Rufus Woods Lake Site #3 Steelhead Trout Net Pen Aquaculture

Pacific Aquaculture, Inc.

Draft NEPA Environmental Assessment

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Glossary of Terms

< Less than.

> Greater than.

Acari – A taxon of arachnids including mites and ticks.

Action – Briefly described, the term "action" in State and Federal environmental review includes new and continuing activities (including projects and programs) entirely or partly financed, assisted, conducted, regulated, licensed, or approved by agencies; and new or revised agency rules, regulations, plans, policies or procedures (WAC 197-11-704).

Aerobic − Oxygen-requiring. Aerobic bacteria need oxygen to grow. Aerobic exercise requires the heart and lungs to work harder to meet the body's increased oxygen demand.

Ammonia nitrogen – Total ammonia nitrogen, includes both ammonium and ammonia. Sometimes abbreviated TAN.

Amphipods − *Amphipoda* is an order of animals that includes more than 7,000 described species of shrimp-like crustaceans ranging from 0.039 to 5.5 inches in length. Amphipod means "feet [poda] on both sides [amphi]", in Greek. Amphipods live in the water column or on the bottom of an aquatic body, and are eaten by seabirds, fish, and marine mammals. Terrestrial amphipods, such as sand fleas, can often be seen amongst sand and pebbles or on beaches.

Anadromous – Anadromous fish are those that hatch in fresh water, then migrate to sea where they live most of their adult lives, then return to the freshwater stream or river of their origin to spawn.

Anaerobic − Occurring in the absence of oxygen or not requiring oxygen to live. Anaerobic bacteria produce energy from food molecules without the presence of oxygen.

Annelids – The annelids, collectively called *Annelida*, are a large phylum of segmented worms, with more than 17,000 modern species. They include polychaetes worms (such as "pile worms"), earthworms, and leeches. They are found in marine environments from tidal zones to hydrothermal vents, in freshwater, and in moist terrestrial environments.

Arthropods − An arthropod is an invertebrate that has an exoskeleton (external skeleton), a segmented body, and jointed attachments called appendages. They include the insects, arachnids (spiders), crustaceans, and others. Arthropods are characterized by their jointed limbs and cuticles (shells), which are mainly made of chitin. The rigid cuticle inhibits growth, so arthropods replace it periodically by molting. The arthropod body plan consists of repeated segments, each with a pair of appendages. It is so versatile that they have become the most species-rich members of all ecological guilds in most environments. They have over a million described species, making up more than 80% of all described living species. They range in size from microscopic plankton up to forms a few meters long.

Attached benthic algae – Algae (as well as some cyanobacteria and heterotrophic microbes) attached to submerged aquatic surfaces. Also known as periphyton. Abbreviated as ABA.

Autotrophic index of trophic state – An index of primary production based activity, abbreviated as AI.

Bathymetry – The study and mapping of underwater depth of a body of water.

Beach seining – Fishing method that uses a seine net operated from shore.

Benthic – Related to the bottom of a body of water.

Benthos – The community of organisms living in the benthic zone.

Biomass – The weight or other measure of living organisms.

^{13}C (carbon) – A natural and stable isotope of the element carbon. Many organisms differentially uptake ^{13}C in comparison to other carbon isotopes. This often allows tracing of a specific source of ^{13}C through a food web.

Calanoid copepods – *Calanoida* is an order of copepods, a kind of zooplankton. They include 43 families with about 2000 species of both marine and freshwater copepods. Calanoid copepods are important in many food webs, taking in energy from phytoplankton and algae and 'repackaging' it for consumption by higher trophic level predators like birds, fishes and mammals. Many commercial fishes are dependent on calanoid copepods for diet in either their larval or adult forms.

Chironomid – *Chironomidae* is a large family of Dipteran insects that often superficially resemble mosquitoes. Chironomids are sometimes known as lake flies or sand flies. Larval chironomids are found in a wide range of aquatic habitats and are often associated with degraded ecosystems because some species can survive in very anoxic conditions. Chironomid larvae are important food items for trout and many other fish.

Chlorophyll *a* – A primary pigment of algal photosynthesis. The analysis of its concentration in water is used as a surrogate measure of aquatic phytoplankton abundance.

Cladocerans − Any of various small, mostly freshwater crustaceans of the order *Cladocera*, which includes the water fleas (e.g., *Daphnia* spp).

Copepods − Any of numerous minute marine and freshwater crustaceans of the subclass Copepoda, having an elongated body and a forked tail. A favorite food for many larval and juvenile fishes.

Creel census – A catch assessment survey undertaken to estimate the catches made by small-scale or recreational fishers, usually through a sampling program involving interviews and inspection of individual catches by a qualified sampler at identified fishing and landing places. A "creel" is a special basket traditionally worn on the belt by sport fishers to carry the fish they catch.

Cryptophytes – Unicellular algae that occur in both freshwater and marine environments. Many cryptophytes are important primary producers in aquatic food webs.

Cumulative Impact – A cumulative impact is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR – Chapter V − Part 1508, §1508.7).

Cyanobacteria – A phylum of organisms that photosynthesize for energy; also known as blue-green algae. They include toxic and harmful species, and most are capable of sequestering nitrogen from air, unlike most other forms of algae.

Decapods – Decapoda is an order of crustaceans that includes crayfish, crabs, lobsters, prawns and shrimp. Larval decapods are often an important component of zooplankton.

Diatoms − Any of various microscopic one-celled or colonial algae of the class *Bacillariophyceae*, having cell walls of silica that consist of two interlocking symmetrical halves (or valves). These organisms live in the water. Many are food for zooplankton.

DIN – Dissolved inorganic nitrogen, the sum product of nitrate, nitrite and ammonia nitrogen.

Dissolved oxygen (DO) – Oxygen gas (O_2) that is dissolved in water. DO concentrations are increased if air is bubbled through water.

Drogue − A kite-like device that drifts in water currents. Also can be used as a sea-anchor.

Effects – Effects include: 1) direct effects, caused by the action and occur at the same time and place; and 2) indirect effects, caused by the action later in time or farther removed in distance, but still reasonably foreseeable. The terms "effects" and "impacts" are synonymous as used in NEPA regulations. Effects may be ecological (such as effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health-related, whether direct, indirect, or cumulative. Effects may beneficial or detrimental.

Electrofishing – A method of fishing that uses electricity to stun fish before they are caught; often used in scientific surveys. Typically results in no permanent harm to fish.

Embayment − A bay or bay-like shape; an indentation of a shoreline larger than a cove but smaller than a gulf.

Entrainment – The process or condition of being caught within something.

Environmental Assessment (EA) – An Environmental Assessment is a concise public information document prepared by or under the direction of a Federal agency that serves to briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or a Finding of No Significant Impact. A NEPA EA shall include brief discussions of the need for the proposal, alternatives to the proposed action, environmental impacts of and mitigation measures for the proposed action and alternatives, and a listing of agencies and persons consulted (40 CFR – Chapter V – Part 1508, §1508.9).

Epiphytic algae – Algae living on another organism, on the bottom of the aquatic environment, or on a surface of an aquatic object.

Eutrophic –Nutrient over-enrichment, generally caused by phosphorus in freshwater. Results in a low level of productivity.

Exoparasite – A parasite that lives on the outer surface of its host.

Flux − The movement of a substance through a medium.

Gastropods − The class *Gastropoda* (or gastropods) forms a major part of the phylum *Mollusca*. Freshwater species of gastropod include freshwater snails and limpets; terrestrial species include land snails and slugs.

Geotextile – Permeable fabrics often used in association with soils. Depending on structure and intended use, geotextiles have the ability to separate, filter, reinforce, protect, or drain different materials.

Ichthyoplankton – Refers to planktonic fish larvae.

Isopods – *Isopoda* is an order of crustaceans with seven pairs of similarly-sized legs. There are some 500 species of freshwater isopods; many live among the benthos while others have developed parasitic lifestyles.

KCFS – Thousand cubic feet per second.

Lake Pateros − Reservoir on the Columbia River bounded by Chief Joseph Dam upstream and Wells Dam downstream.

Littoral zone – The area of an aquatic environment that is close to the shore.

Macrophytes – Aquatic plants that grow in or near water and are emergent, submerged, or floating.

Mesotrophic – An intermediate level of productivity; less than eutrophic areas but more than oligotrophic areas.

^{15}N (nitrogen) – A natural and stable isotope of the element Nitrogen. Many organisms differentially uptake ^{15}N in comparison to other carbon isotopes. This often allows tracing of a specific source of ^{15}N through a food web.

Naturally-enriched conditions − Refers to nutrient enrichment (high levels of nitrogen) from natural causes in marine waters.

NEPA – National Environmental Policy Act. NEPA is the basic Federal charter for protection of the environment. It establishes an environmental policy for the nation, provides an interdisciplinary framework for environmental planning by Federal agencies, and contains action-forcing procedures to ensure that Federal agency decision makers take environmental factors into account. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.

Nitrite plus nitrate nitrogen – Total of nitrite (NO_2) and nitrate (NO_3).

Nitrogen to phosphorus ratio – The proportion of nitrogen to phosphorus in aquatic waters or biota.

NTU – Nephelometric Turbidity Unit, used to measure turbidity.

Oligochaetes – *Oligochaeta* is a subclass of organisms in the phylum *Annelida*. Oligochaetes include terrestrial earthworms as well as freshwater worms including blackworms.

Oligotrophic – Defined as having a low level of productivity, containing relatively few nutrients to support and sustain a variety of life.

Orthophosphate – Soluble reactive phosphorus; the dissolved inorganic form of phosphorus that is most readily used by algae and aquatic plants in their growth and metabolism. It is often the limiting nutrient factor in freshwater ecosystems, when other factors such as temperature and light are in abundant supply.

Periphyton – Mixture of algae, cyanobacteria and heterotrophic microbes attached to submerged aquatic surfaces; also known as attached benthic algae (abbreviated ABA).

Phyla − The plural of phylum. In biology, a phylum is a taxonomic rank below Kingdom and above Class.

Phytoplankton – Microscopic aquatic plants.

Planktonic – Refers to the passively floating or weakly swimming usually minute animal and plant life in a body of water.

Primary biological productivity − The production of organic compounds from atmospheric or aquatic carbon dioxide by autotrophs, usually via photosynthesis. Macrophytes, phytoplankton and cyanobacteria are important primary producers in freshwater systems, and often form the base of the aquatic food web.

Redfield Ratio – The physiological balance point for algal nutrition of approximately 7 to 1 by weight, first described by A.C. Refield in 1934.

Rocky Reach Reservoir − Reservoir on the Columbia River bounded by Wells Dam upstream and Rocky Reach Dam downstream. Also known as Lake Entiat.

Rofiter – *Rotifera* is a phylum of mostly microscopic animals, common in freshwater environments. Many rotifers are planktonic while others live in the benthic zone and/or are sessile. Rotifers are often an important component of freshwater zooplankton and serve as a major food source for other organisms.

Rufus Woods Lake – A run-of-the river reservoir on the Columbia River impounded by Chief Joseph Dam downstream and bounded by Grand Coulee Dam upstream.

Salmonid fish – *Salmonidae* is a family of ray-finned fish that includes salmon, trout, chars and freshwater whitefishes. All salmonids spawn in fresh water, but many are anadromous, spending most of their lives at sea and only returning to freshwater for reproduction. Salmonids are predators and feed on crustaceans, aquatic insects and smaller fish.

SCUBA – Self Contained Underwater Breathing Apparatus.

Sequester – Biological sequestration refers to the net removal of carbon dioxide from the atmosphere by plants and microorganisms, leading to carbon storage in biomass and soils.

Standing stock – A measure of population density or total population size, referring to the weight or biomass of a stock of organisms.

Stratification – The formation layers of water with different temperature or salinity properties.

Taxa – The plural of taxon: taxonomic category or group, such as a phylum, order, family, genus, or species.

TDG – Total Dissolved Gas

Teleost fish – *Teleostei* is an infraclass of the ray-finned fishes; most living fishes, including salmonids, are teleost fish.

Total persulfate nitrogen (TN) – Total nitrogen, including ammonia nitrogen, nitrite plus nitrate nitrogen, and other forms measured from unfiltered samples.

Total phosphorus (TP) – A measure of all particulate and dissolved phosphorus in the water column; often used as an indicator of the nutrient status of lakes, rivers and reservoirs.

Trichopterans – *Trichoptera* is an order of insects that consists primarily of caddis flies; also known as sedge-flies or rail-flies. Larval trichopterans are aquatic, found in a variety of freshwater environments, and are often important prey items for fish. The presence of a high biodiversity of trichopterans generally indicates a healthy environment.

Triploid – Having three sets of chromosomes in the cell nucleus instead of the normal two sets that is induced through pressure-shocking the fertilized fish eggs. Many triploid organisms, including triploid fish, are sterile and unable to reproduce. Some freshwater fish farms and fishery stocking programs sometimes use triploid trout in order to prevent accidental inter-breeding with wild fish.

Trophic level – The position of an organism in a food web. The lowest trophic level typically refers to primary producers; consecutive trophic levels encompass other organisms that consume and are consumed by higher predators.

Turbidity – The cloudiness of haziness of a fluid caused by suspended solid particles; an important water quality test. Turbidity is measured here in nephelometric turbidity units (NTU).

Zooplankton − Plankton that consists of microscopic animals, including the larval forms of fish, rotifers, and crustaceans.

1.0 INTRODUCTION

This *NEPA Environmental Assessment* evaluates the potential environmental impacts associated with authorization of wastewater discharges from a proposed steelhead trout net pen aquaculture facility within Rufus Woods Lake Reservoir under Section 402 of the Clean Water Act (CWA) − the National Pollutant Discharge Elimination System (NPDES). Discharges into waters of the United States associated with the operation of aquaculture facilities are regulated under the Net Pen Subcategory of the Concentrated Aquatic Animal Production Point Source Category [40 CFR Part 451, Subpart B]. Due to the location of the proposed project within the boundaries of the Confederated Tribes of the Colville Reservation, the U.S. Environmental Protection Agency (EPA) is the NPDES permitting authority.

New effluent limitation guidelines and new source performance standards for the Concentrated Aquatic Animal Production Point Source Category were promulgated on September 7, 2004, and became effective on September 22, 2004. Aquaculture facilities constructed after promulgation of these new source performance standards are considered *new sources* under 40 CFR 122.29. In accordance with Section 511(c)(1) of the CWA and EPA's regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA) at 40 CFR Part 6, issuance of NPDES permits for *new sources* are considered major Federal actions subject to NEPA review. As a new source, issuance of an NPDES permit to the Rufus Woods Lake Site #3 Net Pen Facility is subject to NEPA review. EPA has prepared this *NEPA Environmental Assessment* in compliance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations at 40 CFR Part 1500 and EPA's regulations for implementing the procedural provisions of NEPA at 40 CFR Part 6.

1.1 PROJECT PROPONENT

Pacific Aquaculture, Inc. (PAI) is a Washington State-based trout farming company, producing fresh steelhead (an anadromous form of rainbow trout) for the wholesale seafood market. The company is a division of Pacific Seafood (www.pacseafood.com).

In 2008, Pacific Seafood purchased an existing Rufus Woods Lake fish farming operation out of bankruptcy and renamed it Pacific Aquaculture, Inc. The operation has been rearing steelhead in the Columbia River for more than 20 years. PAI raises and controls each fish from hatchery to harvesting, ensuring that only a quality product is delivered to the market place. Production fish are harvested and shipped out the same day to seafood customers located throughout the United States on a year-around basis.

Pacific Aquaculture's long-term vision for the Rufus Woods Lake operation includes building a small upland processing plant (for which all permits have been obtained), and developing a third fish farming site. These improvements will help to secure the long-term viability of the operation, and will increase local employment by 18 individuals – 12 associated with the processing plant (when constructed), and 6 associated with proposed net pen Site #3. It is expected that these positions will be filled with predominantly Colville Tribal members.

1.2 PROPOSED ACTION

Pacific Aquaculture, Inc. presently owns and operates two steelhead trout net pen aquaculture systems on Rufus Woods Lake: a run-of-the-river reservoir of the Columbia River impounded by Chief Joseph Dam. The subject of this application is a proposed third site, to consist of an array of 20 steel net pens (see Drawings #4 and #5 in Attachment 1). Each net pen will have the capacity to hold approximately 50,000

fish at a harvest size of 6 to 8 pounds. The total maximum holding capacity at Site #3 could be as high as 6 million pounds at a stocking density of 1 pound per cubic foot. Annual production may be approximately 25% less, on the order of 4.5 million pounds (live weight). PAI purchases certified disease-free fingerlings from hatcheries approved by the Washington Department of Fish and Wildlife (WDFW). The trout fingerlings to be introduced into the net pens will be sterile (triploid) female-only rainbow trout.

Upland support facilities are proposed on an adjacent 2.87-acre parcel at Pacific Aquaculture Preferred Alternative Site #3 (see Drawing #14 in Attachment 1). The upland site and aquatic area proposed for the location of the Site #3 floating net pen aquaculture facility are within the boundaries of the Confederated Tribes of the Colville Reservation, as are the two existing sites owned and operated by Pacific Aquaculture. The upland parcel at Site #3 would be leased from the U.S. Department of the Interior, Bureau of Indian Affairs.

1.3 SITING CRITERIA

A large number of interrelated factors have to be considered when selecting an optimum site for fish farming. Formal site selection criteria were developed for proposed Site #3. Parameters included water depths, currents, circulation pattern, location within the reservoir, the reservoir cross-section, shore access and suitability for upland support facilities, river bottom characteristics, ambient water quality, anchoring conditions, multiple fish farm interactions, wildlife habitat, and known locations of archaeological and cultural sites. The site selection criteria are described in more detail and applied to alternative sites in *NEPA Environmental Assessment* Chapter 3, Section 3.2.

1.4 LOCATION AND SUMMARY OF SITE CHARACTERISTICS

Existing PAI Sites #1 and #2, and alternative locations for Rufus Woods Lake steelhead net pen aquaculture Site #3 are located on the north shore of the Columbia River within the boundaries of the Colville Indian Reservation. All sites are accessed from Columbia River Road (BIA Road 10), approximately 6 miles west of State Route (SR) 155 (see Drawing #1 in Attachment 1). Rufus Woods Lake is the reservoir impounded by Chief Joseph Dam.

PAI's Preferred Alternative Site #3 is within Section 34, Township 31 North, Range 29 East, Willamette Meridian, Okanogan County, Washington, at river mile 576.4. This location is 2.6 miles downstream from PAI existing Site #1 (see Drawing #2 in Attachment 1). The elevation of the Preferred Alternative site ranges from approximately 960 to 1,000 feet above sea level (ASL). The surrounding topography includes upland areas to the south and north of the river that rise to elevations of more than 2,500 ft mean sea level (MSL), and slope downward toward the shoreline (see Drawing #3). The river is the low point of the surrounding topography, with a typical water level elevation of 956 ft MSL (USACE 2011). Surrounding areas are generally undeveloped, with some sparsely located development along the river shoreline.

Preferred Alternative Site #3 has a coarse substrate river bottom that grades from large cobble and sand to smaller cobble and sand composition. Underwater video along an up-to-down river transect indicated no macro invertebrates or wild fish in the view field. Some of the cobble had a small amount of freshwater sponge growing on it. The adjacent shoreline area is typical of most of Rufus Woods Lake aquatic habitat, with alternating stance of macrophytes and sandy areas, as well as some areas of boulders and embedded rock.

Studies of the downstream motion of water from PAI Preferred Alternative Site #3 were conducted using drift objects set at different depths and attached to a surface buoy. A combination GPS/depth sounder

methods was used to track locations of the drift objects downstream. During strong flows, the drift objects would move quickly to the center of the reservoir and continue downstream far from shore. During less strong flows, the direction of movement was more variable, sometimes toward the main channel, other times immediately downstream, and occasionally toward shore when flows were weakest. These data are of interest to help design underwater video monitoring of the net pen operation, although direction and velocity of flow may be slightly different after the pens are installed.

An acoustic Doppler current meter was deployed at the upstream edge of the proposed net pen array at Preferred Alternative Site #3 for approximately 5 weeks during January and early February 2011. The current meter was housed in a special submarine-shaped float immediately above the river bottom and collected velocity and direction data from a number of depth intervals throughout the water column. The data were analyzed by calculating average, range, standard deviation, and frequency distribution of velocity. These data are then compared to hourly Grand Coulee Dam discharge data to “normalize" the velocity data between sites. The results indicated strong near-surface (0 to 13 m deep) current velocities of approximately 65 cm/s (1.27 knots), and subsurface (14 to 31 m deep) velocities of 56.5 cm/s (1.1 knots). The current meter was then moved to a location immediately upstream of PAI existing Site #1 and operated for approximately another week to provide comparison data to the proposed Site #3 data and found to be significantly less at both depths, but nearly identical nearest the bottom. Overall, current velocity at PAI Preferred Alternative Site #3 was very strong compared to marine net pen sites, and stronger than PAI existing Site #1 in Rufus Woods Lake which should serve to provide a suitable fish culture environment while dispersing wastes adequately to allow for aerobic assimilation by the aquatic food web.

1.5 NEPA Lead Agency

Pacific Aquaculture, Inc. and its consultant team participated in meetings and communications in December 2010 with the Confederated Tribes of the Colville Reservation, Office of Environmental Trust, and with Federal agencies from which permits or approvals are required to authorize the construction and operation of Rufus Woods Lake Steelhead Net Pen Site #3. As the NPDES permitting authority for the proposed facility, the U.S. Environmental Protection Agency (EPA) offered to conduct the nominal lead agency responsibilities under the National Environmental Policy Act (NEPA), concurrent with processing the NPDES waste discharge permit application for the project. Neither the Tribe nor other Federal agencies with jurisdiction expressed a preference to take this role. EPA proceeded to instruct PAI’s consultant team to prepare a draft NEPA Environmental Assessment (EA) in accordance with an outline circulated and reviewed by EPA, the CCT Office of Environmental Trust, the U.S. Army Corps of Engineers and the U.S. Department of the Interior, Bureau of Indian Affairs. EPA has invited Colville Tribal leadership to participate in Government-to-Government consultation on the NPDES permit and EA development, and will provide the Tribe and other Federal permitting agencies with updates on the status of the EA and NPDES permit. Copies of the draft EA and draft NPDES permit will be provided to the Tribe and Federal permitting agencies for review and comment.[1]

1.6 Environmental Assessment Required

EPA’s regulations require that an Environmental Assessment (EA) be prepared under the National Environmental Policy Act (NEPA) for a proposed action that is expected to result in environmental impacts and the significance of the impacts is unknown. An EA is not required if the proposed action is categorically excluded, or if the NEPA Responsible Official (in this case, the designated Responsible

[1] E-mail communication from Jamey Stoddard, NEPA Compliance Specialist, U.S. Environmental Protection Agency Region X, Office of Water and Watersheds, NPDES Permits Unit, December 16, 2010.

Official within EPA) has decided to prepare an Environmental Impact Statement (40 CFR 6.205[a]). The scope of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project does not qualify for a Categorical Exclusion.[2] As demonstrated by this *NEPA Environmental Assessment*, however, the project will not significantly affect the quality of the human environment; therefore, an Environmental Impact Statement will not be required. Under these circumstances, an EA was determined to be the appropriate environmental review document. The scope of this *NEPA Environmental Assessment* is tailored to the environmental resources on which the project may have the most effect, and is commensurate with the size and magnitude of the proposed project. It includes the required nine chapters, plus a References chapter. The *NEPA Environmental Assessment* was prepared by a consultant team under contract to PAI, working under the direction of EPA. As the NEPA nominal lead agency, EPA is responsible for the content and accuracy of the Draft *NEPA Environmental Assessment*, for conducting interagency coordination and public involvement, and for finalizing the environmental review process.

1.7 ACTION AREA

The area of the environment affected by a project (e.g., the "action area") typically encompasses the site and immediate vicinity. The action area may differ for different elements of the environment, and during construction versus during operation of the project. The action area of the proposed Rufus Woods Lake Steelhead Net Pen Site #3 project is defined below for elements of the aquatic environment, upland environment, and human environment.

1.7.1 Aquatic Environment Action Area

The aquatic environment action area during construction will encompass the location (Site #3) where the proposed net pen structure and floating dock would be anchored in-place. The Washington State Department of Transportation *Advanced Training Manual for Biological Assessment Preparation for Transportation Projects* (WSDOT (2008) was used to estimate construction noise levels associated with anchor pin installation, and therefore to define the aquatic environment action area during construction. The Biological Evaluation prepared for the project describes the construction noise analysis in detail, and identifies a radius from in-water work of 3,200 feet (0.6 mile) as the aquatic environment action area. Note that a floating dock is proposed only at PAI's Preferred Alternative location for Site #3, not at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream alternative sites. For this reason, the duration of construction noise associated with anchor pin installation would be less at these alternative sites.

There would be no significant environmental consequences to the PAI existing Site #1 aquatic environment as a result of the proposal to assemble Site #3 net pens in the upland area of Site #1, or to conduct harvest activities for Site #3 fish at Site #1. The net pens are built at a remote, commercial facility and merely assembled with connecting bolts and hinge pins fairly rapidly, then placed in the water to be floated into position for anchoring. Therefore, aquatic environment effects at Site #1 would be inconsequential and are not discussed.

In the operational condition of the project, the aquatic environment action area will vary by category of action. Fish culture activities will be restricted to the net pens themselves and the area between the net pens and the immediately adjacent dock and contiguous upland support property. Aquatic environmental

[2] NEPA defines a categorical exclusion as "a category of [Federal] actions that does not individually or cumulatively have a significant effect on the human environment . . . for which, therefore, neither an EA nor an EIS is required" (40 CFR 1508.4). Typically, these excluded activities are minor, routine, or ongoing undertakings with no potentially significant environmental effects.

effects will occur in the form of some degree of temporary deposition of organic wastes will occur under the pens and downstream for a distance of about 200 feet, judging from what occurs at PAI existing Site #1 net pens during the low flow season. During the high flow season of late spring and early summer, this area of effect will be reduced significantly by resuspension and transport over larger areas. A beneficial food web effect will also occur much further downstream of the pens, with an effect upon benthic invertebrates and demersal fishes. This has been observed at PAI existing Site #1 through the results of stable isotope tracing studies conducted by Rensel (2010), where the extent of effect varied by species from a few hundred feet to one mile or more.

1.7.2 Terrestrial Environment Action Area

The terrestrial environment action area during the construction phase will include existing PAI Site #1 where materials to construct the floating net pen structure would be delivered for assembly, and the 2.87-acre upland site at PAI's Preferred Alternative Site #3 location (Colville Tribal Tract #101-T4213) where support service improvements are proposed. There would be no upland support site at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream alternative locations. If one of these alternatives were selected, support services would be provided by boat from PAI's existing Site #1, and by means of a feed barge (see *NEPA Environmental Assessment* Chapter 3, Section 3.1.2.2).

The terrestrial environment action area in the operational condition of the project would be the 2.87-acre upland site at PAI's Preferred Alternative Site #3 location, and a surrounding radius of approximately 0.5 mile. If one of the alternative sites were selected for the in-water location of the Site #3 steelhead net pen aquaculture project, the terrestrial environment action area for potential operational effects would be PAI's existing Site #1 and a surrounding radius of approximately 0.5 mile.

1.7.3 Human Environment Action Area

The human environment action area during the construction phase would be essentially the same as the action area for potential construction effects on the terrestrial environment described in *NEPA Environmental Assessment* Section 1.7.2, above.

The human environment action area in the operational condition of the project is generally the Colville Indian Reservation as a whole, though for linear elements such Transportation, Utilities, and Areas of Recognized Recreational Value, the action area will be the Columbia River Road (BIA Road 10) corridor. For other elements of the human environment (Noise, Light and Glare, and Areas of Recognized Scenic Value), the operational effects action area is defined as Site #3 and within a 0.5-mile radius.

2.0 PURPOSE AND NEED FOR THE PROJECT

2.1 PRESENT CONDITIONS OF NET PEN AQUACULTURE IN RUFUS WOODS LAKE

Pacific Aquaculture, Inc. (PAI) presently owns and operates two steelhead trout net pen aquaculture projects on Rufus Woods Lake: a run-of-the-river reservoir of the Columbia River impounded by Chief Joseph Dam. PAI purchases certified disease-free fingerlings from hatcheries approved by the Washington Department of Fish and Wildlife (WDFW). The trout fingerlings introduced into the net pens are all sterile female steelhead trout (to avoid breeding with other salmonid species present in the reservoir in the event of escape).

When Pacific Seafood purchased an existing fish farming operation on Rufus Woods Lake in 2008, it was in disarray and in a state of disrepair. In its prime, the operation produced more than 5.5 million pounds of steelhead per year. In 2010, total production was approximately 3.2 million pounds. In 2011, the projected harvest is expected to return to historical levels of approximately 5 to 6 million pounds (Sites #1 and #2 combined).

Pacific Aquaculture presently employs 15 full-time personnel to operate the existing Rufus Woods Lake fish farming operations (Sites #1 and #2). The majority of PAI employees are Tribal members, which helps to partially offset the high unemployment rate on the Colville Indian Reservation.

2.2 EXISTING WATER QUALITY PERMIT ISSUED BY CCT FOR PACIFIC AQUACULTURE RUFUS WOODS LAKE SALMON NET PEN AQUACULTURE SITES #1 AND #2

Pacific Aquaculture acquired a Colville Tribal Pollution Discharge Permit from the Confederated Tribes of the Colville Indian Reservation, Office of Environmental Trust on January 15, 2009 (Permit No. 4-8-9/2009-1). The permit authorizes Pacific Aquaculture to: 1) operate and engage in fish farming operations on or within the riparian zone or property of the Colville Confederated Tribes (CCT) previously used by Columbia River Fish Farms, LLC and its fish farming operations; and 2) discharge in accordance with the special and general conditions set forth in this permit. The receiving water (Columbia River, Rufus Woods Lake) classification is Class I. Special Conditions of the permit establish effluent limitations, environmental monitoring requirements, reporting and record keeping requirements, operating requirements, a Pollution Prevention Plan, a Fish Escape Prevention and Monitoring Plan, a Significant Fish Escape Reporting and Response Plan, and additional contingency planning. It is anticipated that conditions similar or identical to the existing Tribal Pollution Discharge Permit will be required for the proposed Site #3. In addition, a National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit will be required from the U.S. Environmental Protection Agency.

Effluent limitations address water quality and sediment. The net pen operations shall not cause a violation of Tribal surface water quality standards established for the Columbia River, Rufus Woods Lake. Further, there shall be no significant permanent sediment accumulation on the river floor under and adjacent to the net pens.

Environmental monitoring requirements include a schedule, sampling and analytical procedures for the water quality survey, SCUBA diving observations and underwater photographic survey (twice per month, June through October) for sediment accumulation, and continuous remote survey of the river bottom. Water quality parameters sampled include: temperature, dissolved oxygen, Secchi disk transparency, turbidity, pH, total dissolved gas, nutrients and chlorophyll *a*. A macrophyte survey is required in August each year to document abundance, density, diversity, and spatial distribution of nearshore aquatic

macrophyte vegetation. Sediment antibiotic resistance monitoring may be required if the "Department" (CCT Office of Environmental Trust) determines that the permitted discharge from the steelhead trout net pen aquaculture operation poses a threat to human health or the environment. To date, no significant impacts from fish feed or fish feces have been documented in the water quality and sediment monitoring results (Pacific Aquaculture, December 2010).

The Tribal Pollution Discharge Permit also required Pacific Aquaculture to commission a study of the nitrogen (and possibly carbon) stable isotope footprint of downstream pens by sampling sediment and/or epifauna (such as snails and cottid fishes) at several distances downstream of the furthest downstream cages (Site #1). Stable isotopes are naturally-occurring forms of the atoms but have one more neutron per atom, hence are heavier, and therefore are physically enriched or depleted depending on their fate in the food web and "trophic" position (e.g., primary producer plant, secondary consumer, tertiary consumer, etc.). The mass (weight) differences, due to a difference in the number of neutrons, will result in partial separation of the light isotopes from the heavy isotopes during chemical or metabolic reactions and during physical processes such as diffusion and vaporization. This process is called isotope fractionation. Every ecosystem and season will exhibit different stable isotope results, but once charted, these data often allow for determination of the fate of natural or anthropogenic sources of nutrients; i.e., which organisms are eating what and how much of their diet is composed of a particular food source. The purpose of the stable isotope evaluation in Rufus Woods Lake was to document and investigate the spatial extent of the carbon and nitrogen footprint of the net pens due to solids resuspension and movement across the bottom. The fish feed generates a unique marine-derived source of nitrogen that is highly useful in the reservoir because anadromous fish are blocked from reaching Rufus Woods Lake by the downstream system of Columbia River hydroelectric dams. Without anadromous fish mortalities in the lake/reservoir, there is no significant source of nitrogen. The following paragraphs are extracted from the results of the preliminary study conducted in 2009 and reported in 2010 (Rensel 2010):

The stable isotope study was conducted in late summer of 2009 and included diver-collected core samples for total nitrogen and total carbon as well as stable isotopes ^{15}N and ^{13}C. Stable isotope analysis of sediments indicated that enrichment of ^{13}C occurred to a distance of at least 1,300 feet downstream of the net pens at PAI existing Site #1; however, by one mile downstream was not statistically different from the reference area. No enrichment of sediment ^{15}N was found, but rather a curious inverse pattern seen for carbon stable isotope ^{13}C. These data suggest that assimilation of the fish fecal and fish feed discharge are occurring within the cited distances and are not accumulating or being transmitted further downstream. The study design was biased to sampling exactly within the expected trajectory of dissolved and solid waste matter from the pens and as there is little horizontal mixing within such distances, the results overstate the probable effects of the net pens considerably, resulting in a highly conservative estimate.

Results of infauna analysis indicate distinct patterns of enrichment of stable isotopes in Rufus Woods Lake for sediments, snails, crayfish and sculpins, each with their own unique signature. The nutrient enrichment effects of the existing fish farm vary spatially from a few hundred feet downstream to possibly one mile or more for these species. While the patterns of enrichment or depletion of ^{13}C and ^{15}N in relation to the net pens are reasonable, some are curiously different. For example, snail ^{15}N is enriched downstream of the net pens but ^{13}C is depleted. Possible reasons for this are advanced in the Rensel 2010 report. For crayfish, a different result indicates enrichment of ^{13}C but depletion of ^{15}N downstream of the pens. Sculpins (small, epibenthic or demersal fish) showed enrichment of both and prior work showed that they actually consume waste feces and ostensibly waste feed. These data show that the wastes from the fish farm are being utilized in the system and not simply being accumulated downstream where the wastes may have a biological oxygen demand from bacterial respiration. In a system that is generally considered nutrient starved, this may be viewed as a beneficial effect of the net pen operations. But all water bodies have a carrying capacity for nutrient discharge for differing reasons, and there is an eventual

need for further sampling to validate the reference results and fill in some of the blanks for the downstream locations beyond one mile and before the Chief Joseph Dam pool.

2.3 PROPOSED PROJECT DESCRIPTION: SITE #3

The subject of this *NEPA Environmental Assessment* is a third steelhead trout net pen operation. Four alternative sites were evaluated, ranging from 2.6 to 7.0 miles downstream from operations at PAI existing Site #1. PAI Preferred Alternative Site #3 is proposed 2.6 miles downstream from the existing Site #1 location (see Drawing #2 in Attachment 1). The 20-pen floating aquaculture operation would be located approximately 200 feet waterward from the ordinary high water mark, and would be similar in construction to existing Site #1 and Site #2. A dock would be installed at the shoreline to facilitate boat access to the net pens. Upland improvements are proposed to include feed silos, a container (trailer) to house the feeding control system, feed tubes extended from the trailer to the floating net pens, a refrigerated container for cultured fish mortalities, and a road/compacted earth trail for vehicular access (see Drawing #14 in Attachment 1). Principal features of both in-water facilities and upland support improvements are described in *NEPA Environmental Assessment* Chapter 3.

2.4 PURPOSE AND NEED FOR THE PROJECT

The purpose of the Rufus Woods Steelhead Trout Net Pen Aquaculture Site #3 project is to augment the existing Pacific Aquaculture operations on the Columbia River. Existing facilities at Site #1 and Site #2 raise sterile female juvenile steelhead trout in pens located upriver from the proposed Site #3 (see Drawing #2 in Attachment 1). Each site includes an upland area where office and storage facilities are located, and a shoreline area that includes the fish pens as well as a harvesting and loading/unloading area (Site #2 only). A third site is needed to improve the long-term effectiveness of existing Pacific Aquaculture operations to compete with foreign companies that produce farm-raised steelhead trout and export it for sale in the United States. The Site #3 operation will contribute to reducing the United States' seafood trade deficit which has grown to more than $9 billion annually,[1] and will provide additional employment on the Colville Indian Reservation where the Tribal unemployment rate is presently very high.

[1] U.S. Department of Commerce, NOAA Aquaculture Program, February 8, 2011.

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 APPLICANT'S PREFERRED ALTERNATIVE

The Pacific Aquaculture, Inc. (PAI) Preferred Alternative is to construct the Rufus Woods Lake Steelhead Net Pen Site #3 at river mile 576.4, and upland support facilities on Colville Tribal Tract No. 101-T4213 (Latitude 48.1446 North, Longitude 119.1578 West). This site is preferred for optimum environmental effects and fish cultural conditions in relation to the siting criteria for floating net pen aquaculture facilities, for closest proximity to PAI's existing Site #1 for ease of maintenance and operations, and for the least potential for impacts to the known location of cultural resources on lands bordering the river in the area.

3.1.1 Principal Features

Principal features of the steelhead net pen floating aquaculture project are described in the *Rufus Woods Lake Site #3 Proposed Management Plan* (Pacific Aquaculture, December 2010) and include: a 20-pen array of hot-dipped galvanized steel frame fastened to plastic floats, secured to the river/reservoir bottom by steel anchor pins; a floating dock to be secured at the shoreline (also with anchor pins) to access the cages by boat and for possible use during harvest activities; and upland support facilities to include a gravel or crushed rock access road, feed silos, feed lines, and an operations trailer (see Drawing #14 in Attachment 1).

The floating net pen operation is proposed 200 to 300 feet waterward from the ordinary high water mark (see Drawing 14). It would be anchored in-place on the Okanogan County/Colville Indian Reservation side of the Columbia River/Rufus Woods Lake. Net pen construction would be similar to the net pen arrays at PAI existing Site #1 and Site #2 (see Figure 3.1-1). The 20 steel net pen array would be approximately 1,100 feet in length and approximately 210 feet wide (each pen 100-ft by 100-ft in dimension), including 6.5-ft wide center walkways with side walkways approximately 4.5 feet across (see Drawing #6 and Figure 3.1-2). The pens would be constructed of nets connected to the floating frame. The depth of each pen would vary; however, individual pens are typically 30 to 40 feet deep, and are designed so that the bottom of each pen would be at least 10 feet off the river/reservoir bottom (in most cases much more). The net pens and walkways would be constructed of hot-dipped galvanized steel frame structures fastened to plastic floats.

Figure 3.1-1. Pacific Aquaculture, Inc. (PAI) existing steelhead trout net pen aquaculture Site #2: Rufus Woods Lake, Columbia River, Washington.

Figure 3.1-2. Steel net pen array center walkway, side walkway, and typical deck grating.

The cages are designed for a significant wave height of 6 feet, allowing for occasional waves much higher than 6 feet. Several decades of experience with fish farming in the general area and the maximum fetch length (straight line wind exposure distance) at Site #3 indicate such waves are not possible, except as a result of an earthquake and/or a significant bank sloughing event. Therefore, the cages are considered substantial for the conditions of the reservoir in which they will be located.

Second only to ensuring human safety, secure containment of fish within the net pens will be the highest priority at the proposed fish farm. Heavy barrier netting material (minimum 210/60) will be used for operations, along with log-deflector equipment at an up-current location (see Drawings #10 and #11 in Attachment 1).

Each net pen will have the capacity to hold approximately 50,000 fish at a harvest size of 6 to 8 pounds. The total maximum holding capacity for Site #3 could be as high as 6 million lbs at a stocking density of 1 pound per cubic foot (lb/ft^3). Annual production may be approximately 25% less, on the order of 4.5 million pounds (live weight). PAI purchases certified disease-free fingerlings from hatcheries approved by the Washington Department of Fish and Wildlife (WDFW). The trout fingerlings introduced into the net pens will all be sterile (triploid) female-only rainbow trout. PAI applies annually to WDFW for a Fin Fish Transport Permit for the transport of the fingerlings from hatcheries to the net pen facilities. PAI recognizes that any change in species, stock or race of fish reared at net pen facilities will require written authorization from WDFW in compliance with WSR 03-02-047, and from the Colville Department of Fish and Wildlife.

Juvenile fish will be delivered by truck two or three times per year. They will be pumped into transfer pens and towed out to the main pens at Site #3.

At full stocking, the fish could consume as much as 70,000 pounds of feed per day during optimal water temperatures. This condition would rarely occur, as maximum stocking densities are rarely ever reached.

A 13-ft by 35-ft floating dock would be used to access the cages by boat, and potentially during harvest activities. The dock will be constructed of hot-dipped galvanized steel frames fastened to plastic floats. The dock decking material will be composed of grating to allow 35% to 50% light penetration into the water (see Drawing #9 in Attachment 1, and Figure 3.1-2). The entire net pen operation would be anchored over deep water that does not have macrophytes or substantial benthic periphyton.

Five-inch diameter anchor pins would be used to secure the cages to the river/reservoir bottom. Smaller diameter anchor pins would be used to anchor the floating dock in-place so that no shoreline structure would be required.

3.1.2 Farm Management Proposal

The farm management proposal is described in the Pacific Aquaculture, Inc. *Best Management Practices Summary* (December 2010), and the *Rufus Woods Lake Site #3 Proposed Management Plan* (December 2010).

3.1.2.1 Culture Methods

Fish are stocked in the cages as fingerling and fed a size-appropriate diet that is increased in size as the fish grow. Density of fish is low at stocking to ensure fish health but gradually increases as the fish grow commensurate with accepted loading rates for the available space and water currents. Fish numbers and biomass weight are periodically assessed by the use of electronic monitoring equipment that involves splitting the pen in half and allowing swim-over through the measuring device, or through counting and measuring methods during size-grading operations that occur during harvesting. The subsections below describe specific categories of culture methods in more detail.

3.1.2.2 Fish Feeding Methods

Feed would be delivered to the floating net pens via a pneumatic delivery system conveyed in 4-inch diameter PVC pipe (see Drawing #4 and Figure 3.1-3). Fish are fed during daylight hours, 2 to 3 times per day per cage. The feeding system would operate 6 to 8 hours per day. Feeding would be monitored by the use of underwater cameras to ensure that feed is not wasted. Feed quantities will be recorded on a pen-per pen basis, and feed conversion rates will be closely monitored for signs of over-feeding or under-feeding. Underwater video will be used during feeding to ensure that feed loss is kept at an absolute minimum. Feed is rich in nutrients compared to fish feces, sinks faster, and therefore its loss is to be avoided both for environmental and business reasons. If feces or waste feed beneath or downstream of the cages became a problem, PAI would immediately assess why the monitoring system failed to indicate feed loss, and/or would reduce feeding levels and/or stocking densities.

If one of the downstream alternative locations were selected for the Site #3 operation, net pens at any of these locations (High Bank Bight, Mah-Kin Rapids, or Narrows Downstream) would be served by a feed barge (as shown in Figure 3.1-4). A generator would be required to operate the feed delivery system from the barge. The generator would run 6 to 8 hours per day, during daylight hours. The generator and a diesel fuel container (within an approved containment system) would be housed within the feed barge enclosure. Refueling would occur by means of transporting a diesel fuel container (within an approved containment system) on a Pacific Aquaculture barge from PAI existing Site #1 to the Site #3 feed barge – only if one of the downstream alternative locations were selected rather than PAI Preferred Alternative Site #3.

Figure 3.1-3. Pneumatic feed delivery system.

Figure 3.1-4. Feed barge alternative to pneumatic feed delivery system.

3.1.2.3 In-Water Discharges

In-water discharges would include uneaten or regurgitated feed, fish feces, fish oil, and possibly other constituents associated with the steelhead trout net pen aquaculture operation. No antifoulants are used on net pens in a freshwater environment, and pharmaceutical treatments are extremely rare,[1] based on the more than 20-year history of fish culture in Rufus Woods Lake. There has also been no need for fish treatment for exoparisites in the freshwater environment.

Fish oil sheening that may result from fish feed will be accumulated at the down-current end of the floating net pen system using an oil boom (see Drawing #13 and Figure 3.1-5). Oil that is accumulated will be removed with an oil skimmer for disposal with mortalities. This system is currently employed at existing Pacific Aquaculture operations on Rufus Woods Lake (Site #1 and Site #2), and is effective in controlling sheening.

[1] Antibiotics have only been used three times since the inception of the steelhead trout net pen projects on Rufus Woods Lake now owned and operated by PAI (personal communication with John Bielka, PAI General Manager, June 20, 2011). Site #1 was established in 1994. Site #2 was established in 1997.

Figure 3.1-5. Fish oil boom and skimmer.

3.1.2.4 Best Management Practices

A Best Management Practices (BMP) manual was prepared for the Rufus Woods Lake fish farm operations in 2003 (by Columbia River Fish Farms staff, prior to PAI ownership). This manual was updated by PAI in December 2010 to address proposed Site #3. Fish feeding procedures are described, along with net washing practices; fish oil sheen management practices; use of disease control chemicals; and collection, storage and disposal of dead fish (mortalities). The BMP manual includes a Spill Prevention and Response Plan, Spill Prevention and Response Procedures, and Employee Guidance for Routine Handling Procedures to Minimize the Potential for Escapement. Other than during fish handling and grading procedures, SCUBA dive inspections will be routinely conducted on a weekly basis by contract divers and certified employee divers to inspect and repair barrier nets if holes occur.

3.1.2.5 Harvest Methods

PAI plans to purchase a harvest vessel to transport market-ready fish from Site #3 to PAI existing Site #1 for the harvest operation. During harvest, 6 to 8-pound fish are directed into a portable transport pen that is then moved to shore at Site #1. From the transport pen, fish are pumped through a pneumatic stunner (the most humane method available), slit near their gills, immediately placed into ice-and-water-packed containers (totes), and shipped offsite to the company's processing facility in Clackamas, Oregon. Residual blood from the harvested fish is collected into a plastic container and typically shipped off with

the harvested fish. Any accumulated blood water is sent to a rendering facility or a composting operation. At the completion of each harvest (which occurs over a period of a week or two), water used to temporarily store fish at the harvest table is used to clean the concrete pad. This water is collected into a separate plastic tote and also shipped off with the harvested fish. An average harvest consists of 60,000 to 80,000 pounds of fish (5,000 fish per tote) from net pens that hold as many as 200,000 pounds of fish each (personal communication with John Bielka, PAI General Manager, June 20, 2011).

Harvesting usually takes place early in the morning. As much setup as possible will be done the day before. Harvesting will be supervised by a senior staff member to minimize the risk of releasing fish during this procedure. All fittings and hoses will be thoroughly checked and tested before harvesting begins. Harvest speed will be adjusted to account for weather conditions and available staff.

3.1.2.6 Mortalities

Fish mortalities occur naturally as the fish are raised. Certified SCUBA divers will collect fish mortalities several times per week. In the winter, diving will be conducted once per week (unless dive conditions are dangerous), whereas in the summer the diving could be as frequent as once per day. Approximately 2,000 pounds of mortalities per week are typically generated, on average, from a farm the size of proposed Site #3. Weekly mortalities can increase in the summer to as high as 10,000 pounds per week[2] when the water temperature is warmer, and can be less than 500 pounds per week in the late winter and spring when water temperatures are low.

Mortalities will be stored in a refrigerated container unit ("reefer") located at Pacific Aquaculture's Site #2. These mortalities will be transported offsite to Pacific Seafood's rendering facility in Warrenton, Oregon; a permitted composting facility in eastern Washington; or a rendering facility in Spokane.

3.1.2.7 Intentional Releases

The Colville Confederated Tribes (CCT) operate a lake-stocking program to release sterile steelhead trout periodically throughout the year for harvest by Tribal and other licensed fishers.[3] These fish often stay in the vicinity of the cages for some period, or travel up or downstream. Many are caught near the pens but also downstream in a number of locations including near the Chief Joseph Dam forebay (Shallenberger 2009). The program is presently the focus of a food web and acoustic tracking program conducted by CCT and contracted out to fisheries experts that involves creel census, fish stomach analysis, food web enumeration, stable isotope sampling and computer simulation of the food web and fish migration in the lake.

3.1.2.8 Use of Disease Control Chemicals and Therapeutants

As described above in Section 3.1.2.3, the use of pharmaceutical treatments in steelhead trout net pens has been extremely rare over the more than 20-year history of operations on Rufus Woods Lake. The

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[2] There is no direct correlation between number of pounds of mortalities and number of fish, as fish in the net pens vary in size. For example, some net pens hold 6-pound fish while others hold 4-ounce fish. If an average size of 1 to 2 pounds is assumed, summertime mortalities at a rate of approximately 10,000 pounds per week would equate to 5,000 to 10,000 fish (personal communication with John Bielka, PAI General Manager, June 20, 2011).

[3] The number of fish released is a function of available CCT funds. For example, the Tribes generally have approximately $60,000 available for the purchase of fish. At $2.00 per pound, this amounts to about 30,000 pounds of fish. In a size range of 4 to 6-pound fish, this amounts to 5,000 to 7,500 fish. Releases have generally occurred during spring months (personal communication with John Bielka, PAI General Manager, June 20, 2011).

antibiotic oxytetracycline[4] has been used to combat columnaris bacteria. When used, oxytetracycline is introduced in fish feed at a rate of approximately 80 mg per kg of fish for a 10-day treatment (personal communication with John Bielka, PAI General Manager, August 11, 2011).

A Disease Control Chemical Use Operational Log will be maintained for each site by the site manager or other duly authorized personnel. The Operational Log will record the treatment dates, amounts of treatment material used, reason for use, the type of chemical used, and other pertinent information. Medicated feed will be labeled and stored in leak-proof containers while at the facility. Fish medications shall be applied in a manner that minimizes the discharge of treatment substances to ambient waters of the Tribal Reservation. Qualified fish health experts will be consulted prior to any application of medication to the fish population requiring treatment.

Husbandry techniques that prevent or reduce the chance of disease will be used in order to minimize the amount of medications used at the facility. These techniques will include avoidance of fish handling or crowding; regular feed practices; reducing feed rates if dissolved oxygen levels are lower than normal while water temperatures are high; and removing mortalities from the net pens on a regular basis.

The amount of fish health protection and security disinfectants to be used for footbaths, dive nets, and other purposes will be kept to a minimum and reused as much as possible. Waste materials (medications and disinfectants) will be disposed at land-based sewage treatment facilities. The minimum amount of these materials necessary for efficient operation will be stored at the facility.

3.1.3 Upland Support Facilities to be Constructed on Tribal Leased Land

Of the four alternative locations considered for Site #3, only the Preferred Alternative includes an adjacent land parcel suitable for upland support services. It would be necessary to serve the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream site with a feed barge (see Figure 3.1-4), with other support services transported by boat from and to the existing PAI operation at Site #1.

The upland site adjacent to Preferred Alternative Site #3 is 2.87 acres in size. Proposed improvements for support services at this location include power and communications utilities, four feed silos, an 8-ft wide by 40-ft long container (operations trailer) to house the feeding control system (feed cameras, blowers, etc.), 4-inch diameter PVC piping to convey feed to the floating net pens, a gravel or crushed rock road for vehicular access to the site, and a foot path for access to the dock (see Drawing #14 in Attachment 1). These improvements would result in disturbance of approximately 12,000 sf (0.3 acre) – approximately 10% of the site surface area. A concrete pad (15 feet x 60 feet, 1.5 feet deep) will be poured on the upland site to serve as the foundation for four feed silos and the portable operations trailer (see Drawing #12). Other than this 900 sf area of impervious surface, the site would remain unpaved in the developed condition. The road would be constructed in a half-circle for access to/from Columbia River Road (see Drawing #14).

A trailer (i.e., metal container) to house pneumatic blowing equipment and an office would be placed alongside the feed silos, in a similar manner to PAI existing Site #1. The pneumatic delivery system to convey feed to the floating net pens would utilize 4-inch diameter PVC pipe laid across the upland site and water surface between the blowing equipment and the pens (see Drawing #4 and Figure 3.1-3). The nearest point of upland improvements would be approximately 130 feet landward from the ordinary high water mark (Drawing #14).

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[4] Oxytetracycline is described on the following web pages: http://www.drugs.com/vet/terra-vet-200.html, and http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm.

3.1.4 Construction Proposal

Overall construction is estimated to take approximately 6 months, with a target date to begin in mid-summer 2012. Upland support improvements at PAI Preferred Alternative Site #3 are estimated to take 3 to 4 months, and would occur concurrently with the work to assemble and install in-water facilities. The project area is in an arid region in which average annual rainfall is 10 to 14 inches. Erosion-prone surfaces will be stabilized as soon as practicable with rock or gravel (to be used on the Site #3 access road and trail), or by seeding with grasses (to be applied on the waterward side of the slope where the feed silo/operations trailer concrete pad will be poured). Woven geotextile will be placed on the down-slope side of the Site #3 concrete pad to protect the ground from piping of fines. Gravel will then be laid over the geotextile material and installed according to manufacturer's recommendations. An effort will be made to construct upland improvements prior to snowfall and the onset of the winter season.

Net pen parts would be brought to PAI existing Site #1 in containers transported by trucks. The containers would be off-loaded in the Site #1 upland area, where they will be assembled with the aid of PAI's 28-ton crane, a genie lift (10-ton with 48-ft boom), and on-site forklift. Cage assembly is estimated to take approximately 2 months. As the cages are assembled, they will be floated into the water and downstream to Site #3, where they will be maneuvered in-place with the aid of boats.

Twenty-foot long, 5-inch diameter, steel anchor pins proposed to secure the cages and dock will be vibrated into the river/reservoir bottom using a 50-ton cable crane with a vibratory head operating from a floating barge (see Figures 3.1-6 and 3.1-7).

Figure 3.1-6. Anchor pin and vibratory head.

Figure 3.1-7. Anchor pin installation barge.

It is expected that anchor pin installation will take approximately 2 months to complete. A diver or camera will be deployed to the bottom after each pin is inserted to check its placement. In this manner, there would be no mechanical ground disturbance in the shoreline area (above the ordinary high water mark) to install the dock and secure it in-place. Heavy moorings consisting of metallic buoys, stud-link chain, and 2-inch diameter mooring ropes will be used to secure the pens to the anchor pins (see Drawing #8 in Attachment 1).

PAI selected anchor pins as the most reliable option for securing the net pen array within the river/reservoir, with the least potential for environmental consequences. An anchoring option eliminated from further consideration was the use of Danforth/plow anchors. These create a trench 15 to 20 feet long before they "set," and therefore would have more significant effects to bottom sediments, bottom-dwelling organisms, and water quality during the construction phase.

Upland support improvements would be constructed only at PAI Preferred Alternative Site #3. A backhoe and excavator will be used at the Site #3 location for a period of 3 to 4 months for construction of the access road and to construct a level area for the feed silos/operations trailer concrete pad. Soil removed to construct the access road will be used for site leveling. Minimal clearing (0.3 acre or approximately 10% of the available land area) of terrestrial vegetation will occur to create the footprints of the access road, foot path, feed silo pad, and operations trailer. Access road and trail surfaces will be covered with approximately 30 cubic yards of 5/8-inch minus crushed rock or gravel. Approximately 50 cubic yards of concrete will be poured to create the foundation slab for the feed silos and operations trailer. Power will be connected to the upland facilities from the existing power lines along Columbia River Road. There will

be no potable water supply or on-site sewage disposal system at Site #3. A commercial "port-a-potty" will be placed on the site during construction, to be maintained in the operational condition of the project.

3.1.5 Permits and Approvals Required

The upland site and the bed and surface of the Columbia River (Rufus Woods Lake reservoir) to the middle of the original riverbed are within the boundaries of the Colville Indian Reservation. For this reason, no permits are required from State agencies or from Okanogan County. Permits required from Federal agencies and the Tribe are listed below. A Joint Aquatic Resources Permit Application (JARPA) was submitted by the applicant to these agencies December 27, 2010. Additional application forms are required for several of the permits, and will be completed in a timely manner by PAI. PAI will be required to comply with the conditions of these permits during construction and operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

U.S. Environmental Protection Agency	NPDES Waste Discharge Permit
U.S. Army Corps of Engineers	Section 10 Permit for Work in Navigable Waters
U.S. Army Corps of Engineers	Flowage Easement
U.S. Coast Guard	Private Aids to Navigation (CG-2554)
Colville Confederated Tribes	Hydraulic Approval Permit
Colville Confederated Tribes	Pollution Discharge Permit[1]
Colville Confederated Tribes	Conditional Use Permit
Colville Confederated Tribes	Shoreline Development Permit
U.S. Dept of the Interior, Bureau of Indian Affairs	Land Lease

[1] The CCT Office of Environmental Trust anticipates amending PAI's existing Pollution Discharge Permit No. 4-8-9/2009-1 to address Site #3 (personal communication with Todd Thorn, Watershed Program Manager, April 1, 2011).

3.2 ALTERNATIVE SITES CONSIDERED

3.2.1 Site Selection Criteria

This narrative is provided as an overview of the process that was conducted to select the proposed Pacific Aquaculture steelhead trout Site #3 in Rufus Woods Lake, a run-of-the-river reservoir of the Columbia River impounded by Chief Joseph Dam. It is composed of a brief description of the principal considerations that were evaluated for four alternative possible new net pen sites. A matrix that rates the choices and decisions involved with each alternative site considered is provided below in Section 3.2.2. The siting criteria included:

Water Depths: A site with depth greater than 70 feet (ft) is best to avoid effects on the littoral zone (i.e., nearshore) and the plants and animals existing there, and to provide better distribution of organic waste materials for rapid and aerobic assimilation by the aquatic food web. Depth is also important for preventing the pens from grounding on the bottom or being damaged by submerged woody debris.

Currents: Strong currents are best for fish culture, which will be the case at PAI Preferred Alternative Site #3 − similar or slightly greater than at the existing PAI Site #1 and Site #2. Optimum current velocities for large-scale net pen aquaculture are in the range of 10 to 75 centimeters per second (cm/s), with a mean velocity of 20 cm/s (0.45 miles per hour [mph]). In both marine and riverine aquaculture in Washington State, current velocity varies from near zero to above 100 cm/s (2.2 mph) depending on the site. In Rufus Woods Lake, ten year (2000-2009) mean monthly discharge at Grand Coulee Dam are approximately 112 to 140 KCFS (i.e., thousand cubic feet per second in late May and June, respectively. Minimal mean monthly flow of about 62 KCFS occurs in September. Current velocity is considered one

of the primary factors in any net pen siting and is relatively more important than water depth for efficient organic waste distribution and assimilation.

Circulation Pattern: It is best to have a downstream dispersion area within a relatively straight channel with no unusual backwaters, oxbows or side channels to collect organic wastes before they can be assimilated into the food web. Currents and circulation patterns were investigated by use of a moored acoustic Doppler current meter anchored to the bottom at PAI Preferred Alternative Site #3 and at PAI existing Site 31 (Rensel 2010). Repeated drogue (drift object) tracking studies at the alternative sites were also considered in this analysis to assess the pathways and velocity of water as it moved downstream under varying river discharge conditions. Drogues are composed of a surface float attached to a large, weighted and submerged "window shade" set at different depths to "sail" with the currents. In Rufus Woods Lake, several candidate sites were assessed concurrently through the use of this technique for the net pen site evaluation effort.

Location within the Reservoir: Areas of reasonably strong currents are best for a floating net pen aquaculture site. In Rufus Woods Lake, this means upstream of the Chief Joseph Dam pool, which extends several miles upstream and gradually becomes more riverine than lacustrine. This can occur over a broad area, moving upstream or downstream depending on differing flows and reservoir fullness conditions.

Reservoir Cross-Section: Rufus Woods Lake is the narrowest of all Columbia River reservoirs in Washington State with less nearshore (littoral zones) than other reservoirs in the mainstem river. This is helpful for net pens because flows tend to be faster, and deep water areas are more common than in other Columbia River mainstem reservoirs in Washington State.

Shoreside Access and Suitability for Upland Support Facilities: It is desirable to have low bank waterfront, electrical power supply and existing roads or highways nearby for vehicle access to service the site. Shoreline and backshore ownership was not considered in this analysis because a new site could be supported and supplied entirely from PAI existing Site #1, if necessary. In the absence of this capacility, shoreline and backshore ownership would be an important consideration along with avoiding potential conflicts with existing activities.

River Bottom Characteristics: Coarse sand is best, particularly immediately downstream of the site. Some cobble is inevitable but not an issue, but areas of continuous large boulders should be avoided because anchoring may be difficult and waste dispersion could be affected.

Ambient Water Quality: Water quality can be assessed based on distance from known sources of turbidity (e.g., the Nespelem River during storm events), nutrient loading status of the water body (discussed below briefly), and possible differences in water temperature, dissolved oxygen or other parameters known to influence fish growth and survival.

Anchoring Conditions: Several factors are to be considered for anchoring conditions, such as the type of river/reservoir bottom, slope of the bottom, and presence or absence of vertical rock walls at the shoreline. Use of the hydraulically-driven pin anchors allows for siting in more difficult locations with good security.

Multiple Fish Farm Interactions: Fish farms need to be separated from each other by some minimal distance that depends on water circulation patterns, particularly if they are operated by different companies or entities. Considerations include possible spread of disease and environmental effects interactions, such as dissolved oxygen (DO) reduction. DO is usually only an issue within the cages and

possibly a few tens of meters downstream. Salmonids, including farmed fish, are among the most sensitive species to reduced concentrations of DO in many Pacific Northwest aquatic habitats.

Wildlife Habitat: Siting of aquaculture and associated upland facilities should consider terrestrial or riparian habitats of special significance that may be in close proximity, such as the forested area maintained by the U.S. Army Corps of Engineers in one location within the project action area for owl and other bird nesting (see Figure 3.2-1).

Figure 3.2-1. Alternative sites considered for PAI Rufus Woods Lake steelhead trout net pen aquaculture Site #3; two existing fish farms; and U.S. Army Corps of Engineers' managed forested wildlife area.

Archeological and Cultural Sites: Colville Tribal Code Chapter 4-4-7 prohibits excavation, removal, damage, alteration, or defacement to any archaeological resource on the Colville Reservation without a permit. The net pen aquaculture project is also subject to the provisions of Section 106 of the National Historic Preservation Act (NHPA) as a result of the requirement to obtain a Rivers and Harbors Act Section 10 permit from the U.S. Army Corps of Engineers. For this reason, a Cultural Resources Inventory was conducted at the most upstream site of the four alternative sites considered (the PAI Preferred Alternative Site #3), as this is the only alternative location with an adjacent upland parcel suitable for the construction of support services for the new net pen aquaculture operation. The other three sites were qualitatively assessed for the location of sites or resources of archaeological or cultural significance, because no ground-disturbing activities are proposed on the adjacent uplands.

3.2.2 Alternative Sites Evaluation

Using the site selection criteria described above, four sites were quantitatively and qualitatively evaluated prior to making a preferred site selection. The evaluations included, but were not limited to, depth sounding and drogue tracking for circulation study, and in some cases bathymetric data collection and analyses. The general area of each of these sites is shown on Figure 3.2-1. From upstream to downstream these sites are named:

- Pacific Aquaculture Preferred Alternative Site #3 (river mile 576.4)
- High Bank Bight (approximately river mile 573.9)
- Mah-Kin Rapids (approximately river mile 572.4)
- Narrows Downstream (approximately river mile 571.9)

Other locations indicated on Figure 3.2-1 include existing fish farms at Chief Joseph Orchard (a separate and smaller fish farm entity near river mile 570.5), and the existing Pacific Aquaculture Site #1 at river mile 579. A forested riparian area irrigated by the U.S. Army Corps of Engineers in the summer to maintain wildlife habitat is also shown on Figure 3.2-1 on the left bank (looking downstream) of the reservoir. Each potential net pen aquaculture site was evaluated in relation to the site selection criteria and assigned a rating of 1 to 3, poor to good, for a matrix analysis of the ratings (see Table 3-1). This exercise was qualitative. Some factors are essential, such as avoidance of a site where archeological or culturally significant resources are known to be present, and should be more heavily weighted, but each site selected for evaluation was at least marginally acceptable for large-scale fish culture on a basic biological basis. The goal of this procedure was to identify the most suitable location that would require the least energy to develop and that would perform best for fish culture with the least environmental effect. These latter two objectives are usually highly overlapping features in commercial fish aquaculture.

The upper photo on Figure 3.2-2 is a photograph from upstream looking obliquely downstream at the proposed shore support area for PAI Preferred Alternative Site #3. The property begins in the right/center of the photograph near the utility pole along the highway and continues to the left (downstream). The photograph illustrates the relatively gently sloping fore- and back shore area. The lower photo on Figure 3.2-2 shows a view from downstream looking upstream at this same location.

Photographic views of the three other alternative sites are provided in *NEPA Environmental Assessment* Chapter 4 (Figures 4.2-2 through 4.2-5).

Using the analysis method described above, the PAI Preferred Alternative Site #3 scored 32% higher than the average of the three other alternative sites, each of which achieved a similar rating in relation to one another. The possible presence of archeological and cultural resources was not considered in this matrix as only the Preferred Alternative would have an upland support site. That site was investigated by Tribal Archaeologists; no new or previously recorded archaeological sites were found at this location.

Upstream looking obliquely downstream at the proposed shore support area.

Downstream looking upriver at shore and net pen locations in center left of photograph and with two drift object floats in foreground.

Figure 3.2-2. Pacific Aquaculture, Inc. (PAI) Preferred Alternative Site #3.

Considerable attention and study was focused on possible interactions between the existing downstream Chief Joseph Orchards Fish Farm (herein CJOFF) site and any new site placed upstream. Multiple drogue (drift objects) tracking studies were conducted at high and low flow conditions and different depths to see if water from mid-channel or right bank alternative fish farm locations was flowing directly into the CJOFF facility. With few exceptions, the water flowed to the left bank in the CJOFF area, where that farm is located along the right bank. The exception was that occasionally the drogues would pass down the center of the channel, but in no case did water flow directly into the existing facility owned by another company. Inspection of Figure 3.2-1 indicates why this is likely. The farm is located on an inside edge of a river bend; water naturally flows toward the outside edge of the bend and follows the original, deep channel of the river that existed before the dams were built. These and other circulation results are described in detail in a technical report (Rensel and Siegrist 2010) prepared for this project.

Fish culture is potentially possible at any of the alternative sites evaluated in this *NEPA Environmental Assessment*. However, the matrix analysis of all relevant siting criteria shows that the PAI Preferred Alternative Site #3 location is clearly more suitable for the proposed facility than the other alternative sites.

3.3 NO ACTION ALTERNATIVE

If the No Action Alternative were selected, no third site for Pacific Aquaculture, Inc. (PAI) steelhead trout net pen aquaculture would be developed on Rufus Woods Lake at this time. There would be no disturbance to the upland site (Colville Tribal Tract #101-T4213). There would be no increase in efficiency or production associated with PAI's Rufus Woods Lake operation, and no additional jobs created for Tribal members or other residents of the area. Supply of U.S.-produced aquaculture trout and salmon would not be increased. While the proposed project is relatively small compared to world supply of these fish,[5] the United States has very few steelhead trout farms, so even this one farm not coming on-line would have a measurable effect on this food source.

From an environmental perspective, less fish farm-derived nutrients would be introduced into the Columbia River if the No Action Alternative were selected. This would result in a very slightly lower level of nitrogen and phosphorus in the river water column – an undesirable effect as Rufus Woods Lake is considered oligotrophic (nutrient poor). To the extent that nutrients are limiting of phytoplankton or macroalgae production during the growing season, available growth substrate for these species would remain at present levels. For benthic habitats, the No Action Alternative would result in less particulate organic matter and resultant lower biomass of food web components, ranging from bacteria to benthic invertebrates and wild fish. This topic is discussed further in *NEPA Environmental Assessment* Chapter 5, Section 5.5, Cumulative Effects.

[5] In 2007, Americans consumed a total of nearly 5 billion pounds of seafood, which equates to approximately 16 pounds per person per year. The U.S. is the third largest consumer of seafood in the world. Demand exceeds domestic supply from wild stocks. Currently, the U.S. imports 84% of its seafood, and about half of those imports are from aquaculture in other countries. The current trade deficit in seafood is approximately $9 billion (U.S. Department of Commerce Aquaculture Policy, February 2011).

Table 3-1. Matrix comparison rating of site selection criteria for an additional Pacific Aquaculture steelhead trout farm site in Rufus Woods Lake, Columbia River, with ratings from 1 (least desirable) to 3 (best).

Site Selection Criteria	**Narrows Downstream**		**Mah-Kin Rapids**		**High Bank Bight**		**Pacific Aquaculture Preferred Alternative for Site #3**	
Depth	2	80+ feet	3	>100 feet	3	90+ feet	3	~90 feet (upstream) to ~ 75 feet (downstream)
Current Velocity	2	Suitable but some excessive variance	1	Possibly too fast	1	Variable velocity, slow at times	3	Strong but less than Mah-Kin Rapids
Circulation Pattern	2	Mostly centerline of river	2	Mostly centerline of river	1	Variable direction, towards shore for some periods	2	Toward mid channel to North
Location in Reservoir	2	Middle reaches	2	Middle reaches	2	Middle reaches	2	Middle reaches
Riverine Cross Section	2	Modestly narrow	1	Narrow	1	Relatively wide	3	Similar but slightly less than existing Site #1
Shore Support Access	1	High, unstable bank	1	High, steep, rock bank	1	High, unstable bank	3	Low bank, stable earth
Logistics and Proximity to Site #1 Support	1	Far from Site #1	1	Far from Site #1	2	Moderate distance to Site #1	3	Closest to Site #1
River Bottom Characteristics	2	Cobble and sand	1	Giant boulders	3	Sand	2	Cobble and sand

Site Selection Criteria	Narrows Downstream		Mah-Kin Rapids		High Bank Bight		Pacific Aquaculture Preferred Alternative for Site #3	
Ambient Water Quality	2	Downstream of seasonal culvert flow	3	No issues	2	Eroding banks	3	No issues
Anchoring Conditions	1	Unstable bank and sediments	1	Rock ledges and boulders	3	Sand	2	Suitable for "pin" anchors
Fish Farm Interactions	2	Nearest to Chief Joseph Orchards fish farm site (CJOFF)	2	Same as Narrows	2	Not far away from the Narrows Downstream and Mah-Kin Rapids sites	3	Furthest from CJOFF
Wildlife Habitat	2	No known issues	2	No known issues	1	Nearest to Corps of Engineers-managed forested area	2	No known issues
Numerical Rating Summary	**21**	Similar to Mah-Kin Rapids and High Bank Bight	**20**	Similar to Narrows Downstream and High Bank Bight	**22**	Similar to Narrows Downstream and Mah-Kin Rapids	**31**	32% better than the mean rating of other sites considered

Note: The Narrows Downstream, Mah-Kin Rapids, and High Bank Bight sites could not be served by feed silos on an adjacent upland site. Therefore, it would be necessary to serve them using a feed barge (see Figure 3.1-4). All other upland support would originate from existing Site #1 to service floating net pens at any of these three locations.

4.0 EXISTING ENVIRONMENT AS IT PERTAINS TO THE PROJECT

Rufus Woods Lake is a 51 mile long, narrow and relatively deep, fast flowing reservoir of the mid-Columbia River located between Grand Coulee Dam upstream and Chief Joseph Dam downstream. Flow characteristics, morphology and related factors are discussed by Erickson et al. (1977), Rensel (1989, 1993) and others. This chapter provides a description of the existing environment within the aquatic and terrestrial action areas of the proposed project.

4.1 AQUATIC ENVIRONMENT

The aquatic environment action area is defined in *NEPA Environmental Assessment* Chapter 1, Section 1.7.1. The description below provides an overview of conditions and processes that occur throughout the entire lake, not just within the action area. Focusing on the entire lake provides a greater sense of how a variety of factors in Rufus Woods Lake may affect and be affected by fish net pen farms. In addition, because Rufus Woods Lake is part of a larger, interconnected system of reservoirs along the Columbia River, this assessment often describes conditions not only in Rufus Lake, but also downstream in other reservoirs such as Lake Pateros and Rocky Reach Reservoir. One area may be representative of another similar area within the same watershed. If information sources about the proposed project site are lacking, data from another reservoir can supplement and further our understanding of Rufus Woods Lake.

4.1.1 Bottom Characteristics

4.1.1.1 Bathymetry at the Site and in the Vicinity

A bathymetric map of PAI Preferred Alternative Site #3 was prepared in 2010 based on site-specific surveys conducted with a combination GPS and depth sounder instrument and contouring software. Figure 4.1-1 illustrates the bathymetric map. Figure 4.1-2 was drawn from the same data with superimposed plan drawings of the proposed pen placement and anchor lines. The proposed project would be located over the downstream end of a relatively deep trough, ranging from 80 to 100 feet deep. Changes in depth are gradual, and were precisely mapped for the area of the pens in particular, with several hundred sounding observations in that area alone.

Bathymetry at the other alternative sites considered was measured in spot surveys, but as other factors indicated less suitability than the Preferred Alternative Site #3, additional data collection and formal bathymetric map preparation were not performed.

4.1.1.2 Reservoir Bottom Substrate Classification

The reservoir bottom substrate at PAI Preferred Alternative Site #3, as well as most of the reservoir with the exception of the nearshore, littoral zone, is composed of silt and clay, coarse sand and cobble. The PAI Preferred Alternative Site #3 area within the blue shaded depths shown on Figure 4.1-1 was inspected with a drop camera video and found to grade from sand with moderate-sized cobble upstream, to smaller-sized cobble downstream. Nearer to shore on the right banks (looking downstream) in the littoral zone, the substrate grades from coarse sand rock and cobble to sandy mud with occasional cobble. The substrate is similar to PAI existing Site #1 except for an increased prevalence of cobble in the deeper zones and the lack of vertical rock walls along the shoreline at existing Site #1.

Figure 4.1-1. Bathymetry map of PAI Preferred Alternative Site #3 (October 2010).

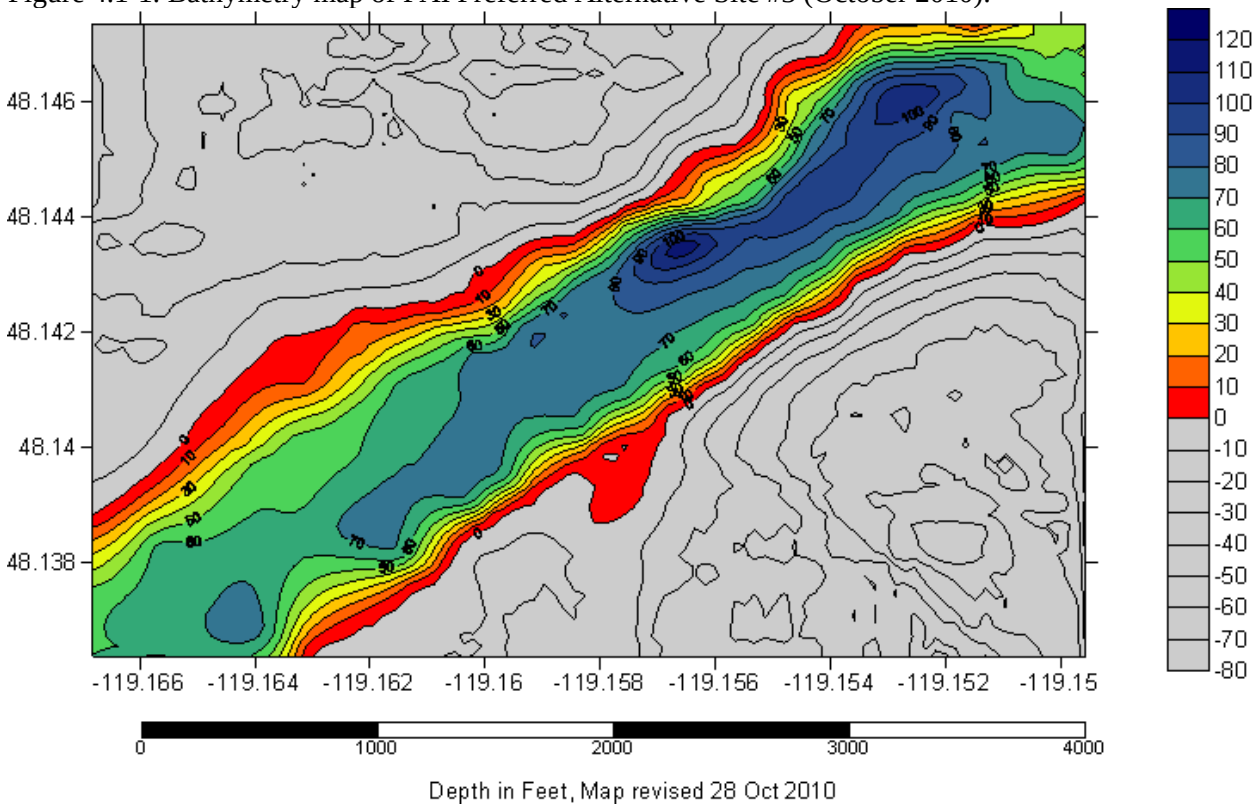
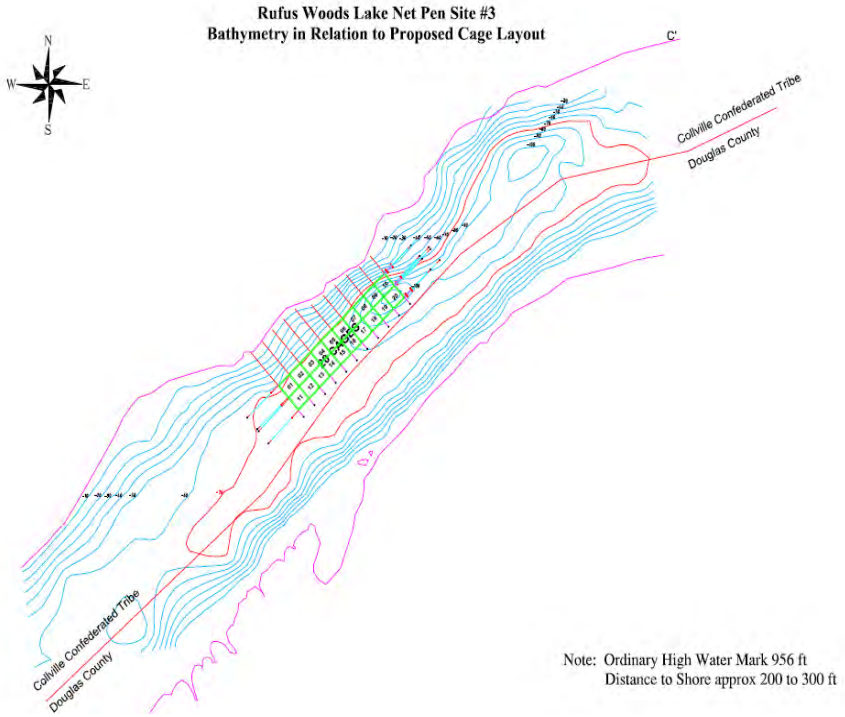


Figure 4.1-2. Bathymetry map of PAI Preferred Alternative Site #3 vicinity with schematic of proposed net pens and anchor lines shown.



The left bank of this reach of the river/reservoir is composed of a relatively steep and eroding bank of sand and gravel with little vegetation. Further downstream, the steep bank abruptly changes to low bank that was apparently mined by hydraulic means prior to reservoir creation. This resulted in a series of acutely shaped small embayments and one relatively large backwater pond surrounded by trees and shrubs (see Drawings #3 and #4 in Attachment 1 to this *NEPA Environmental Assessment*). Although total volume of the reservoir is occasionally cited (e.g., Erickson et al. 1977), there were no readily available references or data in support or no evidence that a comprehensive bathymetric survey had been performed or reported until recently. See Richards, Rensel and Siegrist (2011) for morphometric information about the reservoir obtained from a new digital bathymetric map that they prepared.

4.1.1.3 Sediment Quality

Similar to other mid-Columbia River reservoirs, sediment quality of the Rufus Woods Lake bottom has not been systematically surveyed in detail, although Rensel (2010) evaluated total organic carbon (TOC) and nitrogen content of reference sediments upstream of all fish farms and downstream areas in August 2009. It is not possible to grab sample the river bottom in most areas of Rufus Woods Lake due to the coarse nature of the substrate. However, it is possible to collect small cores by SCUBA diving, which was done in this case. TOC averaged 0.26% and nitrogen averaged 0.04%, indicating relatively low levels of organic enrichment. Immediately downstream of PAI existing net pen Site#1, TOC averaged 0.43% and nitrogen was 0.07% with declines to ambient conditions over the next several hundred feet downstream in a narrow path associated with the prevalent flow direction from the cages. Because areas of embedded boulders dominate the substrate, the above sediment TOC and nitrogen values inflate the actual values that occur (i.e., rocks have no TOC and nitrogen content). No indicators of anaerobic conditions were observed (e.g., hydrogen sulfide smell, black sediments at the surface or a few cm deep, lack of invertebrates, methane gas production). Rather, there were numerous isopods, snails and other invertebrates in and upon these same affected sediments.

4.1.2 Water Column

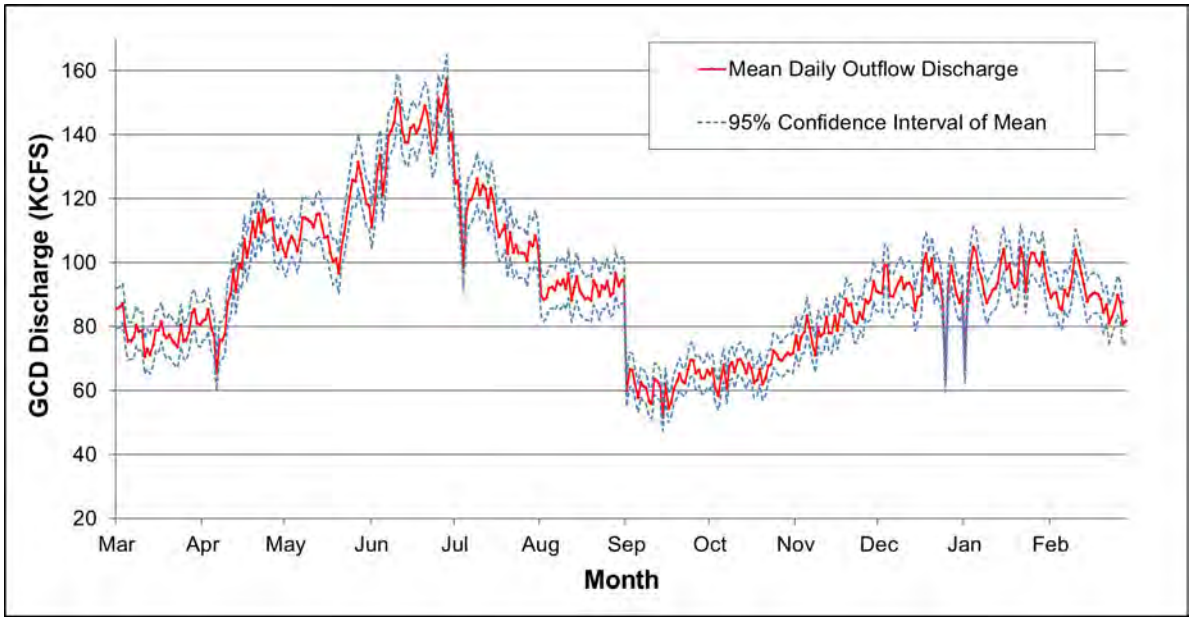
4.1.2.1 Physical Circulation

The Columbia River is the largest North American river flowing to the Pacific Ocean, and is the fourth largest river in the United States in terms of discharge. Water flow in Rufus Woods Lake is controlled by inflow from Grand Coulee Dam above and outflow through Chief Joseph Dam below, with minor corrections for Nespelem River input and summer evaporation losses. Erickson et al. (1977, actually Q.J. Stober, as an important part of a larger volume dealing with terrestrial matters in the area, as well) first pointed out that the lake was more similar to a river with strong flow velocity in the middle and upper reaches where PAI existing steelhead trout net pen operations are located.

Over the past 10 years (i.e., March 2001 through February 2011), mean daily discharge from Grand Coulee Dam averaged 93,400 cubic feet per second (cfs). The hydrograph for this period (Figure 4.1-3) indicates that flows begin rapidly increasing in mid-April, plateau for a period until late May, and rise again to annual peak discharge in early to late June. Flow then declines regularly until a rapid drop in early September associated with the operating rule curve of Lake Roosevelt. Thereafter, there is a gradual increase until early winter when flows are maintained or slightly declining until the cycle starts again the following year. Total discharge (spill plus generation discharge) from Grand Coulee Dam has averaged 107.8 KCFS from 1930 to 1997. A linear equation fitted to the data shows no significant trend of increase or decrease, although considerable decadal or shorter term variation is prevalent. In recent years (March 1 2001 through 2011), mean annual discharge was relatively low, only 93.4 KCFS. Annual peak flows also declined significantly after construction of Grand Coulee Dam and other upstream long-term storage

reservoirs. Note that water flows in spring and summer of 2011 were much higher than the decadal averages. See Richards, Rensel and Siegrist (2011) for more details.

Figure 4.1-3. Ten-year mean daily discharge and 95% confidence intervals at Grand Coulee Dam for the period March 2001 through March 2011.



Erickson et al. (1977) first conducted a semi-quantitative assessment of in-lake current velocity flows by collecting spot measurements throughout the reservoir at unspecified times during May 13-15, 1975. The data ranged from 183 cm/s in the upper (non-reservoir) reaches 5 miles below Grand Coulee Dam, to 44 cm/s at a point about 8 miles upstream of Chief Joseph Dam. The latter dam had not been raised the additional 10 feet of elevation at that time, so the upper reaches of Rufus Woods Lake were still free flowing at a rapid rate. The survey occurred during very high river discharge of about 215 KCFS, so the results represent values near the high end of the flow spectrum (Rensel 1996).

Rensel and Siegrist (2011) conducted physical limnological studies in late 2010 and early 2011 using an acoustic Doppler current meter moored to the bottom upstream of PAI existing Site #1, and in an area immediately upstream of PAI Preferred Alternative Site #3. They also conducted drift object studies of water velocity and direction at the Preferred Alternative Site #3, other alternative sites, and contiguous areas downstream. The current meter study indicated that Preferred Alternative Site #3 hydrodynamics compared favorably with existing Site #1 conditions, with substantially higher rates of flow in surface and subsurface layers (Figure 4.1-4). Compared to modern net pen sites in Puget Sound and elsewhere, average current velocities at PAI Preferred Alternative Site #3 were high. The near-surface flow rate at Preferred Alternative Site #3 averaged 65.5 cm/s (about 1.3 nautical miles per hour).

Frequency analysis of the current meter data showed very different distributions of energy within differing depth ranges (Figure 4.1-5). For surface flows, PAI Preferred Alternative Site #3 had a broad spectrum of flow rates, whereas PAI existing Site #1 data were more tightly grouped in the moderate flow rate category. For subsurface depths, a similar circumstance occurred, but Preferred Alternative Site #3 had a distribution of faster flows far exceeding that of Site #1. The differences diminished in the deepest measured layer, with similar overall but slightly stronger flows on average at Site #1.

Figure 4.1-4. Plots of current velocity at PAI Preferred Alternative Site #3 and existing Site #1 net pens showing extreme ranges (thin vertical lines), 50% of observations (25% each in the colored boxes), and average flow (as the thin black horizontal line in the colored boxes).

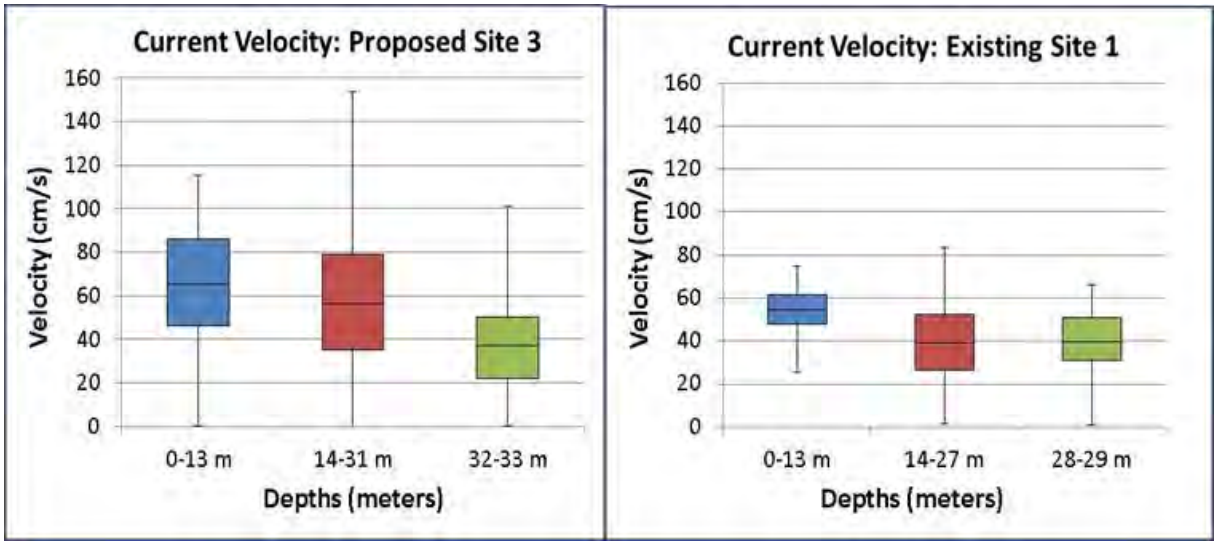
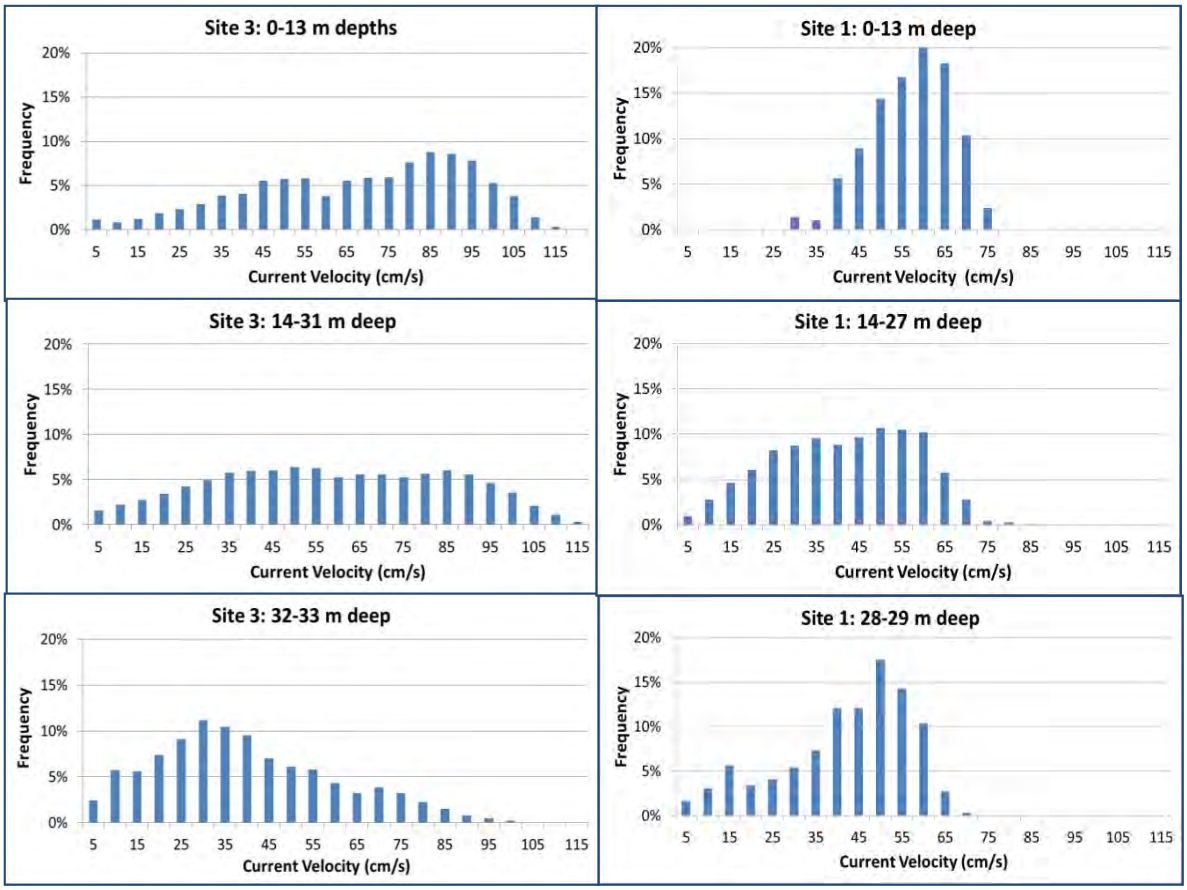


Figure 4.1-5.Current velocity frequency plots at PAI Preferred Alternative Site #3 and PAI existing Site #1 by depth strata.



Moreover, periods of no flow are either very infrequent or nonexistent. In marine waters, slack tidal periods occur for extended periods of time, exceeding an hour in some cases. Strong currents in Rufus Woods Lake benefit fish in culture by providing a constant supply of oxygen, and by mitigating the discharge of particulate fish fecal and uneaten organic food wastes, which are spread over considerable distances downstream to be assimilated by the aquatic food web (Rensel 2010).

Drift object studies of three downstream alternative net pen sites were conducted over a range of river discharge conditions in fall 2010 (Figure 4.1-6). These studies showed the same high rates of water current velocity at PAI existing Site #1 and Preferred Alternative Site #3, and sometimes slowed slightly by a distance of one mile downstream. The drogues rarely grounded, but when they did, it was usually more than one mile downstream near the bend in the river/reservoir where it is wider than at PAI Preferred Alternative Site #3. Drogues set at deep levels tended to move more quickly toward the main channel of the river than shallow drogues.

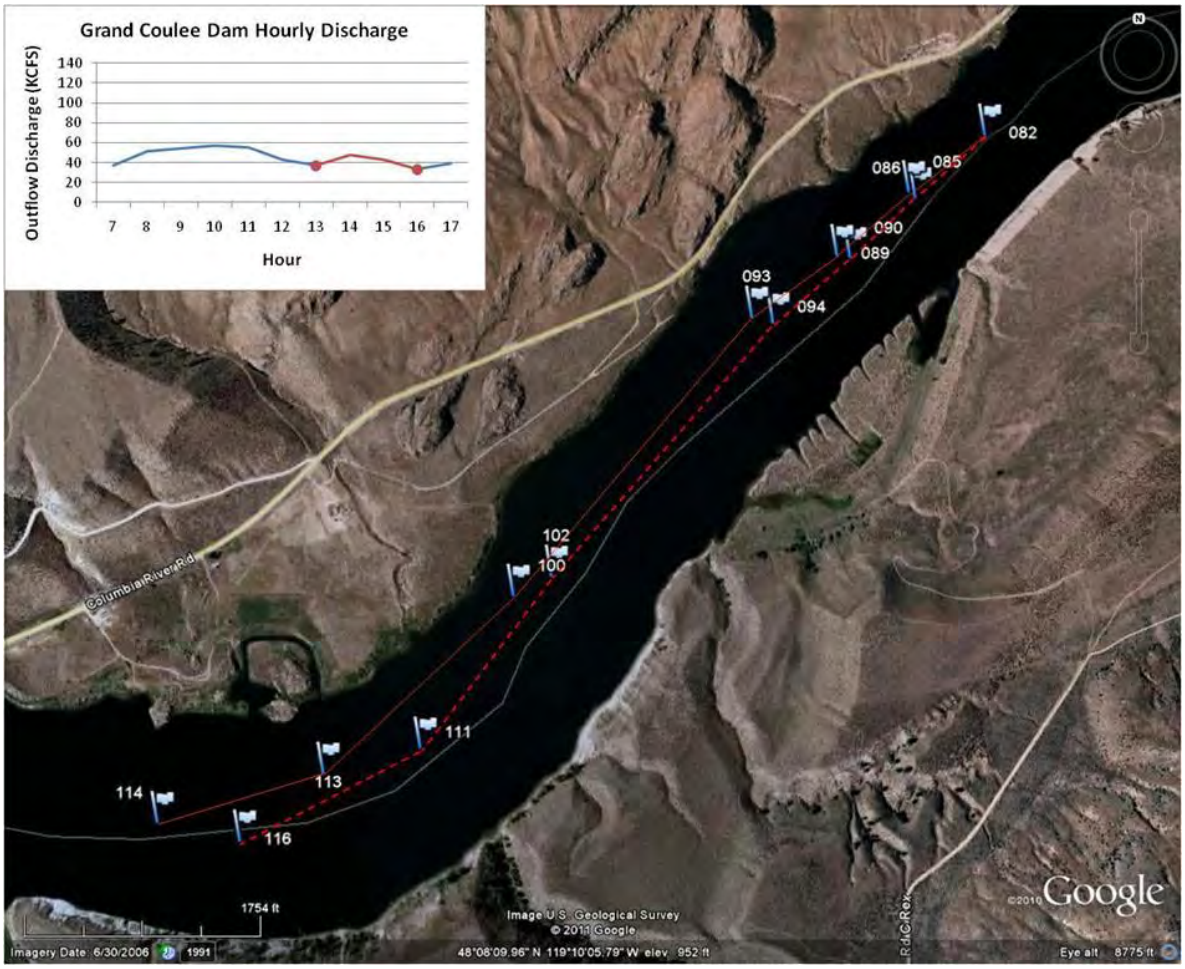
4.1.2.2 Water Quality

Water quality is generally good in Rufus Woods Lake as measured at the Grand Coulee Bridge by the Washington Department of Ecology (Ecology) at a long-term monitoring station first monitored in 1949. Ecology reports that "*Overall water quality at this station met or exceeded expectations and is of lowest concern (based on water-year 2010 summary)*." Ecology does not, however, provide routine time series analyses of all its routine ambient data and in the past this task has been taken on by consultants for the Colville Confederated Tribes, or by fish farm consultants for the station below Grand Coulee Dam (Ecology Number: 53A070). This *NEPA Environmental Assessment* uses data from the year 2000 through 2009 from this source. At the time of writing of this document, only these data were available and considered quality controlled. More recent data are available, but not yet quality-controlled by Ecology, so those data are not used except for chlorophyll *a* data, only collected in the most recent two years. These data were later analyzed by Richards, Rensel and Siegrist (2011) and included as abstracted text below in order to be as representative as possible of recent changes. Because of extremely fast water flow and flushing rates and other factors such as the relatively great depth of this reservoir, data from the Ecology station below Grand Coulee Dam are representative of downstream conditions. There is no evidence of vertical stratification of water temperature or other parameters except possibly in the very few oxbow or side channels that exist in the system. There is one oxbow side channel about one mile downstream of Preferred Alternative Site #3 but given the distance and tendency for water from the proposed site to flow more toward the center channel of the reservoir, no adverse effects, such as a theoretical (but never observed elsewhere) remote deposition zone, are likely.

4.1.2.3 Macronutrients

Until the mid-1990s, biological production in Rufus Woods Lake and the mid-Columbia River was considered to be nitrogen-limited or not limited by the nutrient content in the water but by other factors (i.e., seasonally low water temperature and reduced light intensity at depth). With the closing of the Cominco, Ltd. fertilizer plant that formerly discharged into the river at Trail, British Columbia, primary algal productivity became severely phosphorus-limited (Rensel 1989, 1996). The concentrations of nutrients in a water body are only crude indicators of the nutrient-enrichment status of a water body. More important are the ratios of available macronutrient concentrations and their flux rates through the subject water body, but the latter are much more difficult to measure. Rates of turnover of nutrient conditions are fast as temperatures increase with nitrogen, and phosphorus forms rapidly changing from dissolved to particulate and inorganic to organic forms in many aquatic systems. Throughout the discussion of water quality parameters below, the primary units of nutrients cited are µg/L (micrograms per liter), equivalent to parts per billion or mg/L (milligrams per liter), a factor of 1,000 times greater.

Figure 4.1-6. Example drogue plot from Rufus Woods Lake circulation study (Rensel and Siegrist 2011).



Notes: Drogue paths for 7 Nov 2010 Drogue Set 2. Solid red line displays shallow (2m) drogue path and dashed red line displays deep (10m) drogue path. Inset displays hourly discharge rates from Grand Coulee Dam with approximate time of this specific drogue tracking highlighted in red.

Phosphorus

Total phosphorus (TP) is a measure of all particulate and dissolved phosphorus in the water column that is often used as an indicator of the nutrient status of lakes, rivers and reservoirs. The concentration of TP at the Washington Department of Ecology monitoring station immediately below Grand Coulee Dam (No. 53A070, Columbia River at Grand Coulee) was exceedingly high in the 1980s and early 1990s averaging approximately30 µg/L during the algal growing season (April through November, 1982 − 1988) with a mean concentration of 30.2 µg/L and much month to month variability (standard deviation [SD] = 19.2, Rensel 1989). More recent data from years 2000 through 2009 analyzed for this *NEPA Environmental Assessment* indicated that the trends discussed above have continued. Total phosphorus averaged only 5.6 µg/L (SD = 2.3) in that time period, or 81.5% less than what it formerly was when the Cominco, Ltd. Fertilizer plant was operating upstream of Lake Roosevelt. This is a remarkably huge decline in nutrient loading of phosphorus and as shown below, this nutrient is the key nutrient to consider with respect to algal productivity and potential eutrophication risks in the Columbia River system. In 2011, however, extremely high and prolonged river discharge from February through August was accompanied by much higher than recent normal phosphorus concentrations entering Rufus Woods Lake in May (29 µg/L) and August (15 µg/L, no sampling in June). See Richards, Rensel and Siegrist (2011) for additional detail.

Orthophosphate (or soluble reactive phosphorus) was often undetectable for most of the year leading to a determination of the water body as being oligotrophic or ultra-oligotrophic. Orthophosphate is the form of phosphorus that directly limits pelagic forms of algae (i.e., phytoplankton and facultative benthic algal species). Low concentrations are indicative of low flux rates in vertically mixed aquatic systems like Rufus Woods Lake. Orthophosphate has also declined further since the 1980s and 1990s, and now is often at or below detection limits averaging 3.8 µg/L (SD = 0.8) in the recent 10-year data (Figure 4.1-7). Because several measurements per year are below detection limits, the true average value is undoubtedly less, and in this case the average was calculated using the actual detection limit of 3.0 µg/L when many authors will use one-half of such a reading in their calculation. Accordingly, the values reported here are highly conservative. More recently in 2011, Richards, Rensel and Siegrist (2011) reported monthly orthophosphate was generally the same or lower than the prior decade except during April, May (both about 4.5 µg/L) and August (8 µg/L). Concentrations of this nutrient are typically highest in winter, when aquatic plant production is minimal, and decrease in late winter to lowest levels in spring and very slowly increase through the summer and fall. The unusual results in 2011 were apparently related to the extremely high river discharge in spring and summer and resulted in biological changes in the system such as fouling of macrophytes with noxious periphyton and the occurrence of blue green algal mats discussed below.

Nitrogen

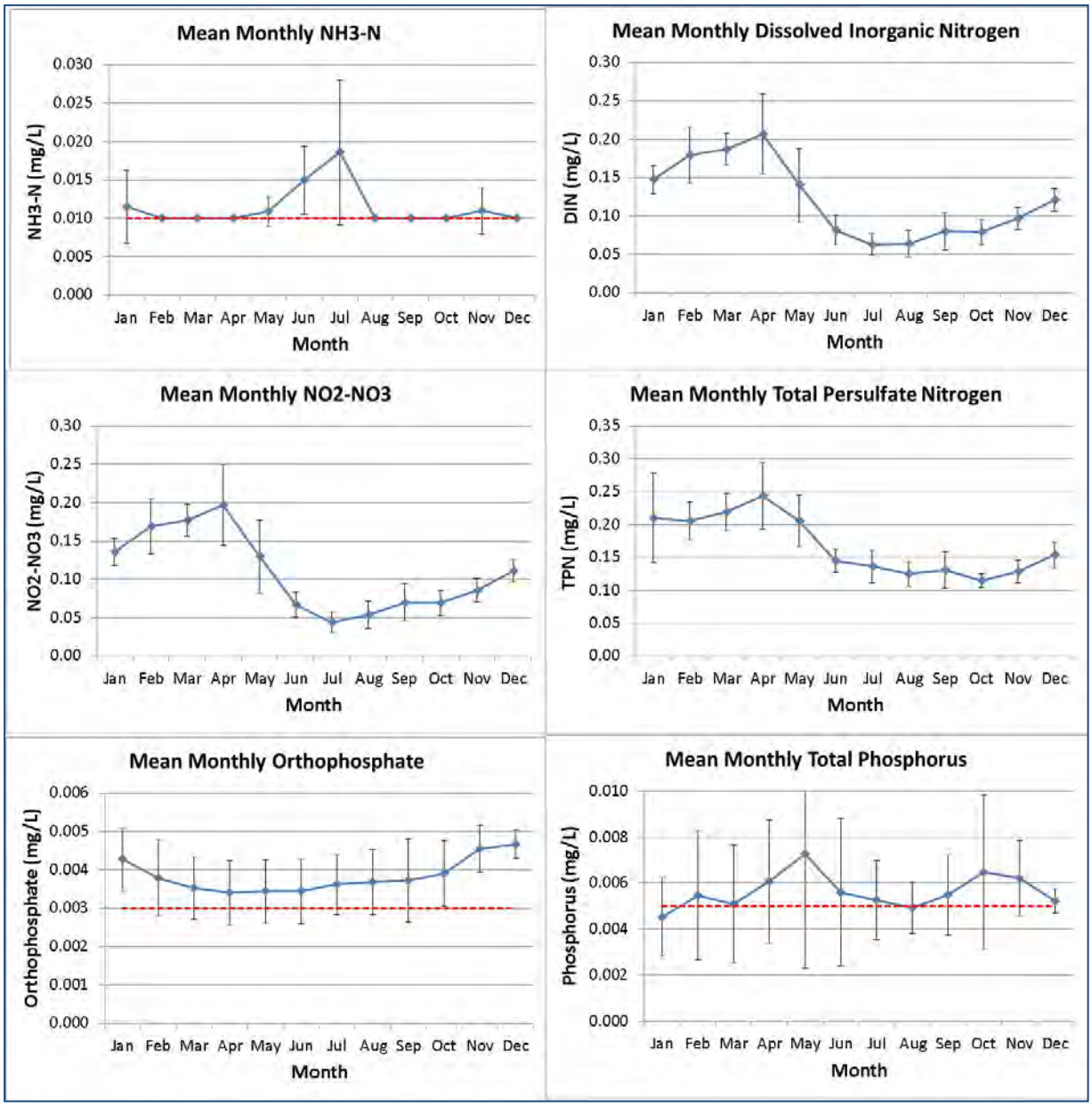
Three forms of water column nitrogen are considered here: ammonia nitrogen (NH_3), nitrite plus nitrate (NO_2+NO_3), and total (persulfate) nitrogen (abbreviated TN). The latter includes both of the former as well as other forms as measured from unfiltered samples. As is the case with orthophosphate, ammonia and nitrite + nitrate are part of the rapidly changing nitrogen pool; for example, ammonia is usually oxidized to nitrite and then nitrate in any well-oxygenated aquatic system. Teleost fish excrete ammonia through their gills as their primary excretory produce; salmonids also produce small amounts of urea nitrogen.

Ammonia nitrogen (also known as total ammonia nitrogen that includes both ammonium and ammonia) concentrations are at or below detection limits for most of the year in Rufus Woods Lake (Figure 4.1-7). Ammonia is a form of nitrogen used by many phytoplankton, but not all, and is harmful to aquatic life at high concentrations. High concentrations of ammonia are not seen inside well-sited and well-operated net pen operations (Rensel 1989, 1996, Parametrix et al. 1990). In May through July, concurrent with peak

annual river discharge rates, mean monthly ammonium at the Ecology monitoring station near Grand Coulee Dam increases to a maximum of about 18 µg/L. The reason(s) for this increase are not clear, except it may reflect venting of Lake Roosevelt deep water through Grand Coulee Dam generation facilities and mineralization of resuspended organic matter upstream by higher flows and increasing water temperatures. Rensel (1989) summarized total ammonia nitrogen data from the same monitoring station during six years of late spring to early fall and found concentrations to range from 10 to 110 µg/L with a mean value of 26.5 µg/L. Average annual concentration for the entire period 1982 through 1987 was 46.3µg/L. The reliability of these early data is not clear, but at a minimum it can be stated that ammonia nitrogen concentrations have not increased and likely decreased significantly over the years − although 2010 and 2011 exhibited increased mean monthly ammonia nitrogen flowing into Rufus Woods Lake during May and June, and also in July and August 2011, concurrent with increased phosphorus influx (Richards, Rensel and Siegrist 2011). But generally in recent years, ammonia nitrogen concentrations were near or below detection limits in all months except June and July (Figure 4.1-7), about an order of magnitude less than what was observed in the 1970s (Rensel 1996).

Nitrite plus nitrate concentrations have a differing seasonal pattern of abundance (Figure 4.1-7) compared to ammonia nitrogen, with an average peak of about 200µg/L early April followed by a significant decline through July and steady recovery until the following April. Annual nitrate plus nitrate concentration averaged about 109 µg/L in the period 2000 through 2009 described above. Nitrite is toxic but occurs in very low concentrations and is very rapidly converted to nitrate in the aquatic nitrogen cycle. The latter is a form utilized by many plants and algae and not considered toxic to vertebrates except at very high concentrations in groundwater. The drawdown in concentration during mid-summer is likely due to primary productivity by algae in Lake Roosevelt. Prior to 1988 the collection and analysis of nitrite plus nitrate was not constant. In 1988, the mean annual average was 95 µg/L with a peak in April of 290 µg/L. Over the entire 1990s decade, mean annual nitrite plus nitrate averaged 117 µg/L with a relatively large standard deviation of 103 µg/L. Compared to the recent 10-year average mentioned above, these and other reliable data indicate no significant change of nitrite plus nitrate concentration over the past 30 years.

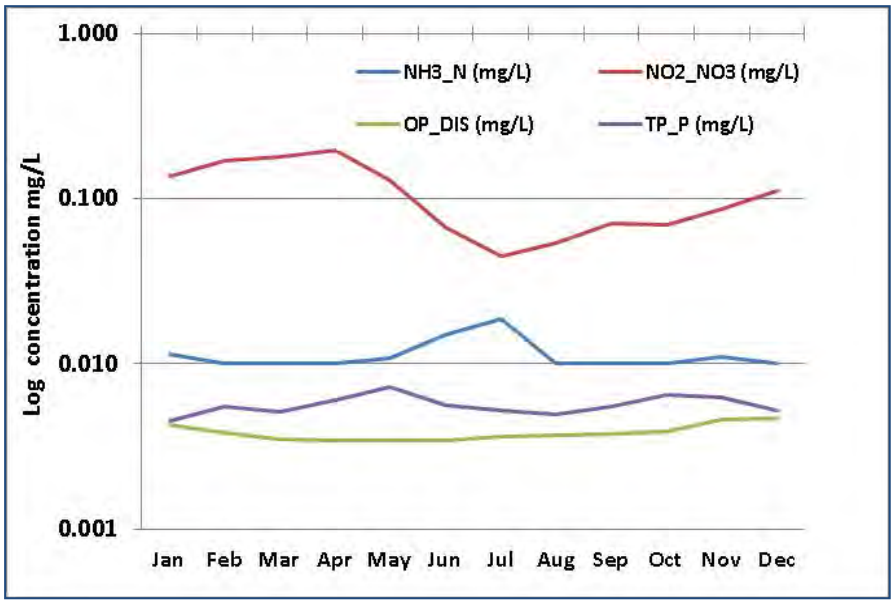
Figure 4.1-7. Mean monthly and standard deviation of ammonia-N, dissolved inorganic nitrogen, nitrite plus nitrate, total persulfate nitrogen, monthly orthophosphate and total phosphorus at Ecology Station 53A070 downstream of Grand Coulee Dam: 2000 through 2009. Detection limits shown as red dashed lines.



Note: Total phosphorus did not include data prior to October 2003 due to analysis and detection limit problems.

Monthly total nitrogen concentrations have a pattern similar to nitrite plus nitrate (Figure 4.1-7), which is reasonable as the latter compose much of the former, the remainder being organic forms of nitrogen, dissolved and particulate. There are no long-term records for total nitrogen concentrations in Rufus Woods Lake, but a comparison of years 1995 through 1999 indicate annual mean concentrations of 215µg/L (SD =169.1). This prior result significantly exceeds the concentrations observed during the period 2000 through 2009 during which the annual average was 168.2 µg/L (SD = 54.2). Figure 4.1-8 summarizes mean monthly distribution of several nutrient parameters in one illustration.

Figure 4.1-8. Mean monthly ammonia-N, orthophosphate, nitrite plus nitrate and total phosphorous for Ecology Station 53A070 downstream of Grand Coulee Dam: 2000 through 2009 expressed in a logarithmic units scale.



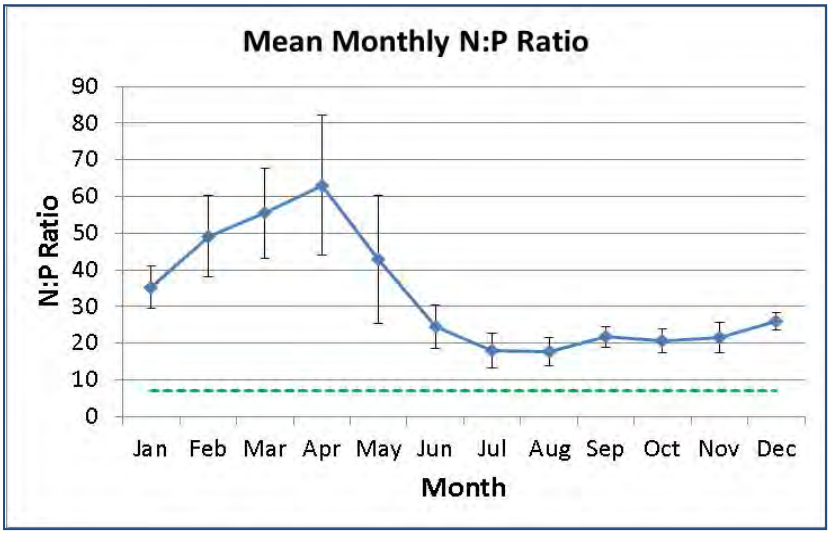
Nitrogen to Phosphorus Ratios

Nitrogen to phosphorus (N:P) ratios are potentially useful indicators of nutrient limitation of algal growth. In this case, N refers to dissolved inorganic nitrogen (DIN) and P refers to orthophosphate, not total N or P. The N:P ratio, coupled with a knowledge of the actual concentration of the least abundant nutrient, may serve as a potential indicator of nutrient limitation, but not as an absolute measure. When both nutrients are in excess supply, other factors may be more important in limiting plant growth, or plant growth may be at physiological maximum rates if no single factor is limiting. Actual algal growth limitation could be demonstrated through nutrient-addition bioassays, knowledge of the nutrient requirements of the dominant species, and other means, but these involve measurements that have not been conducted often enough, nor over a broad enough geographic range to be useful here. Note that nutrient enrichment bottle bioassays with spiked nutrients are more definitive measures of nutrient limitation, but such static assays are not without their limitations and critics.

A balanced N:P ratio for use by plants is about 7:1 (by physical weight, 16 to 1 for atomic weight, Redfield 1958, Ryther and Dunstan 1971, Welch et al. 1992). Over time, freshwater habitats that experience nutrient enrichment often have ratios that increase at first (indicating limited phosphorus) and later decline to less than (<) 7 when the trophic state shifts to a eutrophic condition. Severely eutrophic systems may have atomic N:P ratios < 1:1, as has been measured in Moses Lake, Washington (Welch et al. 1992). In some cases, N becomes more limiting to algal growth in the short term as the eutrophication process accelerates, but in most cases P is still considered the ultimate limiting macronutrient in freshwater. This is because several blue-green algae are able to fix nitrogen from atmospheric nitrogen gas, obviating the need for terrestrial or aquatic source of N.

N:P ratios in Rufus Woods Lake during the period 2000 through 2009 varied seasonally (Figure 4.1-9), not unlike the nitrogen results discussed above (compare to the shape of the nitrite plus nitrate and total nitrogen results of Figure 4.1-7). The system was strongly phosphorus-limited according to these data; i.e., N:P ratios were well above 7 in all cases. Rensel (1996) evaluated prior N:P ratio data for Rufus Woods Lake and noted that significant bias was introduced by using nutrient data that had high detection limits, and accounting for the bias resulted in 1976 through 1990 average ratio of approximately 12 to 16 with data from the Ecology monitoring station in the algal growing season (i.e., April through October). In comparison, during the 2000 to 2009 interval mean growing season, the N:P ratio increased to 29.8 (SD = 17.1). In 2011, these long term trends were punctuated by an abrupt departure to much lower than normal N:P ratios that approached the 7:1 ratio discussed above. This occurred over a long period of time from early spring through late summer and was related to a disproportionately larger increase in concentrations of phosphorus entering the lake through Grand Coulee Dam previously mentioned and discussed by Richards, Rensel and Siegrist (2011).

Figure 4.1-9. Mean monthly and standard deviation N to P (nitrogen to phosphorus) ratio in grams weight units at Ecology Station 53A070 downstream of Grand Coulee Dam: 2000 through 2009 with the Redfield Ratio; i.e., the physiological balance point for algal nutrition of approximately 7 to 1 by weight, shown as the dashed green line.



All of the above metrics indicate that water flowing into Rufus Woods Lake continues to become increasingly oligotrophic (nutrient poor), a condition that is also common in the other great rivers of the world that have had large storage dams constructed. The once-fertile and longest river in the world, the Nile River in North Africa, for example, no longer carries its rich nutrient load to the fields of Egypt or the Mediterranean Sea after the construction of the Aswan High Dam (Oczkowski and Nixon 2008). In both the Nile River and the Columbia River, anthropogenic sources of nutrients increase the nutrient load further downstream in some manner replacing the natural flux of aquatic life-sustaining nutrients. It is unknown how the balance of nutrient species, nitrogen and phosphorus, compare to pre-reservoir era conditions in the river. Rensel (1993) evaluated the relative contribution of trout net pens to the entire flux of nutrients in the Columbia River and showed that at the time a single project made no discernable or measurable difference to the nutrient pool. See the cumulative effects section for additional information on this topic.

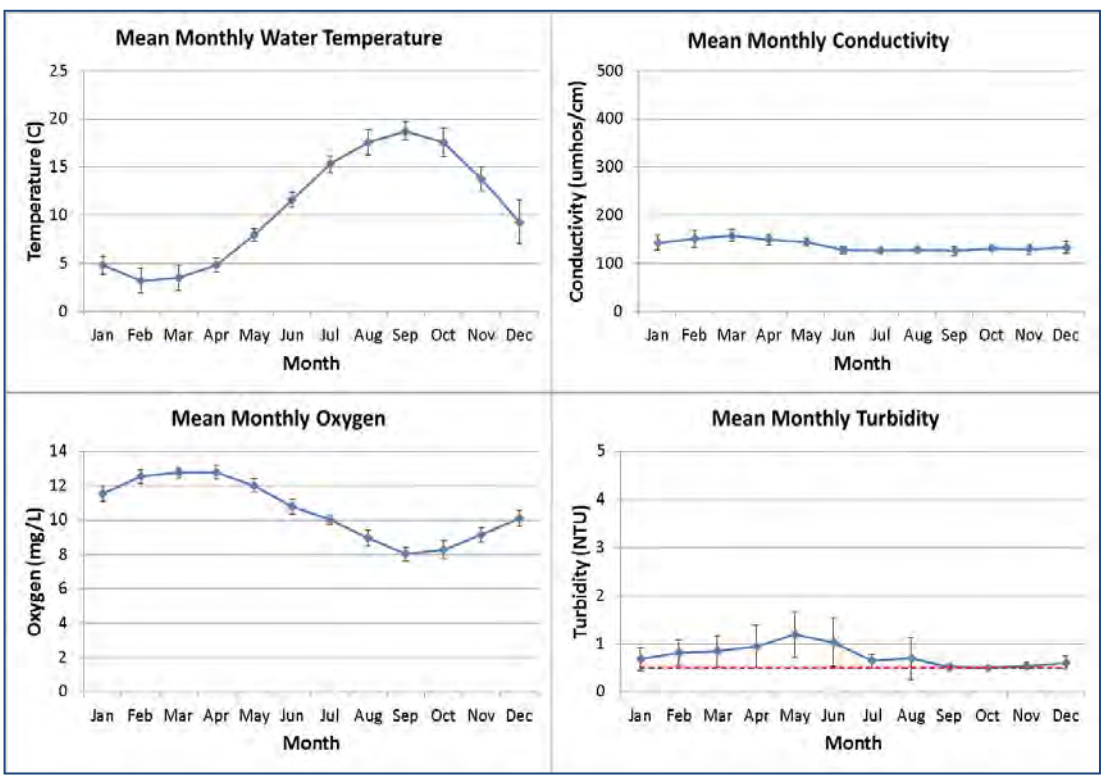
4.1.2.4 Dissolved Oxygen

Dissolved oxygen is relatively high in Rufus Woods Lake at all times. Ecology reports infrequent violations of water quality standards for freshwater of dissolved oxygen (8.0 mg/L), usually associated with elevated water temperatures above 18°C that reduce the saturation level of water for dissolved oxygen. When these events occur, they invariably happen in late summer, and dissolved oxygen concentrations remain just slightly less than the standard, but always greater than (>) 7.5 mg/L, and therefore not near chronic stress levels for the most sensitive species (typically salmonids, such as trout). Dissolved oxygen was slightly lower than normal in spring and higher in August and September 2011 than during the prior decade (Richards, Rensel and Siegrist 2011). In spring every year, highly saturated to supersaturated conditions would be expected due to reservoir drawdown and the tendency for warmer spring weather that has occurred in the drainage basin, resulting in faster snowpack melt. In August and September 2011, elevated dissolved oxygen was probably due to increased photosynthesis by the abundance of algae in the system.

4.1.2.5 Turbidity

Turbidity in the Rufus Woods Lake water column are generally low, especially in fall and early winter. Ecology data shows that turbidity increases in spring concurrent with the annual peak of river discharge, but average levels remain low, less than 1 nephelometric turbidity units (NTU) at the Ecology monitoring station (Figure 4.1-10). By September, turbidity is at or below detection limits, and the water clarity is remarkable when observed from a boat or when diving. However, turbidity can increase during spring runoff due to higher levels of suspended solids in snowmelt. Rensel (1993) concluded that transparency was greater in the 1980s than in prior periods. This may be related to reduced phosphorus loading into Lake Roosevelt following the change in discharge practices at the Cominco, Ltd. Fertilizer plant in Trail, British Columbia. Relatively high and peak turbidity values of 8 NTU were recorded in May 2011 (Richards, Rensel and Siegrist 2011), although compared to other unregulated river systems like the Fraser River, this is a very low value.

Figure 4.1-10. Mean monthly water temperature, conductivity, dissolved oxygen and turbidity at Ecology Station 53A070 downstream of Grand Coulee Dam: 2000 through 2009 with detection limit shown as the dashed red line.



4.1.2.6 Other Water Column Parameters

Temperature

Water temperature exceeded the 18° centigrade (C) standard during 25 monthly measurement periods since 1997, usually by a degree or less, and only on four occasions above 20°C. In 2009, Rufus Woods Lake was listed on Ecology's Water Quality 303(d) list for high temperature resulting from measurements taken just below Grand Coulee Dam (Ecology 2009a). Within the lake, all available data (mostly unpublished technical reports to the Colville Confederated Tribes by the fish farmers) indicate that the lake is not stratified with respect to water temperature (or most other parameters investigated to date).

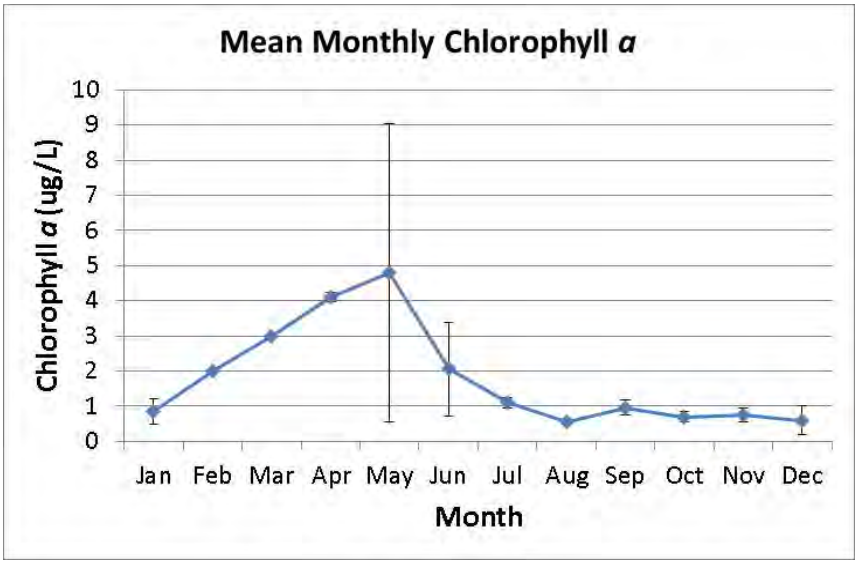
pH

Measurements of pH in Rufus Woods Lake exhibited very little variation over the 10-year period of record examined herein. Average monthly pH values taken just downstream of Grand Coulee Dam between 2000 and 2009 ranged from a minimum of 7.96 to a maximum of 8.12. The 10-year average pH was 8.02, with very low deviation on both monthly and yearly bases. Over the entire monitoring period, there have been only three violations of pH exceeding the maximum goal value of 8.5, but in no case did the results exceed more than 0.4 pH units greater than the goal.

Chlorophyll *a*

Chlorophyll *a* is a primary pigment of algal photosynthesis, and the analysis of its concentration in water is used as a surrogate measure of aquatic phytoplankton abundance. Rensel (1996) reviewed the scant available data suggesting significant declines of chlorophyll *a* concentrations from the first measurements by Erickson et al. (1977) to mid-1990s data collected by fish farm consultants in Rufus Woods Lake that ranged from approximately 4 µg/L in May to < 1 µg/L in August through October. Such concentrations are very low and contribute to the great clarity of the water in this portion of the mid-Columbia River in mid-summer through early fall. Figure 4.1-11 illustrates recent monthly data collected by Ecology at the Grand Coulee Dam station from April 2009 to January 2011.Although the data are limited, these suggest similar results compared to the mid-1990s but a major decline since the 1970s. Chlorophyll *a* concentration is a key indicator of the nutrient enrichment status of a water body. These data corroborate the conclusion that waters entering Rufus Woods Lake are usually oligotrophic (nutrient poor) throughout the year; although as discussed above, extremely high flow years such as 2011 may be significantly different and could result in fluctuation to mesotrophic classification or higher.

Figure 4.1-11. Mean monthly chlorophyll *a* pigment concentration for Ecology Station 53A070 downstream of Grand Coulee Dam: 2000 through 2009.



Conductivity

Conductivity, a measure of the ion content of the water related to hardness is relatively low and invariable in Rufus Woods Lake. It has been positively correlated with river discharge and total suspended solids load in the past (Rensel 1989) and appears to maintain that relationship presently (Figure 4.1-10).

Dissolved Gas

Elston and Rensel (1996) report extensive losses of farmed trout in Rufus Woods Lake that were directly linked to high levels of atmospheric supersaturated gases produced by Grand Coulee Dam. Subsequently, additional monitoring of dissolved gas levels has been conducted by Grand Coulee Dam operations and the problem has generally been reduced. Maule et al. (2003) and Beeman et al. (2003) monitored growth patterns of resident rainbow trout in Rufus Woods Lake over a period that includes several years of high total dissolved gas (TDG) supersaturation (i.e., 1996, 1997). Results did not show differences sufficiently large to suggest annual influences of TDG supersaturation. TDG in the upper Columbia River and near Chief Joseph Dam can exceed Washington State maximum standards. TDG in Rufus Woods Lake is influenced primarily by Grand Coulee Dam and Canadian dam operations upstream. TDG spikes reaching 140% were observed in Rufus Woods Lake prior to the year 2000 (USACE 2000).

In 1972, 1993, 1996, 1997, and again in 2011, water spilled by operators of Grand Coulee Dam (GCD) increased downstream dissolved gas concentrations to acutely toxic levels, resulting in massive fish kills of both wild and farmed fish. Spilling was required as part of GCD's flood control mission and necessitated drafting Lake Roosevelt to create capacity to receive anticipated flood waters. In turn, this required water to be spilled through the "outlet works" (tubes that pass through the dam), rather than over the spillway. Above a certain spill volume, this mode of operation creates acutely toxic conditions for fish downstream. In 2011, the total dissolved gas (TDG) levels in Rufus Woods Lake exceeded 145% due to much higher than normal river discharge in spring and summer.

It is known that fish can compensate for gas supersaturation, to some degree, by remaining at sufficient depth. Fish depth plays a central role in the expression of gas bubble disease in fish because hydrostatic pressure has a strong influence on the TDG exposure for individual fish. Specifically, the increased hydrostatic pressure associated with swimming deeper in the water column inhibits formation of interstitial gas bubbles.

According to a literature review of dissolved gases by Don E. Weitkamp (1976), hydro compensation is an effective method of reducing mortalities during periods of high levels of TDG.

"Marsh and Gorham (1905) recognized that hydrostatic pressure exerted on a fish provides compensation that limited the effects of supersaturation. Each meter of depth exerts additional pressure that increases the solubility of dissolved gases sufficiently to compensate for approximately 10% of saturation. In the range of depths and supersaturations normally of concern, the rule of 10% compensation per meter of water depth is a useful approximation." This means that a total gas pressure of 130% is actually 100% at 3 meters.

"Blahm (1974) and Blahm et al (1976) described further experiments under the same conditions. During 50-55 day tests, juvenile Chinook salmon and steelheads suffered 11% and 6% mortalities, respectively, in 2.5 meter deep tanks compared to 80% mortalities for both species in 1 meter deep tanks (120% to 130% TDG)."

"A number of studies have attempted to simulate more natural conditions by placing live-cage in supersaturated river water. In live-cage studies at Priest Rapids Dam on the Columbia River in 1966, Ebel (1969) reported dissolved nitrogen saturations ranged from 118% to 143%. Juvenile coho salmon were held at depths of 0.5-1.5 m, 2.5-3.0 m, 2.5 -3.5 m, and 0-6.0 m for periods of 8-12 days. Fish held below 2.5 m suffered less than 3% mortality in each test. In the 0-6 m cage, 6% and 16% of the fish died while in the surface cage, mortalities were 100%."

Several papers listed in the TDG review by Weitkamp and Katz (1980) report that mortality due to TDG is very low if the fish are kept a few meters below the surface. During the high TDG levels in Rufus Woods Lake in spring 2011, this theory was tested at PAI's existing Site #1 steelhead trout net pen aquaculture project. Fish in one of the net pens were forced to stay 10 ft (approximately 3 meters) below the surface with the use of a top net. Prior to placing the top net in the pen, mortalities of 300 fish per day were observed. After the top net went into place, the mortality numbers dropped to 50 per day while all other cages continued to see much higher mortality levels. It was theorized that the mortalities that continued in the pen were a result of damage that occurred to the fish prior to the placement of the top net.

Evidence from these tests and from published literature suggests that if fish are kept 10 feet below the surface during high TDG events, they will not suffer significant mortality (PAI, July 19, 2011).

4.1.3 Aquatic Plants and Algae

Richards, Rensel and Siegrist (2011) studied algae, mostly periphyton but also phytoplankton and epiphytic green algae in Rufus Woods Lake from August 2010 through the summer of 2011. They found 76 algal taxa in Rufus Woods Lake that formed assemblages which varied by relative abundances and composition. The assemblages varied by location, season, and to a lesser extent depth, soft bodied algae versus diatoms, and early colonizing taxa versus later successional taxa.

4.1.3.1 Phytoplankton

Phytoplankton species composition in Rufus Woods Lake has not been closely studied in the past, in part because of the fast flushing rates of this lake and the fact that Lake Roosevelt is the water and phytoplankton source. The flushing rate of Lake Roosevelt is much longer than Rufus Woods Lake, allowing some phytoplankton productivity to occur (studied by Erickson et al. 1977, and Welch et al.1992). In early July 2011, floating algal mat samples were collected and sent by Robert Fischer and his U.S. Army Corps of Engineers (USACE) colleagues for species composition analysis. These were found to include small numbers of *Oscillatoria*, a potentially toxic blue green alga. Subsequent testing by the King County (Washington) Environmental Laboratory confirmed positive results for Anatoxin-*a* above the regulatory limit of 1.0 µg/L in the mats found in the lower reservoir. The USACE posted the lake with warning signs to advise users to avoid the floating mats. Subsequent sampling and testing by both USACE and consultants for Pacific Aquaculture Inc. (Carmichael 2011) indicated that the mats and toxins were present in varying quantities in both upper (Buckley Bar) and lower Rufus Woods Lake (Chief Joseph Dam pool and sometimes near the Bridgeport State Park). No toxins were found in the water. By early fall 2011, additional testing indicated the toxins were no longer present and the warning signs were removed. The specific geographic origins of the *Oscillatoria* cells were not determined in 2011, but low levels of cyanobacterial toxins were found in Lake Roosevelt in the forebay of Grand Coulee Dam (Washington Department of Ecology Toxic Algae Database Search results by W. Carmichael, August 30, 2011).

Slightly further downstream in Rocky Reach Reservoir, the species composition of phytoplankton and zooplankton was extensively studied by Parametrix, Rensel Associates, and University of Idaho (2001). The study found that diatoms were the dominant phytoplankton species in terms of abundance and biovolume in the water column, and were more prominent in winter and spring. Next most dominant were cryptophytes (small unicellular flagellates), cyanobacteria (blue green algae) and representatives of several other major taxa. Cyanobacteria may have originated in the Okanogan River system, as it is nutrient enriched compared to the Columbia River and has more suitable growing conditions (Rensel 1998). Total phytoplankton biovolume was relatively large all year, with a prolonged spring peak and a lower summer stanza. No prolonged differences were seen among stations or types of stations. Table A-1 in Appendix A of this *NEPA Environmental Assessment* contains a comprehensive list of phytoplankton genera found in Rufus Woods Lake and other nearby mainstem Columbia River reservoirs.

4.1.3.2 Periphyton

Periphyton are important food sources for aquatic invertebrates and the aquatic food web. Many are benign, beneficial and desirable components that grow on surfaces such as rocks, undisturbed fine-grained substrate, and macrophytes. However, if nutrient loading becomes excessive, the benign forms or noxious forms may grow to nuisance levels and compromise the food web and aesthetic value of freshwater bodies. Periphyton, also known as attached benthic algae, have not been systematically studied in Rufus Woods Lake until recently by Richards, Rensel and Siegrist (2011) for the Colville Confederated Tribes (see Table A-2 in Appendix A of this *NEPA Environmental Assessment*). Ceramic tiles were placed in protective baskets at several locations and depths to grow periphyton and calculate production rates (measured as standing stock of chlorophyll *a* accumulated over time), and to measure species composition. Several soft-bodied algae dominated the algal assemblages. However, at least two noxious filamentous green algal taxa, *Cladophora* sp. and *Spirogyra* sp., as well as one potentially toxic cyanobacteria, *Oscillatoria* sp., were found in late 2010 through 2011 studies. In addition, one cobble scrape in the middle reaches of Rufus Woods Lake was found to contain two cells of *Didymosphenia gemenata*, a nuisance species discussed below in more detail that has reached epidemic proportions in several large tail water tributaries of the Columbia River far upstream of Rufus Woods Lake.

Midsummer 2010 and all of spring and summer 2011 were marked by very high discharge rates through Grand Coulee Dam and higher than recent historical transport of phosphorus from upstream areas. The source of the higher concentration of nutrients is uncertain, but one likely possibility is from deposited fine sediments in upstream reservoir pool and forebay areas. Mats of floating algae were seen in 2010 and 2011 during late June through August. In some cases, these mats included cells of *Spirogyra* spp. and *Cladophora* spp., both filamentous green nuisance algae. In July of 2010, mats of floating algae were seen accumulated on the Chief Joseph Dam forebay floats and were noted accumulating on the upstream edge of the farthest upstream fish farm nets, also suggesting that the problem stemmed from upstream areas, not downstream of the net pens. Surveys and sample collections were conducted in July and August 2011 by agency and contractor staff to assess the distribution and species composition of these mats of algae (see review in Richards, Rensel and Siegrist 2011). Extensive searches of shallows and mainstream areas of the middle and upper reaches of Rufus Woods Lake failed to locate any concentrations of the mats, except near Buckley Bar in the upstream area of the lake. At that location, scattered and occasional mats were observed in shallows and floating out of the shallows as the water surface elevation increased rapidly on a short-term basis. High river discharge flows and fluctuating or higher than normal water surface elevations appeared to exacerbate this process by causing the mats to become dislodged from the shallows and be transported downstream. Excessive nutrients may play a role in the formation of these mats, but there was no evidence that the floating mats were associated with the operation of fish farms. The floating mats were only seen upstream of the fish farms at Buckley Bar, on the upstream edge of the net pens and downstream in the Chief Joseph Pool in several locations but mostly where they naturally accumulated due to the floating boomstick upstream of the dam.

In the upper Columbia River basin in British Columbia and Montana's Kootenai River, the stalked diatom *Didymosphenia geminata* (also known as "Didymo") becomes a nuisance at high abundances, forming thick gelatinous mats consisting of polysaccharides that resemble whitish-gray sewage fungus (Stevenson et al. 1996, and Holderman et al. 2005). Because of high levels of polysaccharides, this periphyton may be less acceptable to grazers that normally consume other periphyton, leading to its superabundance. In the Kootenai River, these periphyton are often observed floating on the water surface during the first spring freshet. No evidence of extensive or even small blooms of this species is available for Rufus Woods Lake, and it is unlikely to have occurred here as it is very noticeable to even casual observers when abundant.

Periphyton chlorophyll *a* concentrations in Rufus Woods Lake in October 2010 varied by site and depth with a mean of 12.8 mg/m^2 (median = 7.9 mg/m^2). Chlorophyll *a* and ash free dry weight values in the Richards, Rensel and Siegrist (2011) study were within the range of values found in other temperate, western North American riverine systems. If river discharge returns to near normal rates in 2012, the biological anomalies seen in 2011 will not recur as the likely source of nutrients (i.e., sediment deposits in upstream dam pools and perhaps bank erosion) will not be as extreme.

Prior studies in Rocky Reach Reservoir, the second downstream reservoir below Rufus Woods Lake, used chlorophyll *a* assessments on littoral zone rocks to generate autotrophic indices (AI) of trophic state (Parametrix, Rensel Associates and University of Idaho 2001). The lowest index in the sampling period of year 2000 was measured as expected in winter and early spring. Periphyton chlorophyll *a* concentrations ranged from a mean of 100.3 mg/m^2 in April to 73.1 mg/m^2 in August. By depth, highest chlorophyll *a* values were measured from the 0 to 2 m depth zone; below 3 m, concentrations dropped rapidly as light diminished. Autotrophic indices ranged from 31.0 in February to 46.8 in August. Annual mean AI was 39.8. Lowest index values occurred in the winter and spring. This suggests that the attached benthic algae community had the highest relative levels of photosynthetic biomass in the winter, with more non-producing biomass in July and August. Overall, attached benthic algae standing stock values found in Rocky Reach were considered by the authors to be high, placing the site in the eutrophic range of

productivity. Rocky Reach mean monthly attached benthic algae levels ranged from a low of 31.0 mg/m^2 to a high of 46.8 mg/m^2, much higher than those of other Columbia River sites, such as Priest Rapids (14.0 mg/m^2 to 44.6 mg/m^2). The authors concluded that autotrophic index values were very low, indicating an efficient algal community within Rocky Reach Reservoir, operating at fairly high physiological nutrient loading to cells. Since the water column concentration of dissolved inorganic nutrients was low, it must have been the flux rate of nutrient delivery that resulted in the relatively high standing stocks of periphyton. Studies in Rufus Woods Lake by Richards, Rensel and Siegrist (2011) in 2010 and 2011 reported lower concentrations of periphyton chlorophyll *a* from natural boulders and tiles placed in the shallow nearshore zone despite unusually high phosphorus concentrations in 2011.

The abundance of periphyton in Rufus Woods Lake is limited by the steep shorelines which result in a relatively less littoral zone area within the photosynthetic zone. Currents tend to be quite strong in Rufus Woods Lake compared with most downstream reservoirs due to the narrowness that constricts flow, so in most areas, except the few side channels or extensive coves, periphyton filaments break off and are swept downstream when growing substrate is placed in strong current areas such as the PAI net pen sites (Moore 1992, 1993, 1994; Rensel 1996). Studies in Rocky Reach Reservoir downstream indicated that periphyton stocks along the shallow shoreline were very productive, despite relatively low concentrations of N and P (Parametrix, Rensel Associates, and University of Idaho 2001). Unlike phytoplankton that are growth-limited at relatively high ambient concentrations of nutrients, periphyton may grow very luxuriously at much lower concentrations of nutrients, because the flux rate of nutrients past the cells is high even though the nutrient concentration is low. In contrast, basic phytoplankton physiology involves a small zone around each cell that becomes nutrient depleted when turbulence is low.

A few types of periphyton including diatoms of the genus *Cymbella* are less useful to higher food web forms and have been found to be prevalent in Rufus Woods Lake upstream of existing fish farms, but at lower densities downstream of existing fish farms. Richards, Rensel and Siegrist (2011) found two undesirable species of slime-forming diatoms, *Cymbella* spp. abundant on macrophytes in 2010 and G*omphonema* spp. on rocks and periphyton collecting tiles in the lower portion of the reservoir.

4.1.3.3 Macrophytes

Macrophytes are defined here as aquatic plants that grow in or near water and are either emergent, submerged, or floating. In lakes, macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen, and act as food and habitat for epiphytic algae (e.g., benthic diatoms and periphyton), invertebrates and some fish and wildlife species. Macrophytes may contain much of the total nutrient content of some lakes and reservoirs and their abundance may pose difficulties in accurately classifying the trophic levels of an aquatic body. As such, they may be an important factor in lake and reservoir ecology and classification.

There have been no systematic surveys of species composition or abundance of macrophytes in Rufus Woods Lake, but extensive surveys of downstream reservoirs occurred annually in past decades (Keesee 1985, 1986, 1987, 1988, 1989; Truscott 1990, 1991) by public utility districts that were concerned about the recent (at that time) introduction of Eurasian milfoil (*Myriophyllum spicatum*), and the possibility that it would replace other, more ecologically desirable species.

Rufus Woods Lake is less suited to extensive beds of macrophytes than all downstream reservoirs due to a minimum amount of shallow shoreline littoral zone areas and relatively greater average depth. Where such areas occur in Rufus Woods Lake, macrophytes are abundant, reach maturity by mid-summer, and begin to decline by late summer. Macrophyte bed extent is limited by depth (light) and sediment type (they need fine-grained sediments).In many areas, recent surveys indicate that most of the macrophyte biomass occurs in less than 15 to 20 feet of depth (J. Rensel and D. Richards, unpublished diving and

video survey data). Common macrophyte species in Rufus Woods Lake include coontail (*Ceratophyllum demersum*), curly-leafed pondweed (*Potamogeton crispus*), *Cladophora* sp. (a green filamentous algae), waterweed (*Elodea* sp.), and Eurasian milfoil (*Myriophyllum spicatum*) (Table A-3 in Appendix A). Personal observations suggest that coontail and pondweed are most prevalent in Rufus Woods Lake, followed by Eurasian milfoil. Luxuriant macrophyte growth has been noted both downstream and upstream of Rufus Woods Lake fish pens. Stable isotope tracing results showed no significant differences between the locations (J. Rensel 2001 and unpublished data). Many freshwater macrophytes utilize nutrients from sediments via their roots, but some, like *Cladophora* spp., have the ability to sequester nutrients from the water column and some are facultative, using both sources.

SCUBA diving surveys conducted in nearby downstream Lake Pateros in July 1998 found many fish near the edges of macrophyte beds (Beak Consultants and Rensel Associates 1999). Differing macrophyte densities may favor different fish species, creating specialized habitats within a lake or reservoir; for instance, bluegill are generally found in less weedy areas than are the similar pumpkinseed. In Lake Pateros, macrophyte growth was noted at an average depth of 6 to 8 feet relative to the mean water surface elevation. Waters less than approximately 6 feet deep were typically devoid of macrophytes, which created other specialized habitat. These shallow, macrophyte-free areas were frequented by numerous small suckers and other fish, while possibly resulting in unfavorable conditions for fish species like pumpkinseed. A similar situation exists in Rufus Woods Lake, although in 2010 surveys macrophyte growth was found to begin at a depth of about 3 feet below the water surface elevation in August, a period of relatively stable water depth in the reservoir (J. Rensel and D. Richards, unpublished 2010 field data). The same study documented that macrophyte beds in Rufus Woods Lake often thin out by 10 or 12 feet depth, become patchy from that point toward greater depths, and did not exceed 20 foot depth in most cases. Much site-to-site variability was noted. Macrophyte bed depth extent is limited by available light sufficient to enable photosynthesis greater than respiration and the need for specific sediment types that include a mix of fine-grained silts and clays with organic matter.

Most macrophytes are beneficial to the aquatic ecosystem under natural conditions; however, anthropogenic perturbations such as excessive nitrogen and phosphorus discharge can alter the community composition or density of macrophyte beds. Excessive abundance of macrophytes in shallow, poorly flushed areas can result in nighttime and fall period respiration that can significantly lower dissolved oxygen concentrations in the immediate area of the plants. This tends to be more of a problem with floating macrophytes such as water lilies (family Nymphaeaceae) and some of the pondweed species, including some species of *Potamogeton* spp. and Elodea spp. (Frodge et al. 1991). However, in Rufus Woods Lake, there are few areas suitable for growth of water lilies, and the other two species are mostly submerged forms.

Excessive phosphorus discharge has also been linked to increasing prevalence of noxious algae such as *Cladophora* spp. This genus is composed of a diverse group of green, filamentous algae with species that are difficult to distinguish and occur in many regions worldwide; excessive presence of *Cladophora* is often used as an indicator of eutrophication. In the North American Great Lakes, problems with *C. glomerata* have increased as zebra mussels (*Dreissena polymorpha*) and later quagga mussels (*Dreissena rostriformis bugensis*) filtered the water and allowed greater light penetration. Nearshore phosphorus loading, more so than nitrogen, is concurrently linked to the abundance of *Cladophora* spp. (Malkin 2007). The alga is either attached to hard surfaces, wrapped around rooted macrophytes or occurs free floating in mats. The floating mats of *Cladophora* spp. in Lake Roosevelt were considered a significant problem when the Cominco, Ltd. fertilizer plant in British Columbia was operating more than 20 years ago with discharges of up to 8 metric tons of phosphorus per day into the Columbia River above Lake Roosevelt (Rensel 1993). The problem disappeared with the abrupt and dramatic cessation of phosphorus loading but because of seasonal timing of *Cladophora* spp. abundance (August and September) and a lack of study, it is not possible to back-calculate the point at which conditions improved. As discussed above,

some *Cladophora* spp. were documented in 2010-2011 in Rufus Woods Lake in relatively small amounts of floating mat (except at the Chief Joseph Dam forebay boomstick), and no reports or observations of the mats in Lake Roosevelt occurred at the same time.

Different species of macrophytes can take up nutrients through sediments and their roots, if so equipped, or their fronds via the water column, or both, depending on their morphology and species-specific characteristics. The unknown species of *Cladophora* that exists in Rufus Woods Lake does not appear to be rooted but appears as an epiphyte on other species of macrophytes, as it does downstream in Lake Pateros, particularly downstream of the confluence of the eutrophic Okanogan River (Rensel, J. unpublished data acquired while conducting fish surveys). Knowledge of interactions between *Cladophora* spp. and fish farms worldwide is limited but more common in brackish-marine waters such as the Baltic Sea, not in freshwater rivers or reservoirs. In some published studies of fish farm effects, the physical circulation and region's nutrient sensitivity and dynamics are not assessed or discussed, and methodological details are sketchy. In one such study, Ruokolahti (1988) found increased density of *Cladophora* spp. at a sheltered fish farm in a Baltic Sea bay that appears to have been a poor choice for growing fish. The three-page paper is, however, often cited as a negative effect of fish farming.

Preliminary stable isotope N and C studies with macrophytes upstream and downstream of existing steelhead trout net pens in Rufus Woods Lake indicated that ^{15}N or ^{13}C from the fish farm operation at PAI existing Site #1 was not traceable to nearby macrophytes located downstream at a location where drift object studies indicated a possibility of shoreline effect (Rensel 2001). The sample sizes were limited, however, and more troublesome species such as *Cladophora* spp. were not sampled as they were not abundant during the time when sampling was conducted. Sampling of *Cladophora* spp. throughout Rufus Woods Lake for stable isotope analysis began again in 2010 (Rensel and Richards, unpublished field and laboratory data), but the study is mostly focused on sampling in 2011. Other researchers such as Kohzu et al. (2008) and King et al. (2009) have been able to use ^{15}N stable isotope measurements to estimate the spatial and population effects of ^{15}N-enriched sewage discharge in other regions so that if phosphorus loading becomes excessive in Rufus Woods Lake, the methodology should detect it if applied properly.

4.1.4 Aquatic Animals

4.1.4.1 Zooplankton

Zooplankton are planktonic invertebrates that are the primary consumers of phytoplankton. In the mid-Columbia River, dominant groups include calanoid copepods, cyclopoid copepods, cladocerans, rotifers, and relatively abundant benthic organisms or their transition forms of chironomids and oligochaetes (Rocky Reach reservoir: Parametrix, Rensel Associates and University of Idaho 2001). These authors summarize by noting that zooplankton biomass was dominated by rotifers in most months. Crustacean zooplankton were relatively scarce compared to regional lakes that are truly mesotrophic, but within the abundance or biomass range found in downstream reservoirs in recent years. Large biovolume and relative size of the preferred fish prey species *Daphnia* were observed from July to September. Lower biovolume and mean size of *Daphnia* spp. was noted at other times. There could be a causal relationship between the fact that *Daphnia* were larger and more abundant later in the summer, after most of the smolt outmigration and maturing of several species of larval juvenile fish that depend in part on zooplankton prey. This determination would require further analysis of our data and fish feeding ecology studies. There were no pronounced differences among biomass estimates for pelagic and littoral stations, with the possible exception of lower to mid-reservoir areas in the fall of 1999 and summer of 2000."

In Rufus Woods Lake, preliminary results of ongoing studies at this time classify a variety of zooplankton found in fish stomachs. Examples from a number of different taxa were identified, including crustaceans,

isopods, amphipods, decopods and icthyoplankton. A composite list of zooplankton from Rufus Woods Lake and other nearby mainstem reservoirs is provided in Table A-4 (Appendix A).

4.1.4.2 Benthic Invertebrates

In the past, population studies of benthic invertebrates have received little or no study in Rufus Woods Lake; e.g., they were not assessed by Erickson et al. (1977). Fish farming effects studies usually concentrated on visual or camera studies of conditions beneath or downstream from fish cages, and there are some archived photographs and videotape of conditions. Commencing in August 2010, however, a study of secondary production occurred in Rufus Woods Lake, conducted by EcoAnalysts, Inc. and Rensel Associates for the Colville Confederated Tribes. The study was designed to evaluate existing invertebrate resources present and catalogue their relative seasonal abundance and involvement in fish diet. Invertebrate populations of Rufus Woods Lake were assessed through dredge suction sampling, sampling of cobble colonization baskets, and by sweeping macrophyte vegetation with fine mesh nets. Samples were identified to lowest practical taxonomic level and enumerated. Some were submitted for carbon and nitrogen stable isotope analysis.. Benthic assemblages varied with season and location. Location differences were primarily due to the different habitats sampled between the upstream (primarily cobbles) and downstream (primarily fine sediments and macrophytes) sites. The overall mean benthic invertebrate density was 2,385/m^2. The measured densities were within the normal range for many trout fisheries but tending towards the low end. About 33 families of benthic invertebrates were collected from a wide array of life histories and ecologies, which translates to the availability of rainbow trout diet items throughout the year. Sculpins, an important trout food item, were observed in all the upstream (upper and mid-reservoir) sites but not in any of the downstream sites (lower reservoir). Estimated sculpin density ranged from about 1-10/m^2 in the upstream sites. Benthic dry weights were highly variable due to occasional large crayfish, caddisflies, or snails in the samples. Crayfish, including invasive species, were often extremely abundant in Rufus Woods Lake, especially in the mid- to upper river sections.

BioAnalysts, Inc. (2006) conducted an in-depth analysis of the benthos of adjacent and downstream Lake Pateros in the summer of 2005. In more narrow and swift-running current areas, chironomids and trichopterans were the most abundant taxa; in slow water littoral areas, chironomids and tricopterans remained prevalent but gastropods were most abundant. Silt and sand-substrate areas near macrophyte beds contained a high percentage of flatworms and isopods. Finally, deep water habitat of the Lake Pateros had a benthos consisting predominantly of clams and roundworms; in the Okanogan River, the dominant taxa included coleopterans, trichopterans, chironomids, clams and segmented worms. The Asian clam (*Corbicula fluminea*) was the dominant bivalve in most deep water and fine sediment bottom substrate habitats.

4.1.4.3 Fish

Washington Department of Fish & Wildlife (WDFW) Priority Habitats and Species (PHS) database search results for the proposed action area and vicinity were reviewed in mid-December 2010 (WDFW 2010). The Columbia River contains rainbow trout (*Oncorhynchus mykiss)*, which is a State priority species. The native redband trout (*Oncorhynchus mykiss gairdneri*) is a priority species that the Colville Confederated Tribes have been working to restore.

The only comprehensive assessment of fish species composition and abundance in Rufus Woods Lake was conducted by Erickson et al. (1977) whose team used a variety of fishing techniques in 1974 and 1975 to determine relative abundance of fish captured in Rufus Woods Lake (Table A-7 in Attachment A). In Erickson's study, the most abundant species by percent of catch were northern pikeminnow (*Ptychocheilus oregonensis*) (34.3%), largescale sucker (*Catostomus macrocheilus*) (16.4%) and peamouth (*Mylocheilus caurinus*) (12.4%); the most abundant game fish were walleye (*Sander vitreus*)

(8.4%) and prickly sculpin (*Cottus asper*) (5.0%). Since this work was conducted more than 36 years ago, it is possible that the results are not representative of existing fish assemblages in Rufus Woods Lake. A more recent survey reported by LeCaire (2000, a biologist with the CCT Fish and Wildlife Department) identified relative abundance of fish caught electrofishing and beach seining in April-July 1999 by other CCT staff. The most abundant fish by percent of catch were longnose sucker (*Catostomus catostomus*) (20.3%), redside shiner (*Richardsonius balteatus*) (15.4%) and rainbow trout (14.6%); sculpins, other suckers, walleye, and northern pikeminnow were also relatively abundant. The information source cited by LeCaire (2000) was personal communications with Dave Venditti, Research Fish Biologist, U.S. Geological Service.

As the Erickson et al. (1977) studies are now dated, comparison of more recent studies in Lake Pateros immediately downstream, by Beak Consultants and Rensel Associates (1999) is appropriate. These authors conducted beach seining in August and September 1998. They found high relative abundance of suckers (35.9%), bluegill (*Lepomis macrochirus*) (21.9%), redside shiner (17.5%) and pike minnow (8.7%). SCUBA diving surveys conducted at the same time also found suckers as the most abundant fish, with a combined relative abundance of juvenile and adult suckers of 46.4%; other abundant species included redside shiner (23.5%) and prickly sculpin (10.6%). In comparison with another study in Lake Pateros in 1974 (Dell et al. 1975), the relative abundances of suckers and redside shiners were very similar, while the relative abundance of pikeminnows and chiselmouth (*Acrocheilus alutaceus*) dropped from 1974 to 1998, and the relative abundance of bluegill greatly increased. Lake Pateros is much shallower than Rufus Woods Lake and has the eutrophic, but much smaller volume, Okanogan River flowing into it so it would not be expected to have identical fish populations.

Recent creel studies conducted by the Colville Confederated Tribes have determined that the steelhead trout net pen industry in Rufus Woods Lake has contributed more than 95% of the established sport and subsistence fisheries of the lake/reservoir, due to fish escape and/or intentional release (Shallenberger 2009). In the last decade, several hundred thousand fish have been purchased by the Colville Tribes for intentional release in order to maintain the Rufus Woods Lake fishery; several hundred thousand more escaped the net pens.[1] This led to an increase in angling pressure, to greater than 40,000 angling days per year. However, escapes have been significantly reduced since 2009. This is likely leading to a drastic reduction in the Rufus Woods Lake fishery. Rainbow trout released in Lake Roosevelt occasionally end up downstream in Rufus Woods Lake via entrainment over or through Grand Coulee Dam; however, in 2009, only 2.7% of the fish observed in a creel study were found to originate in Lake Roosevelt. Only a small percentage (<2%) of trout caught in Rufus Woods Lake were considered 'wild' by creel clerks.

Escaped trout often stay under/near the pens, but an ongoing study by the Colville Confederated Tribes Fish and Wildlife Department with acoustic tagging is showing the pattern of migration that includes some of the purposely-released fish from Chief Joseph Orchards Fish Farm moving upstream toward Pacific Aquaculture pens, and others moving downstream to the Chief Joseph Dam pool. Some of the fish also remain near the release point, while others are being found downstream in Lake Pateros. The study results are incomplete, ongoing through 2011. Escaped fish that do remain near the fish pens likely result in less waste feed reaching the bottom. SCUBA diving surveys have confirmed that escaped fish are selectively consuming waste feed.

Some species of wild fish are attracted to the area near net pens in Rufus Woods Lake because the pens provide a form of floating habitat and food supply. Ongoing acoustic sounding studies by the Colville Confederated Tribes Fish and Wildlife Department show increased abundance of fish near the cages

[1] The prior owner/operator of what are now Pacific Aquaculture Sites #1 and #2 had inferior equipment that resulted in high escapement rates from the net pens. Nets and equipment have been substantially improved under PAI ownership/operation, with the result that escapes are less frequent (now attributable to net manufacturing).

versus reference areas (E. Shallenberger, personal communications, February 16, 2011). Most of the smaller fish in the lake are restricted to the shallow littoral zone, and it is rare to see small, wild fish inside the cages or in the downstream area of the cages as is common in marine waters. The net pens are located offshore in high current velocity areas and the smaller fish require slower moving waters with habitat features such as macrophytes for shade, cover and food. As a result of the accumulated biomass of fish near the cages, there tends to be more sport and subsistence fishers in these areas, and fishing is usually more productive for intentionally released trout. Other sports species such as walleye are not more prevalent at the pens but are fished throughout the reservoir, particularly the upper reaches.

There are no anadromous salmon or steelhead in Rufus Woods Lake. Salmonid species reported by sources reviewed to create Appendix A to this *NEPA Environmental Assessment* are listed in Table A-7.

4.1.4.4 Birds

Erickson et al. (1977) conducted an extensive survey of all bird species identified within the Rufus Woods Lake subbasin. LeCaire (2000) also completed a list of area birds. Results from both studies are compiled in Table A-8 in Appendix A. Several bird species have been observed in or near the aquatic environment of existing Pacific Aquaculture, Inc. net pen sites in the past. At various times of the year, red-winged blackbirds (*Agelaius phoeniceus*), Brewer's blackbirds (*Euphagus cyanocephalus*), great blue herons (*Ardea herodias*), gulls and terns have been observed or reported (B. Clark, personal communications to J. Rensel, August 13, 2009). Some of these birds (e.g., herons) may attempt to prey on net pen fish or use the pens as habitat, but the modern fish culture pen system uses a very large and effective bird exclusion net held in place by numerous vertical supports, well above the water line (see Figure 3.1-2 in Chapter 3). Gulls that might be attracted to the cages to feed on the relatively small amount of fish feed that remains above water on cage surfaces are similarly excluded. Some gulls are usually present near the shore support and feed handling facilities, but feed spills are rare and are cleaned up immediately if one of the large feed transport bags were to fail.

4.1.4.5 Mammals

An extensive list of terrestrial and aquatic mammals found in the Rufus Woods Lake subbasin compiled from Erickson et al. (1977) and LeCaire (2000) is provided in Table A-9 (Appendix A). This table includes species likely not present in any significant quantity in or near PAI existing Sites #1 and #2. Mammals that may be found near PAI existing Site #1 or Preferred Alternative Site #3 include river otters, which have been sighted in recent years in Rufus Woods Lake at locations further upstream (R. Fischer USACE and D. Richards EcoAnalysts, Inc., personal communication to J. Rensel, August 2010). Muskrats also commonly occur in Rufus Woods Lake and were a minor nuisance at the Columbia River Fish Farm location where they would burrow into the styrofoam floats of some of the pens. Pens presently used have hard plastic surfaces and are not subject to this problem. Coyotes are very common along the shoreline of Rufus Woods Lake where they forage for a large variety of prey and food. In 2010, coyote scat containing crayfish shells was observed at several locations along the banks of the mid-section of Rufus Woods Lake.

4.1.4.6 Threatened, Endangered, and Protected Aquatic Species

The Columbia River Distinct Population Segment (DPS) of bull trout (*Salvelinus confluentus*) is Federally-listed as threatened. Currently, migratory bull trout (bull trout that spawn in other basins) are present in the Columbia River during winter and spring. In Rufus Woods Lake, only two juvenile bull trout (mean weight 107 grams) have been documented (Northwest Power Planning Council, 2000, Lake Rufus Woods Subbasin Summary). Bull trout spawn in small streams with very cold clear water with clean gravel substrates − conditions that are not present within the action area of the proposed project.

4.1.4.7 Exotic Species

Exotic species of fish and invertebrates have not been directly studied in Rufus Woods Lake or many of the other Columbia River reservoirs. However, Richards and Rensel (2010) have detected one species of exotic snail (big-eared snail *Radix auricularia*), and the northern crayfish (*Oronectes Virilis*) in their sampling of the lake. Northern crayfish were also reported by Larsen et al. (2010) as occurring near the Coyote Creek confluence with Rufus Woods Lake. The authors speculated that this species may have been introduced through release of live bait by anglers, although there are no bait sellers in the Rufus Woods Lake region that sell crayfish of any kind for use by anglers. The authors speculated that aquaculture could have been responsible (presumably by way of stocking of fish), but at that time and for many years prior the only source of steelhead trout for culture in Rufus Woods Lake was at Trout Lodge, Inc. hatchery fed by an underground spring at the headwaters of Rocky Ford Creek near Moses Lake. Rensel (2010) reported only native crayfish from deeper water of the lake in his diving collections, but no detailed taxonomic analyses were conducted. By 2011, Richards, Rensel and Siegrist found no native signal crayfish, *Pacifastacus leniusculus*; however, 431 invasive Cambaridae crayfish were collected. These non-native crayfish are highly invasive and when established may have far reaching effects on biodiversity, community structure, energy transfer, food webs, effects on fisheries, and severe effects on the structure and functioning of Rufus Woods Lake. For example, Cambaridae crayfish are known predators of snails, an important rainbow trout food item in Rufus Woods Lake. Crayfish and snails were significantly negatively correlated with each other.

The distribution of big-eared snails has not been specifically determined in Rufus Woods Lake; however, in their survey of the lake in late summer of 2010, Richard and Rensel (2010) found several, mostly empty shells, in shallows of small bays such as near Rocky Flats, a small peninsula near a shallow bay of the lower lake area. This species is readily identifiable and none have been seen in the vicinity of the Rufus Woods Lake net pen farms or during research and diving inspections nearby (e.g., Rensel 2010).

Table A-7 (Appendix A) is a list of fish species known to occur in Rufus Woods Lake with introduced species indicated with an asterisk. As no formal study of exotic species has been conducted in the lake, it is useful to summarize studies conducted in other reservoirs of the lower mid-Columbia River. Draheim et al. (2007) found that more than 50 aquatic non-indigenous species have been introduced to the mid-Columbia River since the 1880s. These included fish (54%), aquatic plants (14%), and crustaceans (12%). The remaining 24% were mollusks, bryozoans, hydrozoans, annelids, one amphibian, and one aquatic mammal. These species were primarily the result of intentional stocking for enhancement purposes by agencies, and secondarily by ballast water and intentional releases by individuals.

Exotic invertebrate species were assessed recently in nearby Lake Pateros by BioAnalysts, Inc. (2006) who found eight native species and one non-native snail. Gastropods found included one non-native species (*Radix auricularia*) known as the big-eared radix. Bivalves also included one non-native corbiculid (*Corbicula fluminea*) known as the Asian clam. Ongoing studies in Rufus Woods Lake have also identified species of non-native gastropods and crayfish (D. Richards, EcoAnalysts, Inc., personal communications to J. Rensel, Rensel Associates, November 2010).

4.1.5 Navigation

4.1.5.1 Relationship of the Proposed Site and Steelhead Net Pen Structure to Boat Traffic within Rufus Woods Lake

Most of the boat traffic that occurs on Rufus Woods Lake is related to sport fishers. There are no large commercial vessels. Major launch points include the U.S. Army Corps of Engineers launch or the State Park near Chief Joseph Dam, and at Seaton's Grove upstream near Grand Coulee. There are other small launches along the lake, including one between PAI existing Site #1 and Site #2 on the right bank near Nespelem. Much of the trout fishing that occurs in the middle reaches of the lake occurs near the PAI and Chief Joseph Orchards net pens, where fish have been released intentionally by the Colville Confederated Tribes or escaped unintentionally.

Existing net pens are marked with navigation lights. Except for summer, nighttime boat traffic is rare. Boat traffic is prevented from traveling into net pen areas by diagonally arrayed floating debris deflectors (see Drawings #4, #10, #11, and #13 in Attachment 1).

4.1.5.2 Subsistence Fishing and Sport Fishing Practices Around Steelhead Net Pens

The Colville Confederated Tribes (CCT) Fish and Wildlife Department operates a sterile steelhead trout grow-out and release program in Rufus Woods Lake. A primary goal of the CCT project is to provide subsistence fishing for Tribal members as well as to create a quality sport fishing experience for licensed, non-Tribal members. CCT sells licenses for fishing in Reservation waters to maintain the program. Contract rearing of the fish is conducted at Pacific Aquaculture Inc. and Chief Joseph Orchards pens, with releases planned to occur throughout the year. A significant amount of the sport fishing associated with the trout enhancement program occurs immediately around PAI existing Site #1, as it is accessible both by small boat and a shoreline fishing area immediately downstream of the net pens and maintained by CCT. Many Tribal members who fish with rod and reel use the shoreline area. Fishing also occurs near PAI existing Site #2; however, this general area is not accessible from the shoreline due to a high, steep bluff. At both existing sites, small boats are not allowed to tie to the cages but often anchor or motor slowly around the cages while trolling with lures or bait.

4.1.5.3 Aids to Navigation, U.S. Coast Guard Permit Required

There are few aids to navigation in Rufus Woods Lake between PAI existing Site #1 and the downstream alternative sites considered for PAI Site #3. The fish farms are equipped with yellow blinking navigation lights on up- and downstream ends. There are at least two water withdrawal, well casing/pump assemblies in the lake in the same region that have non-flashing white warning lights to prevent nighttime boaters from colliding with them. The U.S. Coast Guard has no record of either Federal or private marine aids to navigation in this section of the Columbia River (personal communication with Tim Westcott, Private Aids to Navigation Manager, 13th Coast Guard District, March 10, 2011).

Placement of a fish farm net pen in the Columbia River will require review by the U.S. Coast Guard and a determination as to whether or not the structure would need to be marked with private aids to navigation (e-mail communication received from Timothy Westcott, Private Aids to Navigation Manager, 13th Coast Guard District, December 15, 2010).

4.2 TERRESTRIAL ENVIRONMENT

4.2.1 Land Use

Each of the four alternative sites considered for the Pacific Aquaculture, Inc. (PAI) Rufus Woods Lake Steelhead Net Pen Aquaculture Site #3 and adjacent properties within a 0.5-mile radius (i.e., the action area) are currently vacant and undeveloped. Native vegetation has not been disturbed (other than by grazing) for several decades, since inundation of the Rufus Woods Lake reservoir and construction of Columbia River Road.

PAI existing Site #1 where the Site #3 steel cages would be assembled is 55 acres in size and presently developed as the upland support area for an existing steelhead net pen aquaculture project at this location (river mile 579). Existing upland improvements occupy approximately 0.4 acre and include: four feed silos on a concrete pad, an operations trailer that houses the feeding control system, 4-inch diameter PVC piping that conveys feed to the floating net pens, an office (one-story wood frame building approximately 800 sq ft in size), a road/compacted earth trail for vehicular access to the site, and a foot path for access to the dock. Site #1 is fee land, owned by PAI.

Land areas adjacent to PAI existing Site #1 and the alternative locations for Site #3 are within the 200-ft Shoreline environment. The Colville Confederated Tribes Shoreline Designation Map classification for all of these land areas is: Natural Environment within the first 100 feet landward from the ordinary high water mark (OHWM) and Rural Agriculture within the balance of the shoreline jurisdiction (CCT Law and Order Code Chapter 4-15, Appendix B, Water Body-Specific Designations, Columbia River, Reservation side). The relationship of the proposal to the CCT Shoreline Management Code is described in *NEPA Environmental Assessment* Chapter 6, Section 6.2.6.

There is no agricultural use of any of these upland areas at the present time. Grazing by free-range cattle may occur.

Land areas adjacent to PAI existing Site #1 and any of the alternative locations considered for Site #3 are all within the same zoning district: the Special Requirement District (SRD). Development proposals within the SRD require a Conditional Use Permit approved by the CCT Land Use Review Board. The relationship of the proposal to the CCT Land Use and Development Code is described in *NEPA Environmental Assessment* Chapter 6, Section 6.2.2.

4.2.2 Topography and Soils

The project area is in the Big Bend physiographic region of the Columbia Basin, located in the bottom of the Columbia River canyon. Landforms in the area surveyed for archaeological and historic resources include riverine or glacial-flood-derived terraces, granite bedrock outcrops, basalt lag blocks and glacial erratics, and remnant flood bars appearing as mid-channel islands. The riverine terraces are the second and third terraces above the original river channel. Glacially-derived fluvial sediments underline alluvial sands on all low-slope landforms. These sands often are mixed with fine glacial lake deposited silts through slopewash from adjacent, higher elevations (Franklin and Dyrness 1988).

The elevation of proposed Site #3 ranges from approximately 960 to 1,000 feet above sea level (ASL). The surrounding topography includes upland areas to the south and north of the river that rise to elevations of more than 2,500 ft mean sea level (MSL), and slope downward toward the shoreline. The river is the low point of the surrounding topography, with a typical water level elevation of approximately 956ft MSL (USACE 2011). The geology beneath the site typically consists of unconsolidated deposits of

sand and gravel overlying granite bedrock. Shallow groundwater typically resides in the sediments above bedrock at depths that generally correspond to the water level in the Columbia River. Based on the site plan for PAI Preferred Alternative Site #3 (Drawing #14 in Attachment 1), the depth to water beneath the upland portion where the buildings and storage areas are located is estimated to be between approximately 50 and 100 ft below ground surface (bgs).

The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (December 3, 2010) maps PAI Preferred Alternative Site #3 within an area of soil type 358: Pogue stony loam, 0 to 25% slopes. Pogue series soils consist of very deep, somewhat excessively drained soils formed in loess and glacial outwash on terraces and terrace escarpments at elevations of 600 to 2,200 feet. These soils are usually dry in all parts between a depth of 8 and 24 inches for more than half the time when the soil temperature is greater than 41 degrees Fahrenheit. Average annual precipitation is 8 to 12 inches. These soils occur in a climate of hot, dry summers and cold, moist winters (USDA, Natural Resources Conservation Service, February 9, 2011).

Soils excavated during cultural resources shovel testing on the upland site were reported to be consistent with the Skaha soil series (Campbell and Aho 2002). The first 2 to 3 centimeters (one inch) consisted of the turf (grass) layer, followed by brown-colored gravelly loamy sand. At a depth of approximately 40 centimeters (15 to 16 inches), a very gravelly yellowish loamy sand was encountered. Shovel probes excavated along the river bench generally encountered shallower soils before reaching glacial outwash cobbles too large to pry out (CCT History/Archaeology, February 1, 2011). Site-specific investigation is generally considered more accurate than the NRCS mapping. The Skaha soil series has very similar characteristics to the Pogue; therefore, this discrepancy is inconsequential to the project effects analysis.

4.2.3 Air Quality

Information presented in this section is summarized from the Colville Indian Reservation *Integrated Resource Management Plan Final EIS* (September 2000), with updates provided by Kris Ray, Air Quality Program Manager, CCT Office of Environmental Trust (personal communication May 2, 2011).

U.S. Environmental Protection Agency (EPA) Region 10 promulgated rules under the Clean Air Act (CAA) within the region and specific to the Colville Reservation in June 2005. These rules, Federal Air Rules for Reservations (FARR) (40 CFR Parts 9 and 49), created basic Federally-enforceable air quality regulations on thirty-nine Indian reservations in Idaho, Oregon and Washington in order to protect human health and the environment. The FARR rules fill the regulatory gap so that Reservation residents have air quality protections similar to those that exist outside Indian reservations. The Rules apply to all persons and businesses located within the Federally-recognized exterior boundaries of the Colville Reservation. In Subpart M – Implementation Plan for the Confederated Tribes of the Colville Reservation, Washington – specific rules and measures are described that apply to this Reservation.

The Washington State Department of Ecology (Ecology) does not have regulatory authority or jurisdiction over air quality within the exterior boundaries of the Reservation.

The Colville Reservation is unclassified for inhaleable particulate matter − PM 2.5. Particulate matter consists of fine particles of smoke, dust, pollen or other materials that remain suspended in the atmosphere for a substantial period of time. The CCT Office of Environmental Trust Air Quality Program (AQP) conducts monitoring for PM 2.5 in East Omak at the former of 8th Avenue and the Okanogan Omak River Road. Monitoring began at this site in early 2009. A permanent monitoring site was established in October 2010. Data from the permanent site are available at: https://fortress.wa.gov/ecy/enviwa/Default.htm.

Visual observations on the Reservation indicate the largest source of suspended fine particles $PM_{10/2.5}$ appears to be road dust from automobiles and trucks, particularly on non-asphalt surfaced roads. Prescribed fire for forestry improvement periodically releases large quantities of particulate matter, although no studies have been done on the quantity and composition of this source.

The National Weather Service issues air stagnation advisories for the area that includes the Colville Reservation. Ecology issues home heating burn bans for counties without local air quality agencies, which include all counties adjacent to the Reservation. EPA in consultation with the CCT AQP determines the need for and issues burn bans within the exterior boundaries of the Reservation.

Title V of the Federal Clean Air Act requires EPA to implement an air operating permit program that applies to major sources of air pollution and other designated non-major source types. Two Title V facilities are located on the Reservation in the Omak area: Colville Indian Power & Veneer, and Colville Indian Precision Pine. These facilities operate under EPA-issued 40 CFR Part 71 permits (personal communication with Kris Ray, CCT Air Program Manager, July 11, 2011).

According to an anecdotal account of wind conditions at the PAI existing Site #1 steelhead trout net pen aquaculture operation on Rufus Woods Lake, breezy to windy conditions occur approximately 95% of the time in this area. The wind blows predominantly from two directions: NW to SE, or SE to NW following the river channel (personal communication with Bill Clark, PAI Operations Manager, March 14, 2011).

Odors are not apparent within the project action area, in general. An odor of fish oil in proximity to the feed silos and net pens at PAI existing Site #1 is noticeable to some observers.

4.2.4 Floodplains

Along the Columbia River above Grand Coulee Dam, the 1,310-foot elevation mark is recognized as the 100-year flood line. The U. S. Bureau of Reclamation allows no permanent structures to be built below this line.

Existing and proposed PAI steelhead trout net pen aquaculture sites are below Grand Coulee Dam. The Bureau of Reclamation, Corps of Engineers, and Douglas County Public Utility District control the level of the Columbia River with a series of hydroelectric and flood control dams.

Floodplains are managed on the Reservation under direction of Colville Tribal Code, Chapter 4-15, Shoreline Management (discussed in Chapter 6, Section 6.2.6 of this *NEPA Environmental Assessment*). CCT has codified the language of the FEMA National Flood Insurance Program into CCT Tribal Code Chapter 4-20. Outside the City of Omak, no known Federal Emergency Management Agency (FEMA) floodplains exist within the unincorporated boundaries of the Reservation (Colville Confederated Tribes, September 2000).[2]

[2] FEMA map panels and the FEMA Map Information Exchange were consulted to confirm the absence of floodplain or floodway designations along the Columbia River reach where existing and proposed PAI net pen aquaculture sites are located. Map panels 5301171300B and 5301171275B are marked with an asterisk that notes "Areas outside flood boundaries" (FEMA Flood Insurance Rate Map: Okanogan County, Washington [unincorporated areas], January 2, 2003; http://www.msc.fema.gov/webapp/wcs/stores accessed August 9, 2011).

4.2.5 Wetlands

There are no wetlands on the PAI existing Site #1 where the proposal includes construction: assembling net pen frames to be floated downriver for installation at proposed Site #3, and harvest of fish to be barged to existing Site #1 from proposed Site #3.

No upland support improvements are proposed at the High Bank Bight (RM 573.9), Mah-Kin Rapids (RM 572.4), or Narrows Downstream (RM 571.9) alternative sites due to high-bank rock and/or unstable shoreline bank conditions. Therefore, land areas adjacent to these river mile locations were not inspected for the possible presence of wetland conditions.

The open drainage swale along the west boundary of the PAI Preferred Alternative Site #3 was inspected on December 28, 2010 for the presence of wetland indicator plants, hydric soil, and/or standing water (Rensel, January 1, 2011). The swale conveys runoff to the Columbia River (Rufus Woods Lake reservoir) discharged from a culvert beneath Columbia River Road. The length of the swale is approximately 375 feet with a drop in elevation of approximately 40 feet over this distance (average slope 11%). There was no standing water in the swale during the winter season. Soils were uniformly coarse throughout the area surveyed, allowing surface water to quickly percolate into the ground. No facultative or obligate wetland plants were observed anywhere in the drainage swale. For all of these reasons, it was determined that wetland conditions do not exist along the west boundary of the site. No other features on the upland support site prompted the need to check for wetland conditions elsewhere.

4.2.6 Prime or Unique Agricultural Lands

While the PAI Preferred Alternative Site #3 is within a shoreline environment identified as Rural Agriculture on the Colville Confederated Tribes Shoreline Designation Map, site soils do not have an agricultural classification in the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) system (February 9, 2011). The Pogue stony loam, 0 to 25% slopes soil type mapped over the entire site is described as suitable for irrigated orchards, irrigated hay and pasture, livestock grazing, and wildlife habitat. There is no irrigation present on the site or adjacent properties within the 0.5-mile radius action area. The CCT Rural Agriculture shoreline environment designation may indicate suitability for grazing by free-range cattle. The site has not been cultivated for agricultural crops and is not suitable for cultivation due to the very deep, excessively drained nature of the soil type; the absence of irrigation; and its small size (2.87 acres).

4.2.7 Terrestrial Floral Communities

The vegetation zone in which the project area is located is the central arid steppe, which is the driest part of the Columbia Basin (Johnson and Cassidy 1997). This vegetation zone is consistent throughout existing PAI Site #1 and the four alternative sites evaluated for proposed Site #3. In areas where the native vegetation is undisturbed, big sagebrush (*Artemisia tridentata*) and bluebunch wheatgrass (*Agropyron spicatum*) is dominant (see Figure 4.2-1). Other grasses, including needle grasses (*Stipa* sp.) and bottlebrush squirreltail (*Sitanion hystrix*) may also be present (Daubenmire 1988).

Figure 4.2-1. Central arid steppe vegetation typical of upland parcels adjacent to Rufus Woods Lake steelhead trout net pen aquaculture sites.

4.2.8 Terrestrial Faunal Communities

A variety of animal species inhabit the Columbia River corridor/Rufus Woods subbasin. A representative list of reptiles, amphibians, birds, rodents, bats, carnivores, ungulates, fish and shellfish native to Northeastern Washington is provided in Table 1 of the *Cultural Resources Inventory* prepared for the upland parcel adjacent to PAI Preferred Alternative Site #3 (CCT History/Archaeology Program, February 1, 2011). More detailed species lists were compiled for this *NEPA Environmental Assessment* from prior studies conducted in the area between 1977 and 2010. These lists are reproduced in Appendix A. The representative lists do not confirm sightings of all of these species on PAI existing Site #1 (where net pen assembly is proposed), or on the upland support parcel at the location of PAI Preferred Alternative Site #3. Observations of bear scat and coyote scat were common during 2010 site inspections at PAI existing Site #1 and Preferred Alternative Site #3. Both species forage along the shoreline for a variety of prey and food sources, including evidence that they feed on crayfish.

Several of the most mobile species (e.g., birds) may visit PAI existing Site #1 and alternative sites for the #3 net pen operation during foraging activities. Due to the small size of the upland parcel at PAI Preferred Alternative Site #3 (2.87 acres), it is unlikely that many of these species breed, nest, or permanently inhabit the proposed project site. The portion of PAI existing Site #1 that would be used during construction and harvest activities related to proposed Site #3 is already disturbed in the areas where net pen assembly and harvest activities would occur.

Washington Department of Fish & Wildlife (WDFW) Priority Habitats and Species (PHS) database search results for the proposed action area and vicinity were reviewed in mid-December 2010 (WDFW 2010). Terrestrial environment priority habitats and species in the area, all of which are unlikely to be significantly adversely affected by the proposed project, include: waterfowl concentrations in the river/reservoir; two golden eagle (*Aquila chrysaetos*) nests located 0.7 mile and 1.3 miles from PAI Preferred Alternative Site #3 (the latter may be within line-of-sight of the proposed net pens); two bald eagle (*Haliaeetus leucocephalus*) nests located 1.4 miles and 1.9 miles downstream from Preferred Alternative Site #3 (the former is surrounded by an 800-foot shoreline nest buffer); regular use habitats for mule deer (*Odocoileus hemionus hemionus*) and chukar partridge (*Alectoris chukar*) on lands south of the river; and some sage grouse (*Centrocercus urophasianus*) regular use habitats on the south side of the river more than 2 miles from PAI Preferred Alternative Site #3.

The two bald eagle nest trees identified in the WDFW PHS database search are closest to the High Bank Bight alternative site (approximately 0.4 mile to one nest tree, and 1.0 mile to the other). The more distant bald eagle nest tree from the High Bank Bight site is the one surrounded by an 800-ft radius plus shoreline nest buffer. The High Bank Bight site is approximately 0.3 mile (approximately 1,600 feet) downstream from the nearest edge of this nest tree buffer.

Game birds and protected predators such as bald eagle and peregrine falcon are managed by the Tribal Fish and Wildlife Department (Confederated Tribes of the Colville Reservation website, accessed March 2, 2011).

4.2.9 Threatened, Endangered and Protected Terrestrial Species

The Washington Natural Heritage Information System for the List of Known Occurrences of Rare Plants in Okanogan County, Washington, was queried in November 2010. Of the 65 plants listed, 15 were classified as State threatened or endangered. Habitat conditions (high elevations or moist soils) required by these plants are not present at PAI existing Site #1 or at any of the four alternative sites evaluated for

proposed Site #3. No State- or Federally-listed plant species occur within or near the action area of the proposed project.

Federally-listed endangered and threatened species and critical habitat; candidate species for Federal listing under the Endangered Species Act; and species of concern on the U.S. Fish and Wildlife Service (USFWS), Okanogan County list as of December 12, 2010 include:

Federally-Listed Species − Threatened:

Canada lynx (*Lynx canadensis*)
Grizzly bear (*Ursus arctos horribilis*)
Northern spotted owl (*Strix occidentalis caurina*)
Bull trout (*Salvelinus confluentus*) – Columbia River Distinct Population Segment (DPS)[3]
Ute ladies'-tresses (*Spiranthes diluvialis*)

Federal Candidate Species:

Greater sage-grouse (*Centro circus urophasianus*) Columbia Basin DPS
Louie's western pocket gopher (*Thomomys mazama louiei)*
Tacoma western pocket gopher (*Thomomys mazama tacomensis)*
Umtanum Desert buckwheat (*Eriogonum codium*)
White Bluffs bladderpod (*Physaria douglasii tuplashensis*)

According to the USFWS Central Washington Field Office (Gregg Kurz, personal communication, December 14, 2010), habitats for Federally-listed animal species are not present within the action area of the proposed project, and none are known to nest or breed at or near the PAI Preferred Alternative for Site #3. Ute ladies'-tresses are found only in wet meadow zones − conditions that are not present on the upland parcel proposed for support service improvements at the PAI Preferred Alternative for Site #3. Other alternative sites considered would not include upland parcel improvements; therefore, databases were not queried for the possible presence of threatened, endangered or protected species at these locations.

Eagles have Federal protection under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The bald eagle will continue to be protected by these Acts even though it has been delisted under the Endangered Species Act. The species is also protected under the Lacy Act. The proximity of known bald and golden eagle nests to PAI Preferred Alternative Site #3 and to alternative locations considered for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is described in *NEPA Environmental Assessment* Section 4.2.8, above.

Several other migratory bird species that may occur in the area, such as American crow (*Corvus brachyrhynchos),* sage sparrow (*Amphispiza belli*), sage thrasher (*Oreoscoptes montanus*), sandhill crane (*Grus Canadensis),* merlin (*Falco columbarius*), mourning dove (*Zenaida macroura),* red-winged blackbird (*Agelaius phoeniceus),* common loon (*Gavia immer),* Vaux's swift (*Chaetura vauxi*), and most duck species, are also protected under the Migratory Bird Treaty Act.

[3] Bull trout are discussed in the Aquatic Environment section above, (see Section 4.1.4.6).

4.3 HUMAN ENVIRONMENT

4.3.1 Confederated Tribes of the Colville Reservation

The source of information used to describe the Colville Indian Reservation is the Confederated Tribes of the Colville Reservation website (accessed March 2, 2011).

The action area of the proposed project is located within the boundaries of lands traditionally occupied by the Salish-speaking Nespelem and Okanogan people (CCT History/Archaeology, February 1, 2011). Prior to the influx of people of European descent in the mid-1850s, the ancestors of 12 aboriginal tribes were nomadic, following the seasons of nature and their sources of food. Their aboriginal territories were grouped primarily around waterways such as the Columbia River, San Poil River, Okanogan River, Snake River and Wallowa River. The Tribes, commonly known by English and French names, include the Colville, Nespelem, San Poil, Lake, Palus, Wenatchi, Chelan, Entiat, Methow, southern Okanogan, Moses Columbia, and the Nez Perce of Chief Joseph's Band.

The Tribal ancestors were not known to maintain farming communities. Many of them traveled throughout their aboriginal territories and other areas in the Northwest (including Canada) gathering with other native peoples for traditional activities such as food harvesting, feasting, trading, and celebrations that included sports and gambling. Their lives were tied to the cycles of nature both spiritually and traditionally.

The Colville Indian Reservation was established by Presidential Executive Order on April 9, 1872, and was originally twice as large as it is today. The Reservation land base now covers 1.4 million acres (2,187 square miles) in North Central Washington, primarily in Okanogan and Ferry Counties. The Reservation consists of Tribally-owned lands held in Federal Trust status for the Confederated Tribes; land owned by individual Colville Tribal members, most of which is held in Federal Trust status; and land owned by others as fee property, taxable by Counties. Colville Reservation lands are diverse with natural resources that include standing timber, streams, rivers, lakes, minerals, varied terrain, native plants and wildlife.

The Confederated Tribes of the Colville Reservation is a Sovereign Nation, and a Federally-recognized American Indian Tribe.

4.3.2 Areas of Recognized Archaeological or Historic Value

The area of potential effect for archaeological and historic resources is located within Rufus Woods Lake Archaeological District 45DT10 on the Colville Indian Reservation. Several (94) archaeological sites have been previously recorded within one mile the parcel proposed for upland support services at PAI Preferred Alternative Site #3. For this reason, the Colville Confederated Tribes (CCT) History/ Archaeology Program conducted a *Cultural Resources Inventory* (February 1, 2011) to assist with planning the location of feed silos and an access road to this site. The purpose of the study was to document the presence or absence of potentially significant cultural resources within the area of potential effect. The study consisted of background research, a traditional cultural property study, and an archaeological investigation that included a pedestrian survey and excavation of nine shovel probes on the upland site.

Background research for this project included a review of various databases, maps and literature on file at the CCT History/Archaeology Program. In addition, the Washington State Department of Archaeology and Historic Preservation files were examined for previously recorded archaeological sites within or nearby the proposed project area, as well as previous surveys and identification efforts. The background

research did not reveal any previously recorded archaeological sites within the area of potential effect, and field investigation performed in January 2011 found no new archaeological sites on the Preferred Alternative Site #3 property.

The CCT History/Archaeology Program also conducted a preliminary search of available databases, maps and literature on file to determine whether there are any known archaeological sites at the alternative fish farm locations considered for Site #3: High Bank Bight (RM 573.9), Mah-Kin Rapids (RM 572.4), or Narrows Downstream (RM 571.9). According to the GIS database on file at the CCT History/ Archaeology Program, there are no known allotments or Traditional Cultural Properties (TCPs) near these alternative fish farm locations. Documentation provided for this *NEPA Environmental Assessment* notes that this preliminary review of the alternative fish farm sites does not substitute for a comprehensive cultural resources review as required by Section 106 of the National Historic Preservation Act (NHPA) nor under Colville Tribal Code Chapter 4-4-7 (CCT History/ Archaeology Program, February 23, 2011).

As discussed in Section 5.3.2 of this *NEPA Environmental Assessment*, EPA has determined that authorization of aquaculture discharges into Rufus Woods Lake under the NPDES permitting program (at PAI Preferred Site #3 or any of the alternative locations) is not an undertaking that has the potential to cause effects to historic properties or cultural resources. EPA has no jurisdiction over construction or siting of the proposed project (net pens or upland facilities), which are the primary means by which historic properties or cultural resources could be impacted. Therefore, pursuant to 36 CFR 800.3(a)(1), EPA has no further obligations under Section 106 of the National Historic Preservation Act. Rather, Federal and/or Tribal agencies with direct jurisdiction and permitting authority over siting and construction of the proposed facility will need to work with the applicant to ensure that historic properties and cultural resources are protected in accordance with applicable State and Federal law.

4.3.3 Socioeconomic Issues

Socioeconomic issues relate to social and economic impacts that could result from the proposed project, either beneficial or adverse. The proposed action and alternative sites are located within the boundaries of the Confederated Tribes of the Colville Reservation (described above in *NEPA Environmental Assessment* Section 4.3.1). For this reason, the socioeconomic analysis describes population, housing, and employment characteristics on the Reservation.

4.3.3.1 Population

At the time of this writing, there are approximately 9,365 descendents of 12 aboriginal Tribes of Indians enrolled in the Confederated Tribes of the Colville Reservation. The Reservation is occupied by more than 5,000 residents, both Colville Tribal members and their families and non-Colville members, living either in small communities or rural settings. Approximately 50% of the membership of the Confederated Tribes lives on or adjacent to the Reservation (Confederated Tribes of the Colville Reservation website, accessed March 2, 2011).

There is no resident population on PAI existing Site #1 or any of the alternative locations considered for steelhead net pen aquaculture Site #3.

4.3.3.2 Housing

Colville Indian Reservation communities lack adequate, affordable housing, home water systems, and even electricity (Confederated Tribes of the Colville Reservation website, accessed March 2, 2011).

There are no existing dwelling units on PAI existing Site #1 or any of the alternative locations considered for steelhead trout net pen aquaculture Site #3.

4.3.3.3 Employment

The source of information used to describe employment on the Colville Indian Reservation is the Confederated Tribes of the Colville Reservation website (accessed March 2, 2011).

The Confederated Tribes and the Colville Indian Reservation are governed by the Colville Business Council. From its administrative headquarters located at the Bureau of Indian Affairs (BIA) Agency at Nespelem, Washington, the Colville Business Council oversees a diverse, multi-million dollar administration that employs from 800 to 1,200 individuals in part-time and seasonal positions.

The Colville Confederated Tribes (CCT) operates on a yearly budget for which sources of revenue include the sale of the Tribe's timber products and Federal, State, and private contributions. The Confederated Tribes adheres to Colville Tribal Member Preference. Both Colville Tribal members and non-Colville members are employed throughout CCT's extensive governmental operation that provides a variety of services for Colville Tribal members living on the Reservation and elsewhere, and for management of Reservation natural resources.

The Confederated Tribes have also chartered the Colville Tribal Enterprise Corporation (CTEC). CTEC oversees several enterprise divisions including a gaming division and three casinos. The Corporation employs several hundred permanent and part-time employees. The work force is comprised primarily of Colville Tribal members and non-Tribal members from the communities in which the enterprises are located.

Numerous chronic situations affect the daily lives of Colville Tribal members, including high unemployment on the Colville Indian Reservation and lack of employment opportunities for much of the available work force. In many instances, Colville Indian families are living below national poverty standards and depend on the Confederated Tribes and other welfare systems to survive.

Pacific Aquaculture, Inc. presently employs Tribal members in the majority of 15 employment positions to operate their Rufus Woods Lake fish farming operation at existing Sites #1 and #2.

4.3.4 Environmental Justice

Environmental justice refers to legal requirements to provide all peoples specific opportunities related to government programs and activities related to human health or the environment. Specifically, the Environmental Justice Act was enacted to establish and protect the rights of specific populations of people, including minority and low-income populations located with the area of potential effect. Opportunities protected by the Environmental Justice Act include:

- To comment on the project prior to decisions being rendered
- To share the benefits of the project
- To not be excluded from the project
- To not be disproportionately or adversely affected by the project.

Pacific Aquaculture, Inc. (PAI), proponent of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture proposal, has two existing fish farm operations on Rufus Woods Lake. In the process of acquiring and upgrading an existing fish farming operation on the lake in 2008, PAI established an

excellent working relationship with the Colville Confederated Tribes. Elements of PAI's Tribal partnership with CCT include:

- Employ Tribal members in the majority of employment positions to operate PAI existing Sites #1 and #2
- Give preference to Tribal members for new employment positions
- Give preference to Tribal-certified contractors
- Use Tribal member truck drivers to haul fish feed
- Pay a royalty fee to the Tribe ($0.005/lb up to $20,000/year; approximately $18,000 in 2010).
- Provide fish as requested for Tribal elders, the CCT food bank, and for special functions
- Operate a net pen at PAI existing Site #2 to grow native redband trout for the Tribe to release in Rufus Woods Lake
- Grow 6 to 8-pound trout for CCT to release in the lake for a recreational fishery
- Monitor Rufus Woods Lake water quality parameters and provide these data to the CCT Office of Environmental Trust.

In the early stages of planning for a third steelhead trout net pen operation, PAI met with the Colville Confederated Tribes Office of Environmental Trust and Planning Department to inform them of the project and alternative sites being considered. The Tribe was asked if they wanted to serve as the NEPA Lead Agency for preparation of this *NEPA Environmental Assessment*. CCT deferred to the U.S. Environmental Protection Agency (EPA) to serve as the NEPA Lead Agency associated with EPA's permitting authority for the project under the National Pollutant Discharge Elimination System (NPDES). EPA has an established protocol for coordinating the NEPA process with Tribes and Federal partner agencies (other Federal agencies from which permits and/or approvals are required for the proposed action). EPA will invite CCT Tribal leadership to participate in government-to-government consultation regarding the proposed action. EPA will share the draft *NEPA Environmental Assessment* (EA) and draft NPDES permit with the Tribe, hold consultation and informational meetings as necessary, and conduct other activities as agreed to with the Tribe to receive their input to environmental review and permits to be issued for the project. These consultation activities will be documented in the NEPA EA.

In addition to the role of the Colville Confederated Tribes in the environmental review process, the Tribe will also require permits of its own for the Site #3 proposed steelhead trout net pen operation. These Tribal permits will include a Shoreline Permit, a Development Permit, and a Pollution Discharge Permit (the Tribe's water quality permit comparable to the NPDES Waste Discharge Permit required from the U.S. Environmental Protection Agency).

4.3.5 Transportation

Access to PAI existing Site #1 and any of the alternative sites evaluated for Rufus Woods Lake steelhead trout net pen aquaculture Site #3 is from Columbia River Road (BIA Road 10). Columbia River Road is a southeasterly loop from SR 155, originating in the City of Omak, passing by Omak Lake, and terminating at the east end at the Colville Indian Agency near Nespelem. Columbia River Road is two lanes wide with a gravel matt surface. The roadway has little or no shoulder in some areas due to steep topography. The intersection in Omak is signalized; the intersection at the east end near Nespelem is STOP-controlled. There is no other traffic control along this route.

There are no known traffic count data for Columbia River Road. It was noted during observations made by NEPA EA preparers in November 2010 and February 2011 site inspections noted that approximately 10 cars per hour travel on Columbia River Road during weekday daylight hours. This number drops to

approximately 1 car per 30 minutes during evening hours (until approximately 10:00 PM), after which the volume drops to approximately 1 car per hour.

4.3.6 Noise

Sources of noise within the proposed action area include vehicles traveling on Columbia River Road, vessels operating on Rufus Woods Lake, and the pneumatic feed delivery system at PAI existing Site #1. Both vehicle and vessel activity in the area are low. The feed delivery system is housed inside the operations trailer (a metal container), which has a noise-reduction effect. Fish are fed during daylight hours, two to three times per day per cage. The feeding system generally runs 6 hours per day, and may run 8 hours per day at peak times. PAI has received no complaints concerning noise generated by their existing Site #1, as it is in a remote location with no homes or other sensitive receivers nearby (personal communication with John Bielka, PAI General Manager, March 14, 2011).

Sources of vehicle and vessel noise at alternative sites considered for Rufus Woods Lake steelhead trout net pen aquaculture Site #3 are the same as those identified above for PAI existing Site #1.

4.3.7 Light and Glare

Sources of light and glare within the project action area include vehicle headlights and windshields associated with low-volume traffic on Columbia River Road, and reflection off the surface of the river/reservoir. At PAI existing Site #1 where Site #3 net pen assembly is proposed, existing sources of light and glare include yard lights and security lights around the existing office and feed silos, and reflection off the feed silos on sunny days. Yellow flashing lights are installed on the existing floating net pen structure at PAI Site #1 as private aids to navigation. Opposite the High Bank Bight site (on the left bank of the river/reservoir at approximately river mile 574), there are nighttime lights associated with a pump house facility and small buildings set further back from the bank.

4.3.8 Areas of Recognized Scenic Value

The Colville Confederated Tribes Planning Department was consulted to identify areas of recognized scenic value within the proposed action area of PAI existing Site #1 or alternative locations being considered for Site #3. None were reported (personal communication with Connie Davisson, CCT Planning Department, February 17, 2011).

Figures 4.3-1 through 4.3-4 show views of and from each of the four alternative sites considered for Rufus Woods steelhead trout net pen aquaculture Site #3. Views from the Narrows Downstream Site at river mile 571.9 are territorial, showing rangelands and low, flat mountains (Figure 4.3-1). The river is very close to Columbia River Road at this location. There are high-tension power lines in the viewshed downstream from the Narrows site. Views in the vicinity of the Mah-Kin Rapids site at river mile 572.4 are also territorial with rangelands and low, flat mountains (Figure 4.3-2). Views of the High Bank Bight site at river mile 573.9 show the long, high bluff along the shoreline (Figure 4.3-3). Views from Preferred Alternative Site #3 at river mile 576.4 show more abrupt mountains to the north, and narrower canyon sidewalls overall (Figure 4.3-4), similar to PAI existing Site #1.

Figure 4.3-1. View of and from the Narrows Downstream site.

Figure 4.3-2. View of and from the Mah-Kin Rapids site.

Figure 4.3-3. View of and from the High Bank Bight site.

Figure 4.3-4. View of and from PAI Preferred Alternative Site #3.

4.3.9 Areas of Recognized Recreational Value

The Colville Confederated Tribes Parks & Recreation Department was consulted to identify areas of recognized recreational value within the proposed action area of PAI existing Site #1 or alternative locations being considered for Site #3. There is a 20-acre informal campground adjacent to PAI existing Site #1 (see Figure 4.3-5). An unimproved loop road provides access from Columbia River Road to the Rufus Woods Lake backshore area. There is a barbecue grill, picnic table, and an outhouse. The hand-dug outhouse was scheduled to be replaced with a fixed structure in July 2011. This designated campsite is open year-around and is heavily used on a seasonal basis. The CCT Parks & Recreation Department owns the campground on land held in trust by the Bureau of Indian Affairs. The Parks & Recreation Department maintains the campground and charges user fees for day use and overnight stays at this location. Six campsites accommodate a total of approximately 500 to 600 tents, campers and trailers. Thalheimer Boat Launch provides the nearest water access for trailered boats, approximately 2 miles upstream from the campground adjacent to PAI existing Site #1 (personal communication with Linda Palmer, CCT Parks & Recreation Department, April 11, 2011).

There are major boat launch points at the U.S. Army Corps of Engineers launch and the State Park near Chief Joseph Dam, and at Seaton's Grove upstream near Grand Coulee. There are other small launches along the lake, including one between PAI existing Site #1 and Site #2 on the right bank near Nespelem. Much of the trout fishing that occurs in the middle reaches of the Rufus Woods Lake/reservoir occurs near the PAI and Chief Joseph Orchards net pens.

4.3.10 Public Lands

Lands on the north side of the Rufus Woods Lake/Reservoir where existing PAI steelhead trout net pen sites are located, and where alternative locations for Site #3 are being considered, are entirely within the boundaries of the Confederated Tribes of the Colville Reservation, and as such are not public lands. The Reservation boundary extends to the center of the lake/reservoir in this area. Lands on the south side of the river and extending to the middle of the channel are within Douglas County. Public/private ownership of lands in the remote area of Douglas County along the left bank of the river/reservoir between river miles 572 and 579 was not investigated.

4.3.11 Public Services

The nearest public services to PAI existing Site #1 and alternative sites being considered for steelhead trout net pen aquaculture Site #3 are based in Nespelem, approximately 10 miles from PAI existing Site #1, and approximately 17 miles from the most westerly of the alternative sites. These services are all provided by the Colville Confederated Tribe and include a fire station, police, schools, and a clinic. The nearest hospital is located in the City of Coulee Dam, approximately 25 miles from PAI existing Site #1 and approximately 28 miles from PAI Preferred Alternative Site #3.

4.3.12 Utilities

Utilities available along Columbia River Road include Nespelem Valley Electric, and Colville Confederated Tribes (CCT) Disposal (garbage collection services). PAI existing Site #1 is served by these utilities. Site #1 has a well for domestic water supply, and an on-site sewage disposal system to serve the office restroom. Stormwater management complies with Tribal Code and building permit requirements. Telephone service is cellular.

Electrical service and garbage collection service is available to any of the alternative locations being considered for steelhead trout net pen aquaculture Site #3, though an upland support site is only contemplated at Preferred Alternative Site #3.

Note: Aerial photograph taken in 2008 or earlier, before PAI purchased and replaced an existing net pen aquaculture project owned and operated by others.

Figure 4.3-5. CCT designated camping area adjacent to PAI existing Site #1.

5.0 ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES FOR THE PREFERRED ALTERNATIVE

5.1 AQUATIC ENVIRONMENT

Construction Phase

PAI Existing Site #1. There would be no significant environmental consequences to the PAI existing Site #1 aquatic environment as a result of the proposal to assemble Site #3 net pens in the upland area of Site #1, or to conduct harvest activities for Site #3 fish at Site #1. The net pens are built at a remote, commercial facility and merely assembled with connecting bolts and hinge pins fairly rapidly, then placed in the water to be floated into position for anchoring. Therefore, aquatic environment effects at Site #1 are not discussed in this section.

Preferred Site #3 or Alternative Locations. The aquatic environment action area during construction will encompass the PAI Preferred Alternative Site #3 location where the proposed net pen structure and floating dock would be anchored in-place.

No Action Alternative. Under the No Action Alternative, there would be no construction activity and thus no environmental consequences related to construction/installation of an additional steelhead trout net pen aquaculture facility on Rufus Woods Lake.

Operational Phase

In the operational condition of the project, the aquatic environment action area will vary by category of action. Fish culture activities will be restricted to the net pens themselves and the area between the net pens and the immediately adjacent dock and contiguous upland support property. Aquatic environmental effects will occur in the form of some degree of temporary deposition of organic wastes under the pens and downstream for a distance of about 200 feet, judging from what occurs at PAI existing Site #1 net pens during the low river flow season, previously discussed in *NEPA Environmental Assessment* Chapter 4. During the high flow season of late spring and early summer, this area of effect will be reduced significantly by resuspension and transport of particulate wastes over downstream areas. The goal is not dilution of wastes alone, but rather aerobic (with oxygen) assimilation of the organic wastes into the food web of Rufus Woods Lake. A beneficial food web effect will also occur downstream of the pens, with an effect upon benthic invertebrates and demersal fishes. This has been observed at PAI existing Site #1 through the results of stable isotope tracing studies conducted by Rensel (2010), where the extent of effect varied by species from a few hundred feet to one mile or more.

With all aquaculture activities, the issue of carrying capacity of the water body is potentially an issue; to address that, this chapter summarizes upstream and downstream water quality conditions in the middle and lower Columbia River and presents current estimates of the flux of nitrogen and phosphorus from the existing and proposed PAI net pen aquaculture sites. The entire flora and fauna of the Columbia River in Washington State (and much of British Columbia) has been highly perturbed by construction and operation of hydroelectric and water storage project reservoirs that resulted in impoverishment of nutrient concentrations and flux through the system. The proposed Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project will add nutrients to the system, but not replace them to historical levels that occurred before reservoir construction. Studies performed by Richards, Rensel and Siegrist (2011) during the anomalous river discharge and nutrient flux year of 2011 indicated that the river system is capable of returning to previous nutrient flux levels for some period of time (in this case, part of 2010 and spring and

summer of 2011), but this is anticipated to be the exception rather than the rule unless major climate change occurs on a rapid and repeated annual basis.

5.1.1 Bottom Characteristics

5.1.1.1 Bathymetry at the Site and in the Vicinity

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. There would be no measurable change in the lake/reservoir bottom bathymetry due to Site #3 construction or operation at any of the alternative locations considered. No permanent deposition will occur, as water currents exceed those measured at PAI existing Site #1. PAI Preferred Alternative Site #3 is considerably deeper than existing Site #1, providing a larger space beneath the cages to the river bottom.

No Action Alternative. There would be no bathymetry-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

PAI will conduct annual measurements of the location of the pens by a suitably accurate GPS and depth sounding system to document any significant changes in bathymetry.

5.1.1.2 Reservoir Bottom Substrate Classification

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. There should be no change in substrate classification due to construction or operation of the Rufus Woods Lake steelhead trout net pen aquaculture project at any of the alternative locations considered. Some fish fecal wastes will accumulate immediately underneath and downstream of the cages during low flow seasons; however, the deposition area will be reduced or eliminated during the peak flows of May and June that occur each year.

No Action Alternative. There would be no reservoir substrate effects in Rufus Woods Lake as a result of the No Action Alternative. Seasonal effects described above for Preferred Site #3 or alternative locations would not occur.

MITIGATION MEASURES

PAI will conduct routine monitoring of the river bottom (as currently practiced at existing PAI sites) by underwater camera to detect any change in substrate scouring or erosion.

5.1.1.3 Sediment Quality

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Sediment quality upstream and below the upstream portion of the PAI Preferred Alternative Site #3 will not be visually or measurably affected, in terms of waste feed or fish feces, by construction or operation of the Site #3 net pens, except very nearby the downstream end during part of the year. The same conclusions apply to the other alternative sites considered. Noticeable deposition may occur on the downstream end of the cages and extending seasonally about 200 feet

downstream, if the performance is similar to existing PAI Site #1. At Site #1 in 2009, this deposition zone was examined and found to be about one-inch thick at most, and composed of non-consolidated, fish fecal and amorphous materials that were populated with a variety of invertebrates and demersal fish. The waste materials were not black in color or smelling of sulfur (such as what sometimes happens at net pen sites in slower velocity sites in marine waters), suggesting that aeration of these wastes by the periodically strong currents was occurring. In part, the deposition was due to the prior farm operator's inability to remove dead fish from the cages, resulting in fish tissue as evidenced by the white color and other appearance of the wastes. Pacific Aquaculture, Inc. is a much larger company with the resources to correctly manage the cages and avoid similar such events (personal communications with John Bielka, PAI General Manager, 2011). Other alternative sites could have less near field sediment effects (Mah-Kin Rapids), similar effect (Downstream Narrows), or significantly more effect (High Bank Bight) based on water circulation data collected for these sites.

During the peak river flow season (May and June), high velocity currents result in resuspension of the temporary organic waste deposition near the pens and redistribution over a relatively limited distance downstream. Experiments and computer modeling with net pen wastes have shown that there is a threshold rate of flow that results in consolidated (cemented) wastes being resuspended and transported as labile particles across the bottom, in a process known as saltation; however, that rate is site-specific and not easily estimated. Particles skip across the bottom and break down in size but are large enough to be biologically available to macroinvertebrates such as snails, sculpins and crayfish. This is just one of many reasons that Weston (1986) and other leading scientists have concluded that the wastes from net pens are unlike untreated or treated municipal wastes and many forms of terrestrial, non-point source run off (see Parametrix et al. 1990 for more details). Estimates derived from recirculating or flow-through hatcheries are also not appropriate for net pen-produced solids due to less abrasion and turbulence in the latter (Reid et al. 2009). Fish feces of salmonids (including trout) sink much more slowly than waste fish feed, so their initial "touchdown" point is much further downstream than waste fish feed, by a factor of about 3 times. Cromey et al. (2002a), Cromey et al. (2002b), Chamberlain and Stucchi (2007), and Kiefer et al. (2008) provide more information on these processes and how they are measured and modeled.

Current meter records (Rensel and Siegrist 2011) indicate that PAI Preferred Alternative Site #3 experiences very strong peak current velocity that will additionally help resuspension and prevent large quantities of fish waste from settling on the bottom, but rather distribute it over broad areas where it can be assimilated by the food web (i.e., the organic matter sequestered with organic carbon respired or incorporated in biomass, nitrogen assimilated into the aquatic nitrogen cycle, and phosphorus acquired by plants and algae). Because of the high water current velocities throughout the middle reservoir reaches of Rufus Woods Lake, there is little risk of fish feces or waste feed accumulating in any location and becoming an anoxic or hypoxic zone. If the wastes were not labile and transported intact all the way to the Chief Joseph Dam pool (up to 31 miles downstream as measured from PAI Preferred Alternative Site #3 to the forebay), the wastes could accumulate over a broad area and contribute to sediment oxygen demand. Carbon and nitrogen stable isotope analysis of sediments indicated that enrichment of ^{13}C occurred to a distance of at least 1,300 feet downstream of the net pens at PAI existing Site #1; however, by one mile downstream there were no statistical differences compared to the upstream reference area. No enrichment of sediment ^{15}N was found downstream of the pens but rather a curious depletion of ^{15}N immediately downstream of the pens that was inexplicable but could be due to a higher biomass of macroinvertebrates and bacteria that are processing the wastes and having less N than C resulting in a shortage of the former. These data suggest that assimilation of the fish fecal and fish feed discharge are occurring within the cited distances and are not accumulating or being transmitted as unprocessed wastes long distances downstream. The study design was biased to sampling exactly within the expected trajectory of dissolved and solid waste matter from the pens, and as there is little horizontal mixing within such distances, the results overstate the probable effects of the net pens considerably, resulting in a highly conservative estimate.

No Action Alternative. There would be no sediment-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Optimum siting is the principal measure used to avoid potential adverse consequences to sediments by any fish culture project involving net pens. However, PAI will conduct a number of practices to ensure that overloading of sediments that could result in anaerobic conditions will not occur. Field and modeling studies in British Columbia (Chamberlain and Stucchi 2007) have demonstrated that loss of fish feed to the bottom is much more detrimental than waste fish feces because it is much richer in oxygen demanding nutrients such as organic carbon and nitrogen. As fish feed is the most expensive component of any net pen fish farm operation, there is also a strong economic incentive to reduce fish feed losses to very low levels. To this end, the proposed PAI net pen operation at Site #3 will use in-pen underwater cameras monitored by an experienced technician to control the feed delivery system for the most efficient consumption. Such a system is already used at PAI existing net pen Sites #1 and #2 on Rufus Woods Lake. The general rate of fish feed presentation is based on sophisticated software programs that take into account the water temperature, fish size, fish species and other factors; however, the final decision to continue or cease feeding on a daily basis will be made through the use of underwater cameras in each cage. Feeding does not occur in all cages at the same time, so the camera operator, who sits comfortably in a climate-controlled observation room, has the ability to watch individual cages closely.

In addition to measures described above to prevent excessive deposition, PAI will comply with the pollution prevention plans stated in the company's Best Management Practices Policy (PAI 2010), as follows:

- Use properly-sized, highly digestible feeds with a minimum of fines. Purchase fish feed from manufacturers who use milling processes that minimize crumbling and dust.
- Use feeding equipment that minimizes the occurrence of feed breakage.
- Use an experienced technician to oversee the fish feeding process. The technician's main duty will be to supervise the feeding process, maximize the utilization of the fish feed, and to reduce the chance of wasting feed. During periods of reduced water quality or excessive currents, the feeding process will be modified with respect to the anticipated reduction of feed consumption by the fish.
- Use surface observation, underwater cameras and/or other feed monitoring devices when needed to help facilitate observation of the feeding process and possible feed.
- Use underwater video on a regular basis to check for accumulations of feces or waste feed beneath or adjacent to the cages.
- Record feed quantities per pen, per day, and closely monitor the Feed Conversion Rates (FCR) for signs of over- as well as under-feeding and as an indication of possible undetected fish loss from escapes through holes in the netting or otherwise.
- Net washing *in situ* will not be practiced and is not required as biofouling by invertebrates has never been a problem in Rufus Woods Lake and algal fouling is limited to minimal growths of benthic diatoms that slough off naturally in the currents. Antifoulants are therefore never used, thus entirely avoiding the discharge of potential contaminants such as copper.

- Collect fish mortalities that occur in the cages on a regular basis. Dispose of mortalities through on-shore rendering, ensilage or compositing without leaching back into Rufus Woods Lake during any part of the process.[1]

5.1.2 Water Column

Consideration of water column consequences of the proposed action is considered here by segmenting the discussion into effects of dissolved and particulate wastes separately or combined, if appropriate, and other pertinent topics beginning with physical circulation of water. Overall, no significant effect on water quality is probable as a result of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at the preferred location, as explained by consideration of each topic or parameter below.

5.1.2.1 Physical Circulation

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Depending on net mesh size, water flow is partially shunted around and under net pens. One study in Japan showed that about 15% of ambient water flow is deflected by the first set of upstream cages and that each cage downstream has sequentially less water transport (Inoue 1972). Areas that do not allow for extensive clearance below the bottom of the cages can experience accelerated flows toward the sediment-water interface. In the case of PAI Preferred Alternative Site #3, no observable effect is expected as the river bottom is already composed of coarse sands and heavily ballasted with cobble throughout the entire action area. Accordingly, operation of the net pens project at this location should have no significant effect on Rufus Woods Lake circulation. The possibility of slightly accelerated water flow velocity on the downstream end of the proposed net pens where it is slightly shallower than the upstream end is not considered a significant effect. If one of the alternative locations were selected for Site #3, no difference would occur except for the High Bank Bight site where current direction is variable and velocity is slow at times. A net pen aquaculture project at that location could create diversion of flow toward or away from the nearby shoreline, depending on orientation and alignment of the pens.

No Action Alternative. There would be no physical circulation effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Mitigation measures described in *NEPA Environmental Assessment* Section 5.1.1.1, above, would also be effective at minimizing adverse consequences to physical circulation.

[1] Mortalities from PAI existing Sites #1 and #2 are presently delivered to a fertilizer plant in eastern Washington.

5.1.2.2 Water Quality

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Consideration of potential water quality effects is best addressed by segmenting the discussion into effects of dissolved and particulate wastes separately or combined, if appropriate.[2] Overall, no significant adverse environmental consequences to water quality are probable from construction and operation of the proposed steelhead trout net pen aquaculture project at PAI Preferred Alternative Site #3 as explained by consideration of each parameter below. This analysis applies equally to PAI Preferred Alternative Site #3 and other alternative locations considered.

No Action Alternative. There would be no measurable water quality effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

PAI has applied to EPA for a wastewater discharge permit under the regulations of the National Pollutant Discharge Elimination System (NPDES), established by Section 402 of the Clean Water Act. CCT proposes to amend PAI's existing Pollution Discharge Permit No. 4-8-9/2009-1 under Tribal Code of Laws Chapter 4, Title 4-8, Water Quality Standards, to address the addition of Site #3 (personal communication with Todd Thorne, Watershed Program Manager, CCT Office of Environmental Trust, April 1, 2011). PAI will comply with the conditions of these permits, the purpose for which will be to avoid potential adverse environmental consequences to Rufus Woods Lake water quality in the operational condition of the project.

PAI has applied for a Tribal Hydraulic Project Permit under CCT Tribal Code of Laws Chapter 4, Title 4-9, and will comply with the conditions of this permit during construction (see *NEPA Environmental Assessment* Section 5.1.2.6, below).

5.1.2.3 Macronutrients

ENVIRONMENTAL CONSEQUENCES

Phosphorus

Preferred Site #3 or Alternative Locations. Fish feed has a relatively low content of phosphorus (P). This element makes up about 1% dry weight of many modern trout feed formulas. Some of this is not bioavailable and is egested by the fish via fish feces in particulate form, and to a lesser extent as soluble P in excretions (Brett and Zala 1975, Ackefors and Enell 1994, Reid 2007). There may be leaching of the particulate phosphorus to the water column and therefore into the plankton component of the food web.

As discussed in *NEPA Environmental Assessment* Chapter 4 (Section 4.1.2.3), after the closure of the Cominco, Ltd. fertilizer plant upstream in British Columbia in the 1990s, phosphorus loading of water entering Rufus Woods Lake declined 81.5% compared to the present concentrations cited herein. Decreased levels of phosphorus in the waters flowing into Rufus Woods Lake have led to demonstrably

[2] The CCT Class 1 water quality criteria include a fecal coliform standard that is not discussed in this section. Fecal coliform bacteria are produced in the intestines of warm-blooded animals and are a relative measure of sanitary quality. Fish farms do not directly affect ambient (existing) fecal coliform concentrations in a water body because fecal coliform bacteria are not produced in fish.

severe phosphorus limitation with very high nitrogen to phosphorus (N:P) ratios and resulting reduction of primary biological productivity (Rensel 1989, 1996, Chapter 4, Section 4.1.2.3 of this document).

An estimate of phosphorus discharge by each net pen fish farm in Rufus Woods Lake compared to background flux is presented below beginning with Table 5.1-1. This work is a modification of Rensel's (1989) analysis of fish feed components, phosphorus content and total phosphorus flux in Rufus Woods Lake due to fish farm production. Note that flux (concentration of P multiplied by the river discharge volume) is used here rather than concentration of P, as flux is a better measure of what is available to the food web downstream of the pens.

Tables 5.1-1 and 5.1-2 are from a spreadsheet model that calculates total phosphorus entering the fish via fish feed and produces estimates of subsequent phosphorus excretion in soluble form and egestion as particulate feces. Feed use is calculated by multiplying the fish production values by the expected food conversion ratio (abbreviated "FCR"), in this case a ratio of 1.2 feed to 1.0 flesh, a reasonably conservative average value for trout as discussed by Hardy et al. (2000) and a variety of other leading experts. Fish feed loss percentages are from industry-wide accepted values and a variety of literature including Reid (2007), but decreased (improved) by 0.5% to account for continual use of in-pen cameras in all cages that is an operational practice at PAI facilities, as well as for the usually very clear water of Rufus Wood Lake that allows the trout, which are visual feeding fish, to see the pellets before they are swept out of the cages by the currents. The percentage of phosphorus from fish feed that is retained in harvested fish, excreted via urine and via feces, is from Gatlin and Hardy (2002), Green et al. (2002), Peterson et al. (2005) and are configured following Rensel (1989). Estimates of existing and proposed total PAI fish production in Rufus Woods Lake were provided by John Bielka, PAI General Manager (personal communication 2011).

Based on the above and other literature and best professional judgment, 75% of waste feed and fish feces particulate phosphorus ends up buried or adsorbed onto particulate matter while the other 25% (a conservative estimate) leaches back into the water column. Adding the 25% of waste feed and feces phosphorus to all of the phosphorus excreted from fish via urine leads to an estimate of total annual production of soluble phosphorus from each fish farm site in Rufus Woods Lake. Some of the leach-back portion of phosphorus from sediment may be as orthophosphate; some will be as dissolved total phosphorus. These values are compared against estimates of total phosphorus flux below Grand Coulee Dam, as determined with data provided by the USGS (hourly river flow) and WDOE (monthly total P concentration over 7 recent years). The model provides an estimate of percent increase in soluble phosphorus above background concentrations for each fish farm site in Rufus Woods Lake. It also considers a worst-case analysis, in which phosphorus increase due to fish farms is compared to background phosphorus levels during the period of lowest monthly flux, the month of September when the fish farm-derived P would have the greatest net increase and potential biological effect on the Rufus Woods Lake aquatic food web. Although background phosphorus flux into Rufus Woods Lake from Lake Roosevelt greatly increased in 2011 (Richards, Rensel and Siegrist 2011), such increases serve to diminish the relative contribution of fish-farm-origin nutrients relative to the total nutrient flux. Nutrients are not the only factor that limit algal production, so attempts to draw linear correlations between algal abundance and nutrient flux are often not warranted.

Finally, the model directly compares annual Rufus Woods Lake phosphorus flux to the estimated maximum phosphorus increase due to the fish farms, giving a good representation of the relative contribution of phosphorus due to the fish farm sites in average river discharge years. The results of this analysis indicate that operation of PAI Preferred Alternative Site #3 (or any of the alternative locations individually) would result in an annual average increase of 1.7% over background total P flux through the lake. Combined with the three other existing farms (PAI Sites #1 and #2 and the Chief Joseph Orchards [CJO] farm; see Figure 3.2-1 in *NEPA Environmental Assessment* Chapter 3), the percent increase

compared rises to 3.6% as an annual average. During the low natural flux period of September only, the comparable values would be 2.6% and 5.6%.

Table 5.1-1. Summary of existing and proposed fish farm annual production in Rufus Woods Lake and factors used to calculate waste phosphorus production (see text for data sources).

Parameter	Value
Pacific Aquaculture (PAI) expected max. fish production, Site #1, lbs/yr	3,000,000
Pacific Aquaculture (PAI) expected max. fish production, Site #1, kg/yr	1,360,770
Pacific Aquaculture (PAI) expected max. fish production, Site #2, lbs/yr	3,000,000
Pacific Aquaculture (PAI) expected max. fish production, Site #2, kg/yr	1,360,770
Pacific Aquaculture (PAI) expected max. fish production, Site #3, lbs/yr	6,000,000
Pacific Aquaculture (PAI) expected max. fish production, Site #3, kg/yr	2,721,540
Chief Joseph Orchards (CJO) fish production (lbs/yr)	1,000,000
Chief Joseph Orchards fish production (kg/yr)	453,590
Food conversion ratio (biological FCR)	1.2
Fish feed loss (%)	2.5%
Yearly average GCD discharge 01Mar01-28Feb11 (KCFS)	93.44
Mean concentration of total P below GCD 07Oct03-14Sep09 (mg/L)	0.0056
Fish food average phosphorus content (%)	1.1%
Percent of P supplied in fish feed lost to the environment (%)	50%
Perecent of pellets uneaten (%)	2.5%
Perecent of pellets consumed (%)	97.5%
Percent of consumed P in feces (particulate portion in %)	34.2%
Percent of consumed P in excretion (dissolved portion in %)	15.8%
Percent of consumed P retained in fish carcass (%)	50.0%
Percent of particulate P to sediments and leached back into water (%)	25%

Using the parameters in Table 5.1-1, the next table (5.1-2) indicates expected feed use, loss rates, and the calculated volumes of phosphorus in the soluble form that would be available to macrophytes, phytoplankton or periphyton. Table 5.1-3 summarizes the available net pen phosphorus production estimates at each net pen site for annual low and high background phosphorus flux time periods. The remaining particulate total phosphorus would remain on the lake/reservoir bottom to be consumed by macroinvertebrates. Due to the lack of any significant deposition zone in the far field (i.e., from a few hundred meters to many kilometers downstream of the cages), no phosphorus is expected to be buried in soft sediments as would be the case in a typical lake situation.

Table 5.1-2. Summary of expected fish feed use, waste feed, and fate of feed-origin phosphorus in Rufus Woods Lake for existing net pen sites and PAI Site #3.

Expected Feed Use and Loss Rates	**PAI Site #1**	**PAI Site #2**	**PAI Site #3**	**CJO**
Annual feed use (lbs)	3,600,000	3,600,000	7,200,000	1,200,000
Feed (dry weight, lbs)	3,240,000	3,240,000	6,480,000	1,080,000
Feed (dry weight, kg)	1,469,632	1,469,632	2,939,263	489,877
Food loss (lbs/year)	90,000	90,000	180,000	30,000
Total Phosphorus Flux: The distribution of waste P from total annual fish production				
	PAI Site #1	**PAI Site #2**	**PAI Site #3**	**CJO**
P/yr fed (kg)	16,166	16,166	32,332	5,389
P/yr consumed (kg)	15,762	15,762	31,524	5,254
Waste feed P (kg)	404	404	808	135
Retention in fish of P (kg)	7,881	7,881	15,762	2,627
Feces P (kg)	5,397	5,397	10,794	1,799
Excretion P (kg)	2,484	2,484	4,968	828
Total production of soluble P (kg/year) *	3,934	3,934	7,869	1,311
Total production of soluble P (kg/day) *	10.8	10.8	21.6	3.6
Total soluble P per kg fish (kg) *	0.00289	0.00289	0.00289	0.00289
Total soluble P per kg fish (g) *	2.89	2.89	2.89	2.89
Total production of all P (kg/year)	8,285	8,285	16,570	2,762
Total production of all P (kg/day)	22.7	22.7	45.4	7.6
* Total soluble P = 25% of waste feed P + 25% of feces P + 100% of excretion P				

Table 5.1-3. Summary of soluble total P produced by each fish farm in Rufus Woods Lake and comparison to annual low P flux (September) and high P flux (May) months for water entering the lake at Grand Coulee Dam.

		Time Frame		
	Units of Measure	**Annual**	**September**	**May**
Reason for selection of time period		Annual average background P flux	Lowest background P flux	Highest background P flux
Monthly total P mean concentrations	mg/L	0.0056	0.0055	0.00725
Time period mean discharge past 10 years	Liters/min	158,755,308	105,875,076	190,685,950
Average total P background flux at GCD station	Kg P/min	0.89	0.58	1.38
Soluble total P flux from existing PAI Site #1	Kg P/min	0.0075	0.0075	0.0075
Soluble total P flux from existing PAI Site #2	Kg P/min	0.0075	0.0075	0.0075
Soluble total P flux from proposed PAI Site #3	Kg P/min	0.0150	0.0150	0.0150
Soluble total P flux from existing CJO Site	Kg P/min	0.0025	0.0025	0.0025
Increase total P flux from existing PAI Site #1	percent	0.84%	1.29%	0.54%
Increase total P flux from existing PAI Site #2	percent	0.84%	1.29%	0.54%
Increase total P flux from PAI proposed Site #3	percent	1.67%	2.58%	1.08%
Increase total P flux from existing CHO Site	percent	0.28%	0.43%	0.18%
Increase total P flux from all four farms	percent	**3.6%**	**5.6%**	**2.3%**

It is probable that particulate waste matter including phosphorus from the proposed Site #3 (or a net pen aquaculture project at any of the other alternative locations considered in this *NEPA Environmental Assessment*) would benefit the aquatic food web community by increasing the abundance of macroinvertebrates. Because the wastes are initially deposited and resuspended in relatively deep water, below the likely aquatic photosynthesis zone in the lake (Rensel 1989), the wastes are more available to the invertebrate populations than to macrophytes or periphyton (attached benthic algae) that are restricted to the very nearshore shallows. Inevitably, some of the wastes will be incorporated into macrophytes or periphyton, although studies of macrophytes downstream of PAI existing Site #1 did not indicate this to be measurable through stable isotope tracing methods in 1999 and 2000 (Rensel 2001). In part, this is due to the fact that lateral circulation and diffusivity of the water that passes through the cages is minimal as demonstrated through drift object (drogue) studies in Rufus Woods Lake (Rensel 2010, Rensel and Siegrist 2011).

Orthophosphate, the form of phosphorus that directly limits phytoplankton and benthic algal species in Rufus Woods Lake, is relatively low during the algal growing season. Orthophosphate levels, like total P, are much lower now than they were when the Cominco plant was still in operation. It is doubtful that any net increase of orthophosphate resulting from the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at any of the alternative locations considered would have a significant effect on orthophosphate levels, and if so, would only benefit the aquatic community of Rufus Woods Lake. Water and nutrient budgets performed by Rensel (1989) demonstrate this to be so. In addition, it is well known

that most P discharged by fish farms is in the particulate form and will therefore not strongly affect area (dissolved) orthophosphate levels (Enell and Lof 1983).

No Action Alternative. There would be no measurable phosphorus-related effects in Rufus Woods Lake as a result of the No Action Alternative.

Nitrogen

Preferred Site #3 or Alternative Locations. Monthly fluctuations of nitrite and nitrate concentrations, such as an annual decrease in mid-summer, are likely due to algal primary productivity upstream in Lake Roosevelt; monthly total N concentrations have a pattern similar to that of nitrite and nitrate. There has been no significant change of nitrite plus nitrate concentrations over the past 30 years, and no reason to expect that an additional net pen site will have any significant effect. Total N concentrations in the 1990s were significantly higher than average concentrations observed from 2000 to 2009.

Fast flushing rates of Rufus Woods Lake, high N:P ratios, declining summer ammonium+ammonia N concentrations, and no change in summer dissolved inorganic nitrogen (DIN) concentrations all point to an environment not sensitive to minor changes in N loading. Any changes in total nitrogen due to the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project (at any of the alternative locations considered) would likely not be detectable against background N concentrations at a distance of a few tens of meters downstream of the pens, similar to what is seen in marine net pens in Washington State (Parametrix et al. 1990).

Cumulatively, the evidence suggests that the normal flow condition nutrient status of the mid-Columbia River remains oligotrophic to low mesotrophic with or without the addition of a third PAI steelhead trout net pen aquaculture project in Rufus Woods Lake. For the sake of fisheries and the food web and even some wildlife such as aquatic birds, this is a desirable condition to maintain productivity in the system. Except for 2011 and possibly 2010, where river discharge was highly elevated compared to the prior decade, there have been few occurrences of blue green algae (cyanobacterial) blooms in Rufus Woods Lake in recent years that are often associated with excessive nutrient loading, vertical stratification of the water column, and hypolimnetic dissolved oxygen problems, although occasional blue green algae cells may be observable in water samples at times in any portion of the Columbia River. Blue green algal bloom problems are common in the lakes of the Okanogan River, a tributary to the Columbia River at Lake Pateros (Rensel 1998). Blue green algal cells once were common in the waters of Rufus Woods Lake (Moore 1991), but as discussed in *NEPA Environmental Assessment* Chapter 4 (Section 4.1.2.3), have not been seen in Rufus Woods Lake or subsequent downstream lakes of the mid-Columbia River in recent years except 2011 and possibly 2010. Despite these encouraging signs, the recent decline of river discharge at Grand Coulee Dam to Rufus Woods Lake is significant and may be expected to continue with warmer winters and springs that now occur in British Columbia (Zhang et al., 2000; B.C. Ministry of Environment, 2007). The result could be a concentrating of nutrients in less water resulting in a trend reversal from what has occurred over the past 20 years. These potential issues are discussed below in more detail in Section 5.5: Cumulative Effects, as these are basin-wide issues involving other practices such as irrigation withdrawal for agriculture and nutrient loading from tributary streams in the lower mid-Columbia River and lower Columbia River.

The relative effect of all existing and proposed fish farms in Rufus Woods Lake to potential water column eutrophication is put in perspective by noting that PAI Site #3 will produce about 22 kg per day of total phosphorus (Table 5.1-3 transformed to daily values). In comparison, when problems occurred in Lake Roosevelt, the system was being loaded with nearly 7,900 kg phosphorus every day. PAI Site #3 will produce 0.3% of that prior loading rate and the combined total of all farms will be 0.6% of the prior loading rate to upstream waters of Lake Roosevelt. Phosphorus waste reduction is considered a high

priority for any aquaculture operation using ambient water, and can be addressed through all of the measures previously addressed in Section 5.1.1.3, above.

No Action Alternative. There would be no measurable nitrogen-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Extensive progress has also been made by fish food producers to increase the bioavailability of phosphorus in their formulations, with hundreds of papers published on this topic in the past two decades. The trend has been to increase the use of plant proteins to replace fish meal and as that occurs, the level of less digestible phosphorus in the feed decreases. As waste fish feed is significantly richer in phosphorus per unit dry weight compared to fish feces, minimization of fish feed loss is a top priority to reduce nutrient loading and maintain a profitable operation. PAI Best Management Practices for minimizing feed loss are described in Section 5.1.1.3, above.

5.1.2.4 Total Ammonia Nitrogen

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Ammonia nitrogen and urea discharge from the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at any of the alternative locations considered would contribute to the nitrogen pool in Rufus Woods Lake and potential increases of aquatic plant and algal productivity. Rensel (1999) summarized nitrogen production from salmonid fish culture noting that fish feed nitrogen, mostly from protein, is about 7.1% by dry weight. Of the consumed feed, about 50% is retained as protein in the fish carcass, 38% is excreted as soluble nitrogen (ammonia and urea) and the remainder (13%) is associated with the feces. Thus, the bulk of the waste nitrogen is discharged into the water column as soluble and reactive forms of nitrogen.

As discussed in Chapter 4 (Section 4.1.2.3) of this document, the entire mid-Columbia River is by all measures considered depleted of nitrogen and more so of phosphorus due to upstream storage reservoir operations that act as nutrient sinks. In some cases in upstream Columbia River and tributaries, nutrients are purposely added to fertilize reservoirs as their ultra-oligotrophic status threatens keystone species such as unique strains of large-sized rainbow trout, bull trout and the kokanee that the larger rainbow trout prey upon. Reservoir fertilization was judged successful for Kootenay Lake, British Columbia − a Columbia River tributary reservoir (Ashley et al. 1999) and in Upper and Lower Arrow Lakes that are mainstem reservoirs (Schindler et al. 2007). Cumulatively, hundreds of tons of nitrogen and phosphorus were added annually to these lakes and in the latter example, N:P ratios of the additions ranged from 4:1 to 7:1, but sometimes subareas only required nitrogen. The literature is rich and complex on this topic, but lake fertilization has been judged successful for several Columbia River system lakes in British Columbia.

As discussed in Chapter 4 (Section 4.1.2.3), in recent years, the ammonia concentration entering Rufus Woods Lake as measured at the Ecology station near Grand Coulee Dam has not increased, and likely has decreased significantly. High concentrations of ammonia nitrogen are in some cases toxic to fish, depending on pH and temperature that controls the ionic species of the ammonia-ammonium complex. Prior measurements at the fish farms in Rufus Woods Lake discussed herein indicate that ammonia toxicity is unlikely in the pens, much less downstream of them.

No Action Alternative. There would be no measurable total ammonia nitrogen-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

As for phosphorus, prevention of waste feed loss into Rufus Woods Lake is one means to reduce nitrogen loading. Improvement in the quality and digestibility of the protein in the feed may also help increase the amount of nitrogen retained in the trout carcasses, reducing discharge. These measures are discussed above in Section 5.1.2.3. No other mitigation measures are necessary. High concentrations of ammonia are very unlikely at PAI Preferred Alternative Site #3 due to the strong currents. Should high concentrations of ammonia occur, the pen fish would exhibit signs of stress before any wild fish outside the cages were affected. This conclusion applies to any of the alternative sites considered in this *NEPA Environmental Assessment*, but the High Bank Bight alternative would be the site most likely to experience this remote possibility. Wild fish including salmonids are not restricted to the area immediately adjacent to the pens and thus could move away from a temporary, undesirable water quality condition.

5.1.2.5 Dissolved Oxygen

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Due to the large biomass of fish in the Site #3 cages, there will be a drawdown of dissolved oxygen (DO) within the cages and in a narrow band of water downstream of the cages, at whichever alternative location is selected. Extensive studies in other locations of the United States (Parametrix et al. 1990, Normandeau Associates and Battelle 2003) have shown that this effect is not detectable by a distance of about 30 m, compared to upstream locations. Rensel (1996) studied this effect in Rufus Woods Lake and found a slight reduction of 1.8%, but only very close downstream at a distance of six meters from fish pens. The degree of oxygen reduction will be related to the biomass of fish being reared, water temperature, feed rate and timing of previous feeding. Steelhead trout, and other members of the salmonidae family of fishes, are among the most, or perhaps *the* most, sensitive species to low dissolved oxygen in Rufus Woods Lake. Thus, the risk of a large or extensive low DO plume affecting wild fish is very small because it would first adversely affect the farmed fish.

No Action Alternative. There would be no dissolved oxygen-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

PAI will monitor ambient and in-pen dissolved oxygen (DO) during risk periods (late summer) so as not to stress the cultured fish and in turn, wild fish outside the pens. Fish feeding and handling could be reduced as necessary to reduce metabolic oxygen demand of the cultured fish and offset the effects of a temporary DO decline. A theoretical increase in dissolved oxygen is also possible in Rufus Woods Lake at times, and would be associated with increased primary production in the lake as a result of increased nutrients (Moore 1994). This would be offset by the degree to which bacterial oxidation of wastes occurs due to respiration. Such effects are likely impossible to measure *in situ*, due to the huge volume of river water fluxing through the system as discussed by Rensel (1989, 1993).

5.1.2.6 Turbidity

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. The lake/river bottom in deep areas where the net pen array would be located at any of the alternative locations considered for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is cobble and sand; therefore, vibratory installation of the

anchor pins would result in almost no plume of turbidity during the construction phase (confirmed by diving observation during installation of anchor pins at PAI existing Site #1; personal communication with Bill Clark, PAI Operations Manager, March 21, 2011). Anchor pin installation is projected to occur over a 2-month period. There may be more fines in the nearshore area of PAI Preferred Alternative Site #3 where the proposal includes vibratory installation of anchor pins to secure a dock in-place. There would be no dock at the downstream alternative sites. Given the small-scale of sediment disturbance that would occur during installation of each anchor pin, and the velocity of the current that flows through the project area, it is highly unlikely that the applicable water quality standard for turbidity would be exceeded at any time during the construction phase.

Floating fish farms generally produce no measurable increase in the fine solids that are measured by a turbidometer except if *in situ* net washing to remove biofouling occurs (Parametrix et al. 1990). There will be no in-river net cleaning as occurs in marine waters as biofouling with invertebrates is not an issue in Rufus Woods Lake. No active cleaning program has ever been required in the more than 20-year history of net pen operations in Rufus Woods Lake. The solids produced by fish farms are much larger and less infrequent than discharges from terrestrial runoff or untreated domestic or municipal sewage. As such, these large particles of organic matter are more suitable for uptake and use by macroinvertebrates, fish and other animals in the aquatic food web.

Some intra-annual variation in turbidity has been measured in background waters of Rufus Woods Lake in previous years, with lowest levels occurring in summer. Variation is likely due to a number of factors including local rainfall effects and variation of river discharge due to river operation and storage release. It is highly unlikely that PAI Preferred Alternative Site #3, or a net pen aquaculture project at any of the alternative sites considered in this *NEPA Environmental Assessment*, could affect turbidity levels downstream of the facility, due to high river current velocity and volume, rapid movement and dispersion of sediments and wastes.

Previous studies and routine monitoring (Rensel 2001, 2006, and other annual water quality reports from fish farmer consultants not cited herein) have shown that water transparency levels have been steadily increasing, with the exception of the year 2011 as previously discussed, suggesting that the lake/river is becoming more nutrient-poor as phytoplankton stocks in Lake Roosevelt decline. Increased light provides for deeper colonization by macrophytes and increased prevalence of epiphytic algae (periphyton) in Rufus Woods Lake, but not Lake Roosevelt due to annual drawdown practices in the Lake Roosevelt reservoir that prevent the establishment of macrophytes and limit phytoplankton stocks due to transport downstream.

No Action Alternative. There would be no change in turbidity in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

No adverse environmental consequences of construction-related turbidity or fish farm-induced turbidity are expected or likely associated with construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project. PAI has applied for a Tribal Hydraulic Project Permit under CCT Tribal Code of Laws Chapter 4, Title 4-9, and will comply with the conditions of this permit during construction.

5.1.2.7 Other Water Column Parameters

ENVIRONMENTAL CONSEQUENCES

pH

Preferred Site #3 or Alternative Locations. When respiring, fish excrete carbon dioxide that forms a weak acid to potentially influence the pH level of the culture water. Based on prior measurements at existing fish farms in Rufus Woods Lake (Rensel 2006), a very slight reduction of pH may occur from upstream to downstream of PAI Preferred Alternative Site #3. The decline only measured 0.9% to 1.5% lower pH at 6 m and 30 m downstream (respectively) from PAI existing Site #1, which was judged within natural background variation and not biologically significant. A very large fish farm could affect pH if it was located in a poorly flushed area, especially in freshwater as respired carbon dioxide is highly soluble and freshwater is typically less well buffered than saltwater. Pease (1977) reported that a fish farm in a poorly flushed backwater area of Puget Sound did not affect pH and the State of Washington programmatic EIS (Parametrix et al. 1991) concluded that effects are unlikely on this account. Because of the high rates of current velocity and extremely large volume of river flow, no measurable effect or consequences would be expected downstream of PAI Preferred Alternative Site #3 or any of the alternative sites considered in this *NEPA Environmental Assessment*.

No Action Alternative. There would be no pH-related effects in Rufus Woods Lake as a result of the No Action Alternative.

Water Temperature

Preferred Site #3 or Alternative Locations. No effect of net pen farming on water temperature would be expected at or downstream of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at any of the alternative locations considered. Fluctuations in water temperature are closely linked to sources of Lake Roosevelt water being discharged through Grand Coulee Dam. No evidence of vertical stratification of water temperature has ever been recorded (unpublished annual water quality reports of Columbia River Fish Farms Inc.). A similar conclusion was reached for the operation of fish farms in Puget Sound (Parametrix et al. 1990).

No Action Alternative. There would be no water temperature-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Since there are no projected environmental consequences to water pH or water temperature as a result of construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, no mitigation measures are proposed or required.

Dissolved Gas

Preferred Site #3 or Alternative Locations. As described in *NEPA Environmental Assessment* Chapter 4, Section 4.1.2.6, elevated levels of total dissolved gas (TDG) caused in some years by seasonal spilling through Grand Coulee Dam for flood control could cause a temporary condition of adverse consequences to a third PAI steelhead trout net pen aquaculture facility in Rufus Woods Lake. As a result of the 2011 experience, PAI has developed a management approach for high TDG events. These measures have been

added to the Proposed Management Plan for the facility (PAI, July 19, 2011 revised), and are summarized in the Mitigation Measures section below.

No Action Alternative. With the No Action Alternative, there would be no third PAI steelhead trout net pen aquaculture facility constructed and operated within Rufus Woods Lake; therefore, occasional temporary conditions of high TDG levels would affect only existing farms and resident fish within the lake/reservoir.

MITIGATION MEASURES

Pacific Aquaculture will employ horizontal "top nets" 10 feet below the surface when TDG levels are predicted to exceed 120%. These will keep the fish away from the water surface, at depths below 10 feet, where they will be better able to cope with high TDG levels. The top nets will be sewn into the main net prior to such an event. Pacific Aquaculture will monitor available information regarding snow pack, water trends, and anticipated runoff, and will communicate with both the Bureau of Reclamation (BOR), and the Colville Tribe in order to anticipate and prepare for future events of this type.

5.1.3 Aquatic Plants and Algae

Aquatic plants and algae considered here are phytoplankton (free floating, usually minute aquatic plants), periphyton (attached benthic algae), and macrophytes (rooted aquatic submerged or slightly emergent larger plants).

5.1.3.1 Phytoplankton

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. There is a very low possibility of any significant effects on phytoplankton communities within the action area of the proposed project as phytoplankton populations take a day or more to double in size under ideal conditions. The flushing rate of Rufus Woods Lake is very fast (a few days), and the water is relatively deep and well-mixed, which prevents phytoplankton cells from remaining in the near-surface photosynthetic zone to optimize growth. The Chief Joseph Dam Pool and forebay area may be most prone to any possible embellishment of phytoplankton stocks, although no water quality, subarea flushing rate or nutrient-sensitivity data is available from this area at present. Extremely shallow, low-volume or poorly-flushed areas are most sensitive to nutrient loading from fish farms with respect to initiating or maintaining phytoplankton stocks or blooms. Neither PAI Preferred Alternative Site #3 nor any of the other alternative sites considered in this *NEPA Environmental Assessment* have these characteristics. The Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at any of the alternative locations considered would produce relatively much more nitrogen than phosphorus, and the latter is the limiting factor for plant growth in Rufus Woods Lake, based on the N:P ratio analysis previously discussed. Effects on phytoplankton populations downstream are discussed below in Section 5.5: *Cumulative Effects*.

No Action Alternative. There would be no phytoplankton-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Mitigation measures previously described in Section 5.1.2.2 above would also be effective at minimizing environmental consequences for phytoplankton.

5.1.3.2 Periphyton

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Existing fish farm operations and PAI Site #3 at any of the alternative sites considered in this *NEPA Environmental Assessment* may promote additional abundance of periphyton stocks in Rufus Woods Lake, although siting objectives and practices specifically considered this issue by considering farm placement in relation to near field areas where periphyton could grow. It is probable that any measurable effect would occur in the near field, immediately downstream of the net pens where it could be monitored. Moore (1991, 1992, 1993) compared upstream and downstream periphyton growth, measured as chlorophyll *a* density at a previously used net pen site on the Douglas County side of Rufus Woods Lake in 1992. He assayed at 5 depths between 2 and 10 meters in both locations and found no statistical difference was seen between the stations. The biomass of fish in the cages was not noted, and likely was relatively small. Previously, Moore (1991, 1992) tested the efficacy of the method in Rufus Woods Lake and found it to be effective and sensitive. Rensel (1996) also collected periphyton upstream and downstream of PAI existing Site #1 and reported very little growth despite clear water, abundant sunshine, and placement of substrate in the area immediately downstream of the pens. Rensel concluded that currents were sufficient to prevent the periphyton filaments from achieving long length as they do in quiescent, nearshore areas that are sheltered from fast current velocity.

No Action Alternative. There could be slightly less periphyton in photic zones of the littoral zone in downstream areas of Rufus Woods Lake with the No Action Alternative.

MITIGATION MEASURES

Mitigation measures previously described in Section 5.1.2.2 above would also be effective at minimizing environmental consequences to periphyton. Monitoring as a form of mitigation is discussed here specifically for periphyton as a means to detect trends toward shifts in species composition or abundance.

Nutrient loading from net pens in Rufus Woods Lake is initially confined to a narrow band downstream with some mixing due to turbulence and mostly horizontal diffusivity. The narrow band is shown by drift object releases from PAI existing Site #1 (unpublished data, J. Rensel 2010) or from drift object releases at PAI Preferred Alternative Site #3 (Rensel and Siegrist 2011). Similarly, Rensel (1996) measured increased nitrogen and phosphorus downstream of existing net pen Site #1 in 1995 and calculated loadings, but found by 30 m downstream the results varied between no effect and modest loading, compared to a location 6 meters downstream. Numerous measurements of large net pen sites in Puget Sound (Parametrix et al. 1990) indicated that nutrient loading diminished to ambient levels by a distance of 30 m downstream, although fish farms were generally smaller at that time than they are in the present era.

Accordingly, a primary siting criterion and objective used by Rensel and Siegrist (2011) in their physical studies of alternative sites was to locate an area of the reservoir that was relatively straight and had few drift objects impinging upon the shoreline during their field surveys. This allows for nutrient dispersion before a diluted plume of nutrient comes in contact with the shoreline. As previously noted, PAI Preferred Alternative Site #3 best met that objective which is one reason it was selected. Specifically, the net pen site is located over very deep water where the river bottom is below the photosynthetic zone and the circulation path was either directly downstream or to the middle of the channel and downstream most of the time, rather than towards shore.

Because of some variation in flow direction during low river discharge periods that were measured with moored current meters in Rufus Woods Lake (Rensel and Siegrist 2011), some of the nutrients from PAI

Preferred Alternative Site #3 will at times reach nearby shorelines with existing stocks of periphyton on cobble, macrophytes and other surfaces. An existing research project is presently conducting a preliminary examination of the species composition and stable isotope of carbon and nitrogen content of periphyton in other locations throughout Rufus Woods Lake (e.g., Richard and Rensel 2010). As a form of mitigation to possible perturbations that may be caused by the Site #3 farm, additional species composition and stable isotope sampling will be sponsored by PAI to determine existing conditions before Site #3 operation through stable isotope content determination and species composition of the periphyton community in right bank areas immediately downstream and at a few selected locations further downstream. These measurements can be compared to upstream locations above PAI Preferred Alternative Site #3 and above all Rufus Woods Lake fish farms, as conducted for the CCT-sponsored food web study. No performance standard will be associated with this mitigation; rather, the data will be analyzed and reported to the CCT Office of Environmental Trust and other pertinent governing agencies (e.g., U.S. Army Corps of Engineers, Bridgeport and Seattle). Depending on the results of the sampling after a full year of PAI Site #3 operation compared to pre-existing conditions, and in consideration of water quality and nutrient results for water entering Rufus Woods Lake, CCT will decide whether there is a need for additional periphyton monitoring or active mitigation. If an excessive effect on periphyton is detected, the Site #3 operation could be reduced by lowering stocking and grow-out densities of fish as a preferred option. Temporary cessation of fish culture (i.e., fallowing) or pen reorientation or configuration changes within the project area would be more aggressive approaches to mitigation; however, these measures would not be needed if reduced stocking density in the rearing pens were practiced in a timely manner. It is most likely that periphyton abundance and species composition vary interannually, and occasionally vary significantly in Rufus Woods Lake as discussed above, so data collected for a single year will not be sufficient to understand both background conditions at upstream reference sites or the quantitative effects of the net pens.

5.1.3.3 Macrophytes

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Evidence reviewed in *NEPA Environmental Assessment* Chapter 4 (Section 4.1.3.3) indicates that the effects of fish farming to-date on macrophyte abundance in Rufus Woods Lake suggests that there has been no measurable or observed environmental consequences. Rather, macrophyte abundance is limited by the relatively small amount of suitable nearshore habitat. With the addition of PAI Preferred Alternative Site #3, however, fish production will exceed historical levels, so the past is not necessarily a guide to what may occur in the future. PAI Preferred Alternative Site #3 was selected intentionally to avoid sediment deposition in shallow areas. Rather, particulate matter discharged at this location will be spread out over the main channel of the reservoir. However, as previously noted, during periods of low river discharge, some setting of organic wastes from the pens may occur along the adjacent littoral area downstream of the pens. This would be minimal at PAI Preferred Alternative Site #3 compared to other alternative sites including the fast-flowing Mah-Kin Rapids alternative, as drift objects were occasionally observed to enter the small bay immediately downstream where deposition could occur. Risks of excessive deposition may be even greater for the weak and variable currents of the High Bank Bight alternative site.

To provide some perspective of relative risks of shifts in species dominance of macrophytes in Rufus Woods Lake, a literature review by the U.S. Army Corps of Engineers Waterways Experiment Station (Madsen 1998) indicated that lakes or reservoirs most likely to be at risk of dominance by invasive Eurasian watermilfoil had a total phosphorus level of 20 to 60 µg/L. As shown in *NEPA Environmental Assessment* Chapter 4 (Section 4.2.1.3), annual average total phosphorus in Rufus Woods Lake over the past decade has only been 5.6 µg/L, far less than the 20 µg/L minimum value cited by Madsen (1998).

No Action Alternative. There would be no macrophyte-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

Mitigation measures previously described in Section 5.1.2.2 above would also be effective at minimizing environmental consequences to macrophytes. As discussed above, careful siting is a form of mitigation because it can avoid or minimize the adverse environmental effects associated with aquaculture facilities. Monitoring as a form of mitigation is discussed here, as a means to detect trends or incipient shifts in species composition or abundance.

The Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project would be located offshore of the growth zone of macrophytes at any of the alternative locations considered, with flow direction usually oriented along the reservoir channel (Rensel and Siegrist 2011). It is also possible that macrophytes downstream are utilizing phosphorus from existing fish farms, but physical limitations of Rufus Woods Lake (e.g., small littoral zone, lack of fine sediments with nutrients, bank sloughing, and sunlight shading on steep south side reservoir banks) are major factors limiting macrophyte productivity and abundance, not water column soluble nutrient flux. Because of strong currents that extend near shore in most areas of the upper and middle reaches of Rufus Woods Lake, much of the littoral zone may have relatively impoverished levels of phosphorus in the sediments as fine sediments are not present that have associated phosphorus content. As shown below in Section 5.5: *Cumulative Effects*, the total volume of phosphorus discharged from all fish farms in Rufus Woods Lake plus that from proposed Site #3 is only a very small fraction of the total flux of phosphorus through the system. The net pen discharge is far less than what historically occurred throughout the system up until the cessation of nutrient discharge from the fertilizer plant upstream in British Columbia, previously discussed in Section 5.1.2.3, above. Mitigation measures discussed here would be less effective at the High Bank Bight alternative site, as that location has more prevalent weak flows and variable current direction the other sites.

Given the above, increased density and productivity of macrophytes or a shift of community species composition to undesirable or noxious forms would be unlikely but nevertheless cannot be ruled as impossible as a result of PAI Site #3 operations at any of the alternative sites considered. A pragmatic form of mitigation in this case would be to measure baseline conditions including growing season macrophyte areas, species composition and abundance measures for representative and replicate plots adjacent to and downstream from the Site #3 project area, and repeat the measurements annually after operation of Site #3. At the same time, stable isotope analysis of collected fronds of macrophytes can be compared to data being acquired upstream of all Rufus Woods Lake fish farms as part of the CCT-sponsored food web study to be able to detect, rule out, or quantify the environmental consequences to macrophytes. As previously noted in Chapter 4 (Section 4.1.3.3), other researchers such as Kohzu et al. (2008) and King et al. (2009) have been able to use ^{15}N stable isotope measurements to estimate the spatial and population effects of ^{15}N-enriched sewage discharge in other regions so that if phosphorus loading becomes excessive in Rufus Woods Lake, the methodology should detect it if properly applied. Depending on the results of the sampling after a full year of Site #3 operation compared to pre-existing conditions, the CCT Office of Environmental Trust will decide whether there is a need for additional monitoring or active mitigation. If an excessive effect on macrophytes is detected, the Site #3 operation could be reduced by lowering stocking and grow-out densities of fish as a preferred option. Temporary cessation of fish culture (i.e., fallowing) or pen reorientation or configuration changes within the project area would be more aggressive approaches to mitigation; however, these measures would not be needed if reduced stocking density in the rearing pens were practiced in a timely manner.

5.1.4 Aquatic Animals

This section considers the potential environmental consequences of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture operation on zooplankton, benthic invertebrates and wild fish within the aquatic environment action area. Underwater video of the Preferred Alternative Site #3 project area and the alternative sites indicates very little or even no biota on the bottom directly beneath the proposed pens as viewed in October 2010. Based on observations at existing sites in Rufus Woods Lake, the project will result in population of the bottom with a variety of invertebrates including snails, crayfish and isopods, as well as fish including sculpins in shallower areas less than about 75 feet deep.

5.1.4.1 Zooplankton

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. The sterile steelhead trout reared in existing and proposed net pens in Rufus Woods Lake are not known to feed on naturally-occurring zooplankton in the lake, nor would the densities of suitable zooplankton be sufficient to interest these fish. Trout have to eat fish size-appropriate feed, and hatchery fish are conditioned to feed on fish food pellets that are much larger than most suitable zooplankton prey that may occur in the lake, such as water fleas (e.g., *Daphnia magna*). As phytoplankton stocks are transported through the project area in a matter of a few minutes most of the time, no near field effect is expected on them; therefore, zooplankton would also not be affected in the near field. Studies of the diets of purposely-released trout in Rufus Woods Lake are underway by the Colville Confederated Tribe (Shallenberger 2009, Richards and Rensel 2010) with only very few zooplankton occurring in the stomachs sampled and analyzed as of March 2011.

No Action Alternative. There would be no zooplankton-related effects in Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of adverse environmental consequences to zooplankton associated with construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, no mitigation measures for these effects are proposed or required.

5.1.4.2 Benthic Invertebrates

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Observations immediately beneath and downstream of PAI existing net pen Site #1 suggest that there has been an increase of density of native aquatic snails with several species present (Rensel 2010). This consequence would also be expected at the Site #3 net pen aquaculture project, at whichever alternative site is selected for the proposed action. Snails are periphyton grazers and consumers that are most abundant on the cobble substrate. As PAI Preferred Alternative Site #3 has similar or greater abundance of cobble substrate, the snail population there could increase significantly. Snails are an important component of the aquatic food web in the mid-Columbia River where they consume periphyton and remineralize organic nutrients to inorganic nutrients and thus enable nutrient cycling in the aquatic nutrient pool.

The Site #3 project may also provide food for crayfish and sculpins, both taking advantage of increased food via the food web (e.g., isopods) and the latter also directly consuming waste fish feed and fish fecal

detritus on the bottom as observed beneath PAI existing Site #1 (Rensel 2001). Crayfish populations appear to be increasing greatly in Rufus Woods Lake in recent years, from rarely or never seen 20 years ago (unpublished underwater video and photography monitoring by fish farm staff and consultants) to now commonly seen in nearshore to moderately deep depths. Several species including one exotic crayfish species have been recorded from the lake in 2010 (Richards and Rensel 2010). There appeared to be a abrupt shift and increase in population of exotic crayfish only in 2011 (Richards, Rensel and Siegrist 2011). Diving collections near Site #1 net pens and upstream at reference areas in approximately 50 foot depth at several stations in 2009 resulted only in native signal crayfish (*Pacifasticus leniusculus*) observations (Rensel 2010). Crayfish may be increasing because benthic productivity has apparently increased with clearer water in the past few decades that allows sunlight to reach deeper into the littoral zone, causing increased periphyton abundance and resulting secondary production including omnivores such as crayfish. The fact that crayfish are abundant upstream of all net pens as well as downstream suggests that there is no direct cause and effect relationship between net pen use in the lake, although surely the net pen organic, particulate wastes could enhance productivity of the reservoir bottom resulting in more food for crayfish. It was previously thought that crayfish abundance in Rufus Woods Lake decreased dramatically in the late spring and early summer of 2011, apparently as a result of excessive levels of dissolved gas in the system, caused by spill at Grand Coulee Dam when eight of the twenty generation units were taken off line for repair during an unusually high discharge period. Divers collecting routine underwater photographs near the PAI existing Site #1 net pen aquaculture facility found fewer crayfish in July 2011, compared to the previous year when most photographs showed one or possibly two crayfish in each frame (Bill Clark, personal communications to Jack Rensel, July 2011). It is often not possible to determine the species of crayfish seen in photographs and the available data and observations are not robust enough to make reliable estimates of crayfish species and population trends.

If the net pen trout were treated with chemicals or antibiotics, some residue would escape via the fish feces and macroinvertebrates could ingest them. However, use of chemicals or drugs at Rufus Woods Lake Fish farms is extremely rare, occurring perhaps once in the past 20 years, and that only occurring due to fish having been held too densely by a prior ownership before Pacific Aquaculture purchased existing fish farms (unpublished PAI performance evaluation report to Colville Confederated Tribes 2010).

No Action Alternative. There would be no additional site of increased nutrients (in the form of waste fish feed and fish fecal detritus) that might stimulate growth in the population of native aquatic snails and crayfish in Rufus Woods Lake. Factors affecting the density of benthic invertebrate populations would remain the same as they are at present as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of adverse consequences to benthic invertebrates associated with construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, no mitigation measures for such effects are proposed or required.

5.1.4.3 Fish

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Sources of noise and sound level estimates during construction of proposed steelhead net pen aquaculture Site #3 are described in the *Biological Evaluation* prepared for the project (PAI, March 1, 2011). The text below is an excerpt from that document.

The Washington State Department of Transportation *Advanced Training Manual for Biological Assessment Preparation for Transportation Projects* (WSDOT 2008) was used to address the potential construction noise effects of the proposed project and to establish the noise action areas, both upland and underwater. Potential noise effects in the terrestrial environment are discussed in Chapter 5 (Section 5.3.6) of this *NEPA Environmental Assessment*. Assumptions for baseline and construction noise used below are taken from the WSDOT manual. Noise is usually measured in decibels (dB). In-air noise (which commonly is frequency-weighted to approximate human hearing) is measured on an A-weighted scale, denoted as dBA.

Noise behaves in much the same way in air and in water. Underwater noise measurements have different characteristics, however, than noise in air. Underwater noise levels are measured with an underwater microphone, which converts noise pressure to voltage, which is then converted back to pressure, expressed in Pascals (Pa), pounds per square inch (psi), or decibels (dB). Several descriptors are used to characterize underwater noise. Two common descriptors are the instantaneous peak sound pressure level (dB_{peak}) and the Root Mean Square (dB_{RMS}) pressure level during the impulse, sometimes referred to as the peak and RMS level respectively. The peak pressure is the instantaneous maximum overpressure or underpressure observed during each pulse and can be presented in Pascals (Pa) or SPL in decibels (dB) referenced to a pressure of 1 micropascal (dB re: 1 µPa). The RMS level is the square root of the energy divided by the impulse duration. This level is the mean square pressure level of the pulse. It has been used by the National Marine Fisheries Service to describe disturbance-related effects (i.e., harassment) on aquatic organisms from underwater impulse-type noises.

Ambient noise levels in deep freshwater lakes or deep slow moving rivers are approximately 135 dB_{RMS}. Vibratory driving noise levels are generally 10 to 20 dB lower than impact hammer driving (180 dB). It is assumed the vibratory head on the cable crane proposed for the installation of the anchor pins will be similar, but have a lesser effect than a vibratory hammer used for pile driving. The equipment will vibrate the anchor pins into the sediment by use of an oscillating head placed on top of the pin. The vibratory action will cause the sediment immediately surrounding the pin to liquefy so that the pin can be driven through the sediment.

Vibratory installation of steel piles in a river in California resulted in sound pressure levels that were not measurable above the background noise created by the current. Impacts on fishes or other aquatic organisms have not been observed in association with vibratory hammers. This may be due to the slower rise time and the fact that the energy produced is spread out over the time it takes to drive the pile. As such, vibratory driving of piles (and pins) is generally considered less harmful to aquatic organisms and is generally the preferred method. Based on the above facts, the area of effect for underwater construction noise at PAI proposed Site #3 can be set conservatively within 0.6 mile, the same as for construction above the water surface. The estimated duration of anchor pin installation is 2 months. With a projected construction start date of mid-summer 2012, and allowing 2 months for net pen assembly at PAI existing Site #1, the estimated in-water work window would occur during fall 2012.

During anchor pin installation, fish would be expected to avoid the immediate vicinity of the pin being installed, with decreasing effect up to a 0.6-mile radius, after which there would be no effect. If construction were delayed from PAI's objective to obtain permits and start work in mid-summer 2012 such that in-water work were to occur in the spring and early summer, this would coincide with the spawning season of several resident fish species.[3] While it is not specifically known whether these species spawn near PAI Preferred Alternative Site #3, the effect would be discountable because most spawning would occur in shallow water near shore, the disturbance would be temporary (not spanning the entire spawning season), and the project site constitutes a small fraction of the available shoreline habitat for

[3] Kokanee (land-locked sockeye salmon) spawn in creeks, not in Rufus Woods Lake.

spawning within Rufus Woods Lake. Juvenile fishes mainly inhabit the nearshore area, and some could be temporarily disturbed to a minor extent by construction activities. Because construction activity would only occur during daylight hours, the disturbance (fish avoidance of the immediate vicinity) would be expected to be minor.

In the operational condition of the project, some species of wild fish will be attracted to the general area of net pens in Rufus Woods Lake (as discussed in Chapter 4 (Section 4.1.4.3). Sculpins and suckers are found beneath the pens, and other species occur at shallower depths in the water column, but not in any one location such as immediately downstream of the pens as documented by underwater video camera and diver observations conducted as required for annual monitoring by the Colville Confederated Tribes (unpublished reports to CCT Environmental Trust Department). Although fish are not concentrated in any one area, this section considers the potential environmental consequences to wild fish immediately downstream of the pens.

Slightly elevated concentrations of ammonia nitrogen will be measurable a few tens of meters downstream of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture operation at whichever alternative site is selected, except the High Bank Bight alternative site. If that site were used to raise a comparable amount of fish, ammonia concentrations would likely be elevated during the protracted periods of slow current noted to occur there. A similar situation would apply for dissolved oxygen, where a slight (0.1 to 0.2 mg/L or less) depletion of dissolved oxygen, as measured during low flows, would occur. As discussed above, trout are highly sensitive to both elevated ammonia and reduced dissolved oxygen, so it will be in the best interests of PAI to operate their fish farms conservatively to avoid stressing or killing their fish accidentally. Cultured fish reared in net pens in Rufus Wood Lake are vaccinated to prevent disease, and to-date there has been no serious or extended occurrence of disease epizootics at the net pens.

Throughout the operating history of fish farms in Rufus Woods Lake, Columnaris disease caused by the bacterium flexibacter has been detected in the farmed trout. This organism is ubiquitous in water supplies throughout the world and is a common, chronic disease of wild and farmed fish that becomes more prevalent when fish are stressed. During 2010, Dr. Ralph Elston and Dr. Charlie Smith (Consulting aquaculture pathologists) isolated the internal and external versions of the bacteria. Aqua Health, Inc. is in the process of manufacturing an injectable vaccine. It is the goal of PAI to eliminate the need to use any therapeutants in Rufus Woods Lake. Because the disease is common in wild fish, there is no likely effect on existing stocks unless water quality conditions were severely degraded, which is not the present or forseeable future case.

No Action Alternative − Consequences of Construction Noise. There would be no construction associated with the No Action Alternative, and therefore no consequences to fish related to construction noise. There would be no change in the number of steelhead trout net pen sites in Rufus Woods Lake, and thus no additional locations of attraction to wild fish in the lake (e.g., sculpins and suckers). Factors influencing concentrations of ammonia nitrogen and dissolved oxygen would remain unchanged from existing conditions.

MITIGATION MEASURES

In the absence of adverse consequences to fish associated with construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, no mitigation measures for such effects are proposed or required.

5.1.4.4 Birds

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Birds will be excluded from the net pen area by a comprehensive bird and predator avoidance cover that will be secured over the entire cage assembly, as used at PAI existing Sites # 1 and #2 (see Figure 3.1-2 in Chapter 3). As long as this cover is maintained correctly by being stretched tight and not allowed to enter the water, birds will not be otherwise affected. However, some minor spillage of feed has occurred on land in the past and some species such as gulls and Brewer's black birds are more common near the fish farm facilities at times, taking advantage of this food source. Great blue herons are common in the area and with prior operations, used the net pens as fishing stations. They were potentially at risk for entanglement in nets stretched over the pens that were used to prevent bird entry. With the system currently used by PAI, this is no longer a risk as the herons are not able to land on the net pen walkways.

No Action Alternative. There would be no bird-related effects within the study area attributable to the No Action Alternative.

MITIGATION MEASURES

PAI will install and maintain net pen cover systems comparable to those at existing Site #1 and Site #2 to exclude all wild birds. PAI plans to implement improvements to feed handling on shore and feed transfer to silos that will minimize spillage and thus result in fewer pellets being available for wild birds on land at shore-based facilities.

5.1.4.5 Mammals

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. As noted in *NEPA Environmental Assessment* Chapter 4 (Section 4.1.4.5), river otters (*Lontra canadensis*) are rare in Rufus Woods Lake but are occasionally seen. They are sometimes a problem for hatcheries or net pen fish culture in Washington State. These highly mobile aquatic mammals are capable of finding small breaches in nets or covers and removing cultured fish to eat. Construction and operation of proposed Site #3 should have no effect on otter populations if the fish and predator avoidance cover nets are maintained properly. If the otters were able to enter the cages, they would feed on the fish and then exit before in the early morning or late at night before fish farm staff returned on a daily basis.

No Action Alternative. There would be no wild mammal-related effects within the study area attributable to the No Action Alternative.

MITIGATION MEASURES

The mesh predator avoidance covers used to enshroud existing PAI net pens in Rufus Woods Lake would be used at Site #3, at whichever alternative location is selected. If correctly maintained, these mesh covers will prevent the entry of otters and other aquatic mammals, as well as prevent potential injury to these species.

5.1.4.6 Threatened, Endangered, and Protected Aquatic Species

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. Bull trout is the only fish species listed under the Endangered Species Act potentially within the action area. According to a preliminary opinion by Greg Kurz, USFWS (personal communication December 14, 2010), the proposed project is "Not Likely to Adversely Effect" bull trout. Bull trout are rare in Rufus Woods Lake (the proposed action area is not within critical habitat for this species), and if present, would likely benefit from uneaten fish food under or near the proposed net pens at Site #3 (whichever alternative location may be selected for implementation).

The Biological Evaluation prepared for the project (PAI, March 1, 2011) concludes that noise and physical activity during construction would be very localized and would not be expected to alter bull trout behavior in a significant way. If bull trout were in the vicinity when these activities occurred, they would likely move away until they became habituated to the disturbance.

Upon review of the Biological Evaluation, EPA has determined that the only activities with any potential to negatively impact an individual bull trout, if present, would be the in-water work and noise associated with installation of the net pen facilities. EPA has determined that due to the extremely low numbers of bull trout within Rufus Woods Lake, and the effluent limitations and monitoring requirements contained within the NPDES permit to minimize impacts to the receiving water, the authorization of discharges into Rufus Woods Lake under the NPDES permitting program will have no effect on bull trout or any other threatened or endangered species or designated critical habitat.

No Action Alternative. There would be no change in the quantity or number of locations where fish feed is discharged to steelhead trout net pens on Rufus Woods Lake, and thus no change in this possible food source for bull trout (rate within the project action area). There would be no in-water construction and thus no aquatic environment noise from this source. There would be no effects related to other threatened, endangered, or protected aquatic species within the study area attributable to the No Action Alternative.

MITIGATION MEASURES

PAI Best Management Practices (BMP) proposed during construction and operation of the proposed net pen operation will help ensure that there would be no significant adverse environmental effects to bull trout. Proposed practices are described above in Section 5.1.1.3, and include: adaptive management of fish feeding methods; management practices for in-water discharges; use of disease control chemicals; and collection, storage and disposal of dead fish (mortalities). The PAI BMP manual also includes a Spill Prevention and Response Plan, Spill Prevention and Response Procedures, and Employee Guidance for Routine Handling Procedures to Minimize the Potential for Escapement. PAI has also adopted Fish Release Prevention and Response Procedures that minimize the possibility of interactions between escaped farmed fish and native species.

5.1.4.7 Exotic Species

ENVIRONMENTAL CONSEQUENCES

Preferred Site #3 or Alternative Locations. As discussed in Chapter 4 (Section 4.1.4.7), one species of snail and crayfish are relatively new exotic species in Rufus Woods Lake. There are many introduced species of fish, as noted in Table A-7 (Appendix A). There are no known environmental consequences of the construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project

(at any alternative location considered) on any of these species, nor will continued operation introduce any new species. All hatcheries from which juvenile fish are obtained use water from spring sources, not open waters of rivers or lakes, so transferring of unintended macroinvertebrates and fish is a very low risk.

No Action Alternative. There would be no exotic species-related effects within the study area attributable to the No Action Alternative.

MITIGATION MEASURES

Prevention of introduced species is much more preferable than mitigation after a species is introduced. Eradication of exotic species in large aquatic systems after introduction is usually impossible. Accordingly, only hatchery fish reared in Washington State are used on a routine basis for PAI operations. Should fish be imported, they would be quarantined in accordance with State and Federal requirements prior to stocking. PAI has no plans for importation of fish from outside the United States to be stocked directly to Rufus Woods Lake net pens (personal communication with John Bielka, PAI General Manager, March 21, 2011). Should an exotic species be introduced by accident or found, PAI management and staff will report the occurrence immediately to Tribal, State and Federal authorities. As noted above, the risk of this occurring is extremely remote, due to the locations and practices of the regulated hatcheries used to provide the fingerlings.

5.1.5 Navigation

ENVIRONMENTAL CONSEQUENCES

The net pen array at any alternative location selected for Site #3 will be anchored in place north of the mid-channel of Rufus Woods Lake, within the boundaries of the Colville Indian Reservation. At Preferred Alternative Site #3, there would be more than 500 feet of unobstructed waterway for vessels to pass the net pen array between the mid-channel and the south bank (see Drawing #4 in Attachment 1). The channel width is approximately the same at Preferred Alternative Site #3 and PAI existing Site #1 (see Drawing #1 in Attachment 1), where there have been no reported conflicts with vessel traffic (personal communication with John Bielka, PAI General Manager, March 14, 2011; and personal communication with Linda Palmer, CCT Parks & Recreation Department, April 1, 2011).

The channel is wider at the High Bank Bight alternative site, and narrower at the Mah-Kin Rapids or Narrows Downstream sites compared to Preferred Alternative Site #3 (see Figure 3.2-1 in *NEPA Environmental Assessment* Chapter 3, Section 3.2). If any of these locations were selected for implementation of the Site #3 proposal, there would be less (though still adequate) room for vessel passage.

There would be no change to characteristics of vessel navigation or existing private aids to navigation at PAI existing Site #1 associated with the proposal to assemble Site #3 net pens at this location and float them downstream, or associated with harvest operations at Site #1 to pre-process Site #3 fish.

No Action Alternative. No new floating structures requiring private aids to navigation would be introduced on Rufus Woods Lake with the No Action Alternative.

MITIGATION MEASURES

The proposal includes equipping the Site #3 net pen array with private aids to navigation (yellow flashing lights), and a debris deflector that will prevent vessel traffic from attempting to pass by the net pen array

on the shoreward side (see Drawings #4, #10, #11, and #13 in Attachment 1), comparable to the manner in which PAI existing Sites #1 and #2 are equipped.

Placement of the Site #3 net pen array in Rufus Woods Lake will require a Private Aids to Navigation (PATON) permit from the U.S. Coast Guard (USCG), to review and approve the lighting system proposed. PAI will apply for and obtain the USCG permit, contingent upon receiving other required permits and approvals from the Colville Confederated Tribes, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency. PAI will comply with the requirements and conditions of the USCG permit for the specifications and type of private aids to navigation to be installed on the Site #3 net pens.

5.2 TERRESTRIAL ENVIRONMENT

The terrestrial environment action area during the construction phase will include existing PAI Site #1 where materials to construct the floating net pen structure would be delivered for assembly, and the 2.87-acre upland site at PAI's Preferred Alternative Site #3 location (Colville Tribal Tract #101-T4213) where support service improvements are proposed. There would be no upland support site at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream alternative locations. If one of these alternative locations were selected, support services would be provided by boat from PAI's existing Site #1, and by means of a feed barge (as described and illustrated in *NEPA Environmental Assessment* Chapter 3, Section 3.1.2.2).

The terrestrial environment action area in the operational condition of the project would be the 2.87-acre upland site at PAI's Preferred Alternative Site #3 location, and a surrounding radius of approximately 0.5 mile. If one of the alternative sites were selected for the in-water location of the Site #3 steelhead net pen aquaculture project, the terrestrial environment action area for potential operational effects would be PAI's existing Site #1 and a surrounding radius of approximately 0.5 mile.

5.2.1 Land Use

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. The proposal to assemble Site #3 net pens in the PAI existing Site #1 upland area, and to perform Site #3 harvest activities at Site #1 would not alter existing land use at this location. Site #1 is fee land, owned by PAI.

Preferred Site #3. Upland support services are proposed at Preferred Alternative Site #3, similar in character to (though less extensive than) upland improvements at PAI existing Site #1. The upland site adjacent to Preferred Alternative Site #3 is Tribal Trust land, 2.87 acres in size. Proposed improvements include power and communications utilities, four feed silos, an 8-ft wide by 40-ft long container (operations trailer) to house the feeding control system (feed cameras, blowers, etc.), 4-inch diameter PVC piping to convey feed to the floating net pens, a gravel or crushed rock road for vehicular access to the site, and a foot path for access to the dock (see Drawing #14 in Attachment 1). These improvements would result in disturbance of approximately 12,000 sf (0.3 acre) – approximately 10% of the site surface area. A concrete pad (15 feet x 60 feet, 1.5 feet deep) will be poured on the upland site to serve as the foundation for four feed silos and the portable operations trailer (see Drawing #12). Other than this 900 sf area of impervious surface, the site would remain unpaved in the developed condition. The road would be constructed in a half-circle for access to/from Columbia River Road (see Drawing #14).

A trailer (i.e., metal container) to house pneumatic blowing equipment and an office would be placed alongside the feed silos at Preferred Alternative Site #3. The pneumatic delivery system to convey feed to the floating net pens would utilize 4-inch diameter PVC pipe laid across the upland site and water surface

between the blowing equipment and the pens (see Drawing #4 in Attachment 1, and Figure 3.1-3 in *NEPA Environmental Assessment* Chapter 3, Section 3.1). The nearest point of upland improvements would be approximately 130 feet landward from the ordinary high water mark (Drawing #14).

Alternative Locations. Upland parcels adjacent to the alternative locations considered for Site #3 are unsuitable for the development of support services; therefore, there would be no change in land use at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream sites if any of these were selected to implement the Site #3 proposal.

No Action Alternative. There would be no land use alteration with the No Action Alternative.

MITIGATION MEASURES

Pacific Aquaculture, Inc. has applied to the U.S. Department of the Interior, Bureau of Indian Affairs (BIA) to obtain a Tribal Trust land lease for the 2.87-acre parcel (Tribal Tract No. 101-T4213) adjacent to Preferred Alternative Site #3.

Pacific Aquaculture, Inc. has applied to the CCT Planning Department for the combined Conditional Use Permit and Shoreline Development Permit required for upland improvements at PAI Preferred Alternative Site #3. PAI will comply with the conditions of permits and approvals required from the Colville Confederated Tribes (CCT).

5.2.2 Topography and Soils

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. The proposal to assemble Site #3 net pens in the PAI existing Site #1 upland area, and to perform Site #3 harvest activities at Site #1 would not result in environmental consequences to topography or soils at this location.

Preferred Site #3. Soils within the proposed action area are considered suitable for agriculture only if irrigated (USDA NRCS, December 3, 2010). Since there is no existing irrigation system on PAI Preferred Alternative Site #3 at the present time, and it is not presently used for agriculture, there would be no adverse environmental consequence to high value soils as a result of constructing proposed upland support services at this location.

Alternative Locations. Upland parcels adjacent to the alternative locations considered for Site #3 are unsuitable for the development of support services; therefore, there would be no environmental consequences to topography or soils at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream sites if any of these were selected to implement the Site #3 proposal.

No Action Alternative. There would be no disturbance to topography or soils at upland sites adjacent to Rufus Woods Lake as a result of the No Action Alternative.

MITIGATION MEASURES

To the extent practicable, existing vegetation will be left undisturbed during construction of upland support services at PAI Preferred Alternative Site #3. Only approximately 0.3 acre (12,000 sf) will be disturbed – approximately 10% of the land area. Some re-vegetation will be done in consultation with the Colville Tribes Office of Environmental Trust.

The stormwater management proposal during construction includes stabilizing erosion-prone surfaces as soon as practicable with rock or gravel (to be used on the Site #3 access road); by placing geotextile, and/or by seeding with grasses (to be applied on the waterward side of the slope where the feed silo/operations trailer concrete pad would be poured). All requirements of the CCT Development Permit and Shoreline Permit for the project will be complied with.

5.2.3 Air Quality

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. Diesel exhaust emissions would be generated by PAI's 28-ton crane, two forklifts, trucks, and genie lift (10 ton, 48-foot boom) at PAI existing Site #1 during the construction period to assemble and launch the Site #3 cage components from this location. It is estimated that net pen assembly would take approximately 2 months.

Preferred Site #3 or Alternative Locations. On the water, outboard motor-powered work skiffs, and a twin outboard engine utility barge would generate diesel exhaust while transporting and completing the assembly of the net pens in-place at Site #3. Similarly, the 50-ton cable crane with a vibratory head operating from a floating barge would generate diesel exhaust while inserting steel pin anchors to secure the floating net pen structure to the river/reservoir bottom. These environmental consequences would occur at whichever alternative site is selected for implementation of steelhead trout net pen aquaculture Site #3. In-water construction is estimated to take approximately 2 months to complete.

Upland construction vehicle emissions would be generated by the PAI crane, a backhoe and excavator operating at Preferred Alternative Site #3 during installation of upland support services. Temporary, localized emissions of fugitive dust and vehicle emissions (particulates, carbon monoxide, carbon dioxide, volatile organic compounds, and nitrogen oxide) would occur during the estimated 3 to 4-month construction period for these improvements.

In the operational condition of the project, there would be vessel traffic to/from PAI existing Site #1 and the new Site #3 for operational support and during harvest. Boats would travel 1 or 2 times per day between Site #1 and PAI Preferred Alternative Site #3. If one of the alternative locations downstream from Preferred Alternative Site #3 were selected, 3 to 4 boat trips per day between Site #1 and one of these locations or more would be required to transport feed and personnel, due to the absence of an upland support services site at the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream site. The travel distance from Site #1 would be greater (on the order of 5 to 7 miles compared to 2.6 miles to the Preferred Alternative site). The greater number of vessel trips and longer travel distance would result in considerably more fuel consumption and gas and diesel engine exhaust emissions to the air to operate the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project at one of the further downstream alternative sites. If PAI Preferred Alternative Site #3 is selected, there would also be 1 to 2 vehicle trips per day traveling on Columbia River Road between PAI existing Site #1 and Site #3.

If one of the downstream alternative sites were selected (High Bank Bight, Mah-Kin Rapids, or Narrows Downstream), a feed barge would be required, as there would be no upland support site on which to construct feed silos. Large diesel generators would be required to operate the feed barge, which would result in additional diesel exhaust emissions to the air.

Emissions during construction and in the operational condition of the project are not anticipated to exceed applicable National Ambient Air Quality Standards (NAAQS) within the proposed action area due to their temporary and short duration, the absence of air quality concerns within the action area at the present

time, and the fact that emissions from these activities would be dispersed by air movement that is characteristic within the Columbia River canyon where existing and proposed steelhead trout net pen operations are located.

A mild fish oil odor (discernible to some observers) would be introduced within the Site #3 action area (at whichever alternative location is selected) associated with the fish feed. This odor would not require mitigation.

No Action Alternative. With the No Action Alternative, there would be no equipment operation that would generate emissions to the air, and no additional feed storage/distribution location that would generate a mild fish oil odor. Existing sources of odor and emissions to the air would remain unchanged within the project action area.

MITIGATION MEASURES

Representative measures that could be implemented during construction to minimize emissions to the air (to the extent practicable) include the following:

- Use only equipment and trucks that are maintained in good operational condition.
- Restrict idling of construction equipment and vehicles when turning off such equipment would not damage the equipment or excessively delay related activities.
- Implementing a dust control plan.

5.2.4 Floodplains

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Because there is no known FEMA floodplain within the project action area (Colville Confederated Tribes, September 2000), there would be no adverse environmental consequences to floodplains associated with construction and operation of PAI steelhead trout net pen aquaculture Site #3 at any of the alternative locations considered. However, agencies with jurisdiction over managing Columbia River water levels require authorization for projects proposed on the banks and/or water surface of reservoirs within the system (see the description of Mitigation Measures below).

No Action Alternative. The environmental consequences of the No Action Alternative as it relates to floodplains would be similar to that described for Preferred Site #3 or Alternative Locations.

MITIGATION MEASURES

Pacific Aquaculture, Inc. has applied to the U.S. Army Corps of Engineers for a Flowage Easement for the Site #3 net pen operation, and will comply with the conditions of this easement. The Joint Aquatic Resources Permit Application (JARPA) was submitted December 27, 2010.

5.2.5 Wetlands

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. There are no wetlands within the proposed action area. Therefore, there would be no environmental consequences to wetlands as a result of the proposed project.

No Action Alternative. Similarly, there would be no environmental consequences to wetlands as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any potential for environmental consequences to wetlands, no mitigation measures for wetland effects are proposed or required.

5.2.6 Prime or Unique Agricultural Lands

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. The proposed action area is not located within an area of prime or unique agricultural lands. Therefore, there would be no environmental consequences to prime or unique agricultural lands as a result of the project.

No Action Alternative. Similarly, there would be no environmental consequences to prime or unique agricultural lands as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any potential for environmental consequences to prime or unique agricultural lands, no mitigation measures for such effects are proposed or required.

5.2.7 Terrestrial Floral Communities

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. The proposal to assemble net pens at PAI existing Site #1, and to perform harvest activities for Site #3 fish at Site #1, would not require any additional disturbance of vegetation at Site #1.

Preferred Site #3. Approximately 0.3 acre of central arid steppe vegetation (as illustrated in Chapter 4 Figure 4.2-1) would be removed from Preferred Alternative Site #3 to construct the compacted earth access road and concrete pad on which feed silos and the operations trailer would be located. This would not constitute an adverse environmental consequence to a valuable floral community.

Alternative Locations. If one of the other alternative locations were selected to implement PAI steelhead trout net pen aquaculture Site #3, there would be no upland support site improvements, and therefore no environmental consequences to the similar vegetation community that exists at these locations.

No Action Alternative. There would be no disturbance to terrestrial floral communities as a result of the No Action Alternative.

MITIGATION MEASURES

In keeping with a priority held by Colville Reservation land managers, a Vegetation Management Plan is described below to prevent or minimize invasion by noxious weeds of the upland area to be cleared at Preferred Alternative Site #3. The overall intent of a Vegetation Management Plan is to minimize habitat loss and lessen the impact of invasive plants, erosion, sedimentation and flooding. Pacific Aquaculture proposes to implement the following vegetation control measures to achieve these objectives:

- Prior to initiating ground-disturbing activities, the applicant and/or contractor will walk areas of the site to be cleared with a designated representative of the Colville Confederated Tribes (CCT) for the purpose of identifying noxious weed species that may be present.
- Noxious weeds will be extracted manually and removed from the site to be properly disposed, both during construction and in the operational condition of the project. Alternatively, noxious weeds may be burned on-site subject to the conditions of a burning permit obtained from CCT. A designated representative of Pacific Aquaculture will inspect the site once per month during the growing season to identify and remove noxious weeds if any attempt to establish on soils disturbed by site development.
- Standard erosion control practices will be employed on the site during construction if necessary, to prevent runoff from exposed surfaces from entering drainage courses or the Columbia River.
- A minimum 35-ft wide buffer will be maintained from the drainage course along the west boundary of proposed Site #3 to maintain riparian vegetation through which site runoff will filter before reaching the streambed.
- Non-invasive vegetation removal during construction will be accomplished by mechanical means (e.g., with a dozer).
- Vegetation scraped from areas to be graded will be stockpiled for burning on the site (subject to the conditions of a CCT burning permit), or for chipping. Chips would be distributed on the pedestrian pathway between the operations trailer and the dock to stabilize exposed soils.
- Erosion-prone surfaces will be stabilized as soon as practicable with rock or gravel (to be used on the access road) or by seeding with grasses (to be applied on the waterward side of the slope where the feed silo/operations trailer concrete pad would be poured).
- There will be no use of herbicides, pesticides or antifoulants on the site during construction or in the operational condition of the project.
- There will be no on-site fueling of vehicles or equipment during construction or in the operational condition of the project.
- No beach enhancement is proposed (consistent with CCT Code 4-15-15[7]).

5.2.8 Terrestrial Faunal Communities

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Birds, rodents, and reptiles may be temporarily displaced from upland construction areas at PAI existing Site #1 and Preferred Alternative Site #3 as a result of noise and human activity during assembly and installation of proposed net pens and the floating dock. There would be no physical ground disturbance at the downstream alternative sites considered for Site #3, as no upland support site would be created at these locations. The proposed construction period – 6 months beginning in mid-summer 2012 – would avoid sensitive life cycles and periods of peak wildlife activity.

The proximity of bald and golden eagle nests identified in the WDFW Priority Habitats and Species Database in relation to PAI Preferred Alternative Site #3 or alternative sites considered are beyond buffers from construction disturbance recommended by the U.S. Fish & Wildlife Service (USFWS, May 2007).

In the operational condition of the project, there would likely be daily employee visits to Preferred Alternative Site #3, but no full-time office as there is at PAI existing Site #1. Wildlife use of the upland support parcel at Site #3 would likely resume at levels approximately comparable to existing conditions, particularly for nocturnal species.

Because no ESA-listed species or designated critical habitat are known to be present or utilize terrestrial environment action areas that would be affected by upland construction, the proposed action will have no effect on terrestrial ESA-listed species or designated critical habitat.

No Action Alternative. There would be no disturbance to wildlife (birds, rodents, reptiles, mammals), ESA-listed species, or designated critical habitat in the terrestrial environment as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any significant adverse environmental consequences to wildlife, no mitigation measures for temporary impacts to terrestrial faunal communities is proposed or required.

5.2.9 Threatened, Endangered and Protected Terrestrial Species

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. No State- or Federally-listed plant species or their critical habitat occur on or near upland sites that would be subject to construction disturbance as a result of the proposed project. Therefore, no adverse environmental consequences to threatened, endangered or protected plant species are expected and no mitigation measures are proposed. Only approximately 0.3 acre of upland would be disturbed at Preferred Alternative Site #3.

A preliminary opinion was provided in personal communication with a U.S. Fish and Wildlife Service biologist (to be confirmed during informal ESA consultation with USFWS) that the project would have "No Effect" on the Federally-listed animal species, and is "Not Likely to Adversely Effect" bull trout (Greg Kurz, USFWS, December 14, 2010). No other Federally-listed animal or fish species are present within the area of potential effect of the proposed project.

No species protected under the Bald and Golden Eagle Protection Act will be harmed because of the distance between the PAI Preferred Alternative Site #3 action area and known nest tree locations. No bird species protected under the Migratory Bird Treaty Act are likely to be adversely affected because of the small amount of local habitat that would be altered, a construction phase of relatively short duration, and construction disturbance scheduled to occur after the breeding season.
No Action Alternative. There would be no potential for impact to threatened, endangered or protected plant or animals species as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any projected environmental consequences to State- or Federally-listed terrestrial animal species or designated critical habitat, no mitigation measures are proposed. Also see *NEPA Environmental Assessment* Section 5.1.4.6 for a discussion of Threatened, Endangered and Protected Aquatic Species.

5.3 HUMAN ENVIRONMENT

The human environment action area during the construction phase would be essentially the same as the action area for potential construction effects in the terrestrial environment described in *NEPA Environmental Assessment* Section 5.2, above.

The human environment action area in the operational condition of the project is generally the Colville Indian Reservation as a whole, although for linear elements such as Transportation, Utilities, and Areas of Recognized Recreational Value, the action area will be the Columbia River Road (BIA Road 10) corridor. For other elements of the human environment (Noise, Light and Glare, and Areas of Recognized Scenic Value), the operational effects action area is defined as Site #3 and within a 0.5-mile radius.

5.3.1 Confederated Tribes of the Colville Reservation

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. There would be no environmental consequences to the boundaries or governmental structure of the Confederated Tribes of the Colville Reservation as a result of construction and operation of a third PAI steelhead trout net pen aquaculture project. Potential environmental consequences to the aquatic environment, terrestrial environment, and human environment of the Reservation are described in other sections of *NEPA Environmental Assessment* Chapter 5.

No Action Alternative. Similarly, there would be no potential for environmental consequences to the boundaries or governmental structure of the Confederated Tribes of the Colville Reservation as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of environmental consequences to the Reservation per se, no mitigation measures are proposed for this element of the *NEPA Environmental Assessment*. A summary of overall mitigation measures proposed for the steelhead net pen aquaculture Site #3 project is provided in *NEPA Environmental Assessment* Chapter 7.

5.3.2 Areas of Recognized Archaeological or Historic Value

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. There would be no new area of ground disturbance at PAI existing Site #1 where net pen assembly is proposed for the third fish farm.

Preferred Site #3. Pacific Aquaculture, Inc. consulted with the Colville Tribal Historic Preservation Officer (THPO) prior to finalizing the site selection process for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project. The preferred location for the upland support services site was selected based on no known archaeological sites at PAI Preferred Alternative Site #3. The *Cultural Resources Survey* conducted for Colville Tribal Tract 101-T4213 found that the proposed project is unlikely to adversely affect any cultural resources. Therefore, the CCT History/Archaeology Program recommends that the project proponent proceed with caution, subject to the conditions described in the Mitigation Measures section below.

EPA has determined that authorization of aquaculture discharges into Rufus Woods Lake under the NPDES permitting program (at PAI Preferred Site #3 or any of the alternative locations) is not an undertaking that has the potential to cause effects to historic properties or cultural resources. EPA has no jurisdiction over construction or siting of the proposed project (net pens or upland facilities), which are the primary means by which historic properties or cultural resources could be impacted. Therefore, pursuant to 36 CFR 800.3(a)(1), EPA has no further obligations under Section 106 of the National Historic Preservation Act. Rather, Federal and/or Tribal agencies with direct jurisdiction and permitting authority over siting and construction of the proposed facility will need to work with the applicant to ensure that historic properties and cultural resource are protected in accordance with applicable State and Federal law.

Alternative Locations. The CCT History/Archaeology Program was also asked to conduct a preliminary search of available databases, maps and literature on file to determine whether there are any known archaeological sites at the alternative fish farm locations considered for Site #3: High Bank Bight (RM 573.9), Mah-Kin Rapids (RM 572.4), or Narrows Downstream (RM 571.9). No known allotments or Traditional Cultural Properties (TCPs) were identified near these alternative fish farm locations; however, this preliminary review of the alternative fish farm sites does not substitute for a comprehensive cultural resources review as required by Section 106 of the National Historic Preservation Act (NHPA) nor under Colville Tribal Code Chapter 4-4-7 (CCT History/Archaeology Program, February 23, 2011). The Tribal Historic Preservation Officer has not considered these alternative fish farm locations as having no effect on cultural resources. If upland disturbance is proposed at any of these locations, a comprehensive cultural resources review would be required.

No Action Alternative. There would be no potential for disturbance of archaeological sites or cultural resources as a result of the No Action Alternative.

MITIGATION MEASURES

The area surrounding the site proposed for upland support services to the Rufus Woods Lake Steelhead Net Pen Site #3 is rich in archaeological sites and TCPs; therefore, ground-disturbing activities should be monitored during site development. Further, the *Cultural Resources Inventory for the Pacific Aquaculture Feed Silos Facility, Colville Reservation, Okanogan County, Washington* (February 1, 2011) includes the following conditions intended to avoid or mitigate potential encounters with previously unknown items, artifacts, or features:

Condition 1: Inadvertent Discoveries (43 CFR 10.4). In the event that human remains, burials, funerary items, sacred objects, or objects of cultural patrimony are found during project implementation, the project proponent or his authorized agent shall cease work immediately within 200 feet of the find. They shall then take steps to protect the find from further damage or disruption. They shall contact the Tribal Historic Preservation Officer (THPO) or Tribal Archaeologist to report the find. The THPO or Tribal Archaeologist shall contact the appropriate law enforcement authority if human remains are found. No further work shall be allowed on the project until the THPO has approved a plan for managing or preserving the remains or items found.

Condition 2: Post-Review Discoveries (36 CFR 800.13). In the event that prehistoric artifacts (i.e., arrowheads, spear points, mortars, pestles, other ground stone tools, knives, scrapers, or flakes from the manufacture of tools, fire pits, peeled trees, etc.) or historic-period artifacts or features (i.e., fragments of old plates or ceramic vessels, weathered glass, dumps of old cans, cabins, root cellars, etc.) are found during project implementation, the proponent or his authorized agent shall cease work immediately within 200 feet of the find. Then they shall contact the THPO or the Tribal Archaeologist to report the find. No

further work shall be allowed on the project until the THPO has approved a plan for managing or preserving the artifacts or features.

Condition 3: Activities that have the potential to disturb cultural resources outside the areas specified in documents that accompany the *Cultural Resources Inventory* prepared for the site are not approved and will not proceed until cultural resources review of potential adverse effects in the new area has been completed.

5.3.3 Socioeconomic Issues

5.3.3.1 Population

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Implementation of PAI proposed steelhead net pen aquaculture Site #3 on Rufus Woods Lake would have no affect on the number or composition of Colville Tribal member and non-Colville member population residing on the Reservation or in the surrounding area.

No Action Alternative. Similarly, there would be no affect on population as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any potential effect on population, no mitigation measures are proposed or required for this element of the environment.

5.3.3.2 Housing

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Implementation of PAI proposed steelhead net pen aquaculture Site #3 on Rufus Woods Lake would have no effect on the number or type of housing units on the Reservation.

No Action Alternative. Similarly, there would be no affect on housing as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any potential effect on housing, no mitigation measures are proposed or required for this element of the environment.

5.3.3.3 Employment

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Implementation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project would have the beneficial consequence of creating short-term work (primarily for contractors) during construction, and six new jobs to operate an

additional fish farm on the lake/reservoir. PAI proposes to hire Tribal members for the majority of the new employment positions to operate Site #3.

No Action Alternative. No new employment opportunities would be created by the No Action Alternative.

MITIGATION MEASURES

In the absence of any known adverse impacts to employment, no mitigation is proposed or required.

5.3.4 Environmental Justice

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. As described in *NEPA Environmental Assessment* Chapter 4, Section 4.3.4, the Colville Confederated Tribe (CCT) is a partner agency in the environmental review process under the National Environmental Policy Act, and a sovereign nation with permitting authority over the proposed project. These forms of authority to review, authorize, condition, and/or monitor the performance of the proposed project constitute a beneficial consequence for CCT.

Further, as described above in Section 5.3.3.3, PAI steelhead net pen aquaculture Site #3 will create employment for Tribal members, and will generate revenues for the Tribal operating budget. At the current royalty rate of $0.005/lb, PAI anticipates that the Site #3 net pen aquaculture operation will generate approximately $10,000 per year in revenues to be paid to CCT. No known adverse consequences to CCT have been identified in this assessment of the proposed action.

No Action Alternative. There would be no adverse or beneficial environmental justice effects as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of adverse consequences to CCT governmental programs, human health or the environment on the Reservation, no mitigation measures other than those included in the proposal are required in order to achieve environmental justice for the affected population group.

5.3.5 Transportation

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1 and Preferred Site #3. It is estimated that approximately 1 to 2 vehicle round trips per day would be generated on weekdays between PAI existing Site #1 and PAI Preferred Alternative Site #3 to operate the additional Rufus Woods Lake steelhead trout net pen aquaculture project. Feed deliveries would result in approximately 8 round trip truck deliveries per month.[4] This number of trips would have no adverse consequence on Columbia River Road traffic operations due to very low existing traffic volumes.

Harvest associated with the Site #3 project at any of the alternative locations considered would generate additional truck trips to/from PAI existing Site #1, as the proposal includes conducting all harvest activities at the existing Site #1 dock. With Site #3 harvest projected in the range of 4.5 million pounds of fish (live weight) per year, the new operation would generate approximately 120 round-trip truck trips per

[4] Feed trucks transport 28 to 30 tons of feed per semi truck load.

year, or 2 to 3 truck trips per week (personal communication with John Bielka, PAI General Manager, March 30, 2011).[5] This volume would still be well within the operating capacity of Columbia River Road.

Alternative Locations. If one of the alternative locations for Site #3 were selected for implementation, there would be few, if any, vehicular trips on Columbia River Road associated with day-to-day operations as there would be no upland support operation at these alternative locations.

No Action Alternative. Traffic generated by existing uses (including PAI existing Sites #1 and #2) would remain unchanged.

MITIGATION MEASURES

In the absence of adverse consequences to traffic on Columbia River Road, no mitigation measures are proposed or required for Transportation.

5.3.6 Noise

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1 and Preferred Site #3. Sources of noise and sound level estimates during construction of proposed steelhead net pen aquaculture Site #3 are described in the *Biological Evaluation* prepared for the project (PAI, March 1, 2011). The text below is an excerpt from that document.

The Washington State Department of Transportation *Advanced Training Manual for Biological Assessment Preparation for Transportation Projects* (WSDOT (2008) was used to address the potential construction noise effects of the proposed project and to establish the noise action areas, both upland and underwater. Potential noise effects in the aquatic environment are discussed in Chapter 5, Section 5.1.4 of this *NEPA Environmental Assessment*. Assumptions for baseline and construction noise used below are taken from the WSDOT manual. Noise is usually measured in decibels (dB). In-air noise (which commonly is frequency-weighted to approximate human hearing) is measured on an A-weighted scale, denoted as dBA.

Rural areas are the quietest with noise levels of 35 to 40 dBA. A WSDOT noise assessment on the San Juan Islands (similar to the terrain at PAI existing Site #1 and proposed Site #3) identified a baseline of about 35 dBA with regular noise intrusions from traffic and aircraft overflights ranging from 45 to 72 dBA. Typical traffic noise levels for traffic volumes on a two-lane roadway (such as Columbia River Road adjacent to PAI existing Site #1 and proposed Site #3), assuming 4 percent medium trucks, 6 percent heavy trucks, no buses, and no motorcycles, measured at 50 feet from the source, is 60.9 dBA at 50 mph for 125 vehicles per hr. Because traffic is very light on Columbia River Road, a baseline of 55.4 dBA is estimated during daylight hours when construction would occur, assuming a traffic volume of 30 vehicles per hr. Based on these parameters, it is reasonable to assume a noise baseline of 55.4 dBA.

Once the baseline has been estimated, the type and average maximum noise levels (L_{max}) at 50 feet (from the source) is identified for construction equipment noise. In the case of PAI existing Site #1 where net pen assembly is proposed, a crane (81 dBA) and forklifts (79 dBA) will be the loudest equipment. Although noise generated by multiple sources at the same location results in louder levels than a single source alone, the decibel is on a logarithmic scale, so noise levels generated by more than one piece of equipment operating at the same time is not additive by standard addition. Two noises separated by 2 to 3 dB (±1 dB) combine to increase the noise level by 2 dB. Hence, the maximum construction noise level at

[5] Each harvest truck carries approximately 38,000 pounds of fish.

PAI existing Site #1 is estimated to be 83 dBA when the crane and forklifts are operating simultaneously. Similarly at PAI proposed Site #3, a crane (81 dBA) and an excavator (81 dBA) will be the loudest equipment operating during construction. Because the projected noise levels for cranes and excavators are the same, when combined they would raise the noise level by 3 dB. Therefore, the maximum construction noise level on the Site #3 upland parcel is estimated to be 84 dBA at times when the crane and excavator are operating simultaneously.

It is assumed that noise associated with floating the completed net pens downstream will be at baseline sound levels because PAI boats to be used for operations will be similar to existing small vessel traffic that operates on the river/reservoir.

Anchor pin installation will be done with a crane with a vibratory head. No standard noise level is available for this unique set up, but it is known that a vibratory pile driver has a noise level of 101 dBA. It would be conservative to estimate that noise generated during anchor pin installation will be somewhere between 101 and the 81 dBA from the crane, or approximately 91 dBA.

Noise is attenuated with distance, but the amount of sound level reduction over distance depends on whether surface conditions are "soft" or "hard." A hard site exists where noise travels away from the source over a generally flat, hard surface such as water (where anchor pin installation would occur), concrete, or hard-packed soil (subtract 6 dBA for each doubling of distance). When ground cover or normal unpacked earth exists between the source and receptor, the site conditions become absorptive to noise energy (-7.5 dBA for each doubling of distance). Because PAI existing Site #1 and proposed Site #3 are adjacent to water, but have ground cover and normal unpacked earth, they can be characterized as exhibiting intermediate site conditions for the purpose of the construction noise impact analysis. Therefore, a reduction factor of 6.8 dBA per doubling distance is used to calculate the distance at which upland construction noise would attenuate to baseline sound levels. This methodology is used to define the action areas, as calculated in Table 5.3-1, below.

Table 5.3-1. Construction noise attenuation.

Distance from Source	**Construction Noise (-6.9 dBA)**		**Anchor Pin Installation (-6 dBA)**
	PAI Existing Site #1	Proposed Site #3	Proposed Site #3
50	83.0	84.0	91
100	76.2	77.2	85
200	69.4	70.4	79
400	62.2	63.6	73
800	55.8	56.8	67
1,600	49.0	50.0	61
3,200	N/A	N/A	55

Based on the noise attenuation table above, a conservative area of effect for upland construction at PAI existing Site #1 and proposed Site #3 is established at a radius of 1,000 feet, and at a radius of 3,200 feet (approximately 0.6 mile) for anchor pin installation in the aquatic environment at Site #3.

Based on the analysis above described in the Biological Evaluation prepared for the project, noise and physical activity during construction would be very localized. Mobile species would be temporarily displaced from the area during noise-generating activities and human activity (see the discussion in *NEPA Environmental Assessment* Chapter 5, Section 5.28). The estimated construction period is 6 months.

In the operational condition of Site #3, noise associated with the pneumatic feed delivery system would be introduced in a presently undeveloped area. Fish are fed during daylight hours, 2 to 3 times per day per cage. The pneumatic feeding system at PAI Preferred Alternative Site #3 would run 6 to 8 hours per day.

Alternative Locations. Sound levels associated with construction and operation of a third PAI steelhead trout net pen aquaculture facility at an alternative location – also in an undeveloped rural area − would be similar to those described above for Preferred Site #3, with the exception that there would be no upland construction and no upland support services operating at the downstream alternative locations evaluated.

If a feed barge were used at an alternative location other than PAI Preferred Alternative Site #3, there would be noise associated with feed blowers and large diesel generators used to operate the feed delivery system. PAI does not have specifications available to quantify sound levels associated with operating blowers and generators of the type that would be used for this purpose; however, sound levels would likely be comparable to a construction-type air compressor that has a noise level of 78 dBA (WSDOT 2008). Based on the estimated sound attenuation method used in Table 5-3.1 and the paragraphs above, baseline noise levels of 55.4 dBA would be achieved at a distance approximately 500 feet from the source if operated without shielding or insulation.

No Action Alternative. There would be no new facilities constructed with the No Action Alternative, and therefore no consequences to the terrestrial or human environment related to construction or operational noise. Factors affecting existing sound levels within the study area would remain unchanged.

MITIGATION MEASURES

The proposed construction period – 6 months beginning in mid-summer 2012 – would avoid wildlife sensitive life cycles: breeding, nesting, rearing.

Noise-generating equipment associated with the pneumatic feed delivery system at PAI Preferred Alternative Site #3 would be housed inside an operations trailer (i.e., metal container) to minimize the transmission of sound in the area around the site. If one of the downstream alternative sites were selected requiring the use of a feed barge, both the feed blowers and diesel generators would be housed inside the insulated canopy of the feed barge to minimize the noise of this operation. At any of the alternative sites considered in this *NEPA Environmental Assessment*, the locations are remote from homes or other sensitive receivers.

5.3.7 Light and Glare

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1. No additional yard lighting would be needed at PAI existing Site #1 for the short-term activity to assemble Site #3 net pens at this location.

Preferred Site #3. If PAI Preferred Alternative Site #3 is selected for the additional steelhead trout net pen aquaculture operation, yard lights and security lights to be introduced on the upland support site would be a source of nighttime lighting, and feed silos may be an occasional source of glare on sunny days. Under any alternative, lights would be installed on the Site #3 floating net pen structure as private aids to navigation, in accordance with U.S. Coast Guard requirements (see *NEPA Environmental Assessment* Chapter 5, Section 5.1.5).

Alternative Locations. If any of the downstream alternative locations were selected for the new net pen operation, there would be no upland support site and therefore no introduced sources of light in the terrestrial environment.

No Action Alternative. No new sources of light or glare would be introduced on land or on Rufus Woods Lake within the proposed action area with the No Action Alternative.

MITIGATION MEASURES

PAI proposes to shield yard light fixtures in the upland support services area of Preferred Alternative Site #3 to direct illumination downward to avoid glare for vehicles traveling on Columbia River Road and to minimize light spillage into the surrounding area.

5.3.8 Areas of Recognized Scenic Value

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Since no areas of recognized scenic value were identified within the view shed of any of the alternative sites considered for PAI steelhead trout net pen aquaculture Site #3, there would be no adverse consequences to scenic areas as a result of the proposed project.

No Action Alternative. There would be no adverse or beneficial consequences to areas of recognized scenic value as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any adverse consequences to areas of recognized scenic value, no mitigation measures for such effects are proposed or required.

5.3.9 Areas of Recognized Recreational Value

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1 and Preferred Site #3. There would be no direct effects to the designated camping area adjacent to PAI existing Site #1 as a result of the proposal to assemble net pen cages in the Site #1 upland area. If campers were present during the estimated 2-month period during which net pens are being assembled, equipment noise associated with this activity (described in *NEPA Environmental Assessment* Section 5.1.4.3 above) would be audible in the camping area.

PAI existing Site #1 has, and PAI Preferred Alternative Site #3 would have, their own floating dock to facilitate operational vessel access to the net pens.

Alternative Locations. If one of the downstream alternative locations were selected for Site #3, there would be no upland construction, and any of these sites would be distant (approximately 5 to 7 miles) from the informal campground adjacent to PAI existing Site #1. Support services for net pen operation at any of the downstream alternative locations would originate from PAI existing Site #1; project operations would not rely on public boat launches in the area. This would result in an increased number of PAI vessel trips past the informal campground during days of PAI operation, but would not conflict with boat launching or water access for campground users, as the nearest public launch is approximately 2 miles upstream (Thalheimer Boat Launch).

No Action Alternative. There would be no adverse or beneficial consequences to areas of recognized recreational value as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of any adverse consequences to areas of recognized recreational value, no mitigation measures for such effects are proposed or required.

5.3.10 Public Lands

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site # 1, Preferred Site #3 or Alternative Locations. Construction and operation of PAI steelhead net pen aquaculture Site #3 would not adversely affect public lands at any of the alternative locations considered for the third fish farm.

No Action Alternative. There would be no adverse or beneficial consequences to public lands as a result of the No Action Alternative.

MITIGATION MEASURES

In the absence of adverse consequences to public lands, no mitigation measures for such effects are proposed or required.

5.3.11 Public Services

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1, Preferred Site #3 or Alternative Locations. Construction and operation of PAI steelhead net pen aquaculture Site #3 would not exert any regular, on-going need for public services. There may be an occasional need for emergency medical services to attend to an injured worker, or for fire protection services to suppress a fire on the upland support site, for example.

No Action Alternative. The No Action Alternative would result in no occasional or sustained requirement for public services.

MITIGATION MEASURES

Royalties that would be paid by PAI to the Tribe associated with the Rufus Woods Lake Site #3 steelhead trout net pen operation would more than offset the cost of public services (see *NEPA Environmental Assessment* Section 5.3.4, above).

5.3.12 Utilities

ENVIRONMENTAL CONSEQUENCES

PAI Existing Site #1 and Preferred Site #3. If upland support services are constructed at PAI Preferred Alternative Site #3, these facilities would require an electrical connection from Nespelem Valley Electric and Colville Confederated Tribes (CCT) Disposal. There is no cellular phone service at PAI Preferred Alternative Site #3. Company communications would likely occur using marine radios. There would be no potable water supply or on-site sewage disposal system at Site #3. A commercial "port-a-potty" will be placed on the site during construction, to be maintained in the operational condition of the project (personal communication with John Bielka, PAI General Manager, various dates in March 2011).

Alternative Locations. If one of the downstream alternative locations were selected for PAI steelhead net pen aquaculture Site #3, no utility services would be needed as there would be no upland support services site at these locations.

No Action Alternative. In the absence of any new construction with the No Action Alternative, there would be no requirement for new or additional utility services at any of the sites evaluated.

MITIGATION MEASURES

PAI would pay the electrical connection fee and monthly service charges for electricity and garbage collection.

5.4 INDIRECT EFFECTS

Indirect effects are those that would be caused by the proposed action, later in time or farther removed in distance, but still reasonably forseeable.

There are no indirect effects of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project that are reasonably forseeable in the future.

5.5 CUMULATIVE EFFECTS

A cumulative effect is an effect on the environment that results from the incremental effects of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. The Rufus Woods Lake Site #3 steelhead trout net pen project would introduce a fourth salmonid aquaculture operation in this Columbia River reach impounded by Chief Joseph Dam (three PAI sites and the Chief Joseph Orchards fish farm). There are no known applications pending for other projects that would affect the Rufus Woods Lake aquatic environment.

Pacific Aquaculture, Inc. has acquired permits from the Colville Confederated Tribes to construct a 6,000 sq ft fish processing plant adjacent to the location of its existing Site #1 operations (CCT Permit No. 898835 for Tax Parcel No. 90003514, 3378 Columbia River Road, Nespelem, Washington). The plant would be used to process steelhead trout raised in all PAI net pen aquaculture operations on Rufus Woods Lake. If PAI Site #3 receives all required permits and approvals, the company anticipates making a

business decision to proceed with construction of the processing plant. There would be no discharge to the lake/river from the processing plant; therefore, there would be no aquatic environment effects from this separate action. Potential cumulative effects of the processing plant and the PAI Site #3 fish farm on the terrestrial and human environment are discussed below.

There are no other known proposals for actions by others within the area of potential effect of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project (personal communication with Todd Thorn, Watershed Program Manager, CCT Office of Environmental Trust, April 1, 2011).

5.5.1 Cumulative Nutrient Loading in the Aquatic Environment

Cumulative nutrient loading effects are considered here as the only water quality consideration that is remotely possible for downstream areas of Rufus Woods Lake and downriver reservoirs as a result of the operation of a fourth steelhead trout net pen aquaculture project in Rufus Woods Lake. Nutrients specifically are not an issue, but rather the possibility of perturbation of phytoplankton, periphyton or macrophyte stocks downstream. For the reasons stated below, the operation of proposed PAI Site #3 would have a negligible incremental effect on the downstream water quality of Rufus Woods Lake and downstream reservoirs.

All of the water quality effects of net pen aquaculture are demonstrably "near field" (i.e., near to the source) except possibly the nutrient enrichment effects. Nutrients are a potential issue in all freshwater and coastal ecosystems, due to the potential to create excessive or harmful algal blooms that are damaging to the food web and in some cases other human activities. Nutrients in the mainstem Columbia River are rarely addressed, except in some cases during hydroelectric power dam relicensing and in the past when a problem in Lake Roosevelt associated with a Canadian fertilizer plant upstream caused algal problems previously described. There are few long-term water quality monitoring stations in the Columbia River, the most extensive being just below Grand Coulee Dam in Rufus Woods Lake, at the Washington State Department of Ecology (Ecology) Station 53A070. The only other suitable mainstem water quality station is at Ecology Umatilla Station 31A070, located below McNary Dam, east of the Umatilla Interstate Bridge in the upper reaches of the lower Columbia River at river mile 290.5 approximately 255 miles downstream from Chief Joseph Dam.

The concentrations of total phosphorus and orthophosphate, both indicators of trophic level status, were approximately 3 times higher downstream at Umatilla Station (UMT) versus Grand Coulee Dam (GCD) Station (Figure 5.5-1) during the 2000-2009 period discussed above. Mean values were: GCD TP = 5.6 µg/L (standard deviation [SD] 2.3) versus UMT TP = 15.3 µg/L (SD 3.3) and GCD OP = 3.8 (SD 0.8) and UMT OP = 9.1µg/L (SD 3.9). Rensel (1989) reviewed available upstream and downstream nutrient data and discussed nutrient loading status prior to 1989. Since then and as discussed in *NEPA Environmental Assessment* Chapter 4, the concentrations of both N and P have declined dramatically at GCD station. Stober et al. (1981) reported December 1979 to September 1980 total P concentrations at several stations along the 151 mile (243 km) length of Lake Roosevelt. Total P concentration in the tailrace of Grand Coulee Dam averaged about 50 µg/L during the January to April period, declined to < 20 µg/L in the summer, and increased slightly again in the late summer. February to May average total P concentration was 51 µg/L; June to September average was 24 µg/L. During this period, the mid-Columbia River was excessively enriched with nutrients from the Cominco, Ltd. Fertilizer plant in British Columbia that resulted in noxious blooms of the filamentous green algae *Cladophora* spp. that formed large floating mats in Lake Roosevelt (Welch et al. 1992). When the fertilizer plant ceased operation, concentrations of all forms of phosphorus declined and have apparently been declining ever since (Rensel 1989, 1993, 1996, data presented herein), and the floating mats of *Cladophora* spp. are apparently no longer a problem. Periphyton abundance is also affected by nutrient loading, although it is not a simple

relationship with nutrient concentration but involves other factors such as light and current velocity, as previously discussed.

Figure 5.5-1. Mean monthly and standard deviation of ammonia-N, dissolved inorganic nitrogen, nitrite plus nitrate, total persulfate nitrogen, monthly orthophosphate and total phosphorus at Ecology Station 53A070 downstream of Grand Coulee Dam (GCD, blue line) and at Ecology Station 31A070 below McNary Dam (UMA, green line), year 2000 through 2009.

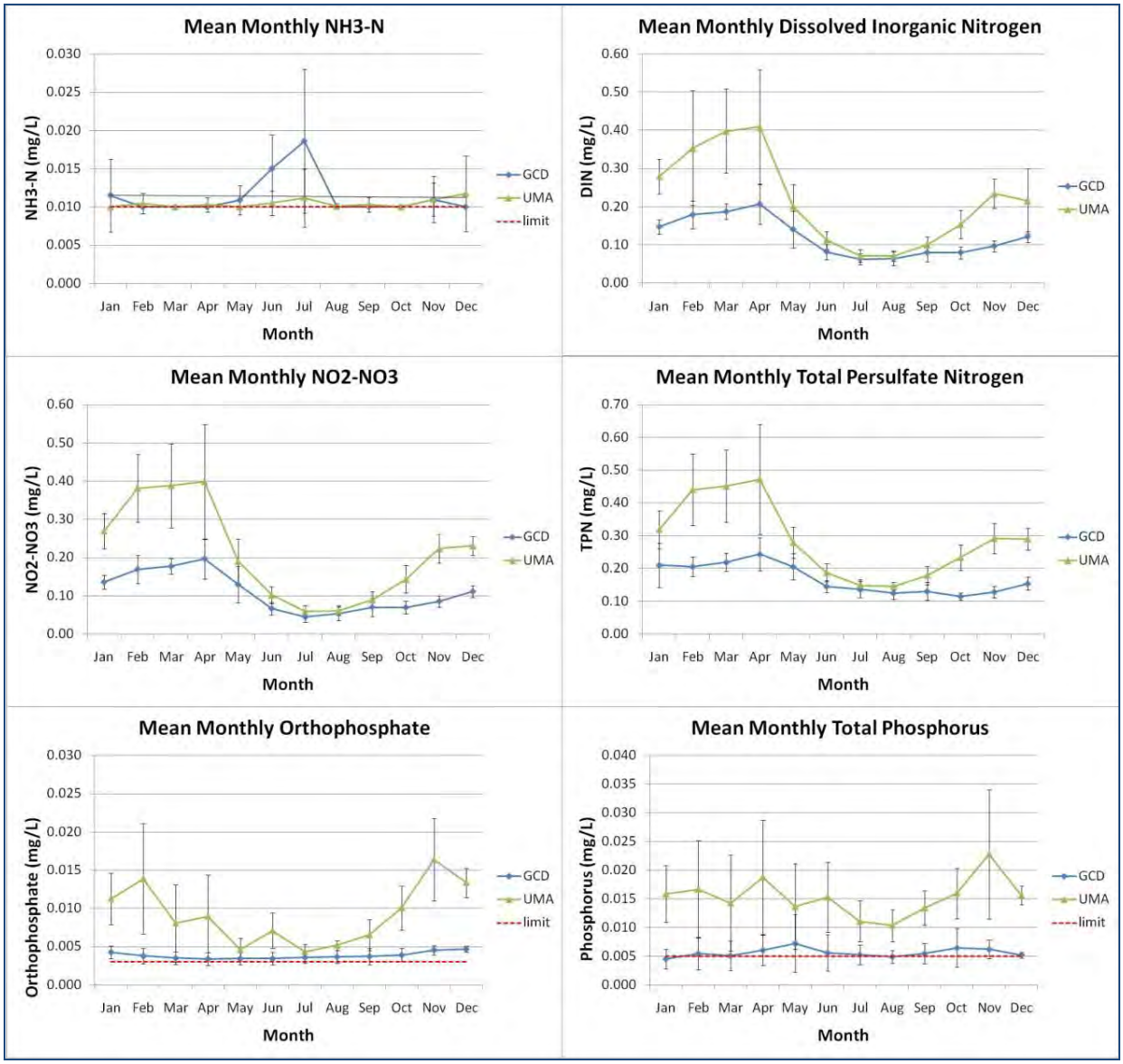
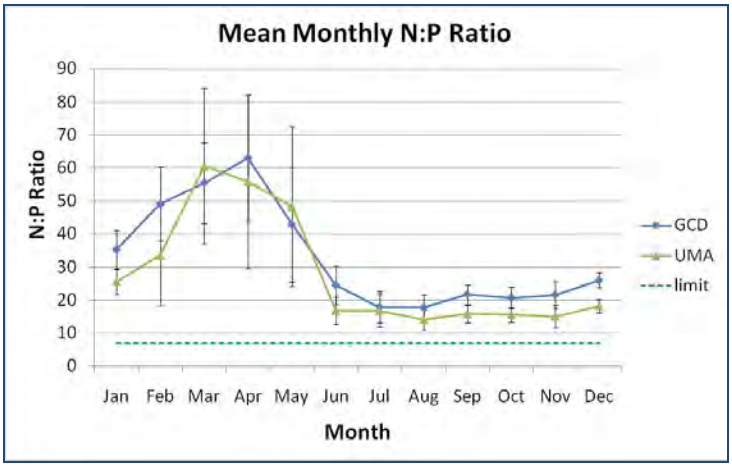


Figure 5.5-2 shows that the important N:P ratio for water entering Rufus Woods Lake and in the lower Columbia River remain essentially the same, with a slight tendency toward relatively less phosphorus downstream except in spring.

Figure 5.5-2. Mean monthly and standard deviation of calculated N:P ratios at Ecology Station 53A070 downstream of Grand Coulee Dam (GCD, blue line) and at Ecology Station 31A070 below McNary Dam (UMA, green line), year 2000 through 2009.



The lower Columbia River is subject to nutrient loading from the Snake and Yakima Rivers that are considerably more eutrophic than the lower mainstem Columbia River. The net effect of these contributing rivers is modest because their total water volume is low compared to the mainstem Columbia River. Because mainstem Columbia River P has declined greatly over the past 20 years, the relative contribution of these rivers is now more important. Another factor that is not accounted for is return flow from the Columbia Basin Project[6] that may be increasing as water tables rise and return flow transports agricultural and other sources of nutrients to the river. However, we would expect nitrogen loading to increase disproportionately to phosphorus as nitrogen is more mobile in soils than phosphorus until the soils are highly saturated with the latter. The lack of a shift to a lower N:P ratio in Figure 5.5-2 suggests that return flow of nitrogen may not be significant over the past decade.

Figure 5.5-3 illustrates basic water quality parameters at the same upriver and downriver locations mentioned above. Water temperature is significantly higher downstream from March through September and conductivity is slightly higher except during the peak river discharge period of late spring and early summer. Mean monthly dissolved oxygen is slightly higher downstream, but not greatly enhanced as it would be if primary productivity was overly abundant. Mean monthly turbidity is relatively higher downstream than upstream, but average or maximum values are relatively low compared to other river systems in the Pacific Northwest, such as the largely unregulated Fraser River in British Columbia.

Collectively, these data do not indicate that nutrient loading is a problem, existing or incipient, for either the mid-Columbia River or the lower Columbia River. There are more sensitive and sophisticated measurements possible, but information on the mainstem Columbia River is relatively scarce compared to the tributary systems. Macrophyte bed composition and extent surveys, for example, once conducted annually by public utility districts in the mid-Columbia River, have not been conducted for many years. Even water quality monitoring stations are few and often not occupied for long time periods, except for the Grand Coulee Dam station in Rufus Woods Lake. Routine measurement of chlorophyll *a* content of the mainstem river has not been a priority of the Washington State Department of Ecology, although

[6] The Columbia Basin Project in central Washington is the irrigation network made possible by Grand Coulee Dam. It supplies irrigation water to more than 670,000 acres within a project area 1.1 million acres in size. Water pumped from the Columbia River is carried over 331 miles of main canals, stored in a number of reservoirs, then fed into 1,339 miles of lateral irrigation canals.

fortunately at the request of the Colville Confederated Tribes, it has been resumed at Grand Coulee Dam station. Figure 5.5-4 illustrates recent data, limited to just a few years that do show higher productivity downstream at Ecology's Umatilla water quality station in the upper reaches of the lower Columbia River in late summer but ostensibly not at other times of the year. For reference, concentrations of chlorophyll *a* less than 5 µg/L are not considered bloom conditions but a range of 3 to 5 µg/L is relatively high compared to recent historical annual average values in Rufus Woods Lake (Moore 1992, Rensel 1996 and other routine monitoring reports provided to Colville Confederated Tribes).

Figure 5.5-3. Mean monthly and standard deviation of water temperature, conductivity, dissolved oxygen and turbidity at Ecology Station 53A070 downstream of Grand Coulee Dam (GCD, blue line) and at Ecology Station 31A070 below McNary Dam (UMA, green line), year 2000 through 2009.

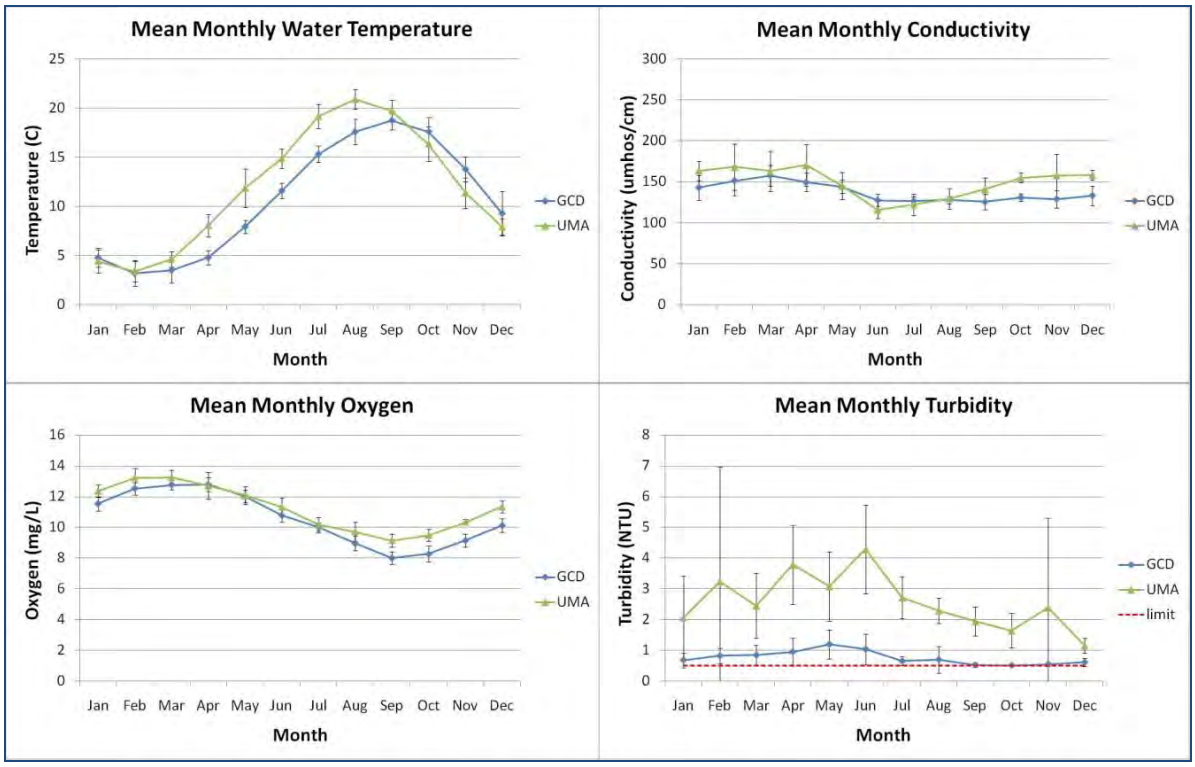
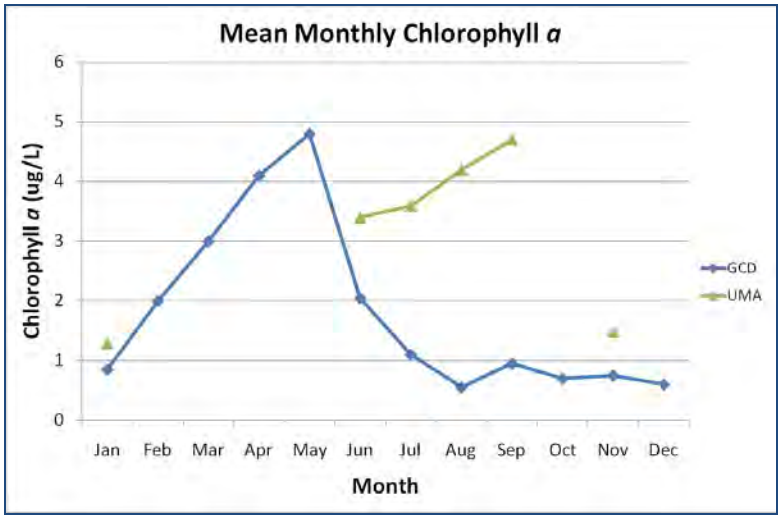


Figure 5.5-4. Mean monthly chlorophyll *a* at Ecology Station 53A070 downstream of Grand Coulee Dam (GCD, blue line) and at Ecology Station 31A070 below McNary Dam (UMA, green line), year 2010 through 2011. Station 31A070 data was only available for part of the year.



Finally, if the lower Columbia River was becoming eutrophic, various indicators would be apparent such as a change in sediment quality. Buck (2004) found that organic carbon compounds in the lower Columbia River were typically below detection limits in sediment and lower-level organisms. Low concentrations of total organic carbon are generally reported in sediments of the lower Columbia River and estuary (Buck 2004, Hedges et al. 1984). Likewise, fine sediments (i.e., silts and clays) that often have significant organic carbon content are rarely found in these areas. This is likely due to relatively fast flushing rates, strong currents, and low particulate organic loading rates that result in low total organic carbon of lower Columbia River sediments.

As discussed above, downstream reservoirs are both warmer and slightly more turbid than Rufus Woods Lake with higher total phosphorus concentrations. Because none of these lakes are long-term water storage reservoirs and the slope of the river is steep compared to other major rivers in North America, the recent and near future risks of eutrophication appear to be small. The annual average total phosphorus concentrations in the lower Columbia River near the Department of Ecology Umatilla monitoring station over the past decade was 15.3 µg/L as shown above in this chapter (Section 5.5.1). This is a modest level of total phosphorus compared to metrics discussed above (e.g., Madsen 1998).

5.5.2 Cumulative Effects in the Terrestrial and Human Environment

If PAI Site #3 receives all required permits and approvals, and if PAI decides to proceed with construction of a 6,000 sq ft processing plant in the upland area adjacent to (east of) its existing Site #1 operations, there would be potential cumulative effects in the terrestrial and human environment when added to upland activities associated with the proposed Site #3 operation. These are discussed below. The project description is derived from a document prepared by Rensel Associates (J.E. Rensel, March 7, 2010).

The plant would be built after the Site #3 net pen aquaculture project is in-place and operational (personal communication with John Bielka, PAI General Manager, March 30, 2011).The estimated construction period for the processing plant and on-site utility systems is 4 months.

The plant would be 60 x 100 feet in dimension, oriented perpendicular to the lake/river, directly north of the existing dock (see Figure 5.5-5). On-site utilities would include water storage tanks and a septic tank/drainfield system. The septic tanks would be approximately 40 meters (approximately 130 feet) from the ordinary high water mark of Rufus Woods Lake.

The plant would be used to process steelhead trout raised by PAI in net pen aquaculture operations on Rufus Woods Lake. Processing would include stunning, gutting, and icing fish to prepare them for shipping to a final processing plant location. Waste product production and distribution would include:

- Fish viscera (guts) of the fish to be shipped out daily in plastic-lined totes to be used as a by-product.

- Process wash water used to wash the gutted fish and to clean surfaces. Approximately 3,500 gallons per day (5 days/week) of process wash water would be generated by the plant. The wash water would be directed to drains inside the plant, then routed through coarse screens and pumps to a rotating screen assembly for removal of solids. The treated process water would flow into a buried, adjacent septic tank system consisting of sequential 10,000 gallon and 6,000 gallon high-strength, "woven-roving" fiberglass polyester resin materials. The first chamber would function as a settling tank. The second chamber in line would serve as an overflow tank to baffle flow from the first tank. The second chamber would be pumped out periodically by automatic level detection under pressure to the upper end of the pressurized septic field system. These tanks will function to allow settling of any solids that escape the screening and drum filter process. The supernatant overlying water would be pumped up to a septic field system approximately 160 meters (approximately 525 feet) up slope to the north on PAI property. It has been recommended that the company develop Best Management Practices specific to the operation of the processing plant to address leak detection, prevention, and clean-up (Rensel Associates, March 7, 2010).

- Other wastes. The processing plant wash water treatment system would not be co-mingled with domestic wastewater (generated by the office restroom or kitchen), or with the on-site stormwater management system. No chemicals would be used in the on-site septic system used to treat process wash water.

Land Use. PAI Site #1 where the processing plant is proposed is already committed to upland support service uses for net pen aquaculture operations. An additional structure would be introduced on the site, thereby resulting in a minor increase in the level of development of rural lands along the Columbia River Road corridor. PAI has acquired the CCT Development Permit to construct the processing plant.

Topography and Soils. Minimal site grading would be required to construct the 6,000 sq ft processing plant in the upland area of PAI existing Site #1. There would be no notable change in topography, just as there would be no notable change at PAI Preferred Alternative Site #3, and therefore no cumulative effect on topography in the backshore area of this reach of the river. Native soils throughout the project area are a mixture of sand, cobble and rock, and therefore well-drained. Given low levels of precipitation in the area, no significant potential would be anticipated for erosion/sedimentation to occur during the construction phase at either site. PAI would comply with CCT stormwater management requirements both during construction and in the completed condition of upland improvements. Preliminary design of the processing plant calls for importation of sands and soils to improve percolation of the filtered wash water in the on-site treatment system. The wash water would be high in dissolved nutrients, particularly nitrogen, which is deficient in native soils. There would be no discharge to soils on PAI Preferred Alternative Site #3. In sum, no cumulative adverse impact to soils would be anticipated if these two projects were constructed simultaneously or close in sequence.

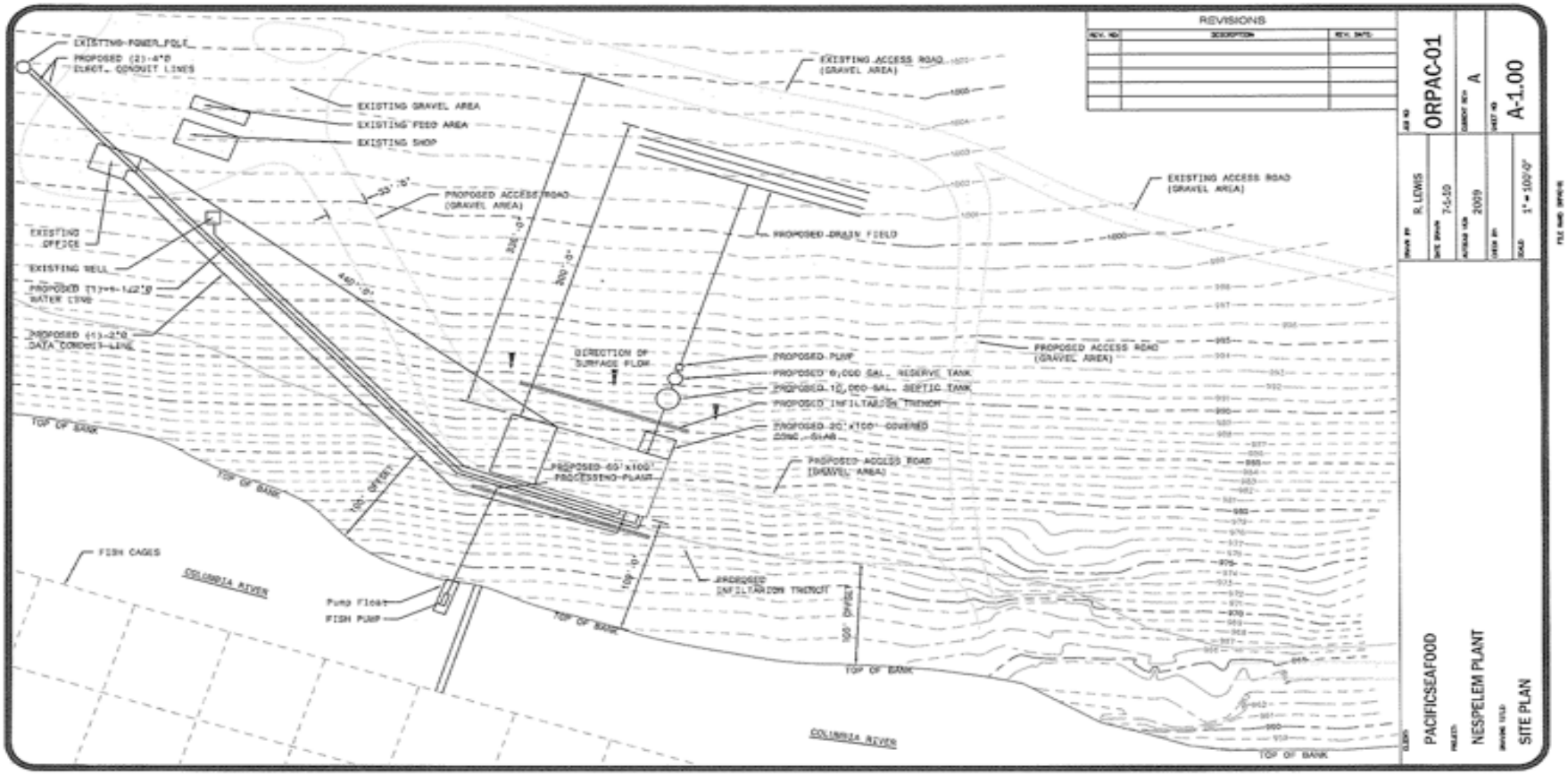


Figure 5.5-5. Pacific Aquaculture, Inc. proposed processing plant.

Air Quality. There would be additional emissions to the air (dust and vehicle exhaust) during an estimated 4-month construction period to build the processing plant and on-site utility systems. However, as there are no air quality conditions of concern within the proposed project area, and air circulation is good due to prevailing winds, no cumulative adverse air quality effects would be anticipated.

Floodplains. While there is no floodplain, per se, within the project area, the U.S. Army Corps of Engineers (USACE) has Government Flowage Easement rights along the Rufus Woods Lake corridor associated with the operation of hydroelectric dams. USACE has issued written consent to PAI for construction of the proposed processing plant within Government Flowage Easement Tract 2407E, having determined that the structure will not interfere with these flowage easement rights. If upland support services are constructed at PAI Preferred Alternative Site #3, feed silos and an operations trailer would be introduced on a site 2.6 miles downstream from the proposed processing plant. No significant cumulative effect on the Government's Flowage Easement rights is anticipated. If Site #3 were introduced at one of the further downstream alternative locations, there would be no upland structures.

Wetlands. There are no wetlands on the site of the proposed processing plant, and there are none on the alternative sites considered for Site #3 of the PAI net pen aquaculture operation on Rufus Woods Lake. Therefore, there would be no cumulative effect to wetlands.

Prime or Unique Agricultural Lands. There are no prime or unique agricultural lands on the site of the proposed processing plant, and there are none on the alternative sites considered for Site #3 of the PAI net pen aquaculture operation on Rufus Woods Lake. Therefore, there would be no cumulative effect to prime or unique agricultural lands.

Terrestrial Floral Communities. The site of the proposed processing plant is already lacking in the central arid steppe vegetative structure that is typical of the area. It is presently disturbed by car and light truck parking associated with access to the dock. Therefore, there would be no cumulative effect to terrestrial floral communities.

Terrestrial Faunal Communities. Due to the disturbed nature of the floral community on the site, the habitat quality for insects, amphibians, reptiles, birds, and mammals is also low. Therefore, there would be minimal cumulative effect to terrestrial faunal communities.

Threatened, Endangered, and Protected Species (TEPS). There are no threatened, endangered, or protected terrestrial species within the action area of PAI existing Site #1, and none on any of the alternative sites considered for Site #3 of Rufus Woods Lake steelhead trout net pen aquaculture. For this reason, there would be no potential for cumulative effects to terrestrial TEPS. Migratory bull trout may be present within the aquatic environment action area of the net pen aquaculture operations during winter and spring; however, no in-water work is proposed during the construction phase of the processing plant, and no discharge of wastewater to the lake/river is proposed during operations. Therefore, there would be no potential for cumulative adverse effects to bull trout.

Areas of Recognized Archaeological or Historic Value. Ground disturbance to construct the 6,000 sq ft processing plant may result in a slight cumulative increase in the potential to encounter presently unknown archaeological sites. The contractor would be required to comply with the same inadvertent discovery and post-review discovery procedures that would be imposed on development of upland support services at PAI Preferred Alternative Site #3; therefore, no cumulative adverse effects to archaeological or cultural resources would be anticipated.

Socioeconomic Issues. The processing plant would not alter population or housing on the Colville Indian Reservation. It would increase employment opportunities by 12 jobs. PAI would seek to fill most

of these jobs with Tribal members. The cumulative total increase in jobs with the Site #3 net pen aquaculture operation would be 18.

Environmental Justice. CCT reviewed PAI's application for construction of the processing plant and issued all required permits. New jobs for Tribal members would be created; therefore, there would be a cumulative beneficial effect to the Tribe as a result of the processing plant and Site #3 net pen aquaculture project.

Transportation. The Site #3 proposal includes transporting fish raised in the new net pen aquaculture operation to Site #1 for processing, from whichever alternative location is selected for Site #3. Therefore, no additional vessel trips would be generated if the processing method at Site #1 is improved by facilities and equipment to be provided in the processing plant. With 12 new jobs to be created with the processing plant, employee vehicle trips to/from Site #3 using Columbia River Road would increase by 12 to 24 round trips per day. The processing plant itself would generate few, if any, new trips other than the employee trips. Trips to from PAI existing Site #1 related to transporting harvested fish off-site presently occur and would increase as a result of the Site #3 harvest with or without the processing plant (see *NEPA Environmental Assessment* Section 5.3.5, above). Harvest occurs every week of the year, and will generate approximately 6 truck trips per week when Site #3 is fully operational (personal communication with John Bielka, PAI General Manager, March 30, 2011). Given the very low volumes of traffic on Columbia River Road, this projected volume of trip generation would have no cumulative adverse effect on traffic operations.

Noise. It is not anticipated that noise external to the processing plant would occur during operations (personal communication with John Bielka, PAI General Manager, March 23, 2011). Construction noise would be similar in character, duration, and volume to that described in *NEPA Environmental Assessment* Section 5.1.4.3 (above) associated with the assembly and "launching" of Site #3 net pen array components at PAI existing Site #1. If/when PAI makes a business decision to proceed with construction of the processing plant, the plant would be built after the Site #3 net pen aquaculture project is in-place and operational (personal communication with John Bielka, PAI General Manager, March 30, 2011). Therefore, there would be no incremental additive construction noise effect. In the absence of sensitive receivers (such as homes) nearby, no significant adverse consequences to the human environment would be anticipated as a result of construction noise.

Light and Glare. The processing plant would be equipped with yard lights and security lights similar in character and intensity to existing yard lights and security lights at PAI Site #1. This would result in an incremental cumulative increase in artificial lighting in the rural area adjacent to Columbia River Road if the Site #3 net pen aquaculture operation is constructed at PAI's preferred alternative location. If the High Bank Bight, Mah-Kin Rapids, or Narrows Downstream site were selected for PAI Site #3, there would be no cumulative increase in artificial lighting, as there would be no upland support services site at these locations.

Areas of Recognized Scenic Value. Given that construction of the processing plant would follow Site #3 net pen assembly in the PAI existing Site #1 upland area, there would be no cumulative construction noise impacts potentially audible to users of the campground adjacent to PAI existing Site #1. There would be two separate construction periods, and thus a longer duration of construction noise. At the time of this writing, there is no estimated construction start date for the processing plant. No conflicts in access to the campground or access to the lake/reservoir would be anticipated as a result of combined activities related to construction/operation of PAI net pen aquaculture Site #3 or the processing plant.

Areas of Recognized Recreational Value. Similarly, there are no areas of recognized recreational value within the project action area; therefore, there would be no cumulative impact to these areas as a result of constructing both the processing plant and the PAI Site #3 net pen aquaculture project.

Public Lands. There are no public lands adjacent to the proposed processing plant or the PAI Site #3 net pen aquaculture operation. Therefore, there would be no cumulative impact to public lands if the two projects were constructed simultaneously or in close succession to one another.

Utilities. Similar to PAI existing Site #1 and proposed Site #3, the processing plant would require electrical service and garbage collection service from Nespelem Valley Electric and CCT Disposal, respectively. A 400-amp service is being installed at PAI existing Site #1 in anticipation of the eventual construction of the processing plant. Actual usage is estimated in the range of approximately 150 continuous amps during operating hours – 8 hours per day, 5 days per week (personal communication with John Bielka, PAI General Manager, March 23, 2011). Since these services are already provided to Site #1, it would be efficient to increase services at a site that is already served. If Site #3 is constructed at PAI's preferred alternative location, there would be a slight cumulative effect in the demand for service along the Columbia River Road route.

6.0 CROSS-CUTTER ENVIRONMENTAL LAWS, COORDINATION AND CONSULTATION

6.1 APPLICABLE FEDERAL REGULATIONS AND EXECUTIVE ORDERS

6.1.1 Archaeological and Historic Preservation Act

The purpose of the Archaeological and Historic Preservation Act (16 USC 3501) is to protect archaeological resources and sites on Indian lands from vandalism and unauthorized collection. Given the similarities in purpose and relationship of the proposal to the AHPA and the NHPA, this discussion is provided in Section 6.1.13, below.

6.1.2 Clean Air Act

The Clean Air Act (CAA) is the comprehensive Federal law that regulates air emissions from stationary and mobile sources (42 USC 7401 et seq.). Among other things, this law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare, and to regulate emissions of hazardous air pollutants. One of the goals of the Act was to set and achieve NAAQS in every state by 1975 in order to address the public health and welfare risks posed by certain widespread air pollutants. The setting of these pollutant standards was coupled with directing states to develop State Implementation Plans (SIPs), applicable to appropriate industrial sources in the State, in order to achieve these standards. Section 112 of the CAA was amended in 1990 to first require issuance of technology-based standards for major sources and certain area sources. “Major sources” are defined as a stationary source or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant, or 25 tons per year or more of a combination of hazardous air pollutants. As the Confederated Tribes of the Colville Nation have not sought delegation from EPA to administer the Clean Air Act on the Colville Reservation, the Federal Air Rules for Indian Reservations (FARR) apply to activities on the Reservation. State and local air agencies are not authorized to administer their CAA rules on Indian reservations.

Minor emissions to the air during construction of the Rufus Woods Lake Site #3 steelhead trout net pen project would not constitute a “major source” as defined by the Clean Air Act; therefore, this regulation is not directly applicable to the proposed action. Further, the proposed action area does not occur within any air quality non-attainment or maintenance areas of the State; therefore, construction and operation of proposed improvements are not subject to a General Conformity determination under Federal air quality rules. Mitigation measures proposed for minor emissions to the air during construction are listed in Chapter 5, Section 5.2.3 of this *NEPA Environmental Assessment*.

6.1.3 Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into waters of the United States and establishing surface water quality standards (33 USC 1251 et seq.). Several permitting and licensing programs to protect water quality were established under the CWA, identified in Sections 401, 402, and 404, described below.

Section 401. Section 401 of the Clean Water Act establishes that any applicant for a Federal or Federally-delegated license or permit that may result in any discharge into the navigable waters of the United States must provide the licensing or permitting agency with a certification from the appropriate agency that any such discharge will comply with the applicable provisions of Sections 301, 302, 303, 306,

and 307 of CWA. Sections 301, 302, 303, 306, and 307 establish, respectively: effluent limitations, water quality-related effluent limitations, water quality standards and implementation plans, national standards of performance, and toxic and pretreatment effluent standards. The U.S. Environmental Protection Agency (EPA) will consult with the Colville Confederated Tribes (CCT) and perform the Section 401 certification for the Section 402 permit discussed below.

Section 402. Section 402 of the Clean Water Act establishes the regulatory program called the National Pollutant Discharge Elimination System (NPDES). The NPDES program, administered by EPA on the Colville Reservation, is intended to limit the amount and type of pollutants discharged into navigable waters so that fish, shellfish, wildlife, and recreational uses are protected. A NPDES permit sets conditions and limits on the discharge of pollutants that, as long as the conditions are met, makes the discharge of these pollutants legal.

Pacific Aquaculture, Inc. (PAI) submitted an application for a NPDES Waste Discharge Permit to EPA Region 10 on November 8, 2010. CCT will also require a separate Pollution Discharge Permit under Colville Tribal Law and Order Code Title 4, Chapter 4-8 (discussed in *NEPA Environmental Assessment* Section 6.2.3, below).

Section 404. Section 404 of the Clean Water Act, jointly administered by EPA and the U.S. Army Corps of Engineers, prohibits the discharge of dredged or fill material into waters of the United States without a permit. The excavation of sand, gravel, or other materials from waters of the U.S. is broadly defined and includes essentially all waterbodies, including intermittent streams, mudflats, sandflats, wetlands, shellfish beds, and wet meadows. A Section 401 Water Quality Certification is also required prior to issuance of a Section 404 permit.

There will be no excavation or fill in waters of the U.S. associated with construction of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

6.1.4 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) applies to every public water system in the United States (42 USC 300). This law authorizes EPA to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. Originally, SDWA focused primarily on treatment as a means of providing safe drinking water at the tap. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water.

SWADA is not applicable to the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project as improvements proposed on the upland support site do not include developing a public or private well.

6.1.5 Coastal Zone Management Act

Coastal areas often provide excellent wildlife habitat and protect inland areas from hurricanes and other storms. Many of this country's coastal areas are experiencing severe developmental pressures for residential, recreational and industrial use. These areas are also prone to storm damage and flooding. To address this condition, Congress enacted laws to protect coastal areas. The Coastal Zone Management Act (CZMA) of 1972 (16 USC 1451 et seq.), as amended, applies to all lands on the boundary of any ocean or arm thereof, and the Great Lakes.

All proposed projects that are within coastal zone management areas must obtain a "consistency determination." Federal consistency is the CZMA's requirement that Federal actions that are reasonably likely to affect any land or water use or natural resource in a coastal zone be consistent with the enforceable policies of a Federally-approved coastal zone management program in the coastal State or territory in which the project is proposed. Federal actions include:

- Direct Federal Actions – Activities and development projects performed by a Federal agency, or a contractor for the benefit of a Federal agency.
- Indirect Federal Actions – Activities not performed by a Federal agency, but requiring Federal permits or licenses or other forms of Federal approval, and Federal financial assistance to States, territories and local governments.

The objective is to ensure that Federal agencies and applicants for Federal approvals and funding adequately consider and comply with State Coastal Zone Management Plans.

Okanogan is not a coastal county. Therefore, projects within this geographical area are not regulated by CZMA. For this reason, CZMA is not applicable to the proposed Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

6.1.6 Coastal Barrier Resources Act

The Coastal Barrier Improvement Act (42 USC 4028) and the Coastal Barrier Resources Act (CBRA; 16 USC 3501) only apply to selected geographic areas designated as "Coastal Barrier Resources System (CBRS) Units." At the present time, such units have been established and delineated only along the coasts of the Atlantic Ocean, Gulf of Mexico, and the Great Lakes. Proposed units have been identified but not designated along the coasts of States bordering the Pacific Ocean. Therefore, 42 USC 4028 and 15 USC 3501 are not applicable to the proposed action area.

6.1.7 Council on Environmental Quality (CEQ) Regulations

The Council on Environmental Quality (CEQ) was created in 1970 when the National Environmental Policy Act (NEPA) was signed into law (40 CFR parts 1500−1508). CEQ was given responsibility for developing environmental policy and overseeing Federal agencies that implement NEPA. CEQ was made a part of the Executive Office of the President to ensure that environmental policy receives high-level consideration within the Federal government. CEQ's NEPA responsibilities focus on advising Federal agencies on both a national basis and an action-by-action basis regarding appropriate NEPA compliance procedures. However, CEQ does not have the authority to specifically review NEPA documents.

NEPA is the basic Federal charter for protection of the environment. It establishes an environmental policy for the nation, provides an interdisciplinary framework for environmental planning by Federal agencies, and contains action-forcing procedures to ensure that Federal agency decision makers take environmental factors into account. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and to take actions that protect, restore, and enhance the environment.

This *NEPA Environmental Assessment* was prepared to fulfill the requirements of the National Environmental Policy Act, under the specific guidelines of the U.S. Environmental Protection Agency:

Environmental Review Guide for Special Appropriation Grants, EPA Publication 315-K-08-001 (April 2008).[1]

6.1.8 Endangered Species Act

The Endangered Species Act (ESA) prohibits unauthorized "take" of listed species (16 USC 1531 et seq.). "Take" means to harm, harass, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Habitat modification that actually injures or kills a listed species through impairment of essential behavior is considered a "take." Where otherwise lawful activity will result in a "take" of a listed species, an incidental take permit must be obtained. The application for an incidental take permit must be accompanied by a conservation plan, often referred to as a Habitat Conservation Plan (HCP).

Informal ESA consultation documentation was prepared for the Rufus Woods Lake Site #3 steelhead trout net pen project (PAI, March 1, 2011). The effects analysis on page 14 of that document concludes that there will be no direct impacts to the following species:

Canada lynx (*Lynx canadensis*)
Grizzly bear (*Ursus arctos horribilis*)
Northern spotted owl (*Strix occidentalis caurina*)
Ute ladies'-tresses (*Spiranthes diluvialis*)

Habitat for these species does not exist within the action area of the proposed project.

The proposed project will have No Effect on designated critical habitat of the Columbia River Distinct Population Segment (DPS) for bull trout because there is no bull trout critical habitat at this site.

Noise and physical activity during construction would be very localized and would not be expected to alter bull trout behavior in a significant way. If bull trout were in the vicinity when these activities occurred, they would likely move away until they became habituated to the disturbance.

The only indirect effects expected would result from the availability of food and cover under the pens, which would be beneficial to bull trout if they happened to be in the vicinity.

As discussed in Section 5.1.4.6 of the *NEPA Environmental Assessment*, EPA has determined that the only activities with any potential to negatively impact an individual bull trout, if present, would be the in-water work and noise associated with installation of the net pen facilities. EPA has determined that due to the extremely low numbers of bull trout within Rufus Woods Lake, and the effluent limitations and monitoring requirements contained within the NPDES permit to minimize impacts to the receiving water, the authorization of discharges into Rufus Woods Lake under the NPDES permitting program will have no effect on bull trout or any other threatened or endangered species or designated critical habitat.

6.1.9 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1801 et seq.) governs marine fisheries management in the United States. The Act mandates the identification of Essential Fish Habitat (EFH) for Federally-managed species as well as the development of measures to conserve and

[1] The Rufus Woods Lake Steelhead Net Pen Site #3 project is a private aquaculture proposal; it does not include an application for a Special Appropriation Grant. These guidelines were approximately followed to prepare this NEPA Environmental Assessment as EPA does not have guidelines specific to aquaculture projects.

enhance the habitat necessary for fish to carry out their life cycles. The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) requires Federal agencies to consult with the National Marine Fisheries Service (NMFS) before authorizing, funding, or conducting an activity that may adversely affect EFH.

Under MSFCMA, EFH has been defined for certain salmon (Chinook, coho, and pink), pelagic, and groundfish species that are managed under the jurisdiction of this Act. These anadromous and marine species are not present in the upper Columbia River system that includes Rufus Woods Lake. Therefore, EFH is not applicable to the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project (PAI, March 1, 2011).

6.1.10 Farmland Protection Act

The Farmland Protection Policy Act (FPPA) is intended to minimize the impact of Federal programs on the unnecessary and irreversible conversion of farmland to non-agricultural uses (7 USC 4201 et seq.). It assures that – to the extent possible – Federal programs are administered to be compatible with State and local units of government, and private programs and policies to protect farmland. Federal agencies are required to develop and review their policies and procedures to implement FPPA every two years. For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forest land, pastureland, cropland, and other land, but not water or urban built-up land.

The U.S. Department of Agriculture, Natural Resources Conservation Service website was queried during the information gathering stage for preparing this *NEPA Environmental Assessment*. NRCS soil types on the upland property proposed for support services at PAI Preferred Alternative Site #3 are described in *NEPA Environmental Assessment* Chapter 4, Section 4.2.2. These soils do not meet the definition of prime, unique, or important farmland. Therefore, FPPA is not applicable to the proposed action.

6.1.11 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 USC §§ 703-712 et seq.) prohibits individuals, government agencies, or corporations from taking a migratory bird, whether the taking is intentional or unintentional. The U.S. Fish and Wildlife Service is the primary Federal agency responsible for the conservation and management of migratory bird resources. Several migratory bird species may pass through the action area of the proposed project. These are mentioned in *NEPA Environmental Assessment* Chapter 4, Section 4.2.9. No detailed analysis has been performed of the timeline of the potential occurrence of bird species in the area in relation to the estimated 6-month construction period of the project for two reasons: 1) the construction start date is uncertain, contingent upon the receipt of all required permits and approvals, and 2) the area of effect is very small in relation to vast areas of similar habitat and the broad corridor of Rufus Woods Lake through which migratory birds can travel. No adverse environmental consequences to migratory birds are anticipated during construction or operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

Bald and golden eagles are among the species protected under the Migratory Bird Treaty Act (MBTA). Bald and golden eagle nests are mapped within a 1.5-mile radius of PAI Preferred Alternative Site #3 on the Washington Department of Fish & Wildlife Priority Habitats and Species database search results obtained during preparation of the Biological Evaluation for this project (December 14, 2010). While some nest trees occur within this radius, each is beyond the action area of the project, and beyond the 800-ft radius plus shoreline nest buffer that applies to the nearest bald eagle nest (see *NEPA Environmental Assessment* Chapter 4, Section 4.2.8).

6.1.12 National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate the environmental impacts associated with major actions they fund, permit, or implement (42 USC 4321 et seq.). NEPA requires Federal agencies to prepare an Environmental Assessment (EA) to determine whether a Federal undertaking would significantly affect the quality of the human environment. If the answer is no, the agency issues a Finding of No Significant Impact (FONSI). The FONSI may address measures that an agency will take to reduce (mitigate) potentially significant impacts. If the EA determines that the environmental consequences of a major action may be significant, an Environmental Impact Statement (EIS) will be prepared An EIS and/or EA is developed by bringing into the decision-making process appropriate and careful consideration of both the environmental impacts of proposed actions, and measures to avoid or minimize the potential adverse effects of these actions. NEPA requires Federal agencies to consider five aspects of planned major actions: 1) the environmental impact of the proposed action; 2) adverse impacts that cannot be avoided with proposed project implementation; 3) alternatives to the proposed action; 4) the relationship between short-term and long-term effects; and 5) any irreversible and irretrievable commitment of resources associated with a proposed action.

This *NEPA Environmental Assessment* is prepared under the guidelines of the U.S. Environmental Protection Agency − the Federal agency to which Pacific Aquaculture has applied for a NPDES Waste Discharge Permit. Based on the information presented in this *NEPA Environmental Assessment* and the related Biological Evaluation, the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is not a major action that would significantly affect the quality of the human environment. Therefore, the proposal does not require preparation of an Environmental Impact Statement (see *NEPA Environmental Assessment* Chapter 1, Section 1.6).

6.1.13 National Historic Preservation Act

The purpose of the National Historic Preservation Act is to protect historic and cultural properties within the United States (16 USC 470 et seq.). The Act sets forth procedures for Federal agencies to follow in consulting with Indian Tribes for the identification, evaluation, and protection of historic properties.

The Confederated Tribes of the Colville Reservation, History/Archaeology Program conducted a *Cultural Resources Inventory* (February 1, 2011) to assist Pacific Aquaculture with complying with Colville Tribal Code 4-4 and with the requirements of Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR 800. The purpose of the cultural resources investigation was to document the presence or absence of potentially significant cultural resources located within the Area of Potential Effect. The study consisted of background research, a traditional cultural property study, a pedestrian survey, and the excavation of nine shovel probes.

Background research showed that the site proposed for upland support services to PAI Preferred Alternative Site #3 does not have any previously recorded archaeological sites, and field investigation did not identify any new archaeological sites within the project boundary. Therefore, the Tribal Archaeologist recommends that construction of the proposed feed silos, access road and boat dock be constructed, subject to conditions regarding Inadvertent Discoveries, Post-Review Discoveries, and activities that have the potential to disturb cultural resources outside the areas specified in accompanying documents (CCT History/Archaeology Program, February 24, 2011). These conditions are described in *NEPA Environmental Assessment* Chapter 5, Section 5.3.2.

As discussed in Section 5.3.2 of this *NEPA Environmental Assessment*, EPA has determined that authorization of aquaculture discharges into Rufus Woods Lake under the NPDES permitting program (at PAI Preferred Site #3 or any of the alternative locations) is not an undertaking that has the potential to

cause effects to historic properties or cultural resources. EPA has no jurisdiction over construction or siting of the proposed project (net pens or upland facilities), which are the primary means by which historic properties or cultural resources could be impacted. Therefore, pursuant to 36 CFR 800.3(a)(1), EPA has no further obligations under Section 106 of the NHPA. Rather, Federal and/or Tribal agencies with direct jurisdiction and permitting authority over siting and construction of the proposed facility will need to work with the applicant to ensure that historic properties and cultural resource are protected in accordance with applicable State and Federal law.

6.1.14 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 provides a process for museums and Federal agencies to return certain Native American cultural items – human remains, funerary objects, sacred objects, and objects of cultural patrimony – to lineal descendents, culturally-affiliated Indian tribes, and Native Hawaiian organizations (25 USC 3001 et seq.).

The Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is proposed by Pacific Aquaculture, Inc. on the Colville Reservation; therefore, 25 USC 3001 is not applicable to the proposed action. A site-specific *Cultural Resources Assessment* was prepared, as described above in Section 6.1.13. No human remains, funerary objects, sacred objects, or objects of cultural patrimony were found. Proposed mitigation measures to be implemented in the event of an inadvertent discovery during construction are described in Chapter 5, Section 5.3.2 of this *NEPA Environmental Assessment*.

6.1.15 Noise Control Act

The Noise Control Act of 1972 establishes a policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare (42 USC 7901 et seq.). To that end, this Act establishes a means for the coordination of Federal research and activities with respect to noise control, authorizes the establishment of Federal noise emission standards for products distributed in commerce, and provides information to the public with respect to the noise emission and noise reduction characteristics of such products. Each department or agency having jurisdiction over any property or facility, or engaged in any activity resulting (or which may result) in the emission of noise, shall comply with Federal, State, interstate, and local requirements respecting environmental noise control and abatement.

Pacific Aquaculture existing steelhead trout net pen aquaculture operations on Rufus Woods Lake (Site #1 and #2) do not presently generate significant noise levels. Therefore, it is not expected that Site #3 would generate significant noise levels in the completed condition of the project. The Colville Confederated Tribes do not have a specific Noise Control Ordinance. Readers are encouraged to also review *NEPA Environmental Assessment* Chapter 4 Section 4.3.6, and Chapter 5 Section 5.3.6.

6.1.16 Wild and Scenic Rivers Act

Only three rivers in Washington State are Federally-listed as wild and scenic: the Klickitat, Skagit (U.S. Forest Service site), and White Salmon (U.S. Fish and Wildlife Service 2011). These do not include the Columbia River within the boundaries of the Colville Reservation. In the absence of any designated wild and scenic rivers within the proposed project action area, 16 U.S.C. 1271 et seq. is not applicable to the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

6.1.17 Executive Order 11514, Protection and Enhancement of Environmental Quality

In furtherance of the purpose and policy of the National Environmental Policy Act of 1969, Executive Order 11514 directs the heads of Federal agencies to monitor, evaluate, and control on a continuing basis their agencies' activities so as to protect and enhance the quality of the environment (3 CFR 1970 Comp., page 104). Such activities shall include those directed to control pollution and enhance the environment, and those designated to accomplish other program objectives that may affect the quality of the environment. Agencies shall develop programs and measures to protect and enhance environmental quality, and shall consult with appropriate Federal, State and local agencies in carrying out their activities as they affect the quality of the environment.

The relationship of this *NEPA Environmental Assessment* to Council on Environmental Quality Regulations and the National Environmental Policy Act is previously described in *NEPA Environmental Assessment* Sections 6.1.7 and 6.1.12, above.

6.1.18 Executive Order 11593, Protection and Enhancement of the Cultural Environment

Also in furtherance of the purposes and policies of the National Environmental Policy Act of 1969, Executive Order 11593 directs the Federal government to provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the Nation (3 CFR 1971 Comp., page 154). Federal agencies shall 1) administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations; 2) initiate measures necessary to direct their policies, plans and programs in such a way that Federally-owned sites, structures, and objects of historical, architectural or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people; and 3) in consultation with the Advisory Council on Historic Preservation, institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-Federally owned sites, structures and objects of historical, architectural or archaeological significance.

The Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is proposed by a private applicant (Pacific Aquaculture) on the Colville Reservation. A *Cultural Resources Assessment* was prepared by the Confederated Tribes of the Colville Reservation, History/Archaeology Program for the upland parcel at PAI Preferred Site #3 where ground-disturbing activities would occur during construction of upland support services. As previously reported in Sections 6.1.1, 6.1.13, and 6.1.14 above, no new or previously recorded archaeological sites were identified on this parcel. Proposed mitigation measures to be implemented in the event of an inadvertent discovery during construction are described in Chapter 5, Section 5.3.2 of this *NEPA Environmental Assessment*.

6.1.19 Executive Order 11990, Wetlands

Executive Order 11990 of May 24, 1977 defined wetlands and recognized the significant values provided by wetlands (3 CFR 1977 Comp., page 121). The Executive Order directed each Federal agency to provide leadership and to take actions to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. To the extent permitted by law, each Federal agency is to avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds that: 1) there is no practicable alternative to such construction, and 2) the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Each Federal agency was also directed to provide opportunity for early public review of any plans or proposals for new construction in wetlands.

The key requirement of Executive Order 11990 is determining whether a practicable alternative exists to locating an action in wetlands. This determination requires the identification and evaluation of alternatives that could be located outside of wetlands (alternative sites); other means that would accomplish the same purpose as the proposed action (alternative actions); and no action. If there is no practicable alternative to locating an action in wetlands, the Executive Order requires that the action include all practical measures to minimize harm to the wetlands and preserve and enhance the natural and beneficial values.

As reported in *NEPA Environmental Assessment* Chapter 4, Section 4.2.5, no wetlands were identified within the proposed action area of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project. Therefore, Executive Order 1990 is not applicable to the proposed action.

6.1.20 Executive Order 11988, Floodplains

Executive Order 11988 of May 24, 1977 requires Federal agencies to recognize the significant value of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains (3 CFR 1977 Comp., page 117). The objective of Executive Order 11988 is avoidance, to the extent possible, of long- and short-term adverse impacts associated with occupancy and modification of the base floodplain (100-year floodplain), and the avoidance of direct and indirect support of development in the base floodplain wherever there is a practicable alternative. Federal agencies are directed to take action to:

- Avoid development in the base floodplain unless it is the only practicable alternative
- Reduce the hazard and risk associated with floods
- Minimize the impact of floods on human safety, health, and welfare
- Restore and preserve the natural and beneficial values of the base floodplain.

As reported in *NEPA Environmental Assessment* Chapter 4, Section 4.2.4, there are no Federal Emergency Management Agency (FEMA) floodplains within the action area of the proposed project.

The U.S. Army Corps of Engineers (Corps) has Government Flowage Easement Rights within and adjacent to Rufus Woods Lake associated with the Chief Joseph Dam project. PAI submitted a Joint Aquatic Resources Application (JARPA) to the Corps on December 27, 2010. It is anticipated that the Corps will issue a letter of consent for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project to be constructed within the flowage easement, based on the precedent letters of consent that have been issued for PAI's two existing steelhead trout net pen aquaculture projects on the lake, for upland improvements at Site #1, and for a proposed processing plant (not yet constructed).

6.1.21 Executive Order 12898, Environmental Justice

Executive Order 12898 of February 11, 1994 requires Federal agencies to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority and low-income populations" (3 CFR 1994 Comp., page 859). The impacts of the project, both negative and positive, on minority and low-income populations must be analyzed. Environmental justice issues include potential impacts on the physical and natural environment, as well as social, cultural, and economic effects of the project.

The environmental justice of constructing the proposed Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project on the Colville Indian Reservation is discussed in *NEPA Environmental Assessment* Chapter 4 Section 4.3.4, and Chapter 5 Section 5.3.4.

6.1.22 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments

The purpose of Executive Order 13175 of November 6, 2000 is to establish regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications, to strengthen the U.S. government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes.

EPA has an established procedure for consultation with Tribal officials when actions by EPA will affect the natural or human environment of a Native American Tribe. EPA's proposal for Government-to-Government consultation with the Colville Confederated Tribes during preparation of this *NEPA Environmental Assessment* is described in Chapter 1, Section 1.5.

6.2 RELATIONSHIP TO CONFEDERATED COLVILLE TRIBES CODE OF LAWS

The Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project is reviewed below in relation to relevant regulations contained in the Confederated Colville Tribes (CCT) Code of Laws. Portions of Title 4, Natural Resources and Environment; and Title 10, Employment and Contracting were identified as the applicable regulations.

6.2.1 Title 4, Chapter 4-1: Fish, Wildlife and Recreation

Chapter 4-1 of the CCT Code of Laws is known as the Colville Tribal Hunting and Fishing chapter of the CCT Code of Laws. It is CCT's policy to restore, preserve, protect and perpetuate the fish and game resources (wildlife) on the Colville Indian Reservation, the North Half, and areas off the Colville Reservation to the extent that wildlife passes through or would pass through the usual and accustomed fishing grounds and stations, hunting areas, or aboriginal lands of the Tribes. The Business Council intends that Tribal members shall be afforded the greatest possible freedom to use and enjoy these resources consistent with the preservation and improvement of these resources for future generations. All wildlife found on the Reservation, whether resident or migratory or introduced, is the property of the membership of the Colville Tribes, shall be regulated by the Tribes, and may be taken only at such times, in such places, and in such a manner as provided by Tribal law. Of secondary importance is the policy of permitting the limited use of the Reservation's wildlife and recreation resources by non-members for the economic benefit of the Tribes as a whole, and for the promotion of intercultural education and goodwill.

CCT assumes exclusive jurisdiction and control over Indian boats and boating within the Indian zone,[2] adopting by reference however the safety regulations of the U.S. Coast Guard with regard to the operation of boats. The Coast Guard, National Park Service and/or the State of Washington are acknowledged to have jurisdiction concurrent with that of CCT to enforce among non-Indians all of the relevant rules and regulations of these agencies regarding boat registration, safety regulations, and related matters.

CCT assumes exclusive jurisdiction to govern and regulate the issuance of permits for concessions, docks, pumping stations and other activities and structures within the Indian zone. Pacific Aquaculture, Inc. will obtain and comply with the conditions of all permits required from the Colville Confederated Tribes.

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[2] The "Indian Zone" is the north half of the Columbia River (from the shoreline to the center of the river), within the boundaries of the Colville Indian Reservation (personal communication with Linda Palmer, CCT Parks & Recreation Department, April 11, 2011).

Any non-Tribal member may purchase a fishing permit that entitles the member to fish during the open season of the permit year in all waters of the Reservation that are open to non-Indians. Fishing permits are not applicable to the PAI steelhead net pen aquaculture project, per se; however, sport fishing in the vicinity of the pens is a popular recreational activity on Rufus Woods Lake. The addition of Site #3 would increase this opportunity.

The *Fish and Wildlife Resource Management Plan and Five-Year Implementation Schedule – 2007-2011* (Colville Tribes Fish & Wildlife Department, August 2006) has as a Resident Fish Goal (RFG) to provide a subsistence and recreational rainbow trout fishery where appropriate and consistent with native species conservation in the Nespelem River and Rufus Woods Reservoir (RFG 4.04). Implementation measures to achieve this goal include managing the rainbow trout fishery in Rufus Woods Reservoir as a mixed-stock of rainbow trout emigrating from Lake Roosevelt and triploid rainbow trout stocked directly into the Rufus Woods Reservoir (RFG 4.04.s-4).

PAI sells triploid trout to the Tribe (most recently in March 2011) to assist them with meeting their Resident Fish Goal. The Tribe plants these trout in the Columbia River (Rufus Woods Lake), or in lakes on the Reservation (personal communication with John Bielka, PAI General Manager, April 3, 2011).

6.2.2 Title 4, Chapter 4-3: Land Use and Development

The legislative intent of the CCT Law and Order Code Land Use and Development Chapter is to preserve and protect the political integrity, economic survival, health and welfare of present and future members of the Confederated Tribes of the Colville Reservation; to exercise the Tribes' powers of self-government and self-determination over all lands of the Colville Indian Reservation; and to implement the Tribes' Comprehensive Land Use Policy Guidelines. The Land Use and Development Chapter applies to all lands established by zoning districts or other property uses of the Colville Reservation.

The CCT Zoning Map (approved April 5, 2007 by Resolution 2007-201) shows PAI existing Site #1 and PAI Preferred Alternative Site #3 located within the Special Requirement zoning district (SRD). The purpose and function of the SRD is to freeze all existing uses and require a Conditional Use Permit for any and all uses, including any modifications, additions, change or expansion of existing uses pending detailed study by the Colville Tribes to determine an appropriate use designation (CCT Title 4, Chapter 4-3, Section 4-3-51). Areas designated SRD exhibit the widest range of disparate, inconsistent existing uses on the Reservation, and are expected to experience the largest amount of future growth.

PAI has prepared and submitted an application for Conditional Use Permit to the CCT Planning Department. Issuance of the permit will be considered at a hearing before the CCT Land Use Review Board, subject to the Board's confirmation that the development will comply with the provisions of the Land Use and Development Chapter if completed as proposed (CCT Title 4, Chapter 4-3, Section 4-3-118). The application will be placed on the Board's agenda upon receipt of an approved land lease with the Bureau of Indian Affairs (BIA) for the PAI Site #3 upland support site at PAI's Preferred Alternative location for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project (personal communication with Stephanie "Pete" Palmer, Land Use and Shoreline Administrator, CCT Planning Department, March 18, 2011).

6.2.3 Title 4, Chapter 4-4: Cultural Resources Protection

Chapter 4-4 of the CCT Code of Laws is known as the Colville Cultural Resources Protection Chapter. Under the National Historic Preservation Act (NHPA) of 1979 (16 USC § 470 cc[c]), the responsible Federal official must notify the Tribes whenever a permit application is being considered which might

adversely affect any religious or cultural off-Reservation site. The NHPA declares a national policy to work in partnership with Indian Tribal governments to protect cultural resources, and provides a mechanism by which Tribal governments may carry out the provisions of the Act. The Colville Cultural Resources Board is authorized and directed to review any proposed undertaking that might adversely affect any on-Reservation archaeological resource or historic property included on or eligible for inclusion on the Colville Register or National Register.

The CCT History/Archaeology Program conducted a *Cultural Resources Inventory* of the land parcel adjacent to PAI Preferred Alternative Site #3 where the proposed action includes constructing upland support services for the steelhead trout net pen aquaculture project (CCT History/Archaeology Program, February 1, 2011). (Alternative locations considered for the Site #3 project do not have adjacent land parcels suitable for the development of upland support services.) The purpose of the archaeological investigation was to document the presence or absence of potentially significant cultural resources located within the area of potential effect. The study consisted of background research, a traditional cultural property study, a pedestrian survey, and the excavation of nine shovel probes. Based on the results of the Cultural Resources study, the CCT History/Archaeology Program recommended to the CCT Planning Department that PAI be allowed to proceed with constructing the fish feed silos, access road, and boat dock (CCT History/Archaeology Program, February 24, 2011). In the event that cultural material is encountered during implementation of the project, work shall be halted in the vicinity of the finds, and the Tribal Historic Preservation Officer (THPO) shall be immediately notified (see *NEPA Environmental Assessment* Chapter 4, Section 4.3.2; and Chapter 5, Section 5.3.2).

6.2.4 Title 4, Chapter 4-8: Water Quality Standards

CCT has a primary interest in the protection, control, conservation, and utilization of the water resources of the Colville Indian Reservation. It is the purpose of this Chapter to establish Tribal Water Quality Standards for the surface waters and ground waters located within the exterior boundaries of the Colville Indian Reservation. The quality of all surface and groundwater on the Reservation shall be protected to ensure the health, economic, aesthetic and cultural well-being of all people residing on the Colville Indian Reservation. CCT has jurisdiction to enforce Tribal Water Quality Standards in order to protect the economy, health, safety and welfare of the Reservation community. The CCT Hydrology Department administers this Chapter.

The specific water quality classification of the Columbia River from the northern Reservation boundary to Chief Joseph Dam is Class I, Extraordinary. This reach includes Rufus Woods Lake. Class I water quality criteria are described in Table 6.2-1, below.

Table 6.2-1. Colville Confederated Tribes class I water quality criteria applicable to Rufus Woods Lake (CCT Law and Order Code, Chapter 4-8 § 4-8-6[a][3]).

Water Quality Parameter	Class I Water Quality Criteria
Fecal coliform organisms − freshwater	Shall not exceed a geometric mean value of 50 organisms/100 milliliters (mL), with not more than 10% of samples exceeding 100 organisms/100 mL
Dissolved oxygen − freshwater	Shall exceed 9.5 mg/L [1]
Total dissolved gas	Shall not exceed 110% of saturation at any point of sample collection
Temperature − freshwater	Shall not exceed 16.0° centigrade (C) due to human activities. Temperature increases shall not, at any time, exceed t=23/(T+5) [2]
pH − freshwater	Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.5 units
Turbidity	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU
Toxic, radioactive, or deleterious material concentrations	Shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, of which may adversely affect any water use
Aesthetic values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.

[1] The dissolved oxygen standard appears to be in error. CCT is currently in the process of revising its water quality standards and will address this issue during the update (personal communication between J.E. Rensel, Ph.D. and Todd Thorn, Watershed Program Manager, CCT Office of Environmental Trust, March 25, 2011).

[2] For the purpose of the CCT water quality criteria, "t" represents the permissive temperature change across the dilution zone, and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

The relationship of the Rufus Woods Site #3 steelhead trout net pen aquaculture project to existing water quality conditions in the lake/river are discussed in *NEPA Environmental Assessment* Chapter 4 (Section 4.1.2) and Chapter 5 (Section 5.1.2). Pacific Aquaculture, Inc. will obtain and comply with the conditions of a Colville Tribal Pollution Discharge Permit for the operation of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project.

6.2.5 Title 4, Chapter 4-9: Hydraulics Project Permitting

The Hydraulics Project Permit chapter of the CCT Law and Order Code applies to all surface waters of the Colville Indian Reservation. Every human activity taking place in the waters of the Colville Indian Reservation that may affect the quality of these surface waters and thereby may potentially affect fish and wildlife is subject to the provisions of this chapter.

The CCT Office of Environmental Trust is responsible for administering this chapter, and for issuing Hydraulic Projects Permits. Any person or governmental agency that desires to construct or perform other work that will use, divert, obstruct or change the natural flow or bed of any river, wetland, or stream, or that will utilize any of the waters of the Colville Indian Reservation or materials from stream beds or wetlands from within the boundary of the water body to the level of the ordinary high water mark shall, before commencing work, obtain written approval from the CCT Office of Environmental Trust concerning the adequacy of the measures proposed for the protection of fish and wildlife. Protection of fish and wildlife and attributes of the aquatic and/or wetland environment that are required to support fish and wildlife are the only grounds on which Hydraulics Project Permit approval may be denied or conditioned.

PAI has applied for a Tribal Hydraulic Permit for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, and will comply with the conditions of this permit during construction. In-water work will involve primarily vibratory installation of anchor pins to secure the Site #3 net pen array and dock in-place. The proposed anchoring system is the same as that presently used to secure PAI existing Sites #1 and #2 in Rufus Woods Lake. The net pen array will not ground, and there will be no anchor movement with the proposed system (compared to the alternative anchoring option described in *NEPA Environmental Assessment* Chapter 3, Section 3.1.4). No dredging, gravel removal, fill placement, or bank protection is proposed.

6.2.6 Title 4, Chapter 4-15: Shoreline Management

The Shoreline Use and Development chapter of the CCT Law and Order Code applies to all shorelines of all bodies of water within the exterior boundaries of the Colville Indian Reservation. Waters of the Reservation are classified into four types. The Rufus Woods Lake/Columbia River reach that is the location of existing and proposed PAI floating net pen aquaculture operations is a Type 1 water,[3] defined as all waters within their ordinary high water mark identified as a temperature-sensitive or a critically sensitive water resource[4] (CCT Law and Order Code Section 4-15-5[g]). For shorelines of Type 1 waters, the applicable regulatory area includes those lands extending landward 200 feet on a horizontal plane from the ordinary high water mark (CCT Law and Order Code Section 4-15-4[mm]). Within the 200-ft shoreline regulatory area, the following shoreline environment designations apply to PAI sites that are the subject of this *NEPA Environmental Assessment*: [5] Natural Environment within the first 100 feet landward from the ordinary high water mark (OHWM); and Rural Agriculture Environment within the balance of

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[3] The Type 1 water classification of Rufus Woods Lake was confirmed in personal communication with Stephanie "Pete" Palmer, CCT Land Use and Shoreline Administrator, April 12, 2011.

[4] "Critically sensitive water resource" is defined as a water resource that is necessary for the management, utilization, or protection of Reservation lands or waters (CCT Law and Order Code Section 4-15-5[a]).

[5] The shoreline environment designations indicated in Section 6.2.6 above apply to the entire Rufus Woods Lake/Columbia River reach between the middle of the Seatons Grove boat launch ramp downstream to the north boundary of Bridgeport State Park. This area encompasses both existing PAI net pen aquaculture sites (Site #1 and Site #2), and all alternative locations considered for Site #3.

the shoreline jurisdiction (CCT Law and Order Code Chapter 4-15, Appendix B, Water Body-Specific Designations, Columbia River, Reservation side).

The term "uplands" is defined in the CCT Shoreline Use and Development chapter as that land lying outside the shoreline jurisdiction or shoreline area as defined in the Code (CCT Law and Order Code Section 4-15-4[uu]); in other words, land more than 200 feet landward from OHWM. For clarification, reference to the PAI Preferred Alternative #3 "upland support services site" throughout this *NEPA Environmental Assessment* refers to the entire backshore area from OHWM landward to Columbia River Road. Some proposed improvements are within the 200-ft shoreline jurisdiction (see Drawing #14 in Attachment 1).

"Aquaculture" is defined as farming or culturing food fish, shellfish, aquatic plants, or other aquatic animals in lakes, streams, inlets, estuaries, and other natural or artificial water bodies. Activities include the hatching, cultivating, planting, feeding, raising and harvesting of aquatic plants and animals and the maintenance and construction of necessary equipment, buildings and growing areas. Cultivation methods include but are not limited to fish pens, shellfish rafts, racks and long lines (CCT Law and Order Code Sections 4-15-4[d] and 4-15-30).

The CCT Land Use Review Board will review the PAI application for Site #3 in relation to the General Shoreline Restrictions and Conditions outlined in Chapter 4-15 Sections 4-15-6 through 4-15-16 of the Shoreline Use and Development Code, and in relation to applicable Shoreline Use Activity Restrictions and Conditions outlined in Sections 4-15-17 through 4-15-31 based on the shoreline environment designations of the subject property.[6] The PAI application for a Shoreline Development Permit will be consolidated with and processed concurrently with the Land Use Permit for the Site #3 project, in accordance with CCT Law and Order Code Section 4-15-39.

Representative elements of the General Shoreline Restrictions and Conditions to be reviewed in relation to the PAI Site #3 proposal include:

- Use of Best Management Practices during construction and operations
- Minimum clearing, grading, and vegetation removal
- Avoidance of the application of herbicides and pesticides where these chemicals could enter water bodies
- Protection and/or avoidance of natural features that are valuable, fragile or unique to the region
- Protection and preservation of cultural resources and archaeological/historical resources
- Protection or avoidance of environmentally sensitive areas
- Avoidance of blocking or interfering with existing, lawful access to the shoreline and water body
- Preservation of view corridors
- Use of non-reflective materials compatible in color and texture with the surrounding area.

The CCT Shoreline Use Activity regulations include a section that specifically addresses Aquaculture (Section 4-15-30). When consistent with pollution control, prevention of damage to the environment, or loss of diversity, aquaculture activities are a permitted shoreline use. Representative elements of the Aquaculture Use Activity regulations that will be reviewed in relation to the PAI application for Site #3 include:

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[6] The CCT Planning Department staff report to the Land Use Review Board describing the relationship of the PAI application to these regulations was not yet available at the time of this writing.

- Substrate modification
- Operational monitoring requirements (possible)
- Use of chemicals (if any)
- Sound construction and maintenance
- Location to avoid restricting navigation, interfering with general navigation lanes and vessel traffic, or interfering with usual and accustomed fishing locations
- Proximity to other aquaculture facilities that include net pens or rafts
- Proximity to wildlife refuge lands and/or habitats of special significance for birds or mammals (as determined by the CCT Fish & Wildlife Department)
- On-shore support structures compliant with height, setback and open space standards
- Proposed processing methods (restrictions to over-water activities).

PAI will obtain a Shoreline Development permit from CCT for the Site #3 operation, and will comply with all conditions of the permit during construction and in the operational condition of the project. Detailed information regarding elements of the PAI Site #3 proposal is provided in *NEPA Environmental Assessment* Chapters 3 through 5.

6.2.7 Title 10: Tribal Employment and Contracting

Tribal members and other Indians have suffered discrimination in employment on and near the Colville Reservation. The Tribal Employment Rights Chapter 10-1 of the CCT Law and Order Code was established to ensure that discrimination does not continue to occur, and that Tribal members and other Indians on the Colville Reservation have an opportunity to participate in the work opportunities that arise on and near the Reservation, and may benefit from the unique rights that flow to Tribal members and other Indians. It is the intent of this chapter to ensure (among other things) that no employer covered by this chapter will discriminate against any Indian in any aspect of employment; to require that all covered employers give preference to Indian-preference-eligible individuals in all aspects of employment; and to require that all entities awarding contracts give preference to Indian Business Enterprises for contract work on the Reservation. All covered employers operating within the lands and territories of the Colville Reservation are required to give preference in all aspects of employment to Indian-preference-eligible individuals in the following order: Colville Tribal member, local Indian, or non-local Indian. Covered employers shall not hire any non-Indian-preference-eligible individual if an Indian-preference-eligible individual meeting the minimum threshold requirements of the job has applied for the position. The Director of the Tribal Employment Rights Office (TERO) may approve exemptions from this requirement.

Hiring practices followed by PAI include notifying TERO when employment positions become available, and placing advertisements in the local newspaper. PAI employment ads state that PAI gives hiring preference to Tribal members. Tribal members also stop by the PAI Site #1 office to drop off applications for employment (personal communication with John Bielka, PAI General Manager, April 3, 2011).

All entities awarding contracts covered by the terms of Section 10-1-20 of the Tribal Employment Rights chapter are required to give preference to certified Indian Business Enterprises in the following order: 100% Colville Business Enterprise, Colville Family Business Enterprise, Colville Business Enterprise, or Indian Business Enterprise. The invitation for bids may be restricted to qualified certified firms (CCT Law and Order Code Section 10-3-7).

PAI will retain a contractor to drive anchor pins to secure the Site #3 net pen array and dock in-place. PAI is not aware of a certified Tribal enterprise with the equipment or expertise to perform this work;

however, the invitation for bids will be open to any qualified bidder (personal communication with John Bielka, PAI General Manager, April 3, 2011).

6.3 AGENCIES AND PERSONS CONSULTED, CORRESPONDENCE RECEIVED

Agencies and persons consulted and correspondence received during preparation of this *NEPA Environmental Assessment* are described below. Copies of these documents were provided to EPA for the project file.

Colville Confederated Tribes (CCT) History/Archaeology Program

A Tribal archaeologist with the CCT History/Archeology Program was retained by the applicant to prepare a *Cultural Resources Assessment* (completed February 1, 2011) of the upland parcel adjacent to PAI Preferred Alternative Site #3 where feed silos, a gravel or crushed rock access road, an operations trailer, dock and pedestrian access path are proposed as support services to an additional steelhead trout net pen aquaculture project on Rufus Woods Lake within the boundaries of the Colville Indian Reservation. On the basis of the findings reported in the *Cultural Resources Assessment*, the Tribal Historic Preservation Officer recommended to the CCT Planning Department that the project proceed in accordance with the site plan provided, subject to compliance with inadvertent discovery and post-review discovery procedures (February 24, 2011).

The NEPA consultant contacted the Tribal archaeologist who conducted the *Cultural Resources Assessment* at PAI Preferred Alternative Site #3, and requested a database search for known archaeological sites on or in proximity to the three downstream alternative sites considered for the additional steelhead trout net pen aquaculture project. The results of this database search were provided by Arrow Coyote, Tribal Archaeologist, February 23, 2011.

All information provided by the CCT History/Archaeology Program was used to prepare the Areas of Recognized Archaeological or Historic Value sections of *NEPA Environmental Assessment* Chapters 4 and 5, as well as to describe the relationship of the proposal to Federal regulations and Executive Orders that pertain to archaeological and historic preservation.

Colville Confederated Tribes (CCT) Planning Department

E-mail requests were sent to Ms. Connie Davisson, CCT Planning Department Land Use Officer, on February 16 and 17, 2011 for information regarding land and shoreline use designations for PAI existing Site #1 and alternative sites under consideration for Site #3; for population, housing, employment, and socioeconomic information to describe existing conditions on the Colville Reservation; and to confirm whether there are any areas of recognized scenic value or areas of recognized recreational value within the action area of the proposed project. Ms. Davisson's replies were received February 22, 2011, with the exception that no response was received regarding areas of recognized scenic value or areas of recognized recreational value. Information received from Ms. Davisson was used to prepare elements of the Human Environment in *NEPA Environmental Assessment* Chapters 4 and 5.

The CCT Planning Director was consulted by e-mail on February 21, 2011 concerning the desired level of detail for the analysis of the relationship of the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture proposal to the Colville Tribal Law and Order Code. The response of Ms. Stephanie "Pete" Palmer was received February 22, 2011. This guidance was used to prepare *NEPA Environmental Assessment* Chapter 6, Section 6.2.

Colville Confederated Tribes (CCT) Parks & Recreation Department

Telephone and e-mail communications were exchanged with Linda Palmer of the CCT Parks & Recreation Department to identify areas of recognized recreational value within the action area of the proposed project, and to discuss navigation on Rufus Woods Lake as it relates to recreational boating and sport fishing. These communications occurred between April 1 and April 11, 2011. The information was used to prepare *NEPA Environmental Assessment* Chapter 4 Section 4.3.9, and Chapter 5 Section 5.3.9.

U.S. Coast Guard, 13th Coast Guard District, Prevention Division, Waterways Management Branch

Mr. Timothy Westcott, U.S. Coast Guard (USCG) Private Aids to Navigation Manager, was consulted by e-mail on December 15, 2010 to confirm whether the USCG has jurisdiction over the Columbia River in reaches above the point where the river is navigable by vessels originating from the sea, due to the system of hydroelectric dams. Mr. Westcott replied the same day with confirmation that the USCG has jurisdiction over the entire Columbia River, and therefore that the proposed net pen aquaculture project will require USCG review and a Private Aids to Navigation (PATON) permit. In follow-up communications with Mr. Westcott March 9 and 10, 2011, it was confirmed that there is no Federal navigation chart for the area of Rufus Woods Lake where existing and proposed net pen aquaculture projects are located; therefore, the USCG has no knowledge of any Federal or private marine aids to navigation within this section of the river at the present time. Mr. Westcott reconfirmed the requirement for Pacific Aquaculture to apply for a PATON permit, and provided the application forms.

This information was used to prepare the Navigation section in *NEPA Environmental Assessment* Chapters 4 and 5, as well as to confirm the permits required for the project (listed in Chapter 3).

U.S. Fish & Wildlife Service

Mark Pedersen, Margenex International, author of the Biological Evaluation (BE) for the Rufus Woods Lake Site #3 steelhead trout net pen aquaculture project, had a telephone conversation with Gregg Kurz, U.S. Fish and Wildlife Service, Central Washington Field Office, on December 14, 2010, to discuss the presence or absence of Federally-listed threatened, endangered, or candidate species of plants and animals within the action area of proposed project. The results of this discussion are reported in the BE, and in *NEPA Environmental Assessment* Chapter 4 Section 4.2.9, and Chapter 5 Section 5.2.9.

Washington Department of Fish & Wildlife

A Habitats and Species Information public data request was sent to the Washington Department of Fish & Wildlife (WDFW) in Olympia, Washington on November 28, 2010. The following results were received on December 14, 2010:

- Priority Habitats and Species (PHS) database
- Wildlife Points and Areas from the Wildlife Survey Data Management (WSDM) database
- Priority Fish Report from the Washington Lakes and Rivers Information System (WLRIS) database.

This information was used to prepare the Biological Evaluation for the project, as well as the Aquatic and Terrestrial Environment Flora, Fauna, Threatened/Endangered/Protected Species sections in Chapters 4 and 5 of this *NEPA Environmental Assessment*.

Washington Department of Natural Resources

The Washington Department of Natural Resources, Natural Heritage Information System was queried in November 2010 for the List of Known Occurrences of Rare Plants in Okanogan County, Washington. The results of this database search were used to prepare the Flora and Threatened/Endangered/Protected Species sections in Chapters 4 and 5 of this *NEPA Environmental Assessment*.

7.0 SUMMARY OF MITIGATION MEASURES

Table 7.1-1 summarizes proposed mitigation measures to avoid or minimize direct impacts associated with construction and operation of the Rufus Woods Site #3 steelhead trout net pen aquaculture project on the Colville Indian Reservation. The full text of the Environmental Consequences and Mitigation Measures analysis is provided in *NEPA Environmental Assessment* Chapter 5.

Table 7.1-1. Summary of proposed mitigation measures for the Rufus Woods Site #3 steelhead trout net pen aquaculture project.

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
AQUATIC ENVIRONMENT			
5.1.1	Bottom Characteristics	Optimum siting is the principal measure used to avoid potential adverse consequences to sediments and other environmental effects.	During site selection
		PAI will conduct routine monitoring of the river bottom by underwater camera to detect any change in substrate scouring or erosion.	During operations
		PAI will use in-pen underwater cameras monitored by an experienced technician to control the feed delivery system for most efficient consumption and minimal loss to the lake/river bottom.	During operations
5.1.2	Water Column, Water Quality	PAI has applied for a Tribal Hydraulic Project Permit under CCT Tribal Code of Laws Chapter 4, Title 4-9, and will comply with the conditions of this permit during construction.	During construction
		PAI has applied to EPA for a Waste Discharge Permit under the regulations of the National Pollutant Discharge Elimination System (NPDES), established by Section 402 of the Clean Water Act, and will comply with the conditions of this permit during operation of the project.	During operations
		CCT proposes to amend PAI's existing Pollution Discharge Permit No. 4-8-9/2009-1 under Tribal Code of Laws Chapter 4, Title 4-8, Water Quality	During operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		Standards, to address the addition of Site #3. PAI will comply with the conditions of this permit during operation of the project.	
		PAI will implement pollution prevention plans described in the company's Best Management Practices Policy (PAI 2010). Proposed measures include:	During operations
		Use properly-sized, highly digestible feeds with a minimum of fines. Purchase fish feed from manufacturers who use milling processes that minimize crumbling and dust.	During operations
		Use feeding equipment that minimizes the occurrence of feed breakage.	During operations
		Use an experienced technician to oversee the fish feeding process. The technician's main duty will be to supervise the feeding process, maximize the utilization of the fish feed, and reduce the chance of waste feed. During periods of reduced water quality or excessive currents, the feeding process will be modified with respect to the anticipated reduction in feed consumption.	During operations
		Use surface observation, underwater cameras, and/or other feed monitoring devices when needed to help facilitate observation of the feeding process and possible feed loss.	During operations
		Use underwater video on a regular basis to check for accumulations of feces or waste feed beneath or adjacent to cages.	During operations
		Record feed quantities per pen, per day, and closely monitor the Feed Conversion Rates (FCR) for signs of over- or under-feeding and as an indication of possible undetected feed loss from escapes through holes in the netting system or otherwise.	During operations
		Net washing *in situ* will not be practiced (not required), and antifoulants will not be used (not needed).	During operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		Collect fish mortalities that occur in cages on a regular basis. Dispose of mortalities through on-shore rendering, ensilage, or composting without leaching back into Rufus Woods Lake during any part of the process.	During operations
		PAI will monitor ambient and in-pen dissolved oxygen (DO) during risk periods (late summer) so as not to stress the cultured fish and in turn, wild fish outside the pens. Fish feeding and handling could be reduced as necessary to reduce metabolic oxygen demand of the cultured fish and offset the effects of a temporary DO decline.	During operations
		Pacific Aquaculture will employ horizontal “top nets” 10 feet below the surface when TDG levels are predicted to exceed 120%. These will keep the fish away from the water surface, at depths below 10 feet, where they will be better able to cope with high TDG levels. The top nets will be sewn into the main net prior to such an event. Pacific Aquaculture will monitor available information regarding snow pack, water trends, and anticipated runoff, and will communicate with both the Bureau of Reclamation (BOR), and the Colville Tribe in order to anticipate and prepare for future events of this type.	During operations
5.1.3	Aquatic Plants and Algae	Mitigation measures described above for water column/water quality effects would also be effective for minimizing environmental consequences for aquatic plants and algae.	During operations
		As a form of mitigation to possible perturbations to periphyton populations, if caused by the PAI Site #3 net pen aquaculture project at any of the alternative locations considered, additional species composition and stable isotope sampling would be sponsored by Pacific Aquaculture, Inc. to determine existing conditions before net pen operation at Site #3 (through stable isotope content determination and species composition of the periphyton community in right bank areas immediately downstream and at a few selected locations further downstream). These measurements could then be compared to	Prior to the start of operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		upstream locations above PAI Preferred Alternative Site #3 and above all Rufus Woods Lake fish farms, as conducted for the CCT-sponsored food web study (Richards and Rensel 2010). No performance standard will be associated with this mitigation, but rather the data would be analyzed and reported to the Colville Confederated Tribes Office of Environmental Trust and other pertinent governing agencies (e.g., U.S. Army Corps of Engineers, Bridgeport and Seattle). Depending on the results of the sampling after a full year of PAI Site #3 operation compared to pre-existing conditions, CCT will decide whether there is a need for additional periphyton monitoring or active mitigation. (Note: It is most likely that periphyton abundance and species composition vary interannually, so data collected for a single year will not be sufficient to understand both background conditions at upstream reference sites or the quantitative effects of the net pens.)	
		Independent contractors retained by PAI will measure the baseline (i.e., Site #3 pre-operation) macrophyte community status including growing season macrophyte areas, species composition and abundance measures for representative and replicate plots adjacent to and downstream of the project area, and repeat the measurements annually after operation of Site #3. At the same time, stable isotope analysis of collected fronds of macrophytes can be compared to data being acquired upstream of all fish farms in Rufus Woods Lake as part of the on-going CCT-sponsored food web study (Richards and Rensel 2010) to be able to detect, rule out, or quantify the environmental consequences to macrophytes. As previously noted in Chapter 4 (Section 4.1.3.3), other researchers such as Kohzu et al. (2008) and King et al. (2009) have been able to use ^{15}N stable isotope measurements to estimate the spatial and population effects of ^{15}N enriched sewage discharge in other regions so that if phosphorus loading becomes excessive in Rufus Woods Lake, the methodology should detect it if, properly applied. Depending on the results of the sampling after one full year of Site #3 operation compared to pre-existing conditions, the Colville Confederated Tribes (CCT) Office of Environmental Trust will decide whether there is a need for additional macrophyte monitoring	During operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		or active mitigation. If an excessive effect on macrophytes is detected, the Site #3 operation could be reduced by lowering stocking and grow-out densities of fish as a preferred option. Temporary cessation of culture (i.e., fallowing) could also be used, though this more aggressive approach to mitigation would not be needed if reduced stocking density in the rearing pens were practiced in a timely manner.	
5.1.4	Aquatic Animals	No mitigation measures are proposed or required for zooplankton, benthic invertebrates, or resident fish as no adverse environmental consequences have been identified.	Not applicable
		PAI will install and maintain net pen cover systems comparable to those presently used at existing Site #1 and Site #2 to exclude birds and mammals.	During operations
5.1.5	Navigation	Equip the net pen array at proposed Site #3 with private aids to navigation (PATON), subject to obtaining and complying with a U.S. Coast Guard PATON permit.	During construction and operations
		Equip the net pen array with a debris deflector that will prevent vessel traffic from attempting to pass on the shoreward side.	During construction and operations
TERRESTRIAL ENVIRONMENT			
5.2.1	Land Use	Obtain and comply with the conditions of a Tribal Trust land lease from the U.S. Department of the Interior, Bureau of Indian Affairs (BIA).	During project permitting
		Obtain and comply with the conditions of required land use permits and approvals from the Colville Confederated Tribes (CCT): Conditional Use Permit, and Shoreline Development Permit.	During project permitting, construction and operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
5.2.2	Topography and Soils	To the extent practicable, leave existing vegetation undisturbed during upland construction activities.	During construction
		Stabilize erosion-prone surfaces as soon as practicable during the construction phase with rock or gravel (to be used on the Site #3 access road); by placing geotextile, and/or by seeding with grasses (to be applied on the waterward side of the slope where the feed silo/operations trailer concrete pad would be poured).	During construction
5.2.3	Air Quality	Use only equipment and trucks that are maintained in good operational condition; restrict idling of construction equipment and vehicles when turning off such equipment would not damage the equipment or excessively delay related activities; and implement a dust control plan (if warranted).	During construction
5.2.4	Floodplains	Obtain written consent from the U.S. Army Corps of Engineers for construction within the Government Flowage Easement, and comply with the conditions of the easement.	During project permitting
5.2.5	Wetlands	No mitigation measures are proposed or required for wetland effects as no adverse environmental consequences were identified.	Not applicable
5.2.6	Prime or Unique Agricultural Lands	No mitigation measures are proposed or required for prime or unique agricultural lands as no adverse environmental consequences were identified.	Not applicable
5.2.7	Terrestrial Floral Communities	Implement a Vegetation Management Plan: Prior to initiating ground-disturbing activities, walk areas of the site to be cleared with a designated representative of CCT for the purpose of identifying noxious weed species that may be present.	During construction
		Extract noxious weeds manually and remove them from the site to be properly disposed. Alternatively, burn noxious weeds on-site subject to the conditions	During construction and operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		of a burning permit obtained from CCT. Inspect the upland site once per month during the growing season to identify and remove noxious weeds if any attempt to establish on soils disturbed by site development.	
		Employ standard erosion control practices, if necessary, to prevent runoff from exposed surfaces from entering drainage courses or the Columbia River.	During construction
		Maintain a minimum 35-ft wide buffer from the drainage course along the west boundary of proposed Site #3 to maintain riparian vegetation through which site runoff will filter before reaching the streambed.	During construction
		Remove non-invasive vegetation by mechanical means (e.g., with a dozer).	During construction
		Stockpile vegetation scraped from areas to be graded for burning on the site (subject to the conditions of a CCT burning permit), or for chipping. Distribute chips (if created) on the pedestrian pathway between the operations trailer and the dock to stabilize exposed soils.	During construction
		Avoid the use of herbicides or pesticides on the site.	During construction and operation
		Refuel vehicles and equipment at a suitable off-site location, outside the shoreline environment.	During construction and operation
		Implement no beach enhancement measures; leave littoral zone vegetation undisturbed to the maximum extent practicable.	During construction
5.2.8	Terrestrial Faunal Communities	No mitigation measures are proposed or required for impacts to terrestrial faunal communities as no adverse environmental consequences were identified.	Not applicable
5.2.9	Threatened, Endangered, and Protected Species	Mitigation measures described above for water column/water quality effects would also be effective at minimizing the potential for adverse effects to bull trout that may seasonally migrate through Rufus Woods Lake.	During operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		No mitigation measures are proposed or required for State- or Federally-listed terrestrial animal species as no listed or candidate species were identified within the proposed action area.	Not applicable
HUMAN ENVIRONMENT			
5.3.1	Confederated Tribes of the Colville Reservation	No mitigation measures are proposed or required for the CCT Reservation, per se. See mitigation measures described below for other elements of the human environment.	Not applicable
5.3.2	Areas of Recognized Archaeological or Historic Value	Monitor ground-disturbing activities during site development.	During construction
		Inadvertent Discoveries (43 CFR 10.4). In the event that human remains, burials, funerary items, sacred objects, or objects of cultural patrimony are found during project implementation, the project proponent or his authorized agent shall cease work immediately within 200 feet of the find. They shall then take steps to protect the find from further damage or disruption. They shall contact the Tribal Historic Preservation Officer (THPO) or Tribal Archaeologist to report the find. The THPO or Tribal Archaeologist shall contact the appropriate law enforcement authority if human remains are found. No further work shall be allowed on the project until the THPO has approved a plan for managing or preserving the remains or items found.	During construction
		Post-Review Discoveries (36 CFR 800.13). In the event that prehistoric artifacts (i.e., arrowheads, spear points, mortars, pestles, other ground stone tools, knives, scrapers, or flakes from the manufacture of tools, fire pits, peeled trees, etc.) or historic-period artifacts or features (i.e., fragments of old plates or ceramic vessels, weathered glass, dumps of old cans, cabins, root cellars, etc.) are found during project implementation, the proponent or his authorized	During construction

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
		agent shall cease work immediately within 200 feet of the find. Then they shall contact the THPO or the Tribal Archaeologist to report the find. No further work shall be allowed on the project until the THPO has approved a plan for managing or preserving the artifacts or features.	
		Avoid activities that have the potential to disturb cultural resources outside the areas specified in documents that accompany the *Cultural Resources Inventory* prepared for the site. Ground disturbance in such areas is not approved and will not proceed until cultural resources review of potential adverse effects in the new area has been completed.	During construction
5.3.3	Socioeconomic Issues	No mitigation measures are proposed or required for population, housing or employment.	Not applicable
5.3.4	Environmental Justice	No mitigation measures are proposed or required for CCT governmental programs or human health (other than those inherent in the proposal, described in *NEPA Environmental Assessment* Chapter 4, Section 4.3.4) to achieve environmental justice for the affected population of the Colville Confederated Tribes.	During construction and operations
5.3.5	Transportation	No mitigation measures are proposed or required for vehicle trips on Columbia River Road as no adverse environmental consequences were identified.	Not applicable
5.3.6	Noise	The proposed construction period – 6 months beginning in the fall of 2011 – would avoid sensitive life cycles and periods of peak wildlife activity.	During construction
		Equipment used to operate the fish feed delivery system at PAI Preferred Alternative Site #3 would be housed within the operations trailer to minimize the transmission of sound.	During operations
		If one of the downstream alternative locations were selected for PAI Site #3 requiring the use of a feed barge, both the feed blowers and diesel generators would be housed inside the insulated canopy of the feed barge to minimize the noise of this operation.	During operations

NEPA EA Section	Element of the Environment	Proposed Mitigation Measures	Timeframe for Implementation
5.3.7	Light and Glare	PAI proposes to shield yard light fixtures in the upland support services area of Preferred Alternative Site #3 to direct illumination downward to avoid glare for vehicles traveling on Columbia River Road and to minimize light spill into the surrounding area.	During operations
5.3.8	Areas of Recognized Scenic Value	No mitigation measures are proposed or required for areas of recognized scenic value, as none are present.	Not applicable
5.3.9	Areas of Recognized Recreational Value	No mitigation measures are proposed or required for areas of recognized recreational value.	Not applicable
5.3.10	Public Lands	No mitigation measures are proposed or required for public lands, as none are present.	Not applicable
5.3.11	Public Services	Royalties paid by PAI to CCT associated with Site #3 harvest would offset the cost of the low anticipated demand for public services.	During operations
5.3.12	Utilities	PAI will pay the electrical connection fee and monthly service charges for electricity and garbage collection.	During construction and operations

8.0 PUBLIC PARTICIPATION

The U.S. Environmental Protection Agency (EPA) will follow the public notice/public comment protocols set forth in the Code of Federal Regulations (CFR) for the National Environmental Policy Act (NEPA), for EPA permit actions, and for the Council on Environmental Quality (CEQ), all of which are contained within Title 40: Protection of Environment. These protocols are cited below.

40 CFR Part 6.203 − NEPA

The NEPA Responsible Official will, to the greatest extent possible, give notice to any State or local government, or Federally-recognized Indian tribe that, in the Official's judgment, may be affected by an action for which EPA plans to prepare an Environmental Assessment (EA). *40 CFR Part 6.203(a)(4)*

The Responsible Official must make reasonable efforts to involve the potentially affected communities where the proposed action is expected to have environmental impacts or where the proposed action may have human health or environmental effects in any communities, including minority communities, low-income communities, or Federally-recognized Indian tribal communities. *40 CFR Part 6.203(a)(5)*

At least thirty (30) calendar days before making the decision on whether, and if so how, to proceed with a proposed action, the Responsible Official must make the EA and preliminary Finding of Non-Significance (FONSI) available for review and comment to the interested Federal agencies, State and local governments, Federally-recognized Indian tribes and the affected public. The Responsible Official must respond to any substantive comments received and finalize the EA and FONSI before making a decision on the proposed action. *40 CFR Part 6.203(b)(1)*

40 CFR 124, Subpart A – EPA Permit Actions

The Director shall give notice that an NPDES new source determination has been made under Section 122.29. *40 CFR 124, Subpart A (a)(vi)*

Public notice of a draft permit shall allow at least 30 days for public comment. *40 CFR 124, Subpart A, Section 124.10(b)*

Public notice shall be given by the following methods: *40 CFR 124, Subpart A, Section 124.10(c)*

By mailing a copy of the notice to:

- The applicant.
- Any other agency which the Director knows has issued or is required to issue Section 404 permit for the same facility or activity.
- Federal and State agencies with jurisdiction over fish, shellfish, and wildlife resources and over coastal zone management plans, the Advisory Council on Historic Preservation, State Historic Preservation Officers, including and affected Indian tribes.
- Any State agency responsible for plan development under the Clean Water Act (CWA) Section 208(b)(2), 208(b)(4) or 303(e) and the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.
- Any user identified in the permit application of a privately-owned treatment works.

- Any unit of local government having jurisdiction over the area where the facility is proposed to be located.
- Persons who request in writing to be on the mailing list.

Soliciting persons for "area lists" from participants in past permit proceedings within the project area.

Notifying the public of the opportunity to be put on the mailing list through periodic publication in the public press.

40 CFR Part 1500, Section 1506.6 – CEQ Regulations

Agencies shall:

(a) Make diligent efforts to involve the public in preparing and implementing their NEPA procedures.

(b) Provide public notice of NEPA-related hearings, public meetings, and the availability of environmental documents so as to inform those persons and agencies who may be interested or affected.

(1) In all cases the agency shall mail notice to those who have requested it on an individual action.

(3) In the case of an action with effects primarily of local concern the notice may include:

(i) Notice to State and area-wide clearinghouses pursuant to OMB Circular A-95 (Revised).

(ii) Notice to Indian tribes when effects may occur on reservations.

(iii) Following the affected State's public notice procedures for comparable actions.

(iv) Publication in local newspapers (in papers of general circulation rather than legal papers).

(v) Notice through other local media.

(vi) Notice to potentially interested community organizations including small business associations.

(vii) Publication in newsletters that may be expected to reach potentially interested persons.

(viii) Direct mailing to owners and occupants of nearby or affected property.

(ix) Posting of notice on and off site in the area where the action is to be located.

(c) Hold or sponsor public hearings or public meetings whenever appropriate or in accordance with statutory requirements applicable to the agency.

9.0 LIST OF PREPARERS

The consultant team responsible for preparing the Pacific Aquaculture, Inc. (PAI) *Rufus Woods Lake Steelhead Trout Net Pen Aquaculture Site #3 NEPA Environmental Assessment* included J.E. (Jack) Rensel, Ph.D., Mark Pedersen, M.S., FP-C, Vicki Morris, B.A. Ed., and Zach Siegrist, M. Sc. Members of this team have worked together on aquaculture projects since 1999 in the capacity of preparing SEPA/NEPA documents, Biological Evaluations for information consultation under the Endangered Species Act, and for independent technical review. Brief biographical sketches are provided below for each team member.

The applicant's authorized agent, John Bielka, P.E., General Manager of Pacific Aquaculture, Inc., provided information and responded to questions regarding the description of the proposed action and alternatives considered.

J.E. (Jack) Rensel, Ph.D., Rensel Associates Aquatic Sciences

Jack Rensel is involved in aquaculture research and aquatic environmental issues. He was responsible for much of the basic research and analysis that led to the first Federally-sanctioned State permits for net pen aquaculture in the U.S. Dr. Rensel conducts research on current aquaculture and food web topics, including the beneficial food web aspects of optimally-sited commercial net pens, integrated multi-trophic aquaculture and physiological ecology of fish. With the support of the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture (USDA), and industry, Dr. Rensel has been a partner with the University of Southern California AquaModel team in developing, testing and validating the comprehensive water column and benthic effects GIS-model for salmon or other fish species net pens that may be used for a single farm or an array of farms throughout an entire coastal region (www.AquaModel.org). Dr. Rensel has worked extensively in North and South America, the Caribbean Sea, Southeast Asia, the Middle East, and in other locations worldwide. He is a recognized international expert on harmful algal bloom dynamics, and has been involved in the development and testing of mitigation strategies for farmed and wild fish stocks. He was lead author of a recent scientific publication explaining how harmful blooms were strongly linked to extreme inter-annual variation of Fraser River sockeye salmon marine survival. As principal of Rensel Associates Aquatic Sciences, Dr. Rensel has written more than twenty peer-reviewed articles or book chapters and hundreds of technical reports. His clients have included seafood processing, fish farming, Tribal and other governmental organizations in the U.S. and abroad. He is also a consultant to Earth Justice Hawaii on water and sediment quality issues.

Mark Pedersen, M.S., FP-C, Margenex International

Mark G. Pedersen is a Senior Aquatic/Marine Scientist and President of Margenex International, founded in 1991. He is a Certified Fisheries Professional (FP-C) by the American Fisheries Society (AFS), and is President of the Washington-British Columbia Chapter of AFS. Mr. Pedersen has extensive experience in strategic planning and business development related to natural resources management. Technical specialties include: aquatic and marine environmental issues; biology of economically important marine fishes, salmon species, and shellfish; fishery management policy and regulations; seafood business and statistics for commercial, artisanal, and recreational fisheries along the Pacific coast of North America, Peru, and Micronesia, in the Baltic Sea, Papua-New Guinea, and the northwest coast of Africa (Mauritania and Ghana); and calculation of lost fishing vessel revenues and fishermen's potential earnings due to accidents. He has directed, managed, and/or participated in numerous projects involving fishery characterization, fish and wildlife habitat enhancement, and mitigation for development impacts;

fish migrations, and fish stock assessments. Mr. Pedersen's work also involves project compliance with local, state, national, and international environmental regulations including the Endangered Species Act and World Bank, International Finance Corporation, and Espoo Environmental Standards; and planning and design of natural resource-related projects. His responsibilities include project management, research, analysis, preparation and presentation of proposals and reports, and negotiation with government agencies. Prior to becoming a consultant, Mr. Pedersen was employed by the Washington Department of Fisheries, Olympia, Washington (1973-1991), where his last position was Deputy Assistant Director, Marine Fish and Shellfish.

Vicki Morris, B.A. Ed., Vicki Morris Consulting Services

Vicki Morris is a SEPA/NEPA and permit assistance specialist, self-employed as a woman-owned business since 1991. She has 35 years' experience as project manager and primary author of Environmental Impact Statements, expanded Environmental Checklists and related documents, and 10 concurrent years of experience assisting clients with the acquisition of aquatic environment and land use permits. She has prepared more than 150 environmental compliance documents under the Washington State Environmental Policy Act (SEPA), and several recent documents under the National Environmental Policy Act (NEPA). Projects have included aquatic development projects; habitat restoration and enhancement; commercial, industrial, residential, and recreational development proposals; utility extensions and rehabilitations; and programmatic actions: comprehensive land use plan updates, land use code amendments, and annexations. Her area of expertise is complex and potentially controversial projects, emphasizing coordination with decision makers; inclusion of affected parties; thorough analysis; organizing and sequencing team tasks and project milestones.

Zach Siegrist, M.Sc.

Zach Siegrist is an aquatic scientist with Rensel Associates Aquatic Sciences performing field work and data analysis of research and monitoring projects. He holds a Master of Science in Biology, as well as dual Bachelor of Science degrees in Biology and French. Mr. Siegrist was a National Merit Scholarship winner. In recent years, Zach has led or participated in a range of marine science projects involving such topics as Integrated Multi-Trophic Aquaculture, shellfish and finfish studies, Pacific Northwest invasive species, ecological monitoring and modeling, and flow visualization of benthos. He also spent two years teaching several different collegiate-level science laboratory courses at Western Washington University in Bellingham, and has significant experience presenting scientific material to both scientific and non-scientific audiences. While an undergraduate student, Zach spent a year living in Grenoble, France and studied both French and regional biology, including sub-alpine ecology and alpine soil ecosystems.

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Appendix A

Biota of Rufus Woods Lake and Environs

Table A-1. Phytoplankton of Rufus Woods Lake based on surveys downstream in Lake Pateros and Rocky Reach Reservoirs (Sources: 3, 6 and 7 listed on page A-13).

Phylum	Genus	Phylum	Genus
Chlorophyta	*Aetinastrum*	Chrysopyta	*Fragilaria*
Chlorophyta	*Ankistrodesmus*	Chrysopyta	*Frustulia*
Chlorophyta	*Ankyra*	Chrysopyta	*Gomphoneis*
Chlorophyta	*Closterium*	Chrysopyta	*Gomphonema*
Chlorophyta	*Cosmarium*	Chrysopyta	*Gyrosigma*
Chlorophyta	*Dictyosphaerium*	Chrysopyta	*Hannaea*
Chlorophyta	*Eudorina*	Chrysopyta	*Mastogloia*
Chlorophyta	*Gloeocystis*	Chrysopyta	*Melosira*
Chlorophyta	*Haematococcus*	Chrysopyta	*Meridion*
Chlorophyta	*Hormidium*	Chrysopyta	*Navicula*
Chlorophyta	*Micractinium*	Chrysopyta	*Nitzschia*
Chlorophyta	*Microspora*	Chrysopyta	*Opephora*
Chlorophyta	*Monoraphidium*	Chrysopyta	*Pinnularia*
Chlorophyta	*Oocystis*	Chrysopyta	*Rhizosolenia*
Chlorophyta	*Pandorina*	Chrysopyta	*Rhoicosphenia*
Chlorophyta	*Pediastrum*	Chrysopyta	*Rhopalodia*
Chlorophyta	*Pseudosphaerocystis*	Chrysopyta	*Stephanodiscus*
Chlorophyta	*Pyramimonas*	Chrysopyta	*Surirella*
Chlorophyta	*Scenedesmus*	Chrysopyta	*Synedra*
Chlorophyta	*Schroederia*	Chrysopyta	*Tabellaria*
Chlorophyta	*Sphaerocystis*	Chrysopyta	*Tetracyclus*
Chlorophyta	*Spirogyra*	Chrysopyta	*Chroomonas*
Chlorophyta	*Spondylosium*	Chrysopyta	*Cryptomonas*
Chlorophyta	*Staurastrum*	Cryptophyta	*Cyanomonas*
Chlorophyta	*Stigeoclonium*	Cryptophyta	*Dinobyron*
Chlorophyta	*Tetraedon*	Cryptophyta	*Mallomonas*
Chlorophyta	*Ulothrix*	Heterokontophyta	*Synura*
Chrysopyta	*Achnanthes*	Heterokontophyta	*Anacystis*
Chrysopyta	*Amphipleura*	Heterokontophyta	*Aphanizomenon*
Chrysopyta	*Amphora*	Pyrrhophyta	*Aphanocapsa*
Chrysopyta	*Anomoeoneis*	Pyrrhophyta	*Cerastium*
Chrysopyta	*Asterionella*	Pyrrhophyta	*Chroococcus*
Chrysopyta	*Aulacoseira*	Pyrrhophyta	*Cyanobacteria*
Chrysopyta	*Caloneis*	Pyrrhophyta	*Glenodinium*
Chrysopyta	*Cocconeis*	Pyrrhophyta	*Gymnodinium*
Chrysopyta	*Cyclotella*	Pyrrhophyta	*Lynbya*
Chrysopyta	*Cymbella*	Pyrrhophyta	*Merismopedia*
Chrysopyta	*Diatomella*	Pyrrhophyta	*Oscillatoria*
Chrysopyta	*Diploneis*	Pyrrhophyta	*Peridineum*
Chrysopyta	*Epithemia*	Pyrrhophyta	*Phormidium*
Chrysopyta	*Eunotia*	Pyrrhophyta	*Schizothrix*

Table A-2. Preliminary list of periphyton genera reported from Rufus Woods Lake
(Source: 13 listed on page A-13). Also see Richards, Rensel and Siegrist (2011) for a more complete and updated list.

Genus
Achnanthes
Aulacoseira
Botryococcus
Cocconeis
Coelastrum
Cryptomonas
Cymbella
Diatoma
Didymosphenia
Ellerbeckia
Epithemia
Fragilaria
Frustulia
Gomphonema
Lyngbya
Melosira
Mougeotia
Navicula
Neidium
Oscillatoria
Phormidium
Rhizoclonium
Sphaerocystis
Synedra
Ulothrix

Table A-3. Common macrophytes of Rufus Woods Lake (Sources: 7, 8, 10 and 11 listed on page A-13).

Common name	Scientific name
coontail	*Ceratophyllum demersum*
curly-leafed pondweed	*Potomogeton spp.*
Eurasian milfoil	*Myriophyllum spicatum*
green algae	*Cladophora* sp.
waterweed	*Elodea sp.*

Table A-4. Zooplankton of Rufus Woods Lake based on surveys downstream in Lake Pateros and Rocky Reach Reservoirs (Sources: 3 and 6 listed on page A-13).

Phylum	Genus	Phylum	Genus
Annelida	oligochaete worms	Arthropoda	*Sida*
Arthropoda	*Alona*	Arthropoda	*Skistodiaptomus*
Arthropoda	*Alonella*	Cnidaria	*Hydra*
Arthropoda	*amphipods*	Mollusca	*Bivalve*
Arthropoda	*Bosmina*	Mollusca	*Pelecypoda*
Arthropoda	*Camptocercus/Kuzia*	Nematoda	nematode worms
Arthropoda	*Ceriodaphnia*	Rotifera	*Ascomorpha*
Arthropoda	Chironomidae larvae	Rotifera	*Asplanchna*
Arthropoda	*Chydorus*	Rotifera	*Bdelloide*
Arthropoda	*Cyclops*	Rotifera	*Cephalodella*
Arthropoda	*Daphnia*	Rotifera	*Collotheca*
Arthropoda	*Diacyclops*	Rotifera	*Euclanis*
Arthropoda	*Diaphanosoma*	Rotifera	*Filinia*
Arthropoda	*Diaptomus*	Rotifera	*Kellicottia (longispina)*
Arthropoda	*Epischura*	Rotifera	*Keratella*
Arthropoda	*Eucyclops*	Rotifera	*Lecane*
Arthropoda	*Eurycercus*	Rotifera	*Lophocharis*
Arthropoda	Family Macrothricidae	Rotifera	*Macrochaetus*
Arthropoda	*Graptoleberis*	Rotifera	*Monostyla*
Arthropoda	*Harpacticoid*	Rotifera	*Mytilina*
Arthropoda	*Latona*	Rotifera	*Notholca*
Arthropoda	*Leptodiaptomus*	Rotifera	*Polyarthra*
Arthropoda	*Leptodorakindtii*	Rotifera	*Rotifera*
Arthropoda	*Leydigia*	Rotifera	*Scaridium*
Arthropoda	*Macrocyclops*	Rotifera	*Synchaeta*
Arthropoda	*Mite*	Rotifera	*Trichocerca*
Arthropoda	Odonata nymph	Rotifera	*Trichotria*
Arthropoda	ostracods	Tardigrada	tardigrades

Table A-5. Common macroinvertebrates of Rufus Woods Lake; species identifications and numerous other species to be added as a result of the Richards and Rensel ongoing food web studies (Sources: 9, 13 and 14 listed on page A-13). Also see Richards, Rensel and Siegrist (2011) for a more complete and updated list.

Common name	Phylum	Class	Family	Scientific name
pea clam / fingernail clam	Mollusca	Bivalvia	Sphaeriidae	
pond snail	Mollusca	Gastropoda	Lymnaeidae	*Stagnicola* sp.
pond snail	Mollusca	Gastropoda	Lymnaeidae	
bladder / pouch / bubble snail	Mollusca	Gastropoda	Physidae	*Physa* sp.
ramshorn snail	Mollusca	Gastropoda	Planorbidae	*Gyraulus* sp.
ramshorn snail	Mollusca	Gastropoda	Planorbidae	
snail (sp.)	Mollusca	Gastropoda		
sponge (sp)	Porifera			

Table A-6. Biota reported from 2010 Rufus Woods Lake trout and walleye stomach surveys (Sources: 13 and 14 listed on page A-13). Also see Richards, Rensel and Siegrist (2011) for a more complete and updated list.

Common name	Phylum	Class	Order	Family
freshwater jawless leeches	Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae
mites	Arthropoda	Arachnida	Actinedida	Arrenuridae
mites	Arthropoda	Arachnida	Actinedida	Hydrachnidae
mites	Arthropoda	Arachnida	Actinedida	Hydrodromidae
mites	Arthropoda	Arachnida	Actinedida	Limnesiidae
mites	Arthropoda	Arachnida	Actinedida	Pionidae
mites	Arthropoda	Arachnida	Actinedida	Unionicolidae
jumping spiders	Arthropoda	Arachnida	Araneae	Salticidae
unidentified spiders	Arthropoda	Arachnida	Araneae	
daphnia / water fleas	Arthropoda	Branchiopoda	Cladocera	Daphniidae
predatory water fleas	Arthropoda	Branchiopoda	Cladocera	Leptodoridae
millipedes	Arthropoda	Diplopoda		
ant-like beetles	Arthropoda	Insecta	Coleoptera	Anthicidae
carabid beetles / ground beetles	Arthropoda	Insecta	Coleoptera	Carabidae
leaf beetles	Arthropoda	Insecta	Coleoptera	Chrysomelidae
true weevils	Arthropoda	Insecta	Coleoptera	Curculionidae
predaceous diving beetles	Arthropoda	Insecta	Coleoptera	Dytiscidae
whirligig beetles	Arthropoda	Insecta	Coleoptera	Gyrinidae
scarab beetles	Arthropoda	Insecta	Coleoptera	Scarabaeidae
rove beetles	Arthropoda	Insecta	Coleoptera	Staphylinidae
darkling beetles	Arthropoda	Insecta	Coleoptera	Tenebrionidae
biting midges	Arthropoda	Insecta	Diptera	Ceratopogonidae
chironomids / non-biting midges	Arthropoda	Insecta	Diptera	Chironomidae
frit flies / grass flies	Arthropoda	Insecta	Diptera	Chloropidae
crane flies	Arthropoda	Insecta	Diptera	Tipulidae
acalyptrate muscoids	Arthropoda	Insecta	Diptera	
small squaregill mayfiles	Arthropoda	Insecta	Ephemeroptera	Caenidae
aphids	Arthropoda	Insecta	Hemiptera	Aphididae
leafhoppers	Arthropoda	Insecta	Hemiptera	Cicadellidae
squash bugs / leaf-footed bugs	Arthropoda	Insecta	Hemiptera	Coreidae
water boatmen	Arthropoda	Insecta	Hemiptera	Corixidae
backswimmers	Arthropoda	Insecta	Hemiptera	Notonectidae
assassin bugs and thread-legged bugs	Arthropoda	Insecta	Hemiptera	Reduviidae
bees	Arthropoda	Insecta	Hymenoptera	Apidae
cuckoo wasps	Arthropoda	Insecta	Hymenoptera	Chrysididae
ants	Arthropoda	Insecta	Hymenoptera	Formicidae
ichneumon wasps	Arthropoda	Insecta	Hymenoptera	Ichneumonidae
moths and butterflies	Arthropoda	Insecta	Lepidoptera	
alderflies	Arthropoda	Insecta	Megaloptera	Sialidae
damselflies	Arthropoda	Insecta	Odonata	Coenagrionidae
dragonflies	Arthropoda	Insecta	Odonata	Libellulidae
stoneflies	Arthropoda	Insecta	Plecoptera	
snakeflies	Arthropoda	Insecta	Raphidioptera	Raphidiidae
microcaddisflies / purse-case caddisflies	Arthropoda	Insecta	Trichoptera	Hydroptilidae
long-horned caddisflies	Arthropoda	Insecta	Trichoptera	Leptoceridae
case-contsructing caddisflies	Arthropoda	Insecta	Trichoptera	Limnephilidae
amphipods	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae
gammarids / scuds	Arthropoda	Malacostraca	Amphipoda	Gammaridae
amphipods	Arthropoda	Malacostraca	Amphipoda	Hyalellidae
crayfish	Arthropoda	Malacostraca	Decapoda	Astacidae
crayfish	Arthropoda	Malacostraca	Decapoda	Cambaridae
Caecidotea sp.	Arthropoda	Malacostraca	Isopoda	Asselidae
isopods	Arthropoda	Malacostraca	Isopoda	
copepods	Arthropoda	Maxillopoda	Cyclopoida	Cyclopidae
sticklebacks	Chordata	Actinopterygii	Gasterosteiformes	
ray-finned fishes	Chordata	Actinopterygii	Superorder Acanthopterygii	
pea clam / fingernail clam	Mollusca	Bivalvia	Veneroida	Sphaeriidae
pond snail	Mollusca	Gastropoda	Basommatophora	Lymnaeidae
Physid / bladder / pouch / bubble snail	Mollusca	Gastropoda	Basommatophora	Physidae
planorbid / ramshorn snail	Mollusca	Gastropoda	Basommatophora	Planorbidae

Table A-7. Fish of Rufus Woods Lake (Sources: 2, 3, 5, 14 and 16 listed on page A-13).

Common name	Scientific name	Family
white sturgeon	*Acipenser transmontanus*	Acipenseridae
bridgelip sucker	*Catostomus columbianus*	Catostomidae
largescale sucker	*Catostomus marcrocheilus*	Catostomidae
longnose sucker	*Catostomus catostomus*	Catostomidae
black crappie *	*Pomoxis nigromaculatus*	Centrarchidae
largemouth bass *	*Micropterus salmoides*	Centrarchidae
pumpkinseed *	*Lepomis gibbosus*	Centrarchidae
smallmouth bass *	*Micropterus dolomieu*	Centrarchidae
mottled sculpin	*Cottus bairdii*	Cottidae
prickly sculpin	*Cottus asper*	Cottidae
torrent sculpin	*Cottus rhotheus*	Cottidae
carp *	*Cyprinus carpio*	Cyprinidae
chiselmouth	*Acrocheilus alutaceus*	Cyprinidae
longnose dace	*Rhinichthys cataractae*	Cyprinidae
northern pikeminnow	*Ptychocheilus oregonensis*	Cyprinidae
peamouth	*Mylocheilus caurinus*	Cyprinidae
redside shiner	*Rhichardsonius balteatus*	Cyprinidae
speckled dace	*Rhinichthys osculus*	Cyprinidae
tench *	*Tinca tinca*	Cyprinidae
burbot	*Lota lota*	Gadidae
three-spined stickleback	*Gasterosteus aculeatus*	Gasterosteidae
black bullhead *	*Ameiurus melas*	Ictaluridae
brown bullhead *	*Ameiurus nebulosus*	Ictaluridae
walleye *	*Sander vitreus*	Percidae
yellow perch *	*Perca flavescens*	Percidae
brook trout *	*Salvelinus fontinalis*	Salmonidae
brown trout *	*Salmo trutta*	Salmonidae
bull trout	*Salvelinus confluentus*	Salmonidae
chinook salmon	*Oncorhynchus tshawytscha*	Salmonidae
cutthroat trout	*Oncorhynchus clarkii*	Salmonidae
Dolly Varden	*Salvelinus malma malma*	Salmonidae
kokanee salmon	*Oncorhynchus nerka*	Salmonidae
lake whitefish *	*Coregonus clupeaformis*	Salmonidae
mountain whitefish	*Prosopium williamsoni*	Salmonidae
rainbow/steelhead trout	*Oncorhynchus mykiss*	Salmonidae

*Non-indigenous to Rufus Woods Lake as according to Source 13 (Scholz and McLellan 2009).

Table A-8. Birds of the Rufus Woods Lake subbasin (Sources: 3 and 5 listed on page A-13).

Common name	Scientific name	Common name	Scientific name
American coot	*Fulica americana*	common loon	*Gavia immer*
American goldfinch	*Spinus tristis*	common merganser	*Mergus merganser*
American kestrel	*Falco sparverius*	common nighthawk	*Chordeiles minor*
American robin	*Turdus migratorius*	common raven	*Corvus corax*
American white pelican	*Pelecanus erythrorhynchus*	common snipe	*Capella gallinago*
American widgeon	*Mareca americana*	Cooper's hawk	*Accipiter cooperii*
arctic loon	*Gavia arctica*	dark-eyed junco	*Junco hyemalis*
bald eagle	*Haliaeetus leucocephalus*	dipper	*Cinclus mexicanus*
bank swallow	*Riparia riparia*	downy woodpecker	*Dendrocopos pubescens*
barn owl	*Tyto alba*	eared grebe	*Podiceps caspicus*
barn swallow	*Hirundo rustica*	eastern kingbird	*Tyrannus tyrannus*
barrow's goldeneye	*Bucephala islandica*	evening grosbeak	*Hesperiphona vespertina*
belted kingfisher	*Megaceryle alcyon*	ferruginous hawk	*Buteo regalis*
black-backed woodpecker	*Picoides articus*	flammulated owl	*Otus flammeolus*
black-billed magpie	*Pica pica*	flycatcher (Hammond's or dusky)	*Empidonax sp.*
black-capped chickadee	*Parus atricapillus*	Forster's tern	*Sterna forsteri*
black-crowned night heron	*Nycticorax nycticorax*	fox sparrow	*Passerella iliaca*
black-headed grosbeak	*Pheucticus melanocephalus*	gadwall	*Anas strepera*
blue grouse	*Dendragapus obscurus*	golden eagle	*Aquila chrysaetos*
blue-winged teal	*Anas discors*	golden-crowned kinglet	*Regulus satrapa*
bohemian waxwing	*Bombycilla garrulus*	grasshopper sparrow	*Ammodramus savannarum*
Bonaparte's gull	*Larus philadelphia*	gray partridge	*Perdix perdix*
Brewer's blackbird	*Euphagus cyanocephalus*	great blue heron	*Ardea herodias*
Brewer's sparrow	*Spizella breweri*	great horned owl	*Bubo virginianus*
brown creeper	*Certhia familiaris*	green-winged teal	*Anas carolinensis*
brown-headed cowbird	*Molothrus ater*	herring gull	*Larus argentatus*
bufflehead	*Bucephala albeola*	hooded merganser	*Lophodytes cucullatus*
burrowing owl	*Athene cunicularia*	horned grebe	*Podiceps auritus*
California gull	*Larus californicus*	horned lark	*Eremophila alpestris*
California quail	*Lophortyx californicus*	house finch	*Carpodacus mexicanus*
calliope hummingbird	*Stellula calliope*	house sparrow	*Passer domesticus*
canada goose	*Branta canadensis*	house wren	*Troglodytes aedon*
canvasback	*Aythya valisineria*	killdeer	*Charadrius vociferus*
canyon wren	*Catherpes mexicanus*	lark sparrow	*Chondestes grammacus*
Cassin's finch	*Carpodacus cassinii*	lazuli bunting	*Passerina amoena*
cedar waxwing	*Bombycilla cedrorum*	least sandpiper	*Erolia minutilla*
chipping sparrow	*Spizella passerina*	lesser scaup	*Aythya affinis*
chukar partridge	*Alectoris chukar*	lesser yellowlegs	*Totanus flavipes*
cinnamon teal	*Anas cyanoptera*	Lewis' woodpecker	*Asyndesmus lewis*
Clark's nutcracker	*Nucifraga columbiana*	loggerhead shrike	*Lanius ludovicianus*
cliff swallow	*Petrochelidon pyrrhonota*	long-billed curlew	*Numenius americanus*
common crow	*Corvus brachyrhynchos*	long-eared owl	*Asio otus*
common flicker	*Colaptes auratus*	Macgillivary's warbler	*Oporornis tolmiei*
common goldeneye	*Bucephala clangula*	mallard	*Anas platyrhynchos*

Table A-8. Birds of the Rufus Woods Lake subbasin, *continued*

Common name	Scientific name	Common name	Scientific name
marsh hawk	*Circus cyaneus*	Say's phoebe	*Sayornis saya*
merlin	*Falco columbarius*	sharp-shinned hawk	*Accipiter striatus*
mountain bluebird	*Sialia currucoides*	sharp-tailed grouse	*Tympanuchus phasianellus*
mourning dove	*Zenaida macroura*	short-eared owl	*Asio flammeus*
northern goshawk	*Accipiter gentilis*	shoveler	*Spatula clypeata*
northern oriole	*Icterus galbula*	snow goose	*Chen hyperborea*
northern shrike	*Lanius excubitor*	solitary sandpiper	*Tringa solitaria*
orange-crowned warbler	*Vermivora celata*	song sparrow	*Melospiza melodia*
osprey	*Pandion haliaetus*	spotted sandpiper	*Actitis macularia*
pectoral sandpiper	*Erolia melanotos*	spruce grouse	*Dendragapus canadensis*
peregrine falcon	*Falco peregrinus*	starling	*Sturnus vulgaris*
pied-billed grebe	*Podilymbus podiceps*	steller's jay	*Cyanocitta stelleri*
pileated woodpecker	*Dryocopus pileatus*	Swainson's hawk	*Buteo swainsoni*
pine siskin	*Spinus pinus*	Townsend's solitaire	*Myadestes townsendi*
pintail	*Anas acuta*	Townsend's warbler	*Dendroica townsendi*
poor-will	*Phalaenoptilus nuttallii*	tree sparrow	*Spizella arborea*
prairie falcon	*Falco mexicanus*	tree swallow	*Iridoprocne bicolor*
red crossbill	*Loxia curvirostra*	turkey	*Meleagris gallopavo*
red-breasted merganser	*Mergus serrator*	turkey vulture	*Cathartes aura*
red-breasted nuthatch	*Sitta canadensis*	upland sandpiper	*Calidris himantopus*
red-eyed vireo	*Vireo olivaceus*	varied thrush	*Ixoreus naevius*
redhead	*Aythya americana*	Vaux's swift	*Chaetura vauxi*
red-necked grebe	*Podiceps grisegena*	vesper sparrow	*Pooecetes gramineus*
red-tailed hawk	*Buteo jamaicensis*	violet-green swallow	*Tachycineta thalassina*
red-throated loon	*Gavia stellata*	water pipit	*Anthus spinoletta*
red-winged blackbird	*Agelaius phoeniceus*	western bluebird	*Sialia mexicana*
ring-billed gull	*Larus delawarensis*	western grebe	*Aechmophorus occidentalis*
ring-necked duck	*Aythya collaris*	western kingbird	*Tyrannus verticalis*
ring-necked pheasant	*Phasianus colchicus*	western meadowlark	*Sturnella neglecta*
rock dove	*Columba livia*	western tanager	*Piranga ludoviciana*
rock wren	*Salpinctes obsoletus*	western wood pewee	*Contopus sordidulus*
rough-legged hawk	*Buteo lagopus*	whistling swan	*Olor columbianus*
rough-winged swallow	*Stelgidopteryx ruficollis*	white-crowned sparrow	*Zonotrichia leucophrys*
ruby-crowned kinglet	*Regulus calendula*	white-fronted goose	*Anser albifrons*
ruddy duck	*Oxyura jamaicensis*	whitehead woodpecker	*Picoides allbolarvatus*
ruffed grouse	*Bonasa umbellus*	white-throated swift	*Aeronautes saxatalis*
rufous hummingbird	*Selasphorus rufus*	willow flycatcher	*Empidonax traillii*
rufous-sided towhee	*Pipilo erythrophthalmus*	Wilson's warbler	*Wilsonia pusilla*
sage grouse*	*Centrocercus urophasianus*	winter wren	*Troglodytes troglodytes*
sage sparrow	*Amphispiza belli*	wood duck	*Aix sponsa*
sage thrasher	*Oreoscoptes montanus*	yellow warbler	*Dendroica petechis*
sandhill crane	*Grus canadensis*	yellow-headed blackbird	*Xanthocephalus xanthocephalus*
savannah sparrow	*Passerculus sandwichensis*	yellow-rumped warbler	*Dendroica coronata*
saw-whet owl	*Aegolius acadicus*		

*Of the bird species listed in Table A-3, greater sage grouse (*Centrocercus urophasianus*) is a candidate for Federal listing as threatened. The U.S. Fish & Wildlife Service (USFWS) Central Washington Field Office was consulted during preparation of the Biological Evaluation for the project. Personal communication with Greg Kurz (USFWS, December 14, 2010) confirmed that habitats for Federally-listed or candidate bird species are not present within the action area of the Pacific Aquaculture Rufus Woods Lake Steelhead Net Pen Site #3 project, and none are known to nest of breed at or near the adjacent proposed upland support site.

Table A-9. Mammals of Rufus Woods Lake subbasin (Sources: 3, 4 and 5 listed on page A-13).

Common name	Scientific name
badger	*Taxidea taxus*
bat	*Myotis sp.*
beaver	*Castor canadensis*
black bear	*Ursus americanus*
bobcat	*Lynx rufus*
bushy-tailed wood rat	*Neotoma cinerea*
cougar	*Felis concolor*
coyote	*Canis latrans*
deer mouse	*Peromyscus maniculatus*
elk	*Cervus elaphus*
fisher	*Martes pennanti*
gray wolf	*Canis lupus*
great basin pocket mouse	*Perognathus parvus*
house mouse	*Mus musculus*
least chipmunk	*Eutamias minimus*
lynx	*Lynx lynx*
marten	*Martes americana*
Merriam's shrew	*Sorex merriami*
montane meadow mouse	*Microtus montanus*
moose	*Alces alces*
mule deer	*Odocoileus hemionus*
muskrat	*Ondatra zibethica*
northern pocket gopher	*Thomomys talpoides*
Nuttall's cottontail	*Sylvilagus nuttallii*
porcupine	*Erethizon dorsatum*
raccoon	*Procyon lotor*
river otter	*Lontra canadensis*
sagebrush meadow mouse	*Lagurus curtatus*
shrew	*Sorex sp.*
striped skunk	*Mephitis mephitis*
Townsend's big-eared bat	*Corynorhinus townsendii*
Washington ground squirrel	*Spermophilus washingtoni*
weasel	*Mustela vison*
western harvest mouse	*Reithrodontomys megalotis*
white-tailed deer	*Odocoileus virginianus*
white-tailed jackrabbit	*Lepus townsendii*
wolverine	*Gulo luscus*
yellow pine chipmunk	*Eutamias amoenus*
yellow-bellied marmot	*Marmota flaviventrii*

Table A-10. Reptiles and amphibians of the Rufus Woods Lake subbasin
(Sources: 3 and 5 listed on page A-13).

Common name	Scientific name
Columbia spotted frog	*Rana luteiventris*
pacific tree frog	*Hyla regilla*
western toad	*Bufo boreas*
common garter snake	*Thamnophis elegans*
gopher snake	*Pituophis melanoleucus*
racer	*Coluber constrictor*
western rattlesnake	*Crotalus viridis*

Table A- 11. Common terrestrial flora of the Rufus Woods Lake subbasin
(Sources: 3 and 12 listed on page A-13).

Common name	Scientific name
big sagebrush	*Artemisia tridentata*
bitterbrush	*Purshia tridentata*
cheatgrass	*Bromus tectorum*
Douglas fir	*Pseudotsuga menziesii*
Idaho fescue	*Festuca idahoensis*
indian wheat	*Plantago patagonica*
ponderosa pine	*Pinus ponderosa*
rabbitbrush	*Chrysothamnus nauseosus*
three-tip sagebrush	*Artemisia tripartita*
western juniper	*Juniperus occidentalis*

Sources of Information for the Listings of Biota of Rufus Woods Lake and Nearby Areas

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13) Richards, D. and J.E. Rensel. 2010. Rufus Woods Lake Food Web and Creel Survey Project, Quarterly Report: August 2010 through October 2010. Preliminary report.

14) Richards, D. and J.E. Rensel. 2010. Unpublished field survey and fish stomach data.

15) Rocky Reach Hydroelectric Project FERC Project No. 2145, 1999. Benthic Analysis Study Plan. Public Utility District No. 1 of Chelan County. Wenatchee, WA.

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Also noted on some tables:

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