecology) Clean Water Act §401 Water Quality Certification, Federal Energy Regulatory Commission (FERC) license, and other public agency mandates. The FMP provides for the framework for fish management related to the Enloe Hydroelectric Project. Implementation of the FMP will be carried out in consultation with a Fish Workgroup (FW), made up of representatives from the various agencies that manage aquatic resources in the Project area. The agencies include U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Bureau of Land Management (BLM), Washington Department of Fish and Wildlife (WDFW), Ecology, and Confederated Tribes of the Colville Reservation (CCT). Each of these agencies will have an integral role in the continuation and development of the FMP over the term of the Project license. The role of the FW will be to monitor the success of the proposed mitigation and enhancement measures associated with the Project. The following is a brief description of the responsibilities of each organization associated with fisheries resources in the Similkameen River:

- **Ecology** is responsible for protecting and enhancing Washington's water quality, quantity and the associated protection to aquatic life.
- **CCT** is a co-manager of fish and wildlife with WDFW, USFWS, and NMFS in the Project area.
- **USFWS** has authority and management responsibilities for fish and wildlife on federal lands and at federally licensed dams.
- **NMFS** and **USFWS** have authority and management responsibilities for threatened and endangered species in the basin.
- **BLM** is a major landowner in the vicinity of the Enloe Dam, and as part of their management directive is responsible for managing habitat and fisheries resources.
- **WDFW** has primary responsibility for the management of fish and wildlife in Washington State.

2.0 OVERVIEW OF THE ENLOE DAM PROJECT

This section provides an overview of the physical and biological resources associated with the Project and Project facilities and operations. Additional information on these topics is presented in the FLA (District 2008).

2.1 PHYSICAL DESCRIPTION

Enloe Dam is located on the Similkameen River approximately nine miles upstream of its confluence with the Okanogan River. The dam is a concrete gravity arch dam 315 feet long with an arch radius of 200 feet and a maximum hydraulic height of 54 feet. The central overflow spillway crest that occupies most of the dam has a length of 276 feet. Reservoir outflow travels 54 vertical feet down the spillway chute into a bypass reach between Enloe Dam and Similkameen Falls (the Falls). Similkameen Falls plunges about 22 vertical feet into Similkameen Falls Pool, which is 370 feet downstream of the base of Enloe Dam. Similkameen Falls Pool is a narrow deep plunge pool that has been eroded in bedrock at the toe of the falls. The following is a description of the main features of the Project, as they relate to fish and fish habitat.

2.1.1 Enloe Reservoir

Above the Enloe Dam lies a shallow reservoir (mean depth of 8.4 feet at the existing dam crest elevation of 1044.3 feet above mean sea level (amsl); maximum depth 55.6 feet (MaxDepth 2006). The existing reservoir is approximately 2 miles long and averages about 250 feet in width. The proposed Project includes restoring the functionality of the flashboards on the crest of the existing spillway by retrofitting crest gates. These gates will be 5 feet high, which will increase the spillway crest elevation to 1049.3 feet, increase the water level upstream of the dam, increase the hydraulic head available for power generation, and reduce the amount of water fluctuation in the reservoir. During normal operation, the water surface elevation will be kept just below the crest of the gates (i.e. about elevation 1048.3 feet) to avoid uncontrolled spill due to surge or waves. At this elevation, the reservoir extends about 2.3 miles upstream from the Dam, has a surface area of 76.6 acres, a mean depth of 10.1 feet, and a volume of 775 acre-feet.

The annual spring freshet on the Similkameen River typically starts in March or April and ends between June and August. During this high-flow period, the inflow to Enloe Reservoir will exceed the hydraulic capacity of the powerplant (1600 cfs). At these times, the powerplant will normally operate at full capacity and surplus flow will be released downstream via the spillway. In normal and dry years, the spillway crest gates will slowly be lowered to maintain a constant water level on the reservoir. In wet years, inflow exceeds the combined hydraulic capacity of the spillway crest gates and powerplant, so at these times the gates will be fully lowered and the reservoir elevation will be controlled by the rating curve of the spillway crest, as it is now. Figure 1 shows the relationship between impoundment volume and water-surface elevation between

and elevation of 1044.3 feet (existing spillway crest) and elevation of 1057.3 feet (flood of record).

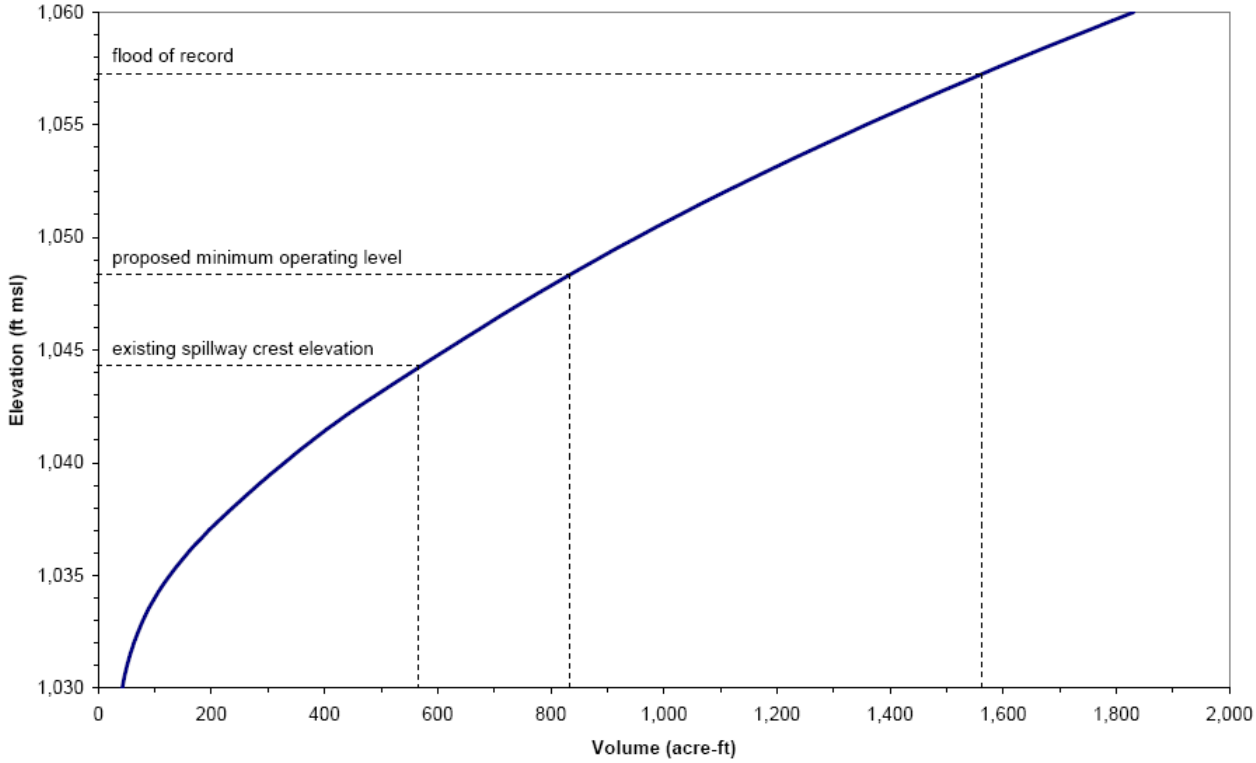


Figure 1. Enloe Reservoir Storage Capacity

For the remainder of the year (mid-summer through the next spring) flows in the river are typically less than the hydraulic capacity of the powerplant. During these times, outflow from the reservoir will normally be through the powerplant and will be regulated to match inflow to the reservoir, with the exception of flows that need to be released through the instream flow outlet to provide flow in the bypass reach for fish use. The reservoir will not be drawn down to serve generation; only available inflows will be used to generate (run-of-the-river operation). Occasional short-duration storms during winter may require a short period of spill over the spillway crest gates until flows recede below the flow capacity of the powerplant.

2.1.2 Dam and Powerhouse

The Project is designed to divert water from the Similkameen River at 1,600 cfs hydraulic capacity through a powerhouse with a total nameplate generation capacity of 9.0 MW. The powerhouse is to be constructed on the east bank of the Similkameen River about 230 feet downstream of the east abutment of Enloe Dam and 140 feet upstream of Similkameen Falls. The following sections describe the basic features of the dam and powerhouse and how they may influence the existing biota in the reservoir or Similkameen River.

Intake Structure

An intake structure for the existing decommissioned hydro plant exists in the west abutment block of the dam. The intake is comprised of two conduits through the dam which each have a slide gate and a concrete intake/trashrack structure at their upstream end. The District will decommission the old intake by backfilling the conduits through the abutment block with concrete, leaving provision for a small controlled outlet for instream flow releases to the bypass reach below the dam.

The intake for the proposed Project is located on the east bank of the river immediately upstream of the existing dam. A headrace channel is proposed to carry inflow diverted from the Similkameen River 190 feet to the penstock intake. The headrace channel will be excavated in rock and designed to be wide (120 feet) and shallow (8 feet) at the upstream end to minimize sediment disturbance in the reservoir, tapering to 30 feet wide and 26 feet deep at the penstock intake structure to ensure adequate submergence for the intake.

The penstock intake structure is designed as a 35 foot long by 30 foot wide reinforced concrete gravity type structure founded on bedrock and connected to two above-ground steel penstocks that will be 150 feet long and 8.5 foot diameter. These penstocks will slope steeply down to the powerhouse carrying water to the turbines.

Trashracks will be provided at the intake structure to protect the turbine water passages from blockage by debris. The trashracks will be 22 feet high by 12.5 feet wide. An automatic motorized trashrack mounted on a monorail will be provided to remove accumulated trash and debris. A one-inch clear spacing is proposed between trashrack bars to prevent adult resident fish in the reservoir and moderate to large debris from entering the intake.

The trashrack design excludes larger fish from the intake, as they experience substantially greater mortality when passing through turbines. Smaller fish in the size range that will pass through the trashrack will have a high survival rate (generally above 90 percent) when passed through turbines (FLA Section E.3.2.2; District 2008). Therefore, the design does not propose to exclude small fish from the project intake.

Turbines

Two vertical axis Kaplan turbines with adjustable blades and wicket gates will be located in the reinforced concrete powerhouse (70 feet long by 30 feet wide). The turbines have a rated capacity of 6170 horsepower at 360 revolutions per minute under a rated net head of approximately 76 feet. Kaplan turbines are generally safer for fish passage then other conventional turbine types. Estimated ranges of probable passage survival are provided in the FLA, Section 3.2.2, Tables E.3-6 and E.3-7 (District 2008).

Tailrace Channel

An open tailrace channel is proposed for the Project, which offers an aesthetic advantage over a pipe from the Key Observation Points. The tailrace channel will be generally similar in appearance to the natural gorge that has been excavated by the river and to the existing channels cut through the east terrace in the early 1900's for the original power development at the site. The tailrace channel will convey water a distance of about 180 feet from the powerhouse to the Similkameen River at the base of the Falls. This is a relocation of the tailrace exit from the existing exit 980 feet downstream of the dam. Relocating the exit closer to the Falls provides for better circulation of water to the deep pool at the base of the Falls, which helps to maintain water quality and provides a cool-water refugia for fish using the Similkameen River. A concrete training wall constructed on the west end of the powerhouse will separate the powerhouse and tailrace channel from the short reach of the Similkameen River between Enloe Dam and the pool at the base of Similkameen Falls.

2.1.3 Bypass Reach

The bypass reach is an approximately 370 foot long reach between the dam and the pool at the base of Similkameen Falls that is bypassed when water is diverted through the powerhouse. The bypass area basically consists of a plunge pool at the base of the dam, bedrock chutes, and runs. Depth information in the bypass reach is poor, and what has been surveyed is from a variety of snorkel surveys. In August 2006, ENTRIX recorded a mean depth estimate of 15 feet at a flow of 239 cfs at the Nighthawk gage (ENTRIX 2007a). During the September 15, 2010 snorkel survey, WDFW and Ecology measured maximum depths ranging from 8.1 to 15.2 feet at approximately 600 cfs (WDFW 2010).

Based on snorkel and habitat surveys, substantial fish use is not expected during most of the year in the bypass reach (ENTRIX 2007a, District 2008). When conditions are favorable, such as summer and fall low flows and moderate temperatures, resident fish access and utilize the bypass reach by going over the dam. Fish species present in the bypass reach were documented during snorkel and hook and line surveys in September of 2010 (WDFW 2010). During high spring and early summer flows, fish will likely have a very difficult time remaining in most of the area due to extremely high velocities (Figure 2). During the winter, when flows are reduced, the area is expected to be covered in ice (Figure 3). Features such as anchor and frazil ice will further reduce any substantial use for fish in the area. Because of the potential for fish to utilize the bypass area, instream flows will be provided in the bypass reach year-round, as discussed below.

Figure 2. View of Spring Flow Conditons at Enloe Dam and in the Bypass Reach during a 20,000 cfs Event (photo taken June 8, 2011 by N. Christoph, Okanogan PUD)

Figure 3. View of Winter Conditions Flow Conditions at Enloe Dam and in the Bypass Reach during a 550 cfs Event (photo taken January 8, 2009 by N. Christoph, Okanogan PUD)

2.1.4 Downstream of Enloe Dam

According to habitat surveys, the Similkameen River downstream of the Falls can be separated into three distinct reaches based on stream gradient, macrohabitat type, and dominant substrates (Kaumheimer 1988, ENTRIX 2007b). Reach 1 (RM 8.8 to RM 7.1) begins below the Project and is typical of canyon habitat with deep pools interspersed with rapids. This reach has a channel gradient that averages over 2 percent. The dominant substrate is bedrock with large boulders (ENTRIX 2007b). Reach 2 (RM 7.1 to 4.7) progresses from a high (2 percent) to moderate slope (0.1 percent) and has an average stream gradient of approximately 0.4 percent. Habitat is a mix of run, pool, and riffle types with a few side channels. While most of the reach contains smaller substrate, such as cobble and sand as compared to Reach 1, larger boulders are more common in the upstream areas near the canyon reach (Kaumheimer 1988, ENTRIX 2007b). Reach 3 (RM 4.7 to RM 0) is the lower reach and had a braided channel with a low gradient (less than 0.1 percent). Cobble and gravel comprised most of the streambed substrate; however, pockets of sand and areas dominated by boulders were also present. Pools and runs dominated the main channel, while riffles usually occurred in the side channels (Kaumheimer 1988, ENTRIX 2007b).

Naturally-occurring environmental conditions limit salmonid production in the Similkameen River. Conditions in the river can be naturally detrimental to juvenile salmonids in May and June downstream of Similkameen Falls when flows exceed 8000 cfs and the dissolved gas exceeds 120 percent. The most significant factor affecting salmon and steelhead survival in the river from mid-July through mid-September is high water temperature. Natural water temperatures exceed 23^{o}C from mid-July through mid-September and can be lethal to salmonids (2008 Final License Application).

In the winter, the formation of anchor ice can dewater streams and cause high levels of scour, affecting embryos and young over-wintering salmonids.

In late summer in dry years, dewatered reaches are common in the side channels of both the transition reach (Reach 2) and the lower reach (Reach 3). Low flows can restrict access to upstream habitat, dewater redds, and strand juveniles. Side channels that contain water during the summer provide important rearing habitat, especially in those areas where overhanging vegetation provides cover. These may be areas of groundwater upwelling (ENTRIX 2007a).

The Similkameen River downstream of the Project appears to have limited gravel supplies and contains low habitat diversity. Habitat upstream of the dam is characterized by low amounts of gravel. Large woody debris (LWD) contributes minimally to habitat diversity, and is mostly absent from the river. The river (most notably adjacent to the town of Oroville) has been channelized and diked, also greatly reducing the habitat diversity in the lower reach (ENTRIX and Golder Assoc. 2007, ENTRIX 2007b). These conditions, along with naturally-occurring environmental conditions, limit fish production in the river below the dam.

2.2 FISH SPECIES IN THE SIMILKAMEEN RIVER

Several anadromous and resident fish species are found in the Similkameen River (Table 1). Native anadromous fish species include Upper Columbia River (UCR) Chinook salmon, sockeye salmon and UCR summer steelhead trout (District 2008, Exhibit E.3, Section E.3.2.1). UCR steelhead trout are currently listed as threatened under the Endangered Species Act. Similkameen Falls has been reported as a natural barrier to anadromous fish (Chapman et al. 1994, NPCC 2004) and the historical record indicates that runs of anadromous fish stopped at Similkameen Falls (Mitchell 1980, WDFW 1990, District 1991). Tables of seasonal activity (phenology) of the anadromous species and several resident species with potential recreational or cultural significance are presented in Appendix A.

Native resident species found in the Similkameen River in the vicinity of the Project include chiselmouth, peamouth, rainbow trout, suckers, sculpins, whitefish, longnose dace, burbot and northern pikeminnow. In addition to native fish species, a number of introduced (non-native) species occur in the Project Area including large and small mouth bass, crappie, perch and carp (IEC Beak 1984, District 1991, WDFW 2005, District 2008).

Table 1. Resident Fish Species Documented in the Vicinity of Enloe Dam in Three Separate Studies

Species		Native	Source**			
Scientific Name	Common Name	Y/N/Un	IEC Beak (1984)	District (1991)	District (2008)	WDFW (2010)
Catostomus columbianus	Bridgelip Suckers	Y	D	U	U	
Catostomus macrocheilus	Largescale Suckers	Y		U/D	U/D	
Catostomus spp.	Unidentified sucker	Un				B
Lepomis spp.	Unidentified Sunfish	N			U	
Micropterus dolomieui	Smallmouth Bass	N			D	B
Micropterus salmoides	Largemouth Bass	N		U/D	U/D	
Pomoxis nigromaculatus	Black Crappie	N	D	D		
Cottus spp.	Sculpins	Y	D	U/D	U/D	B
Acrocheilus alutaceus	Chiselmouth	Y			U	
Cyprinus carpio	Common Carp	N			U/D	
Cyprinidae spp.	Unidentified minnows	Un		U	U/D	
Mylocheilus caurinus	Peamouth	Y			U	
Ptychocheilus oregonensis	Northern Pikeminnow	Y	D	U	U/D	B
Rhinichtys cataractae	Longnose Dace	Y	U/D		U	
Richardsonius balteatus	Redside Shiner	Y		U	U/D	
Lota lota	Burbot	Y		U		
Perca flavescens	Yellow Perch	N			U	

Table 1. Resident Fish Species Documented in the Vicinity of Enloe Dam in Three Separate Studies

Species		Native	Source**			
Scientific Name	Common Name	Y/N/Un	IEC Beak (1984)	District (1991)	District (2008)	WDFW (2010)
Oncorhynchus sp.	Unidentified Trout	Un		D	D	
Oncorhynchus mykiss	Rainbow Trout	Y	U*	D	D	B
Oncorhynchus mykiss	Steelhead Trout	Y			D	
Oncorhynchus nerka	Kokanee / sockeye	Y	U (kokanee)		D (sockeye)	
Prosopium williamsoni	Mountain Whitefish	Y	D	U/D	U/D	U***
Oncorhynchus tshawytscha	Chinook	Y			D	

Y = Yes, N = No, Un = Unknown, U = upstream of Enloe Dam, D = downstream of Similkameen Falls, B = Bypass Reach

U* = upstream above Project Boundary, in Canada and in the Palmer Lake area (Arterburn, Pers. Comm. 2010)

U*** Verhey, Pers Comm 2010

** Previous studies in the Similkameen River (IEC Beak 1984 and District 1991) utilized different sampling gear than the District (2008) investigation, and the IEC Beak study covered a much broader area, including rivers and streams that join the Similkameen River in Canada.

The WDFW (Parsons 2005) reported that two species of native freshwater mussels occur in the vicinity of the Project: including the western ridged mussel (*Gonidea angulata*), and the western pearlshell[1] (*Margaritifera falcata*). Of these, the western ridged mussel is the most abundant species in the Similkameen (Hallock, pers. comm. 2007). Mussel relative abundance increases downstream from the Dam as the prevalence of finer sediments increases (District 2008; Section E.3).

2.2.1 Chinook Salmon

The summer run of upper Columbia River Chinook salmon (*Oncorhynchus tshawytscha*) was found "Not Warranted for Listing" in 1998, and the federally-endangered spring run has been extirpated from the Okanogan Basin (Myers et al. 1998). Chinook salmon occur in the Similkameen River downstream of Similkameen Falls (the Falls), which are considered an historical barrier to upstream fish passage (District 2008). Adult summer Chinook salmon are typically present in the Similkameen River during their spawning season (October through November) and during the months preceding spawning activities in holding areas below the Falls (District 2008). Juvenile Chinook salmon rear in the river through the spring, and start their downstream migration as early as mid-March. The majority of summer Chinook salmon spawn in the

[1] Standardized common and scientific names are from Turgeon, D.D. et al. 1998. Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks. Second Edition. American Fisheries Society Special Publication 26.

lower 5 miles of the river in Reach 3 (Arterburn et al. 2006). Arterburn et al. (2006) reported that summer Chinook hold in the pool area below Similkameen Falls. Additionally, because water temperatures in the Similkameen River are typically 2 to 3°C lower than the Okanogan River (Arterburn et al. 2006), all three anadromous species found in the Similkameen River (steelhead, summer Chinook salmon and sockeye salmon) will use the downstream reach during the summer as a thermal refuge (Arterburn et al. 2007, ENTRIX 2007a).

2.2.2 Rainbow Trout / Steelhead Trout

Steelhead trout, the anadromous form of rainbow trout (*O. mykiss*), are technically part of the Upper Columbia River stock that was listed as endangered under the Endangered Species Act (ESA) in 1997 (62 FR 43937), reduced to threatened in 2006 (71 FR 834), and revised back to endangered in 2007 by the U.S. District Court (74 FR 162). Adult steelhead spawn during the spring (mid March through May) and juveniles may rear in the river throughout the year if summer temperatures are suitable (District 2008). In 2009, the CCT observed 244 steelhead redds in the lower Similkameen River (reach 3) (Arterburn et al. 2010). Table 1 provides an indication of the spawning stock potential of the Similkameen River based on passage at Wells Dam on the Columbia River in 2008 through 2010. Steelhead enter the Similkameen as early as mid July and may remain until mid May (District 2008). They will typically hold in pools and other cold-water habitat downstream of the Falls.

Rainbow trout, the resident form of rainbow trout, are found both upstream and downstream of Enloe Dam (District 2008). The CCT fish crew caught trout above Palmer Lake when fishing for an Ecology sampling project looking at arsenic in fish tissue (Era-Miller 2007), but not in the reservoir or in the vicinity of Enloe Dam (J. Arterburn pers. comm., 2009). Downstream of Enloe Dam, rainbow trout have been observed in the bypass reach (observed by WDFW, Ecology, ENVIRON and CCT in September 2010) and are known to spawn downstream of the Falls in early summer (June through August) and rear in the river throughout the year (ENTRIX 2007a, District 2008, ENTRIX 2010).

2.2.3 Kokanee / Sockeye Salmon

Kokanee, the resident form of sockeye salmon (*O. nerka*), were documented upstream of Enloe Dam by IEC Beak (1984) and was assumed to be from the hatchery population established in Palmer Lake, upstream of the Project. Stocking by WDFW has occurred in Palmer Lake since 1972, which primarily included kokanee and other trout species (Osborne et al. 2003).

Sockeye salmon, the anadromous form of *O. nerka*, do not typically spawn in the Similkameen River, but do use the river as a thermal refuge from higher water temperatures in the Okanogan River from mid-June to mid-November (Arterburn et al. 2007, ENTRIX 2007a, District 2008). Typical spawning habitat for sockeye salmon in the Okanogan River is located upstream of the Okanogan-Similkameen River confluence in Lake Osoyoos or upstream of the lake (NMFS 2010).

2.2.4 Mountain Whitefish

Mountain whitefish (*Prosopium williamsoni)* is another salmonid occurring both upstream and downstream of Enloe Dam (ENTRIX 2007a, District 2008, Verhey pers. comm. 2010). Although mountain whitefish occur upstream of the reservoir, they have not been documented in the reservoir, most likely due to the abundance of predators (e.g., northern pikeminnow and bass), warm temperatures, and lack of cover (District 2008). However, they were observed in numerous surveys downstream of the Falls (IEC Beak 1984, District 1991, ENTRIX 2007a). Mountain whitefish spawn in the spring (April through May).

2.2.5 Pacific Lamprey

The Pacific lamprey (*Lampetra tridentata*) is considered to be a federal species of concern (WDFW 2010). Although the historical distribution of Pacific lamprey coincided with the distribution of Pacific salmon (Close et al. 1995), this species is not known to occur in the Similkameen River. However, unidentified ammocoetes (juvenile lamprey) that were most likely Pacific lamprey were observed by WDFW in 2007 in the hatchery's Similkameen Pond on the lower reaches of the Similkameen River close to the confluence with the Okanogan River (Hallock, pers. comm. 2007). In 2006, the CCT Fish & Wildlife Division collected both adults and ammocoetes (juvenile lampreys) from screw traps in the Okanogan River downstream of the confluence with Salmon Creek (Rayton, pers. comm. 2007). Additionally, potential lamprey redds were observed in the middle reach of the Okanogan River in 2008 (J. Arterburn, pers. comm. 2008), but there was no confirmed presence of adults. Therefore, there is a potential for Pacific lamprey to be found in the vicinity of Enloe Dam.

2.2.6 Other Native Fish Species

Most of the fish in the Enloe Reservoir include warm-water species adapted to lotic (slow current) environments, including the native species chiselmouth (*Acrocheilus alutaceus*) and peamouth (*Mylocheilus caurinus*). In a 2006 survey of the Enloe Dam reservoir, six native species were collected including bridgelip sucker (*Catostomus columbianus*), largescale sucker (*C. macrocheilus*), sculpin (*Cottus* spp.), chiselmouth, peamouth, and redside shiner (*Richardsonius balteatus*) (ENTRIX 2007a). Other sources have also reported longnose dace (*Rhinichthys cataractae*), and northern pikeminnow (*Ptychocheilus oregonensis*) in the reservoir (IEC Beak 1984, District 1991). Surveys in the bypass reach have identified three native species (aside from rainbow trout described above) including juvenile suckers, sculpin, and Northern pikeminnow (ENTRIX 2007a, ENTRIX 2010). Access to the bypass reach is possible via flow over the dam. Surveys conducted downstream of the Falls showed that all of the native species that were noted as present upstream of the dam were also located below the Falls (IEC Beak 1984, District 1991, ENTRIX 2007a, District 2008). During snorkel surveys completed in 2006, suckers dominated (59%) the fish assemblage in the transitions area between the canyon (Reach 2) and low grade habitat near the confluence of the Okanogan River (Reach 3) (RM 7.1 to RM 4.7) and minnows dominated (56%) in the low gradient habitats (RM 4.7 to RM 0) (ENTRIX 2007a).

2.2.7 Non-native Fish Species

Among the introduced warm-water species found in the Similkameen River, smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*) are considered sport fisheries both upstream and downstream of the Project. Most of the fish in the Enloe Reservoir are warm-water species adapted to lotic environments, including introduced fish within the family Centrarchidae (bass and sunfish). ENTRIX (2007a) reported that centrarchids comprised 30% of the total catch in 2006 and 21% in 2007. Smallmouth bass were sampled upstream of Enloe Dam, in the bypass reach, and downstream of the Falls (ENTRIX 2007a, ENTRIX 2010). Largemouth bass were sampled upstream of Enloe Dam and downstream of the Falls (District 1991, ENTRIX 2007a). Surveys completed by ENTRIX (2007a) documented three additional non-native species in the Enloe Dam reservoir, including sunfish (*Lepomis* spp.), common carp (*Cyprinus carpio*), and yellow perch (*Perca flavescens*). The only non-native species, besides largemouth bass, with a downstream distribution (below the Falls) is black crappie (*Pomoxis nigromaculatus*) (IEC Beak 1984, District 1991).

Four native freshwater mussel species occur in the Okanogan and Similkameen basins. The western ridged mussel (*Gonidea angulata*) and western pearlshell (*Margaritifera falcata*) were reported by Krueger et al. (2007) in the vicinity of Enloe Dam, the western floater (*Anondonta kennerlyi*) was found upstream of Enloe Reservoir in Palmer Creek (Parsons 2005), and the California floater (*A. californiensis*) was documented in the Okanogan River (Nadeau et al. 2005). According to ENTRIX (2007a), the relative abundance of mussels increased downstream from the dam as the prevalence of finer sediments increased.

3.0 FISH MANAGEMENT PLAN (FMP)

The goals and objectives of the FMP are addressed through four sub-plans. Each sub-plan represents one of the four main geographic areas associated with particular habitats that can be influenced by Project structures or operation. These four geographic areas are: (1) Enloe reservoir (the Reservoir Plan), (2) dam and powerhouse (the Powerhouse Plan), (3) bypass reach (the Bypass Plan), and (4) downstream of Enloe Dam (the Downstream Plan). For each portion of the Project, the primary fisheries issues, management goals and objectives, management measures, methods, schedule, and potential adaptive management measures are provided below. The primary fisheries issues were initially identified in the FLA (District 2008). Management goals and objectives are presented for specific fish species in the Similkameen River or a general fish group with target species that address the primary fisheries issues. Finally, the recommended methodologies are presented to implement measures that will improve and protect aquatic life in the Similkameen River.

Included in the FMP is a monitoring and evaluation program that provides the ability to assess the efficacy of management actions, utilize an adaptive management process if water quality or fish management standards are not met, and implement the adaptive management process within a timeframe acceptable to Ecology (as specified by the 401 certification). The ultimate goal of a monitoring and evaluation program is to determine whether the goals and objectives have been met. A master schedule table for each issue discussed is presented in Appendix B.

Each sub-plan addresses:

- Primary Issues Overview
- Management Goals and Objectives
- Management
    - Management Measure
    - Implementation Schedule
    - Potential Adaptive Management Measures
- Monitoring
    - Monitoring Measure
    - Monitoring Schedule

3.1 ENLOE RESERVOIR – THE RESERVOIR PLAN

There are two main management issues associated with the Enloe Reservoir that may influence fish resources, including: (1) water surface elevation changes and associated habitat inundation, and (2) sediment transport. Each of these is discussed below.

3.1.1 Water Surface Elevation Changes and Habitat Inundation

Primary Issues

The placement and operation of crest gates on the Enloe Dam will provide a more consistent water surface elevation in the reservoir by increasing the water surface elevation in the reservoir during low flow periods (as described above). This increase in water surface elevation during low flow periods will extend the reservoir 0.4 miles further upstream to a location above Shanker's Bend and increase the surface area of the reservoir by 16.5 acres.

Because the Enloe Reservoir is constrained by a steep valley, it is unlikely that the reservoir will substantially increase in width, but will inundate vegetation and wetland habitats that would not normally be covered by water in the low flow months. Based on a survey of the riparian habitat near the upstream end of the reservoir, overhanging bank vegetation was extremely limited and included only a few willow trees. The bank vegetation was dominated by various grasses, shrubs, and poison oak (District 2008). Several species of native and warm water fish reside in the reservoir, and a few of the introduced species (bass and perch) likely utilize the littoral zones (Wydoski and Whitney 2003). Inundation will essentially move this habitat up the bank and impact the current vegetation in the area.

Management Goals and Objectives

- **Goal**: Maintain or enhance resident fish habitat in the reservoir, with a focus on native and game fish species.
    - **Cold water target species**: mountain whitefish and rainbow trout.
    - **Warm water target species**: largemouth bass and smallmouth bass
- **Objective 1**: Provide shading, habitat complexity and lateral habitat for target species through enhancement of riparian vegetation along the reservoir.
- **Objective 2**: Identify, monitor and address adverse Project-related impacts on adult and juvenile habitat in the reservoir, including the new inundation zone.

Management Measures

- **Management Measure 1**: Riparian vegetation will be planted along the reservoir that will benefit fish and aquatic resources along the impoundment shoreline. The

addition of overhanging bank vegetation will decrease water temperature along the littoral zone and provide cover for juvenile and small fish species.

- **Implementation Schedule**: Vegetation planting for riparian habitat will occur within the first year of inundation. Baseline data, as described in the Vegetation Monitoring and Management Plan (VMMP), will be collected before the project is constructed.

- **Potential Adaptive Management Measures**: Percent survival of planted vegetation will be established as criteria for replanting (see the VMMP for additional details of the replanting criteria). The FW will determine if the criteria are met. If the criteria are not met, riparian vegetation will be replanted to ensure establishment of shoreline vegetation that improves the quality of habitat for resident fish associated with the reservoir.

- **Management Measure 2**: Target species will be monitored in the reservoir. Methods will follow the reservoir sampling discussed in the FLA (Appendix C), including snorkel surveys along transects in the reservoir and minnow traps in the margins, which includes the inundation zone to determine the change in the fish population community.

  - **Implementation Schedule**: A total of three monitoring events: baseline (pre-construction), 5 years post construction, and 10 years post construction, and every 10 years thereafter, unless determined otherwise by the FW.

  - **Potential Adaptive Management Measures**: If the population of target species appears substantially lower than baseline conditions, due to Project effects, after a 10 year period, adaptive management measures will be developed in consultation with the FW.

Monitoring Measures

- **Monitoring Measure 1**: A survey of the plants that were planted and how many survived.

  - **Monitoring Schedule:** Surveys will take place in late summer. There will be two annual surveys beginning the year after planting. If survival is low and substantial plants need to be replaced, additional surveys may be necessary.

- **Monitoring Measure 2**: Minnow traps and snorkel surveys at established transects.

  - **Monitoring Schedule**: Traps and surveys will be completed prior to dam operation to establish a baseline pre-construction and then at 5 and 10 years, and every 10 years thereafter, unless determined otherwise by the FW. The surveys will include seasonal surveys such as in April, August and October as determined by the FW to reflect the seasonal changes in population. This will include angler surveys as needed, as determined by the FW.

3.1.2 Sediment Transport

Primary Issue

The Similkameen basin is characterized as a naturally gravel-starved system (Arterburn and Kistler 2006), and Enloe Dam exacerbates gravel delivery to the lower river. Although the reservoir is thought to be near equilibrium in terms of sediment transport, Enloe Reservoir will continue to interrupt gravel transport from upstream sources.

Management Goals and Objectives

- **Goal**: Maintain or enhance spawning habitat for anadromous and resident fish species, with a focus on salmon and steelhead.
    - **Anadromous target species**: Chinook salmon and steelhead
- **Objective**: Provide enhanced spawning gravels in the lower river that are within the size range for target species.

Management and Monitoring Measure

- **Management and Monitoring Measure**: Gravel augmentation will be provided to mitigate for gravel becoming trapped in the reservoir. This management and monitoring measure is described in the downstream section of the FMP, Dam Downstream Plan (below).

3.2 ENLOE DAM AND POWERHOUSE – THE POWERHOUSE PLAN

There are four main management issues associated with operation of the proposed dam and powerhouse that may influence fish resources: (1) entrainment of fish in the intakes, (2) attraction to the tailrace draft tubes, (3) water quality, and (4) blockage of LWD to downstream areas. Each of these is discussed below. Construction Best Management Practices (BMPs) are not discussed here, but can be found in the Construction Water Quality Assurance Project Plan.

3.2.1 Entrainment

Primary Issues

Entrainment of fish into the intakes and passage through the turbines could result in injury or mortality of reservoir fish. Because the population density of fish in the reservoir appears to be relatively low, the rate of entrainment is also likely to be low. Smaller fish are expected to be more susceptible to entrainment; however, larger fish will likely have a greater potential of occupying the area near the intake. Fish species that will most likely be impacted include rainbow trout, chiselmouth, Northern pikeminnow, native suckers, mountain whitefish, largemouth bass, carp, and yellow perch.

Survival of fish passing through the turbines was estimated in the FLA (District 2008) using predictive models developed by U.S. Department of Energy's Advanced Hydro Turbine System Program (Franke et. al. 1997). In terms of non-salmonid fish, larger individuals (≥6 inches) will have an anticipated survival rate of 87%, medium fish (2-6 inches) will have a rate of 91%, smaller fish (≤2 inches) will have a rate of 95%. In terms of salmonid survival, fish 50-100 mm will have an anticipated survival rate of 92%, fish 100-150 mm will have a rate of 89%, fish 150-250 mm will have a rate of 84%, and fish >250 mm will have a rate of 73%.

Management Goals and Objectives

- **Goal**: Manage Project operations to minimize entrainment of resident target species in the Project intake and turbines.
    - **Cold water target species**: mountain whitefish and rainbow trout.
    - **Warm water target species**: largemouth bass and smallmouth bass.
- **Objective 1**: Discourage fish from entering the penstock intake structures.
- **Objective 2**: Identify and address Project-related impacts on downstream passage and survival of target species.

Management Measures

- **Management Measure**: The proposed trashrack within the penstock intake structure will have one-inch clear spacing between the bars, such that smaller fish could pass through and larger fish will be discouraged or prevented from passing through. The Kaplan turbines chosen for the Project have a relatively high survival rate for the small-sized fish that may pass through them.
    - **Implementation Schedule**: Continuous during operation of the dam and powerhouse.
    - **Potential Adaptive Management Measures**: A monitoring study will evaluate the entrainment potential of fish at the intakes and survival through the turbines (described below). If survival of fish through the turbines is found to be lower than that predicted, or is found to be contributing to depleted fish stocks in the reservoir or upstream of the reservoir, then several adaptive management options will be developed to offset negative effects on the reservoir fish populations beyond those predicted and mitigated for in the current Project. Adaptive management will be applied.

Monitoring Measures

- **Monitoring Measure**: Possible injury or mortality through the turbine will be examined by placing nets in the tailrace discharge for the purpose of trapping fish that may pass through the turbines. Live fish captured in the nets will be examined for evidence of physical trauma and mortality, and results will be recorded.

Entrainment into the power canal is a function of seasonal variation in fish density, seasonal variation in approach velocities (as a function of discharge), fish size, and species-specific swimming capability. Given the low fish densities observed in the reservoir, field crews may capture only small numbers of fish in the tailrace. In this event, the sampling crew will capture fish in the reservoir margins with a seine and place fish directly in the intake canal to observe actual mortality and trauma associated with passage through the turbine, given a known quantity and size of fish. This information will allow an estimate of mortality and injury of fish passing through the power plant, but not the number of fish entrained under normal operating conditions. If the number of fish entrained is low under normal conditions, then the loss of fish from the upstream fishery will be low, and the potential for recruitment of individuals to the downstream fishery will also be low, regardless of the injury or mortality rate. If the number of entrained fish is higher, at least for certain portions of the year, the mortality and injury estimates will assist in determining the magnitude of the reduction in potential recruitment of individuals to the downstream fishery.

To relate the fish entrainment data with the fish distribution and relative abundance of fish in the reservoir, a fish monitoring program will be conducted in the reservoir in conjunction with the entrainment studies. The reservoir sampling efforts will be enacted using methods outlined in the ENTRIX technical fisheries report on Enloe Reservoir (ENTRIX 2007a). The methods will involve minnow traps and seining in the margins of the reservoir and gill netting in the deeper portions. Pacific lamprey and bull trout will also be noted if they are observed.

- **Monitoring Schedule:** Surveys in the reservoir suggest that fish densities in nearshore environments vary substantially with season. To gain an understanding of the magnitude of the potential impact, it will be necessary to seasonally examine fish entrainment. The District proposes to conduct quarterly fish sampling over a three-year period. Sampling will occur at fixed intervals (e.g., every six hours) over two consecutive 24-hour periods for each quarterly sampling period. This will be reported to the FW in the yearly monitoring report. The District will monitor every five years thereafter, unless determined otherwise by the FW.

3.2.2 Tailrace

Primary Issues

Fish downstream in Similkameen River at the base of the Project may be attracted to the draft tubes in the tailrace and potentially travel up the tubes to the turbines. Chinook salmon, sockeye salmon, and steelhead trout have been documented utilizing the pool below the Falls as a holding area. During full turbine flow operations, when high-velocity flow is passing through the turbines, fish will not be able to travel sufficiently far upstream in the draft tube to be injured by the turbine. Fish will need to swim for a distance at speeds in excess of the velocity in the upper reaches of the draft tube to reach the turbine, an achievement that is beyond the ability of even the largest

anadromous fish. During low flow operations, larger anadromous salmonids could potentially swim up into the draft tubes. Other fish species may be attracted, as well.

Management Goals and Objectives

- **Goal**: Monitor and address potential impacts to fish that may be attracted to the draft tubes in the tailrace.
    - **Anadromous target species**: Chinook salmon, sockeye salmon, and steelhead trout.
    - **Other fish species include**: Pacific lamprey, bull trout.
- **Objective 1**: Prevent fish from entering the draft tubes in the tailrace.
- **Objective 2**: Monitor and adaptively manage if monitoring indicates loss of fish, as determined over a two-year period.

Management Measures

- **Management Measure 2a**: Video monitoring will be done before using a net (see measure 2b). The net may not be necessary or appropriate. Results of video monitoring will be presented to the FW each year and a decision will be made whether to install the net.
- **Management Measure 2b**: During periods of reduced turbine flows, when fish could theoretically reach the turbine, a physical net barrier would be installed at the outlet of each draft tube. The net barriers include a small opening at the downstream end of the net to allow any fish that had safely passed through the turbine to exit and move downstream. The barrier will be made of conventional heavy duty fishnet with one-inch mesh and 600 square feet of area, capable of a design gross approach velocity of 1.25 feet per second (fps). At the apex of the net, a short tube with a flexible one-way opening will be provided to allow any fish that have passed through the turbine to escape downstream. This escape exit will also be made of dark material with trailing streamers in order to discourage fish attempting to swim upstream from entering.
    - **Implementation Schedule**: The net barriers will be installed before outflows are low enough to allow anadromous salmonids access to the draft tubes and prior to planned shut-down or start-up of the turbines. The barriers will not be deployed during high turbine flow conditions. During these conditions velocities through the turbine are high enough to prevent fish from reaching the turbine, as described above. In the event of an unplanned shutdown, it may be necessary to deploy the barrier before restarting, depending on flow conditions and fish presence.
    - **Potential Adaptive Management Measures**: If fish are observed entering the escape exits, different materials could be attached to the downstream

ends of the barriers to further discourage entry. Alternatively, a more stable exclusion structure could be developed to ensure exclusion during any flow level.

Monitoring Measures

- **Monitoring Measure**: A video monitoring study will evaluate the behavior of fish in the tailrace and their interaction with the draft tubes and the net barrier. Observations of the escape exits of the net barriers will be conducted using suspended underwater video cameras. The study will document whether fish are entering the nets at the downstream end of the barriers, or if some individuals do enter the nets, are able to safely exit the barrier. Pacific lamprey and bull trout will also be noted if they are observed.

    - **Monitoring Schedule:** Observations will be made during periods of peak presence in the tailrace for each of the three anadromous salmonid species. Peak presence of adult salmonids is shown in Table 2 below (see Appendix A):

Table 2. Peak Adult Salmonid Presence

Salmonid Species	Peak Presence (Adult)
Steelhead Trout	mid-September to mid-March
Summer Chinook Salmon	July to November
Sockeye Salmon	mid-July to mid-October
Overlap	September and November

During each of the first two years of operation, the openings of the net barriers will be continuously monitored during the overlap period of peak presence for each of three salmonid species (September and November). The video will then be reviewed and summarized to determine adult salmonid interactions with the draft tubes and net barrier. Observations will be reported to the FW in the yearly monitoring report.

3.2.3 Water Quality

Primary Issues

There will be water quality differences from natural conditions because a portion of the water will be diverted through the powerhouse with the tailrace outlet located at the downstream end of the large pool below the Falls, which serves as a holding area for salmon and steelhead.

A major impact avoidance feature of the Project design was moving the entire powerhouse facility, including the tailrace location, upstream from where the existing

powerhouse is located so that the Project waters will be released near the pool below the Falls. This reduces the length of the bypass reach.

Total dissolved gas (TDG) should be less of a problem than under existing conditions, due to the decrease in spill over both the dam and the Falls, and temperature will not be adversely affected (see District 2008).

Presently during the summer, when temperatures are high, dissolved oxygen (DO) may be naturally low in the upstream Similkameen River and the reservoir. This can have negative impacts on fish. The District proposes to aerate both the powerhouse flows and the bypass flow to improve water quality above natural conditions. In addition, water in the pool at the base of the Falls will have good circulation provided by the nearby tailrace discharge, which should prevent stagnation and sustain dissolved oxygen.

Management Goals and Objectives

- **Goal**: Manage Project operations to avoid negative effects to water temperature, TDG levels, and DO levels for target species.
    - **Anadromous target species**: Chinook salmon, sockeye salmon, and steelhead trout
    - **Resident target species**: rainbow trout, and mountain whitefish
- **Objective 1**: Maintain or improve habitat conditions, including water temperature, TDG, and DO below Similkameen Falls and in the lower river.
- **Objective 2**: Identify and address Project-related impacts on fish habitat below Similkameen Falls.

Management Measures

- **Management Measure 1**: To minimize impacts to fish that use the holding area below Similkameen Falls, the tailrace location was changed. The new location of the tailrace was chosen to provide improved circulation and water exchange in the pool, therefore providing good water quality for fish.
- **Management Measure 2**: To offset the reduced aeration that would otherwise occur with water flowing over the dam and falls, the powerhouse draft tubes will be equipped with aeration vents and operated to increase DO during critical periods, if needed.

Monitoring Measures

- **Monitoring Measure**: TDG, DO and temperature will be monitored in accordance with the Operations Quality Assurance Project Plan (District 2012a) for details. Monitoring, coupled with the adaptive management process, will determine when (or

if) the aeration vents should be opened after high flows have receded in the early summer.

- **Monitoring Schedule:** Results will be reported to the FW in the yearly monitoring report. Please refer to the Operations Quality Assurance Project Plan (District 2012a) for details.

3.2.4 Large Woody Debris (LWD)

Primary Issue

Dams and reservoirs can block the downstream passage of LWD that is beneficial for fish habitat. LWD is an integral part of fish habitat because it: 1) provides shelter where fish can avoid predation, 2) provides a substrate for the production of macroinvertebrates on which many fish forage (Johnson et. al. 2003), 3) alters river hydraulics resulting in creation of pools and gravel bars (Beechie and Sibley 1997), and 4) provides refuge from extreme flows, thereby reducing the energy that fish must expend to swim (Harvey et. al. 1999). Although both the upper and lower Similkameen River basins have limited deposits of LWD (ENTRIX 2007b), restoring hydropower generation could potential limit downstream LWD resources further.

Management Goals and Objectives

- **Goal**: Manage Project operations to allow LWD to pass downstream to be used for fish habitat.
  - **Anadromous Target Species**: Chinook salmon, sockeye salmon, and steelhead trout
  - **Resident Target Species**: rainbow trout, and mountain whitefish
- **Objective**: Transport LWD that enters the reservoir to the lower river to maintain downstream fish habitat.

Management Measures

- **Management Measures**: To improve habitat downstream, LWD will be naturally transported over the dam during the annual flood or physically transported to the river downstream of the dam so that it is allowed to continue downstream naturally.
  - **Implementation Schedule**: This will be periodic during Project operations whenever LWD is present.
  - **Adaptive Management Measures**: If it is determined that the Project is significantly limiting LWD in downstream resources, then a new strategy will be developed to deliver LWD downstream.

Monitoring Measures

- **Monitoring Measure**: A summary of LWD in the reservoir and any active removal and transport downstream will be provided to the FW.
    - **Monitoring Schedule:** This will be reported to the FW in the yearly monitoring report.

3.3 BYPASS REACH – THE BYPASS PLAN

There are two main management issues associated with the bypass reach that may influence fish resources: (1) minimum instream flow and associated water quality, and (2) down ramping rates during dam operation. Each of these is discussed below.

3.3.1 Minimum Instream Flow

Primary Issues

The bypass reach is the area from the base of Enloe Dam to the Similkameen Falls Pool, at the foot of Similkameen Falls. The proposed project will divert flow around this 370-foot section of the Similkameen River. Seasonality is a concern for holding and feeding habitat in the bypass reach for fish that have come over the spillway. As discussed in Section 2.1.3, habitat in the bypass reach is naturally severely diminished for fish in May and June due to high flow events from mid-July through mid-September when water temperatures are high, and in the winter due to ice formation (Figure 2 and Figure 3). During high flow events, slow water refuge in the bypass reach is eliminated or greatly diminished. Additionally, high velocities scour macroinvertebrates from the area, reducing feeding potential. During the summer, temperatures can exceed levels that are lethal for salmonids (23^{o}C).

During winter, the water freezes (anchor, frazil and surface ice are common) and likely prevent use by fish. It is likely that the large quantities of ice in the reservoir and on the dam prevent a steady source of water from entering the bypass from over the dam during the winter.

Management Goals and Objectives

- **Goal**: Manage project operations to avoid effects and enhance feeding and holding habitat for resident species, with a focus on rainbow trout and native species.
    - **Resident Target Species**: Rainbow trout.
- **Objective 1**: Maintain minimum flows in the bypass reach to support feeding and holding of native fish species.
- **Objective 2**: Maintain water temperature and DO levels in the bypass reach to meet State Water Quality standards to support fish rearing.

Management Measures

- **Management Measure 1**: The main purpose of the instream flow measures is to protect fish feeding and holding habitat in the bypass reach between the dam and the tailrace (or "Falls") pool, about 370 feet downstream of the dam. The recommendation for minimum instream flow requirements within the bypass reach between the dam spillway and the Falls is 30 cfs between July 15 and September 15 and 10 cfs for the remainder of the year. This minimum instream flow is calculated to meet the State Water Quality Standards and maintain water quality conditions in the bypass reach for fish and aquatic invertebrates.

  Stream flow requirements would automatically be met by spill at the dam when total river flows exceed 1,610 cfs (or 1,630 cfs in the period mid-July to mid-September). This is generally in the period from April through July, with some spill also occurring during warm winter storms. Previous studies determined that passing flow over the existing spillway increased DO in the outflow from the reservoir by an estimated 1 mg/l (Appendix D of the CSMP). When there is no spill, instream flow will be maintained by continuous releases through a pipe that takes water at depth in the reservoir near the dam face and releases it to the scour pool at the base of the dam. As described in the instream flow outlet works (Appendix D of the CSMP), the pipe will deliver water from the reservoir via the existing penstock intake in the west abutment at a depth of about 16 feet below the proposed normal water surface elevation (El 1032 feet). The outlet will be about 17 feet above the normal water level in the spillway plunge pool (El 1004.5 feet), and angled upward at a 30^{o} angle so that the flow trajectory will be as long as possible to facilitate spreading and aeration of the discharge jet. In addition, aeration of instream flow will occur at the ring jet valve where air will be entrained in the flow via the valve hood.

  The primary advantage of this configuration is that the flow can be accurately controlled and measured to ensure that the required minimum releases are provided under varying streamflow conditions.

  Management Measure 2: A low-level outlet with a concentrated discharge would also minimize any temperature gain in water released from the reservoir, as compared to a widely dispersed release of a thin film of surface water over the existing spillway. By drawing water from depth in the forebay, the low-level outlet will deliver cooler water to the bypass reach during periods of summer stratification above the dam. Cooler water drawn from below the surface will be a benefit in the bypass reach, which can naturally reach lethal temperatures for cold water fish in the summer under existing conditions. This flow release is expected to be about $1^{o}C$ cooler in summer when natural water temperatures can be lethal to salmonids.

  In addition, the water will be aerated via a ring jet valve.

  Monitoring and compliance measures are provided in detail in the Operations Quality Assurance Project Plan (District 2012a).

- **Implementation Schedule**: The minimum flows will be provided continuously, once the certification is issued.

- **Potential Adaptive Management Measures**: It is expected that the instream flows, with the low-level outlet, will meet the Water Quality Standards for water temperature and DO for fish. The determining factor for success for this management measure will be State Water Quality Standards for temperature and DO. This will provide adequate fish habitat.

- However, if temperature standards are not met with the proposed flows under existing conditions, the first adaptive management measure to be tried would be to explore structural measures to reduce heating, such as modification of the channel to direct water into narrower channels through the bedrock to route flows between the plunge pool at the base of the dam to the Falls. There is an existing channel that appears to be sufficiently deep that structural modifications may be able to focus on blocking distributary channels to keep flow in a single channel. The purpose will be to reduce the surface area of the bypass flow and thereby reduce radiant energy influx through the water surface and reduce radiant heat transfer from the rock.

  The first adaptive measure for DO would include adjusting the instream flow outlet works to provide more aeration. Additional aeration could be achieved through air entrainment by: (1) using a venturi or injection of compressed air in the discharge pipeline, (2) adding a discharge jet, where the water impacts bedrock or the spillway plunge pool, or (3) using compressed air or a surface aerator in the bypass reach. Options would be discussed with the FW.

  If structural adjustments aren't able to attain the desired temperature and DO levels, other mitigation options such as additional instream flow release would be considered. The proposed downstream mitigation (side channel enhancement described below) is to offset impact in the bypass reach.

Management Measure 3: The bypass flow outlet will also be designed to aerate instream flow releases before they enter the pool at the base of the dam. The instream flow for the bypass release will be taken about 11 to 17 feet down in the reservoir to provide water approximately $1^{o}C$ cooler in the bypass in summer. As described in the description of instream flow outlet works (Appendix D of the CSMP), aeration of instream flow will occur at the ring jet valve where air will be entrained in the flow via the valve hood (Section 3.3.1 describes the outlet works in the bypass and aeration of instream flow in more detail).

- **Implementation Schedule**: This will be a continuous during Project operations.

- **Potential Adaptive Management Measures**: DO levels will be monitored and aeration adjusted according to required levels for fish survival

Monitoring Measure

- **Monitoring**: Monitoring will take place as described in the Operations Quality Assurance Project Plan (District 2012a).

- **Monitoring Schedule:** Flow, water temperature and DO will be monitored as described in the Operations Quality Assurance Project Plan. A summary of water quality and flow data through the bypass reach will be reported to the FW in the yearly monitoring report and will be reviewed annually for the first 5 years. If no issues are found by Ecology (based on exceedance of water quality criteria) over a 5-year period, then the 10 and 30 cfs minimum flows will become permanent requirements. Refer to the Water Quality Management Plan (District 2012b) for goals and objectives for water temperature and DO.

- For the first three years after instream flow releases begin, the District shall conduct snorkel surveys when no water is being released as spill. The yearly snorkel surveys will occur three times a year: in mid-April, first week of August, and second week of September to determine the number, size, and species of the fish population in the bypass. The FW will determine after three years if any further surveys are needed.

- Report data, summaries and identified trends on a yearly basis to the FW in the yearly monitoring report.

3.3.2 Bypass Ramping Rates

Primary Issues

Although "up-ramping" is not a concern, down ramping rates can potentially create stranding issues in the bypass reach. Research by Hunter (1992) indicated that natural flow recession associated with the annual snowmelt hydrograph occurred at a very slow rate, which reduced the likelihood of stranding of small salmonids. However, if discharge is decreased too rapidly by flow regulation, then fish (typically fry and juvenile life stages) can be stranded and killed. Therefore, flow regulation will be based on the "Hunter criteria," which recommends a rate of 1 inch/hour when steelhead fry are present and 2 inches per hour during juvenile rearing periods (Hunter 1992).

Management Goals and Objectives

- **Goal**: Manage Project operations to avoid changes in decreases in water level that potentially strand fish in the bypass reach, with a focus on native resident fish species.

    - **Resident target species**: Sculpin, suckers, Northern pikeminnow and rainbow trout

- **Objective 1**: Identify ramping rates, flow ranges and locations that potentially strand fish.

- **Objective 2**: Avoid stranding of fish in the bypass reach.

Management Measure

- **Management Measure**: There is a three-step process to incorporate efficiency in establishing ramping rates for the project. First, in the absence of other information, the Hunter criteria (Hunter 1992) will be used for all flows during Project operation. Second, prior to beginning operation, photographs can be taken and correlated to the Nighthawk USGS gage to show the range of flows through the bypass reach that will require monitoring of ramping rates using the Hunter criteria as a standard. The photographs will focus on when the rock ledge is beginning to be exposed and when the ledge is completely exposed and flows are dropping into the steeper part of the channel. These values can be used by the FW to establish a more limited range of flows for monitoring. Third, after operations have begun and flows in the bypass reach have been controlled (and safe access to the area is possible), a more detailed range of ramping flows can be determined.

    - **Implementation Schedule**: The timing of each management measure is detailed above.

    - **Potential Adaptive Management Measures**: Adaptive management was also discussed above in identifying a more detailed and specific range of ramping flows (step three). This constant refinement will help define a narrow range of flows in which the rock ledge may affect stranding. It will also provide potential adjustment of the Hunter criteria to better reflect the risk of stranding and examination of other stranding mitigation, such as physical modification of the ledge area or human retrieval of stranded fish.

  Other mitigation measures will be investigated to prevent the stranding of fish from down ramping events, if necessary. These alterative mitigation measures could include activities from modification of flat channel areas to removal of stranded fish using nets.

Monitoring Measure

- **Monitoring Measure**: Monitor flows through photographic and observational methods by comparing potential stranding areas to streamflow. Monitor within the range of flows that can potentially strand fish; monitor actual fish stranding through observation.

    - **Monitoring Schedule**: Observations of the bypass reach will be obtained during flows within the established ramping criteria and within the range of flows that are found to be potential stranding issues. Approximately five potential stranding flows will be monitored for fish stranding in the bypass reach. If no stranding is observed in this timeframe, then potential stranding

conditions will be reported to the FW for review and approval. Additional observations will be collected if requested.

3.4 DOWNSTREAM OF ENLOE DAM - THE DOWNSTREAM PLAN

There are four main management activities that may affect fish resources downstream of the Enloe Dam (1) gravel augmentation, (2) side channel enhancement, (3) downstream flow and water quality, and (4) ramping rates. Each of these is discussed below.

3.4.1 Gravel Augmentation

Primary Issue

Gravel augmentation below the Project is a mitigation measure related to the potential for the Enloe reservoir to capture sediment that would normally be transported downstream.

Management Goals and Objectives

- **Goal**: Maintain or enhance spawning habitat for anadromous and resident fish species, with a focus on salmon and steelhead.
    - **Anadromous target species**: Chinook salmon and steelhead
- **Objective 1**: Provide enhanced spawning gravels in the lower river.
- **Objective 2**: Monitor spawning habitat use within the lower river in relation to gravel augmentation.

Management Measures

- **Management Measure**: Approximately 3,000 cubic yards of spawning gravels (1-3 inches in size) will be placed in the active flood plain during low flow periods in each 5-year period spanning the first 25 years of the license. Additional gravel may be required, depending upon the results. Gravels will be placed in a location (or locations) that will facilitate the transport of gravel under high flow during spring. Two potential sites were identified for gravel placement, one preferred and one candidate, between river mile (RM) 5 and RM 6. The gravel will be placed in the main channel of the Similkameen River upstream of the bridge crossing in Oroville. The location is upstream of a 3-mile long reach of river that contains most of the spawning habitat in the river.

  It may require several years to distribute the gravel, depending on the magnitude of high flows. The District will complete the first gravel augmentation in year 3 of the new license. Information will be gathered during years 1 and 2 of the license in order to determine the best way to place the gravel (i.e., truck, conveyor belt) and choose the placement location(s) based on channel hydraulics. The quantity of

gravel provided exceeds the estimated gravel trapped by the dam and reservoir over the life of the current dam.

A monitoring study will evaluate the effectiveness of gravel supplementation (described below).

- **Implementation Schedule**: Gravel supplementation will begin the third year of operation and subsequent stockpiles every 5 years for the next 20 years, depending on high flows and transport of the gravel.

- **Potential Adaptive Management Measures**: If gravels are not distributing throughout the river, or being utilized by salmonids, the amount and location of gravel supplementation may be modified. If gravels are not distributing due to the size of the stock piles, then increase the number and decrease the size of the piles to be able to transport more effectively. If there seems to be sufficient gravels being distributed in terms of habitat use by salmonids, the amount of gravel could be reduced.

Monitoring Measures

- **Monitoring Measure**: Monitoring of gravel distribution and use by spawning salmonids will involve integration with and using habitat surveys and fish distribution methodologies currently being done as part of the Okanogan Basin Monitoring and Evaluation Project (OBEMP). After the gravel is placed in the river and flows have distributed the gravel downstream, habitat and fish use will be surveyed. The gravel may have an appearance that is different than the native gravel in the river.

    - **Gravel Monitoring Schedule:** A baseline survey of gravel will be conducted the year prior to the first gravel stockpiling. The initial gravel surveys would be conducted after the gravel is placed in year 3. The surveys conducted in years 4, 5 and 7 will map gravel distribution and be compared to baseline conditions. After the initial round of gravel placement and subsequent monitoring, the results of the monitoring program will be will be presented to the FW to discuss the effectiveness of the program and make recommendations regarding the next gravel augmentation that is planned for year 8. Monitoring surveys would be conducted in year 10 and year 12. The results of the surveys will be discussed with the FW. The FW may make recommendations for the gravel augmentations that would occur in year 13. Gravel will be placed in years 18 and 23. Surveys would be conducted the year before gravel placement in years 17 and 22 to provide an opportunity to make modification prior to placement.

    - **Reporting Schedule:** There will be a yearly report due to the FW and Ecology on December 31st of each year that monitoring is conducted or gravel is deposited, describing the gravel distribution and the past year's success or failure with gravel use by salmonids; include recommendations for changes needed to achieve successful use by spawning salmonids.

3.4.2 Side Channel Enhancement

Primary Issue

Mitigation needs were estimated to account for project impacts that could not be avoided or minimized. These specifically related to diversion of flow around the bypass reach, any loss of fish habitat in the bypass and the loss of fish through turbine morality. The proposed mitigation addresses these losses by providing cool water refuge and fish habitat in a side channel for steelhead and resident fish rearing.

Management Goals and Objectives

- **Goal**: Enhance rearing habitat for steelhead and resident fish species in the lower Similkameen River.
    - **Anadromous target species**: steelhead
    - **Resident target species**: rainbow trout and mountain whitefish
- **Objective 1**: Provide enhanced rearing habitat in the lower river within an existing side channel habitat.
- **Objective 2**: Monitor and identify target species distribution and abundance of the enhanced side channel habitat.
- **Objective 3**: Adaptively manage operation of side channel enhancement if target fish species utilization is determined to not be substantial.

Management Measures

- **Management Measure**: The side channel enhancement project was developed through extensive consultation and study with a focus on benefits to native fish species. The channel will address two of the most substantial limiting factors for salmonids in the system, including high temperatures during low flow and the limited rearing habitat for salmon and steelhead in the system.

  An existing channel will be enhanced that has the appropriate size, shape, and geomorphology to maintain suitable physical components during all flow conditions. A concept sketch of the side channel enhancement project is provided in Figure 4. The side channel enhancement would provide cool water and habitat enhancement in the lower portion of the side channel referred to as the pilot project. For this pilot project, 400 to 450 feet of channel would be treated in the downstream section of the side channel. A log structure (limiter log) would be installed at the upstream end of the side channel to reduce the amount of flow that the side channel would carry under high flows. Channel modifications are planned for this lower portion of the side channel and consist of (from downstream to upstream) a backwater connector channel where the side channel interfaces with the mainstem channel, run habitat,

riffle habitat, and boulder weir placed at the head of the riffle. The purpose of the boulder weir is to prevent head-cutting upstream of the constructed riffle.

A shallow well pad will be installed to extract the cooler water flowing through the gravel of the streambed. This water will be pumped to perforated PVC pipe buried with spawning-sized gravel in a modified (but existing) side channel. Water will be pumped through the PVC pipe during critical warm water periods and will provide upwelling of the cooler water. One additional power pole with distribution line to a short terminal pole at the well will provide the power for pumping water into the side channel.

Riparian cover lost during construction of the side channel will be restored to ensure that there is cover from predators and shade to keep the water from warming. Canopy trees shall be protected and retained to provide habitat benefits to the finished channel. Where possible, existing shrubs shall be protected. Additionally, existing large woody debris would be maintained or replaced in the constructed channel.

Juvenile steelhead trout prefer relatively cool water areas and will occupy both pool and riffle habitat but often prefer water velocities more typically found in riffles (Bisson et al. 1988). In terms of the proposed off channel specifications, such habitat is likely to be best suited to age 0+ trout, and to a lesser degree age 1+ trout; the relatively shallow water depths within the off channel are likely to preclude significant occupancy by older age cohorts of trout and salmon (Quinn 2005). The potential benefits of the proposed project can be assessed in terms of the estimated carrying capacity of juvenile trout and salmonids that the improved and/or additional summer rearing habitat would provide.

Enloe Hydroelectric Project
FERC Project No. 12569-01

Side Channel Enhancement Site
Similkameen River

Okanogan County, Washington

Cardno ENTRIX

Image: ESRI World Imagery.

0 75 150 Feet

1:3,000

Implementation Schedule: The side channel enhancement will be accomplished in three phases. The first phase will begin in the first year of Project operation and will involve enhancement of the preliminary information, including finalization of topography data, channel construction plans, finalize administrative issues related to pump house and channel location and use. The second phase will take place during year two and include a more detailed examination of the channel stability, development of flow duration curves, finalizing the site plan, and conducting design of the project. The last phase will be building the project in Years 3 and 4 and then operating, and monitoring the project in subsequent years.

- **Potential Adaptive Management Measures**: Monitoring will provide information on fish use in the channel. This data can be used to modify the habitat to maximize utilization if expected use is not attained. If channel features are changed because of events such as high flow, potential effects on utilization will be discussed and repairs and corrections implemented if it is found beneficial and effective.

Monitoring Measure

- **Monitoring Measure**: Monitoring of fish distribution and abundance of the side channel will involve integration with and using habitat surveys and fish distribution methodologies currently being done as part of the OBEMP. Baseline conditions such as depth, velocity, substrate, length of channel, temperature, and dissolved oxygen will be established in the enhanced side channel and three control or reference sites (channels) prior to construction.

  A yearly inspection of the channel will be made during the low flow period (prior to wetting the channel) to see if any structural damage has occurred to the channel. Recommendations for repair and need for a future fish survey will be provided to the FW.

  - **Monitoring Schedule:** It is assumed that fish distribution and abundance monitoring will occur over a 5-year period and will be coordinated with other monitoring efforts in the basin. Data, summaries and identified trends will be reported on a yearly basis to the FW in the yearly monitoring report.

3.4.3 Downstream Flow Assurances

Primary Issue

Although flow through the powerhouse and over the spillway will be automatically regulated to maintain a stable water level in the reservoir so that total outflow from the reservoir will closely track inflow, operation of the crest gates could cause flow fluctuations downstream of the Falls.

Management Goals and Objectives

- **Goal**: Manage Project operations to avoid negative effects to downstream habitat.

- **Anadromous target species**: Chinook salmon, sockeye salmon, steelhead

- **Objective 1**: Manage Projects so that operations have minimal impacts on downstream fish habitat.

- **Objective 2**: Identify and address Project-related impacts on downstream cool water refuge for pre-spawning fish.

Management Measures

- **Management Measures**: Project operation will be run-of-river and will not significantly affect the flow regime of the Similkameen River downstream of the proposed project. Flow through the powerhouse and over the spillway both will be automatically regulated to maintain a stable water level in the reservoir so that total outflow from the reservoir will closely track inflow. During large flood events the crest gates on the spillway will be fully open and water levels on the reservoir will be controlled by the capacity of spillway as it is today. Powerhouse and crest gate operation are further described in Appendix B.

  During a planned unit outage, outflow from the reservoir will be maintained by switching flow to the other generation unit. During a planned outage of both units, outflow from the reservoir will be maintained by partially opening the spillway crest gates. During an unplanned outage of the plant (both units) the spillway crest gates will act as a synchronous bypass that will automatically open to maintain downstream flow in the river. A small, short-term fluctuation in downstream flows could occur as flow through the powerplant is reduced and flow over the spillway crest gates increases. The estimated travel time from the spillway to the pool below the falls depends on flow, but is in the order of about one minute. Any fluctuation in river flow downstream of the project will be of short duration and will be attenuated by water storage in the large pool below the tailrace and in the river channel further downstream. Therefore no significant effects on fish are expected.

  - **Implementation Schedule**: Consistent with normal operations.

  - **Potential Adaptive Management Measures**: If it is found that flow is significantly altered downstream of the Project during power outages, Project operations will be reviewed to improve planned or unplanned changes in flow through the powerhouses or over the dam.

Monitoring Measures

- **Monitoring Measure**: Power outages and flow responses will be monitored and reported to the FW.

  - **Monitoring Schedule:** Data and a summary will be reported to the FW in the yearly monitoring report.

3.4.4 Ramping Rates

Primary Issues

Although "up-ramping" is not a concern, down ramping rates can potentially strand fish in the lower river.

Management Goals and Objectives

- **Goal**: Manage Project operations to minimize changes in decreases in water level that potentially strand fish in the lower river, with a focus on fry and juvenile anadromous and native fish species.
    - **Anadromous target species**: steelhead, Chinook salmon, sockeye salmon.
    - **Resident target species**: rainbow trout, and mountain whitefish.
- **Objective 1**: Identify ramping rates, flow ranges and locations that potentially strand fish.
- **Objective 2**: Avoid stranding of fish in the lower river.

Management Measures

- **Management Measure**: Monitor flow stage changes in a location where stranding potential is present (i.e., where young fish may be rearing in low gradient areas). The first shallow location downstream from the Falls is in a gravel area by the golf course (Figure 5). Other locations may be identified through consultation with the FW. Use Hunter criteria (Hunter 1992) as a starting place for which flows to monitor (Appendix D).
    - **Implementation Schedule**: Monitor stage fluctuations until a consistent pattern is established (2 years of observation) and critical flows are identified for stranding potential.
    - **Potential Adaptive Management Measures**: If no consistent pattern for potential stranding is established, then look for further refinement of management through consultation with the FW.

Monitoring Measure

- **Monitoring Measures**: Monitor water level changes through use of a water level monitoring station equipped with a pressure transducer. In addition, individual observations will be completed through photographic documentation when low gradient areas are covered and then exposed.
    - **Monitoring Schedule**: Data from the water level monitoring station will be downloaded every month and evaluated every year in relation to individual observations. Individual observations will be obtained during critical flows

within the established ramping criteria (see discussion of Hunter criteria in Section 3.3.2) and within the range of flows that are found to be potential stranding issues. Potential stranding events will be monitored over the first 5 years, which include emergency shut downs, and one summer and one winter low flow event. If no stranding is observed in this timeframe, then potential stranding conditions will be reported to the FW and they will determine if additional observation is necessary.

4.0 REFERENCES

Arterburn, A., K. Kistler, C. Fisher, and M. Rayton. 2007. Okanogan basin spring spawner report for 2007. Colville Confederated Tribes, Department of Fish and Wildlife, Anadromous Fish Division – Omak Office. Omak, Washington. BPA Project # 200302200. Performance Period: March 1, 2007-February 28, 2008.

Arterburn, J. and K. Kistler. 2006. 2005 steelhead spawning ground surveys, final report. Colville Confederated Tribes, Department of Fish and Wildlife, Anadromous Fish Division – Omak Office. Omak, Washington. Prepared for Bonneville Power Administration, Department of Fish and Wildlife.

Arterburn, J., B. Miller, and J. Panther. 2010. 2009 Okanogan Basin steelhead redd surveys, revision 1. Colville Confederated Tribes, Department of Fish and Wildlife, Anadromous Fish Division – Omak Office. Omak, Washington. Prepared for the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. BPA Project #200302200. 42 pp.

Arterburn, J., K. Kistler and M. Rayton. 2006. Colville Tribes Okanogan Basin monitoring and evaluation report for 2005. Colville Confederated Tribes, Department of Fish and Wildlife, Anadromous Fish Division – Omak Office. Omak, Washington. BPA Project # 200302200.

Arterburn, J. 2008. Personal communication January 10, 2008. Colville Tribes Department of Fish and Wildlife.

Beechie, T.J., and T.H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society. 126: 217-229.

Bisson, P.A., K. Sullivan and J.L. Nielsen. 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout. Transactions of the American Fisheries Society 117:262-273.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc. (now BioAnalysts, Inc., Eagle, ID.). Boise, ID.

Close, D., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (*Lampetra tridentata*) in the Columbia River basin. Project No. 94-026, Contract No. 95BI9067. Report to the U.S. Department of Energy, Bonneville Power Administration. Portland, Oregon.

ENTRIX (Cardno ENTRIX) and Golder Associates. 2007. Salmon and steelhead habitat limiting factors assessment watershed resource inventory 49: Okanagan watershed. Seattle, Washington. Prepared for the Colville Confederated Tribes.

ENTRIX (Cardno ENTRIX). 2007a. Fish distribution and habitat use of the Similkameen River in relation to the Enloe Dam, draft report. Olympia, Washington. Prepared for the Public Utility District No. 1 of Okanogan County.

ENTRIX (Cardno ENTRIX). 2007b. Draft technical memorandum for water and sediment quality study. Seattle, Washington. Prepared for the Public Utility District No. 1 of Okanogan County.

ENTRIX (Cardno ENTRIX). 2010. Technical memorandum: Analysis of proposed bypass reach minimum instream flow requirements for Enloe Hydroelectric Project. Seattle, Washington.

Prepared for Public Utility District No. 1 of Okanogan County and Washington Department of Ecology. November 10, 2010.

Era-Miller, B. 2007. Similkameen River and Palmer Lake investigation of arsenic in fish tissue. Washington State Department of Ecology, Environmental Assessment Program. Olympia, Washington. Publication No. 07-03-034.

Franke, G.F., D.R. Webb, R.K. Fisher, Jr., D. Mathur, P.N. Hopping, P.A. March, M.R. Headrick, I.T. Laczo, Y. Ventikos, and F. Sotiropoulos. 1997. Development of environmentally advanced hydropower turbine system design concepts. Idaho National Engineering and Environmental Laboratory.

Hallock, M. 2007. Personal communication on January 22, 2007. Washington State Department of Fish and Wildlife.

Harvey, B.C., R.J. Nakamoto, and J.L. White. 1999. Influence of large woody debris and a bankfull flood on movement of adult resident coastal cutthroat trout (*Oncorhynchus clarki*) during fall and winter. Canadian Journal of Fisheries and Aquatic Science. 56: 2161-2166.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: a review of the biological effects, mechanical causes, and options for mitigation. State of Washington Department of Fisheries, Technical Report 119, Sept. 1992.

IEC Beak. 1984. Natural propagation and habitat improvement – Washington. Volume IIB – Similkameen River Habitat Inventory. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. 73 pp.

Johnson, L.B., D.H. Breneman and C. Richards. 2003. Macroinvertebrate community structure and function associated with large wood in low gradient streams. River Research and Applications. 19: 199-218.

Kaumheimer, D.J. 1988. Similkameen River instream flow study, Okanagan County, Washington: Part 2. Fish preference curves, final report. U.S. Fish and Wildlife Service. Olympia, Washington.

Kistler, K., J. Arterburn, C. Fisher and M. Rayton. 2008. 2007 Okanogan Basin Snorkel Surveys. BPA Project 200302200. Colville Confederated Tribes Fish and Wildlife Department. Nespelem, WA.

Krueger, K., P. Chapman, M. Hallock, and T. Quinn. 2007. Some effects of suction dredge placer mining on the short-term survival of freshwater mussels in Washington. Northwest Science. 81(4): 323-332.

Mitchell, S. 1980. The Fish Passage Issue at Enloe Dam: An Assessment. Washington State Department of Ecology, Seattle, Washington.

Mullan, J.W. 1990. Status of Chinook salmon stocks in the mid-Columbia. In Park, Donn L. 1990. Status and Future of Spring Chinook Salmon in the Columbia River Basin—Conservation and Enhancement. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS F/NWC-187. 130 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35. Website: http://www.nwfsc.noaa.gov/publications/techmemos/tm35/

Nadeau, E., A.K. Smith, and J. Stone. 2005. Freshwater Mussels of the Pacific Northwest. US Fish and Wildlife Service. Xerces Society for Invertebrate Conservation. 48 pp.

Northwest Power Conservation Council (NPCC). 2004. Okanogan Subbasin Plan. Available at: http://www.nwcouncil.org/fw/subbasinplanning/okanogan/plan/

NMFS (National Marine Fisheries Service). 2010. Okanogan River Sockeye ESU. Assessed on January 12, 2010. Website: http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Sockeye/SOOKR.cfm

Osborne, R.S., M.R. Peterson, and C.S. Jackson. 2003. 1999 warmwater fisheries survey of Palmer Lake (Okanogan County), Washington. Washington Department of Fish and Wildlife, Warmwater Fish Enhancement. Ephrata, Washington. FPT 03-03. 42 pp.

Parsons, C. 2005. Freshwater mussels of the Similkameen River, brochure. Washington Department of Fish and Wildlife, Regional Habitat Program. Ephrata, WA.

Public Utility District No. 1 of Okanogan County (District). 1991. Application for license for major unconstructed project, Enloe Hydroelectic Project, Project No. 10536. Okanogan Washington. June 1991.

Public Utility District No. 1 of Okanogan County (District). 2008. Enloe Hydroelectric Project (FERC Project No. 12569), Final license application. Before the Federal Energy Regulatory Commission. August 2008.

Public Utility District No. 1 of Okanogan County (District). 2012a. Operations Quality Assurance Project Plan. Enloe Dam Water Quality Monitoring. February.

Public Utility District No. 1 of Okanogan County (District). 2012b. Water Quality Management Plan. February.

Rayton, M. 2007. Personal communication January 30, 2007. Colville Tribes Department of Fish and Wildlife.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. UBC Press, Vancouver.

UCSRB (Upper Columbia Salmon Recovery Board). 2007 Upper Columbia spring Chinook salmon and steelhead recovery plan. 352 pp. Website: http://www.ucsrb.com/UCSRP%20Final%209-13-2007.pdf

WDFW (Washington Department of Fish and Wildlife). 2010. Washington State species of concern lists. Accessed January 12, 2010. Website: http://wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=StateStatus&search=SM

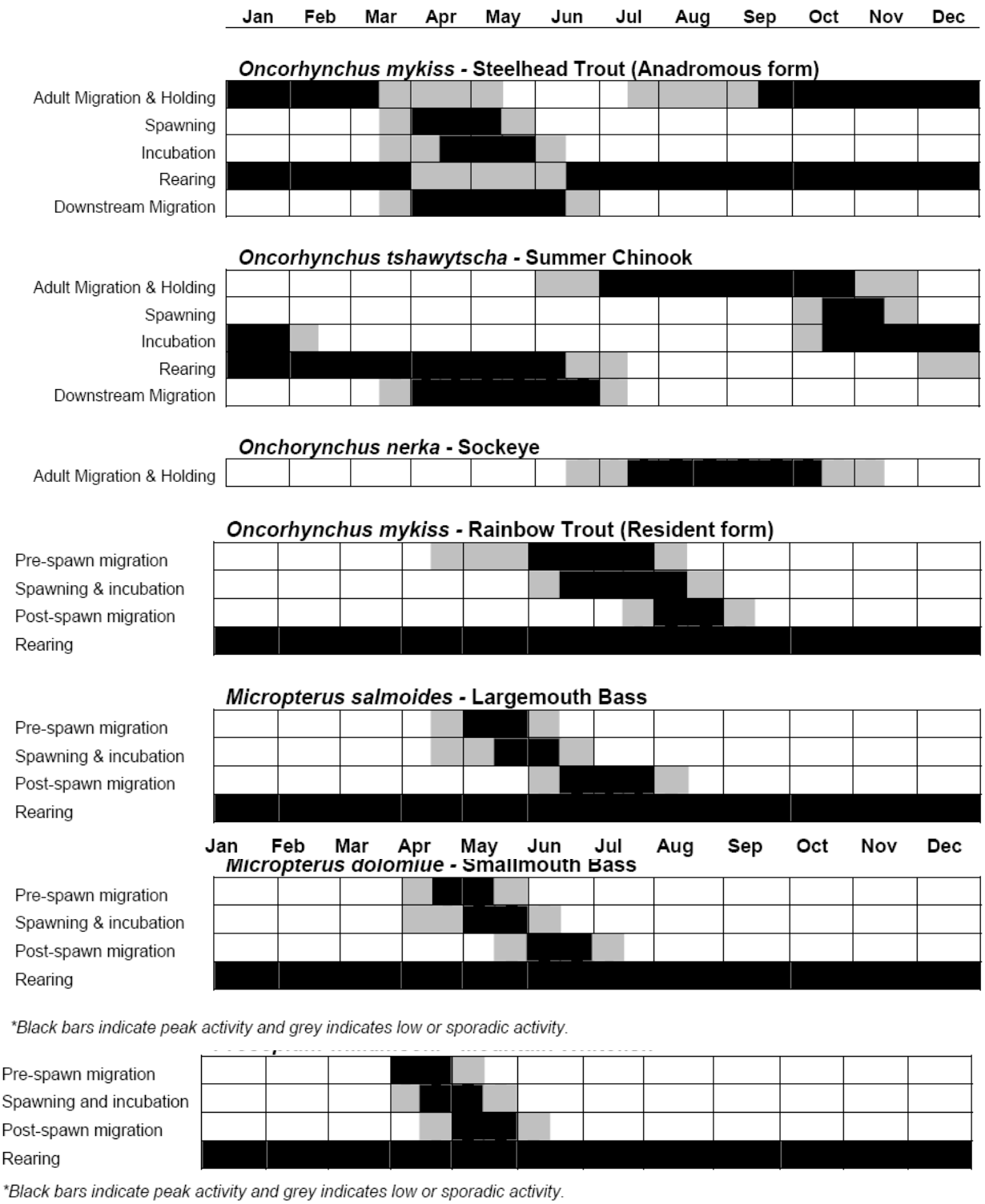
WDFW (Washington Department of Fish and Wildlife). 2005. Warmwater Fishes of Washington. Report number FM93-9, Revised April 2005. Accessed January 8, 2007. Available at: http://wdfw.wa.gov/fish/warmwater/warmwater_2005.pdf

Washington Department of Fish and Wildlife (WDFW). 1990. Methow and Okanogan Rivers Sub-basin: Salmon and Steelhead Plan. Washington Department of Fish and Wildlife, Olympia, Washington.

Wydoski, R.S. and R.L. Whitney. 2003. Inland fishes of Washington. Second Edition. University of Washington Press, Seattle, Washington.

Appendix A:

Seasonal Activity (Phenology) of Anadromous and Resident Fish



Appendix B:

Master Schedule Table

Plan Primary Issue	**Goal**	**Management/Monitoring Measure**	**Schedule**	**Frequency**	**FW Involvement**
1. The Reservoir Plan					
Water Surface Elevation Changes and Habitat Inundation	Maintain or enhance resident fish habitat in the reservoir, with a focus on native and game fish species.	Management Measure 1: • Baseline survey • Replant riparian vegetation along the reservoir Monitoring Measure 1: • plant surveys	Management: • Baseline (Year0) • Replant (Year1) Monitoring: • Late summer	Management: • Year 1 • Year 1 Monitoring: • Year 2	• Identify if planting criteria are met. • Decide if additional surveys are necessary.
		Management Measure 2: • Monitor target species in the reservoir Monitoring Measure 2: • fish surveys	• Baseline (Year0) • Survey (Year5) • Survey (Year10)	Total of 3 monitoring events	Determine how to improve target fish species populations if they are depleted.
Sediment Transport	Maintain or enhance spawning habitat for anadromous and resident fish species, with a focus on salmon and steelhead.	Management and Monitoring Measure: • Gravel augmentation to mitigate for the potential of trapping gravel in the reservoir	• (see gravel augmentation below)	•	
2. The Powerhouse Plan					
Entrainment	Manage Project operations to minimize entrainment of resident target species in the Project intake and turbines.	Management Measure: • Install trashrack with 1-inch clear spacing between bars Monitoring Measure: • Live fish capture nets in the tailrace	Management: • Year 1 Monitoring: • Year 1	Management: • Continuous Monitoring: • 4 (24 hr periods)	Determine how to mitigate if loss of fish is found through intake and turbines.
Tailrace	Monitor and address potential impacts to anadromous fish that may be attracted to the draft tubes in the tailrace.	Management Measure: • Net barriers Monitoring Measure: • Video monitoring •	Management: • • Periods of reduced turbine flow Monitoring: • Years 1,2	Management: • Annually Monitoring: • Annual	• Reported in annual monitoring report

Plan Primary Issue	**Goal**	**Management/Monitoring Measure**	**Schedule**	**Frequency**	**FW Involvement**
Water Quality	Manage Project operations to avoid negative effects to water temperature, TDG levels, and DO levels for target species.	Management Measure: • Tailrace relocated. • Aeration in draft tubes Monitoring Measure: • Monitor TDG, DO, temperature	Management: • Construction Monitoring: • Annual	Management: • 1 Monitoring: • Annual	• Included in annual report
Large Woody Debris (LWD)	Manage Project operations to allow LWD to pass downstream to be used for fish habitat.	Management Measure: • LWD transport Monitoring Measure: • LWD summary	Management: • Periodic Monitoring: • Annual	Management: • Periodic Monitoring: • Annual	• Included in annual report • • • •
3. The Bypass Plan					
Minimum Instream Flow	Manage project operations to avoid effects and enhance feeding and holding habitat for resident species, with a focus on rainbow trout and native species.	Management Measure: • Protect fish in bypass Low level outlet • Aerate bypass flow outlet Monitoring Measure: • Water quality monitoring • Snorkel surveys	Management: • Continuous Monitoring: • As described in Operations QAPP • First 3 years after instream flow releases begin	Management: Continuous Monitoring: • As described in QAPP • When no water is released as spill	• Included in annual report
Ramping Rates	Manage project operations to avoid changes in decreases in water level that potentially strand fish in the bypass reach, with a focus on native resident fish species.	Management Measure: • Ramping rates • Monitoring Measure: • Photographic and observational measures	Management: • Ongoing • Monitoring: • During flows within ramping criteria	Management: • Ongoing • Monitoring: • Periodic	• Included in annual report
4. The Downstream Plan					
Gravel Augmentation	Maintain or enhance spawning habitat for anadromous and resident fish species, with a focus on salmon and steelhead.	Management Measure: • Gravel augmentation Monitoring Measure: • Monitor gravels	Management: • Third year of operation, and every 5 years for the next 20. Monitoring: • Baseline (year prior to augmentation)	Management: • Annual Monitoring: • Annual	• Included in annual report

Plan Primary Issue	**Goal**	**Management/Monitoring Measure**	**Schedule**	**Frequency**	**FW Involvement**
			• Years 3,4,5,7,10,12,13,17,22,23.		
Side Channel Enhancement	Enhance rearing habitat for steelhead and resident fish species in the lower Similkameen River.	Management Measure: • Side channel enhancement project Monitoring Measure: • Monitor fish distribution and abundance at side channel.	Management: • Three phases, fhe first beginning in year 1 of operations. Monitoring: • Occurs over a 5 year period. • Yearly maintenance inspection of side channel.	Management: • Ongoing Monitoring: • Ongoing	• Included in annual report.
Downstream Flow and Water Quality	Manage Project operations to avoid negative effects to downstream habitat.	Management Measure: • Run of river operations Monitoring Measure: • Monitor power outages and flow responses	Management: • Ongoing Monitoring: • Ongoing	Management: • Ongoing Monitoring: • Ongoing	• Included in annual report.
Ramping Rates Year0 = pre-construction Year1 = first year of operation Year2 = second year of operation	Manage Project operations to minimize changes in decreases in water level that potentially strand fish in the lower river, with a focus on fry and juvenile anadromous and native fish species.	Management Measure: • Monitor flow stage changes where stranding potential is present. Monitoring Measure: • Monitor water level changes through pressure transducer and photographs.	Management: Ongoing for first 5 years Monitoring: • Until a consistent pattern is developed •	Management: Monthly data downloadsMonitoring: • 2 years of observation •	• Included in annual report • Evaluate need for additional monitoring after 5 years.

Appendix C:

Reservoir Sampling Methods

Okanogan Public Utility District
Enloe Hydroelectric Project

2007 RESERVOIR SAMPLING METHODS
(EXTRACT FROM PUD 2008, APPENDIX E.3.1)

2007 Surveys

ENTRIX biologists conducted fish abundance and distribution surveys twice, during March and July 2007, to represent typical stream temperature and flows, as well as the presence of fish life stages. Fish surveys in the reservoir were conducted using, beach seines, minnow traps, and gill-nets.

Beach Seine

Beach seine sampling was conducted at four locations (sites BS1 through BS4) on the east bank of the reservoir. Sites BS1 and BS2 are located downstream and upstream of the boat ramp (Figure 1). Sites BS3 and BS4 are located in the upstream portion of Enloe Reservoir at Shanker's Bend.

Biologists conducted beach seine sampling with a seine measuring 30 feet long by 5 feet high and with a mesh size of ¼ inch. A sampling team pulled the net upstream over a distance of 30 to 45 feet at each site.

Minnow Trap

During each sampling event, ENTRIX biologists set minnow traps along the lateral margins of the reservoir at locations indicated on Figure 1 (TS1 through TS7). These locations were selected during the ENTRIX 2006 survey. Two traps tethered to an onshore anchor point were set at each site in approximately 1 and 4-foot depths. The traps consist of two pieces of a galvanized steel mesh with their bases hinged together forming a barrel-shaped enclosure. The traps are approximately 16 inches long with a 9-inch diameter and a 1-inch opening on each end. Traps were baited with a mixture of salmon roe and "Power Bait" (a commercial fishing product) wrapped in cheesecloth. Traps were set for approximately 24 hours.

Gill Netting

ENTRIX biologists conducted gill net surveys in the reservoir during the March and July. Four gill nets were placed in the following locations (see Figure 1):

- Immediately downstream of BS1
- 150 yards upstream of BS4
- Immediately upstream of TS4
- Immediately upstream of TS3

The gill nets are 8 feet deep with four 10-foot panels of differing mesh size arranged from smallest to largest. The nets were placed approximately 5 to 10 yards from shore perpendicular

to the current with the smallest mesh placed closest to shore. Each net was tethered to an onshore anchor point and held in place with mushroom anchors. Nets were set for 24 hours.

2006 Surveys

Fish surveys in the reservoir were conducted using, beach seines, minnow traps, and electrofishing during the 2006 field season.

Beach Seine

Beach seine sampling was conducted during each of the three sampling events at two locations (sites BS1 and BS2) on the east bank of the reservoir. These were located downstream and upstream of the boat launching facility (Figure 1). Two additional sites farther upstream were surveyed by beach seine in the downstream portion of Shanker's bend during the first survey.

Biologists conducted beach seine sampling with a seine measuring 30 feet long by 5 feet high and with a mesh size of ¼ inch. A sampling team pulled the net upstream over a distance of 30 to 45 feet at each site. Relative abundance was estimated by calculating a "catch per unit effort" (CPUE) for each survey.

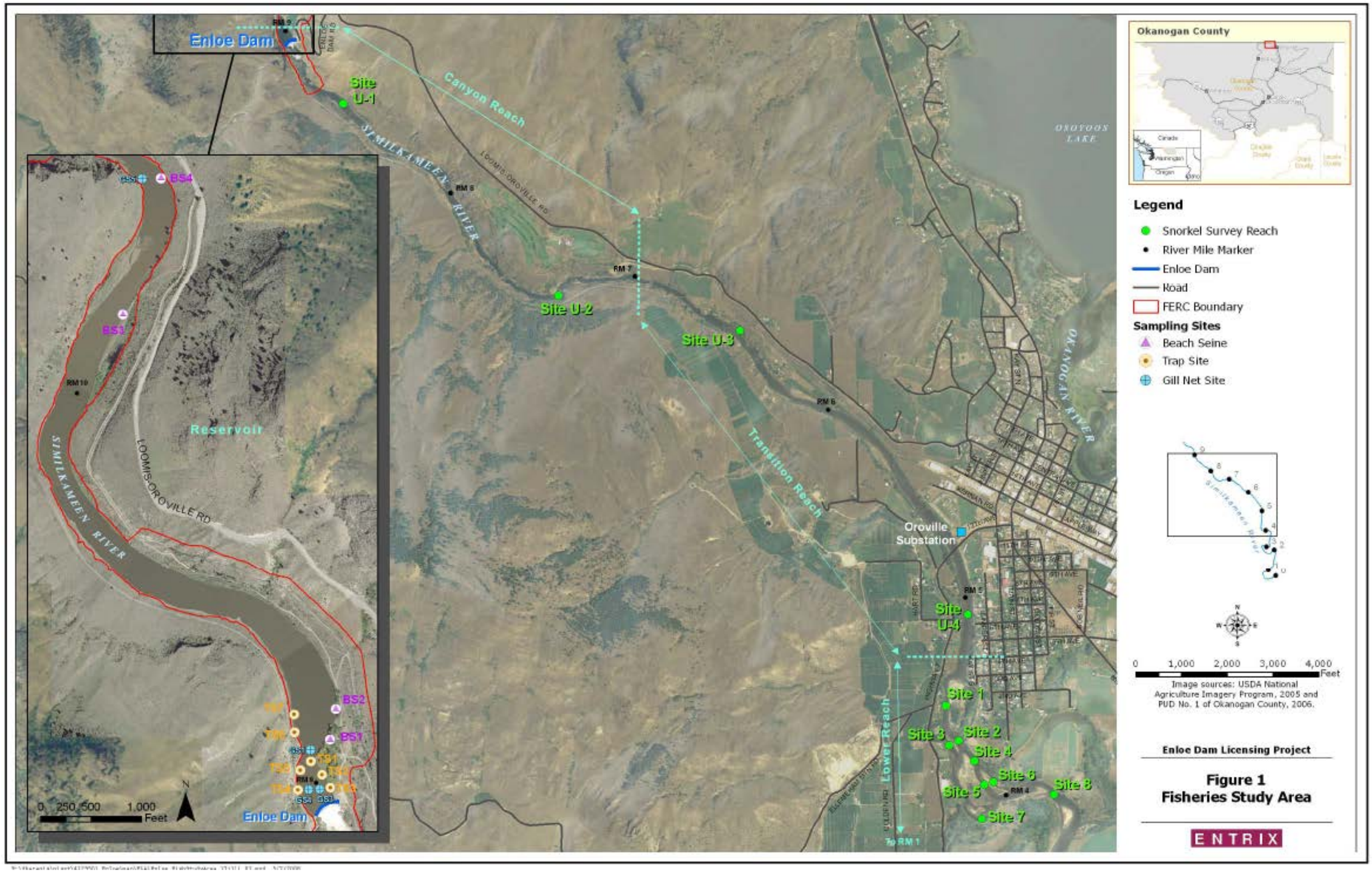
Minnow Traps

During each sampling event, ENTRIX biologists set minnow traps along the lateral margins of the reservoir at locations indicated on Figure1 by "TS#." Sites TS1, TS2, and TS3 were on the east bank, while TS4, TS5, TS6, and TS7 were on the west bank (Figure 1). The survey team selected locations with cover and other features attractive to fish, if such structure was present. Two traps were set at each site in approximately 1 and 4-foot depths. A tether fastened the traps to an anchor point on shore.

The traps consisted of two pieces of a galvanized steel mesh with their bases hinged together forming a barrel-shaped enclosure. The traps were approximately 16 inches long with a 9-inch diameter and a 1-inch opening on each end. Bait consisted of salmon roe and "Power Bait", a commercial fishing product, wrapped in cheesecloth. Traps were set for a minimum of 24 hours. Catch rates were too low to calculate CPUE for the minnow trap surveys.

Electroshocking

ENTRIX biologists conducted electroshock surveys in the reservoir only during the July and August surveys. Each electrofishing survey consisted of a biologist making a single pass with a backpack electroshocker. Voltage and pulse widths followed guidelines described by NOAA Fisheries (2000) for the appropriate conductivity of the reservoir. These protocols included not using the shockers when sensitive fish species may be spawning, or if redds[2] are observed in the immediate area.


Enloe Dam
Site U-1
Canyon Reach
SIMILKAMEEN RIVER
LOOMIS-OROVILLE RD
RM 9
RM 8
RM 7
RM 6
RM 5
RM 4
RM10
OSOYOOS LAKE
OKANOGAN RIVER
Site U-2
Site U-3
Transition Reach
Oroville Substation
Site U-4
Lower Reach
To RM 1
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
BS1
BS2
BS3
BS4
TR1
TR2
TR3
TR4
TR5
TR6
TR7
Reservoir
0 250 500 1,000 Feet
N
Okanogan County
Legend
Snorkel Survey Reach
River Mile Marker
Enloe Dam
Road
FERC Boundary
Sampling Sites
Beach Seine
Trap Site
Gill Net Site
0 1,000 2,000 3,000 4,000 Feet
Image sources: USDA National Agriculture Imagery Program, 2005 and PUD No. 1 of Okanogan County, 2006.
Enloe Dam Licensing Project
Figure 1
Fisheries Study Area
ENTRIX

Appendix D:

Hunter Criteria

Okanogan Public Utility District
Enloe Hydroelectric Project

HUNTER CRITERIA (HUNTER 1992 EXCERPT, PAGES 21-25)

Mitigation Requirements and Considerations

Mitigation negotiations require a timely development of information and, in response to this information, terms and conditions for construction, further evaluation, and operation. This section provides an example on how and when to address the issues and develop criteria.

Washington Department of Fisheries (WDF) requires full mitigation for all fish kills and all losses of anadromous fish habitat (i.e., no net loss). Owners of existing facilities up for relicensing must make all reasonable attempts to avoid harm to anadromous fish and correct facility activities or features that are currently causing habitat losses. If salmon production cannot be restored to pre-project levels, alternative mitigation, either in the form of off-site enhancement, or hatchery production, will be requested. Proposed new facilities must demonstrate that no impact on the salmon resource will occur before WDF supports construction. If there is any doubt as to whether certain operation procedures and/or facility designs are harmful to fish, the burden of proof is on the developer or utility to study the potential impact and demonstrate that no harm will occur.

These relatively high standards of mitigation are a policy response to the high value the public places on the anadromous fish resource, and the historical and ongoing losses of fish and fish habitat as a result of hydropower development. In addition, the Indian treaty fishing rights implicitly includes preservation of the freshwater habitat needed by wild salmonids. Current policy precludes new hydropower development in a river reach accessible to anadromous fish. Resource agencies in other areas may need to interpret the criteria presented below in light of their own policies. Furthermore, criteria should be modified to protect local species which may have different life cycles, behaviors, and periods of vulnerability.

Mitigation activities for flow fluctuations continue throughout the development of a project, including consultation, licensing and operations. The following discussion parallels the U.S. Federal Energy Regulatory Commission's licensing procedures. In general, mitigation criteria for rivers are well established. However, more research is needed to fully understand the impact of flow fluctuations on streams (i.e., average annual flows less than 500 cfs), and at this time, WDF does not have a clearly defined set of criteria to apply to smaller projects. Criteria for these smaller projects will be influenced by site-specific observations and future research.

a. Consultation

During consultation, the agencies identify concerns and informational needs, and the applicant collects information and performs studies as requested.

The applicant should identify the fish species present and locate the barriers to anadromous fish passage. This information will give biologists a rough idea of which impacts may occur. Pre-project information on flow, species composition, and fish also serve as a baseline to compare against post-construction information. A life history schedule of the important fish species should be developed to determine time periods when stranding or redd dewatering are likely to occur.

i. Under most circumstances, permanent ramping rate criteria can be established for projects located on rivers, as listed below. These criteria also serve as interim ramping rate criteria for facilities located on streams:

Season	Daylight Rates[3]	Night Rates
February 16 to June 15[1]	No Ramping	2 inches/hour
June 16 to October 31[2]	1 inch/hour	1 inch/hour
November 1 to February 15	2 inches/hour	2 inches/hour
1 Salmon fry are present 2 Steelhead fry are present 3 Daylight is defined as one hour before sunrise to one hour after sunset		

ii. The applicant should collect information for a rating table at the most confined (i.e., narrowest) river transect immediately downstream of the source of the flow fluctuations (i.e., powerhouse, and for run-of-the-river projects, diversion dam). For some projects, this transect will be located close to the tailrace of the project. The location of this transect must be approved by agency biologists. This transect becomes the control point for measuring the ramp rate.

iii. If the applicant wants to peak flow discharges to follow load demand, he should demonstrate that the load following capacity is needed and not available elsewhere. The applicant should indicate the times of the year this peaking is anticipated and consult with the agencies on the biological impacts and potential mitigative actions. However, in productive river systems, peaking may simply be an unacceptable mode of operation. Currently, WDF opposes peaking operations at proposed facilities with free-flowing downstream reaches accessible to salmon.

b. Licensing

During licensing, biologists should specify terms and conditions that minimize the occurrence of fluctuations. When fluctuations are unavoidable, they should specify terms and conditions that establish ramping rates and ramping schedules that permit a smooth transition in flow. Some or all of the following terms and conditions can be applied to achieve these objectives.

i. All proposed run-of-the-river facilities should have the mechanical capacity to maintain flow continuation for 48 hours. When a powerhouse failure occurs, flow continuation should be maintained a minimum of 24 hours. During salmon fry emergence, flow continuation should continue beyond 24 to avoid ramping during daylight hours. This additional time should also take into account the lag time it takes for the fluctuation to reach sensitive downstream rearing habitats. Under most circumstances, more lenient flow continuation criteria can be specified at high flows (i.e., above the 10 percent annual flow exceedence).

Dam facilities should have the capacity for indefinite flow continuation. A value should be installed in the dam to permit flow discharges independent of the turbines.

ii. Proposed facilities shall have the designed capacity to down ramp the powerhouse discharge at 1 inch of stage per hour at the transect approved by agency biologists during consultation. For run-of-the-river projects, the diversion and intake structure should have the capacity to ramp bypass flows at 1 inch per hour. If necessary, existing facilities should upgrade their equipment to meet the 1 inch per hour ramp capacity.

iii. Agency biologists will assist the applicant in determining the critical flow, in other words, the flow above which the risks of stranding are negligible. This may best be determined by observing the key stranding areas at different flows.

iv. For existing dam and penstock facilities without flow continuation equipment, operators can offset fluctuations in the downstream reach by increasing the bypass flow prior to a powerhouse shutdown. Once the higher bypass flow reaches the powerhouse, the powerhouse can ramp down at a relatively fast rate. Obviously, fluctuations from unanticipated powerhouse shutdowns cannot be prevented with this method.

v. In the event of an intake failure at a run-of-the- river facility, the powerhouse should be operated to ramp flows down as smoothly as possible using residual water in the penstock and surge tank. Intake fish screens shall be cleaned and maintained as often as necessary to prevent intake failures. Under most circumstances, mechanical cleaning equipment should be required.

vi. Cycling is forbidden.

vii. Applicants should design and operate projects to avoid forebay surges.

viii. If peaking is permitted, the resource agencies shall determine seasonal and daily limitations on this mode of operation.

c. Operations

i. The operation manual shall explicitly list the operation procedures needed for flow continuation, ramping and maintaining the intake screens. Critical flows must be identified.

ii. Utilities should operate large storage facilities to avoid redd desiccation in spawning areas below dams. Flow discharges during spawning should be kept relatively stable, but not so low that the migration and spawning activity are impeded and not so high that water storage is reduced and there is risk of redd dewatering during incubation.

Biologists and utilities often have difficulty identifying a fixed operating procedure, especially when the utility has to manage flow releases for other objectives, such as summer reservoir recreation (i.e., keep reservoir pool high and stable), winter flood control (i.e., draw reservoir pool down), and power demand. Since most stocks of salmon spawn just before or during the heavy rain season (late fall to early winter), the desirable strategy is to increase flows during the spawning season only when necessary to meet

flood control requirements and avoid reducing flows. When spawning is complete, excess water is released if necessary, and a minimum incubation flow is established. This strategy maintains greater flow flexibility during incubation and emergence. Under some circumstances, a written operation plan that takes into account all possible hydrologic scenarios can be developed. However, sometimes in-season communications between biologists and operators provide the best means of protecting redds.

iii. For projects located on streams, the permanent ramping rates may be established after construction on the basis of site-specific observations and any new research on the impact in streams.