Additional Water Storage Project, Final Feasibility Study Report & Final EIS

Howard Hanson Dam,
Green River, Washington
August 1998

prepared by
Seattle District
US Army Corps of Engineers

Tacoma Public Utilities

US Army Corps of Engineers®

FINAL FEASIBILITY STUDY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT

COVER SHEET

PROPOSED PLAN FOR THE HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT, GREEN RIVER, KING COUNTY, WASHINGTON

LEAD AGENCY: US Army Corps of Engineers, Seattle District. There are no cooperating agencies.

This report includes an integrated EIS within the report text.

Abstract: Howard Hanson Dam is a multi-purpose project on the Green River, a tributary of Puget Sound. Since 1989 Seattle District has investigated the potential for the project to help meet Municipal and Industrial water supply needs of the Puget Sound area. In 1994 the scope of the study was expanded to include ecosystem restoration. A final array of four reservoir storage alternatives with options for fish passage and other restoration features was considered. 1) No action would not meet planning objectives; 2) A single purpose water supply project would not meet restoration planning objectives; 3) a dual purpose water supply/restoration project in a single phase would meet objectives but could not accommodate adaptive management strategies to minimize impacts; 4) a dual purpose water supply/restoration project implemented in phases would meet planning objectives and allow adaptive management strategies. Plan 4 has been selected based on its ability to meet planning objectives and assure environmental compatibility.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENTS IS 30 DAYS FROM THE DATE ON WHICH THE NOTICE OF AVAILABILITY OF THIS FINAL FEASIBILITY REPORT/ FINAL EIS APPEARS IN THE FEDERAL REGISTER.

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NOTE: Information, displays, maps, etc. discussed in the Howard Hanson Additional Water Storage Feasibility Report and EIS are incorporated by reference in the EIS.

FINAL FEASIBILITY STUDY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT

EXECUTIVE SUMMARY

LEAD AGENCY: US Army Corps of Engineers, Seattle District

TYPE OF ACTION: Legislative

BACKGROUND: This combined Feasibility Report and Environmental Impact Statement (FR/EIS) addresses the Howard Hanson Dam (HHD) Additional Water Storage (AWS) Project Study which was initiated by Seattle District, US Army Corps of Engineers at the request of Tacoma Public Utilities (TPU). The study was begun in August 1989 to determine if HHD could be used to meet the Municipal and Industrial (M&I) water supply needs of the Puget Sound area. In 1994, in response to a change in federal law, the scope of study was expanded to include ecosystem restoration.

Northwesterners have grown increasingly concerned about the availability and quality of regional drinking water sources. This concern and focus on water supplies is a result of recent droughts, which led to water rationing measures; our ever-expanding population; and the region's escalating inability to support salmon and other species dependent on rivers and streams. In turn, people and planners have recognized that water, like all resources, is finite and will become a limiting factor in the region's growth and development. The salmon and steelhead crisis, as evidenced by the proposed listing of the Puget Sound chinook salmon as a threatened species, also emphasizes that the region's anadromous fish require an abundant, reliable, clean water supply and that they are currently losing to the numerous and competing demands on this finite resource.

Between 1911 and 1913, the City of Tacoma constructed a 17-foot-high water supply diversion dam at river mile 61.0. At that time, because of the diversion dam, upstream passage of anadromous fish to the Upper Green River watershed (Upper Watershed) ceased. Howard Hanson Dam was constructed in the early 1960's and was authorized to provide flood control, downstream low flow augmentation (LFA), irrigation, and M&I water supply. The irrigation and water supply portions of the authorization were never implemented. The HHD project has provided an estimated $695 million in flood damage prevention through 1996 and billions of dollars worth of commercial and industrial

development, in the protected floodplain, resulting in employment opportunities, while allowing Tacoma to meet its drinking water quality objectives.

In the absence of anadromous fish in the Upper Watershed, HHD was constructed with low level water conveyance outlets only. Juvenile hatchery winter steelhead, coho, and fall chinook have been planted in the Upper Green River watershed annually since 1982, 1983, and 1987 respectively. Outmigrating juvenile fish resulting from these watershed plantings have had to traverse the slack water reservoir and locate the deep water outlets to exit the project. Survival of these juvenile fish has been poor; in fact, without the HHD AWS Project, future planting of juvenile coho and chinook above HHD will likely cease.

At present, the Corps stores approximately 26,000 acre-feet (ac-ft) of water behind HHD for downstream LFA during the summer and fall. An additional 5,000 ac-ft of water for LFA is authorized through a Section 1135 restoration project. Tacoma presently diverts 113 cubic feet per second (cfs) of water, at their diversion dam, to provide M&I water to Tacoma under their first diversion water right (FDWR). Tacoma is also authorized to divert 100 cfs of M&I water under its Second Supply Water Right (SSWR). This 100 cfs SSWR is conditioned by the Tacoma Public Utilities/ Muckleshoot Indian Tribe (TPU/MIT) Agreement, which establishes minimum in-stream flows for the Green River through each calendar year. These flows exceed the current state established minimum flows.

STUDY PROCESS: The baseline condition for this project includes conditions as a result of all current operating projects and facilities. These include: 1) the existing HHD project, which is used for flood control during the late fall and winter and for spring storage of 26,000 ac-ft of water for summer LFA; 2) the HHD Section 1135 Fish and Wildlife Restoration Project, which authorizes storage of an additional 5,000 ac-ft of water for LFA, a "without project" feature; 3) TPU's Pipeline Projects, Pipeline No. 1 (P1), which was constructed to carry Tacoma's FDWR, and 4) Pipeline No. 5 (P5), which will carry TPU's SSWR. TPU was granted a permit, under Section 404 of the Clean Water Act, to construct P5. Construction is scheduled to be complete by 2003, before the HHD AWS Project is scheduled to be implemented, this is a "without-project" feature.

A final array of four reservoir storage alternatives were considered to provide M&I water supply for the Tacoma area and ecosystem restoration improvements on the Green River. The alternatives are: 1) no action; 2) a single-purpose water supply project with increased conservation storage of 22,400 ac-ft for M&I water supply and fish passage as mitigation; 3) a dual-purpose water supply and ecosystem restoration project with immediate full implementation of the AWS Project, with increased storage of 22,400 ac-ft of M&I water supply and 9,600 ac-ft of LFA water; and 4) the preferred alternative, a dual-purpose water supply and ecosystem restoration project with phased

implementation: Phase I, storage of 20,000 ac-ft for M&I water supply; and Phase II, additional storage of 2,400 ac-ft for M&I water supply and 9,600 ac-ft for LFA.

AREAS OF CONTROVERSY: Over the past 8 years, the Corps and TPU have worked with the US Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (WDOE), and the Muckleshoot Indian Tribe (MIT) to scope, conduct, and evaluate the feasibility studies for the HHD AWS Project. As part of this long term evaluation process, the resource agencies and the MIT participated in an intensive technical review of the feasibility studies with the Corps and TPU. During this period, the resource agencies and the MIT evaluated technical study conclusions, identified concerns and data gaps, and discussed how those concerns and data gaps might be addressed. Adjustments to the project have been made based on agency and tribal input and on the results of the additional studies that have been conducted during the past years.

As a result of this coordination, the preferred project alternative was designed to be implemented in the two phases mentioned above. Raising the reservoir results in inundation impacts to existing habitat. Forested wetlands, elk grazing areas, and streams will be inundated by each phase of pool raises. Phase I includes construction of all mitigation features having to do with raising the pool to elevation 1,167 feet and all ecosystem restoration features planned for this project, no restoration features are included in Phase II except for low flow augmentation. Phase I includes a full height fish passage facility, right abutment drainage remedies, and Phase I fish and wildlife habitat mitigation, which will fully compensate for habitat inundated by the pool raise. Tacoma's SSWR (up to 100 cfs/day or 20,000 ac-ft over a different time period) will be stored in the spring for M&I use in the summer and fall. Timing and rate of storage will be adaptively managed while delivery will be at a rate established by Tacoma. Phase II includes construction of all remaining AWS Project mitigation features required for a pool raise to elevation 1,177 feet. Under Phase II, an additional 2,400 ac-ft of M&I water plus 9,600 ac-ft of LFA water will be stored, for a combined total of 32,000 ac-ft of water storage under the HHD AWS Project. Delivery rate of the stored M&I water will be established by Tacoma and delivery rate of the LFA water will be adaptively managed by the Corps, TPU, the resource agencies, and the MIT. Implementation of Phase II is dependant on the evaluation of Phase I success and consensus of the resource agencies, MIT, the City of Tacoma and the Corps.

Restoration of fish passage through HHD is the keystone of the AWS Project ecosystem restoration. Improved fish passage, increased instream flows, and fish and wildlife habitat restoration measures all provide historic opportunities to restore and maintain self-sustaining and harvestable runs of salmon and steelhead for the Green River. The phased implementation and adaptive management measures proposed for the project allow for the flexibility to make adjustments to ensure the protection of fish and wildlife. The goal – to satisfy regional water supply needs for the 50-year project life – is nearly achievable

under Phase I and can be achieved under Phase II. The storage of an additional 22,400 ac-ft of water for M&I water, as proposed in the ultimate development, will provide a stable cost effective water supply for the region well into the next century.

As a result of the phased implementation and adaptive management proposal, NMFS, USFWS, and WDFW endorsed the Phase I project proposal and indicated a willingness to implement Phase II if it could be demonstrated that Phase II impacts could be sufficiently minimized and mitigated. The MIT has not indicated approval for or opposition to the project.

Total cost of the proposed project, in October 1997 dollars, is $74,908,000. The federal share would be $36,284,000 and the non-federal share would be $38,624,000. The non-federal sponsor would be required to pay 100% of the cost attributable to M&I water supply and 35% of the cost attributable to ecosystem restoration with the federal government paying the remaining 65% of the cost attributable to ecosystem restoration.

Tacoma operates an unfiltered surface water supply in compliance with EPA requirements. Protection of water quality during both project construction and operation is of critical importance. Special measures to meet water quality objectives may need to be developed to insure quality drinking water for over 250,000 people.

UNRESOLVED ISSUES: While there are a number of concerns that will require further, more detailed study and refinement in the PED, for purposes of the project and feasibility determination there are no unresolved issues.

MAJOR CONCLUSIONS: The recommendation is that the existing Howard A. Hanson Dam project authorized by the River and Harbor Act of 17 May 1950 be modified to include the following:

1. New intake tower with new fish collection and transport facility including: a wet-well, a floating fish collector, a fish lock, a discharge conduit, a fish transport pipeline and monitoring equipment.
2. Mitigation features including management of riparian forests, planting of water-tolerant vegetation and maintenance of instream habitat in Phase I and Phase II.
3. Ecosystem restoration features other than fish passage including gravel nourishment, a side channel reconnection project, and river and stream habitat improvements.
4. Right abutment drainage remediation
5. New access bridge and access road
6. New buildings, or additions to existing buildings, including: an administration, a maintenance and a generator building.
7. Change reservoir operation (Phase I) to store 20,000 ac-ft of M&I water to elevation 1,167 feet in the spring for release in the summer and fall.

8. Change reservoir operation (Phase II) to store an additional 12,000 ac-ft of water, 2,400 ac-ft for M&I water supply and 9,600 ac-ft of water for LFA, to elevation 1,177 feet in the spring for release in the summer and fall. Implementation of Phase II is dependant on the evaluation of Phase I success and consensus of the resource agencies, MIT, the City of Tacoma and the corps.

Recommendations contained herein reflect the results of this extensive study, formulation, and coordination effort and are respectfully submitted by Tacoma Public Utilities and the Corps for authorization to proceed with construction and operation of Phase I of the Howard Hanson Dam Additional Water Storage Project.

FINAL FEASIBILITY STUDY REPORT AND FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

SPECIES LISTS

(at end of text)

TABLE

(at end of text)

FIGURES

(at end of text)

PLATES/DRAWINGS

(at end of text)

APPENDICES

(Bound in separate volumes)

SECTION 1. PURPOSE AND NEED

1.1 STUDY AUTHORIZATION

This study is being conducted under Section 216, Public Law 91-611, Review of Completed Projects, River, Harbor and Flood Control Act of 1970.

1.2 STUDY OBJECTIVE

The Howard A. Hanson Dam (HHD) Additional Water Storage (AWS) Project study was initiated by the Seattle District, US Army Corps of Engineers (USACE; the Corps) in August 1989 to address how the existing federal HHD Project could meet water supply needs of Puget Sound residents (see figures 1.1 and 1.2). In response to a change in federal policy in 1994 making environmental restoration a higher federal priority, the study objective was expanded to include environmental (ecosystem) restoration.

1.3 INCORPORATION OF DRAFT FEASIBILITY REPORT/EIS

This is the Final Feasibility Report/Final Environmental Impact Statement incorporating by reference the Draft Feasibility Report/Draft Environmental Impact Statement except as modified herein.

SECTION 2. MODIFICATIONS TO REPORT

INTRODUCTION

This report (including a revised executive summary; purpose and need statement; revised sections on environmental compliance, coordination, economics, and recommendations; as well as an index and an updated Appendix I (including the responses to public comments)), in combination with the draft feasibility report (DFR) and draft environmental impact statement (DEIS) with appendices, comprise the Final Feasibility Report (FFR) and Final Environmental Impact Statement (FEIS) for the Howard Hanson Dam Additional Water Storage Project.

Changes to the DFR/DEIS are incorporated through the responses to public comments, found in the revised Appendix I. Appendix I also includes the Final Coordination Act Report from the U.S. Fish and Wildlife Service (USFWS). The recommendations of the USFWS for the project, and the Corps' responses to those recommendations are included in Section 2.12 of this document. Substantive changes were made to Section 2 (Environmental Compliance and Coordination), Section 4.13 (Economics), and Section 8 (Recommendations) of the DFR/DEIS. These changes are included in section 2 of this document. In addition, a Financial Plan has been added to the FFR in Section 2.10. The remainder of the DFR/DEIS (including all appendices except Appendix I) remain unchanged from the original document.

Two minor corrections to the wildlife information are included here: 1) The population of elk in the watershed was given as 590-650. Recent data obtained by the Washington Department of Fish and Wildlife ("GMU 485 Elk Mark - Recapture Population Estimate" Final Report, Sept. 1997, Rocky Spencer) indicates the population of elk in the watershed has dramatically declined to 200-300 animals. Information provided by the Muckleshoot Indian Tribe (MIT) indicates that the elk hunt in the watershed was cancelled in 1996 and 1997 and will be closed until the elk herd rebounds and productivity increases. 2) A plant and wildlife species list for the watershed is included at the end of this document.

Table 5-1 "Chronology of Events in the Green-Duwamish River Basin Between 1850 - 1997" from the DFR/DEIS was revised to reflect the treaties between the MIT and the United States government and is included at the end of this document.

An additional change regards the description of the Chambers Creek property on pages 53 and 73 of the DFR/DEIS. This Pierce County owned property contains ground water rights of 12.9 MGD, restricted to 5,778 acre-feet per year. Developing the groundwater rights associated with the Chambers Creek Properties to be used in the Tacoma Water

Division's 576 pressure zone would require approximately 15,000 feet of transmission pipeline to convey the water from the Chambers Creek Properties to the nearest Tacoma Water Division distribution system located at 40th and Bridgeport. A pump station would also be required to lift the groundwater to the hydraulic grade line of the distribution system at elevation 576. This revision does not change the results of the analysis of alternatives in the DFR/DEIS.

The archeological sites in the existing pool are now being evaluated for their National Register Eligibility. If they are eligible, the effects of erosion and inundation will be addressed in a Historic Properties Management Plan, and a memorandum of agreement will be prepared to stipulate conditions for their management within Howard Hanson reservoir. Planning and coordination with the Muckleshoot tribe will be an important part of these efforts. This course of action will satisfy requirements of Section 106 NHPA.

The Muckleshoot Indian Tribe is a federally recognized tribe located on the Muckleshoot Indian reservation in King and Pierce Counties. MIT has rights under and is successor to certain bands and tribes who were parties to the Treaty of Point Elliot (12 Stat. 927) and the Treaty of Medicine Creek (10 Stat. 1132). MIT holds federally guaranteed rights under the Treaty of Point Elliot, including fishing and hunting rights, in the Green/Duwamish River system. These rights were retained in exchange for lands ceded by the Tribe in the treaties and are considered property rights. MIT has rights and responsibilities for the management of the fish and wildlife resources and other natural resources of the Green/Duwamish basin, including the protection of those resources from environmental degradation. While salmon and steelhead fishing remains the center of tribal culture, subsistence, and economy, fishing opportunity has been severely restricted in recent years due to low abundance. The WDFW, the Suquamish Indian Tribe and the Muckleshoot Indian Tribe completed a stock status report in 1993, and at that time, concluded the Green River stock of chinook salmon were healthy; determination under the Endangered Species Act may be different.

During pre-construction engineering and design (PED) the Corps will investigate whether additional snowpack monitoring and improved runoff forecasting will benefit the reliability and flexibility of spring water storage and release. If it is determined to be beneficial the Corps and Tacoma are committed to enhancing monitoring/forecasting and will develop details of an expanded monitoring/ forecasting plan during the PED project phase.

2.1 ENVIRONMENTAL COMPLIANCE

Two Executive Orders (EO) were inadvertently omitted from Table 2-1; these were Environmental Justice (E.O. 12898), and Indian Sacred Sites (E.O. 13007). Table 2-1 has been modified to reflect that these two E.O.'s have now been included in the discussion within the FR/FEIS.

TABLE 2-1. STATUS OF PROJECT WITH APPLICABLE LAWS AND STATUTES

Federal Statutes	Compliance Status
Archaeological and Historic Preservation Act	In Process
Clean Air Act of 1977, as amended	July 1998[1]
Clean Water Act of 1977, as amended	In Process
Coastal Zone Management Act	July 1997
Endangered Species Act of 1973, as amended	August 1998
Federal Water Project Recreation Act, as amended	July 1997
Fish and Wildlife Coordination Act, as amended	August 1998
Marine Protection, Research & Sanctuaries Act, as amended	July 1997
National Environmental Policy Act of 1969, as amended	August 1998
National Historic Preservation Act of 1966, as amended	In Process
Watershed Protection and Flood Prevention Act, as amended	November 1997
Executive Orders (E.O.)	
Protection and Enhancement of the Cultural Environment (E.O. 11593)	In Process
Floodplain Management (E.O. 11988)	November 1997
Protection of Wetlands (E.O. 11990)	November 1997
Environmental Justice (E.O. 12898)	August 1998
Indian Sacred Sites (E.O. 13007)	In Process

Compliance with environmental laws and statutes has been achieved to the point necessary to support a feasibility level determination. In many, even most, resource areas activities will continue into pre-construction engineering and design (PED), construction, and operation. For example, certain archaeological statutes require the completion of a Memorandum of Agreement (MOA) between tribes and the Federal Government. These MOA's have not been achieved for the Archaeological and Historic Preservation Act, the National Historic Preservation Act of 1966, as amended, or for E.O. 13007, Indian Sacred Sites. However, the Corps is actively working with Muckleshoot Indian Tribe (MIT) to achieve the objectives of each statute, so these compliance actions are in process and will continue into PED. Similarly, full compliance with Clean Water Act (CWA) Section 404 requirements and water quality certification cannot be obtained until PED level design information is available. Consultations pursuant to the Endangered Species Act will also be ongoing as current studies continue and responsible agencies make listing decisions that may apply to this project. This approach is ongoing, iterative planning is in accordance with paragraph 25 of ER 200-2-2.

2.2 COORDINATION AND PUBLIC INVOLVEMENT

The DFR/DEIS was officially filed with the U.S. Environmental Protection Agency published in the Federal Register and distributed for public and agency review on May 1, 1998. The public comment period ended on June 15, 1998—a period of 45 days.

[1] Coordination with Puget Sound Air Pollution Control Agency on 1 July 1998 indicates they would require no permits or special actions by the Corps for this project.

Approximately 400 copies of the DFR/DEIS were distributed to elected officials, government agencies, tribal organizations, associations, businesses, individuals, and public libraries.

One public meeting held at the Tacoma Water Division office auditorium, in Tacoma, Washington, on May 28, 1998, was attended by 23 people.

The meeting consisted of four parts. The first part was an open house where individuals could review a video presentation showing the Green River as photographed from a helicopter flying upstream from Auburn to Howard Hanson Dam, a video tape program discussing the Additional Water Storage project, and poster displays showing the major features of the AWS Project and issues raised by resource agency and tribal technical staff during the course of the Feasibility Study. The second part was an overhead presentation addressing the purposes, alternatives, issues involved, and anticipated effects of the AWS Project. The third part of the meeting was a question and answer session in which the audience asked questions of a technical panel. The panel included key staff from the Corps, the City of Tacoma, and staff from R2 Resource Consultants. The fourth part of the meeting was a formal public hearing open to all speakers who wished to provide testimony. A court reporter recorded all hearing testimony (including the panel discussions). No formal verbal comments were received during the public hearing, most of the hearing testimony is in the form of question and answer. Copies of the hearing transcript and the complete printed record of all comments received on the Draft EIS are maintained by the Corps and are available for public review at the U.S. Army Corps of Engineers, Seattle District Office, 4735 E. Marginal Way S., Seattle, WA 98124-2255.

The Corps encouraged recipients of the DFR/DEIS to submit written comments on the document. In all, 86 letters, including two comment cards, were received before the June 15 deadline. In addition, two other letters were received after the deadline (one from the U.S. Department of Interior in Portland (dated June 19, 1998), the other from the U.S. Environmental Protection Agency (EPA) in Seattle (letter dated July 7, 1998)). Because they arrived after the June 15th 1998 deadline, the responses to public comments in Appendix I do not include these two letters. A complete list of those receiving the DFR/DEIS for review can be found in revised Appendix I, dated August 1998.

Details of the comments and responses are found in revised Appendix I, dated August 1998.

As described in the Appendix F1, Section 8. Habitat Restoration and Mitigation Project Descriptions, Measure 4: MS-09 Truck and Haul of Large Woody Debris, the wood would be deposited in the active channel. Large woody debris could be placed below Tacoma's Headworks in late fall following initial reservoir drawdown for flood control to minimize the effects of LWD on recreational boaters. Details of the large woody debris transport plan will be worked out during the PED phase of the project. A public involvement program has been requested by King County, and as local sponsor of the

original Howard Hanson Dam Project, the Corps will consider King County's request. Coordination with King County and recreational groups is needed to help design the plan to minimize impacts to recreational boating where it doesn't negate benefits to fisheries resources. Public coordination is also needed to prevent boaters, anglers and other recreationists from cutting the wood after it becomes stranded in the Green River channel.

2.3 PROPOSED FISH PASSAGE FACILITY

The proposed fish passage facility was reviewed in light of the proposed listing of the Puget Sound Chinook Salmon as a threatened species and it remains the alternative of choice. The reconnection of the upper river, through combined upstream fish passage by Tacoma and downstream passage by the Corps, is the greatest single measure available for restoring significant anadromous fish habitat to the Green River basin. The Washington Department of Fish and Wildlife Commission on December 5, 1997 adopted "Policies to Sustain and Rebuild Wild Salmonid Stocks." The two policy documents constitute the state's Wild Salmonid Policy. The policy includes direction for higher levels of anadromous fish spawner escapement and more conservative management of harvest. However, the policy was adopted by the state with the goal of "rebuilding wild stock populations to levels that permit commercial and recreational fishing opportunity." Therefore, our harvest estimates used in the incremental evaluation (see Appendices B and F1, section 8) for this report remain unchanged. Even if harvest were reduced, it would not change the selection of the preferred fish passage facility. Three reasons for this conclusion are: 1) ESA listing will not affect two of three species used in the incremental evaluation, coho and steelhead, so the majority of benefits are not affected by a listing; 2) in comparison to historic peak harvest rates for Green River chinook (69%-83% in the 1980's), we used a reduced harvest estimate for chinook salmon (55%) in our incremental evaluation. We have already assumed a lower, long-term historic average harvest rather than peak rate; and 3) the preferred alternative was the only alternative that met all of the EC 1105-2-210 Final Selection Criteria, see DFR/DEIS pg. 84-85.

The proposed fish passage facility is a new structure that is intended to pass migrating juvenile fish downstream through the Howard Hanson Dam (see figures 1-4. 1-5, 4-1, 4-2, and 4-5). It is not intended to pass migrating adult fish upstream through the dam. Adult fish passage will be provided by the local sponsor through a "trap and haul" facility at the Tacoma Diversion Dam. The main features of the downstream fish passage facility are:

- a new tower,
- a wet-well,
- a floating fish collector,
- a fish lock,
- a discharge conduit
- a fish transport pipeline.

Currently, the entire Green River flow must pass through the existing outlet works intake structure located below elevation 1070 feet (bypass is at 1069 feet). Upon completion of the new facility, which will be located adjacent to the existing outlet works, flows will pass through either the existing intake structure or the new floating fish passage facility or both.

Essentially, this facility will operate as a lock. The fish are collected into the fish lock by a floating fish collector located in the wet-well, just upstream of the fish lock. During the main fish migration season (April to October) most of the reservoir's flow will pass through the fish collector. The fish collector houses a modular-inclined screen that allows 95 percent of the flow to pass, while preventing the fish from passing through it. The remaining five percent of the flow "washes" the fish across the modular-inclined screen into a flume that deposits the fish into the fish lock. When a sufficient number of fish are collected, the water level in the fish lock is lowered to a predetermined elevation, and the remaining quantity of water and fish are then discharged as a unit through the fish transport pipeline to the Green River just below the existing stilling basin.

Under operating conditions, there will be a small difference between the upstream reservoir water elevation and the wet-well water elevation, and a 2-foot difference between the wet-well water elevation and the fish lock water elevation. This difference in water elevations, or head, provides the (hydraulic) energy necessary to make the fish collector function.

2.3.1 Wet-Well Structure

The wet-well structure is a 105-foot-long by 30-foot-wide by 150-foot-deep open-end box structure. Approximately 105 to 115 feet of the structure will be embedded in rock. The structure has a top elevation of 1185 feet and a floor elevation of 1035 feet. It is located at a 60-degree skew to the axis of the existing intake tower and conduits (see sheet 31 of 50 at the end of text). The upstream end, or intake horn, of the wet-well structure is flared to a width of about 45 feet, and the right edge abuts the left side of the existing intake tower trashrack structure. A floating trashrack is attached at the flared end of the wet-well structure.

A removable steel framework and grating will be installed on top of the structure to provide a work deck for safety, operation, maintenance, and debris handling functions. This framework will also prevent the fish collector from floating out of the wet-well structure while reservoir elevations exceed 1185 feet.

The structure will be constructed of normal weight reinforced concrete, with an average wall thickness of 24 inches to 72 inches. For the portion of the structure embedded in rock, anchoring the structure with rock anchors may provide a more economical design than for a free-standing, or unanchored, design. Prestressing the concrete may provide a

more economical design as well. Both rock anchors and prestressed concrete will be considered in the development of design for the Feature Design Memorandum.

2.3.2 Fish Collector Assembly

The fish collector assembly is, essentially, a floating container for a modular inclined screen. The modular-inclined screen (MIS) will be mounted in the center of the collector housing, and will have hinges along its center of rotation that attach it to the housing framework. The MIS is held in position by low-pressure hydraulically powered mechanical actuators, and may be rotated to allow accumulated debris to be washed off of the screen. Various instrument sensors will be installed to monitor water flow and debris accumulation.

As mentioned in Paragraph 2.3, the MIS allows 95 percent of the flow to pass through it, while preventing the fish from passing through the screen. The remaining five percent of the flow "washes" the fish across the modular-inclined screen into a flume that deposits the fish into the fish lock.

The housing will be designed to provide optimal hydraulic flow conditions, in order to attract the maximum number of fish. Specifically, the upstream portion, or inlet horn, will have elliptical-shaped surfaces (walls, roof, and floor) so as to minimize changes in water velocity as the flow passes through the collector. Minimizing the changes in water velocity is believed to help reduce holding of the fish just upstream of the collector. In other words, rapid fluctuations in localized water velocities is believed to discourage migrant fish movement.

Attached to the lower lip of the intake horn will be a skirt. This skirt will have neoprene bulb seals attached to its edges, and will press against the back side of the stoplogs.

Located at the downstream end of the fish collector will be a flume that will discharge the fish over the stoplog set that separates the wet-well from the fish lock. There will be a skirt, similar to the one attached to the fish collector intake horn, attached to the discharge flume. This skirt will have neoprene bulb seals that will bear against the upstream face of the stoplog set that separates the wet-well from the fish lock. If the fish collector house is to have a variable depth below the water surface, as discussed below, then this flume must be designed to adjust for the location of the collector house, in order to maintain the 2-foot head between the fish lock and the wet-well.

The fish collector assembly will be suspended from a pontoon. The pontoon provides the buoyancy necessary to maintain the fish collector at a predetermined height below the wet-well water surface. This height may be varied by changing the length of the locating struts that attach the collector to the pontoon. A steel framework attached to the walls of the wet-well will provide support for bearings attached to the pontoon and collector

assembly. The bearings will be designed to allow for vertical movement of the assembly while maintaining the location of the collector assembly within the wet-well.

The surface skin of the collector housing, along with the MIS framework, will most likely be constructed of stainless steel. Supporting structural members and components will most likely be made of hot-dipped galvanized steel.

2.3.3 Stoplogs

The stoplogs are an integral part of this facility. There are three sets of stoplogs. There is one set of large stoplogs at the upstream end of the wet-well structure, separating the fish collector assembly from the reservoir. There are two sets of smaller stoplogs: one set between the wet-well and the fish lock, and, one set between the fish lock and the fish lock regulation well. The large stoplogs will have a span of about 25 feet, and both sets of the smaller stoplogs will have a span of about 5 feet.

Each stoplog set will be comprised of 15 identical stoplogs, each 10 feet in height, that will be stacked for a total height of 150 feet. There may be a slight cost savings associated with designing each individual stoplog for a specific location within the stack; however, doing this may create more complicated storage and handling problems. From an emergency operations perspective, it may be desirable to be able to use any individual stoplog at any location within the stack.
As noted above, each stoplog will be approximately 10 feet in height. This is to allow the fish collector to move 10 feet without removing a stoplog. At this time, it is not anticipated that the reservoir elevation will fluctuate more than 10 feet during a 16-hour period. The mating surfaces of each stoplog will most likely incorporate a neoprene seal. For the large stoplogs that separate the reservoir from the wet-well, a seal between each stoplog is required in order to meet the fish criteria. These criteria state that, under operating conditions, it is undesirable to have any flow from the reservoir to the wet-well at any point other than at the intake horn of the fish collector.

Each stoplog set, or stack, will be designed to withstand a water level difference of a 150 feet, in order to allow for dewatering of the respective areas behind the stoplogs. Most likely the stoplogs will be constructed of hot-dipped galvanized structural steel members.

When not installed in an appropriate guide slot, the stoplogs will most likely be stored in storage racks attached to the right wall of the wet-well structure. The outer face of the right wall will be exposed above the 1140 foot elevation. A steel framework, or rack, installed along this wall could be constructed so as to store up to five stoplogs per rack. As indicated above, the stoplog system is an integral part of the operation of this facility. As the reservoir elevation changes, the fish collector floats along with it. A skirt attached to the lower lip of the fish collector intake horn provides for a watertight seal between the fish collector and the uppermost stoplog of the upstream stoplog stack. As noted above a similar skirt is attached to the discharge flume (at the downstream end of the fish

collector). This skirt will bear against the upstream face of the stoplog set that separates the wet-well from the fish lock If the reservoir elevation moves more than 10 feet, then a stoplog must be added to, or removed from, the stack. Handling of the stoplogs will be accomplished with a new service crane. (See Appendix A for additional discussion and drawings).

2.4 OPERATION AND MAINTENANCE

It is assumed in section 4.12 of the DFR/DEIS that an increase in staff of 9 full time equivalents (FTE's), at a cost of approximately $468,000 per year, will be required to operate and maintain the project features proposed in the AWS Project. Of that total approximately 5 FTE's are dedicated to operation and maintenance, including required periodic inspections, of the new tower and fish passage. It is assumed, for the purpose of this report, that these people will be Corps personnel, however, if new agreements and operating procedures can be negotiated between the Corps and TPU it may be possible for TPU personnel to participate in the operations of the new fish passage facility. TPU currently maintains facilities similar to this in the area and has indicated a willingness and ability to share in O&M. Further definitions of roles and responsibilities will be part of the PED.

During the PED phase of this project opportunities for automation of the fish passage facility will be investigated with the goal of reducing the number of personnel required to operate the facility.

The remaining 4 FTE's will be used mainly to maintain the habitat mitigation and restoration sites in the upper and lower Green River Basin and transport adult fish upstream. At present TPU or their contractors could maintain the sites in the basin below the dam, and with some minor changes to our operating procedures could maintain the sites in the upper basin and transport the adult fish. Therefore, the assumption is that these 4 FTE's would be TPU employees or contractors directly responsible to TPU. The Corps would not be directly involved in O&M of the habitat mitigation/restoration sites.

The DFR/DEIS did not include a cost for supplies and materials in the O&M costs. O&M costs will be revised in PED and it was assumed that with automation of the facility the number of FTE's would decrease enough to cover those costs. However, a cost for supplies and materials will be added here. To determine an appropriate amount to use it was determined that the cost of supplies and materials was approximately 50% of the labor cost at Mud Mountain Dam and at the existing Howard Hanson Dam facility the cost of supplies and materials was determined to be 40% of the cost of labor. The cost of supplies and materials for the AWS Project is estimate to be 45% of the labor cost or approximately $211,000 per year, in 1997 dollars.

Additionally, starting in project year eleven, there will be costs for ongoing monitoring to insure optimal operation of the new fish passage, the non-fish passage restoration facilities, and the mitigation facilities. These monitoring costs, in 1997 dollars will range from $20,000 to $345,000 per year. The average annual present worth cost of O&M monitoring, in 1997 dollars, is estimated to be $42,000

Major replacement of features is not expected during the life of this project. The average annual cost of O&M, in 1997 dollars, of the AWS Project features is estimated to be approximately $721,000 per year for phase I and phase II (estimated $621,000 is associated with phase I and $100,000 is associated with phase II).

A portion of the costs of the new buildings may be allocated to the existing project O&M if they are used for the performance of functions required for the existing project and replace existing buildings. For example if it is deemed appropriate to replace the existing administration building a portion of the costs, related to existing project functions, would be allocated to O&M.

The local sponsor is also required to pay a portion of the existing project O&M costs related to water supply. This amounts to 7.8% of the net O&M costs of the existing project in phase I and 8.8% in phase II, or $95,774 per year in 1997 dollars in phase I. Revision of the HHD O&M manual will be initiated during PED and developed during construction and equipment installation phase of the AWS Project in accordance with ER 1130-2-500 and will reflect the involvement of the local sponsor as roles and responsibilities are defined in PED.

O&M costs will be re-evaluated in PED.

2.5 VALUE ENGINEERING

All features valued at $2,000,000 or greater will be value engineered during PED, per Corps' regulations.

2.6 MONITORING

The AWS Project is a dual purpose water supply and ecosystem restoration project. The reliability of future water supply sources for Tacoma and Seattle are the result of 20 years of negotiation with resource agencies and tribes: the Corps has been involved in these negotiations for the last 8 years through the AWS Project. The current scope of the AWS Project FR/FEIS is a result of these negotiations. As currently described, the monitoring plan (at $4.26 million for project years 1-10) is a critical link to agency and tribal acceptance of regional water supply plans and for implementation of the project. The City of Tacoma is attempting to resolve ESA questions through a negotiated Habitat

Conservation Plan (HCP) with National Marine Fisheries Service and the U.S. Fish and Wildlife Service. The monitoring plan as currently described is included in the HCP and is already being reviewed by both of the above agencies.

2.6.1 PED Modifications to the Monitoring and Evaluation Plan.

Some revisions to the recommended monitoring plan presented in the DFR/DEIS will be accomplished during the PED Phase including expansion of the monitoring study plan. The revised study plan would have two major components -- monitoring of juvenile fish rearing and migration through the constructed project and lower river and understanding of how fish respond to various flow manipulations.

As part of a revised plan we can include items such as:

- A decision tree that adds a specific purpose to the data collection including how the data will be used to refine dam and reservoir operations.

- Details on what operational strategies (flow management) will be monitored and evaluated.
- A decision making structure for adaptively managing refill and release of the reservoir; based on evaluation of monitoring results.

- Identification of Phase II structural solutions to fish passage problems that cannot be addressed by changes in project operation in Phase I or Phase II.

- During plan refinement we will justify specific study elements that require 5 continuous years (or more) of monitoring based on project needs along with elements of lesser duration (2-3 years of initial monitoring). Each element would include provisions to expand study duration or study focus (new study methods) of certain, specific areas based on evaluation of initial years monitoring.

Seattle District developed the following interim (until PED) supporting rationale for the 5 continuous years (or more for specific items) of fish passage monitoring. Monitoring of fish movement for a 5 year period following initial project operation is recommended to provide feed-back to adjust project operations as described below:

The single largest budget item of the proposed AWS Project involves construction of a $34 million downstream fish passage facility. The design of the fish passage facility was based on observations of fish behavior at the existing Howard Hanson Dam and reservoir and at other Pacific Northwest dams supporting anadromous fish passage. As evidenced by the numerous projects where downstream fish passage has proved problematic long after project construction (see DFR/DEIS Section 3.2.4.12), successful implementation of downstream fish passage facilities requires innovative technology, knowledge of the physical characteristics of the site under proposed operating conditions, attention to the

biological requirements of the target species and the ability to respond to variances in site-specific fish behavior. The proposed downstream fish passage facility at HHD was designed to accommodate those requirements, provided adequate feed-back on actual fish passage makes full use of project flexibility. In addition to affecting juvenile salmonid passage through the project, the storage and release of water affects existing downstream fishery resources.

Monitoring of fish movement after an initial short-term (<5 year) intensive effort may be inconclusive or we may discover that particular aspects of project operation are a problem. An adaptive management plan may require additional years (4 to 5 or more) to evaluate changes in project operation (flow management) or to identify construction solutions that could be implemented in Phase II. Monitoring for more than 3 years (up to a general duration of 5 years) following project construction is strongly recommended for the following reasons:

1) Fish migratory behavior is strongly influenced by annual and seasonal run-off patterns. Fish migration will commence earlier during warm years and later during cold years. High, sustained run-off early in the spring will have a different effect than late sustained run-off. Freshets (short-term high flow releases) may initiate fish movement or potentially impede movement depending on the magnitude, timing and duration of the freshet. Observing the response of fish over a variety of environmental conditions will very likely require more than three years of monitoring. Five years of monitoring is considered a minimum effort since we not only need to document and respond to patterns of fish behavior under a variety of conditions, but continued monitoring is needed to confirm that operational responses are appropriate. For instance, fish behavior during a specific environmental condition may represent a single causative function (i.e. warm but wet spring). Monitoring several iterations of cause and effect, could conceivably require even more than five years to cover the range of conditions needed to develop a long-term operating strategy.

2) One of the primary cost factors for the facility is the large capacity, surface intake which provides increased opportunity for flow management to enhance fish passage through the reservoir and dam. The volume, timing, duration and frequency of project releases separately, and in concert, influence juvenile salmon and steelhead passage through the reservoir and attraction into the fish passage facility intake. Monitoring the effect of a range of operational strategies will require a long-term monitoring commitment. The fish passage facility has a large flow capacity to enhance fish passage; but, use of the full capacity of the facility must be carefully managed to ensure project objectives of reservoir storage are also met. Understanding the trade-offs between project fish passage and reservoir storage inherent in flow management will require several annual iterations.

3) The proposed operating strategy involves an adaptive management process where we will be testing a variety of flow management techniques (refill timing, refill rates, baseflow augmentation, freshet release) to maximize survival of juveniles migrating through the reservoir/dam. These operating strategies are subject to seasonal run-off risks in addition to the uncertainties from dam and reservoir operations. The effect of these operating strategies on downstream resources must also be documented. Just as several iterations of cause and effect are needed to protect and enhance upstream resources, several iterations are needed to protect and enhance downstream resources. Monitoring of downstream resources will be conducted concurrent with upstream monitoring efforts, but the added complexity justifies the five year monitoring process to optimize project benefits.

4) The first years operation and start-up logistics may result in the first year as a "pilot year" where the fish passage facility may not be fully operational (this is a unique facility that has not been operated before) while monitoring equipment will be tested and evaluated, therefore at least an additional 2 years beyond this would be a bare-minimum under any monitoring program.

5) Hatchery fish used to re-establish salmon and steelhead above HHD will typically be planted as fry during late winter or early spring, many of these fish will over-winter above the reservoir and emigrate the following spring. Monitoring is typically considered by hatchery release-group (year-class), so to cover a minimum of two years for release groups in project years 1 and 2, a third year would be required to evaluate project operations on overwintering fish. In addition, if project year 1 is considered a pilot year, monitoring through project year 4 would be necessary to evaluate project operations on overwintering fish planted in years 2 and 3.

In addition to justification for five continuous years of fish passage monitoring, we have also developed a brief justification for two situations where monitoring beyond year 5 (years 8-9, 12-13) could be justified.

1) The proposed AWS will double the size of the reservoir which presents additional variability in our monitoring environment. The reservoir food web and physical environment will be changing dramatically during the first few years of the project because of the large influx of nutrients from inundated areas. The reservoir nutrient flux is expected to stabilize after the first few years and continued monitoring beyond the first five years will be needed to ensure that project operations continue to maximize successful downstream fish passage.

2) Monitoring beyond the first five years of project operations is required to document potential changes in the behavior of salmon and steelhead outmigrants. Using Chinook as an example, if initial upper watershed chinook production is derived from hatchery plants of fry, the majority of juveniles will probably outmigrate as fry. Juvenile chinook produced from returning adults may exhibit different behavior and a

higher portion may outmigrate as yearlings. The timing, migration rate, and response to flow change of naturally reared chinook fry often differs from hatchery fry while timing and behavior of naturally-reared chinook yearlings can vary substantially from hatchery stock. Continued monitoring beyond the first five years will be needed to document actual behavior. Project operations may have to be adjusted to maximize passage of chinook salmon which are proposed for listing under the ESA.

2.6.2 Monitoring Issue Areas

There are six Issue Areas for Monitoring and Evaluation, these six Issues are:

1. Downstream Fish Passage through Howard Hanson Reservoir and Dam (*Project Fish Passage*);
2. Impacts to Downstream Habitat and Aquatic Resources (*Downstream Impacts*);
3. Restoration of Middle, Upper, and Headwaters Green River Stream Habitat (*Fish Habitat Restoration Projects*);
4. Mitigation for Tributary and Riparian Habitat Inundated by the Phase I Pool (*Fish Habitat Mitigation Projects*);
5. Mitigation for Wildlife and Forest/Sedge Habitat Inundated by the Phase I Pool (*Wildlife Habitat Mitigation*); and
6. Adult Fish Returns to the Upper Green River (*System-wide Analysis*). This item is transferred to other agency responsibility and eliminated as a restoration monitoring item (see paragraph 2.6.3 below).

The Issue Areas are the major areas of concern regarding operation of the AWS Project (Table 2-2). The Monitoring Items are related to the Ecosystem Restoration Authority Guidance (EC 1105-2-210) of 1) specific purposes – ecosystem restoration or mitigation of water supply storage; 2) review of whether the project is functioning per objectives; 3) need to make adjustments for unforeseen circumstances as needed; and 4) need for changes in structures or their operation, of management techniques as needed. Under the Agency Resolution Process, the Corps and Tacoma agreed to an adaptive management plan for the AWS Project. The key components of the Plan include experimentation, monitoring and analysis, and synthesis of results, followed by adaptive management practices responsive to the scientific results of those efforts. The AWS Project Adaptive Management Plan involves: 1) implementation, so changes in the ecosystem can be studied with long-term monitoring; 2) incorporation of potential changes in project design and management/operation as we learn from phased implementation studies and monitoring; 3) implement changes in program structure if monitoring results and outcomes justify changes; and 4) ongoing coordination with agencies and the MIT throughout the project to ensure that good science is incorporated into management strategies and decision making.

TABLE 2-2. ISSUE AREA, MONITORING ITEM, CONSTRUCTION OR SPONSOR FUNDING, AND DURATION OF MONITORING OF FISH AND WILDLIFE RESTORATION AND PHASE I MITIGATION PROJECTS.

Issue	Monitoring Item	Construction Funding[1] Project Years	Sponsor Funding[1] Project Years
(1) Project Fish Passage	Reservoir Passage of Juvenile Fish	1-5, 8-9	12-13, 15, and 16-50 -- repeated once every 2-6 yr. as necessary
	Fish Passage Facility Collection Efficiency	1-5, 8-9	12-13, 15, and 16-50 -- repeated once every 2-6 yr. as necessary
	Fish Collector Passage	1-10	11-15, and 16-50 as necessary
	Water Quality Monitoring	Equipment	1-50 covered under existing O&M funding
(2) Downstream Impacts	Side-channel Connectivity	2,3 and 4	6-15 by sponsor, as necessary[2]
	Juvenile Instream Migration/Habitat Use	1-5	6-15 by sponsor, as necessary[2]
	Adult Spawning and Egg Incubation	1, 2, and 3	4-15 by sponsor, as necessary[2]
	Spawner Surveys Above and Below HHD	1-5	6-15 by sponsor, as necessary[2]
(3) Fish Habitat Restoration	M. Green Gravel Nourishment	0, 1, 2, 5, 10	5 yr. increment by sponsor
	U. Green Side Channel Improvement	0, 2-5, 10	5 yr. increment by sponsor
	Headwaters Stream Improvement	0,2-5, 10	5 yr. increment by sponsor
(4) Fish Habitat Mitigation	Instream Habitat Projects		0, 2-5, 10 and 5 yr. increment after 10
	Riparian Habitat Projects		1,2,5, 10 5 yr. increment after 10
(5) Wildlife Mitigation	Elk Habitat Use		1,2,5, 10
	Forest Habitat Use		1,2,5, 10

1. Construction funding is cost-shared between federal government and local sponsor at 65:35. All other items and project years are 100% local sponsor cost.
2. Additional monitoring beyond that identified for construction funding will be dependent on biological need.

2.6.3 Monitoring Items and Monitoring Elements

Following is a brief summary of the monitoring items and sub-ordinate monitoring elements. A description of each monitoring element – purpose, objective(s), methods, estimated cost, and duration -- can be found in Appendix F1, Section 10 *Adaptive Management Monitoring and Evaluation Program.* A listing of the original Issue Areas, Monitoring Items, Cost-Allocation (construction or sponsor funding), and an overall length of monitoring (project years) are provided in Table 2-2.

In most descriptions of the items and elements we have only provided a brief description of the proposed monitoring: an example of a more developed justification of one monitoring item is the *Instream Migration* under the *Downstream Impacts Issue Area.* In our initial draft of the HHD AWS FR/EIS we only had a minimal write-up on an adaptive management and monitoring plan. With Headquarters concurrence, in January 1998, we quickly developed the framework of such a plan, see *Section 10 Appendix F1*, but with plans to further develop and refine the plan during PED phase in FY 1999.

(a) Project Fish Passage (Issue Area 1)

Monitoring and evaluation will assess how well fish move through the larger reservoir, the efficiency of juvenile collection, survivability/passage through the fish collector and passage structure, water quality/limnology and fish use of the larger reservoir. The proposed period is for 15 years, corresponding to 4 adult life-cycles of salmon and steelhead. Because new fish passage technology is being utilized, extensive monitoring is necessary to learn how best to operate the project. This overall longer monitoring period is also required to learn the optimal facility and reservoir operation depending on variability in water years and as the composition of hatchery and natural production changes (as for most monitoring elements the actual restoration funded monitoring only occurs in 9 of the 15 years. The restoration funding is considered continuous for project years 1-5 with two, 2-year, return periods of restoration monitoring in project years 8-9 and 12-13. We did not feel we could justify restoration funding for the entire 15 year period, but we do consider it necessary to continue restoration monitoring of this adaptively managed project within selected periods of the 15 years. To do this, we are proposing the two, 2-year restoration funded monitoring periods at three year return intervals. There are 4 Monitoring Items with 10 Monitoring Elements under this Issue Area: some monitoring elements provide information for more than one monitoring item. The four monitoring items are 1) Reservoir Passage of Juvenile Fish; 2) Fish Passage Facility Collection Efficiency; 3) Fish Collector Passage; and 4) Water Quality Monitoring. The Monitoring Elements and objective/purpose of each are:

1. *Estimation of Reservoir Survival, Attraction Rate of Fish Passage Facility, and Total Project Survival Using Passive Integrated Transponders (PIT-tags).* To estimate reservoir survival, fish passage facility attraction (collection) rate, and total project survival, we are proposing that 5,000 coho, chinook and steelhead juveniles or smolts will annually be tagged, released and monitored during 9 of the first 15 years of project operation during project years 1-5, 8-9, and 12-13.
2. *Efficiency of the MIS Screen and Fish Bypass Facility.* The MIS screen is still considered experimental technology and although laboratory tests have shown juvenile survival rates exceeding 95%, a controlled test of the screen is necessary. A series of coho, chinook salmon or steelhead fry releases will occur during normal juvenile outmigration periods during the first years of operation to test the efficiency (injury rate and survival) of the MIS screen and fish bypass facility.

3. *Sampling Station at Outfall of Fish Passage Facility.* The Fish Passage Facility as a whole is unique in the combination of its components. A regular, systematic sampling program is necessary to assess the condition of fish that are screened by the MIS, passed through the bypass system, locked through the wetwell, and released through the discharge flume. A sampling station will be used to assess condition (injury, mortality, length/weight, smoltification, and stress) of test and natural outmigrants after passage through the collection facility. This element is considered for restoration funding for project years 1-5, 8-9, and 12-13, other years (6-7, 10-11, 14-50) this will be considered an O&M funded requirement.
4. *Forebay Scanning of the Dam.* To assess the utility of flow ramp-ups (freshets) and ramp-downs in attracting and collecting juveniles into the fish passage facility hydroacoustic monitoring can be used to continuously map the number and location of outmigrant juveniles and larger resident salmonids in the forebay above the fish passage facility and at the entrance to the facility (the horn). A split-beam transducer on a dual-axis rotator can continuously sample the forebay area and near the facility horn for outmigrants and larger fish (potential predators). This element is considered for restoration funding for project years 1-5, 8-9, and 12-13. As necessary, this monitoring element could be continued under O&M funding in project years 6-7, 10-11, and 14-50.
5. *Hydroacoustic Monitoring to Provide Estimated Outmigration Numbers and Fish Behavior in Fish Lock.* The objective of this monitoring component is to provide detailed evaluation of juvenile fish passage into/in the fish lock and evaluate potential passage at high flows through the radial gates. Hydroacoustic monitoring in the lock chamber can be linked to an automatic lock control system to vary the cycle time of the lock based on the number of smolts in the chamber (see Automatic Lock Control below). This element is considered for restoration funding for project years 1-5, 8-9, and 12-13.

   Automatic Lock Control System/Hydroacoustic Monitoring. The fish passage facility as now planned would have an automatic control that regularly cycles lockages at pre-programmed times. The linked control to hydroacoustic monitoring in the wetwell would be more biologically based, giving actual estimates of fish density in the lock chamber required before locking fish through. This monitoring element is considered an O&M funding requirement.

   Observation of the MIS. There is concern that at certain flow rates the normal and sweeping velocities over the bypass screen may exceed the swimming ability of juvenile outmigrants. The screen surface would be periodically monitored at various flow rates/velocities to assess impingement of smolts against the screen. The bypass and screen are currently proposed to have viewing portals so an observer can look directly at the screen. This monitoring element is considered an O&M funding requirement.
6. *Fyke Netting at the North Fork and Mainstem Reservoir Confluence.* The objective of the element is to characterize immigration of juvenile salmonids into the reservoir from winter through early summer: as restoration proceeds, the species composition, number and timing of immigrants could vary dramatically. During the first 15 years

of project operation (project years 1-5, 8-9, 12-13, 15), a weekly evaluation (2-3 days/week) of immigration timing of juvenile fish entering the reservoir will be performed included metrics on species composition, growth characteristics, and stomach contents (if necessary) would occur. As necessary, this monitoring element will be conducted as an O&M funded element in project years 6-7, 10-11, and 14-50.

7. *Mobile Hydroacoustic Surveys of the Reservoir.* The objective of this element is to characterize horizontal and vertical distribution (diel and seasonal) of juvenile and adult anadromous and resident salmonids in the reservoir (paralleling work done by USFWS in 1993). This information would be used in conjunction with other monitoring to evaluate necessary actions such as selective predator removal (periodicity of predator build-up at tributary confluence) and the need for increased outflows at the fish passage facility (from build-up of juvenile outmigrants above the passage facility). Restoration funded monitoring would occur in project years 2,3, 8, and 13. As necessary, this monitoring element will be conducted in regular intervals, every 5 years, as an O&M funded element beginning in project year 18.
8. *Zooplankton/Neuston Sampling in the Reservoir.* The objective of this element is to characterize the reservoir foodwebs, zooplankton and neuston, and to evaluate changes in the foodweb as the reservoir environment changes through time. To complement reservoir surveys for information on juvenile rearing, sampling for composition of invertebrate community including distribution and densities would be conducted in 5-year increments. The reservoir will be undergoing dynamic changes during the initial years of the pool raise with continuing long-term changes as the system attempts to reach equilibrium. These changes will include a large influx of nutrients from inundating surrounding vegetation, run-off from short-term landsliding, increase in heat budget and development of a more dramatic thermocline, and lastly, the re-introduction of salmon carcasses and increased juvenile rearing densities. These changes can result in dramatic changes to the reservoir food web upon which salmonids are dependent. In selected years, on a seasonal basis, surveys would be performed to collect invertebrate data in the upper and lower sections of the reservoir and would be analyzed in conjunction with stomach contents collected during sampling for juvenile salmonids. Restoration funded invertebrate surveys of the reservoir are planned for project years 3, 8, and 13. As necessary, this monitoring element will be conducted in regular intervals, every 5 years, as an O&M funded element beginning in project year 18.
9. *Predator Monitoring* The objective of this element is to monitor and evaluate the changes in trout populations and their consumption rates (of juvenile salmon) during restoration of salmon runs with the AWS Project. This is a preventative measure to insure successful outmigration of chinook salmon juveniles (the smallest migratory fish) and possibly to increase survival of salmon and steelhead fry that rear in the reservoir. Members of an interagency team of biologists were concerned about the possible increase in predation that may occur at migratory transition points -- such as the confluence of the tributaries with the reservoir and at the fish passage facility. If there is an increase in overall predator abundance in response to migratory juvenile presence, a selective predator removal program could be initiated: the watershed is

currently closed to angling. As originally proposed, restoration funding of this monitoring item will occur in project years 3, 5, 10, and 15: these years may be adjusted to align with other monitoring such as the mobile hydroacoustic surveys (see above). If this tool proves effective, this would become an O&M item to improve smolt survival through the project.

10. *Water Quality Monitoring.* Three permanent water quality stations would be added in order to continuously monitor temperature, dissolved oxygen, and conductivity in the lower reservoir and at the dam outfall. These stations are primarily for monitoring temperature stratification of the reservoir and will be used to assess changes in flow releases in order to meet restoration outflow temperature requirements. The purchase of the stations is considered a restoration funding item, operation of the stations will be covered by O&M funding.

(b) Downstream Impacts (Issue Area 2)

The purpose of this element is to assess the impacts/needs of Lower Watershed anadromous fish during Phase I later winter and spring re-fill. The expected time frame is 5 years. The results will improve our evaluation of effects of existing storage and potential impacts from the AWS Project and help assess the design and efficacy of tools (baseflows, refill rates, freshets etc.) designed to minimize existing effects and future impacts of additional water storage. The focus will be on side-channel connectivity, juvenile instream migration and adult use of habitat. Although the re-fill under the proposed project is primarily associated with water supply, monitoring under this element provides valuable information on impacts (and opportunities for adaptive management) associated with the existing project.

1. *Side Channel Monitoring Pre- and Post-Construction.* The objective of this item is to 1) monitor Middle Green River side channel quantity, quality and use by rearing juvenile salmonids during Phase I winter and spring refill and 2) use this information to develop an adaptive storage and release program that minimizes impacts to side channel habitat and habitat use. Post-construction sampling of habitat quantity/quality will be conducted in project years 1 and 4 and sampling of habitat use will be conducted in years 2 and 5.
2. *Instream Migration Pre- and Post-Construction.* The objective of this monitoring item is to minimize the impact of AWS Project storage and release on the survival of emigrating (natural-reared and hatchery) juvenile salmon and steelhead. The analysis of AWS Project effects on salmonid emigration through the Lower Watershed includes several untested assumptions – including whether artificial freshets are an appropriate mitigation tool. In order to minimize the risk of unforeseen project impacts, monitoring of juvenile salmonid instream migration through the lower river will be conducted pre- and post-construction. This before and after AWS Project monitoring will provide important feedback through an adaptive management process so storage and release regimes can be adjusted in response to observed results. Post-construction monitoring will occur during project years 1-5 and will be tied to the

specific adaptive management objective of minimizing impacts of spring refill on juvenile outmigration (survival). To accomplish this, post-construction monitoring will continue to document instream migration characteristics, including potential changes to migration timing and species response if Lower Watershed fish management practices are changed in response to ESA listings and as Upper Watershed fish begin increasing in number. In addition, post-construction monitoring will refine the understanding of the migratory fish response to flow changes.

3. *Spawning and Egg Incubation.* The objective of this monitoring component is to avoid dewatering salmon redds and incubating eggs during late winter and early spring refill: current refill only occurs in spring. Salmon redd surveys would be conducted during the first three years of Phase I during the fall and winter to identify off-channel and mainstem margin habitats that could be affected by earlier refill in late winter during Phase I. Redds would be monitored to incubation during refill. Water surface elevations necessary to maintain continuously wetted substrates will be assessed and used to refine baseflow targets used during refill. If additional years of monitoring are necessary it will be considered an O&M funded item.

(c) Fish Habitat Restoration Projects (Issue Area 3)

This Issue Area is for monitoring the side-channel, gravel nourishment, instream restoration projects, and upper watershed spawning habitat.

1. *Middle Green River Gravel Nourishment.* The objective of this monitoring item is to determine the effectiveness of gravel nourishment in reducing bed armoring in the Middle Green River during initial years of the gravel nourishment program. An additional objective is to monitor water surface elevations above Auburn (below the nourishment areas) to ensure that nourishment is not effecting flood protection areas. Pre-construction surveys will include evaluation of aerial photographs and river cross-sections at points upstream and downstream of the proposed nourishment area to determine the distribution and quality of gravels. Post-construction will include re-survey of cross-sections and aerials and evaluation of water surface elevations in downstream flood protection areas. Cost-shared surveys would occur project years 0, 1, 2, 5, and 10; after year 10 costs become a fully funded O&M requirement.
2. *Upper Green River Side Channel Improvement and Headwaters Channel Improvement.* The objective of this monitoring item is to assess the effectiveness (habitat quantity, quality and use) of these habitat restoration projects. Surveys of instream habitat and habitat use will occur pre- and post-construction. Restoration funded surveys will occur over the first five project years and will include a baseline survey before project operation begins (project year 0). As part of the restoration funded surveys, periodic intensive inspections of how well the projects are functioning (example: is large wood still in place or washed out) will occur in years 1, 2, 5, and 10. Periodic intensive inspections will occur in 5-year increments following year 10 as a fully funded O&M requirement. Annual spot inspections of structures will also occur as an O&M item.

3. *Upper Watershed Spawner Surveys.* The objective of this monitoring element is to assess use of the restoration projects by adult salmon and steelhead by conducting annual surveys of salmon and steelhead spawning in areas (affected by the restoration activities) above and below the AWS Project. Surveys would be conducted for 5 years to document adult spawner use in various areas including 1) in the Upper Green River side channel project; 2) in areas influenced by temperature regulation of the new fish passage facility (from 3-6 miles below the dam); and 3) within the Headwaters Channel Improvement area.

(d) Fish Habitat Mitigation (Issue Area 4)

This monitoring issue is for impacts associated with the larger reservoir for water supply, and since it is a mitigation element, the non-federal sponsor would be expected to pay 100%.

1. *Instream Habitat Projects.* The objective of this monitoring item is to assess the effectiveness of the instream habitat structures. Surveys of habitat quantity/quality and habitat use following installation of instream habitat mitigation structures would occur in project years 3 and 4. In addition to the evaluation of the use of the habitat mitigation projects, periodic intensive inspections of how well the projects are functioning (example: is large wood still in place or washed out) will occur in years 2, 5, 10 and 15.
2. *Riparian Habitat Projects.* Periodic inspections of how well the reservoir and above-reservoir riparian plantings and thinning projects are functioning will occur in years 1,2, 5, 10 and 15.

(e) Wildlife Habitat Mitigation (Issue Area 5)

This monitoring issue is for impacts associated with the larger reservoir for water supply, and since it is a mitigation element, the non-federal sponsor would be expected to pay 100%.

To summarize that discussion, we expect to monitor wildlife use of the sites, and plant survival, in years 2, 5, and 10 following planting of vegetation. Per EC 1105-2-100, paragraph 21.b (3), the primary goal is to assess whether elk use of pastures is sufficient to justify continuing O&M of the pasture(s), or perhaps that different management could lead to greater use of pastures. The goal of monitoring the sedge meadows and wetlands is to assure maximum survival of plants. If it is found that some areas will not support plants, those areas will be avoided, and other areas, where plants are found to be robust, will be planted with replacement plants. These monitoring efforts would require studies of plant growth, density, and nutritional content; and of actual elk usage of the sites (a resumption of the elk exclusion cage study, Section VI of Appendix F2 would be conducted), and of elk pellet composition.

(f) System-wide Analysis (Issue Area 6)

As originally discussed in the DFR/DEIS, Issue Area 6 -- Adult Returns or System-wide Analysis -- had two monitoring elements, 1) coded-wire-tagging (CWT) of chinook salmon fry and 2) adult spawner surveys. In the FR/FEIS, restoration funding for the CWT element has been eliminated and is considered the responsibility of the local sponsor while the Spawner Survey element has been moved to Fish Habitat Restoration Monitoring. The Fish Restoration Facility (a naturalized rearing facility, part of the MIT/Tacoma Agreement, see DFR/DEIS pg. 14 and 60), if approved by WDFW and NMFS, will have a monitoring and evaluation program attached to it which could include CWT of outplanted juvenile salmon and steelhead: we assume that Tacoma will most likely cover the cost. Adult spawner surveys are continued but are moved to issue area 3 (see above). This effectively eliminates monitoring issue no. 6) Adult Fish Returns as a restoration funded cost. The monitoring of adult fish returns to the basin is still absolutely necessary and will still be conducted, we assume by resource agencies, the Muckleshoot Tribe or the City of Tacoma.

Monitoring under the AWS Project will provide an indicator of adult returns with spawner surveys in project years 1-5 in habitat restoration areas above and below the project. The use of PIT tags can also provide a small database or indicator for assessing juvenile-to-adult returns. Reported returns of PIT tags are maintained in a database by the Pacific Salmon Fisheries Commission; just as CWT are maintained.

2.6.4 Monitoring Schedule and Cost

Since official filing of the DFR/DEIS on June 15, 1998, we have refined the cost-allocation of the project. Construction funding (cost-shared monitoring at 65% federal and 35% local sponsor) for all restoration monitoring and evaluation has been defined by project year. Construction funding has been limited to post-construction monitoring during project years 1-5 (Phase I) and project years 6-10 (the first five years of Phase II)[2]. Monitoring beyond year 10 will be the responsibility of the local sponsor.

Initial costs and schedule for the first 15 years of post-construction monitoring are shown in Tables 2-3 and 2-4: cost in Table 2-3 includes contingency, cost in Table 2-4 does not. A schedule has not been developed for monitoring in project years 16-50 but costs were developed based on project year monitoring in years 11-15. These monitoring costs, in 1997 dollars will range from $20,000 to $345,000 per year (without contingency). The average annual present worth cost of O&M monitoring, in 1997 dollars, is estimated to be $42,000.

[2] The definition of Phase I and Phase II by project years was done to identify the period of construction funding and does not imply that Phase II will commence in project year 6. However, Phase II cost-shared monitoring will only be undertaken after implementation of Phase II. The actual inception date of Phase II is dependent on evaluation of Phase I results and consensus of resource agencies, Muckleshoot, Corps and the City of Tacoma.

TABLE 2-3. MONITORING COSTS (INCLUDING 20% CONTINGENCY – 1.20) BY PROJECT PHASE 1) PHASE I, PROJECT YEARS 0-5; 2) PHASE II, PROJECT YEARS 6-10; AND 3) FIRST FIVE YEARS OF OPERATION AND MAINTENANCE (O&M) FUNDED MONITORING, PROJECT YEARS 11-15.

Item And Years of Monitoring	Phase I Cost (Project Yr. 0-5)	Phase II Cost (Project Yr. 6-10)	Total Cost (Project Yr. 1-10)	Project Yr. 11-15 (O&M Funding)
(1) Fish Passage (15 Yr.)	$1,465,000*1.20 = $1,758,000	$635,000*1.20 = $762,000	$2,520,000	$705,000*1.20 = $846,000
(2) Downstream Impacts (5 yr.)	$785,000*1.20 = $942,000		$942,000	
(3) Fish Habitat Restoration (Yr. 2-3, 5, 10, 15.)	$212,000*1.20 = $254,000	$40,000*1.20 = $48,000	$302,000	$40,000*1.20 = $48,000
(4) Fish Habitat Mitigation[3] (Yr. 2-3,-5, 10, 15)	$127,000*1.20 = $153,000	$15,000*1.20 = $18,000	$171,000	$15,000*1.20 = $18,000
(5) Wildlife Habitat Mitigation[3] (Yr. 1, 2, 5, 10)	$205,000*1.20 = $246,000	$68,340*1.20 = $82,000	$328,000	
TOTAL	$3,353,000	$911,000	$4,264,000	$912,000

TABLE 2-3A. FULL FUNDED CONSTRUCTION MONITORING COSTS AND COST-SHARING (YEARS 1-10). TOTAL FEDERAL CONTRIBUTION IS $3,451,000 AND NON-FEDERAL IS $2,558,000.

			Phase I		Phase II	
Monitoring Item	Phase I Full Funded Cost	Phase II Full Funded Cost	Federal	Non-Federal	Federal	Non-Federal
(1) Fish Passage	$1,758,000*1.349 = $2,372,000	$762,000*1.633 = $1,244,000	$1,542,000	$830,000	$809,000	$435,000
(2) Downstream Impacts	$942,000*1.349 = $1,271,000		$826,000	$445,000	Not Developed	Not Developed
(3) Fish Habitat Restoration	$254,000*1.349 = $343,000	$48,000*1.633 = $78,000	$223,000	$120,000	$51,000	$27,000
(4) Fish Habitat Mitigation3	$153,000*1.349 = $206,000	$18,000*1.633 = $29,000		$206,000		$29,000
(5) Wildlife Habitat Mitigation[3]	$246,000*1.349 = $332,000	$82,000*1.633 = $134,000		$332,000		$134,000
TOTAL	$4,521,000	$1,487,000	$2,591,000	$1,933,000	$860,000	$625,000

[3] Fish Habitat Mitigation and Wildlife Habitat Mitigation are not cost-shared since they are assigned to water supply with 100% non-federal funding.

TABLE 2-4. PROPOSED COSTS (IN THOUSANDS OF DOLLARS, OCTOBER 1997 COST, WITHOUT CONTINGENCY) OF COST-SHARED MONITORING ELEMENTS FROM FISH AND WILDLIFE MITIGATION AND RESTORATION PROJECTS BY PROJECT YEAR. PROJECT YEARS 0-5 ARE PRESENTED AS PHASE I, YEARS 6-10 AS PHASE II, AND YEARS 11-15 AS O&M FOR COST ALLOCATION PURPOSES.

		Annual Cost (in thousands of dollars)															
		Phase I						Phase II					Operation and Maintenance				
Monitoring Item	Monitoring Type/	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	Project Years	0[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fish Passage																	
Reservoir	Fyke Nets		15	15	15	15	15			15	15			15	15		15
	Mobile Hydroacoustics			50	50					50					50		
	Paired PIT Tag[b]		Below[c]	Below[c]	Below[c]	Below[c]	Below[c]			Below[c]	Below[c]			Below[c]	Below[c]		
	Predator Manipulation				45		45					45					45
	Zooplankton/neuston				30					30					30		
Collection	Paired PIT Tag[b]		120[c]	120[c]	120[c]	120[c]	120[c]			120[c]	120[c]			120[c]	120[c]		
	Hydroacoustic Forebay and Horn[b]		40	40	40	40	40			40	40			40	40		
Collector Passage	Paired PIT Tags[b]		Above[c]	Above[c]	Above[c]	Above[c]	Above[c]			Above[c]	Above[c]			Above[c]	Above[c]		
	Marked Fry		20	20	20												
	Sampling Station[b]		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Hydroacoustic in Wetwell[b]		30	30	30	30	30			30	30			30	30		
Water Quality	Thermistor	60															
	SUBTOTAL	60	245	295	370	225	270	20	20	305	225	65	20	225	305	20	80
Downstream Impacts																	
Side-channel	Inlets/Outlets		35			35											
	Habitat Use			50		50											
Instream Migration	Screw-trap		90	90	90	90	90										
Spawning /Incubation	Redds/Emergence		30	30	30												
	Spawner Surveys[d]		15	15	15	15	15										
	SUBTOTAL	0	170	185	135	190	105	0	0	0	0	0	0	0	0	0	0

TABLE 2-4 CONT.

Fish Habitat Restoration																	
M. Green Gravel	Distribution; Quality	10	25	25			25					25					25
U. Green Side Channel	Inspection		7.5	7			7.5					7.5					7.5
Headwaters Stream	Inspection			7.5			7.5					7.5					7.5
	Habitat Survey	15			25	25											
	Habitat Use	5			10	10											
	SUBTOTAL	30	32.5	39.5	35	35	40	0	0	0	0	40	0	0	0	0	40
Fish Habitat Mitigation																	
Instream Habitat	Inspection			7.5			7.5					7.5					7.5
	Habitat Survey	15			25	25											
	Habitat Use	5			10	10											
Riparian Habitat	Inspection		7.5	7.5			7.5					7.5					7.5
	SUBTOTAL	20	7.5	15	35	35	15	0	0	0	0	15	0	0	0	0	15
Wildlife Habitat Mitigation																	
Wildlife	Animal Surveys		45.34	45.34			45.34					45.34					
Vegetation	Vegetation Surveys		23	23			23					23					
	SUBTOTAL		68.34	68.34			68.34					68.34					
TOTAL ANNUAL MONITORING COST (without Contingency)		$110	$523.3	$602.8	$575	$485	$498.3	$20	$20	$305	$225	$188.3	$20	$225	$305	$20	$135

a. Project Year 0 indicates monitoring of sites/conditions during construction phase (any year between 2001-03 when conditions permit) for immediate pre-project conditions.

b. Assumes hardware costs are already incorporated in the FPF construction cost: 1) $200,000 for PIT tag detector/monitor in juvenile bypass system; 2) $225,000 for Hydroacoustic transducers, rotators, cables, for the forebay/horn/trashrack/wetwell; and 3) $200,000 for Sampling station; total cost of $625,000 (D. Chow pers comm. said $750,000 set-aside for hardware).

c. Paired PIT-tag releases and detections overlap in monitoring of three different fish passage issues -- 1) reservoir passage/survival; 2) fish collection efficiency; and 3) fish collector passage - costs are only listed for fish collection efficiency but monitoring will cover all three issues.

d. System-wide Analysis was eliminated as a restoration funded monitoring item which included coded-wire-tagging (CWT) of chinook and spawner surveys: Tacoma Public Utilities is expected to provide monitoring and evaluation funding of CWT adult returns during implementation and operation of the Fish Restoration Facility, if this facility is not implemented this item will have to be re-evaluated for funding under the AWS Project.

2.7 ECONOMICS

2.7.1 Construction Cost and Investment Costs

Project first costs consist of construction cost. Major construction items consist of modification to the outlet works to include lands, intake tower, intake gates and equipment, seepage control, foundation work, access road, mitigation features and monitoring of fish and wildlife restoration and mitigation features. Total construction costs, including monitoring of $4,263,000, are estimated to be $72,786,000 in October 1997 prices. Investment costs include construction costs plus interest during construction (IDC). IDC was computed by compounding interest over the construction period at 7 1/8 percent interest. Shown below is a summary of project construction costs and investment costs.

2.7.2 Annual Costs

Estimated annual costs are based on investment costs levelized over the 50-year economic life of the project at 7 1/8 percent interest. The estimated incremental increase in annual operation, maintenance and replacement costs associated with the proposed project are also included. Shown below are the estimated annual costs of the proposed project.

Construction Cost [4]	$ 68,523,000
Interest During Construction	5,000,000
Present-Worth of Monitoring Costs	2,620,000
Investment Cost	$ 76,143,000
Average Annual Costs	
Interest and Amortization (50-Yrs @ 7 1/8%)	$5,605,000
Operation, Maintenance and Replacements	721,000
Total Annual Cost	$6,326,000

2.7.3 Allocation of Project Costs

While the proposed project does not affect the outputs of the existing project, the project does add two additional project purposes; both with different cost sharing requirements. As project sponsor, Tacoma Water Division is responsible for paying 100% of the construction costs allocable to water supply and 35% of the construction allocable to ecosystem restoration. As a result, an allocation of the proposed project construction costs is necessary. The project sponsor is required to pay 100 percent of the operation,

[4] Includes present-worth of monitoring costs ($4,263,000 non-discounted).

maintenance and replacement (OM&R) costs associated with water supply and ecosystem restoration and, as a result, a cost allocation pertaining to these costs is not necessary. This allocation of costs establishes the proportion of joint-use construction cost of the proposed project to be allocated to each project purpose as well as identifies the specific costs associated with each project purpose. Given the need to establish a firm basis for allocating project costs as part of the construction cost sharing agreement between the local sponsor and federal government, the identification of specific costs and the determination of the joint-use percentages in this allocation is considered to be final.

Following is a discussion of the cost allocation methodology used to establish the allocation of project construction costs. Due to the uncertainty regarding what number of years labor required for monitoring is considered a construction cost item, a separate allocation of the labor costs associated with monitoring was developed and is discussed in sub-paragraph f of this section with the results shown in Table 2-9.

2.7.4 Cost Allocation Methodology

Since ecosystem restoration benefits are not quantified in dollar terms, a *modified separable cost - remaining benefits (SCRB) cost allocation methodology* was developed and used for this project. This cost allocation methodology has been approved by Corps Headquarters and is considered to provide an equitable allocation of construction costs to each authorized project purpose. Following are definitions of costs which apply to the cost allocation methodology:

- Specific Costs - are those accounting feature(s) or sub-feature(s) cost, all of which are associated with only one project purpose.

- Separable Costs - are the costs incurred by adding a project purpose. These costs include all specific costs plus that portion of the joint costs identified as belonging to only one project purpose. These costs represent the difference in cost between the multiple purpose project and the multiple purpose project with a project purpose omitted.

- Joint-Use Costs - are the total costs allocated to a project purpose (separable plus allocated residual joint costs) minus the specific costs.

- Joint-Use Percentage - the proportion of joint-use costs to be allocated to each project purpose.

This methodology uses a SCRB like method of allocation except that since there are no dollar quantified benefits for restoration, the benefits of restoration are assumed to be at least as great as the cost of the alternative single-purpose restoration and therefore, the cost of the single purpose restoration project is used in the allocation. Like the SCRB

method, specific and separable costs are identified and quantified and used in determining the total allocation to each project purpose and in determining the joint-use percentage to be used in allocating the joint-use construction costs of the project.

In order to determine the separable costs of the proposed project, the costs of the multiple-purpose project with a function omitted are computed and compared to the cost of the multiple purpose project. The difference in cost represents the separable costs of that purpose. Due to some uncertainty about the length of time/cost of monitoring funded with construction dollars, the following discussion of the cost allocation excludes the monitoring associated with construction. Monitoring costs were handled separately and are discussed in section 2.8.4f of this report. Since monitoring costs are considered specific costs to either water supply or ecosystem restoration, the exclusion of these costs from this part of the allocation will not influence the determination of the joint-use percentage used to allocate joint-use costs.

a. Multiple-Purpose Projects With Function Omitted.

The construction cost estimates for each of these projects were determined based on input from the design and cost engineers. Each accounting feature line item presented in the multiple-purpose project was evaluated with respect to each of these multiple purpose projects with a function omitted. Following is a discussion of each project:

(1) Without M&I Water Supply. Facilities and operation of the project with water supply omitted would be the same as the alternative single-purpose ecosystem restoration project. This alternative would provide ecosystem restoration benefits equal to those of the multiple purpose project. This project would consist of a single purpose restoration project constructed at the same site to pool elevation 1155 (1147 plus 8 feet for low flow augmentation). A fish passage facility similar to the multiple purpose project (Alternative A8-the preferred alternative. See DFR/DEIS Section 3.2.4.8 for more details.) would be constructed, but to elevation 1155 instead of elevation 1177. However, this fish passage, like A8, would, like the multiple purpose project, have the vent line and casing constructed to elevation 1254. The habitat improvement measures would be the same as the multiple purpose project. Right bank seepage treatment would also be performed but only to elevation 1155. The construction cost of this project in October 1997 prices is estimated at $53,512,000 and is shown in table 2-5.

(2) Without Ecosystem Restoration. Facilities and operation of the project with ecosystem omitted would be the same as the alternative single-purpose water supply project. This alternative would provide water supply benefits equal to those of the multiple-purpose project. This project would consist of a single purpose water supply project constructed at the same site to pool elevation 1169 (1147 feet plus 22 feet for water supply) Fish mitigation would consist of a fish passage facility similar to measure A4(see DFR/DEIS Section 3.2.4.4) but constructed to elevation 1169, instead of 1177. Other mitigation measures associated with water supply impacts would be the same as the

multiple purpose project. Right bank seepage treatment would also be performed but to pool elevation of 1169, instead of 1177. Cost of this project in October 1997 prices is estimated at $29,440,000 and is shown in table 2-5.

Also shown in Table 2-5 are the construction costs, by accounting feature and sub-feature for the multiple-purpose project and the costs of the multiple-purpose projects with a function omitted. Since this proposed project only has two project purposes, the multiple-purpose projects with a purpose omitted also serves as the single purpose project. This is consistent with the "Libby Dam Project, Design Memorandum 29, Cost Allocation, dated November, 1976".

TABLE 2-5. HOWARD HANSON DAM WATER SUPPLY AND ECOSYSTEM RESTORATION PROJECT COST ALLOCATION[5] (OCTOBER 1997 PRICES)

	Multiple -Purpose Project		Multiple-Purpose Projects With Function Omitted			
Permanent Features	**Specific Water Supply**	**Specific Restor.**	**Joint Use**	**Total**	**Without Restor.[6]**	**Without W.S.[7]**
01. Land & Damages			$3,948,000	$3,948,000	$2,600,000	$1,335,000
04. Dams						
4.03 Outlet Works						
03.01 - 03.10 [8]			16,468,000	16,468,000	8,257,000	14,475,000
03.11 Foundation Work	$0	$2,991,000	0	2,991,000	0	2,991,000
03.12 Seepage Control [9]			10,276,000	10,276,000	6,781,000	3,495,000
03.29 App. & Outlet Ch.	0	2,103,000	0	2,103,000	0	2,103,000
03.54 - 03.57 [10]			17,621,000	17,621,000	7,152,000	17,621,000
03.99.01 Electrical			1,956,000	1,956,000	1,026,000	1,956,000
03.99.02 Crane	0	4,853,000	0	4,853,000	0	4,853,000
06. Fish & Wildlife						
03.99 Wildlife Hab. Mit.						
Phase I	$1,718,000	$0		1,718,000	1,718,000	0
Phase II			1,233,000	1,233,000	247,000	986,000
03.99 Fish Hab. Mit.						
Phase I	1,159,000	0		1,159,000	1,159,000	0
Phase II			2,386,000	2,386,000	500,000	1,886,000
03.99 Fish Hab. Rest.						
Phase I	0	1,811,000		1,811,000	0	1,811,000
Total Project Cost	**$2,877,000**	**$11,758,000**	**$53,888,000**	**$68,523,000**	**$29,440,000**	**$53,512,000**

[5] Excludes labor costs associated with project fish and wildlife monitoring of $4,263,000.

[6] Also serves as single purpose water supply project. See Libby Dam Project, Design Memorandum 29, Cost Allocation, Nov, 1976.

[7] Also serves as single purpose restoration project. See Libby Dam Project, Design Memorandum 29, Cost Allocation, Nov, 1976.

[8] Includes: Mob & demob., coffer dam, roads and parking, bridge, buildings, and earthwork.

[9] Includes: Grouting, feeder wells, adit extension, horizontal drains, pressure gauge, and rock blanket,

[10] Includes: Tunnel and Conduit, intake gates and equipment, and intake structure.

b. Specific Cost Line Items. As shown in table 2-5, specific cost line items by accounting feature/sub-feature (not including monitoring) consist of the following:

		Specific Project Purpose
4.03.11	Foundation Work	Ecosystem Restoration
4.03.29	Approach and Outlet Channel	Ecosystem Restoration
4.03.99	Crane only	Ecosystem Restoration
6.03.99.1	Construction of all wildlife & fish habitat mitigation sites during Phase I.	M&I Water Supply
6.03.99.2	Construction of fish restoration sites during phase I.	Ecosystem Restoration

c. Determination of Separable Costs. The cost information for the multiple purpose project and multiple purpose project with a function omitted shown in Table 2-5 is used in Table 2-6 to determine the separable cost of each project purpose. As shown in Table 2-6, separable costs of water supply total $15,011,000 and the separable costs of ecosystem restoration total $39,083,000. Separable costs total $54,094,000 leaving $14,429,000 in joint costs.

TABLE 2-6. HOWARD HANSON DAM WATER SUPPLY AND ECOSYSTEM RESTORATION PROJECT DETERMINATION OF SEPARABLE AND RESIDUAL JOINT COSTS (OCTOBER 1997 PRICES IN $1,000'S)

	Project Cost
MULTIPLE-PURPOSE PROJECT	$68,523 [11]
MULTIPLE-PURPOSE WITH FUNCTION OMITTED:	
Without Water Supply	$53,512
Without Restoration	29,440
SEPARABLE COSTS:	
Water Supply	15,011
Restoration	39,083
TOTAL SEPARABLE COSTS	$54,094
RESIDUAL JOINT-USE COSTS	$14,429

d. Determination of Joint-Use Percentage. As previously mentioned, since the project purpose of ecosystem restoration does not have benefits which are quantified in dollar terms, a modified separable cost-remaining benefit (SCRB) cost allocation was used to

[11] Excludes monitoring costs of $4,263,000 for restoration and mitigation facilities and sites.

determine the joint-use percentage to each project purpose. The cost allocation using this methodology is shown in table 2-8. Conclusions of the Howard Hanson Dam Additional Water Storage Project joint-use cost allocation are presented in table 2-7 and show that of the total joint-use construction cost, 28.6 percent is to be allocated to M&I water supply and 71.4 percent is to be allocated to ecosystem restoration. Percentages to be allocated to each project purpose were rounded to the nearest 1/10 of 1 percent for application to financial records.

TABLE 2-7 HOWARD HANSON DAM ADDITIONAL WATER STORAGE PROJECT SUMMARY OF JOINT-USE PERCENTAGES

Project Purpose	Percent of Joint-Use Construction Costs
M&I Water Supply	**28.6%**
Ecosystem Restoration	**71.4%**

TABLE 2-8 HOWARD HANSON DAM ADDITIONAL STORAGE PROJECT CONSTRUCTION COST ALLOCATION BY MODIFIED SEPARABLE COST-REMAINING BENEFITS METHOD (October 1997 Prices in $1,000's)

Allocation of Construction Costs	M&I Water Supply	Ecosystem Restoration
a. Capitalized Benefits	$19,267,000	N/A
b. Alternative S/P Const.Costs	29,440,000	$53,512,000
c. Limited Benefits	19,267,000	53,512,000
d. Separable Const. Costs	15,011,000	39,083,000
e. Remaining Benefits/Costs	4,256,000	14,429,000
f. Percent Remaining	22.8%	77.2%
g. Allocated Resid. Const. Costs	3,290,000	11,139,000
h. Total Allocation Const. Costs	18,301,000	50,222,000
i. Specific Const. Costs	2,877,000	11,758,000
j. Joint-Use Const. Costs	15,424,000	38,464,000
k. **Joint-Use Percent**	**28.6%**	**71.4%**

e. Allocation of Fish and Wildlife Monitoring Costs. Due to on going discussion regarding the acceptable level of construction related monitoring, the allocation of these costs was treated separately. Labor cost for monitoring fish and wildlife facilities during construction for phase I and II are expected to be expended over 10 years in some cases. All monitoring costs expended over this time frame are considered to be construction costs and have been included as part of the overall project cost allocation of construction costs. Labor costs associated with monitoring the fish and wildlife features (restoration and mitigation) of the proposed project consist of five major items. These items and years of monitoring consist of: (1) downstream fish passage (0-10), (2) downstream impacts to habitat and

aquatic resources (1-5), (3) fish habitat restoration (1-5 and 10), (4) fish habitat mitigation (years 0-5 and 10), (5) wildlife mitigation (years 1, 2, 5,and 10). Items 1 -3 are considered specific restoration costs and 100% of these costs are allocable to ecosystem restoration. Items 4 and 5 are associated with reservoir impacts primarily created by storing water for water supply during phase I and are therefore, considered to be specific water supply costs and are 100% allocable to water supply. Shown in Table 2-9 is a summary of the recommended allocation of labor costs associated with monitoring fish and wildlife features. Also, see table 10-3 of Appendix F1 for the specific line items associated with the 5 items of monitoring and their estimated costs.

TABLE 2-9. HOWARD HANSON DAM ADDTIONAL STORAGE PROJECT - ALLOCATION OF LABOR COSTS ASSOCIATED WITH-PROJECT MONITORING

Item And Years Of Monitoring	Allocation	Total Cost	Specific Water Supply	Specific Restoration
(1) Fish Passage (Years 0-10)	100% Restoration[12]	$2,520,000	$0	$2,520,0,000
(2) Downstream Impacts (Years 1-5)	100% Restoration[12]	$942,000	$0	$942,000
(3) Fish Habitat Restoration (Years 1-5 and 10)	100% Restoration[12]	$302,000	$0	$302,000
(4) Fish Habitat Mitigation (Years 0-5 & 10)	100% Water Supply[13]	$171,000	$171,000	$0
(5) Wildlife Mitigation (Years 1-5 & 10)	100% Water Supply[13]	$328,000	328,000	$0
TOTAL		**$4,263,000**	**$499,000**	**$3,764,000**

Based on the current construction cost estimate for this project in 1997 prices and using the results of this allocation which allocates 28.6% of the joint-use construction costs to water supply and 71.4% to ecosystem restoration plus the specific costs associated with each project purpose to include construction monitoring, show that an estimated $18,800,000 is allocable to water supply and $53,986,000 is allocable to ecosystem restoration. See Table 2-10 for a summary of the cost allocation results.

[12] Restoration monitoring is cost shared at 65% Federal and 35% Non-Federal.

[13] Water supply monitoring costs are 100% Non-Federal.

TABLE 2-10. HOWARD HANSON DAM WATER SUPPLY AND ECOSYSTEM RESTORATION PROJECT COST ALLOCATION OF PROPOSED PROJECT (OCTOBER 1997 PRICES) [14]

	M&I Water Supply	Ecosystem Restoration	Total Cost
Specific Cost [15]	$2,877,000	$11,758,000	$14,635,000
Joint-Use Costs	15,424,000	38,464,000	53,888,000
Allocation of the New Project Construction Costs w/o Monitoring	$18,301,000	$50,222,000	$68,523,000
Specific Monitoring Costs	499,000	3,764,000	4,263,000
Total Proposed Project	$18,800,000	$53,986,000	$72,786,000

f. Share of Existing Project Construction Costs. In addition to the construction costs associated with the proposed project are the construction costs associated with the existing HHD project. The cost sharing formula requires the local sponsor to repay a portion of the existing project when storage in an existing project is used to provide M&I water supply. The sponsors share of the existing project construction cost is based on a remaining benefits concept and computed as indicated in ER1105-2-100, Paragraph 4-32e which states the sponsor shall be responsible for a share of the existing project based on an amount equal to 50 percent of the sponsor's savings (i.e. sponsor's savings = water supply benefits minus the present-worth cost of the proposed modification attributed to water supply or remaining benefits). Table B2-11 shows the computation of sponsors estimated share of existing project use for water supply. Since there are more costs associated with the proposed project allocated to water supply than water supply benefits, there are no savings to the sponsor and their share of the existing project construction cost is zero.

[14] See tables 2-8 and 2-9.

[15] Excludes monitoring costs.

Table 2-11. Howard Hanson Dam Water Supply And Ecosystem Restoration Project Computation Of Sponsor's Estimated Share Of Existing Project Use For Water Supply [16]

AVERAGE ANNUAL COST OF LEAST COST ALTERNATIVES (i.e. Water supply Benefits in Oct 97 Prices)	$1,418,000
LESS: SPONSOR'S SHARE OF WATER SUPPLY COSTS OF PROPOSED PROJECT(Oct 97 Prices)	$1,526,000 [17]
REMAINING BENEFITS	$0
SPONSOR'S SHARE IS 1/2 THE REMAINING BENEFITS	$0

g. Summary of the Construction Cost Allocation.

Shown in Table 2-12, is a summary of the estimated construction costs, in 1997 prices, allocable to water supply and restoration. The total includes construction costs associated with the new water supply and restoration project plus the construction costs associated with the existing project assigned to water supply.

TABLE 2-12. SUMMARY OF COSTS ALLOCATION RESULTS NEW PROJECT PLUS SHARE OF EXISTING PROJECT

	M&I WATER SUPPLY	ECOSYSTEM RESTORATION
NEW PROJECT	$18,800,000	$53,986,000
EXISTING PROJECT	0	0
TOTAL ALLOCATION	**$18,800,000**	**$53,986,000**

h. Operation and Maintenance Costs.

1. **Proposed Project.** The purpose of a cost allocation is to identify the specific costs and allocate a equitable share of the joint-use costs to each project purpose for cost sharing purposes. Since the local sponsor is responsible for 100 percent of the operation and maintenance costs of the proposed project, an allocation of these costs to each project purpose is not necessary. However, it should be noted that an accounting methodology which can identify or distinguish between operation and maintenance costs of the existing project versus operation and maintenance costs of

[16] Numbers rounded to nearest $1,000.

[17] Based on the allocated water supply construction costs of $18,301,000 excluding IDC (see table 2-10) plus the present worth specific water supply monitoring costs of $383,000 annualized over the 50 year project life at 7 1/8 percent plus $150,000 in water supply operation and maintenance costs associated with the proposed project.

the additional/new project needs to be established prior to completion of construction. Operation, maintenance and replacement costs including labor costs for monitoring, in 1997 prices are estimated at $721,000 on an average annual basis. Of this total, approximately $140,000 is incurred as a result of Phase II.

2. **Existing Project.** In accordance with Corps regulation ER 1105-2-100, since the local sponsor is using an existing Corps dam to generate water supply outputs, the local sponsor is responsible for a share of the joint-use operation and maintenance costs associated with the existing project. Joint-use operation and maintenance costs are defined as total operation and maintenance cost minus any specific operation and maintenance costs such as recreation. The methodology used to determine the sponsor's share of the existing project operating and maintenance cost is based on seasonal use of storage for water supply and has been approved by Corps Headquarters as an acceptable method. The total year around storage at Howard Hanson Dam is 106,000 acre feet. Phase I of the proposed project will provide 20,000 a.f. of storage over a 5-month period for water supply. Phase II, will provide 22,400 a.f. of storage for water supply over the same 5-month period. Based on the amount of seasonal storage used for water supply versus the total storage available, the sponsors share of the existing project operation and maintenance costs of phase I and phase II are as follows:

$$\text{Phase I: } = \frac{20{,}000 \text{ a.f. X } 5/12 \text{ (months)}}{106{,}000 \text{ a.f.}} = 7.86\%$$

$$\text{Phase II } = \frac{22{,}400 \text{ a.f. X } 5/12 \text{ (months)}}{106{,}000 \text{ a.f.}} = 8.80\%$$

Based on the actual 1997 operation and maintenance costs at Howard Hanson Dam of $1,257,188 less the specific recreation cost of about $38,000, the project sponsor's share during phase I of the project would have been $95,828. See computation below.

Phase I = $1,257,188 - $38,000 = $1,219,188 X 7.86% = $95,828

2.7.5 Cost Sharing

As previously mentioned, M&I water supply and ecosystem restoration have different cost sharing requirements. All costs (construction, operation, maintenance and replacement costs) allocated to water supply, including monitoring, are considered non-federal costs and are the responsibility of the project sponsor. Construction costs allocable to restoration are cost shared 65% federal and 35% non-federal. Operations and maintenance requirements are the responsibility of the non-federal project sponsor.

a. Construction Costs. Shown below are the estimated construction cost sharing requirements based on the current sharing of construction costs and the results of the cost allocation. Cost sharing numbers are in 1997 prices as well as to the mid point of

construction or full funded dollars. The full funded share of costs allocated to each purpose was determined based on the percent of construction costs allocated to each purpose using October 1997 price levels and the full funded estimate of project construction costs. That is, based on a full funded construction cost estimate of $84,000,000, 48.4% was allocated to the federal government and 51.6% was allocated to the non-federal sponsor as shown in Table 2-11.

TABLE 2-13. HOWARD HANSON DAM ADDITIONAL STORAGE PROJECT FEDERAL AND NON-FEDERAL SHARE OF CONSTRUCTION COSTS (OCT 1997 PRICES AND FULL FUNDED)

	COST SHARING BY PROJECT PURPOSE		
PROPOSED PROJECT	FEDERAL	NON-FEDERAL	TOTAL
WATER SUPPLY	$0.0	$18,800,000	$18,800,000
ECOSYSTEM RESTORATION	$35,091,000	$18,895,000	$53,986,000
TOTAL COST-PROPOSED PROJECT (97 Prices)	$35,091,000	$37,695,000	$72,786,000
ALLOCATED SHARE IN PERCENT	48.2%	51.8%	100.0%
FULL FUNDED SHARE	**$40,403,000**	**$43,422,000**	**$83,825,000**
SHARE OF EXIST. PROJ. LESS: NON-CASH LANDS [18]	**0**	**1,486,000**	**1,486,000**
CASH REQUIREMENT	**$40,403,000**	**$41,936,000**	**$82,339,000**

Table 2-13 shows the estimated share of full funded construction costs, including the cash share for the project sponsor and federal government. These construction costs include costs for both Phase I and Phase II of the project. The estimated construction cost incurred in each phase of the project is shown in Table 2-14. Except for an estimated $90,000 associated with Phase II of the fish passage facility, all other Phase II costs will be expended when Phase II is implemented. These costs include an estimated $2,802,000 for phase II lands, $1,270,000 for wildlife habitat mitigation and $2,465,000 for fish habitat mitigation.

[18] Estimated value.

TABLE 2-14. ESTIMATED FULL FUNDED CONSTRUCTION COST EXPENDITURE BY PHASES

	PHASE I	PHASE II
Construction Costs	$77,288,000 [19]	$6,537,000

b. Operation, Maintenance and Replacement. All operation, maintenance and replacement costs associated with water supply and ecosystem restoration are the responsibility of the project sponsor. Based on October 1997 prices, average annual operation, maintenance and replacement costs of the proposed project are estimated to be $721,000 per year of which $100,000 is associated with implementation of Phase II. The sponsor is also responsible for 7.86 percent of the joint-use operation and maintenance cost of the existing project during phase I and 8.8 percent during phase II. Based on 1997 prices and the actual HHD operation and maintenance costs, the sponsors share of the existing project joint-use O&M costs during phase I, was estimated at $95,828. Future operation and maintenance cost responsibilities of the project sponsor can be expected to increase over time due to price level increases plus any agreed to changes in or modifications to the proposed project.

2.7.6 Description of Phase I and Phase II

Based on negotiations between the project sponsor, resource agencies, Muckleshoot Indian Tribe and Corps of Engineers, the operation of the recommended project has been divided into two separate phases called Phase I and II. Phase I begins when the proposed project goes into operation in year 2003 and ends at the completion of year 2008 (or 6 years). Phase II begins in year 2009[20] and extends over the remaining economic life of the project to year 2053 (44 years). The difference between the two phases can be separated into two separate elements. The first element reflects a change in the water storage operation of the proposed project between Phase I and Phase II. The second element is based on the outputs associated with each phase (i.e. how much water is stored) and the additional cost associated with implementing construction elements associated with that phase.

Following is Table 2-15 which presents the reservoir elevation, summer storage provided in acre feet, project outputs and a description of project operations for each phase of the

[19] Includes $90,000 for Phase II fish passage facility expended during Phase I.

[20] The definition of Phase I and Phase II by project years was done to identify the period of construction funding and does not imply that Phase II will commence in project year 6. The actual inception date of Phase II is dependent on evaluation of Phase I results and consensus of resource agencies, Muckleshoot, Corps and the City of Tacoma.

project. The table also presents the incremental change between phases associated with each item.

TABLE 2-15. PROPOSED PROJECT - SUMMER/FALL OUTPUTS BY PHASES

Item	Phase I	Phase II	Incremental Change Between Phases
Reservoir Elevation (from 1147)	1,167	1,177	10 FEET (8 feet Restoration) (2 feet Water Supply)
Summer Storage (af)			
* Low Flow Augmentation	NONE	9,600	9,600
* Water Supply	20,000	22,400	2,400
TOTAL ACRE FEET	20,000	32,000	12,000
OUTPUTS			
Ecosystem Restoration			
* Low Flow Aug.	NO	39 cfs @ 78% Rel. Over 123 Day Period	39 cfs @ 78% Rel. Over 123 Day Period
* Fish Passage	YES (to elev. 1177)	No Change From P1	No Change
* Habitat Improvement	YES	No Change From P1	No Change
Water Supply	42 mgd @ 95% Rel. Over 153 Day Period	48 mgd @ 95% Rel. Over 153 Day Period	6 mgd @ 95% Rel. Over 153 Day Period
Project Operations			
Water Right: • 1933 First Diver. Water Claim =113 cfs • State Min. In-Stream = 300 cfs[21] • 1995 Second Supply Water Right = 100 cfs	Store Second Supply Water Right of 100 cfs during spring for release during summer and early fall.	Water in excess of First Diversion water right, minimum in-stream flows, and Second Supply Water Right (113 + 300 + 100 cfs = 513cfs) is stored during spring for release during summer and early fall.	Water for low flow augmentation and Additional Water Supply.

[21] This water volume is for a average water year. Minimum in-stream flow requirements vary from 350 cfs during a wet year to 250 cfs during a dry year.

Phase I - The outputs/benefits produced during this phase consists of: (1) 42 mgd of M&I water supply at 95% reliability over a 153 days summer period; (2) a fish passage facility to elevation 1177; and (3) all fish habitat improvements.

Phase I storage for water supply would be accomplished as follows:

In 1995, Tacoma obtained an additional water right for water from the Green River. This right is known as the Second Supply Water Right (SSWR) and consists of 100 cfs which Tacoma is entitled to year around as long as minimum in-stream flows can be met. Since Tacoma has a surplus of water during the spring, this 100 cfs of water, instead of being withdrawn from the river, will be stored behind HHD during the spring months for release during the summer and early fall. Storage of this water will be sufficient to supply 42 mgd at 95% reliability over the 153 day summer demand period.

During Phase I, from 2003 to 2008, adaptive management of the resources will be undertaken to determine the actual impacts of a higher pool and to determine what if any modifications to Phase I and II should be undertaken.

Phase II - The primary output of this phase is to provide 9,600 ac-ft of storage for low flow augmentation which will produce 39 cfs at 78% reliability over a 123 day summer period. In addition, 2,400 ac-ft, or 6mgd at 95% reliability over the 153 day summer period, would be provided for water supply. Total water supply would be 48 mgd (See Table 2-15).

Storage for low flow augmentation and water supply during Phase II would be provided as follows:

In addition to Tacoma's 1995 Second Supply Water Right of 100 cfs they also have a 1933 First diversion water claim of 113 cfs. This water claim has a higher priority than even minimum in-stream flows. That is, this water can be withdrawn from the river even if by doing so, minimum in-stream flows cannot be met. During this phase, water associated with Tacoma's Second Supply Water Right would no longer be stored during the spring. Instead, water in excess of Tacoma's First diversion water right, minimum in-stream flows (300 cfs on average), and Second Supply Water Right (113 + 300 +100 cfs = 513 cfs) would be stored during the spring for release during summer and early fall. See Table 2-15 for more information.

a. **Economic Evaluation of Phase II.** This analysis is specific to evaluating the feasibility of expending additional construction costs in Phase II versus outputs achieved. It is important to note that from an analytical standpoint the proposed change in operation of project for storage purposes can be accomplished without expending any additional costs and is not contingent on providing additional low flow or water supply. That is,

Phase II could be implemented from an operational standpoint and no further construction costs would necessarily be required.

The additional construction costs incurred as a result of producing additional outputs associated with Phase II consist of constructing several fish and wildlife mitigation sites associated with the higher pool for low flow augmentation and water supply, land associated with the mitigation measures, plus constructing an additional 10 feet of fish passage tower. Cost of these items in 1997 prices and including interest during construction of $300,000 is estimated at $6,300,000. Discounting these costs from year 2008 to 2003 results in a present worth investment cost of $4,217,000. Annualizing the investment cost over the 50-year project life results in an annual cost of $310,000. Phase II present worth annual operation and maintenance cost is estimated at $71,000 for a total Phase II present worth annual cost of $381,000.

Project costs and benefits of Phase II are primarily associated with providing the low flow restoration feature. Of the total annual cost of $381,000, approximately $376,000 is associated with restoration and the remaining $5,000 is associated with water supply.

b. Low Flow Augmentation Outputs. All of the anadromous salmonids in the Green River begin their life as embryos incubating within the substrate of the stream bed, with most incubation occurring from fall to early spring. Failure to maintain water quantity and quality can lead to drying and mortality of eggs and fry. Adult salmon in their upstream migration and spawning are also dependent on adequate water quantity and quality. Adult chinook salmon require a minimum flow volume, flow depth and temperature range to migrate upstream to preferred spawning areas. In recent years, the channel shape of the Green River has become wider and shallower and during low flow years adult chinook salmon have become trapped in lower river areas. In addition, riparian areas along the river are almost non-existent through the lower 35 miles of river. In most years, summer temperatures in the Green River may reach a point where chinook salmon are delayed on their upstream migration for extended periods. Researchers have established an optimum or preferred range of flows for spawning of salmon in the Green River. Successful spawning requires a useable range of stream temperatures for adult salmon migration, spawning and egg incubation. Fall stream temperatures in the Green often exceed this range for days to weeks. Flow augmentation will restore a major limiting factor for the Green River, low flows during summer and early fall. Phase II of the proposed project will provide 9,600 ac-ft of storage available for low flow augmentation. Augmenting flows during the summer and early fall months alters the flow regime from HHD (RM64) to the estuary (RM 7) during the period when (1) juvenile salmonids are rearing in the river, (2) steelhead eggs are incubating and fry are emerging, (3) adult chinook and coho salmon are migrating upstream, and (4) chinook salmon are spawning in the river. Flow augmentation produced by Phase II can be used to increase summer and fall flows which will increase available habitat with potential improvements in water temperature from increased stream velocities, pool depths and wetting of side-channel areas. The analysis of Phase II augmentation assumed that the

water would be held and released in the late summer and fall to benefit adult salmon migrating and spawning. Adult chinook and coho salmon begin their upstream migration into the lower Green River during August and September.

c. Water Supply Outputs. Constructing Phase II of the proposed project will incrementally add 2,400 ac-ft of storage for M&I water supply. These acre feet of storage will provide an additional 6 mgd of water at 95% reliability over the 153 day summer period. Based on the medium growth forecast for M&I water during the summer demand period and assuming Phase I water continues to be provided as defined until the deficits exceed the amount of Phase I water, the additional 6 mgd of water provided by Phase II would not be needed for meeting average summer demand until project year 45. In addition, this water would not be needed to help meet the 4-day peak demand until project year 35. Based on these conditions, the present-worth value of Phase II water supply is estimated at $8,000 per year.

2.7.7 Total Project Storage.

The existing project provides a total of 106,000 acre-feet of storage for flood control and low flow augmentation. During the months of November through May, this total storage is used to provide flood control. During the summer and fall months of June-October, the existing project provides 30,400 acre-feet for low flow augmentation (includes the 1135 project with 5,000 acre-feet of storage). The proposed project will not add any additional storage above the 106,000 acre-feet but will take advantage of storage available during the summer/fall months to provide M&I water supply and additional low flow augmentation. Table 2-16, shows the total project (existing and proposed projects) allocated acre feet of project storage by season for phase I and phase II. The storage shown for flood control during the summer/fall months of June-October is basically default storage to flood control as during these months the project is not normally operated for flood control.

TABLE 2-16 HOWARD HANSON ADDITONAL STORAGE PROJECT PROJECT STORAGE BY SEASON AND BY PHASES (in acre-feet)

	June-October	November-May
Phase I:		
M&I Water Supply	20,000 af	None
New Low Flow Aug.	-	None
1135 Low Flow Project	5,000	None
Existing Low Flow Aug.	25,400	None
Flood Control	55,600	106,000 af
Total acre-feet of storage	106,000	106,000
Phase II:		
M&I Water Supply	22,400 af	None
New Low Flow Aug.	9,600	None
1135 Low Flow Project	5,000	None
Existing Low Flow Aug.	25,400	None
Flood Control	43,600	106,000 af
Total acre-feet of storage	106,000	106,000

2.7.8 Risk and Uncertainty

a. Water Supply. Water supply benefits are sensitive to the water demand forecast and resulting supply deficits over time. The Tacoma Water Division prepares a high and low demand forecast. Since water supply benefits are sensitive to the forecast used to determine the level of supply deficits over time, a medium demand forecast (midway between the high and low forecast) was used to quantify water supply benefits for this report. Should actual demand turn out to higher or lower than the forecast used, water supply benefits (and cost sharing) will be impacted accordingly. For example, if the low demand forecast is used in quantifying water supply benefits, these benefits decrease to approximately $8,600,000. Based on the separable water supply costs developed in the cost allocation, these benefits would not be sufficient to cover separable water supply costs and water supply would be eliminated from the proposed project leaving a single purpose ecosystem restoration project. On the other hand, if the high demand forecast is used, waters supply benefits increase to approximately $27,000,000. This benefit is not only higher than the water supply separable costs, based on the cost allocation, it would increase the costs, in 1996 prices, allocated to water supply from an estimated $18,510,000 to an estimated $20,130,000.

The risk taken by the local sponsor if the water supply deficits are lower than used in this report is they will have paid more for a project than necessary and for a project whose need is not immediate. On the other hand, the federal government will have received more than full value for use of HHD. If the deficits turn out to be greater than forecast, the sponsor will have paid less for a project than they should have and the federal government will not have received full value for use of HHD. Using a medium water

demand forecast in this analysis of benefits and cost sharing is a viable way of trying to equalize the risk for both parties in this project.

b. Ecosystem Restoration. There is always some level of risk and uncertainty associated with the outputs claimed for any project. Ecosystem restoration is certainly no exception. Measurement of the risk and uncertainty for a project with a goal of increasing the number of returning adult salmon to the point where self sustaining runs are established is very difficult. It is difficult because of the many risks and uncertainties anadromous fish face in their cycle of life. For example, while there is risk and uncertainty about the success of the proposed fish passage measure itself there is also even greater risk and uncertainty associated with the likelihood of salmon surviving the obstacles they encounter in the open seas and successfully returning to the project to spawn. Obstacles such as water temperature (El Niño), disease, predation, commercial and recreational fishing from both U.S. and Canadian fishermen and land management decisions by major landowners in the watershed, all play a significant part in the perceived success of a project. While risk and uncertainty at the project site can be measured and controlled to some degree, risk and uncertainty in the open seas is a wild card and cannot be controlled. Therefore, while a restoration project may be operating as planned and designed, other important factors outside the control of the restoration measure will also play a critical role in the achieving the desired goal of the project. For these reasons, a risk and uncertainty analysis for restoration was not performed.

2.7.9 Benefit-Cost Analyses of M&I Water Supply.

a. **Benefit-Cost Based on Separable Costs.** When constructing a project with more than one project purpose, the economic test as to the economic viability of a given project purpose is whether the benefits for that purpose exceed the separable costs of that purpose. The following analysis, as shown in table 2-17, compares the average annual benefits of M&I water supply to the separable average annual construction, IDC and annual OM &R associated with water supply. As shown the average annual water supply benefits total $1,418,000 and the average annual separable water supply costs are $1,276,000, resulting in a benefit-cost ratio of 1.1 to 1.

TABLE 2-17 HOWARD HANSON DAM ADDITIONAL STORAGE PROJECT BENEFIT-COST ANALYSIS OF WATER SUPPLY BASED ON SEPARABLE COSTS

SEPARABLE CONSTRUCTION COSTS	$15,011,000
Interest During Construction (7 1/8%)	800,000
P.W. of Specific Monitoring	383,000
Investment Cost	$16,194,000
Average Annual Costs	
Interest and Amortization (50 Yrs @ 7 1/8%)	$1,192,000
Operation and Maintenance Costs	100,000
Total Annual Separable Cost	$1,292,000
Average Annual Water Supply Benefits	$1,418,000
Benefit-Cost Ratio Based on Separable Costs	1.1 to 1

b. Benefit-Cost Based On Total Costs Allocated To Water Supply. Following is an analysis of water supply which compares the average benefits to the total average annual cost of the new project allocated to water supply. As shown in table 2-18, average annual benefits total $1,418,000 and average annual cost of all costs allocated to water supply total $1,597,000. The benefit cost ratio is .89 to 1. The benefit-cost ratio is lower than 1 to 1 because the costs allocated to water supply were not limited to the quantified water supply benefits, as is typically done. As a result, more costs are allocated to this purpose than this purposes' benefits will support.

TABLE 2-18 HOWARD HANSON DAM ADDITIONAL STORAGE PROJECT BENEFIT-COST ANALYSIS BASED ON TOTAL COSTS ALLOCATED TO WATER SUPPLY

TOTAL ALLOCATED CONSTRUCTION COSTS	$18,301,000
IDC (7 1/8%)	975,000
P.W. of Monitoring Costs	383,000
Investment Cost	$19,659,000
Average Annual Costs	
Interest and Amortization (50 Yrs @ 7 1/8%)	$1,447,000
Operation and Maintenance	150,000
Total Annual Cost	$1,597,000
Average Annual Water Supply Benefits	$1,418,000
Benefit-Cost Ratio Based on Total Allocated Costs	.89 to 1

2.8 COST ESTIMATE

8/18/98 Full Funded.xls

TOTAL - ALL CONTRACTS — TOTAL PROJECT COST SUMMARY

BASED ON 35% DESIGN DATED 14 JULY 1997 AND OCTOBER 1997 DOLLARS

PROJECT: HOWARD HANSON DAM FISH PASSAGE
LOCATION: HOWARD HANSON DAM, WASHINGTON

CURRENT MCACES ESTIMATE PREPARED: Jan 98
EFFECTIVE PRICING LEVEL: Oct 97

ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	FEATURE MIDPT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)										
04	DAMS										FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007 =
04.03	OUTLET WORKS	37,810	7,562	20.0%	45,372	OCT 02	13.7	42,990.0	8,598.0	51,588				9,745	14,409	25,072	2,362			
06	FISH AND WILDLIFE FACILITIES																			
06.03	WILDLIFE FACILITIES AND SANCTUARY	5,581	1,117	20.0%	6,698	OCT 02	13.7	6,346.0	1,270.0	7,616				2,639	554	553	553			3,316
	TOTAL CONSTRUCTION COST	$43,391	$8,679	20.0%	$52,070			$49,336	$9,868	$59,204				$12,384	$14,963	$25,625	$2,915	$0		$3,316
01	LANDS AND DAMAGES										FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	2007 ==>
	PHASE I	1,381	276	20.0%	1,657	APR 99	7.2	1,480.0	296.0	1,777			690	886						
	PHASE II	1,909	382	20.0%	2,291	OCT 02	22.3	2,335.0	467.0	2,802										2,801
30	PLANNING, ENGINEERING AND DESIGN (P	6,950	1,390	20.0%	8,340	APR 99	7.2	7,450.0	1,490	8,940	21	2,476	4,503	1,522	418					
31	CONSTRUCTION MANAGEMENT	3,471	694	20.0%	4,165	OCT 02	22.3	4,245.0	849.0	5,094				1,273	1,273	2,242	306			
	TOTAL PROJECT COSTS	$57,102	$11,421	20.0%	$68,523			$64,846	$12,970	$77,816	$21	$2,476	$5,393	$16,065	$16,654	$27,867	$3,221	$0		$6,117
	MONITORING																			
	PHASE I	2,794	559	20.0%	3,353		34.9	3,769.0	754.0	4,523						178	847	975	931	1,590
	PHASE II	759	151	20.0%	910		63.3	1,239.0	248.0	1,486										1,486
	TOTAL PROJECT COSTS PLUS MONITORIN	60,655	12,131	20%	72,786			69,854	13,972	83,825	21	2,476	5,393	16,065	16,654	28,045	4,068	975	931	9,193
											FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005		2007 ==>

TOTAL - ALL CONTRACTS

TOTAL PROJECT COST SUMMARY

BASED ON 35% DESIGN DATED 14 JULY 1997

PROJECT: HOWARD HANSON DAM FISH PASSAGE
LOCATION: HOWARD HANSON DAM, WASHINGTON

DISTRICT: SEATTLE
POC: STEPHEN PIERCE, ACTING CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: 26 Jan 98 EFFECTIVE PRICING LEVEL: Oct 1997 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZED/BUDGET YEAR: EFFECTIVE PRICING LEVEL: COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE COST ($K)	CNTG ($K)	FULL ($K)
04	DAMS	37,810	7,562	20.0%	45,372				42,990	8,598	51,588
06	FISH AND WILDLIFE FACILITIES	5,581	1,117	20.0%	6,698				6,346	1,270	7,616
	TOTAL CONSTRUCTION COST	$43,391	$8,679	20.0%	$52,070				$49,336	$9,868	$59,204
01	LANDS AND DAMAGES	3,290	658	20.0%	3,948				3,815	763	4,578
30	PLANNING, ENGINEERING AND DESIGN	6,950	1,390	20.0%	8,340				7,450	1,490	8,940
31	CONSTRUCTION MANAGEMENT	3,471	694	20.0%	4,165				4,245	849	5,094
	TOTAL PROJECT COSTS	$57,102	$11,421	20.0%	$68,523				$64,846	$12,970	$77,816
	MONITORING	3,552	710	20.0%	4,262				5,007	1,001	6,009
	TOTAL PROJECT COSTS PLUS MONITORING	60,654	12,131	20.0%	72,786				69,854	13,971	83,825

THIS TPCS REFLECTS A PROJECT COST CHANGE OF _____

TOTAL FEDERAL COSTS _____

TOTAL NON-FEDERAL COSTS _____

THE MAXIMUM PROJECT COST IS _____

DISTRICT APPROVED:

Stephen Pierce Acting — CHIEF, COST ENGINEERING

_____ CHIEF, REAL ESTATE

_____ CHIEF, PLANNING

_____ CHIEF, ENGINEERING

_____ CHIEF, CONSTRUCTION

_____ ~~CHIEF, OPERATIONS~~

_____ ~~CHIEF, PROGRAMS MANAGEMENT~~

_____ PROJECT MANAGER

_____ DDE (PM)

DIVISION APPROVED:

_____ CHIEF, COST ENGINEERING

_____ DIRECTOR, REAL ESTATE

_____ CHIEF, PROGAMS MANAGEMENT

_____ DIRECTOR OF PPMD

APPROVED DATE: _____

TOTAL - ALL CONTRACTS

TOTAL CONTRACT COST SUMMARY

BASED ON 35% DESIGN DATED 14 JULY 1997

PROJECT: HOWARD HANSON DAM FISH PASSAGE
LOCATION: HOWARD HANSON DAM, WASHINGTON

DISTRICT: SEATTLE
POC: OLTON SWANSON, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: 26 Jan 98 EFFECTIVE PRICING LEVEL: Oct 1997 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZED/BUDGET YEAR: EFFECTIVE PRICING LEVEL: COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE FEATURE MIDPT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
04	DAMS												
04.03	OUTLET WORKS	37,810	7,562	20.0%	45,372				OCT 02	13.7%	42,990	8,598	51,588
06	FISH AND WILDLIFE FACILITIES												
06.03	WILDLIFE FACILITIES AND SANCTUARY	5,581	1,117	20.0%	6,698				OCT 02	13.7%	6,346	1,270	7,616
	TOTAL CONSTRUCTION COST	$43,391	$8,679		$52,070						$49,336	$9,868	$59,204
01	LANDS AND DAMAGES												
	PHASE I	1,381	276	20.0%	1,657				APR 99	7.2%	1,480	296	1,776
	PHASE II	1,909	382	20.0%	2,291				OCT 02	22.3%	2,335	467	2,802
30	PLANNING, ENGINEERING AND DESIGN	6,950	1,390	20.0%	8,340				APR 99	7.2%	7,450	1,490	8,940
31	CONSTRUCTION MANAGEMENT	3,471	694	20.0%	4,165				OCT 02	22.3%	4,245	849	5,094
	TOTAL PROJECT COSTS	$57,102	$11,421		$68,523						$64,846	$12,970	$77,816
	MONITORING												
	PHASE I	2,793	559	20.0%	3,352				OCT 06	34.9%	3,768	754	4,521
	PHASE II	759	152	20.0%	911				OCT12	63.3%	1,239	248	1,487
	TOTAL PROJECT COSTS PLUS MONITORING	$ 60,654	$ 12,131		$ 72,786						$ 69,854	$ 13,971	$ 83,825

FEDERAL FIRST COSTS | TOTAL CONTRACT COST DETAIL SUMMARY | PAGE 3 OF 3

BASED ON 35% DESIGN DATED 14 JULY 1997

PROJECT: HOWARD HANSON DAM FISH PASSAGE
LOCATION: HOWARD HANSON DAM, WASHINGTON

DISTRICT: SEATTLE
POC: OLTON SWANSON, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: 26 Jan 98				AUTHORIZED/BUDGET YEAR:			FULLY FUNDED ESTIMATE				
		EFFECTIVE PRICING LEVEL: Oct 1997				EFFECTIVE PRICING LEVEL:							
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MIDPT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
04	DAMS												
04.03	OUTLET WORKS												
04.03.01	MOB, DEMOB & PREPARATORY WORK	820	164	20.0%	984								
04.03.03	CARE AND DIVERSION OF WATER												
04.03.01.02	COFFER DAM	3,503	701	20.0%	4,204								
04.03.03	PERMANENT ACCESS ROADS AND PARKING	2,002	400	20.0%	2,402								
04.03.05	BRIDGE	220	44	20.0%	264								
04.03.09	BUILDINGS	1,856	371	20.0%	2,227								
04.03.10	EARTHWORK FOR STRUCTURES	2,666	533	20.0%	3,199								
04.03.11	FOUNDATION WORK	2,010	402	20.0%	2,412								
04.03.12	SEEPAGE CONTROL												
04.03.12.1	CONSOLIDATION GROUTING	3,035	607	20.0%	3,642								
04.03.12.2	ADIT EXTENSION	724	145	20.0%	869								
04.03.12.3	FEEDER WELLS	249	50	20.1%	299								
04.03.12.4	HORIZONTAL DRAINS	375	75	20.0%	450								
04.03.12.5	PRESSURE GAGE	2	0	0.0%	2								
04.03.12.6	RE-PERFORATE FEEDER WELLS	21	4	19.0%	25								
04.03.12.7	ROCK BLANKET	2,500	500	20.0%	3,000								
04.03.29	APPROACH AND OUTLET CHANNELS	1,413	283	20.0%	1,696								
04.03.54	OUTLET PORTAL AND STILLING BASIN	75	15	20.0%	90								
04.03.55	TUNNEL AND CONDUIT	1,518	304	20.0%	1,822								
04.03.56	INTAKE STRUCTURE	6,846	1,369	20.0%	8,215								
04.03.57	INTAKE GATES AND EQUIPMENT	3,400	680	20.0%	4,080								
04.03.99	ELECTRICAL	1,314	263	20.0%	1,577								
04.03.99	CRANE	3,261	652	20.0%	3,913								
		37,810	7,562		45,372								
06	FISH AND WILDLIFE FACILITIES												
06.03	WILDLIFE FACILITIES AND SANCTUARY												
06.03.99	WILDLIFE HABITAT MITIGATION												
	PHASE 1	1,154	231	20.0%	1,385								
	PHASE 2	828	166	20.0%	994								
06.03.99	FISH HABITAT MITIGATION												
	PHASE 1	779	156	20.0%	935								
	PHASE 2	1,603	321	20.0%	1,924								
	FISH HABITAT RESTORATION PHASE 1	1,217	243	20.0%	1,460								
		5,581	1,117		6,698								
	TOTAL CONSTRUCTION COST	$43,391	$8,679	20.0%	$52,070								

2.9 IDENTIFICATION OF LOCAL SPONSOR

The Local Sponsor for this project is the City of Tacoma also referred to in this document as Tacoma, Tacoma Public Utilities, TPU and Tacoma Water Division.

2.10 LOCAL SPONSOR'S STATEMENT OF FINANCIAL CAPABILITY

Following the Sponsor's Statement are two tables (pg 53 and 54) that list the source of funds and the dollar amount to be provided by each source.

CITY OF TACOMA
SPONSOR'S STATEMENT OF FINANCIAL CAPABILITY
HOWARD HANSON DAM PROJECT

1. GENERAL

The City of Tacoma, local sponsor for the project, acknowledges that its financial participation in the estimated total full funded project construction cost of $83,825,000 will be approximately $43,422,000 or 51.8 percent of the total project construction cost. The cash share of our total is estimated at $41,936,000. This estimate is based on the most recent full funded construction cost estimate by the U.S. Army Corps of Engineers and final cost allocation.

In addition to the above construction costs, the City of Tacoma acknowledges our responsibility for paying each year:

(1) 100 percent of the incremental phase I and II operation and maintenance costs, including monitoring costs, attributed to water supply and ecosystem restoration and estimated, on an average annual basis, at $859,000 per year (based on 1997 estimate of $721,000 escalated at 3.0 percent per year to project year one of 2003). Phase I O&M is estimated to begin in year 2003, phase I and II O&M is estimated to begin in year 2011 and monitoring O&M is estimated to begin in year 2014.

(2) 7.86 percent of the existing project net O&M costs for phase I (i.e. water supply) and 8.8 percent of the existing project net O&M cost for phase I & II (i.e. water supply). Net O&M costs are defined as total existing project O&M minus any identified specific costs (such as recreation identified as accounting feature 06). Based on the actual 1997 O&M costs at HHD of $1,257,188 and specific recreation costs of $38,695 the sponsor's estimated share of the existing project O&M for phase I is estimated at $95,774. Based on a 3 percent escalation rate, this amount is estimated to be $114,000 in project year one prices or year 2003.

We acknowledge that our share of the project operation and maintenance costs performed by Corps personnel will be paid at the beginning of each fiscal year based on estimates and adjusted at the end of the fiscal year for actual costs. We also acknowledge that future O&M costs can be expected to increase over time and that if phase II (water supply and low flow augmentation) is implemented, that the sponsors share of existing project net O&M costs will increase from 7.86 percent to 8.8 percent.

The financing plan to obtain our estimated share of construction costs and operating and maintenance costs includes: (list sources of funds).

The City of Tacoma recognizes the costs shown in the plan are estimates and that actual costs will be determined based on the final audit performed after completion of construction.

2. SOURCES OF FUNDS. (describe each source of funds and the dollar amount which will be provided by each source - sources of funds should cover both construction costs and expected annual operation and maintenance costs).

3. SPONSOR'S CONTRIBUTIONS:

(Sponsor to discuss each source of funds and the amounts available from each source to cover both construction costs and operation and maintenance costs.)

~~(This statement of financial capability is to be signed by _____)~~

This statement identifies the sources of funds to be used by Tacoma and its project partners to fund the local share of construction and O&M costs for the Howard Hanson Dam Additional Storage Project. Tacoma acknowledges these costs and cost allocations as reflecting current USACE estimates, policies, and statutes. We expect to work with the USACE to achieve significant construction and operating efficiencies during PED to reduce these costs. Any changes in policy or statute which may benefit the local sponsor from a cost basis shall be reflected in Tacoma's ultimate share of project costs.

John C. Kirner

John C. Kirner
Deputy Water Superintendent
Tacoma Water

FINANCING PLAN - CONSTRUCTION COSTS
CITY OF TACOMA
HOWARD HANSON DAM PROJECT
BASED ON FULL FUNDED COST ESTIMATE
($1,000 of dollars)

	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007 +	TOTAL
A. Local Sponsor's Cost Sharing Requirements											
Cash	**$5.0**	**$619**	**$3,468**	**$7,722**	**$7,741**	**$14,527**	**$2,107**	**$505**	**$482**	**$4,760**	**$41,936**
Non-Cash											
*** LERR**				**$600**	**$886**						**$1,486**
										Total =	**$43,422**
B. Sources of Cash (list)											
(1) *City of Tacoma Water Division	$ 1.67	$206.33	$1,156	2,574	$ 2580.33	4,752.33	702.33	168.33	160.67	$ 1,586.67	$ 13,987.67
(2) *City of Seattle Public Utilities	$ 1.67	$206.33	$1,156	2,574	$ "	"	"	"	160.67	$ "	$ "
(3) * South King County Utilities **	$ 1.67	$206.33	$1,156	2,574	$ "	"	"	"	160.67	$ "	$ "
C. Total Cash	**$5.0**	**$619**	**$3,468**	**$7,722**	**$7,741**	**$14,527**	**$2,107**	**$505**	**$482**	**$4,760**	**$41,936**

* All sources of cash result from contributions by project partners (City of Tacoma, Lakehaven Utilities District**, Covington Water District**, City of Kent**, and Seattle Public Utilities/Cascade Water Alliance). The initial source will be accumulated cash and the proceeds of revenue bonds. Bonds will subsequently be repaid from rate revenue and water sales.

FINANCING PLAN - OPERATION AND MAINTENANCE COSTS
PHASE I
CITY OF TACOMA
HOWARD HANSON DAM PROJECT [22]
($1,000)

Component	Project Year 1 [23]	Project Year 2	Project Year 3	Project Year 4	Project Year 5
			Non-federal Cash Share		
Proposed Project [24]	$691	$712	$733	$755	778
Existing Project [25]	114	117	120	124	128
Total Requirement	$805	$829	$853	$879	$906

Sources of Funds: (List source of funds and amount from each source for funding O&M costs.)

* Water utility rate revenues will be source of funds in all cases. Costs will be shared in one-thirds among the City of Tacoma Water Division, the Seattle Public Utilities, and a group of South King County utilities consisting of Lakehaven Utilities District, the City of Kent, and the Covington Water District.

[22] Starting in project year 11are O&M costs associated with monitoring of restoration and mitigation facilities. These costs, in 1997 prices range from $20,000 to $345,000 per year. Average annual present-worth O&M monitoring costs are $42,000 per year.
[23] Based on phase 1 costs in 1997 dollars of $579,000 (excluding average annual O&M monitoring of $42,000 which begins in project year 2014) escalated to 2003 (project year 1) at 3.0 percent per year.
[24] Escalated at an estimated 3.0 percent per year.
[25] Phase 1 costs only.

2.10.1 Assessment of Financial Capability

The local sponsor is required to pay to the federal government for their cash share of the project construction an estimated $41,936,000. Their plan to finance this cost is to obtain one-third of the funds from the City of Seattle Public Utilities/Cascade Water Alliance, one-third of the funds from South King County Utilities (Consisting of Lakehaven Utilities District, Covington Water District, and the City of Kent,) and to obtain one-third of the funds from cash generated via Tacoma water rates plus proceeds from new Tacoma Water Division revenue bonds.

In addition, the local sponsor is required to pay to the federal government annual operation and maintenance costs associated with this project. Beginning in project year one the local sponsors share is an estimated $805,000 (year 2003 prices). These annual operation and maintenance costs will be paid using revenues generated from water usage sales. Costs will be shared in one-thirds among the City of Tacoma Water Division, the Seattle Public Utilities, and a group of South King County utilities consisting of Lakehaven Utilities District, the City of Kent and Covington Water District.

Assuming letters/or copies of contractual agreement with Tacoma from each of the other utilities are received prior to the signing of the PCA that acknowledge their financial commitment to this project and how they plan to generate the funds they need to pay for their share.

2.11 LOCAL SPONSOR RESPONSIBILITIES

Prior to construction, during plans and specifications, the local sponsor must sign a Project Cooperation Agreement (PCA) with the Department of the Army. Major provisions of the PCA summarized here below require the non-Federal sponsor to:

a. Provide 100 percent of the project costs allocated to water supply and 35 percent of the project costs allocated to environmental restoration as further specified below:

(1) Enter into an agreement which provides, prior to construction, 25 percent of pre-construction engineering and design (PED) costs;

(2) Provide all necessary water rights;

(3) Provide, during construction, any additional funds needed to cover the non-federal share of PED costs;

(4) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the

performance of all re-locations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(5) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(6) Provide, during construction, any additional costs as necessary to make its total contribution equal to 100 percent of the separable project costs allocated to water supply and 35 percent of the separable project costs allocated to environmental restoration.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

c. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

e. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

f. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

g. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

h. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

i. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

j. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

k. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

2.12 US FISH AND WILDLIFE SERVICE COORDINATION ACT REPORT RECOMMENDATIONS AND RESPONSES

2.12.1 Recommendations

U.S. Fish and Wildlife recommendations contained in the Coordination Act Report (CAR) follow along with Corps responses to the recommendations. For full text of CAR see Appendix I.

Recommendations Presented in CAR by U.S. Fish and Wildlife Service:

The Service believes the Phase I impacts of the proposed AWS Project can be reduced to acceptable levels if the fish and wildlife mitigation and restoration measures that have been identified in the Feasibility Report and EIS are implemented and the following recommendations are incorporated into the AWS Project. The Service did not provide Phase II fishery resource recommendations at this time because their development should be based on the phase I monitoring and evaluation results.

FISHERY RESOURCES

1. The fish passage facility should be designed to achieve maximum fish survival

past HHD. The Service supports the Corps' proposed option, which includes a new intake tower, floating collection facility, modular incline screen, fish lock and bypass system. Additional refinements should be pursued during the advanced engineering and design phase to further enhance passage survival.

2. Impacts to riparian and stream habitats from enlarging the conservation pool need to be fully mitigated. The Service supports the Corps' mitigation approach, but we cannot specifically address the adequacy of the selected elements at this time because the details are still being developed. The Service requests the opportunity to participate in the development of the mitigation elements during the Corps' Plans and Specifications Phase.

3. All of the identified restoration elements should be implemented. The construction of HHDR adversely affected the natural transport of sediments necessary to replenish spawning habitat, inundated riparian and stream habitats, and eliminated most of the high flow events needed to create side channels. All of the restoration measures are needed to partially offset these impacts. The Service requests the opportunity to participate in the design refinement of the restoration elements during the Corps' Plans and Specifications Phase.

4. An adaptative management approach to project operation should be adopted and used to provide maximum flexibility to protect and enhance the fishery resources. At the very least, it should specifically address: (1) base flow targets; (2) adequate flow levels to protect steelhead spawning and incubation; (3) refill rates and storage volumes that maximize survival through the reservoir; (4) flows to maintain the optimal use of side channel habitat; and (5) the creation of artificial freshets, if needed.

5. The storage of up to 5,000 acre-feet in non-drought years should be implemented at the beginning of phase I, as part of the adaptive management approach. The resource agencies and Tribe, in consultation with the Corps and Tacoma, should have the joint responsibility for making the decision on how much of this water to store in any given year (including the option of not storing additional water) after considering the current conditions.

6. The "dampened dam" approach, as describe in Appendix F of the Corps' Feasibility Report and EIS, should be included as a project feature.

7. Reservoir refill should begin by February 15 and target an end of February storage volume of 5,000 acre-feet. The Corps should conduct the appropriate analysis to resolve the flood control concern of King County, if necessary. The February storage of water would reduce the amount that would need to be taken during the period, March through May, when fishery impacts would likely be greater.

8. Initially, the Corps' proposed maximum refill rates (400 cfs in March, 300 cfs in April, and 200 cfs in May) should be used and evaluated.

9. The storage volume of 25,400 acre-feet should be further evaluated to determine if this quantity is necessary to provide the project authorized 98% reliability for maintaining a minimum instream flow of 110 cfs.

10. Continuous staff coverage at HHDR (i.e., personnel available on a 24 hour per day, 7 day per week basis) should be provided, as needed, during project refill and other critical periods, e.g., steelhead spawning, to allow more timely adjustments in project outflow to provide better protection of the fishery resources. More frequent coordination with the resource agencies and Tribe will also be necessary.

11. The Corps should continue to develop its hydrologic data base and refine its ability to accurately forecast runoff. The reliability of the snowpack surveys for use in predicting runoff should be improved.

12. All large trees within the enlarged conservation pool between elevation 1,141 and 1,177 feet MSL should be retained as fish habitat to improve the prospects for restoring self-sustaining runs of anadromous fish above HHDR.

13. Measures to protect Tacoma's water quality should not come at the expense of the fishery resources. If it is necessary to flush turbid water from storage or to delay refill to pass turbid water, the lost or precluded storage should be deducted from Tacoma's storage account, unless replacement can be accomplished without adversely affecting the fishery resources.

14. The trap and haul of sufficient adult steelhead and salmon to achieve the natural production objectives for the upper watershed should not be precluded by Tacoma's water quality concerns.

15. The Service, other resource agencies, and the Tribe should be given the opportunity to participate in the development of the monitoring and evaluation plan during the Corps' PED phase.

TACOMA LAND MANAGEMENT PLAN (TLMP)

1. The TLMP is the major component upon which most of the mitigation planning has been based. It is the recommendation of the Service that this plan be adopted as part of the mitigation package and used to further refine specific components of the plan.

2. The TLMP should be modified to reflect current recommendations for snag densities and coarse woody debris.

ELK AND OTHER SPECIES USING PASTURE AND FORAGE

1. The quality and quantity of elk forage should be increased by:

   a. Expanding existing meadows by reversing conifer encroachment.
   b. Creating new meadows within selected forest stands next to existing openings.
   c. Increasing forage value within power line right of ways (ROW).
   d. Increasing forage value in existing meadows.

   Techniques to be used are described in Raedeke (1996) and in previous Planning Aid Letters from the Service. The Service has provided suggested seed and fertilizer mixes previously (Bodurtha 1995).

2. Within the ROW, evergreen trees and shrubs should be planted to break up sight distances and screen the pasture areas from the roads. Tree species that should be considered include Pacific yew (*Taxus brevifolia*), Lodgepole pine (*Pinus contorta*), and Western white pine (*Pinus monticola*) since they are either naturally short or can be easily maintained at shorter heights. Several *Vaccinium* species should be considered since although they are deciduous, the leaves tend to be persistent through much of the winter. In addition, yew and *Vaccinium* are preferred browse species and would provide additional forage value.

3. Sites should be selected from the list provided in Raedeke (1996) to provide the widest range of opportunity for forage production and diversity. The initial sites should be monitored closely until the initial assumptions for increased forage are realized. Although the techniques have been shown to be successful in other areas, they have yet to be proven for the specific site conditions in the project area. The loss of substantial elk habitat dictates that we make a concerted effort to at least replace this lost habitat.

4. A small area of each meadow should be used to test the techniques to determine which one would provide the best results in terms of enhancing productivity and increasing forage. For example, applications of various fertilizers on small test plots could help indicate which fertilizer would be most appropriate.

5. To attract elk to the improved or created meadow sites, salt or mineral blocks could be placed in these areas in advance of the pool raise. Mineral and protein supplements have been used successfully to draw livestock to upland sites and to re-distribute use over a larger area.

6. It would appear from the proposed filling schedule that a substantial part of the inundation zone would be above the water line during the growing season in late

August and September. We recommend that a fall planting of cereal rye, winter wheat, and perennial rye be tried on any mudflats that develop as a result of inundation. Cattle growers have used these grasses to provide winter food sources for grazing. White-tailed deer have been observed in Kansas using this food source along with the cattle. Cereal rye and winter wheat has been planted for and used by elk in Southwest Oregon (Gene Stagner personal observation). These cereal grains germinate quickly and provide rapid cover and forage throughout the winter. If the initial tests of these cereal grains show success in providing usable winter forage the Service recommends that this should become part of the annual management plan for forage.

7. Use a wide variety of plant species (black cottonwood, rushes, and other species of willows and sedges) to revegetate the drawdown zone. This will help increase the habitat diversity and subsequent use by fish and wildlife.

8. Optimal thermal cover is significantly lacking in the project area. The techniques used to improve pileated woodpecker habitat will also help re-establish optimal thermal cover. Under planting with shade tolerant shrubs and conifers will allow a more rapid development of winter forage base and better snow interception.

PILEATED WOODPECKERS, OTHER PRIMARY EXCAVATORS AND RED-BACKED VOLES

1. The development of late-successional characteristics should be accelerated using the following techniques:
   a. Provide at least .5 snags per acre $\geq$ 20" dbh for primary cavity nesters.
   b. Provide at least 11 snags per acre from 6" to 20" dbh for smaller woodpeckers and secondary cavity nesters.
   c. Provide raptor perch trees and snags at the edge of the reservoir. The trees and snags within the new conservation pool should be left standing because of their value to wildlife. Trees and snags will provide important perching and nesting habitat for birds, and hiding cover for fish when the reservoir is full.
   d. Thin even age class stands to stimulate mid-story and understory species development.
   e. Maintain the dominant trees in all aged stands and cut subdominant conifer and deciduous. During thinning it is important to retain some of the mid-level canopy if present.
   f. Leave felled trees on the ground to increase the coarse woody debris (CWD) component of the forest floor. This component of the forest ecosystem is especially important for the red-back vole, one of the target species. Many other forest species use a wide variety of CWD sizes.
   g. Under plant with shade tolerant shrubs and conifers to allow a more rapid development of a multi-level canopy.

2. Manage the land base to develop natural snags as much as possible. In areas lacking in snags, create snags by topping live trees or installing artificial snags. Provide a wide variety of sizes and decay classes of snags. This will need to be a long-term effort due to the relatively young stands involved. Preferred tree species are Douglas fir and Western red cedar.

3. Our recommended topping technique is blasting above at least one live lower branch. The jagged top left by blasting seems to provide a more rapid snag development than does topping with a chainsaw.

4. In areas devoid of snags or cavities, it may be necessary for a short time period to provide nest boxes or constructed cavities. Since primary excavators rarely use nest boxes these should be provided in sizes and appropriate habitat to accommodate secondary cavity nesters such as wood ducks and bluebirds.

5. Artificial snags should be randomly erected within the natural and conservation zones to help mitigate the loss of pileated woodpecker AAHUs.

WOOD DUCKS AND OTHER WETLAND DEPENDENT SPECIES

1. Sub-impoundments should be created along the perimeter of the upper reservoir and other appropriate locations to function as shallow open water habitat during drawdown. This would help reduce the loss of riparian zone and wetland habitats and provide stable habitat areas for wood ducks, amphibians and other wetland dependent species. The close proximity between open water and forest habitats would result in greater diversity. The Service believes the creation of sub-impoundments would provide significant benefits to fish and wildlife, and therefore, should be included. This will especially benefit amphibians that breed in slack or slow moving water and utilize submerged vegetation for food and spawning substrate.

2. The creation of a sub-impoundment behind the old railroad grade should be included as a project element because of the significant wildlife benefits that would result from its implementation. An outlet structure that is capable of safely passing fish would be a necessary component of this restoration element.

3. Habitat within the upper reservoir subimpoundments should be improved (install wood duck nest boxes, place large woody debris, plant emergent vegetation and willow cuttings).

MONITORING AND EVALUATION

1. The Service recommends the development of a management plan specific to the project mitigation lands. This plan should be approved by appropriate agency

representatives and include annual management evaluations and the development of an annual standard operating procedure (SOP) that would detail the specific management techniques to be applied during the next year. An annual report should be prepared that would include an outline of the activities on the sites, any evaluation and monitoring results, and recommendations for future work.

The TLMP should be used as a basis to develop this plan since most of the goals and objectives for natural and conservation zone lands meld with the goals and objectives for mitigation of this project. The advantage in a specific management plan would be that there would be a standing committee of agency representatives to help evaluate proposals and results, and suggest changes in management to better fit new information or changes in objectives. A signed agreement would give some long term assurance that the goals and objectives for the project lands would not be arbitrarily changed due to changes in Tacoma's management philosophy.

2. A detailed monitoring plan should be developed after the decision has been made on specific restoration elements. For the first 5 years, annual reports should be prepared that contain the monitoring results of the preceding year so that refinements to the restoration program can be made, as needed. From year 6 to year 20 reports should be prepared every 5 years and every 10 years from year 20 to year 50.
Monitoring is necessary to determine the effectiveness of the restoration efforts, whether the restoration plan needs to be modified, or if corrective measures need to be taken. The Service should participate in the review of the monitoring results and annual report.

3. A contingency plan and process are needed to guide management changes if the present techniques are not creating the desired conditions. An adaptive management approach should be used so that the desired future conditions for all species are met.

2.12.2 Corps Responses to U.S. Fish and Wildlife Recommendations

RECOMMENDATION	CONCUR	PARTIALLY CONCUR	NONCONCUR
FISHERY RESOURCES			
1. The fish passage facility should be designed to maximize fish survival. Additional refinements should be pursued during PED.	X		
2. Impacts from pool enlargement need to be fully mitigated for. The Service requests participation in developing mitigation during PED.	X		
3. All restoration should be implemented. The Service requests participation in developing restoration during PED.	X		
4. Adopt an adaptive management approach to project operation.	X		
5. Store up to 5,000 ac ft in non-drought years beginning in Phase I. It would include joint responsibility for the storage and use of the water.	X		
6. The "dampened dam" should be included as a project feature.	X		
7. Begin reservoir refill by Feb 15 and target 5,000 ac ft storage for the month. Analyze measures to resolve flood protection issues.		Agree with refill start, analysis as needed to resolve flood protection, and total February storage for Phase II, 5,000 ac. ft. The Corps has agreed to store 3,000 ac. ft. between 15 Feb and 28 Feb during Phase I, and will evaluate whether 5,000 ac. ft. can be stored in February during PED.	
8. Initially, use the proposed maximum refill rates and evaluate benefits.	X		
9. Storage volume of 25,400 ac ft should be evaluated further to see if the entire quantity is necessary for 98% reliability for minimum flows.		In high run-off years 25,400 ac ft may be more storage than is required to meet 110 cfs at 98% reliability. We can evaluate the need for meeting or not meeting current rule curve based on resource agency and MIT agreement to share risk in not meeting low flow augmentation storage targets and based on evaluation of run-off forecasts.	

RECOMMENDATION	CONCUR	PARTIALLY CONCUR	NONCONCUR
10. Continuous staff coverage should be provided, as needed, during refill and early conservation season. More frequent coordination will be necessary.	x		
11. Continue to develop hydrologic database and improve snowpack surveys for predicting run-off.	X		
12. All large trees in new inundation zone should be retained for fish habitat.	X		
13. Measures to protect TPU's water supply (turbidity) should not be at expense of fish conservation storage. Loss of storage to flush turbid water or to delay refill should be counted against M&I water supply unless replacement can be accomplished without adverse affects to fish.		We agree that measures to protect TPU's water supply will not come at the expense of existing conservation storage. The decision to flush turbid water or delay refill to protect water supply, that may also risk adaptive storage of Section 1135 water or Phase II fish conservation storage, would be a cooperative process involving resource agencies, MIT, Tacoma and the Corps.	
14. The trap and haul of sufficient adult steelhead and salmon to meet Upper Watershed natural production objectives should not be constrained by TPU's water quality concerns.	X		
15. The Service, other resource agencies, and MIT, should be included in development of the monitoring and evaluation plan during PED.	X		
TACOMA LAND MANAGEMENT PLAN (TLMP)			
1. The TLMP is major component of mit. plan. Service recommends adoption of plan as part of mit. package, and used to further refine components.		Concur—the Corps has asked Tacoma to adopt the TLMP as part of the mitigation package. Tacoma has indicated its willingness to do this.	
2. The TLMP should be modified to reflect current recommendations for snag densities and coarse woody debris		The Corps concurs—however, depending on forest stands, snag densities may not be achievable in some areas.	

RECOMMENDATION	CONCUR	PARTIALLY CONCUR	NONCONCUR
ELK AND OTHER SPECIES USING PASTURE AND FORAGE			
1. Elk forage should be increased by:			
a. expanding existing meadows	X		
b. creating new meadows	X		
c. increasing forage value in ROW's	X		
d. increasing forage value in existing meadows	X		
The Service has provided suggested seed and fertilizer mixes	X		
2. Plant evergreen trees and shrubs in ROW areas.		Agree with all suggested species, although BPA and Puget Sound Energy will have ultimate approval in their ROW areas.	
3. Select sites from Raedeke's report. Monitor sites for forage production.	X		
4. Devote small areas of each meadow to testing of productivity, including selection of fertilizers.		Test areas will be established, but probably not on every meadow. Areas with similar soils, topography, and aspect will have only one test area.	
5. Place salt or mineral blocks to attract elk to created pastures.	X		
6. Sow cereal rye, winter wheat, and perennial rye on mudflats in fall to provide additional winter forage for elk.	X		
7. Use a wide variety of plant species to re-vegetate drawdown zone.		Agree. However, due to tremendous seasonal fluctuations of the reservoir, most species can only be planted along the edge of the highest reservoir elevation (including willows, cottonwoods, rushes, and most sedges).	
8. Optimal thermal cover is significantly lacking in project area. Plant shade-tolerant shrubs and conifers under forest canopy.	X		

RECOMMENDATION	CONCUR	PARTIALLY CONCUR	NONCONCUR
PILEATED WOODPECKERS OTHER PRIMARY EXCAVATORS, AND RED-BACKED VOLES			
1. Accelerate late-successional characteristics by:			
a. providing at least .5 snag ≥20" dbh per acre	X		
b. providing at least 11 snags 6" to 20" dbh per acre	X		
c. providing raptor perch trees and snags at edge of reservoir	X		
d. thin even-aged stands to stimulate understory development	X		
e. maintain dominant trees in uneven-aged stands and cut subdominant conifer and deciduous trees.	X		
f. leave felled trees on ground.	X		
g. underplant with shade tolerant shrubs and conifers.	X		
2. Develop natural snags to extent possible. Preferred tree species are Douglas fir and Western red cedar.	X		
3. Recommended topping technique is blasting above at least one live lower branch.		Concur, as long as Tacoma can accommodate this request (i.e., blasting may not be an acceptable method in the watershed, or be allowed by OSHA, etc.)	
4. Provide nest boxes or constructed cavities in areas devoid of snags.	X		
5. Artificial snags should be randomly erected in natural and conservation zones to increase pileated woodpecker HU's.		Concur, though this will be limited by the availability of acceptable logs.	
WOOD DUCKS AND OTHER WETLAND DEPENDENT SPECIES			
1. Sub-impoundments should be created along perimeter of upper reservoir to function as shallow open water habitat during draw-downs.	X		

RECOMMENDATION	CONCUR	PARTIALLY CONCUR	NONCONCUR
2. Sub-impoundment behind old railroad grade should be included as a project element. Fish passage would be required.		Fish passage is currently not included in the design for the 1135 study, as the sub-impoundment is not intended to be over-topped by the reservoir. For the AWS, fish passage will need to be discussed.	
3. Improve habitat within upper reservoir sub-impoundments by installing wood duck boxes, LWD, and planting of emergent vegetation and willows.	X		
MONITORING AND EVALUATION			
1. Recommend development of a management plan for project mitigation lands. Plan would be approved by agency representatives and include an annual SOP and annual reports in years 1-5. In years 6-20, reports would be done every 5 years; years 21-50, reports would be prepared every 10 years.		MIT would also be included in development and approval of management plan. We feel evaluation would not be necessary every year the first five years. Rather, in the first year, and then again in year five. Assume reports would be prepared by the mitigation land manager.	
Tacoma's forest land management plan should be used as the basis for the management plan.	X		
2. Detailed monitoring plan should be developed. Annual reports should be prepared years 1-5; every 5 years (years 6-20); every 10 years (years 20-50)		The Corps plans to have an evaluation of the mitigation sites every 5 years through year 15. Reports would be prepared at the close of each evaluation year. Annual evaluations should not be necessary; the program should be well in hand by year 15.	
3. A contingency plan and process are needed to guide management changes to correct for undesirable results. An adaptive management approach should be used.		Agree; however, by its nature, adaptive management will be developed as we proceed with management (i.e., it cannot be fully developed prior to implementing the mitigation plan).	

2.13 RECOMMENDATIONS

I have given careful consideration to all significant aspects of this study in the overall public interest, including engineering and economic feasibility, as well as social and environmental effects. The recommended plan described in this report provides the optimum solution for increasing summer conservation storage at Howard A. Hanson Dam on the Green River, Washington.

I recommend that the existing Howard A. Hanson Dam Project be modified for the purpose of water supply and environmental restoration. This modification has significant value to the Puget Sound region. The fully-funded cost estimate for all modifications is estimated at $83.8 million. The cost of the modifications will be repaid according to the allocations to water supply and restoration.

I recommend that the existing Howard A. Hanson Dam Project authorized by the River and Harbor Act of 17 May 1950 be modified to include the following:

1. New intake tower with new fish collection and transport facility including: a wet-well, a floating fish collector, a fish lock, a discharge conduit, a fish transport pipeline and monitoring equipment.

2. Mitigation features including management of riparian forests, planting of water-tolerant vegetation and maintenance of instream habitat in Phase I and Phase II.

3. Ecosystem restoration features other than fish passage including gravel nourishment, a side channel reconnection project, dam flow release water temperature improvement, and river and stream habitat improvements.

4. Right abutment drainage remediation.

5. New access bridge and access road.

6. New buildings, or additions to existing buildings, including: an administration, a maintenance and a generator building.

7. Change reservoir operation (Phase I) to store 20,000 ac-ft of M&I water to elevation 1,167 feet in the spring for release in the summer and fall.

8. Change reservoir operation (Phase II) to store an additional 12,000 ac-ft of water, 2,400 ac-ft for M&I water supply and 9,600 ac-ft of water for LFA, to elevation 1,177 feet in the spring for release in the summer and fall. (Implementation of Phase II is dependent on an evaluation of Phase I success

and consensus of the resource agencies, the Muckleshoot Indian Tribe, the City of Tacoma and the Corps.)

This recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

James M. Rigsby 2 Sep 98

James M. Rigsby date
Colonel
Commanding

CENWD-NP-ET-P (CENWS-PM-CP/2 Sep 98) (1105) 1st End
Mr. Jaren/kb/(503)808-3857
SUBJECT: Howard Hanson Dam Additional Water Supply, Feasibility Study

CDR, Northwestern Division, Corps of Engineers, PO Box 2870, Portland, OR 97208-2870 15 September 1998

FOR CDR, USACE (CECW-AR), Kingman Building, 7701 Telegraph Road, Alexandria, VA 22310-0103

I concur in the conclusions and recommendations of the District Commander.

ROBERT H. GRIFFIN
Brigadier General, USA
Commanding

INDEX

Species Lists

Plant Species of Howard Hanson Reservoir by Habitat Type

Upland Habitat Types

1. Deciduous Forest

Trees:	*Acer macrophyllum*	Big-leaf Maple
	A. circinatum	Vine Maple
	Alnus rubra	Red Alder
	Populus balsamifera	Black Cottonwood
	Pseudotsuga menziesii	Douglas Fir
	Thuja plicata	Western Red-Cedar
	Tsuga heterophylla	Western Hemlock
	Salix lasiandra	Pacific Willow
	Prunus emarginata	Bitter Cherry
	Rhamnus purshiana	Cascara
	Cornus nuttallii	Pacific Dogwood
	Arbutus menziesii	Madrona
Shrubs:	*Rubus spectabilis*	Salmonberry
	R. ursinus	Trailing Blackberry
	R. parviflorus	Thimbleberry
	Oemleria cerasiformis	Indian Plum
	Vaccinium parviflorum	Red Huckleberry
	Oploplanax horridus	Devil's Club
	Sambucus racemosa	Red Elderberry
	Cornus stolonifera	Red-osier Dogwood
Forbs:	*Polystichum munitum*	Sword Fern
	Pteridium aquilinum	Bracken Fern
	Urtica dioica	Stinging Nettle
	Heracleum lanatum	Cow Parsnip
	Oenanthe sarmentosa	Pacific Water-parsley
	Prunella vulgaris	Self-heal
	Tolmiea menziesii	Pig-a-back
	Galium spp.	Bedstraw
	Rumex spp.	Docks
	Juncus spp.	Rushes
	Ranunculus repens	Creeping Buttercup
	Dicentra formosa	Bleeding Heart
	Poaceae	Grasses

1. Deciduous Forest - Alder

Trees:	*Alnus rubra*	Red Alder
	Thuja plicata	Western Red-Cedar
	Tsuga heterophylla	Western Hemlock
Shrubs:	*Rubus spectabilis*	Salmonberry
	R. discolor	Himalayan Blackberry
	R. parviflorus	Thimbleberry
	Ribes sanguineum	Red Flowering Current

Forbs:	*Polystichum munitum*	Sword Fern
	Athyrium filix-femina	Lady Fern
	Maianthemum dilatatum	False Lily-of-the-Valley
	Tiarella trifoliata	Foam Flower
	Poaceae	Grasses

3. Deciduous Forest - Cottonwood

Trees:	*Populus balsamifera*	Black Cottonwood
	Alnus rubra	Red Alder
	Acer circinatum	Vine Maple
Shrubs:	*Rubus spectabilis*	Salmonberry
	R. parviflorus	Thimbleberry
	Oemleria cerasiformis	Indian Plum
	Sambucus racemosa	Red Elderberry
Forbs:	*Polystichum munitum*	Sword Fern
	Tolmiea menziesii	Pig-a-back
	Ranunculus repens	Creeping Buttercup

4. Deciduous Forest - Seedling/Sapling

Trees:	*Alnus rubra*	Red Alder
	Acer circinatum	Vine Maple
Shrubs:	*Rubus discolor*	Himalayan Blackberry
	R. ursinus	Trailing Blackberry
	R. spectabilis	Salmonberry
Forbs:	*Epilobium angustifolium*	Fireweed
	Poaceae	Grasses
	Polystichum munitum	Sword Fern
	Pteridium aquilinum	Bracken Fern
	Agrostis alba	Redtop Bentgrass

5. Coniferous Forest

Trees:	*Pseudotsuga menziesii*	Douglas Fir
	Thuja plicata	Western Red-Cedar
	Tsuga heterophylla	Western Hemlock
	Acer circinatum	Vine Maple
	Alnus rubra	Red Alder
	Picea sitchensis	Sitka Spruce
Shrubs:	*Berberis aquifolium*	Tall Oregon Grape
	Rubus parviflorus	Thimbleberry
	R. ursinus	Trailing Blackberry
	R. spectabilis	Salmonberry
	Gaultheria shallon	Salal
	Sambucus racemosa	Red Elderberry
	Oplopanax horridum	Devil's Club
Forbs:	*Achlys triphylla*	Vanilla Leaf
	Galium aparine	Cleavers
	Poaceae	Grasses

	Maianthemum dilatatum	False Lily-of-the-Valley
	Montia sibirica	Western Spring Beauty
	Polystichum munitum	Sword Fern
	Pteridium aquilinum	Bracken Fern
	Smilacina racemosa	False Solomon's Seal
	Tolmiea menziesii	Pig-a-back
	Linnaea borealis	Twinflower

6. Coniferous Forest

Trees:	None	
Shrubs:	*Pseudotsuga menziesii*	Douglas Fir (sapling)
	Alnus rubra	Red Alder (sapling)
	Rubus ursinus	Trailing Blackberry
	R. spectabilis	Salmonberry
	R. discolor	Himalayan Blackberry
	R. parviflorus	Thimbleberry
	Holodiscus discolor	Ocean Spray
	Oemlaria cerasiformis	Indian Plum
Forbs:	*Epilobium angustifolium*	Fireweed
	Polystichum munitum	Sword Fern
	Agrostis alba	Redtop Bentgrass
	Pterdium aquilinum	Bracken Fern
	Poaceae	Grasses

7. Mixed Coniferous Forest

Trees:	*Acer macrophyllum*	Big-leaf Maple
	Alnus rubra	Red Alder
	Pseudotsuga menziesii	Douglas Fir
	Thuja plicata	Western Red-Cedar
	Tsuga heterophylla	Western Hemlock
Shrubs:	*Berberis aquifolium*	Tall Oregon Grape
	Rubus parviflorus	Thimbleberry
	R. ursinus	Trailing Blackberry
	R. spectabilis	Salmonberry
	Sambucus racemosa	Red Elderberry
Forbs:	*Galium aparine*	Cleavers
	Maianthemum dilatatum	False Lily-of-the-Valley
	Montia sibirica	Western Spring Beauty
	Polystichum munitum	Sword Fern
	Pteridium aquilinum	Bracken Fern
	Smilacina racemosa	False Solomon's Seal
	Tolmiea menziesii	Pig-a-back
	Achlys triphylla	Vanilla Leaf
	Blechnum spicant	Deer Fern
	Poaceae	Grasses

8. Shrubland

Trees:	*Acer circinatum*	Vine Maple
	Alnus rubra	Red Alder
	Pseudotsuga menziesii	Douglas Fir
	Tsuga heterophylla	Western Hemlock
Shrubs:	*Holodiscus discolor*	Creambush Oceanspray
	Rubus ursinus	Trailing Blackberry
	R. spectabilis	Salmonberry
	R. discolor	Himalayan Blackberry
	Sambucus racemosa	Red Elderberry
	Cytisus scoparius	Scot's Broom
Forbs:	*Anaphalis margaritacea*	Pearly Everlasting
	Epilobium angustifolium	Fireweed
	Polystichum munitum	Sword Fern
	Pteridium aquilinum	Bracken Fern
	Verbascum thapsus	Common Mullein
	Cirsium arvense	Canadian Thistle
	Tolmiea menziesii	Pig-a-back
	Equisetum arvense	Horsetail
	Ranunculus repens	Creeping Buttercup
	Rumex spp.	Docks
	Poaceae	Grasses

9. Grassland

Trees:	None	
Shrubs:	*Rubus ursinus*	Trailing Blackberry
Forbs:	*Agrostis alba*	Redtop Bentgrass
	Cirsium arvense	Canadian Thistle
	Elymus glaucus	Western Rye Grass
	Holcus lanatus	Common Velvetgrass
	Phleum sp.	Timothy
	Poa pratensis	Kentucky Bluegrass
	Senecio spp.	Ragworts
	Trifolium spp.	Clovers
	Rumex spp.	Docks
	Taraxacum spp.	Dandelions

10. Talus Slope/Rock

Trees:	None	
Shrubs:	*Alnus rubra*	Red Alder (sapling
	Pseudotsuga menziesii	Douglas Fir (sapling)
	Tsuga heterophylla	Western Hemlock (sapling)
Forbs:	*Agrosta alba*	Redtop Bentgrass
	Anaphalis margaritacea	Pearly-everlasting
	Crucifer	unknown Mustard
	Poaceae	Grasses
	Hypericum perfoliatum	St. Johnswort
	Trifolium spp.	Clovers
	Verbascum thapsus	Common Mullein
	Epilobium angustifolium	Fireweed

11. Roadway/Railroad

Trees:	None	
Shrubs:	*Rubus discolor*	Himalayan Blackberry
	R. spectabilus	Salmonberry
Forbs:	*Cirsium arvense*	Canadian Thistle
	Achillea millefolium	Yarrow
	Epilobium angustifolium	Fireweed
	Anaphalis margaritacea	Pearly-everlasting
	Senecio spp.	Ragworts
	Verbascum thapsus	Common Mullein
	Poaceae	Grasses

Wetland Habitat Types

1. Forested Swamp

Trees:	*Alnus rubra*	Red Alder
	Fraxinus latifolia	Oregon Ash
	Populus balsamifera	Black Cottonwood
	Thuja plicata	Western Red-Cedar
	Tsuga heterophylla	Western Hemlock
	Picea sitchensis	Sitka Spruce
Shrubs:	*Rubus spectabilis*	Salmonberry
	Salix spp.	Willows
	Acer circinatum	Vine Maple
Forbs:	*Lysichitum americanum*	Skunk Cabbage
	Oenanthe sarmentosa	Pacific Water-parsley
	Scirpus spp.	Bulrush
	Epilobium watsonii	Watson's Willow-herb
	Juncus effusus	Soft Rush
	Petasites Frigiduc	Colts Foot
	Glyceria sp.	Mannagrass
	Heracleum Lanatum	Cow Parsnip

2. Shrub Swamp

Trees:	None	
Shrubs:	*Salix hookeriana*	Hooker's Willow
	Salix spp.	Willow
Forbs:	*Scirpus cyperinus*	Woolgrass
	Agrostis sp.	Bentgrass

3. Emergent Marsh

Trees:	None	
Shrubs:	None	
Forbs:	*Agrostis alba*	Redtop Bentgrass
	Carex spp.	Sedge
	Holcus lanatus	Common Velvetgrass
	Juncus effusus	Soft Rush
	Poa spp.	Bluegrass
	Ranunculus flammula	Creeping Buttercup
	Scirpus cyperinus	Woolgrass
	Eleocharis spp.	Spike-Rush
	Typhus latifolia	Common Cattail
	Equisetum spp.	Horsetail

4. Moss

Trees:	None	
Shrubs:	None	
Forbs:	*Agrostis alba*	Redtop Bentgrass
	Bryophyta	Mosses
	Chara sp.	Stonewort
	Ranunculus flammula	Creeping Buttercup
	Spirogyra sp.	Green Algae
	Zygnema sp.	Green Algae

5. Mudflat

Trees:	None	
Shrubs:	None	
Forbs:	*Bryophyta*	Mosses
	Chara sp.	Stonewort
	Spirogyra sp.	Green Algae
	Zygnema sp.	Green Algae

6. Riverbed

Trees:	None	
Shrubs:	None	
Forbs:	*Spirogyra sp.*	Green Algae
	Zygnema sp.	Green Algae

7. Open Water

Trees:	None	
Shrubs:	None	
Forbs:		phytoplankton
		floating algae

Bird Species of Howard Hanson Reservoir

Gavia immer	Common Loon
Aechmophorus occidentalis	Western Grebe
Ardea herodias	Great Blue Heron
Butorides virescens	Green Heron
Cathartes aura	Turkey Vulture
Branta canadensis	Canada Goose
Aix sponsa	Wood Duck
Anas crecca	Green-winged Teal
A. platyrhynchos	Mallard
A. strepera	Gadwall
A. americana	American Wigeon
Aythya collaris	Ring-necked Duck
Aythya affinis	Lesser Scaup
Histrionicus histrionicus	Harlequin Duck
Bucephala islandica	Barrow's Goldeneye
B. albeola	Bufflehead
Lophodytes cucullatus	Hooded Merganser
Mergus merganser	Common Merganser
Pandion haliaetus	Osprey
Haliaeetus leucocephalus	Bald Eagle
Circus cyaneus	Northern Harrier
Accipiter striatus	Sharp-shinned Hawk
A. cooperii	Cooper's Hawk
A. gentilis	Northern Goshawk
Buteo jamaicensis	Red-tailed Hawk
Falco sparverius	American Kestrel
F. columbarius	Merlin
Dendragapus obscurus	Blue Grouse
Bonasa umbellus	Ruffed Grouse
Charadrius vociferus	Killdeer
Tringa melanoleuca	Greater Yellowlegs
T. solitaria	Solitary Sandpiper
Actitis macularia	Spotted Sandpiper
Calidris mauri	Western Sandpiper
Gallinago gallinago	Common Snipe
Larus californicus	California Gull
Columba fasciata	Band-tailed Pigeon
Zenaida macroura	Mourning Dove
Bubo virginianus	Great Horned Owl
Glaucidium gnoma	Northern Pygmy-Owl
Strix occidentalis	Spotted Owl
S. varia	Barred Owl
Chordeiles minor	Common Nighthawk
Cypseloides niger	Black Swift
Chaetura vauxi	Vaux's Swift
Selasphorus rufus	Rufous Hummingbird
Ceryle alcyon	Belted Kingfisher
Sphyrapicus ruber	Red-breasted Sapsucker

Picoides pubescens	Downy Woodpecker
P. villosus	Hairy Woodpecker
Colaptes auratus	Northern Flicker
Dryocopus pileatus	Pileated Woodpecker
Contopus cooperi	Olive-sided Flycatcher
C. sordidulus	Western Wood-Pewee
Empidonax traillii	Willow Flycatcher
E. hammondii	Hammond's Flycatcher
E. difficilis	Pacific-slope Flycatcher
Lanius excubitor	Northern Shrike
Vireo cassinii	Cassin's Vireo
V. huttoni	Hutton's Vireo
V. gilvus	Warbling Vireo
V. olivaceus	Red-eyed Vireo
Perisoreus canadensis	Gray Jay
Cyanocitta stelleri	Steller's Jay
Corvus brachyrhynchos	American Crow
C. corax	Common Raven
Progne subis	Purple Martin
Tachycineta bicolor	Tree Swallow
T. thalassina	Violet-green Swallow
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Riparia riparia	Bank Swallow
Hirundo pyrrhonota	Cliff Swallow
H. rustica	Barn Swallow
Poecile atricapillus	Black-capped Chickadee
P. rufescens	Chestnut-backed Chickadee
Psaltriparus minimus	Bushtit
Sitta canadensis	Red-breasted Nuthatch
Certhia americana	Brown Creeper
Thryomanes bewickii	Bewick's Wren
Troglodytes troglodytes	Winter Wren
Cistothorus palustris	Marsh Wren
Cinclus mexicanus	American Dipper
Regulus satrapa	Golden-crowned Kinglet
R. calendula	Ruby-crowned Kinglet
Myadestes townsendi	Townsend's Solitaire
Catharus ustulatus	Swainson's Thrush
C. guttatus	Hermit Thrush
Turdus migratorius	American Robin
Ixoreus naevius	Varied Thrush
Sturnus vulgaris	European Starling
Anthus rubescens	American Pipit
Bombycilla cedrorum	Cedar Waxwing
Vermivora celata	Orange-crowned Warbler
V. ruficapilla	Nashville Warbler
Dendroica petechia	Yellow Warbler
D. coronata	Yellow-rumped Warbler
D. nigrescens	Black-throated Gray Warbler

D. townsendi	Townsend's Warbler
D. occidentalis	Hermit Warbler
Oporornis tolmiei	MacGillivray's Warbler
Geothlypis trichas	Common Yellowthroat
Wilsonia pusilla	Wilson's Warbler
Piranga ludoviciana	Western Tanager
Pipilo maculatus	Spotted Towhee
Passerculus sandwichensis	Savannah Sparrow
Passerella iliaca	Fox Sparrow
Melospiza melodia	Song Sparrow
Zonotrichia leucophrys	White-crowned Sparrow
Z. atricapilla	Golden-crowned Sparrow
Junco hyemalis	Dark-eyed Junco
Pheucticus melanocephalus	Black-headed Grosbeak
Agelaius phoeniceus	Red-winged Blackbird
Sturnella neglecta	Western Meadowlark
Euphagus cyanocephalus	Brewer's Blackbird
Molothrus ater	Brown-headed Cowbird
Carpodacus purpureus	Purple Finch
C. mexicanus	House Finch
Loxia curvirostra	Red Crossbill
Carduelis pinus	Pine Siskin
C. tristis	American Goldfinch
Coccothraustes vespertinus	Evening Grosbeak
Passer domesticus	House Sparrow

Mammal Species of Howard Hanson Reservoir

Didelphidae:	*Didelphis virginiana*	Virginia Oppossum
Soricidae:	*Sorex vagrans*	Vagrant Shrew
	S. obscurus	Dusky Shrew
	S. palustris	Northern Water Shrew
	S. bendirii	Marsh Shrew
Talpidae:	*Neurotrichus gibbsi*	Shrew-mole
	Scapanus townsendii	Townsend Mole
	S. orarius	Coast Mole
Vespertilionidae:	*Myotis lucifugus*	Little Brown Bat
	M. yumanensis	Yuma Myotis
	M. keeni	Keen Myotis
	M. evotis	Long-eared Myotis
	M. volans	Long-legged Myotis
	M. californicus	California Myotis
	Lasionycteris noctivagans	Silver-haired Myotis
	Eptesicus fuscus	Big Brown Bat
	Lasiurus cinereus	Hoary Bat
	Plecotus townsendii	Townsend's Big-eared Bat
Leporidae:	*Ochotona princeps*	Pika
	Lepus americanus	Snowshoe Hare
Aplodontidae:	*Aplodontia rufa*	Mountain Beaver
Sciuridae:	*Eutamias townsendii*	Townsend's Chipmunk
	Tamiasciurus douglasii	Douglas Squirrel
	Glaucomys sabrinus	Northern Flying Squirrel
Castoridae:	*Castor canadensis*	Beaver
Cricetidae:	*Peromyscus maniculatus*	Deer Mouse
	Neotoma cinerea	Bushy-tailed Woodrat
	Phenacomys intermedius	Heather Vole
	Clethrionomys gapperi	Boreal Red-backed Vole
	Microtus townsendii	Townsend's Vole
	M. longicaudus	Longtail Vole
	M. oregoni	Oregon Vole
	Ondatra zibethica	Muskrat
Zapodidae:	*Zapus trinotatus*	Pacific Jumping Mouse
Erethizontidae:	*Erethizon dorsatum*	Porcupine
Ursidae:	*Ursus americanus*	Black Bear
Procyonidae:	*Procyon lotor*	Racoon

Mustelidae:	*Martes americana*	Marten
	Mustela erminea	Short-tailed Weasel
	M. frenata	Long-tailed Weasel
	M. vison	Mink
	Lutra canadensis	River Otter
	Spilogale putorius	Spotted Skunk
	Mephitis mephitis	Striped Skunk
Canidae:	*Canis latrans*	Coyote
	Vulpes fulva	Common Red Fox
Felidae:	*Felis concolor*	Mountain Lion
	Lynx rufus	Bobcat
Cervidae:	*Cervus canadensis*	Rocky Mountain Elk
	Odocoileus hemionus	Black-tailed Deer

Reptile Species of Howard Hanson Reservoir

Anguidae:	*Gerrhonotus coeruleus*	Northern Alligator Lizard
Colubridae:	*Thamnophis sirtalis*	Common Garter Snake
	T. elegans	Western Garter Snake
	T. ordinoides	Northwestern Garter Snake

Amphibian Species of Howard Hanson Reservoir

Ambystomidae:	*Ambystoma gracile*	Northwestern Salamander
	A. macrodactylum	Long-toed Salamander
Plethodonidae:	*Plethodon vehiculum*	W. Red-backed Salamander
	P. larselli	Larch Mountain Salamander
	Ensatina eschscholtzi	Escholtz's Salamander
Salmandridae:	*Taricha granulosa*	Rough-skinned newt
Leiopelmatidae:	*Ascaphus truei*	Tailed Frog
Bufonidae	*Bufo boreas*	Western Toad
Hylinidae:	*Hyla regilla*	Pacific Treefrog
Ranidae	*Rana aurora*	Red-legged Frog
	R. cascadae	Cascades Frog

Tables

TABLE 5-1. CHRONOLOGY OF EVENTS IN THE GREEN-DUWAMISH RIVER BASIN BETWEEN 1850-1997

DATE	EVENT	RESULT
1850	Oregon Donation Land Act	Land granted to settlers after 5 years homesteading
1851	First Euro-American settlers arrive in the Duwamish area	Land clearing begins - three claims filed
1852	Livestock introduced into Green River valley	Grazing begins on land
1853	Extension of Land Act through 1855	Seventeen claims filed along the river
1854	First road built in King County	Road built through the river valley
1854-55	Medicine Creek Treaty/Point Elliott Treaty	Created Muckleshoot Indian Reservation and former tribal lands ceded to U.S.
1855-58	Removal of debris from river for navigational purposes.	Elimination of LWD habitat
1855-56	Indian Wars	Settlers move to Seattle for protection - settlement slows
1856	Land clearing resumes	Duwamish area gardens planted, orchards established, timber cutting begins
1858	Drainage Laws	County passes laws permitting ditches for drainage, swamp land drainage begins
1862	Homestead Act	Settlement of territory encouraged
1866	Population of valley starts to grow in earnest	Displacement of Native Americans
1867	First railroad bridge built across Black River	Local railroad construction begins in DGB
1870	277 settlers living in valley	Displacement of Native Americans
1870s	Major railroads build lines	Pace of logging increases in Green/Duwamish River watershed
1875	Channel Improvement Act	County road funds used for improvement of rivers
1880-1910	Extensive logging occurs in the watershed	Extensive road and railroad construction
1883	RR bridge built across White River	Northern Pacific Railroad constructs east/west line through Green River valley
1893	Great Northern Railroad develops lines in north/south direction in valley	Increases population of basin
1895	Drainage District Act	County Drainage Districts formed
1895	Duwamish East Waterway construction begins	East Duwamish Waterway dredged and used for Harbor Island fill
1902	Green River Hatchery	State operated Green River Hatchery opens on Soos Creek
1901-04	Hydraulic sluicing of Beacon Hill	Fill placed in the intertidal area of the Duwamish River to raise land and decrease flooding potential

DATE	EVENT	RESULT
1906	Major flooding in rivers during fall and winter	Log jam on lower White River forces flood water into the Puyallup River
1902-27	Interurban Electric railway	Interurban rail eclipses riverboat travel
1910	Tacoma Water Diversion authorized	City of Tacoma Green River Diversion Dam construction is begun for municipal water
1911	White River Diversion	White River completely diverted to Puyallup River to reduce flooding problems
1913	Tacoma Water Diversion completed	Water diverted from Green River, complete blockage to upstream migration of fish
1916	Black and Cedar Rivers diverted from Green/Duwamish River	Ship Canal cut to Lake Union draining Lake Washington to Puget Sound. Reduced flooding in Green/Duwamish Basin
1917	East/West Duwamish Waterways finished	Dredging of channel completed, 2.2 square miles of Duwamish intertidal area filled, flooding reduced
1919	Private and county levees built to protect lowlands from flooding	Encouraged more productive agricultural use
1931	Installation of first stream gauge at Palmer	Begin to acquire river flow data
1959	One of the largest floods on record (28,000 cfs at Auburn)	Significant property damage
1960s	Extensive levee building by local and federal government	Channelization of the river
1963	Howard Hanson Dam completed	Reduces maximum flow of Green River to 12,000 cfs at Auburn to reduce flooding
1977	Tacoma completed their North Fork Valley well fields	Allows Tacoma to provide water during periods of high turbidity or low flows in the river
1980	Washington State Department of Ecology establishes instream flows at Palmer and Auburn	All but eliminates any future river diversions during periods of low flows
1995	Tacoma and Muckleshoot Agreement for future off-stream or diversions and instream flows	Further protection of fisheries resources during low flow periods
1996	Corps completes a Section 1135 Environmental Assessment for additional water supply at HHD for low flow augmentation	Further protection of fisheries resources during low flow periods
1997	Corps completes the Reconnaissance Report for the Green-Duwmaish Ecosystem Restoration Study and begins Feasibility Phase	Proposed project has restoration features that complement the HHD AWS Project

Figures

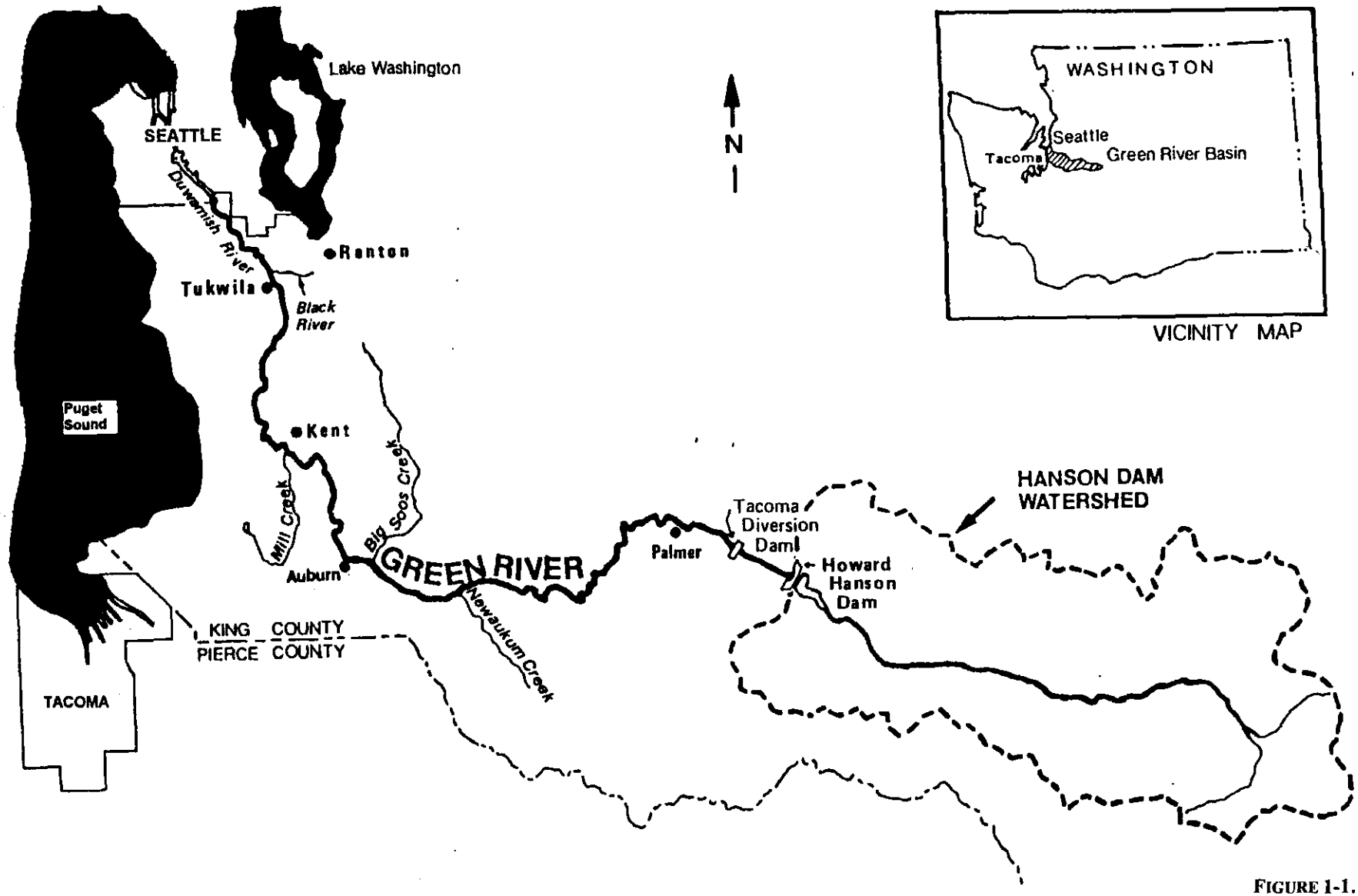


FIGURE 1-1.
VICINITY AND LOCATION MAP

FIGURE 1-2. HOWARD HANSON DAM WITHIN THE GREEN RIVER WATERSHED

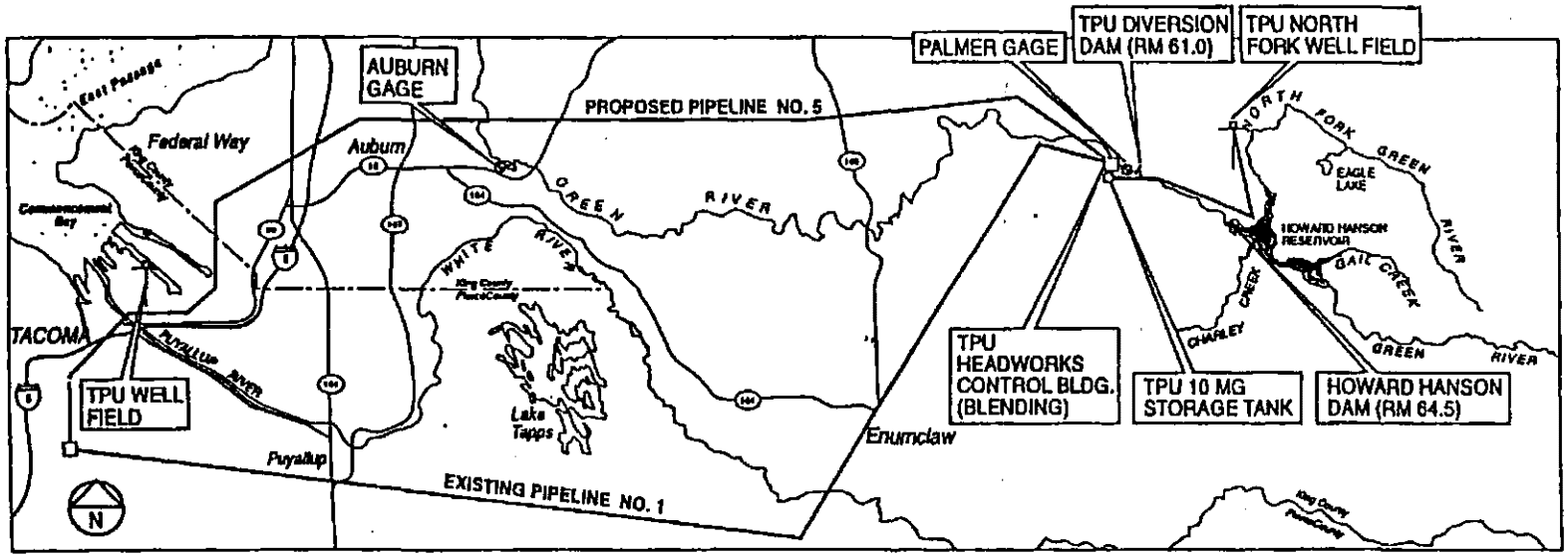


FIGURE 1-4. SITE MAP

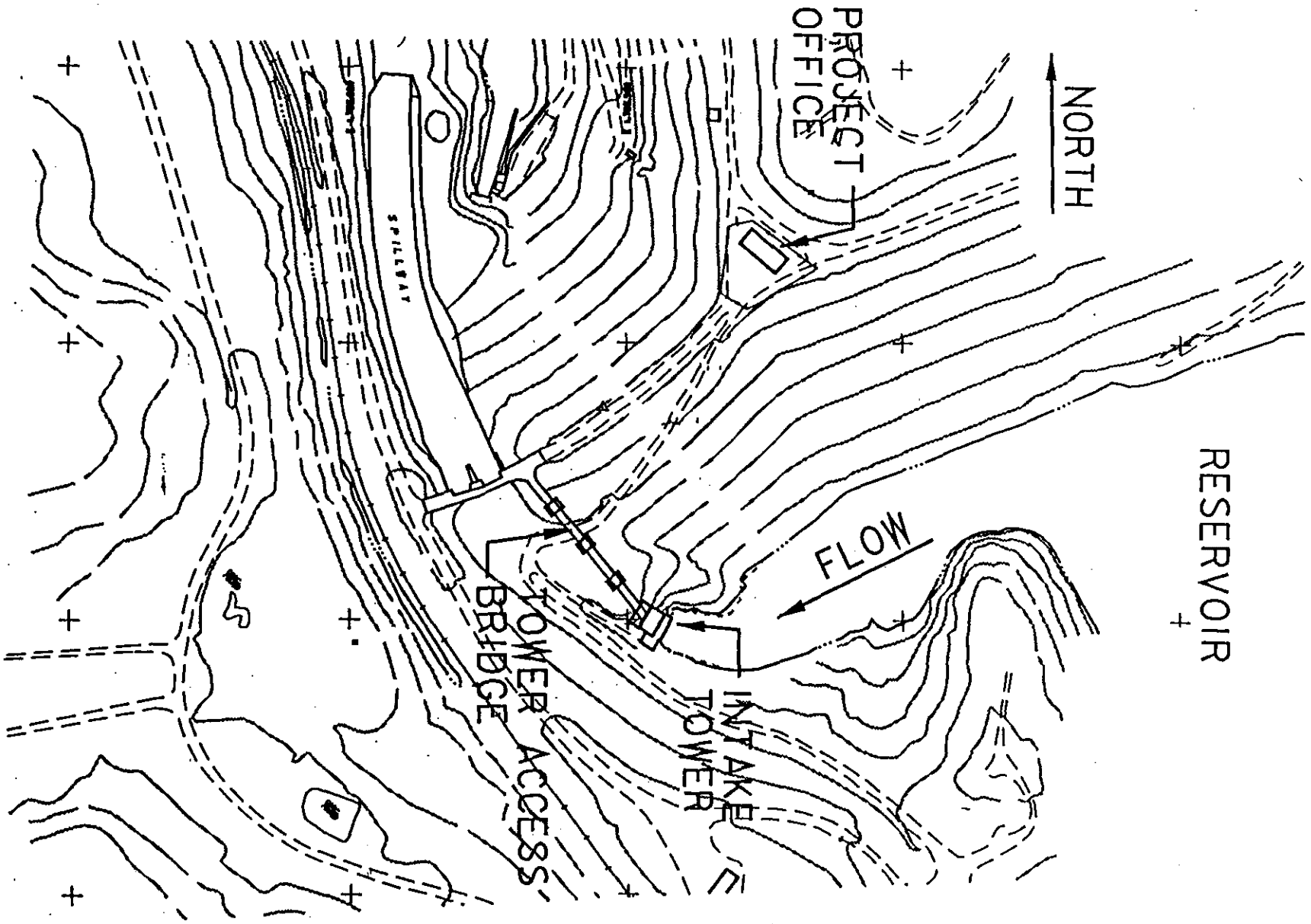


FIGURE 1-5. HOWARD HANSON DAM, CROSS-SECTION AND ELEVATION

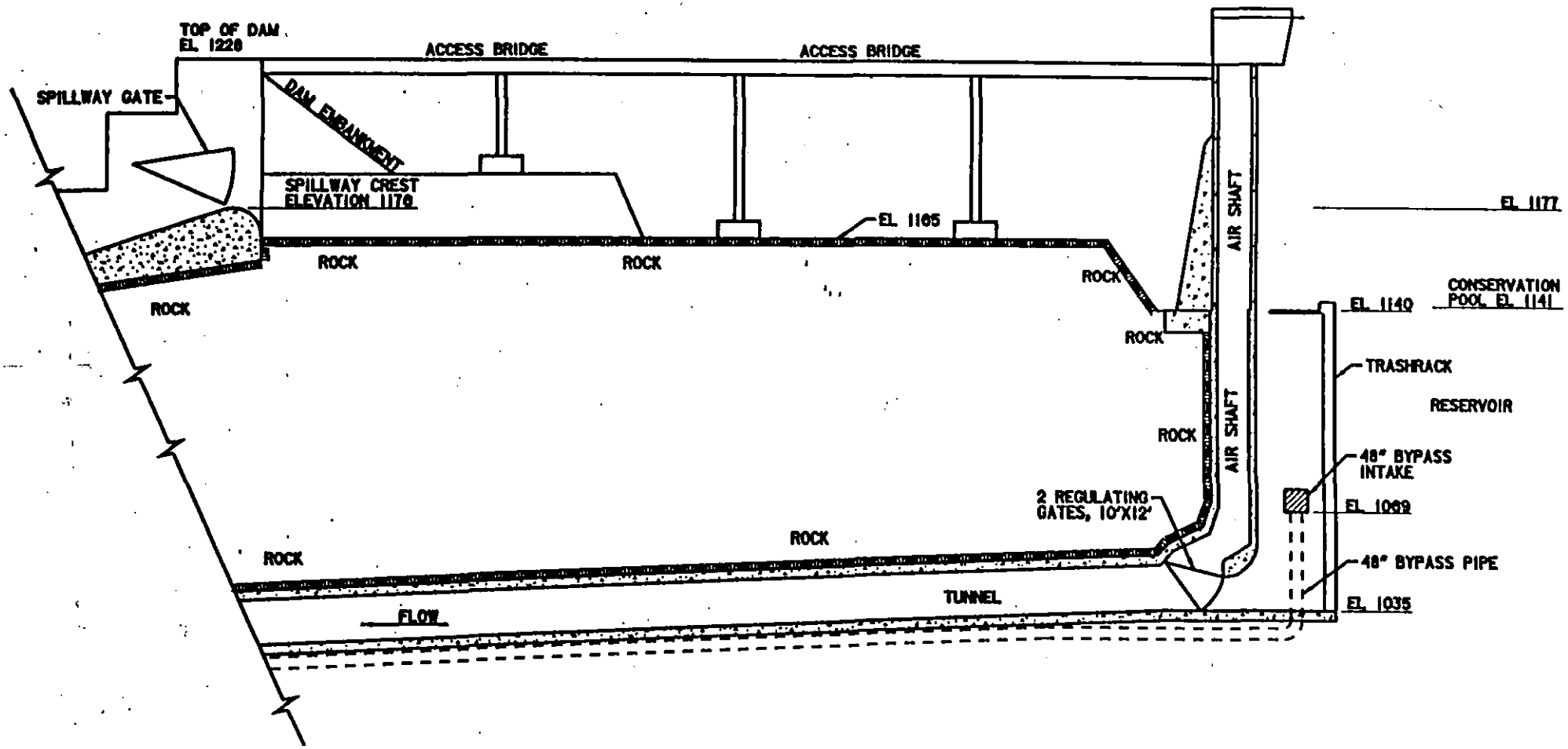


FIGURE 4-1. MIS CHAMBER AND FISH LOCK

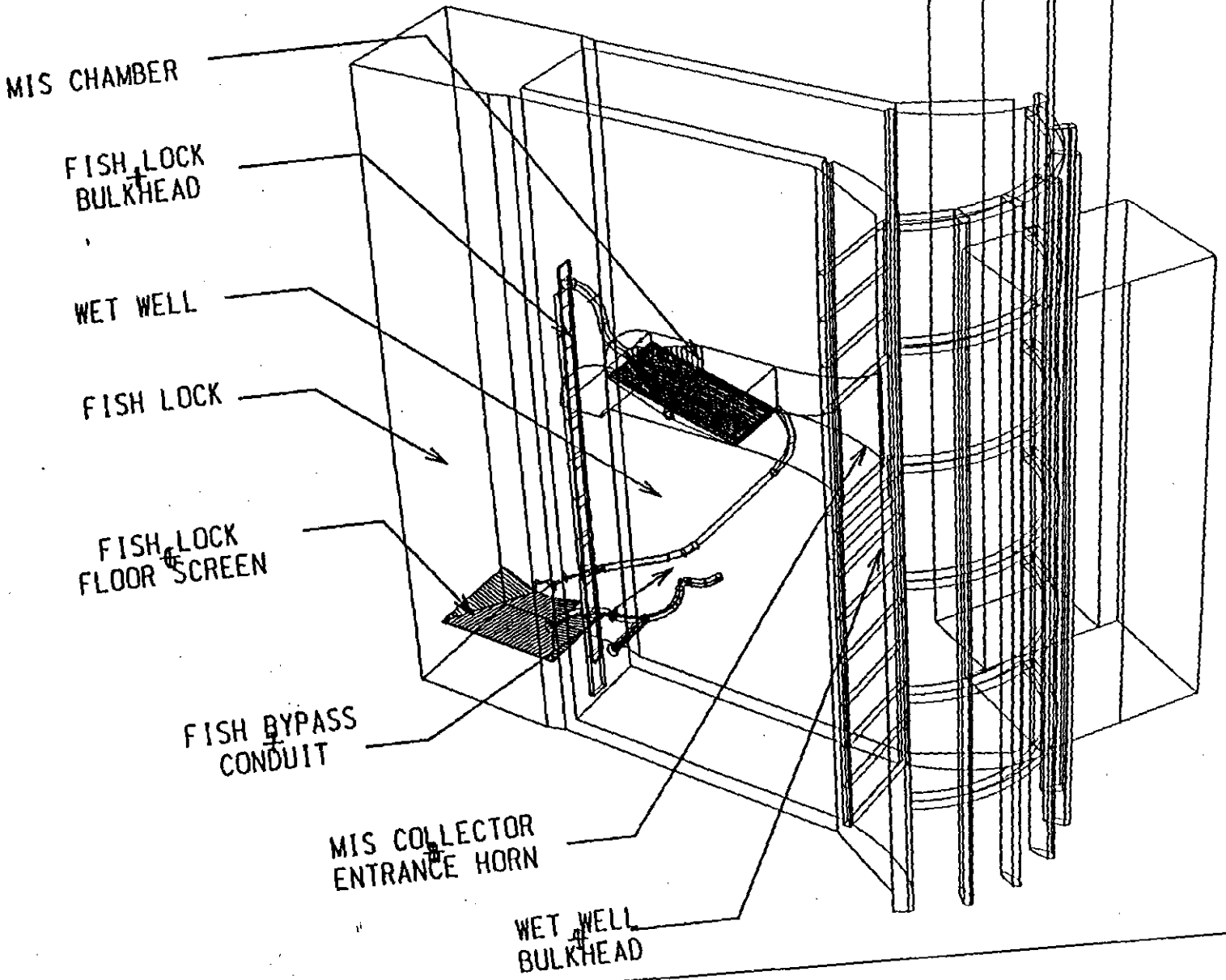


FIGURE 4-2. MIS CHAMBER AND LOCK, SECTION A

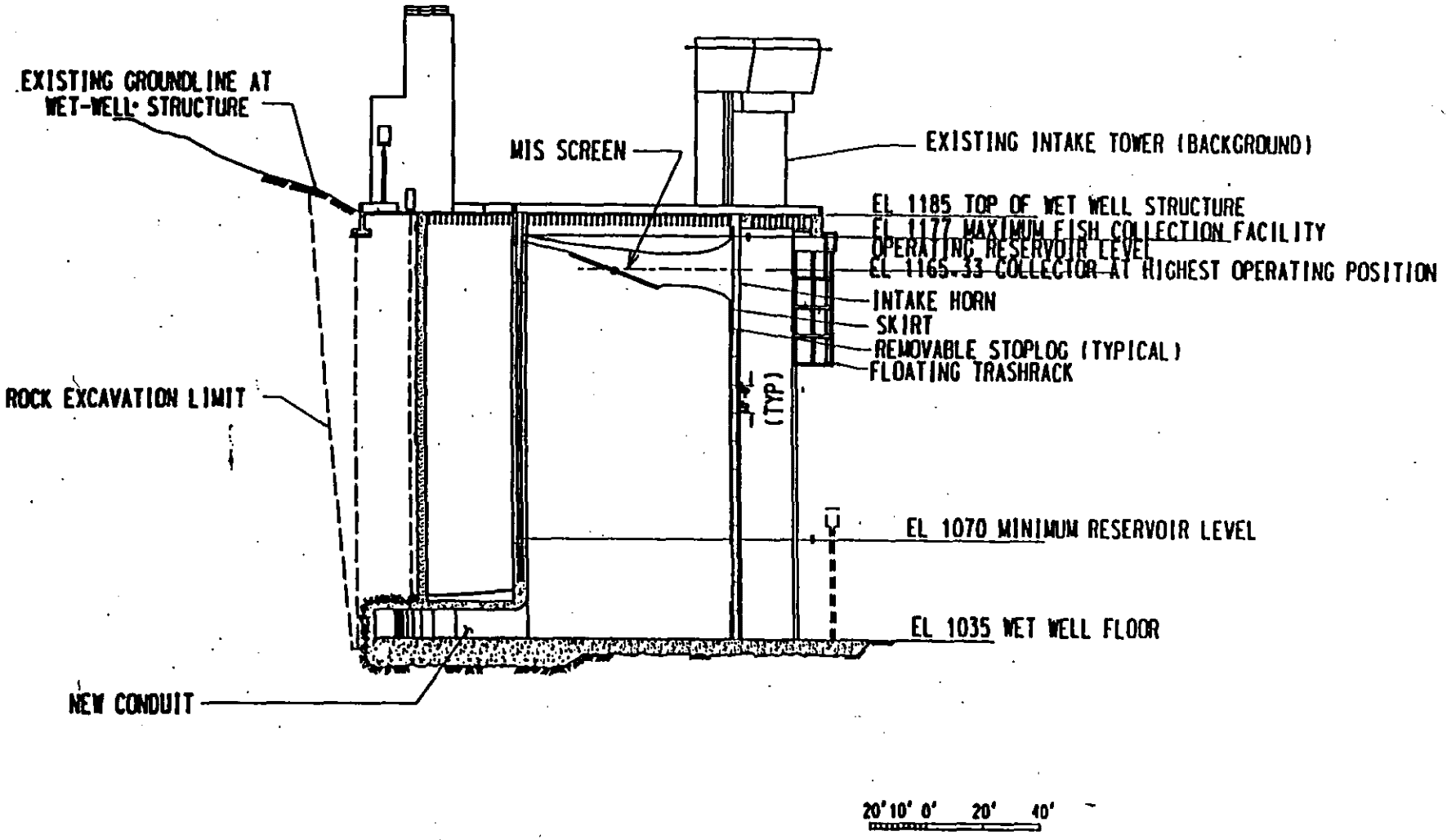
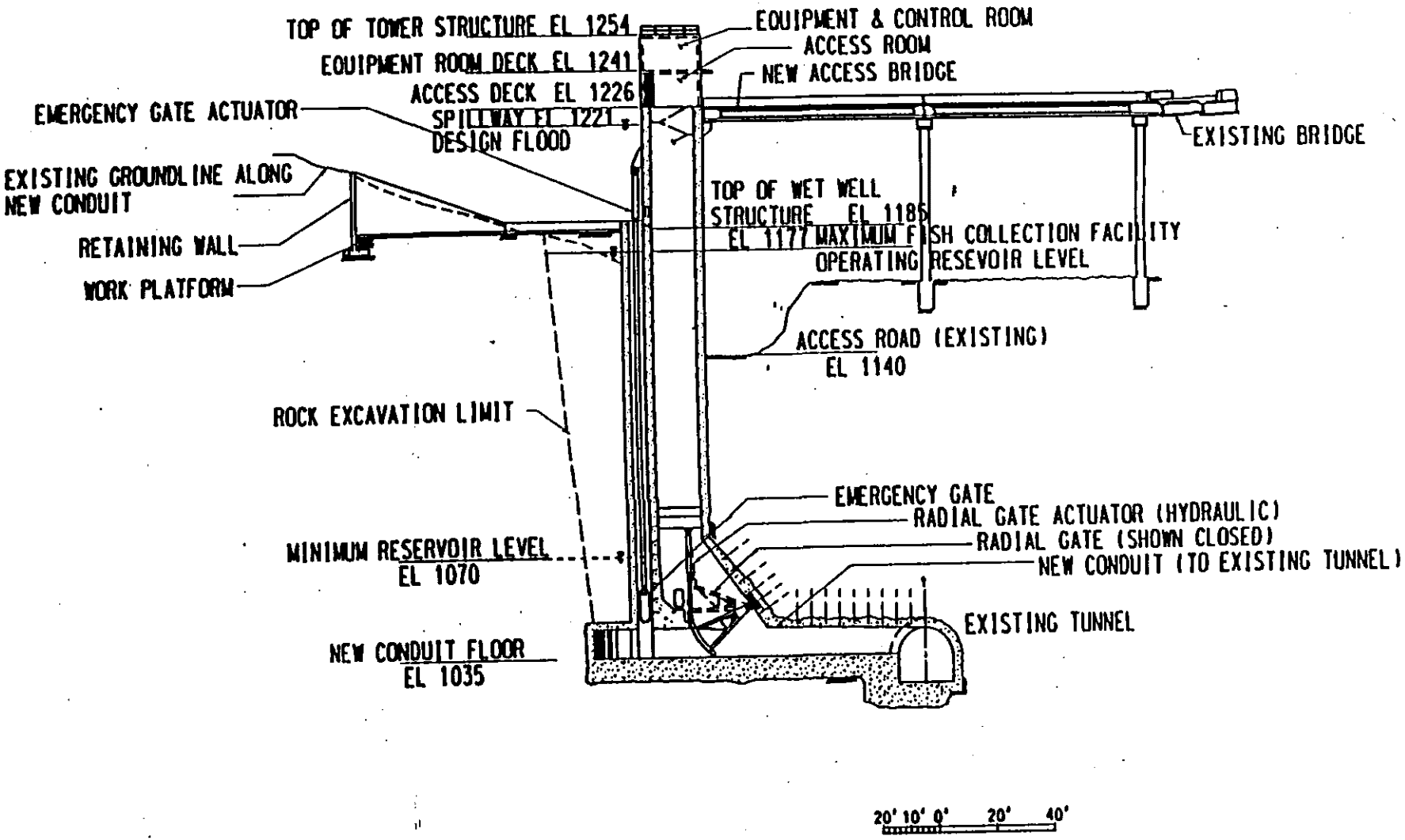
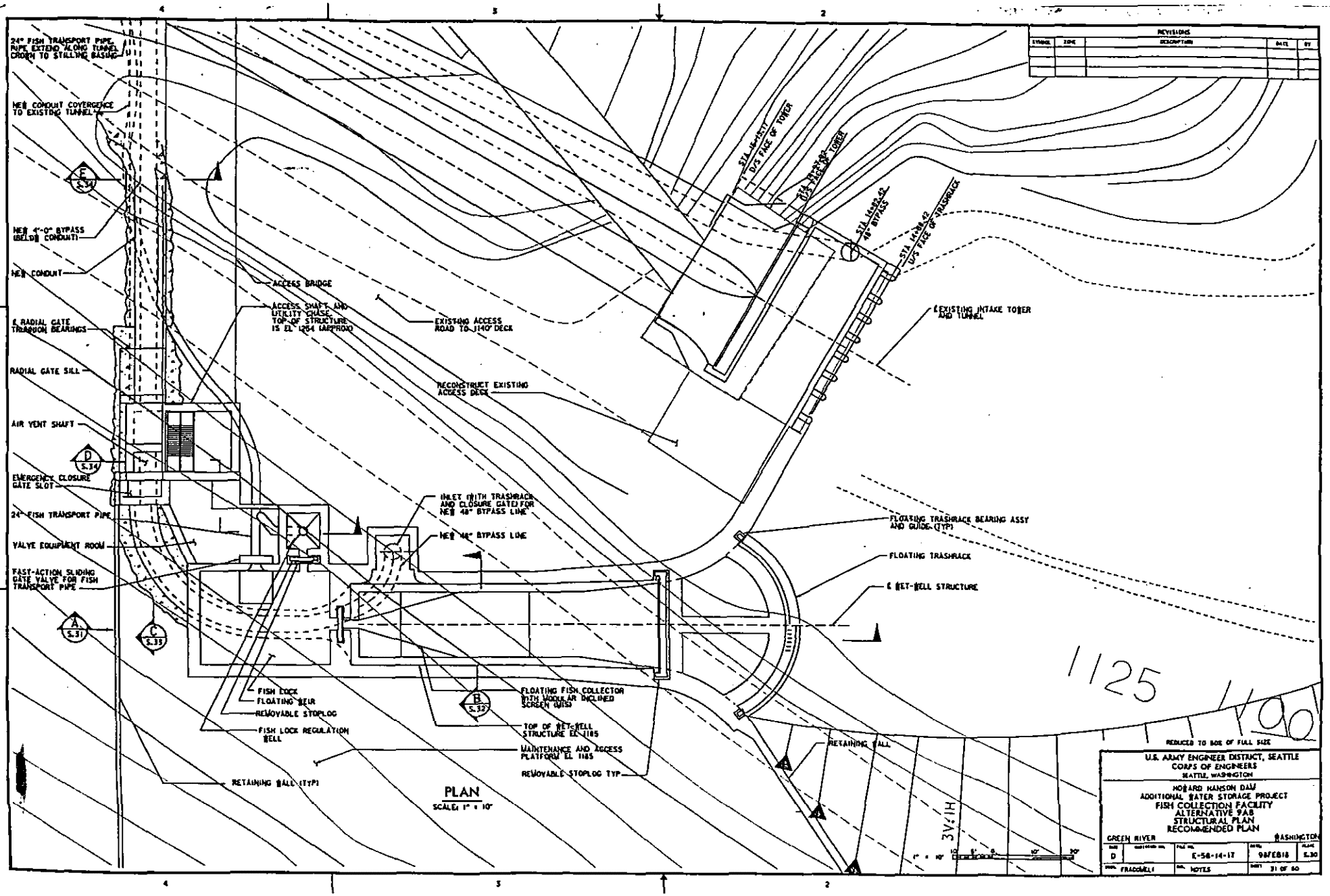


FIGURE 4-3. MIS CHAMBER AND LOCK, SECTION C



Plates/Drawings



PLAN
SCALE 1" = 10'

REDUCED TO 80% OF FULL SIZE