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Initial Alternatives for Design Features

Wynoochee Dam, Section 1135 Fish Restoration Project

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INTRODUCTION

The Wynoochee Dam Fish Restoration Project is being conducted under Section 1135 of the Water Resources Development Act of 1986 by the U.S. Army Corps of Engineers (USACE), Seattle District, on the Wynoochee River in Grays Harbor County, Washington. The overall purpose of this project is to successfully develop improvements to Wynoochee Dam to allow adequate fish passage. As the first step in the process, this report will establish the initial alternatives of each design feature. Ultimately, this project will produce an Interim Design Report, which will identify and develop project features to a prescribed level of design and present the designs in a detailed narrative. The Interim Design Report will be the basis for future project plans and specifications, and serve to guide the implementation process.

The proposed process of fish transport begins at the Wynoochee Dam intake wetwell and gate shaft where fish enter the turbine penstock. From this point, the fish move down gradient to the proposed penstock Eicher screen, which diverts the fish into a pressurized bypass pipe. This pipe would carry the fish across a bridge to a multi-level discharge point, where, on occasion, fish may be collected for testing purposes. From this point of discharge, the fish would be transferred into a gravity flume of open channel flow, traveling down gradient to either an immediate discharge outlet or supplementation/conditioning ponds. Here, sorting of wild and hatchery fish may occur with structural modifications to the existing trap system.

The structural features involved in creating the fish bypass system have been identified and specific alternatives are being explored. The proposed structural modifications and additions to the Wynoochee Dam Project include the following features: intake wetwell and gate shaft; penstock Eicher Screen; pressure bypass pipe; multi-level discharge to flume; gravity flume; discharge outlet; test facilities; supplemental ponds; and trap modifications.

Presented in the following discussion is a narrative of the proposed fish bypass design features and their initial alternatives. The associated assumptions and descriptions are

subject to change based on additional engineering, information gathered from participating entities, and subsequent field reconnaissance and review by the USACE, City of Tacoma, and other involved agencies.

PROPOSED PROJECT FEATURES

Intake Wetwell and Gate Shaft

Two alternative points of entry exist in this fish bypass system. To date, fish have been entering the Penstock through both a wetwell intake and a temporary gate shaft opening located near the wetwell. The potential for one of these structures to be the preferred route of entry into the system has yet to be determined; therefore, further monitoring is planned after the completion of the Eicher screen installation. Until this time, no further intake modifications will be made. One issue to be addressed, which was raised by resource agencies, was the question of whether or not the fish would dive deep enough into the wetwell to be attracted by the intake velocity. Such inquiries will be considered in the selection of the appropriate alternatives.

Alternatives

Once the initial evaluation of the intake system (with operating Eicher screen) is complete, the USACE, City of Tacoma, and other resource agencies will determine the optimal wetwell operation and decide whether the gate shaft is needed. Therefore, two design alternatives exist.

1) The first alternative is the use of the wetwell only. This would require a modification to the intake structure, which would involve removing the temporary gate shaft gate, closing and sealing the opening.

2) The second alternative would utilize the existing, temporary gate shaft route. If this alternative is chosen, permanent hoisting equipment and baffles will need to be installed and the gate shaft construction will need to be completed. Some concrete will need to be removed from the gate shaft to allow for a smooth transition from the gate shaft into the penstock.

Penstock Eicher Screen

An Eicher Screen is a pivoting screen positioned within the cross-sectional area of a penstock that allows water to flow through the screen to the turbines while separating fish bearing flows and swiftly conveying fish to a bypass pipeline. This system utilizes higher flow velocities that maintain increased turbine efficiency while redirecting fish out of the penstock. The Eicher Screen design makes use of a gradation of porosity to sustain a constant flow of water across its surface. This flow guides fish along or above the screen surface, minimizing the chance of fish getting trapped on the screen, and directing them into the pressurized bypass pipeline.

A 40-foot long section of the Wynoochee Dam penstock will be modified to incorporate the Eicher screen. The modified penstock section is 10 feet in diameter and is located 200 feet downstream of the dam face. It is the assumption/conclusion of this project that the Eicher Screen is the selected fish screen type and no other screen types are to be considered.

Alternatives

Two construction alternatives exist for the modified penstock Eicher screen section, and are presented below.

1) The first alternative involves a removable, as well as replaceable, section of penstock. The modified section, which includes the Eicher screen, could be interchanged with a regular section of penstock. Such an interchange would be expected to occur during times of non-fish screening or for maintenance and repair purposes. Prior to switching the sections, the penstock would be dewatered. For interchangeable ease, each section would be mounted on a small track system operating perpendicular to the penstock. This track is expected to be bolted to the floor of a concrete structure that is cast between the two ends of the penstock shaft. This track system would allow the sections to roll in and out of alignment with the penstock. Important to its

design, this system would require adequate stability for the penstock in times of emergency shutdown.

The benefit of this alternative is no head loss when the Eicher screen is not in use since the regular penstock section would continue to allow free flow. The disadvantage associated with this alternative is the downtime needed to change out the penstock section. The hydroelectric plant would need to be taken off-line.

2) The second alternative involves the penstock to be split into two permanent sections. In this dual design, flow could be directed to either an Eicher screen section of penstock or a non-Eicher screen section of penstock depending on need to transport fish. A custom "Y" section could be designed and factory fabricated, to provide high quality control that incorporates a swing gate that directs the flow into either of the two parallel penstock sections. The swing gate would be motor actuated. This "Y" section could be fabricated in three major sections to be assembled in the field. The "Y" section would have a durable yet somewhat flexible coating that would allow to swing gate to seal against the section walls and provide a smooth contact area. The cross sectional areas of the "Y" section would be larger than the penstock cross sectional area to allow for a static pressure regain resulting from reduced velocity pressure yielding a constant total pressure and thereby avoiding a reduction in flow rate. The swing gate would have a parabolic shape. View port could be incorporated to allow visual verification of proper and complete change.

The primary benefit associated with this alternative is that flow can be switched from the Eicher screen section to the regular section without taking the hydroelectric plant off line. If for some reason it is necessary to take the plant off line during the switch, it would be significantly less time than required for the first alternative. Once installed, all alignments are fixed and

will not change. Another benefit associated with this alternative is that minimal labor is needed to make the change.

Disadvantages associated with this alternative are the following: 1) the "Y" section would require careful design and fabrication, and 2) the system would be the first of its kind and unproven.

Pressure Bypass Pipe

The pressure bypass pipe would intercept the penstock above the Eicher screen and carry the bypass discharge and fish across a bridge to a multi-level discharge flume. Initially, flow would accelerate through the pipe entrance and into the pressurized system. Once initial entry is made, average flow velocity throughout the bypass system would remain moderate (6.4 – 9.5 feet per second) and uniform. Flow through the pipe is estimated to be 20 to 30 cubic feet per second (cfs), which is about 5-15 % of the expected penstock flow.

The pressurized bypass would be designed to prevent debris jams, facilitate operation and maintenance, and to protect fish from injury. To accomplish this, considerations for wall smoothness and adequate, moderate velocities would be made. A portion of the bypass pipe alignment will be suspended from the existing USFS road bridge.

Alternatives

To date, no alternatives have been identified, although it's recommended that detailed hydraulic analyses be performed. As part of the analyses, it is also recommended that a variety of materials and sizes for the pressure pipe and the support systems from the existing bridge be evaluated.

Multi-Level Discharge to Flume

At the terminus of the pressure bypass pipe is the proposed multi-level discharge system. An arrangement of outlets in the bypass pipe would discharge flow and fish into a gravity flume (discussed below) at different elevations. Depending upon reservoir elevations,

different discharge outlets would be opened to allow for appropriate flow characteristics needed by the outgoing fish. The discharge transitions to the gravity flume will need to be designed to prevent fish injury. The flow for this operation is currently estimated at 20 to 30 cfs, although these criteria may change with further review. It is expected that final design and hydraulic analyses will determine the exact number of discharge points needed and at what elevations they should be placed. Since this depressurizing feature is only a conceptual design, exploration into other cost-effective alternatives is encouraged with the participation of the sponsors.

Alternatives

To date, no alternatives have been identified, although recommendations to investigate other alignments or features have been made by the sponsors. The sponsor has conducted some preliminary research in regards to the use of slide diverter valves and multi-port knife gate valves to switch flow from one pipe to another. Also, a thorough hydraulic analysis based upon the topographic survey alignments is recommended.

Gravity Flume

A gravity flume will start at the multi-level discharge points and will maintain open channel flow conditions to the outlet channel. Surfaces and joints will be made smooth to prevent injury to fish. The flume will maintain supercritical flow throughout its run. Its slope will vary, with the steepest being about 20%. Preliminary design allows for a sidewall freeboard of 24 inches and a minimum water depth of 9 inches.

The flume will run along the left riverbank dam abutment at elevations needed to meet the hydraulic discharge criteria for the multi-level discharge system, and continue down gradient where it will cross under two roads and eventually descend to the Wynoochee River elevation. The flume will have a top screen to prevent debris fall and vandalism in most sections or will be covered under the roads. The final approach through the discharge outlet at the river will require a cut in the bank.

Alternatives

Alternative investigations will focus on developing a system which will effectively transport the fish from the multi-level discharge at the upper end of the flume to the river

at the discharge outlet (See "Discharge Outlet" Alternatives below). Supercritical flow will be maintained throughout the length of the gravity flume. A primary focus of the hydraulic analysis will be to design the flume such that there is no potential for the development of hydraulic jumps. Due to the proposed supercritical flow regime, the potential for other hydraulic conditions such as reflection waves and water surface superelevation will need to be incorporated into the analysis. In addition, several types of liner materials for the flume will be evaluated, and it is anticipated that both open and closed piped sections will be used.

Discharge Outlet

The discharge outlet is located at the terminus of the gravity flume. The two identified alternatives for discharge of flow and fish follow:

Alternatives

1) Discharge directly to the river using a design similar to the successful White River Project fish return system, which passes 20 cfs to the shallow river.

2) Create transition ponds that would allow for flow to transition from supercritical to subcritical laminar flow, while at the same time providing fish refuge. The design of such facilities would require a high level of coordination and input from fishery agencies and will likely experience several phases of refinement.

Test Facilities

The multi-level points of discharge are identified as an appropriate location to collect fish to test for injury caused by the Eicher screen. A suitable collection mechanism, procedure, and facility should be developed. No alternative facilities have been proposed.

Supplementation Ponds

Two small conditioning ponds are recommended for implementation. One pond would host 25,000 winter run steelhead (5-7 fish/lb.) and the other would host 55,700 coho salmon (16-18 fish/lb.). The dimensions of the ponds are expected to be 30'x 60, and they are expected to be 8 feet deep. Water supply will be gravity flow via an existing line from the hydroelectric project, where penstock water will be the primary supply. Pumps will be necessary for river-water back-up during periods of penstock dewatering. Pumping and intakes exist, however pumps and alarm systems must be added. Additionally, a mechanism must be established to force the fish out of the ponds when emptied. Also, outlet structures must allow for voluntary movement of fish from the ponds to the river. These ponds would need to be cleaned periodically; therefore, design features to accommodate draining and cleaning must be included.

Alternatives

Two alternatives are to be developed for the supplemental pond system:

1) Development of rectangular/sterile/featureless ponds, and
2) Development of natural/habitat feature laden/interesting ponds.

Trap Modifications

The existing trap needs to be modified to allow for sorting of wild fish and hatchery fish. The modification may include changes in the sorting flume and installation of two additional holding tanks. Other modifications include the extension of the operator's platform to direct fish into the appropriate tanks, and the installation of new lifting devices to assist in truck loading. The hauling truck will need to be modified, as well, to match the hopper for the water-to-water transfers. To date, no alternatives have been identified.

Control Systems

Due to its remote location, Wynoochee Dam is lightly staffed and typically only one person is available for operational procedures at any given time. Therefore, there is a need to automate and control all aspects of this fish bypass system from the dam

operations office. To accomplish this, close coordination will need to occur between all relevant parties to ensure the proper design of all features to be compatible with the Tacoma's control system. To date, no alternatives have been identified for this feature.

REFERENCES

Wynoochee Dam Section 1135, Interim Design Report Scope of Work. DACA67-02-D-2009 Delivery Order 2.

Wynoochee Dam, Fish By-pass PMR/EA Review Comments. October 2001. Tetra Tech, Inc.