Howard A. Hanson Dam
Additional Water Storage Project

Section 902 Post Authorization Change Validation Study – Fish Passage
King County, Washington

APPENDIX E

MONITORING AND ADAPTIVE MANAGEMENT PLAN FRAMEWORK

Final Integrated Validation Report and
Supplemental Environmental Impact Statement

US Army Corps of Engineers®
Seattle District

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Howard A. Hanson Dam
Additional Water Storage Project

Section 902 Post-Authorization Change Validation Study – Fish Passage

Updated Monitoring and Adaptive Management Framework for

Fish Passage Facility Post-Construction Performance Criteria Monitoring

April 2022

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1 Overview

Monitoring guidance for Corps projects was detailed in ER1105-2-100 in 2000 (USACE 2000). Since then, Implementation Guidance for Section 2039 of WRDA 2007 Monitoring of Ecosystem Restoration (USACE 2007) was issued and supersedes the 2000 guidance. Additionally, Section 1161 of WRDA 2016 requires that ecosystem restoration projects include appropriately scoped monitoring and adaptive management plans (or provide justification for why adaptive management is not warranted). The 2007 guidance states that a plan for monitoring ecological success must be included in the decision document, must include the rationale for monitoring, and must identify key project-specific parameters and how they relate to achieving the desired outcomes for making a decision about the next phase of the project. The guidance also states that the monitoring and adaptive management costs will be included in the project cost estimate and cost-shared accordingly. The monitoring plan should also identify the criteria for success and when adaptive management is needed. The primary source for guidance on full development of the project's final monitoring and adaptive management plan will be Fischenich et al. (2019), titled "A Systems Approach to Ecosystem Adaptive Management".

During the Feasibility Study for the Howard A. Hanson Dam (HAHD) Additional Water Storage Project (AWSP), the Corps developed a monitoring and adaptive management plan for the juvenile downstream fish passage facility (FPF) component of the AWSP. This plan is included in the Draft Feasibility Report and Environmental Impact Statement of 1998 as Appendix F (USACE 1998). This plan will serve as a reference for the updated list of monitoring and adaptive management measures the Corps will develop in detail during pre-construction engineering and design phase through coordination with the natural resources agencies and Tribes.

The purpose of the updated plan framework presented in this document is to introduce the methods through which the Corps will determine whether the performance criteria of the FPF are being met as set forth in the National Marine Fisheries Service (NMFS) 2019 Biological Opinion (BiOp). Success is determined by monitoring metrics that are specifically tied to project objectives and the performance criteria. In addition, the plan identifies what adaptive management is proposed if the performance criteria are not met. Specific performance criteria and testing periods appear in Appendix C of the 2019 BiOp (NMFS 2019).

This monitoring framework applies only to ASWP Phase I to the pool elevation of 1,167 feet; any monitoring effort for Phase II would occur if and when the additional pool level raise to 1,177 is proposed and coordinated with Tacoma Public Utilities, the Muckleshoot Indian Tribe, and the relevant natural resources agencies.

2 Biological Opinion Requirements for Performance Criteria

The primary purpose for the new fish passage system is to provide safe, timely, and effective downstream fish passage throughout the range of conditions likely to occur during the annual fry and smolt migration. The new system must meet the passage performance criteria provided in Reasonable and Prudent Alternative (RPA) 1.

Performance criteria for the FPF as specified in the 2019 Biological Opinion (WCR-2014-997) RPA 1 and described in Appendix A and C of that document are the following:

1. An overall juvenile fish project passage survival rate of 75%, from entry into Eagle Gorge Reservoir to release points downstream of HAHD.
2. 95% collection of fish attracted to the FPF (from the fish collection efficiency line shown in Figure 1 into the FPF, and
3. 98% survival of all fish through the FPF to their release downstream of HAHD.

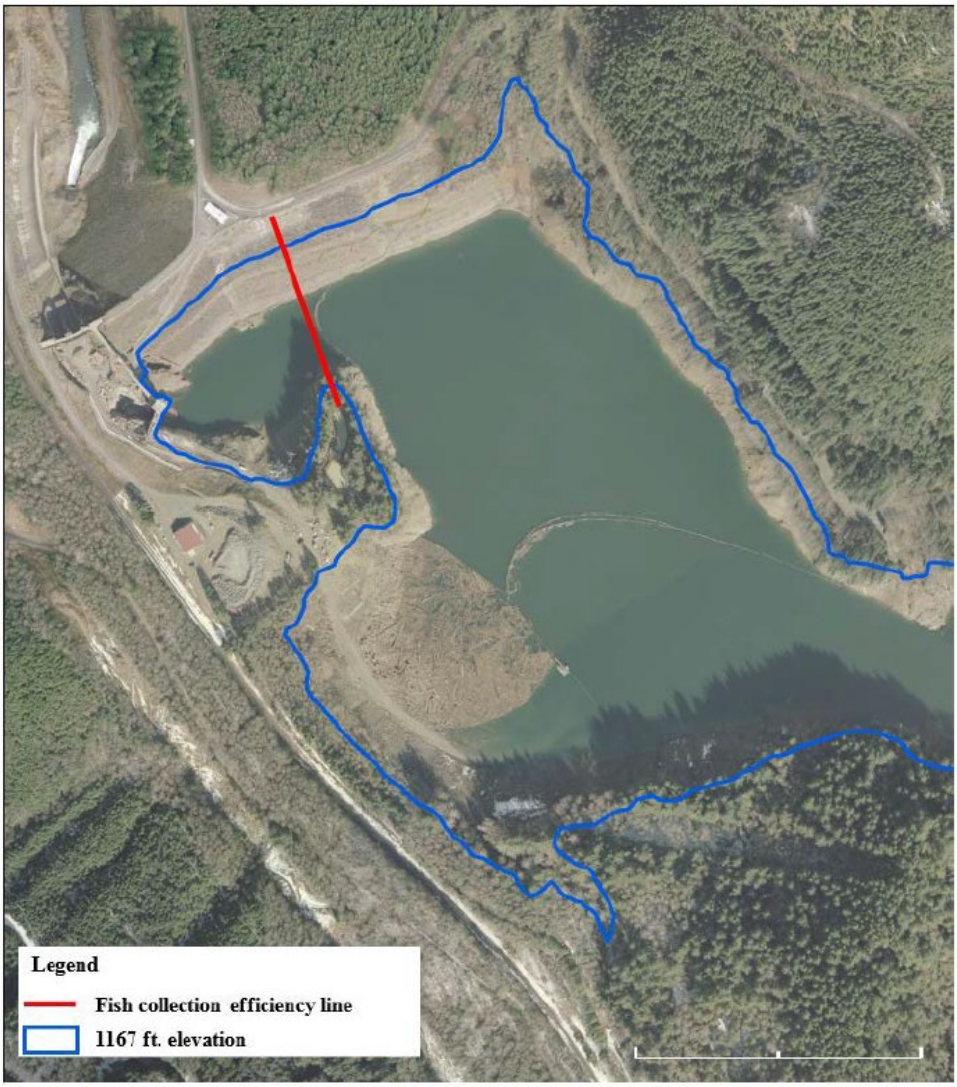

Figure 1. Location of the fish collection efficiency measurement point at the forebay.

3 Purpose and Framework

The purpose of the Monitoring and Adaptive Management Plan is to determine whether the FPF is meeting the criteria set forth by NMFS (NMFS 2019). These criteria will serve as the performance targets for evaluating the FPF. Ecological success will be determined by monitoring metrics specifically tied to the performance targets. Additionally, the plan will identify adaptive management measures proposed to improve performance if the performance targets are not met.

The following tables present the updates to monitoring and adaptive management established during the Section 902 Validation Study. The evaluation methods are directly tied to the studies that will be conducted during pre-construction engineering and design (PED) phase to inform the design of the FPF to optimize the structure. The primary purpose for developing these evaluation methods and potential adaptive management measures was to arrive at a cost estimate to finalize the Section 902 Validation Study and to provide public disclosure of the Corps' plans in the Final Validation Report and Supplemental Environmental Impact Statement. All studies, methods, and adaptive management measures will be finalized during pre-construction engineering and design phase.

Table 1. Overview of evaluations required to determine whether the FPF is meeting BiOp performance criteria.

Study Name	Study Description	Risk/Concern addressed by Study	Proposed Duration	Study design basis
Fish Passage, Distribution, and Survival	Post-construction active tag study of new facility to evaluate project performance for reservoir passage success, attraction and collection in the facility. Study would focus on conditions at the dam with multiple hydrophones to detect tagged fish positioned at multiple locations along existing structures.	Need post-construction survival estimates through reservoir entry to downstream outlets to determine if the project is meeting BiOp requirements and to assess facility performance. Determine percentage of population encountering the dam. Find population depth distribution and milling behavior. Allows comparison of biological response to hydraulic and water quality conditions. Determine route of passage and survival rate of route.	3 years of post-construction evaluation	based on similar fish facility post construction biological studies; cost includes cost for active tags
Hydraulic and Environmental Conditions through New Facility	Post-construction monitoring and evaluation of the multiport/steep slope using methods similar to NWP recent evaluation of the Green Peter steep slope with radio tagged or balloon tagged fish and combined with sensor fish.	Evaluate performance of the intake screen, emergency bypass, steep slope bypass to safely pass fish relative to the 98% facility survival. Bypass survival studies FPF structures hydraulics using PNNL BioPA model. Allows designers to map fish exposure to potentially harmful hydraulic conditions within a given passage route using numerical modeling results. Proposed designs are then modified to eliminate or reduce exposure to said hydraulic conditions. Could do laboratory studies of release system.	link to the above post-construction passage and survival study for cost savings	based on similar biological studies at Green Peter
Predator Study	Predator Study in reservoir and at facility outlet if necessary. Avian study only if informal monitoring warrants more comprehensive investigation.	This study would occur if the survival study shows less than 75% survival of ESA-listed species. Need at least 2 study years for more confidence around the mean consumption rate; 4 years would help determine whether there is a trend. Need a large enough sample size of juveniles entering the reservoir.	2 to 4 years of study	substantially reduced scope from 2008 effort
Juvenile Migration Timing and Abundance	Screw Trap (located either at HAHD outlet or near TPU diversion dam)	Provides longer-term information after construction is complete and patterns develop; provides rough abundance, migration timing; cooperative effort with Tribes, TPU, WDFW; critical measurement point for indicating productivity of upper watershed; provides opportunity to collect fish to inspect fish health, size, etc.	conduct annually long-term (5+ years)	similar to the cooperative effort in lower Green River

Table 2. Proposed monitoring studies with their objectives, metrics to be measured, potential methods for sampling and data collection, along with the performance target that must be achieved according to requirements of the NMFS 2019 BiOp.

Method/Study Name	Objective Name	Objective Description	Metric	Potential Methods	Performance Target
Fish Passage, Distribution, and Survival	juvenile salmon attraction	determine percentage of population approaching the attraction line in reservoir	number of juvenile salmon in the reservoir that are attracted past the attraction line toward the FPF	tagged fish and hydrophones	95% of juvenile salmon are attracted toward the FPF across the attraction line
Fish Passage, Distribution, and Survival	BiOp criteria 95% collection	determine percentage of population that enters the facility	number of juvenile salmon that cross the attraction line and are collected into the FPF	tagged fish and hydrophones	95% of juvenile salmon are collected into the FPF and passed downstream
Fish Passage, Distribution, and Survival	population estimate	determine the total number of juvenile salmon in the reservoir in each migration year	population estimate of migrating juvenile salmon	hydroacoustic surveys	overall survival of 75% from reservoir entry to release points downstream
Fish Passage, Distribution, and Survival	depth distribution	study patterns of depth distribution of juvenile salmon near the FPF entrance	open collector horn at depth of majority of fish	tagged fish and hydrophones	95% collection of juvenile fish past the attraction line
Hydraulic and Environmental Conditions through New Facility	intake screen survival	measure rate and type of injury caused by the Modular Inclined Screens (MIS)	percent mortality and percent of injury	radio tagged or balloon tagged fish, combined with sensor fish	98% survival through FPF
Hydraulic and Environmental Conditions through New Facility	emergency bypass survival	measure rate and type of injury caused by the emergency bypass route	percent mortality and percent of injury	radio tagged or balloon tagged fish, combined with sensor fish	98% survival through FPF
Hydraulic and Environmental Conditions through New Facility	steep slope survival	measure rate and type of injury caused by the steep slope bypass pipes	percent mortality and percent of injury	radio tagged or balloon tagged fish, combined with sensor fish	98% survival through FPF

Method/Study Name	Objective Name	Objective Description	Metric	Potential Methods	Performance Target
Predator Study	population estimate of cutthroat in reservoir	estimate the population of cutthroat trout in the reservoir during the juvenile salmon outmigration period	number of cutthroat trout 350mm and larger	scientific gillnetting; hydroacoustics	overall survival of 75% from reservoir entry to release points downstream
Predator Study	diet analysis of cutthroat in reservoir	determine how many juvenile ESA-listed salmonids are lost to predation for each outmigrating cohort	annual mean number of juvenile salmon consumed by cutthroat	gastric lavage of cutthroat captured	overall survival of 75% from reservoir entry to release points downstream
Predator Study	population estimate of cutthroat in reach between dams	estimate population of cutthroat trout in the reach between dams during juvenile salmon outmigration period	number of cutthroat trout 350mm and larger	snorkel surveys	TBD - coordinate among agencies
Predator Study	diet analysis of cutthroat in reach between dams	determine how many juvenile ESA-listed salmonids are lost to predation for each outmigrating cohort	annual mean number of juvenile salmon consumed by cutthroat	gastric lavage of cutthroat captured	TBD - coordinate among agencies
Predator Study	bird population estimate	identify number of fish-eating birds around the reservoir and in river between dams	annual average number of fish-eating birds present during juvenile salmon outmigration	bird counts and behavior observations	overall survival of 75% from reservoir entry to release points downstream; specific downstream river reach target is TBD
Predator Study	trend analysis	determine whether the number of juvenile salmon lost to predators is increasing	annual mean number of juvenile salmon consumed by cutthroat	at least 3-4 years of data collection and analysis of other metrics in predator study	overall survival of 75% from reservoir entry to release points downstream; specific downstream river reach target is TBD

Method/Study Name	Objective Name	Objective Description	Metric	Potential Methods	Performance Target
Juvenile Migration Timing and Abundance	population increase	determine whether the populations of re-introduced salmonid species are increasing	total number of each migrating salmon species each year	screw trap at HAHD outlet or near TPU diversion dam	positive trend
Juvenile Migration Timing and Abundance	FPF operations period	determine whether the target operations period of the FPF is correct for the timing of outmigrating salmonids	migration timing	screw trap at HAHD outlet or near TPU diversion dam	operate FPF for >95% of migration period
Juvenile Migration Timing and Abundance	productivity of watershed	determine whether the outmigrating salmon are able to contribute toward an increasing trend in the overall population	fish size and health	screw trap at HAHD outlet or near TPU diversion dam	98% survival through FPF

4 Contingency Planning for Adaptive Management Measures

Contingency measures (adaptive management) will be implemented if the monitoring program indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-federal sponsor would then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. Monitoring and adaptive management activities in this plan will be refined in pre-construction engineering and design phase. Additional metrics, methods, performance targets, and adaptive management measures may be added if needs are identified.

The overall timeline for meeting performance targets is 10 years after construction. This is estimated to be ample time to determine ecological success through measurement of the physical and biological parameters outlined in this monitoring and adaptive management plan and is in alignment with the NMFS requirement to meet the BiOp criteria for 2 consecutive years within the first 10 years after construction is complete. Table 3 provides a list of potential adaptive management measures that may be required to meet the BiOp criteria; the table also provides the study team's assessment of the probability of needing to perform the change.

The current cost estimate for the identified potential adaptive management measures is $11,384,000. Cost efficiencies may be found during design of adaptive management measures and when combining efforts in post-construction modifications. Further details on the costs of adaptive management measures appear in Appendix C Cost Engineering.

Table 3. List of potential adaptive management measures and the likelihood of needing their implementation.

#	Title	Description	Likelihood
1	HAHD Existing Tunnel Relining	Fish are being injured (bruised, descaled) in HAHD's existing outlet tunnel, requiring the tunnel to be relined or refinished	Expected
2	Changes to Porosity Plates	Water velocity through screens is too high or low, requiring a change in the porosity plates behind the screens.	Expected
3	Changing Screen Material	Screens are collecting too much debris or impinging fish, requiring the screen material to be replaced	Unlikely
4	Remove MIS	Screens or primary bypass are causing significant problems, screens are removed to more efficiently use the full-flow bypass	Expected
5	Guidance Structures	Fish are not finding (attracted to) the facility, guidance or exclusion nets are installed to funnel fish to the facility	Somewhat likely
6	False Weir	Collector is too deep and fish are not finding the entrance, install a mobile false weir between horns and trashrack to facilitate more surface oriented collection.	Unlikely
7	Acclimation Ponds	fish are disoriented at release and need a pond to recover before reintroduction into the river	Somewhat likely
8	Scour Hole Modifications	scour hole at release point is injuring fish, requiring additional excavation	Somewhat likely

#	Title	Description	Likelihood
9	Release Point Relocation	release point is not satisfactory and requires relocation	Expected
10	Additional Log Boom	system is experiencing too much debris, install an additional log boom with curtain to remove more debris from the reservoir	Somewhat likely
11	Artificial Light	fish are rejecting the dark entrance and require artificial light	Somewhat likely
12	Orifice Modifications	Orifice transition from collector to bypass is injuring fish, requires changing the transitions shape	Unlikely
13	Bypass Coating System	new bypass is too rough and requires a new coating to prevent abrasion to fish	Unlikely
14	Changing Bypass Conduit Shape	find adverse hydraulic conditions in bypass, requiring a modification to the shape of the bypass	Unlikely
15	Modify Steep Slope Radius	bottom radius in the steep slope is too turbulent, requires a large bend radius be installed	Unlikely
16	Modify Fish Passage Stilling Basin	stilling basin at the release point is too turbulent, this may cause injury/mortality to fish, requiring a longer, flatter structure	Somewhat likely
17	Modify HAHD Existing Stilling Basin	dam outlet stilling basin is too turbulent, this may cause injury/mortality to fish, requiring a longer flatter structure	Expected
18	Predator Management	Predator monitoring would occur if the 75% overall reservoir entry to downstream release survival criteria is not met; then coordination with natural resources agencies and Muckleshoot Tribe would occur to determine whether predator management is warranted. Potential removal of cutthroat trout over 350mm fork length; efforts likely conducted by Muckleshoot Tribe and/or WDFW. Potential for need for bird deterrent netting over fish outlet pipe	Unlikely

5 Plan Development and Execution

At the commencement of PED phase, the project delivery team will initiate the pre-construction environmental and biological studies (monitoring) that are required to inform the design of the FPF. These pre-construction studies are largely similar to the post-construction studies proposed in this document for monitoring and evaluating performance of the FPF. The purpose of the pre-construction studies is to gather baseline information on juvenile fish (salmon and steelhead) reservoir entry timing, age class during outmigration, behavior and distribution in the reservoir and forebay of the dam, downstream migration timing, passage and survival through the dam under current conditions, test hypotheses, and reduce uncertainties. Once those studies have been designed and have begun implementation, the project delivery team will formally update and finalize the Monitoring and Adaptive Management Plan.

Study design for the pre-construction and post-construction monitoring and evaluations will be finalized during pre-construction engineering and design phase. This work will involve detailed descriptions of the objectives that need to be met, the metrics that will be used to assess the facility and ecosystem, the methods of data collection, and the performance targets as mandated in the NMFS 2019 BiOp. Each performance target will be matched to one or more adaptive management measures that can be implemented should the metrics show the performance target is not being met.

The process that will be used to develop the pre-construction studies and post-construction monitoring and adaptive management will involve regular coordination and input from NMFS and the other resource agencies (WDFW, USFWS, Tribe). The Corps will first the draft monitoring plans (pre-and post-construction) and the adaptive management plan and engage NMFS and the other resource agencies and Tribe for review and input. The monitoring plans will include the metrics to be evaluated for pre-construction baseline and post-construction performance of the FPF. The general metrics that will be documented in the monitoring plans to collect baseline information and post-construction performance include, but are not limited to, juvenile salmon and steelhead reservoir entry timing, age class during outmigration, behavior and distribution in the reservoir and forebay of the dam, downstream migration timing, passage and survival through the dam under pre-construction and post-construction conditions.

After the monitoring plans are coordinated with NMFS and the other resource agencies and Tribe, the Corps will contract one or more research organizations/contractors, who are experts in these types of studies, to conduct the studies and deliver the results in the form of technical reports. These reports will be shared with NMFS and the other resource agencies and Tribe for review and comment and the final results will be used to inform additional studies and post-construction adaptive management to improve performance of the FPF. The adaptive management plan will include operational (e.g., changes in flows through the FPF) or engineering improvements (e.g., any design changes) that will be conducted during the start up and initial year of the FPF to improve the performance of the facility.

The pre-and-post construction monitoring plans will include objectives of the studies; that is, information is required to inform baseline conditions and the design of the FPF and objectives to inform the performance of the facility post-construction. The objectives will be described in detail in the plans with input from NMFS and the other resource agencies and Tribe to address the objectives. The research contractor(s) will develop study designs to address the objectives laid out in the monitoring plans. The study designs will identify the technology and methods that will be used to conduct the study (e.g., active tag, hydroacoustics, screw trap, seine and nets) to collect data, sample sizes to include the precision and analysis used to determine necessary sample sizes, frequency of sampling and data collection, the process for processing raw data to prepare for statistical analysis, and the statistical analysis that will be used to analyze the data and produce results that address the objectives of the study. The results of the study will be delivered to the Corps in the form of technical reports. The pre-construction study results will be used to inform baseline conditions and engineering design of the FPF. The results from the post-construction studies will be used to inform the post-construction performance of the FPF. The results of the post-construction studies will also be used to inform any changes to operations of the facility (e.g., changes in flows to attract and pass more fish) or engineering improvements (e.g., changes to screen size, modifications to any features of the facility) to improve fish passage and survival.

To ensure a comprehensive and robust monitoring and adaptive management plan is developed with regional stakeholder agreement, the Corps will coordinate early and often with the natural resources agencies including NMFS, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, and Muckleshoot Indian Tribe. The Corps is responsible for executing the work of the monitoring plan; some of this monitoring and reporting effort may be carried out by government staff but will more likely be under contract. The current cost estimate for the proposed post-construction monitoring is $12,173,000. Cost efficiencies may be found during plan development and when combining efforts in field work. Further details on the costs of the monitoring plan appear in Appendix C Cost Engineering.

The disposition of the information and analysis will be through annual reports on the results of each year that monitoring is conducted. Reports will be sent to NMFS to provide a progress report on meeting BiOp criteria. Additionally, reports can be distributed to partner agencies and stakeholders directly and can be made available via publishing on the Seattle District website. Monitoring data must be preserved and stewarded for long-term access and usability. Formal archiving is critical to ensure establishment of institutional memory for the project, and to develop the redundancy and long time series necessary for rigorous statistical analysis.

The Corps will be able to closeout the project and discontinue the formal monitoring plan after meeting the NMFS 2019 BiOp criteria.

6 References

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