1. EXECUTIVE SUMMARY

1.1. The Colville Tribes and Bonneville Power Administration (BPA) requested the services of the Corps to perform a limited reconnaissance study to evaluate and recommend potential water sources for a planned fish hatchery (BPA Intergovernmental Contract No. 16123). This reconnaissance study was conducted to determine if there are water sources that can be developed and conveyed to the Colville Tribes fish hatchery, provide sufficient quantity and quality of water in a secure manner that does not pose a risk to dam safety and at minimal cost to the Government.

1.2. The Colville Tribes hatchery consultants determined the amount of water required from each potential source to satisfy the total flow and temperature. Sources identified include the reservoir, relief tunnel, and nearby well sites. Hatchery water requirements were originally identified the as 22 cfs from the relief tunnel drainage system, 25 to 30 cfs from the reservoir by way of the irrigation inlets, and 6 cfs from wells for summer/fall Chinook. The relief tunnel and well water is of particular importance because it is 6 months out of phase in temperature with the reservoir water. Subsequent hatchery design has identified the maximum flow requirement for temperature averaging as 35.1 cfs combined from the relief tunnel and wells and 42.2 cfs from the reservoir if spring Chinook are added. The hatchery design is ongoing and the flow requirements are subject to further revision.

1.3. The water supply study determined the potential to supply 20 cfs from the relief tunnel by enlarging the existing relief tunnel sump and installing a 450 HP pump and the potential to supply 45 cfs from the reservoir by opening the irrigation inlet and outlet on the upstream and downstream faces of the dam and installing a 30-inch diameter metal pipe with an emergency gate valve, trash rack, fish screen, and stoplogs.

1.4. Conveyance of the relief tunnel water to the hatchery site will require a 20-inch diameter metal pipe and conveyance of the reservoir water will require a 30-inch diameter metal pipe. The pipes must be buried for seismic and security considerations and would run approximately 300 feet through the riprap on the embankment and 2,400 feet under the existing road. This will require demolition and repaving the road and excavating pipe trench 8-feet deep by 11-feet wide.

1.5. The preliminary construction cost estimate for the modifications to the relief tunnel sump, opening the irrigation inlet, and the pipelines to the Head Box at the hatchery is $3,074,000.

1.6. A potential well field site is identified in the study upstream of the dam seepage blanket in the vicinity of the State Park and golf course approximately 2 miles from the dam. From available information potential well field sites at the hatchery do not look promising and a well field in the vicinity of the relief tunnel is precluded by dam safety considerations.

1.7. Testing of water samples from the relief tunnel and the reservoir forebay at the elevation of the irrigation indicates generally good water quality at the relief tunnel and forebay locations with no exceedances of either Washington Department of Fish and Wildlife (WDFW) or Washington Department of Ecology (WDOE) criteria. The parameters monitored show little difference between the relief tunnel and the forebay samples. Water quality samples will be collected at the relief tunnel, forebay, and hatchery well site in the spring and summer to determine if any seasonal variations in water quality exist for these source waters. The test results will be added to this study as supplements.

1.8. A further and more detailed investigation will be needed in the next phase of design to confirm the assumptions and cost estimates developed in this study and to address dam safety issues. In view of the more certain potential to supply additional water from the reservoir and the uncertainty on the location and yield from a well field in the area, it is recommended that the next phase of deign also investigate mechanical heating and cooling of additional water from the reservoir to achieve the desired temperatures for rearing fish.

2. INTRODUCTION

2.1. Background

2.1.1. The Colville Tribes proposed to the Northwest Power Planning Council (NPCC) and Bonneville Power Administration (BPA) that a fish hatchery be constructed near Chief Joseph Dam to mitigate the loss of tribal salmon fisheries caused by the construction of Federal hydropower dams. On April 30, 2003 the BPA approved funding for preparation of a Step 1 Master Plan for the project, now titled the Chief Joseph Dam Hatchery Project, with funding of subsequent steps contingent upon approval of the Master Plan.

2.2. Project Description

2.2.1. The Colville Tribes and BPA requested the services of the Corps to perform a limited reconnaissance study to evaluate and recommend feasible water sources for a planned fish hatchery (BPA Intergovernmental Contract No. 16123). This reconnaissance study was conducted to determine if there are water sources that can be developed and conveyed to the Colville Tribes fish hatchery, provide sufficient quantity and quality of water in a secure manner that does not pose a risk to dam safety and at minimal cost to the Government. The Corps study will evaluate several water sources associated with the Chief Joseph Dam and determine if they are technically and economically feasible and supply the quantity and quality of water required. The study will include preliminary cost estimates to develop the water sources. The Corps will conduct reviews of existing information, perform the necessary engineering evaluations, evaluate potential costs and recommend possible water sources to the Colville Tribes.

2.3. Specific Objectives and Tasks

2.3.1. The following outlines the tasks that need to be conducted in order to evaluate and recommend water sources for the hatchery.

2.3.1.1. **OBJECTIVE 1**: Evaluate Potential Water Sources. Evaluate several potential water sources for the fish hatchery, these include but not limited to, relief tunnel and the irrigation diversion intake on the right bank. Determine the engineering feasibility of water conveyance of each of these sources. In addition, compare to the constraining factors to determine whether it is a viable source.

2.3.1.2. **OBJECTIVE 2**: Evaluate Water Quality. Evaluate the water quality of each of the potential water sources identified in Objective 1. This will include review of existing data collected by the Corps and the Colville Tribes or their consultants and additional water quality sampling and testing in the winter, spring and summer.

2.3.1.3. **OBJECTIVE 3**: Prepare Report. Prepare a water supply study that presents the results of this work and recommend possible water sources. The study will also recommend possible methods of water conveyance from the source to the hatchery and include "conceptual" sketches at a 10% design level.

2.4. Hatchery Water Supply Requirements

2.4.1. At the project kick off meeting, John McKern of Fish Passage Solutions, a consultant to the Colville Tribes, identified the hatchery water requirements as 22 cfs from the relief tunnel drainage system, 25 to 30 cfs from the reservoir by way of the irrigation inlets, and 6 cfs from wells for summer/fall Chinook. The relief tunnel and well water is of particular importance because it is 6 months out of phase in temperature with the reservoir water. Tetra Tech KCM, the consultant to the Colville Tribes for the hatchery design, subsequently identified the maximum flow requirement for temperature averaging as 35.1 cfs combined from the relief tunnel and wells and 42.2 cfs from the reservoir if spring Chinook are included. The hatchery design is ongoing and the flow requirements are subject to further revision.

3. WATER SOURCES AND CONVEYANCE

3.1. Review Existing Information

3.1.1. A site visit was conducted to the Chief Joseph Dam on Tuesday, 12 January 2004. This visit was conducted to observe the actual site conditions of the right bank abutment in relation to the development of a water supply source from the right bank or the dam for a proposed fish hatchery. This hatchery would be located on the right bank approximately 3,500 feet downstream of the dam. The Coleville Tribes will operate the fish hatchery. The construction of the hatchery on the right bank is desired by the Tribe since their Reservation lands are on the north side of the Columbia River. The Federal Government owns the parcel of land in question.

3.1.2. Summer/fall Chinook flow requirements for the hatchery were identified as 22 cfs from the relief tunnel, 25 to 30 cfs from the reservoir, and 6 cfs from wells. If spring Chinook are included, 35.1 cfs combined from the relief tunnel and wells and 42.2 cfs from the reservoir are the maximum required flows for temperature averaging.

3.2. Development of Alternatives

3.2.1. Right Bank Water Sources. Consultants for the Coleville Tribes have identified possible water sources for the hatchery as the relief tunnel, irrigation inlet, and right bank abutment. Water from the relief tunnel is desired for hatchery operations since this water displays temperature variations, which are six months out of phase with the temperature of the surface water. Therefore, the relief tunnel water will be warm in the winter and cool in the summer relative to the river or reservoir water. Similarly, water extracted from the right bank by means of groundwater wells would also produce water with these temperature variations. The reservoir water is desired for rearing of juvenile fish in the hatchery. Reservoir water is suitable for rearing fish when mixed with waters from the relief tunnel to achieve desired temperatures. The hatchery design proposes several open tanks for rearing fish and a fish ladder at the river for capturing adult fish. In addition to the hatchery water requirements, five hundred seventy-five cfs will be supplied from the river via low head pumps for adequate attraction flow at the fish ladder.

3.2.1.1. <u>Relief Tunnel.</u> The relief tunnel extends over one thousand feet from the northwest end of Monolith 1 into right abutment. Access to the tunnel is by way of galleries in the interior of the dam. The tunnel is designed to reduce pore pressure in the soil of the right abutment. Water drains into the tunnel through wells located in the floor of the tunnel. These wells are of wood stave construction. Outflow from the tunnel was originally 95 cfs. The current outflow is 22 cfs. The tunnel drains into a sump, which connects to a four feet diameter conduit. This conduit exits the dam through the spray wall north of spill bay number one. The elevation of the bottom of the sump is 777 feet. The tunnel is typically flooded with water since the elevation of the tail water is typically above the elevation of the relief tunnel outlet at elevation 783 feet.

3.2.1.1.1. The collection of water from the relief tunnel will difficult. A valve or gate will may need to be installed in the four feet diameter culvert to prevent the mixing of the tunnel water with river water. Extraction of water from the sump will require the installation of pumps and piping to transport the water through access galleries to the surface where it may drain by gravity to the proposed hatchery site. The rise in elevation required will be at least 175 feet if the water is pumped to the top of the dam through the existing dam galleries. Alternatively, the relief tunnel water could be pumped via a pressure pipe from the sump to the hatchery along the existing road alignment.

3.2.1.1.2. The sump may be intercepted by a bore hole using directional drilling methods. The bore hole could be drilled from the surface at the west end of the parking area at the north end of the dam to install a vertical well to the sump. Alternatively, an inclined bore hole could be installed from the paved access road to the toe of the dam on the right bank to the bottom of the sump. The water in the vertical well would need to be lifted about 170 feet to the surface and could drain by gravity to the hatchery. The water produced from the inclined well would need to be raised 93 feet to reach the elevation of the Head Box for the proposed hatchery, which is at elevation 870 feet.

3.2.1.1.3. The wells in the tunnel may require future cleaning and maintenance, which may include the cleaning of the wells with weak acids to remove encrusting or biological fouling materials. The working and wash water for this operation would not be suitable for hatchery use. Residual traces of cleaning chemical could remain in the tunnel water for a period of time after maintenance. Low concentrations of these chemicals could impact fish development. The hatchery would need to have a redundant water source to allow well maintenance.

3.2.1.2. Irrigation Inlet. The irrigation inlet would require a new gate and construction of internal walls and decking before use. Water from the inlet would flow through an open channel or closed pipe to the hatchery site. The elevation of the outlet is 920 feet. The water from the inlet would drop 50 feet over a distance of 2,700 feet to the proposed hatchery Head Box Control Structure at elevation 870. The inlet has two openings that are 4 feet wide and 5 feet high.

3.2.1.2.1. An open channel could be constructed along the slope of the right bank. This slope is composed of gravels and sands and has experienced erosion and stability problems in the past due to surface water running down this slope. An access road would need to be constructed from the existing road to the outlet of the irrigation inlet. This road could be placed on top of the existing rip rap on the abutment slope. The base of the channel would need to be supported by bracing or piles across the face of the slope in order for the channel to have an average slope of 2.0%. The excavation of the channel into the slope is not recommended due to stability issues. Construction of the channel and possible leakage during operation could be detrimental to the stability of the right bank slope. Alternatively, water from the inlet could flow through a pressurized water pipe to the site. The pipe could follow the existing access road and be anchored to the ground along the existing road to the toe of the dam on the right bank.

3.2.1.3. Right Bank Well Field. A well field could be installed in the right bank to provide water to the hatchery. These wells would be vertical wells and a sufficient number of wells would need to be installed to provide the required hatchery flows. The wells could possibly improve the stability of the right bank abutment by the removal of seepage water and a resulting reduction of the pore pressure at the north end of the dam.

3.2.1.3.1. The number of wells will need to be determined. Groundwater will need to be pumped to the surface and collected in a large holding tank from which it would drain by gravity through a pipe line to the hatchery.

3.2.1.4. Inclined Wells. Inclined wells could be drilled into the right abutment from the existing road to the toe of the dam on the right bank. These wells would pass under the relief tunnel and terminate on the poolside of the dam. The wells would be constructed to take advantage of the higher hydrostatic pressure on the upstream side of the dam to produce flow of water from the wells.

3.2.1.4.1. The number of wells and screen lengths will need to be determined to ensure adequate water supply. The amount of reduction in pore pressure in the right bank due to the installation of the wells will need to be evaluated to determine if the wells assist in improving the stability of the right bank abutment. Drilling will require special equipment and set up and highly experienced personnel to install large diameter wells under differential hydrostatic pressure. Improper drilling or installation methods could pose a hazard of opening a pathway for water to flow around the dam. This flow of water could result in the erosion of soil from the right bank and seriously impact the stability of the right bank and dam structure. Uncontrolled piping of water and sediment could result in catastrophic failure of the right bank and extensive downstream flooding.

3.2.1.5. Horizontal Wells. Horizontal wells could be installed to provide water for the hatchery. The collars for these wells would be on the upstream side of the dam. These wells could be installed in bore holes that would pass under the relief tunnel but would not exit the face of the right bank. The wells could be screened in the area of the relief tunnel or other locations to assist in the reduction of pore pressure in the abutment. Large capacity pumps will be required to pump groundwater to the surface from these wells, where the water would be collected in a large holding tank. The water would then drain by gravity to the hatchery.

3.2.1.6. Vertical Wells at Hatchery Site. Vertical wells may be installed in the vicinity of the hatchery site. Two vertical wells are present under the power line that traverses the site. These wells are reported to produce 40 gallons per minute (gpm) and 60 gpm. The wells are currently used to provide irrigation water to the open area surrounding the visitor center. These wells were reported to produce water with elevated levels of E-coli bacteria. The bacteria may have entered the wells due to high pump rates, which pulled river water into the wells.

3.2.1.7. Wells at Hatchery: Wells installed at the hatchery site may not produce sufficient water for the hatchery needs. Contamination and temperature of the water are of concern. The actual water use requirements for the hatchery will need to be determined as well as the option for the recycling or recovery of water used in the hatchery. If a large quantity of water is not required on a continuous basis, then a large holding tank may be constructed at the site. This tank could store water for demand needs and be slowly refilled by pumping of wells installed at the site.

3.2.1.8. Horizontal Infiltration Gallery. A horizontal infiltration gallery could be installed at the proposed hatchery site. The fill and alluvial material that underlies the site is estimated to be at least thirty feet thick from the surface to the top of the anticipated groundwater table. Therefore, parallel horizontal wells could be installed to create an infiltration gallery, which could provide a higher amount of water with less drawdown relative to vertical wells.

3.2.1.9. Reservoir Water. Water could be pumped or transferred by a siphon to the hatchery site directly from the reservoir. Reservoir water alone is not desired for hatchery rearing, but it will be mixed with relief tunnel and well water to insure the best temperature for fish. Water treatment equipment such as ultraviolet systems could be installed to eliminate harmful organisms before use, and fish will be regularly inspected in the hatchery and provided with treatment should disease outbreaks occur.

3.2.1.10. River Water. River water could be used for attraction water for the fish ladder. The amount of water required for the operation of the ladder is 75 cfs at the top of the ladder and at least 500 cfs at the outlet. Several large pumps could be installed directly upstream of the ladder outlet. These pumps could lift water from the river to provide the 500 cfs for the outlet attraction flow. These pumps could also provide the 75 cfs required at the top of the ladder. The river water would not be used for the hatchery operations.

3.2.2. Contamination Issues. Groundwater obtained from the right bank could be contaminated with pesticides or other agricultural related chemicals. Several apple orchards are at the top of the right bank. Irrigation water from these orchards could carry these contaminants to the water table. Routine ultraviolet treatment systems would not eliminate these contaminants. The groundwater that may be obtained from the right bank should be tested before selection as a water source. This testing should be performed as soon as possible before design efforts proceed. The presence of detrimental contaminants could eliminate groundwater from the right bank as a water source for the hatchery. Numerous piezometers are in the right bank. The collection of groundwater samples from these instruments is not recommended due to possible introduction of contamination during installation or monitoring. The installation of new groundwater monitoring wells constructed to EPA standards is recommended for the sampling of the right bank groundwater.

3.2.2.1. Water Temperature. The temperature of reservoir water could be raised or lowered to the desired ranges for use. The water would need to be cooled in the summer and warmed in the winter. Heat pump systems or evaporative cooling systems could be installed to perform this task.

3.2.3. Left Bank Water Sources. Several potential water sources could be developed on the left bank. These sources are from groundwater and reservoir water upstream of the powerhouse and administration building and from the penstock lay down area, which is downstream of the dam.

3.2.3.1. Powerhouse Water Source. An extensive area of fill is to the south of the powerhouse on the southern shore of the reservoir. This fill was placed as part of the construction of the dam. Numerous wells could be installed in the fill to provide water to a holding tank. A water line could be constructed from this tank to the hatchery. The water line would need to run along the bridge crossing the river to reach the right bank. The quantity or quality of water that could be produced from the fill is not known.

3.2.3.2.. Vertical Wells or Horizontal Infiltration Gallery at Penstock Lay Down Area. Vertical wells or a horizontal infiltration gallery could be installed at the penstock lay down area. These wells could provide water to the hatchery on the right bank by a pipeline under the existing roadway bridge or directly to the hatchery if the hatchery were constructed on the left bank at the lay down area.

3.2.3.3. Reservoir Water. Reservoir water could be obtained from the west end of the concrete cut off wall for the powerhouse pool. An irrigation port is in this wall and provides water for irrigation to the penstock lay down area. This port could be modified to produce a higher flow. The water would need to flow through a pipeline along the bridge crossing the river to reach the right bank hatchery site. Water treatment equipment such as ultraviolet systems could be installed to eliminate harmful organisms before use.

3.2.3.4. Groundwater. A perennial spring is to the west the administration building. This spring flows year round and suggests a reliable groundwater source that may be present in this area of the left bank. Numerous wells could be installed in the vicinity of the spring and provide water via a pipeline under the bridge to the right bank hatchery site.

3.2.3.5. Municipal Water. The visitor site on the right bank is provided with water by a two-inch diameter pipeline. The source for this water is the powerhouse, which is also used to supply water to the administration building. Depending on the frequency of use, this water source could be used in its existing condition to supply water to a large holding tank at the right bank hatchery site. This option would not be viable if water usage by the hatchery requires continuous flow.

3.2.4 Alternative Hatchery Location**.** The hatchery could be located on the left bank at the pen stock lay down area. This site is a flat area composed of fill that is on the south side of the river. Alternatively, the hatchery could be sited on the extensive area of fill behind the powerhouse. A fish ladder should need to be constructed from the hatchery to the downstream side of the dam. This site should be considered since this location will require the minimal amount of behavioral screen to be placed in the reservoir to direct fish to the hatchery and fish ladder for downstream migration. A final option would be to site the hatchery at a location downstream of the dam where an available and desired water source is available. This water source would not be associated with the dam or its operations.

3.3. Evaluation of Recommended Alternatives

3.3.1. Relief tunnel. The relief tunnel extends over one thousand feet from the northwest end of Monolith 1 into the right abutment. Access to the tunnel is by way of galleries in the interior of the dam. The tunnel is designed to reduce pore pressure in the soil of the right abutment. Water drains into the tunnel through wells located in the floor of the tunnel. These wells are of wood stave construction. Outflow from the tunnel was originally 95 cfs. The current outflow is 22 cfs.

The tunnel drains into a sump, which connects to a four feet diameter culvert. This culvert exits the dam through the spray wall north of spill bay number one. The elevation of the bottom of the sump is 777 feet. The tunnel is typically flooded with river water since the elevation of the tail water is above the elevation of the tunnel outlet.

3.3.1.1. This water source alternative was selected by the Coleville Tribes due to water temperature characteristics and assumed quality. The temperature from the water in the right bank is approximately 6 months out of phase with the temperature of the Columbia River and this temperature difference is considered to be beneficial for the rearing of fish. Therefore, water provided from the relief tunnel would be warm in the winter and cool water would be obtained from the tunnel in the summer relative to the river water. The quality of the relief tunnel water is assumed to be good due to the filtering effects of the granular media through which the water flows to the relief tunnel. This filtration is assumed to remove parasitic organisms that could be detrimental to the health of juvenile fish.

3.3.1.2. Obtaining water from the relief tunnel will impact Chief Joseph Dam and possible dam safety impacts will have to be carefully investigated during the next phase of design.

3.3.1.2.1. Structural modifications to the dam would be required to access the relief tunnel. The existing sump and part of the relief tunnel would have to be demolished and a new larger sump and weir installed. These modifications could impact the operation and safety of Chief Joseph Dam. For example, a gate or valve may be required to prevent river water from entering the relief tunnel sump. Pumps would be required to remove the water from the sump and lift this water to a pipeline that would be connected to the fish hatchery. Since the rate of pumping would most likely be less than the flow generated by the relief tunnel, a concern is that failure of a check gate could result in water becoming trapped in the tunnel and reduce drainage from the right bank. This drainage is necessary for the safety of the right bank abutment and slope. Therefore, the possibility exists that the safety of the right bank could be jeopardized if water is obtained from the relief tunnel.

3.3.1.2.2. The quantity of water from the tunnel cannot be guaranteed. The flow from the tunnel has decreased in the past from 95 cfs. Therefore, it is possible that the current flow rate of 22 cfs may decrease in the future and not be sufficient for hatchery needs.

3.3.1.2.3. The quality of water may be impacted by agricultural waste from orchards that are up gradient of the relief tunnel. Testing of water samples from the relief tunnel in February 2004 for this study indicates good water quality. Additional samples from the relief tunnel will be tested in the spring and summer to determine the existence of seasonal variations in water quality.

3.3.1.2.4. Chief Joseph Dam operation will require periodic inspection and maintenance of the tunnel. Such activities may impact the uninterrupted delivery of water to the hatchery. Project operations and safety will take precedence over hatchery needs.

3.3.1.3. The rehabilitation of the existing wells in the relief tunnel may provide additional yield of groundwater into the tunnel assuming that the reduction of flow from the wells was not due to other causes. Rehabilitation will require performing down hole camera surveys of the wells to determine the current conditions of the well screens. These screens are composed of wood staves held together by wire. The well yield may have been diminished due to the encrustation of minerals on the screen or biofouling of the well interior and surrounding filter pack and formation by iron reducing bacteria. In this event, the wells will require cleaning using weak acidic solutions and water jetting. It is possible that the well screens may have deteriorated or collapsed. In this case, a new well screen will need to be installed to replace the wood stave screen. The existing well screens could be removed and replaced with new steel or plastic well screens.

3.3.1.4. A test of the increase in well yield should be conducted prior to committing to the rehabilitation or replacement of all the wells in the relief tunnel. Such a test would involve at least three wells that would be cleaned and monitored for increased production. The rehabilitation or replacement of the well screens will not prevent future maintenance and cleaning efforts that may impact the quality of the water produced from the relief tunnel. In addition, such efforts may have marginal impact on well production, since the reduction in well flows may have been related to reductions in seepage flowing through the right abutment due to the seepage blanket rather than deteriorating well performance. Well screen replacement, though possible, will be difficult due to the limited working space in the relief tunnel, need for special equipment for well screen extraction and placement, and difficult access to the tunnel through the dam structure.

3.3.1.5. Access to the sump during construction could be achieved by a vertical shaft through the existing random and impervious fill. The shaft could be made a permanent feature for maintenance access to the pump.

3.3.2. <u>Irrigation Inlet</u>. The irrigation inlet is in Monolith No. 2 on the right side of the dam. This inlet was built during the initial dam construction but was never used. The irrigation inlet will require a new gate and construction of internal walls and decking before use. Water from the inlet will flow through a closed pipe to the hatchery site. The elevation of the outlet is 920 feet. The water from the inlet would drop 50 feet over a distance of 2,700 feet to the Hatchery Head Box at elevation 870. The inlet has two openings that are 4 feet wide and 5 feet high. The pipeline to the fish hatchery must be underground for seismic and security considerations to connect the inlet. This pipeline would be placed in a trench that would traverse the right bank slope (See Figure 1).

3.3.2.1. This water source is possible but the following concerns must be addressed. The right bank is composed of material that is easily eroded. In addition, the increase in the moisture in the soils that compose the right bank could result in a decrease in slope stability. Any pipeline constructed in the right bank must be free of leaks and placed in a lined trench that is well drained. Monitoring instruments, such as open standpipe, will be required along the alignment of the pipe to allow testing for the presence of pipe leakage or the presence of water in the trench due to infiltration of precipitation.

3.3.3. Right Bank Well Field. A water supply well field may be installed on the right abutment. This well field would consist of vertical wells drilled upstream of the impermeable seepage blanket. The wells would obtain water from the seepage flowing around the right abutment of the dam. Electric pumps would lift water from the wells to a large holding tank. A pipeline would extend from the holding tank to the hatchery.

3.3.3.1. The construction of a well field near the relief tunnel, whether vertical, inclined, or horizontal, could impact the safety of the structure and is not recommended. The amount of water required for hatchery operations could result in a large area of depressed water levels in the well field due to water extraction. This depressed water table in close proximity to the dam structure would increase the hydraulic gradient between the reservoir and the right bank through the impermeable seepage blanket, thereby increasing the possibility of the piping of fines from the blanket and aquifer into the extraction wells. In addition, high seepage velocities could develop between the dam structure and the adjacent fill material resulting in the erosion of fines from the fill. This piping of fines from the fill material could seriously impact the safety of the dam.

3.3.3.2. The installation of a well field in the right bank remains a viable option if the location of the well field is moved to directly north of the proposed hatchery, to the golf course or State Park upstream of the impermeable seepage blanket on the right bank. The subsurface geology and the presence of water bearing strata capable of providing the required hatchery flows will determine the feasibility, size, and design of the well field(s). In addition, the quality of the water extracted from the possible well field sites may be contaminated with agricultural wastes and will require sampling and testing.

3.3.4. Left Bank Water Sources. Possible water sources on the left bank are not considered practical due to their distance from the proposed hatchery site, possible interference with future dam expansion, and need for large pipelines to carry the requested amount of water for hatchery operations.

US Army Corps of Engineers
Seattle District

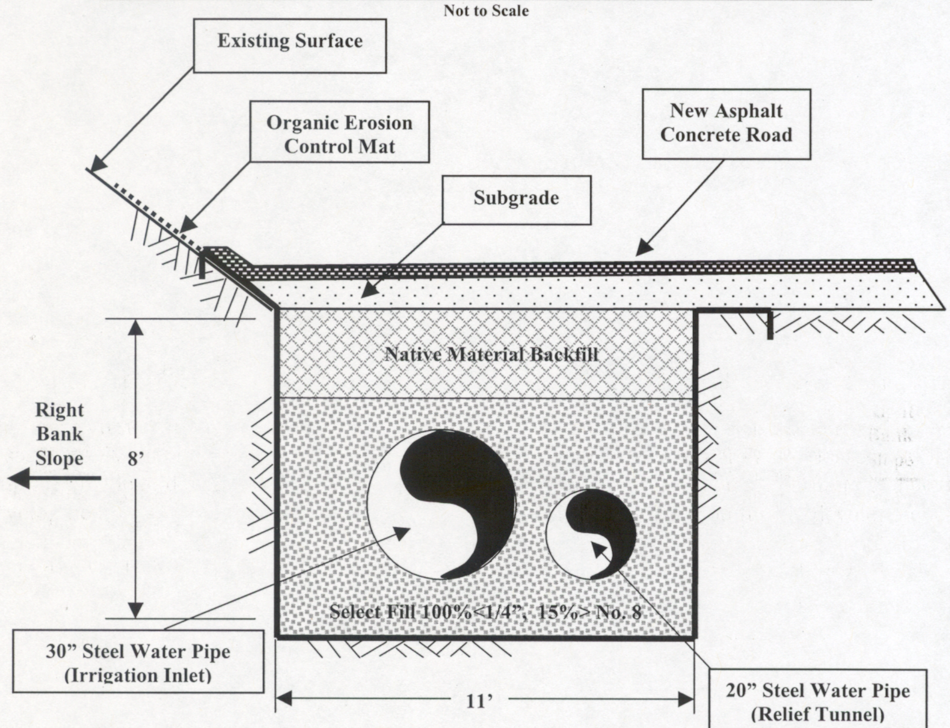
Water Supply Pipeline Trench, Chief Joseph Dam, WA
Proposed Fish Hatchery

Prepared by: PFA CENWS-EC-DB-CS 03 March 2004

** FOR ESTIMATING PURPOSES ONLY - NOT FOR CONSTRUCTION **

Typical Cross Section of Lined Pipeline Trench – Paved Road Alignment

Not to Scale



Notes:

1. Trenches shall be lined with 40-mil LLDPE liner that shall extend fully across the trench bottom and sidewalls. All seams shall be welded per specifications. The liner shall be free of wrinkles and folds.
2. All trench walls shall be shored during installation. Dewatering may be required.
3. Liner shall be covered with 12" thick layer of select fill. Top of fill shall be at grade for bottoms of pipes. Select fill shall be placed around pipes and cover pipes by 24" layer. Native fill may be placed from top of select fill to surface. Select fill and native fill shall be placed in 6" lifts compacted to 90% density.
4. Pipes shall be separated by 18" minimum and centered in trench.
5. New subgrade and 15' wide AC road shall be installed with total length of 2,400 feet.
6. Riprap slope shall be repaired to existing conditions after the installation of pipes. Length of trench in riprap estimated at 300 feet.
7. Organic erosion control mat shall be placed to at least three feet up slope from the ditches and seeded.
8. Excess material disposed of off-site, transport distance of 3 miles RT.
9. Pipes shall be anchored in 8' wide by 6' high by 4' thick concrete thrust blocks every 100 feet and at bends (3) or grade changes (3).

Figure 1