US Army Corps
of Engineers®

Final Integrated Feasibility Report and Environmental Assessment

Oaks Bottom Section 206 Habitat Restoration Project Feasibility Study

Portland, Oregon

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US Army Corps of Engineers ®
Portland District

FINDING OF NO SIGNIFICANT IMPACT

for the Integrated Feasibility Report and Environmental Assessment
Oaks Bottom Section 206 Habitat Restoration Project Feasibility Study Portland, Oregon

I find the proposed action will not significantly affect the quality of the human environment and that an environmental impact statement is not required. This Finding of No Significant Impact (FONSI) is supported by the U.S. Army Corps of Engineers (Corps) *Integrated Feasibility Report and Environmental Assessment, Oaks Bottom Section 206, Portland, Oregon* (EA) and is hereby incorporated by reference.

The EA and FONSI have been prepared pursuant to the National Environmental Policy Act (NEPA) in accordance with the Council on Environmental Quality regulations as contained in 40 Code of Federal Regulations (CFR) Parts 1500 to 1508, and the Corps procedures for implementing NEPA found at 33 CFR Part 230.

PROJECT PURPOSE AND NEED

Section 206 of the Water Resources Development Act of 1996 authorizes the Corps to conduct studies and implement aquatic ecosystem restoration projects. The purpose of the proposed action is to restore a more natural tidal hydrologic connection between Oaks Bottom and the Lower Willamette River, improve fish and wildlife habitats, reduce non-native species populations, and provide unhindered fish passage into and out of Oaks Bottom. This restoration project is needed because Oaks Bottom is one of the last remaining tidal floodplain habitats in the Lower Willamette River and could provide a substantial area for juvenile salmon rearing and refuge habitat.

PROPOSED ACTION

The proposed action includes: 1) replacement of the existing 5-foot diameter culvert under the railroad embankment with a 16-foot wide by 10-foot high culvert with a natural substrate at a lower elevation to provide connections 95% of all tidal cycles; 2) removal of the existing water control structure that impounds a large pond; 3) excavation of tidal slough channels to connect the south part of the refuge and other ponds to the channel and culvert; 4) removal of invasive species; and 5) revegetation with riparian and wetland species. Work would be conducted during one summer season (July through October) during the in-water work window designated for the Lower Willamette River.

FINAL DETERMINATION

The Corps is required to make every effort to fulfill all statutory authorized project purposes and directions provided by Congress. The features of Section 206, as amended, are authorized by the Water Resources Development Act of 1996. Under Section 206, the Corps identified a viable aquatic ecosystem restoration project. The Corps recognizes that in fulfilling the authorization, the Corps needs to assess whether the impacts of a project rise to the level of "significantly affecting the human environment." The following is an assessment of the impacts of the proposed action when compared to the "significance" of the impact. "Significance" requires considerations of both context and intensity (40 CFR § 1508.27). "Context" means that the significance of an action must be analyzed in several contexts (such as society as a whole, the affected region, the affected interests, and the locality). "Intensity" refers to the severity of impact. Listed below are 10 tests of intensity and Corps determinations that should be considered in the context of Corps proposed action when determining significance.

1) *Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.*
The proposed restoration action will benefit multiple fish and wildlife species, including species that are listed under the Endangered Species Act (ESA). The restoration of hydrologic connectivity and fish and wildlife access to and from the Lower Willamette River, will mimic the natural wetland/floodplain/riparian forest/tidal channel sloughs that were historically widely prevalent in the Columbia/Willamette Rivers estuary complex. A finding of no significant impact is not biased by the beneficial effects of the action.

2) *The degree to which the action affects public health or safety.*
The construction effects will be short-term, localized, and temporary, and as such will have no adverse effects on public health and safety. The closure of the Springwater Trail and the work area to exclude the public from construction zones will prevent a public safety hazard.

3) *Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.*
The project site is a floodplain wetland and pond complex located adjacent to the Lower Willamette River within the City of Portland. The Corps will: protect historic and cultural resources that may be inadvertently discovered during construction; and existing high quality wetlands, shorelines, and streams from construction activities to the maximum extent practicable. There will not be any measurable adverse effects to Essential Fish Habitat. Construction will avoid and minimize impacts to Waters of the United States. There are no prime farmlands, wild and scenic rivers, ecologically critical areas, or other unique natural features in the project area, and thus, no effects will occur to unique geographical characteristics.

4) *The degree to which the effects on the quality of the human environment are likely to be highly controversial.*
The effects of the proposed action are well known and not controversial. The types of restoration activities proposed are supported by the resource agencies. The Corps solicited public comments on the Draft EA. The Draft EA was circulated for a 30-day public and agency review on July 14, 2015. The comment period ended August 14, 2015. During the comment period, two comment letters were received; one commenter requested additional project monitoring and information; the other commenter expressed support for the proposed action.

5) *The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.*
There are no uncertain or unique risks associated with the implementation of the proposed action. None of the features are expected to provide unique or uncertain risks beyond those addressed during the feasibility study.

6) *The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.*
Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303) authorizes the Corps to implement aquatic ecosystem restoration projects. The proposed action does not set a precedent for future actions in scope, scale, or design of a restoration project; nor does it set a future precedent in action or operation of the project area.

7) *Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.*
The Draft EA considered the effects of implementing the proposed action in association with past, present, and reasonably foreseeable actions in and near Oaks Bottom. Significant cumulative impacts were not identified, and the proposed action may incrementally reverse some of the adverse effects of past actions that have occurred in the area.

8) *The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.*
Inspections and testing within the project area have not identified any sites, structures, or objects that are listed or eligible for listing in the National Register of Historic Places. The likelihood of any significant scientific, cultural, or historic resources is low because the site occurs on a historic floodplain subject to river migration, sediment deposition, and erosion. Corps determined that the proposed undertaking will result in a finding of No Historic Properties Affected. Concurrence from the Oregon State Historic Preservation Office was obtained on September 30, 2015. The Confederated Tribes of Siletz Indians, Confederated Tribes of the Grand Ronde Community of Oregon, and the Confederated Tribes of Warm Springs were consulted on this undertaking; no comments were received in regards to the proposed action.

9) *The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.*
While the proposed action may have temporary adverse impacts as a result of excavation, grading, and installation of the culvert, every effort will be made to minimize those impacts by incorporating anticipated conservation measures and best management practices. Corps determined that the proposed action would have "no effect" to U.S. Fish and Wildlife Service listed species and their listed critical habitat. Corps accepted the biological assessment prepared by the applicant (dated August 2010) and consulted with National Marine Fisheries Service (NMFS). The NMFS Biological Opinion (BiOp), dated August 27, 2012, concluded that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, LCR coho salmon (*O. kisutch*), LCR steelhead (*O. mykiss*), or UWR steelhead or result in the destruction or adverse modification of their designated critical habitats. "The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take

statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures."

10) *Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.*

The Corps is required to make every effort to fulfill all statutory authorized project purposes following the balance of purposes and other directions provided by the Congress in the authorization documents. The Corps is also required to take into account other legal mandates such as the Clean Water Act and the Coastal Zone Management Act. The proposed action does not threaten a violation of any law or requirements imposed for the protection of the environment.

20160129
Date

Jose L. Aguilar
Colonel, Corps of Engineers
District Commander

EXECUTIVE SUMMARY

The purpose of this report is to present the results of a U.S. Army Corps of Engineers and City of Portland Section 206 Aquatic Ecosystem Restoration Feasibility Study undertaken to identify and evaluate alternatives for restoring habitat for sensitive fish and wildlife resources at the City of Portland's Oaks Bottom Wildlife Refuge. This report documents the environmental, planning, engineering, and preliminary construction details of the recommended restoration plan. Following approval of this report, the project can proceed to detailed designs and construction.

The Oaks Bottom Wildlife Refuge is a 160-acre park with diverse habitats including an extensive floodplain located along the east bank of the Lower Willamette River at approximately River Mile 16 in southeast Portland, Oregon. The project area is within the 100-year floodplain of the Willamette River, which is within the tidal zone of the Columbia River. The Willamette River merges with the Columbia River approximately 16 miles downstream of the project site. Daily freshwater tidal fluctuations typically range up to 2.5 feet in the project area. Oaks Bottom offers a unique opportunity for a large, natural, tidally influenced floodplain and wetland area to be restored in the heart of the city.

The purpose of the proposed action is to restore a more natural tidal hydrologic connection between Oaks Bottom and the Lower Willamette River, improve diverse fish and wildlife habitats, reduce non-native species populations, and provide unhindered fish passage into and out of Oaks Bottom.

A number of restoration measures were considered during the plan formulation process undertaken in this Feasibility Study and evaluated based on their potential benefits to fish and wildlife and costs. The recommended restoration plan includes the following elements:

- Replacement of the culvert under the railroad berm with a 16-foot by 10-foot culvert,
- Removal of the water control structure,
- Excavation of tidal slough channels to connect to the reservoir and southern ponds,
- Removal of invasive species,
- Revegetation with riparian and wetland species along the channels and around the perimeter of the reservoir and southern ponds, and
- Placement of two viewing platforms adjacent to the Springwater Trail.

The recommended restoration plan would provide unhindered fish passage into and out of Oaks Bottom and reduce the potential for fish stranding and mortality; improve the quality of a variety of natural tidal, floodplain, and riparian habitats; reduce invasive species; and maintain a smaller year-round pond at the south end of the existing reservoir. This plan would also provide important benefits to listed salmonid species that occur in the Columbia River estuary.

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Acronyms and Abbreviations

µg/L	Micrograms per liter
AAFCUs	Average Annual Functional Capacity Units
ADA	Americans with Disabilities
BCR	benefit cost ratio
BMPs	Best Management Practices
BP	Before Present
CE/ICA	Cost effectiveness and incremental cost analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic feet per second
City	City of Portland Bureau of Environmental Services
COP	City of Portland
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DDD	Dichloro diphenyl dichloroethane
DDE	Dichloro diphenyl dichloro ethylene
DDT	Dichloro diphenyl trichloroethane
DDx	DDT, DDD, and DDE (collectively)
EAD	Estimated annual dollars
EPA	U.S. Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCUs	Functional capacity units
FEMA	Federal Emergency Management Agency
FLIR	Forward-Looking Infrared
fps	Feet per second
FY	Fiscal Year
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HGM	Hydrogeomorphic Model
IDC	Interest during construction
LERRDs	Lands, easements, rights-of-way, relocations, and disposal areas
LiDAR	Light detection and ranging
LWD	Large woody debris
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NPV	Net present value
O&M	Operations and maintenance
OAR	Oregon Administrative Rule
OBIC	Oregon Biodiversity Information Center
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
PCBs	Poly-chlorinated biphenyls
Portland Parks	Portland Parks and Recreation
PPA	Project Partnership Agreement
RM	River Mile
UDV	Unit Day Value
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WRDA	Water Resources Development Act
WSE	Water Surface Elevation

1. INTRODUCTION

1.1 Purpose of the Report

The purpose of this report is to present the results of a U.S. Army Corps of Engineers (Corps) and City of Portland Section 206 Aquatic Ecosystem Restoration Feasibility Study undertaken to identify and evaluate alternatives for restoring important fish and wildlife resources at the City of Portland's Oaks Bottom Wildlife Refuge. This report is an integrated feasibility report and environmental assessment and documents the environmental, planning, engineering, and preliminary construction details of the recommended restoration plan.

1.2 Project Authority and Guidance

This study is being conducted under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996, Public Law 104-303. Section 206 provides authority for the Secretary of the Army to carry out aquatic ecosystem restoration projects within the Continuing Authorities Program. These projects usually include manipulation of hydrology in and along bodies of water, including wetlands and riparian areas.

The WRDA of 2014, Section 1030 modified the Federal cost-sharing limits of the Section 206 program; each project in the Section 206 program is now limited to a Federal cost share of not more than $10 million (previous limit was $5 million). This Feasibility Study has been prepared according to the procedures for the Continuing Authorities Program as described in Appendix F of Engineering Regulation (ER) 1105-2-100 for projects under Section 206 of the WRDA of 1996.

1.3 Study Location

The Oaks Bottom Wildlife Refuge is a 160-acre park with diverse habitats including an extensive floodplain located along the east bank of the Lower Willamette River at approximately River Mile (RM) 16 in southeast Portland, Oregon (Figure 1-1 and Figure 1-2). The project area is within the 100-year floodplain of the lower Willamette River, which is within the tidal zone of the Columbia River. The Willamette River merges with the Columbia River approximately 16 miles downstream of the project site. Daily freshwater tidal fluctuations typically range up to 2.5 feet in the project area. Oaks Bottom Wildlife Refuge (hereafter referred to as Oaks Bottom) is owned and operated by the City of Portland Parks and Recreation and was the first wildlife refuge designated within the city. Oaks Bottom offers a unique opportunity for a large, natural, tidally influenced floodplain and wetland area to be restored in the heart of the city.

Figure 1-1 Project Location

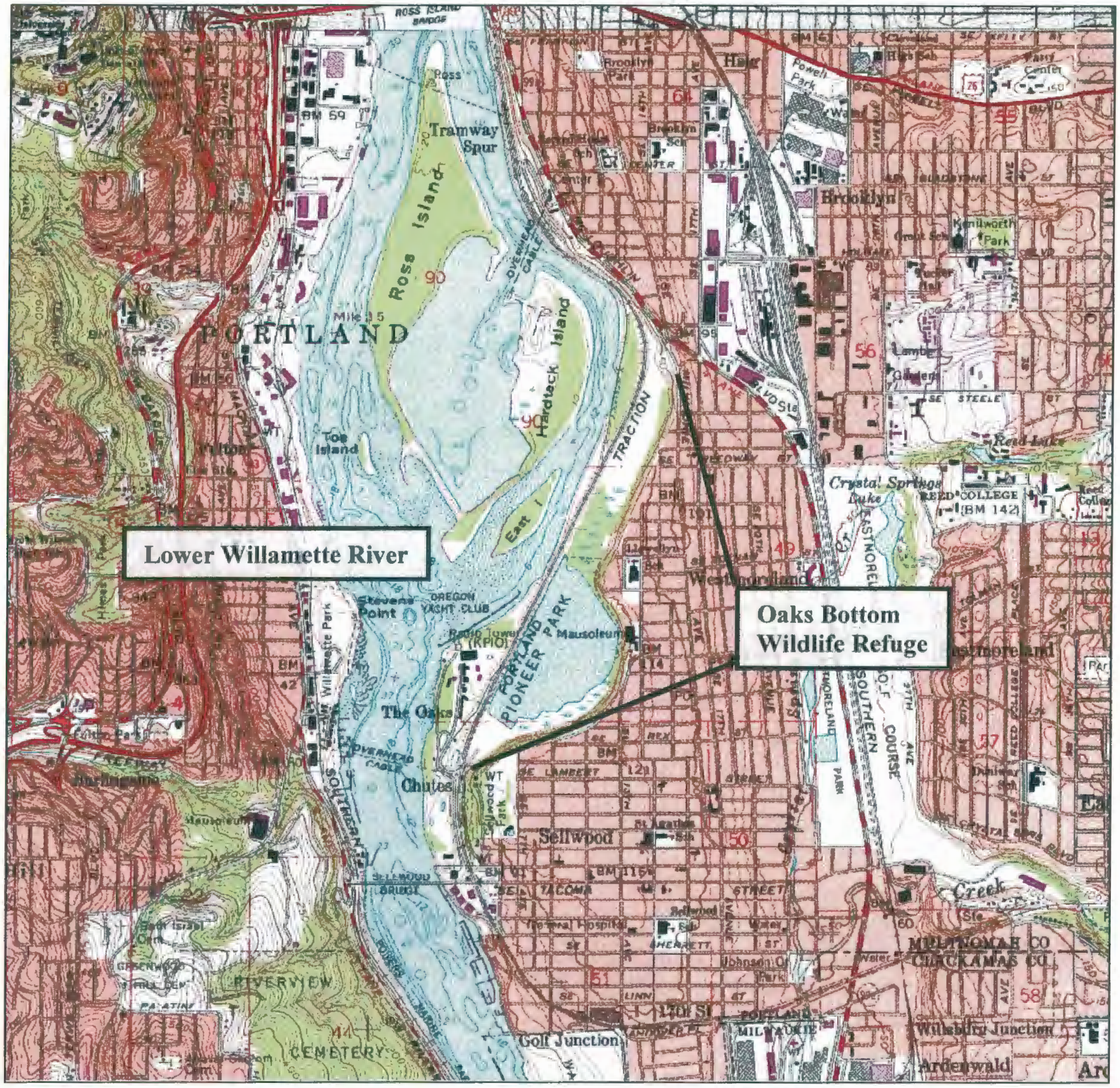

Figure 1-2 Project Location Topographic Map

1.4 Purpose and Need

Historically, the Oaks Bottom study area was part of the Lower Willamette River floodplain and subject to natural river meandering, flooding, and daily tidal fluctuations. The construction of a railroad embankment along the entire western perimeter of the site in the early 1900s mostly isolated Oaks Bottom from the river, except for a small culvert connection. The purpose of the proposed action is to restore a more natural tidal hydrologic connection between Oaks Bottom and the Lower Willamette River, improve diverse fish and wildlife habitats, reduce non-native species populations, and provide unhindered fish passage into and out of Oaks Bottom.

This restoration project is needed because Oaks Bottom is one of the last remaining tidal floodplain habitats in the Lower Willamette River and could provide a large area for juvenile salmon rearing and refuge habitat. Under current conditions, the site is mostly inaccessible to salmon due to the railroad berm with a small culvert that precludes salmon access with high velocities and poor positioning (the culvert is disconnected during low tides and completely submerged at high tides). In addition, much of Oaks Bottom is dominated by non-native fish and plant species that have reduced habitat values for native fish and wildlife. If no action were taken, the habitats would continue to remain mostly disconnected from the river, continuing to cause fish stranding and mortality, and become ever more dominated by non-native plant and animal species, further reducing habitat values for native species.

The scope of this ecosystem restoration action would include restoration of a natural tidal hydrologic regime to the site (to allow daily tidal fluctuations and riverine connections) and access to approximately 60 acres of aquatic and floodplain wetland habitat that is currently inaccessible to fish species during the primary juvenile salmonid rearing and refuge season (defined for the purposes of the project as November to June). It would also improve wildlife habitat and migratory corridors, and restore associated native vegetation communities.

1.5 Project History

The Oregon Pacific Railroad Line was constructed along the Lower Willamette River in the early 1900s; this includes a raised berm and likely buried trestle that effectively separate Oaks Bottom from the natural hydrologic fluctuations of the Willamette River. A 5-foot-diameter culvert (invert elevation 7.2 feet City of Portland [COP] datum[1] at upstream end, which is just below the daily mean water surface elevation) exists and was likely installed through the embankment to allow drainage from Oaks Bottom out to the Willamette River, although it is not known precisely when or by whom the culvert was installed. However, the culvert does not provide effective fish access under most conditions and likely causes stranding of the few fish that do manage to enter due to limited outflows. The potential stranding of salmonids likely causes increased mortality to the populations that use the Lower Willamette River. Figure 1-3 shows the location of major features within the project area for reference.

Following construction of the railroad berm, portions of the project site were used as a landfill, including the North and South Fill areas, thus reducing the floodplain. The City of Portland acquired the South Landfill property from the Donald M. Drake Company in 1969 in order to block its development as an industrial park. The area was believed to be one of the few remaining tidal marshland areas in Portland, and local residents were strongly opposed to its development as an industrial property. Local residents, students, environmental and community groups campaigned during the 1970s to protect the wildlife habitat and provide park amenities. In 1987, Oaks Bottom was designated as the City's first wildlife refuge. A Management Plan (Houck 1988) was developed in 1988 to guide the City's management of the refuge for fish and wildlife habitat enhancement and protection and passive recreation. Restoring more diverse native plant communities was a key component of the management plan, including the construction of a water control structure to reduce the area dominated by willows and control invasive non-native species.

The water control structure was constructed in 1989 to impound a reservoir within the Oaks Bottom Wildlife Refuge, the benefits of which included an increase in the area of open water habitat for waterfowl, reduction in the area of non-native reed canary grass and what was perceived to be thickly

[1] The City of Portland (COP) uses its own datum that is 1.375 feet above National Geodetic Vertical Datum or NGVD 1929 and 2.10 feet below North American Vertical Datum or NAVD 1988. All elevations in this document are in the COP datum because the City requires all project designs to be recorded in its own datum to allow direct comparisons to City infrastructure and other data.

overgrown willows, and a reduction in mosquito populations (Houck 1988). The reservoir can be managed between elevation 8 and 14 feet (COP datum) by the placement and removal of flash boards within the structure, which isolates the reservoir from tidal fluctuations and typical river flows. The water control structure and reservoir have not been successful in reducing non-native plant species, and purple loosestrife, has become dominant within the reservoir. In the past decade, Portland Parks and Recreation initiated additional vegetation management, particularly in the upland prairie and oak savannah habitats, to promote native species and reduce blackberries and other invasive species.

The proposed restoration project is a collaborative effort between the Corps and the City of Portland Bureau of Environmental Services (City) and Portland Parks and Recreation (Portland Parks). Restoration planning has been under way for the project since at least 2001, when Portland Parks hired a consultant to conduct a habitat assessment and develop restoration recommendations (MWH 2002). In 2003, the Corps began a Section 206 Feasibility Study to evaluate restoration alternatives and develop a recommended restoration plan. A tentatively recommended restoration plan was identified that included replacement of the culvert, removal of the water control structure and installation of weirs, revegetation around the reservoir, revegetation around the ponds, moderate reservoir contouring/creation of islands, and excavation of channels and sloughs. However, due to changed priorities for Federal funding, the Feasibility Study was suspended in 2004 due to a lack of funding and not completed.

In 2007, the City separately used capital funding to complete a pre-design study to continue progress on the tentatively recommended restoration plan and conduct additional analyses to prepare preliminary restoration designs, with the intent of restarting the partnership with the Corps when funding again became available. During the City's pre-design study, a number of issues were raised relative to the design of the project, which required additional investigation, including:

- Potential effects of tidal channel/slough excavation on existing wetlands,
- Fish passage and habitat use criteria,
- Construction methods and culvert versus bridge alternatives, and
- Sediment and water quality contamination.

The City continued design work and technical investigations with capital and grant funding in anticipation of additional Corps funding in 2010. Additional data have been collected and analyzed by the City to help answer questions and address all of the issues identified above.

In 2010, the City requested that the Corps reinitiate this Feasibility Study.

Figure 1-3 Project Area Features (reservoir area outlined in blue)

1.6 Other Planning Studies, Reports, or Efforts

Willamette River SubBasin Plan – The *Willamette Subbasin Plan* was completed in 2004 as one of the plans developed for the Northwest Power and Conservation Council that oversees fish and wildlife mitigation and management for Bonneville Power Administration (BPA) within the Columbia River Basin (which includes the Willamette River). The plan was prepared to identify restoration and conservation needs and develop a strategy for achieving watershed health and species recovery. The plan identifies several priority conservation themes for restoring fish and wildlife to productive and sustainable levels throughout the basin including: fixing culverts and diversions to allow fish passage; restoration of lowland riparian areas; and restoration of the Willamette River floodplain.

Lower Willamette River Ecosystem Restoration GI Study – This study is a cost-shared study between the Corps and the City of Portland and is focused on the identification and evaluation of ecosystem restoration opportunities throughout the Lower Willamette River and its tributaries to enhance fish and wildlife habitats and provide fish access. This study initially included Oaks Bottom as a potential restoration site, but now that this study is underway, the Oaks Bottom site is no longer being considered as part of that study. One site being considered in the vicinity of Oaks Bottom is at Sellwood Riverfront Park just upstream of Oaks Bottom. This site could be restored to improve riparian habitat and create an off-channel area and wetland.

South Riverbank Projects – The City of Portland has implemented seven riverbank and riparian restoration projects on the left bank of the Lower Willamette River across and upstream of Oaks Bottom. Features included stormwater swales, riparian revegetation, placement of wood, removal of invasive species, and removal of concrete and other materials.

Stephens Creek Enhancement – The City of Portland implemented a creek channel and floodplain habitat restoration project at the mouth of Stephens Creek across the Willamette River from Oaks Bottom. Habitats restored included floodplain backwater, riparian zone, and improved cover in the channel and as it enters the Willamette River.

1.7 Planning Process

Development of this Feasibility Study followed the Corps' six-step planning process specified in ER 1105-2-100. This process identifies and responds to problems and opportunities associated with the Federal objective, as well as specified state and local concerns. The process provides a flexible, systematic, and rational framework to make determinations and decisions at each step. This allows the interested public and decision-makers to be fully aware of the basic assumptions employed, the data and information analyzed, the areas of risk and uncertainty, and the significant implications of each alternative plan.

As part of identifying the recommended plan, a number of alternative plans were developed and compared with the "No Action" alternative, allowing for the ultimate identification of the National Ecosystem Restoration (NER) Plan. The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options.

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2. INVENTORY AND FORECAST OF RESOURCE CONDITIONS

2.1 General

Oaks Bottom is a wildlife refuge and nature park located in the floodplain of the lower Willamette River between RMs 15 and 16, adjacent to Ross, Hardtack, and East Islands. The project site is located on the right overbank (east side) of the lower Willamette River and is situated below the bluff on the western edge of the Sellwood-Westmoreland neighborhood of southeast Portland. On its west side, the site is bounded by a railroad embankment that separates Oaks Bottom from the Willamette River. The project area includes the floodplain between the North and South Fill areas, including the North Wetland, Duck Ponds, and Reservoir Area. A channel connects from the culvert to the water control structure and then on up to the reservoir. There are a number of springs that arise from the bluff along the east side of the refuge that flow into the North Wetland and several small channels that connect to the main channel connecting the reservoir to the culvert.

The project area is owned and operated by Portland Parks as a natural area and wildlife refuge with passive recreational features. The railroad embankment is now owned by the Portland Metropolitan Regional Government (METRO) and the railroad line on top of the embankment is a third-party easement for the Oregon Pacific Railroad and used for regular transport of commercial goods between the Union Pacific Railroad mainline to the north down to warehouses and distribution centers located in Milwaukie, Oregon, south of Portland. The Springwater Trail is also located on top of the railroad embankment and is managed by Portland Parks as a multi-use recreational trail. Oaks Bottom Wildlife Refuge is accessible to the public from the Springwater Trail, from trails from Sellwood Park located on the bluff to the south and east of Oaks Bottom and from a designated parking area located at the northeast end of the refuge off of Milwaukie Avenue.

Oaks Bottom is a 160-acre former floodplain and wetland area of the Willamette River that has been isolated by the railroad embankment and has been further degraded by the placement of fill on both the north and south ends of the site and disturbance prior to its designation as a wildlife refuge that promoted the invasion of non-native species. The only connection to the river is via a 5-foot-diameter culvert under the railroad line with an upstream invert elevation of 7.2 feet (City of Portland datum), which is just above the mean tide level, thus connecting only at high tides or when the river elevation is higher during storm events. The culvert precludes fish passage nearly 50 percent of the time simply because of its invert elevation. A water control structure is located approximately 50 feet upstream of the culvert and is used to impound a large reservoir in the southern half of the site. This water control structure further precludes tidal inflows and fish passage and is in poor structural condition (water flows under and around the structure in multiple locations). Several habitat types are present within the refuge including a 60-acre open water pond/reservoir; mixed wetland habitats north of the reservoir; open grassland on the south fill area; Willamette River riparian (between the railroad line and the river); and upland forest and grasslands on the bluffs.

The Lower Willamette River provides migratory and rearing habitat for all of the salmon species that utilize the Willamette River, as well as habitat for a diversity of other aquatic and terrestrial species. Salmonid species in the project area include Chinook, coho, and chum salmon, bull trout, steelhead, and cutthroat trout. Several species of lamprey are also likely to be present. The Lower Willamette River through the project area is highly developed for industrial, commercial, and residential purposes. Much of the river is fringed by seawalls or riprapped embankments. The thousands of acres of deltaic wetlands and riparian zone that historically occurred within and along the Lower Willamette River are almost non-existent today. Oaks Bottom is the largest remaining floodplain wetland habitat along the Lower

Willamette River upstream of Sauvie Island. This project presents a unique opportunity to restore tidal slough habitat, access to rearing and refuge habitat for juvenile salmonids, and suitable habitat for other native fish including lamprey species. It also provides habitat for native amphibians, migratory songbirds, raptors, and waterfowl.

Tidal hydrology and fish passage from the river to the project area is limited to a 0.02-acre area below the water control structure except when river levels exceed ordinary high water (2-year flow event). During higher river stages the culvert is submerged and surface-oriented juvenile salmonids do not typically dive down to enter structures below the surface. Thus, salmonid access is likely to be very limited; to date no salmon have ever been captured in Oaks Bottom. For any fish that may occasionally enter the culvert, stranding is highly likely to occur following a flood event because the water control structure is not fish passable. One indication of the level of degradation is that very high numbers of non-native carp occur in Oaks Bottom using the vegetated areas for spawning, whereas native fish are limited in number. Carp use warm vegetated backwaters for spawning and also stir up high levels of turbidity because they typically uproot vegetation and stir up the sediments while feeding.

The reservoir currently provides important waterfowl and herptile (amphibians and reptiles) habitat, but has poor water quality conditions such as high temperatures and turbidity. The existing reservoir with warm water and dense perimeter vegetation (i.e., purple loosestrife) provides excellent spawning habitat for the non-native carp and has likely contributed to their dense population. Warm water conditions provide poor habitat for native fish (i.e., salmonids, lamprey) and amphibians. The wetland areas to the north of the reservoir have wide-spread exotic plant species problems, particularly with reed canary grass (*Phalaris arundinaceae*), Himalayan blackberry (*Rubus procerus*), and purple loosestrife (*Lythrum salicaria*), which occupy 75 to 100 percent of the understory. The wetland area does provide habitat for numerous small mammal species and amphibians and reptiles. The surrounding bluffs and south landfill have numerous exotic plant species and are also used extensively by neighborhood residents for jogging and other passive recreation. The surrounding neighborhood is primarily residential and Oaks Bottom provides an important green space within the otherwise urbanized landscape.

In general, future without-project conditions are anticipated to result in a continued decline in overall habitat quantity and quality. Conditions would include the continued spread and higher dominance of non-native species; the culvert and water control structure would continue to limit tidal connectivity, and fish habitat will likely remain degraded and largely inaccessible; and fish will continue to be periodically trapped within the reservoir where they would most certainly die due to high temperatures and predation. Although the City would continue to manage Oaks Bottom Wildlife Refuge primarily for native amphibian and waterfowl habitat, these efforts would not result in a sustainable, long-term solution to the lack of tidal connectivity, high water temperatures, spread of non-native plants, or lack of fish access or habitat value. For each of the following resource areas addressed below, future conditions without restoration efforts are described.

2.2 Hydrology

The Willamette River Basin drains over 11,000 square miles of the Coast Range, Cascade Mountains, western foothills, and the Willamette Valley. The mainstem Willamette River flows for 185 miles from the confluence of the Middle and Coast Forks of the Willamette, and is the largest river wholly contained within the State of Oregon (WRI 2004). The Lower Willamette River extends from the confluence with the Columbia upstream to Willamette Falls (at RM 27) and is tidally influenced through the Columbia River, which flows out to the ocean. Daily tides range from 1 to 2.5 feet in the vicinity of Oaks Bottom. Oaks Bottom collects runoff from a small basin of approximately 240 acres that includes the entire refuge and a small fringe of the bluff surrounding the site. A number of springs are present along the bluff that provide continuous flow year-round to the wetlands and small channels throughout the floodplain of Oaks Bottom.

The City and others have conducted extensive monitoring of surface and groundwater elevations in the project area and at the outlet of the culvert along the Willamette River. Figure 2-1 shows the water surface elevation frequency curve for the Lower Willamette River on a daily average basis throughout the year and then for the November 1 to June 15 juvenile salmonid rearing season. The arrow on the figure shows the frequency at which the low tide elevation meets or exceeds the culvert elevation (approximately 42% of the time). The median daily mean water surface elevation is approximately 7.7 feet (exceeded 50 percent of the time), which would provide approximately 6 inches of depth at the upstream end of the existing culvert (7.2 feet elevation) approximately 50 percent of the time. The rearing season median daily mean water surface elevation is approximately 8.7 feet, which provides approximately 18 inches of depth at the upstream end of the existing culvert approximately 50 percent of the time. The existing culvert has been observed to have high velocities when there is a foot or more of head difference between the river stage and the water level in Oaks Bottom. Velocities in the culvert exceed 2 feet per second (fps) from 30 to 70 percent of the time, depending on the hydrology in the Willamette River, which can preclude fish passage.

In addition, the water control structure immediately upstream of the culvert blocks tidal flow from coming into Oaks Bottom and prevents fish passage into the site until the Willamette River exceeds the elevation of the water control structure. The top elevation of the water control structure is 14 feet, which is only equaled or exceeded less than 5 percent of the time. As high flows recede below 14 feet, any fish that may have passed into the reservoir would almost certainly become trapped behind the water control structure because the primary outflow is via small channels undermining the structure or via spill over the top of the structure that drops onto rocks below.

The reservoir can impound up to 60 acres when all of the flashboards are installed. Additionally, when the Lower Willamette River stage is above ordinary high water (calculated to be at 18.2 feet), over 70 acres of the refuge can be inundated (labeled as the South Pond/Reservoir in Figure 2-2). An existing high spot along the channel from the reservoir to the culvert generally maintains the reservoir at a minimum size of 4 to 6 acres even when all the flashboards at the water control structure are removed. The North Wetland area also becomes inundated when the Willamette River is above ordinary high water, with approximately 15 acres inundated to a depth of 3 feet or more.

The City operated the water control structure from its installation in 1989 to approximately 2010 to impound a 40-60 acre reservoir during the winter and spring months. The flashboards were typically installed to an elevation of 12 to 14 feet (COP datum) in October and then removed to an elevation of about 7 feet in April. This operation typically prevented purple loosestrife, reed canary grass, and willows from establishing in an approximately 40 acre area – a variety of annual emergent wetland species colonized portions of the reservoir area in the summer months. Since approximately 2010, the City has not installed the flashboards and allowed Oaks Bottom to flood naturally during spring runoff. This has promoted the spread of purple loosestrife into much of the reservoir area, but has also allowed the City to begin plantings of native species such as cottonwood and willows around the perimeter of the reservoir to begin to shade out invasive species.

Groundwater monitoring from piezometers installed in the refuge have indicated there is an overall net outflow of groundwater from the bluff toward the river. A minimum of 0.2 cubic feet per second (cfs) of groundwater flow exits as surface water into the channel from the reservoir on an average annual basis. The springs are an important source of cold water to the refuge and channels and could provide very high quality habitat for salmonids if access was restored. This continuous outflow would also assist salmonids to find their way out of the refuge when river flows and elevations drop in late spring and early summer.

Figure 2-3 shows the estimated water budget for the project site with precipitation, stormwater runoff, and groundwater inflows resulting in continuous surface water discharge/outflow through the culvert.

The hydrology and geologic conditions of riverine and tidal systems is the primary driving force in habitat development. Complex hydrologic forces are required to maintain diverse habitats that meet the needs of each life stage of salmonid development. Persistent shallow or slack water habitats are especially important for survival of early life history stages of fishes. Regular scour and meandering of a natural system regulates growth of native and non-native plant species. Altered hydrology and loss of tidal floodplain inundation have resulted in environmental conditions to which native species are not well adapted. This has created opportunities for non-native plants to outcompete native plants and non-native fish to outcompete native fish.

Habitat diversity along the heavily urbanized Willamette River has been substantially reduced as a consequence of upstream hydrologic regulation, bank armoring, and floodplain filling/development. Tidal backwater rearing habitat is now extremely rare in the area.

If the existing culvert remains in place, the natural tidal hydrologic connection between Oaks Bottom and the Willamette River will continue to be severely restricted. Though the City could modify the water control structure by removing flashboards, without fundamental modification, the structure would continue to hinder fish ingress and egress to Oaks Bottom, except at high flows, and would continue to be a trapping hazard. In the future without-project condition, this unnatural regime of limited tidal fluctuation within Oaks Bottom will likely result in increased densities of non-native fish and plant species that are able to out-compete native species, and salmonids would continue to rarely enter the site.

Summary Statistics (Period of Record)

	Daily WSE (ft, COP Datum)		
	Daily Avg.	Low Tide	High Tide
Min.	3.99	2.37	4.51
Max.	30.12	29.35	30.67
Mean	8.46	7.38	9.75
Median	7.73	6.61	9.18

Summary Statistics (Nov-Jun Rearing Season)

	Daily WSE (ft, COP Datum)		
	Daily Avg.	Low Tide	High Tide
Min.	3.99	2.67	4.51
Max.	30.12	29.35	30.67
Mean	9.47	8.55	10.53
Median	8.77	7.82	9.91

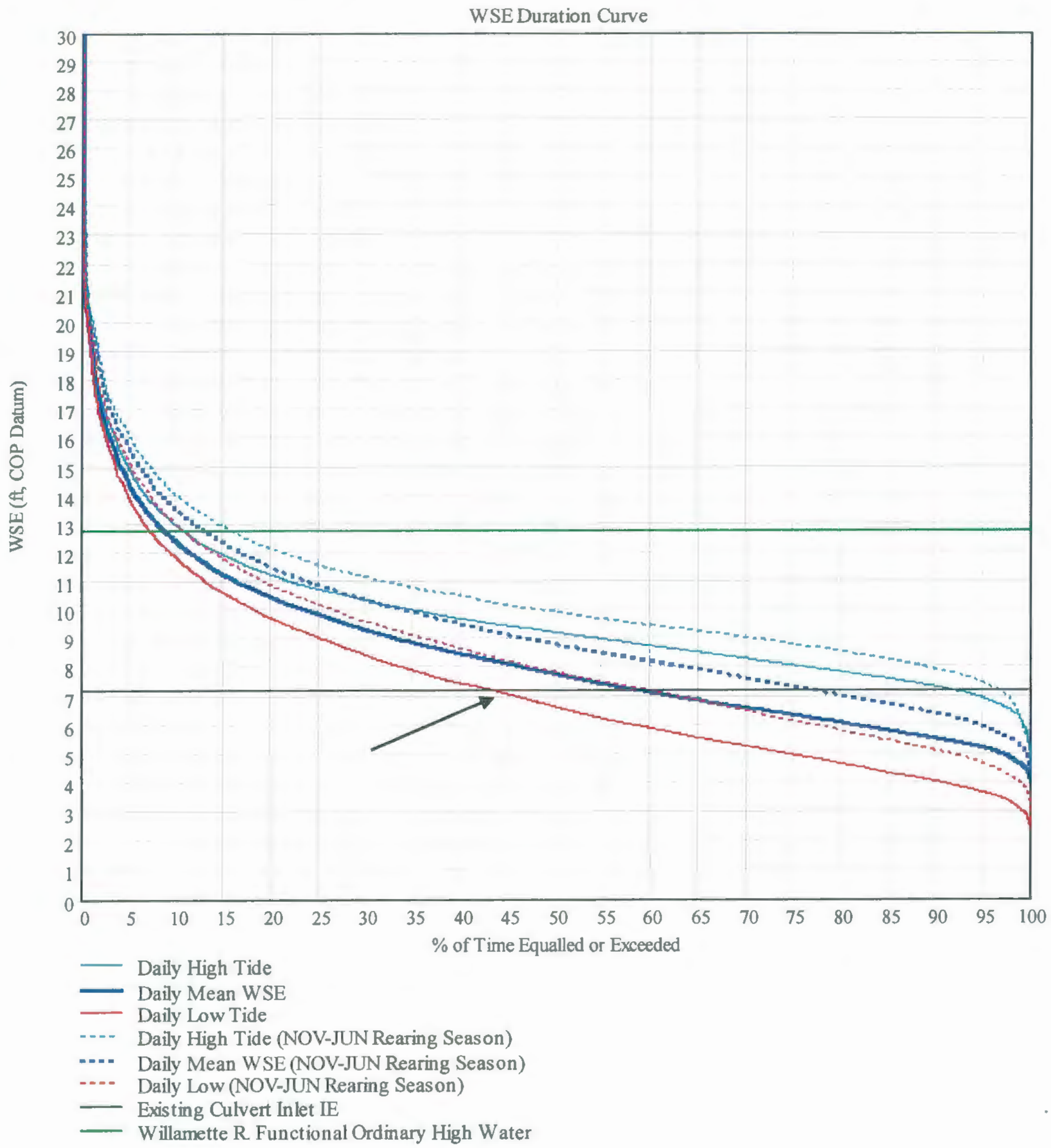


Figure 2-1 Water Surface Elevation (WSE) Frequency Curves, Lower Willamette at Oaks Bottom

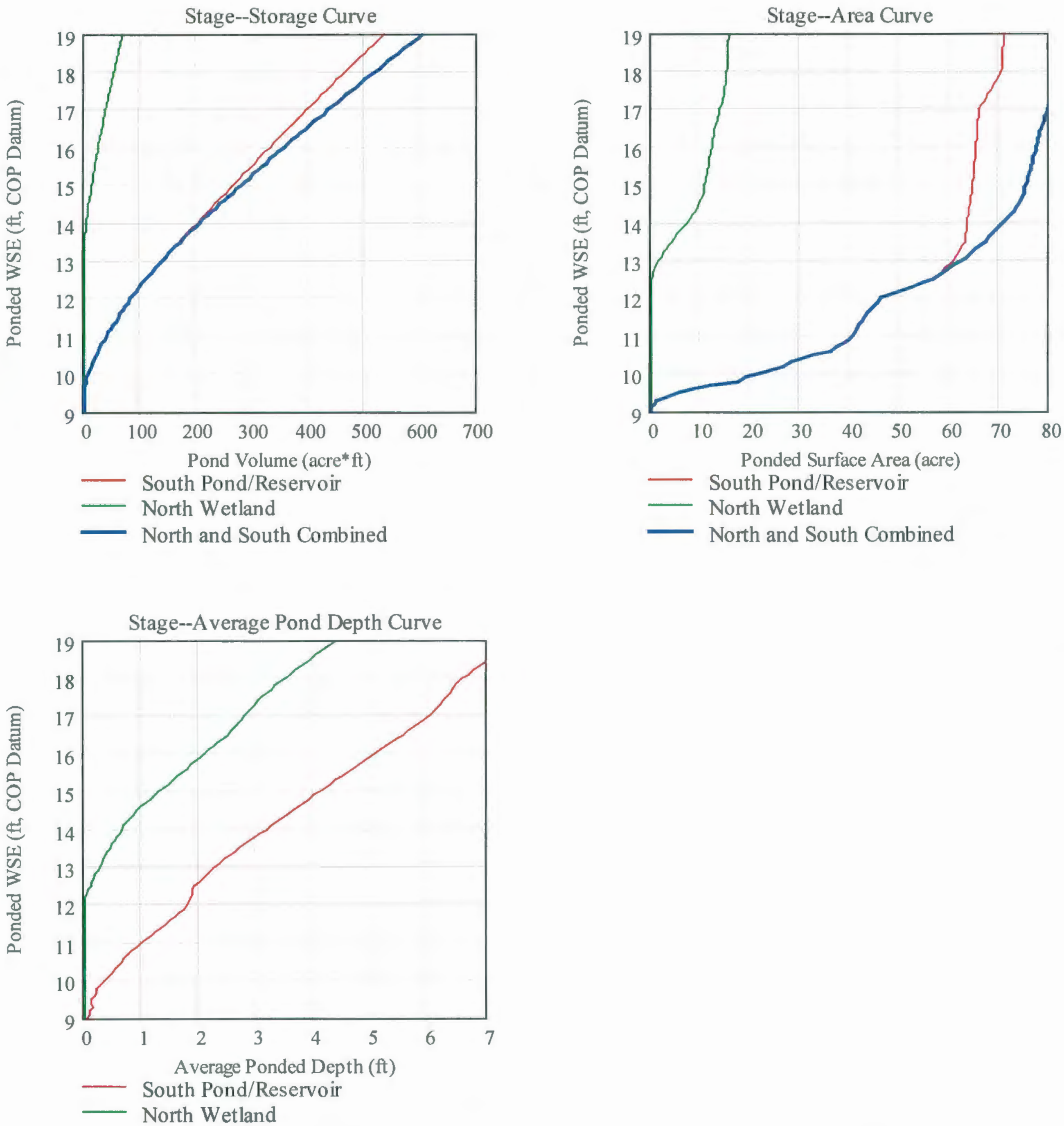
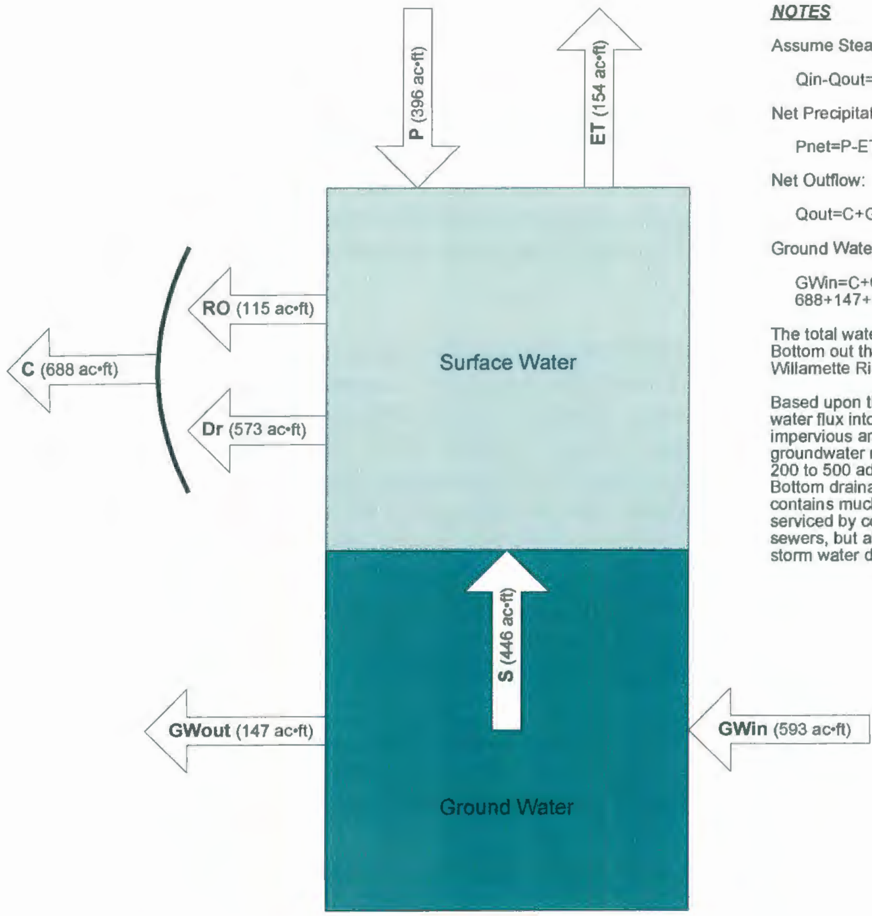


Figure 2-2 Reservoir Volume Storage Curve, Surface Area Curve, and Average Pond Depth Curves

Estimated Annual Water Budget for Oaks Bottom: Preliminary Analysis



<u>*NOTES*</u>

Assume Steady-state Conditions:

Qin-Qout=dVol/dt=0

Net Precipitation:

Pnet=P-ET ==> 396-154=242 ac•ft

Net Outflow:

Qout=C+GWout ==> 688+147=835 ac•ft

Ground Water Influx:

GWin=C+GWout+ET-P ==> 688+147+154-396=593 ac•ft

The total watershed area draining to Oaks Bottom out through the culvert and to the Willamette River is about 125 acres.

Based upon the computed value for the ground water flux into the site (assuming a mapped impervious area of about 35%), the groundwater recharge area is an approximate 200 to 500 additional acres outside of the Oaks Bottom drainage. The presumed recharge area contains much of the Sellwood district which is serviced by combined sanitary and storm sewers, but also has a significant number of storm water drywells/sumps (a.k.a., UIC's).

Variable	Description	Data Source	Annual Volume (ac•ft)	Average Flow/Flux (ft^3/s)
P	Total Precipitation	Rainfall Record	396	0.55
ET	Evapotranspiration	City MIKE-SHE Modeling	154	0.21
RO	Direct Rainfall Runoff	City MIKE-SHE Modeling	115	0.16
C	Culvert Out Flow	Monitoring Data	688	0.95
Dr	Drainage	Computed (Dr=C-RO)	573	0.79
S	Seepage	Computed (S=GWin-GWout)	446	0.62
GWin	Ground Water Influx	Computed (See Notes)	593	0.82
GWout	Ground Water Outflux	IGW Modeling	147	0.20

Figure 2-3 Water Budget

2.3 Geology/Soils

The project area is within the floodplain of the Lower Willamette River and generally consists of the naturally deposited Quaternary alluvium and the fill deposits placed by human activities at the north and south ends of the project area.

Soils are mapped at the project site as Rafton silt loam and Sauvie-Rafton-Urban land complex. Rafton silt loam is a very poorly drained soil on broad floodplains of the Columbia River formed from recent alluvium with some mixing of volcanic ash. The water table is typically within 12 inches of the surface from December through July. The Sauvie-Rafton-Urban land complex is poorly drained Sauvie soils and very poorly drained Rafton soils that have been filled, graded, cut, or otherwise disturbed (Soil Conservation Service 1983). The hill slope to the east side of the project area is mapped as consisting of Quaternary, unconsolidated, stratified silt, sand, and gravel deposits. Troutdale cemented gravels have also been encountered in nearby water wells at an elevation corresponding to approximately mean sea level.

Geotechnical investigations through the railroad embankment at the location of the proposed culvert have indicated that the embankment is composed of poorly to moderately compacted silty, gravelly sand. There is also indication from a ground-penetrating radar survey of a buried timber trestle structure. Beneath the embankment is approximately 6 feet of plastic, clayey silt, then below that layer are granular deposits including silty sands and silty sandy gravels. At 108 feet below the embankment surface, there are very dense silty gravelly sands and silty sandy gravels that are believed to be representative of the Troutdale formation (Northwest Geotech 2010).

Part of the park is built on a sanitation landfill consisting of 400,000 cubic feet of construction waste material, which has been overlaid with soil (south landfill). Another area of fill was created by material moved during highway construction (north fill).

The project area also lies within the Portland Hills fault zone, which includes a series of northwest-trending subsurface faults, including the Portland Hills fault, East Bank fault, and Oatfield fault that extend for a distance of approximately 25 miles along the Portland Hills (Northwest Geotech 2010).

The physical composition of soils and existing geology conditions are not anticipated to change into the future. Sediment quality conditions are more closely examined in the following section.

2.4 Water and Sediment Quality

A number of agencies have conducted water and sediment quality sampling at Oaks Bottom. The City has conducted water quality sampling, including extensive temperature monitoring, within the reservoir and channel leading to the culvert. The City and Corps also have conducted sediment quality sampling, especially in association with the south landfill and in areas where the pesticide DDT (dichloro diphenyl trichloroethane) and its breakdown products have been identified in the past.

The City conducted water temperature monitoring from May through October 2008 and captured representative low flow (summer/fall) temperatures for groundwater, the reservoir, and within the channel at both the water control structure and culvert. Temperatures during the winter months are typically cold. Flows passing through the culvert were also monitored. Over the period of monitoring, groundwater temperatures only varied within a range of 50° to 55°F (10° to 13°C) and showed no daily fluctuation. However, surface water temperatures varied widely and showed a great deal of daily fluctuation up to as high as 90°F (32°C). Being a shallow and open water body, the reservoir naturally heats up and its temperatures were on average about 7°F (4°C) higher than those at the culvert. In 2011, the City conducted a Forward-Looking Infrared or FLIR mapping that showed several cool inflows between the pond and the culvert (Figure 2-4). This suggests that a relatively steady supply of cooler groundwater is surfacing between the pond and culvert, contributing to the culvert's total flow and to the somewhat cooler water temperatures within the channel as compared to either the reservoir or the river.

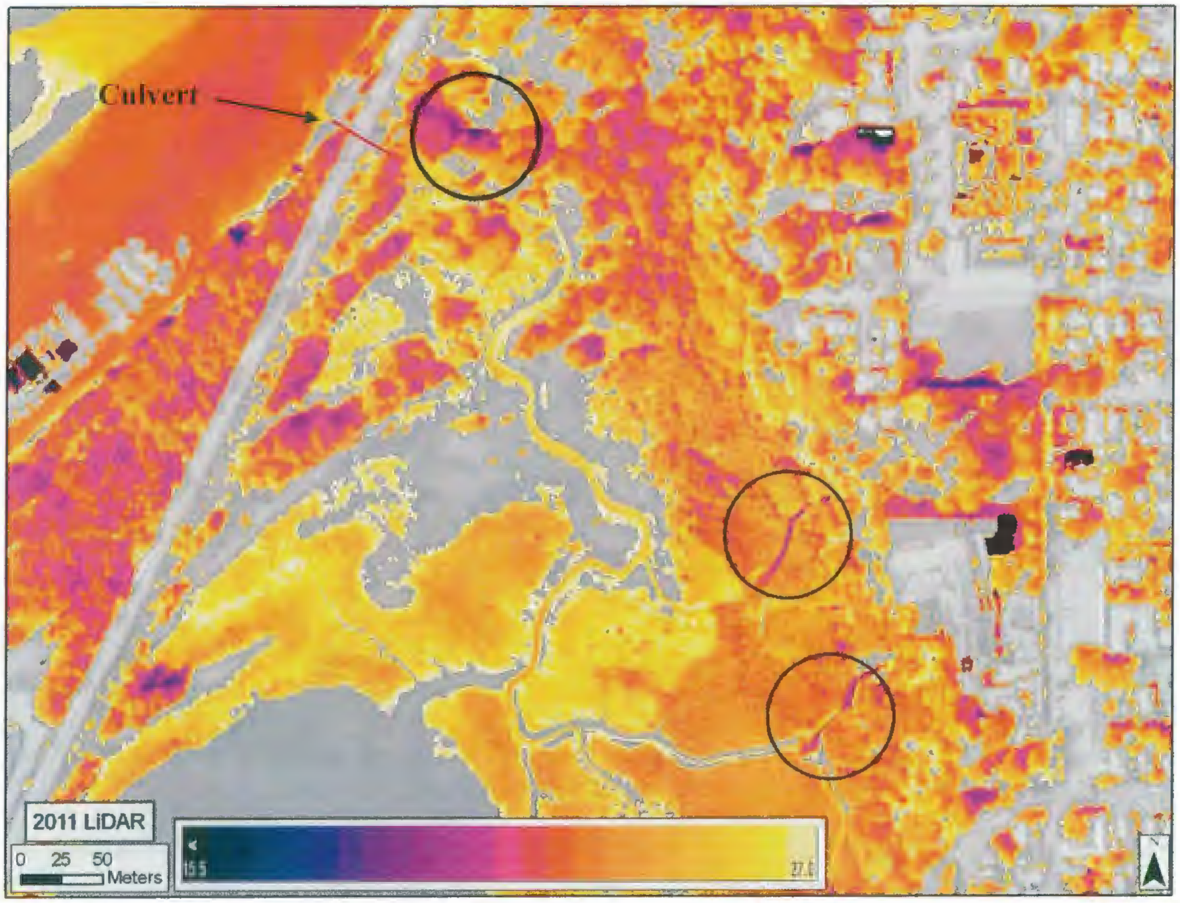


Figure 2-4. Forward-Looking Infrared Image of Oaks Bottom Showing Water Temperatures
(Circles show key cooler water inputs from springs and groundwater flow.)

Water within the reservoir varied from 50° to 90°F (10 to 32°C) over the year, while water passing through the channel at the water control structure varied from 46° to 84°F (8 to 29°C) over the year. Water temperature at the culvert varied from 50° to 81°F (10 to 27°C) over the year and reflects inflows from the Willamette River as well as outflows from the reservoir and groundwater flows. Temperatures at the culvert (river-dominated) are typically less than 59°F (15°C) from October to mid-June and increase as river flows decrease and temperatures in the reservoir increase throughout the summer and early fall prior to the onset of the rainy season. Past sampling in the Lower Willamette River has indicated the river temperatures immediately outside the culvert can exceed 77°F (25°C) during the summer (City of Portland 2010d). Salmonids typically prefer water temperatures below 61°F (16°C) (Bjornn & Reiser 1991) and naturally move out of floodplain habitats as water temperatures rise when access is unimpeded. Oregon water quality standards for salmonid rearing and migration require temperatures less than 64°F (18°C) (Oregon Department of Environmental Quality [ODEQ] 2012).

The City conducted comprehensive water quality sampling in 2007 and 2009 to identify contaminants of concern within Oaks Bottom. Past sampling by the Corps (2003) identified the presence of antimony, arsenic, chromium, copper, lead, mercury, nickel, poly-chlorinated biphenyls (PCBs), benzo(a)pyrene, DDD or dichloro diphenyl dichloroethane, DDT, and heptachlor; although none had been found at particularly high levels except for copper. Figure 2-5 shows the location and year of water quality sampling, as well as the location of potential restoration measures and project features, which were used as a guide for some sampling efforts.

The City conducted sampling in 2009 for conventionals, petroleum hydrocarbons, metals, PCBs, volatile organic compounds, semi-volatile organic compounds, and pesticides. The results of the 2009 water quality sampling indicated that lead was the only contaminant of concern above published levels or screening criteria at Oaks Bottom, and that it was present at Site 8 in the reservoir at levels of 2.97 micrograms per liter (μg/L), which is only slightly above the freshwater screening criteria of 2.5 μg/L (City of Portland 2010a). It appears the natural breakdown of chemicals over time and/or flushing has substantially reduced the presence of contaminants of concern for surface waters in Oaks Bottom.

Groundwater was sampled from a boring in the south landfill in 2009 (City of Portland 2010b) and from the seeps emerging from the landfill to identify if contaminants might be seeping from the landfill into the reservoir area. The groundwater samples from the landfill exceeded screening criteria for arsenic. However, arsenic was not detected above screening levels in the reservoir, so it does not appear to be migrating from the landfill. Though one reservoir sample was above the screening level for lead, this contaminant was not found in the seep sample or other samples, so it likewise does not appear that lead is migrating from groundwater in the landfill to surface waters.

Sediment quality sampling in the past (Corps 2003) had indicated several contaminants of concern present in sediments at Oaks Bottom including DDT, DDD, DDE, dieldrin, PCBs, and gamma-chlordane. The City conducted additional sediment sampling throughout the site and at the south landfill in 2006, 2007, 2009, and 2010 (Figures 2-5 and 2-6). Several 2006 samples from the landfill had levels of arsenic and lead above screening levels. Chromium and cadmium were detected above screening levels in one sample each. DDD was detected above screening levels in one sample.

The City conducted sediment sampling in 2007 to identify the presence and levels of contaminants of concern specifically in areas of proposed excavation, including the reservoir, channel, and culvert area. The contaminants detected above screening levels included pesticides, DDT, DDD, DDE, and chlordane. The DDT suite was detected in several samples. This information was incorporated into a Level 1 Assessment prepared by the City (2010c). The receptors of concern at Oaks Bottom include benthic organisms, fish, and birds. Benthic organisms and fish are potentially at risk through dermal contact or ingestion of sediments. Birds are potentially at risk from consuming benthic organisms or fish.

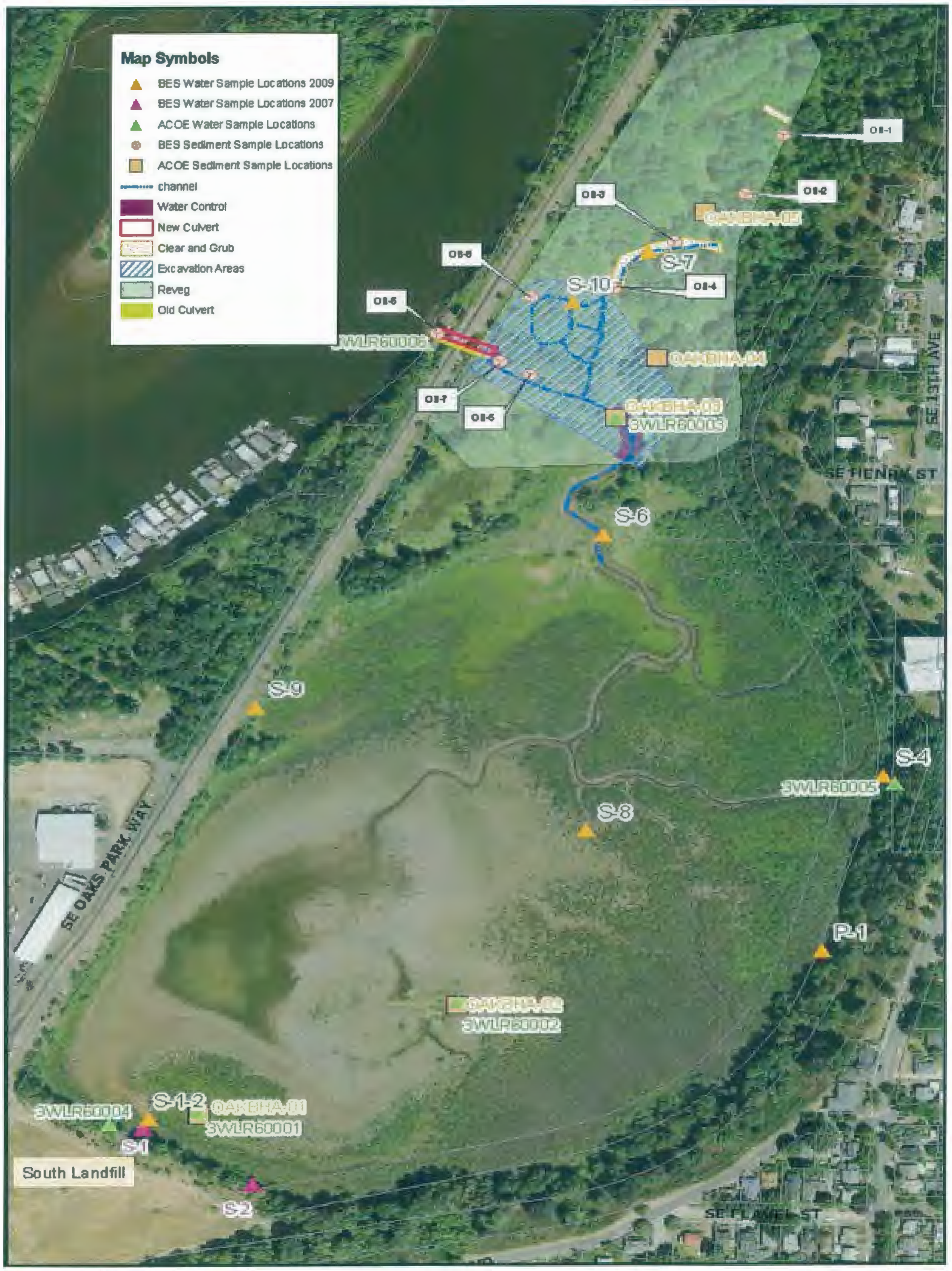


Figure 2-5 Water and Sediment Sampling Locations

Figure 2-6 Landfill Sampling Locations

Additional sampling was then conducted in 2009 and 2010 based on the Level 1 Assessment and the Sampling and Analysis Plan developed for and reviewed by the Project Review Group[2]. The areas of proposed excavation were sampled at the existing surface and at the depth of the proposed "new surface" that would be exposed after excavation. Additional areas not currently included in the proposed project design, but which could be considered in the design, were also sampled. The results of this sampling indicate that DDT, DDD, and DDE (collectively DDx) are present in both the channel and in the reservoir at the existing surface, and that zinc, chlordane, and PCBs are present at levels above screening criteria. However, the proposed "new surface" locations had no contaminants. Areas proposed for excavation will reveal clean substrate.

[2] The Project Review Group includes representatives from the Corps, Environmental Protection Agency, U.S. Fish and Wildlife Service, NOAA Fisheries, Washington Department of Ecology, and Oregon Department of Environmental Quality who review all projects that include dredging and/or excavation within waterbodies and wetlands to determine if the excavated material is suitable for disposal within Waters of the U.S. or must be disposed of in an upland or landfill location.

The City completed an Ecological Risk Assessment in 2010 (GeoEngineers 2010) based on the previous sediment sampling. The purpose of the assessment was to evaluate the potential risks to fish and piscivorous wildlife following construction of the proposed restoration project. The existing invertebrate and fish populations are exposed to the chemicals of concern via dermal exposure and ingestion of sediment. Piscivorous birds, wildlife, and shorebirds may be bioaccumulating chemicals of concern by consuming invertebrates or fish under current conditions. The risk assessment concluded that, when modeled using "site-specific" variables, fish and wildlife within Oaks Bottom were at moderate to low potential risk from the presence of DDx, and that chlordane presented low to no potential risk.

Following review of the Ecological Risk Assessment and the Biological Assessment submitted by the City in 2010, NOAA requested that the City conduct fish tissue sampling to identify if any bioaccumulation was occurring in fish in Oaks Bottom. The City and NOAA conducted fish sampling in June 2011 (GeoEngineers 2011). No salmonids were collected, but three-spine stickleback were captured and are considered by NOAA as a suitable surrogate for juvenile salmon because they use similar prey species and are of similar size as juvenile salmon. Tissue samples from stickleback indicated that DDx was present in fish tissue at low levels ranging from 29 to 44 µg/kg (wet weight). These levels are all lower than either generic or site-specific critical tissue levels that represent tissue levels at or below which approximately 95 percent of the organisms bearing this residue would be highly unlikely to experience adverse health effects. The conclusion from the fish tissue sampling is that fish in Oaks Bottom are unlikely to bioaccumulate DDx at levels that would cause adverse health effects, and that the levels present in the fish are well below the levels estimated for the risk assessment. Thus, the risk to salmonids is low from contaminant levels in Oaks Bottom.

Organochlorine pesticide concentrations have been declining slowly since DDT and other persistent pesticides were banned in 1972. Henny et al. (2008) found that osprey populations have increased substantially along the Lower Columbia River between 1998 and 2004 (including the Portland area), and the organochlorine pesticide burden (such as from DDx) has decreased in eggs. An osprey nest has been located immediately adjacent to the project site along the Springwater Trail for the past several years, and has successfully fledged young each year. The concentration of organochlorine pesticides in this particular nest site does not appear to be reducing reproductive success for this mating pair of ospreys.

In the future without-project condition, contaminated sediment would remain within the project area, but it appears that contaminants are slowly breaking down. Contaminants could be more efficiently broken down by exposure to ultraviolet and sunlight, but because the reservoir is frequently ponded due to the presence of the water control structure, sediment is rarely exposed. Based on the current rate of contaminant breakdown, it could take another 50 years for the DDx levels to fall below regulatory thresholds if no action were taken. The invertebrates, fish, and birds using the refuge would continue to be exposed, although based on sampling results the uptake is generally low.

Water temperatures within the reservoir are expected to remain high in the future without-project condition, and could increase if native riparian vegetation declines and the non-native emergent species continue to spread. Local seeps and springs are expected to continue to contribute cooler waters, but are too small in volume to counter the effects of increasing temperatures within the reservoir. The reservoir is generally several degrees warmer than the Willamette River already, and continued warm water or increasing temperatures would further degrade its value as native fish or wildlife habitat. Warm waters attract non-native species such as bullfrogs and pest species such as mosquitoes, which both prefer warm, calm water. Colder waters are preferred by native amphibians, birds, and fish. If warm water temperature habitats that are more suitable for bullfrogs were to expand, then bullfrog populations would likely increase and would adversely affect native amphibian populations.

2.5 Vegetation and Wetlands

The project site is located in the floodplain of the Willamette River. A reconstruction of 1851 vegetation maps (Pacific NW Ecosystem Research Consortium 2011) indicates the site historically had a closed canopy riparian and wetland forest with a small area of prairie. The reservoir has existed as a wetland pond since the 1852 mapping (
Figure 2-7).

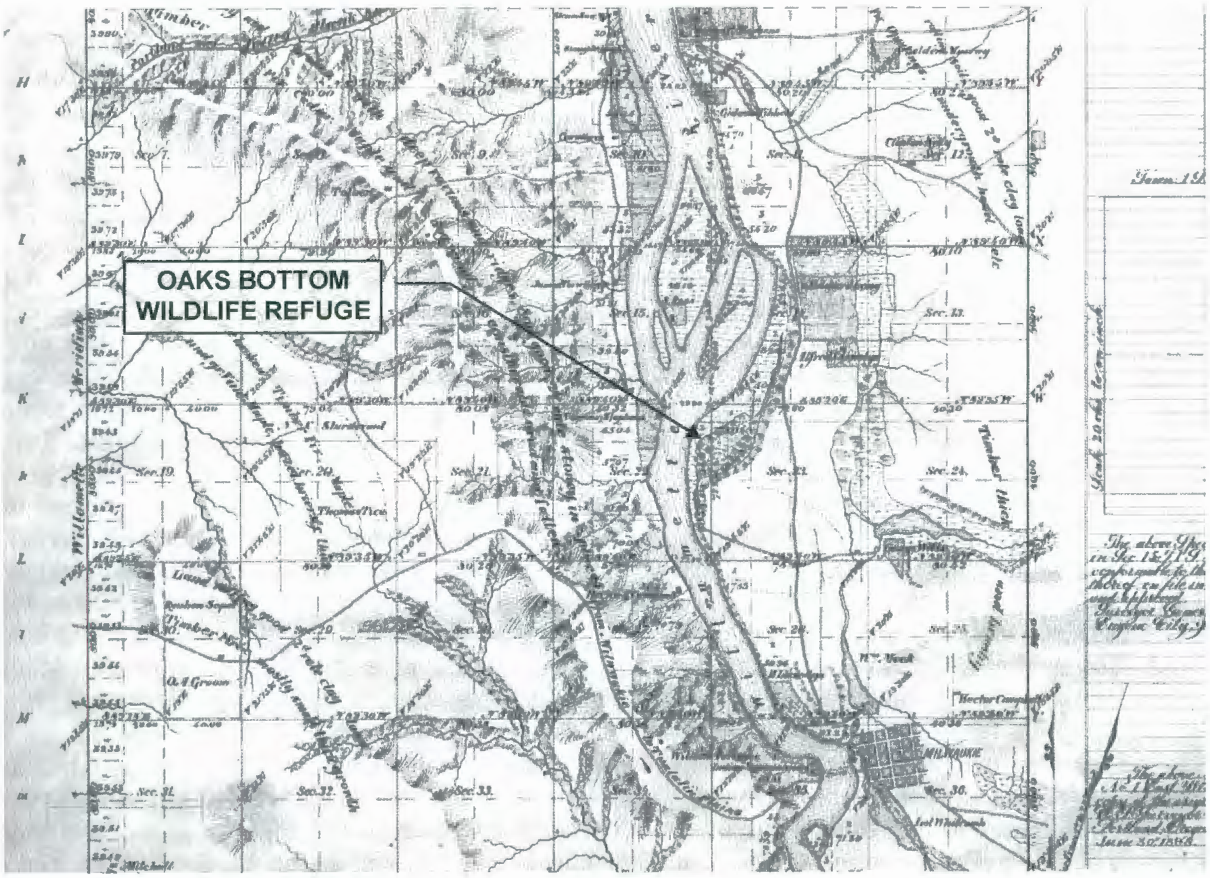


Figure 2-7 General Land Survey Office Map of 1852

The majority of the trees in the project area are medium to small in size and tend to be one of three species: black cottonwood *(Populus balsamifera),* willows *(Salix lasiandra* and others*)*, and Oregon ash *(Fraxinus latifolia).* Red osier dogwood (*Cornus stolonifera*) is present along the edges of the wetlands. Weedy species, most of them invasive, dominate many of the project areas. Reed canary grass and purple loosestrife dominate the understory in the vast majority of the project area. Some native emergent vegetation is present including Columbia River sedge (*Carex aperta*) and smartweed (*Polygonum hydropiperoides*). Portland Parks has undertaken a substantial effort to reduce Himalayan blackberry and other invasive plants along the bluff and the north fill area. Efforts to control purple loosestrife have, so far, been largely unsuccessful because the artificial control and inundation of the reservoir have hindered the leaf-out of the loosestrife in the early spring when the bio-control species (beetles) hatch and feed (thus eliminating their food source).

A small area of wetland occurs north of the reservoir and is dominated by Oregon ash, mature Pacific willow, and an understory of smartweed. This wetland appears to have a primarily groundwater-dominated hydrologic regime from ground and surface flow from the bluffs to the east.

Non-native species, primarily purple loosestrife and reed canary grass, are expected to increase under the future without-project condition. These species are more tolerant of warm water conditions and the current regulated hydrologic regime, and are expected to expand in density and area over time. The City or other local stakeholders will likely continue to undertake efforts to control non-native plants. These efforts would primarily include cutting, clearing, and changes to the hydrology regime through the reduced operation of the water control structure, such as has occurred since 2010. Bio-control introduction (beetle that feeds on purple loosestrife) has already proven to be unsuccessful due to the existing water regime. It appears that, without the proposed culvert replacement and hydrologic changes, invasive species control would be difficult and unsustainable.

2.6 Fish and Wildlife

The Willamette Basin has 31 native fish species and 30 introduced non-native species (WRI 2004). Most of these species occur in the Lower Willamette River, including the native Lower Columbia River Chinook, coho, chum, and sockeye salmon, steelhead, mountain whitefish, Coastal cutthroat trout, 3-spine stickleback, Northern pike minnow, and a variety of sculpins, dace, and lamprey. Non-native fish include walleye, largemouth bass, smallmouth bass, yellow perch, sunfish, carp, Oriental weatherfish, crappie, goldfish, and bullhead (Friesen 2005). Carp are in very high abundance and the water control structure seems to have created ideal spawning conditions for carp in the purple loosestrife zone.

Because Oaks Bottom is within the City of Portland, there are limited habitat areas available for mammals; however, because of the unique location along the river corridor and adjacent to the Springwater Trail, deer, coyote, river otter, beaver, skunk, possum, squirrels, and the non-native nutria all occur in the refuge. Beavers occur throughout the project area and have frequently built dams near the existing culvert and water control structure. The City currently has installed a beaver deceiver device to limit dam building at the water control structure so that the reservoir is not impounded. Otter and nutria are commonly observed in the channels and duck pond area. Eight species of bat are likely to occur in Oaks Bottom, including five sensitive species.

Several bat species are also known to occur in Oaks Bottom. Very uniquely, seven native amphibian species occur in the refuge including red-legged frog and chorus frog. Over 157 bird species have been identified in the project area, including a wide variety of waterfowl, shorebirds, raptors, and songbirds that makes Oaks Bottom a premier bird-watching destination in the area and a favorite of residents and visitors alike. Of particular note, a heron rookery is present in the older cottonwoods along the Willamette River to the northwest of the project area, and several osprey nests are located along the railroad line. Bald eagles are also frequently observed perching or foraging in the refuge and a nest is present on Ross Island. See Appendix G for a list of bird species observed in Oaks Bottom.

In the future without-project condition, high water temperatures, restricted tidal fluctuation, and expansion of non-native species would all cumulatively contribute to a continued reduction in the availability of habitat for native wildlife species. Currently, native frogs do not appear to have been substantially affected from the presence of the non-native bullfrog, which is better adapted to warm, deeper waters. Bullfrogs often eat smaller frogs, and even small bullfrogs, turtles, and fish. Bullfrogs could become more established in the future, although the reservoir does drain down after spring runoff and deep water is not maintained on the site year-round, which will always limit the area of habitat suitable for bullfrogs. Non-native fish species such as carp damage native fish habitats by frequent disturbance of the bed of the reservoir causing very turbid conditions. Native migratory birds and mammals that nest in the area would have reduced habitat as native riparian habitat is further encroached upon by purple loosestrife and reed canary grass that tend to prevent succession of woody vegetation. A mostly non-native assemblage of fish within the reservoir would still attract foraging wading birds and waterfowl and may also continue to supply food for the nearby nesting heron and osprey. However, nesting opportunities would decline for species dependent on native vegetation for nest building, such as songbirds. It is expected that the diversity and abundance of native birds, mammals, and amphibians would continue to decline in the future without-project condition.

2.6.1 Threatened and Endangered Species

In accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed and proposed threatened or endangered species.

Fifteen threatened or endangered species may occur in the project area, as well as two proposed species and two species that are candidates for Federal protection (Table 2-1). Based on previous data collection efforts and data within the Oregon Biodiversity Information Center (OBIC) database, there are only six species that have been known to occur within Oaks Bottom, including Lower Columbia Chinook salmon, Upper Willamette River Chinook salmon, Lower Columbia coho salmon, Columbia River chum salmon, Lower Columbia River steelhead, and Upper Willamette River steelhead. All other species are unlikely to be present in the project area, and have not historically been documented there and are not discussed further in this report.

Table 2-1 Potentially Occurring Listed Species

Species	Listing Status	Critical Habitat	Presence in Project Area	Managing Agency
Columbian white-tailed deer *Odocoileus virginianus leucurus*	Endangered	Not Designated	Unlikely	USFWS
Northern spotted owl *Strix occidentalis caurina*	Threatened	Designated; not within project area	Unlikely	USFWS
Streaked horned lark *Eremophila alpestris strigata*	Threatened	Designated; not within project area	Unlikely	USFWS
Oregon spotted frog *Rana pretiosa*	Threatened	Designated; not within project area	Unlikely	USFWS
Lower Columbia Chinook salmon *Oncorhynchus tshawytscha*	Threatened	Designated; includes Lower Willamette River	Present	NOAA
Upper Willamette River Chinook salmon *O. tshawytscha*	Threatened	Designated; includes Lower Willamette River	Present	NOAA
Lower Columbia coho salmon *Oncorhynchus kisutch*	Threatened	Proposed; includes Lower Willamette River	Present	NOAA
Columbia River chum salmon *Oncorhynchus keta*	Threatened	Designated	Unlikely	NOAA
Lower Columbia River steelhead *Oncorhynchus mykiss*	Threatened	Designated	Present	NOAA

Table 2-1 Potentially Occurring Listed Species

Species	Listing Status	Critical Habitat	Presence in Project Area	Managing Agency
Upper Willamette River steelhead *O. mykiss*	Threatened	Designated; includes Lower Willamette River	Present	NOAA
Willamette daisy *Erigeron decumbens var. decumbens*	Endangered	Designated; not within project area	Unlikely	USFWS
Water howellia *Howellia aquatilis*	Threatened	None	Unlikely	USFWS
Bradshaw's desert parsley *Lomatium bradshawii*	Endangered	None	Unlikely	USFWS
Kincaid's lupine *Lupinus sulphureus ssp. Kincaidii*	Threatened	Designated	Unlikely	USFWS
Nelson's checker-mallow *Sidalcea nelsoniana*	Threatened	None	Unlikely	USFWS
North American wolverine *Gulo gulo luscus*	Proposed, Withdrawn	N/A	Unlikely	USFWS
Yellow-billed cuckoo *Coccyzus americanus*	Threatened	Not Designated	Unlikely	USFWS
Red tree vole *Arborimus longicaudus*	Candidate	N/A	Unlikely	USFWS
Northern wormwood *Artemisia campestris var. wormskioldii*	Candidate	N/A	Unlikely	USFWS

Extensive planning efforts have been under way throughout the Lower Columbia River estuary (which includes the Lower Willamette River), particularly since the development of the *Lower Columbia River Estuary Comprehensive Conservation and Management Plan* and the *Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan*, to address the loss of fish and wildlife and their habitat throughout the Lower Columbia River corridor. Under the guidance of these reports, there are many recovery measures taking place for listed species, particularly salmonids. Restoration efforts elsewhere in the estuary are expected to slowly increase the essential wetland and off-channel floodplain habitats necessary for recovery of threatened and endangered species. However, in the future without-project conditions, within the Oaks Bottom Wildlife Refuge, Federally protected salmonid species would continue to experience reduced rearing/refuge opportunities and increased mortality from entrapment behind the water control structure due to high temperatures and predation. Overall, the availability of floodplain habitats along the Lower Willamette River would likely remain limited, as most areas of the floodplain have been developed. Without comprehensive restoration actions within the refuge, an important piece of potentially recoverable tidal wetland would continue to be largely inaccessible to salmonids and decline in quality over time due to the extensive areas of invasive species.

2.6.2 Lower Columbia River and Upper Willamette River Chinook Salmon, Threatened

Fall-, summer-, and spring-run Chinook salmon (*Oncorhynchus tshawytscha*) occur along the Washington and Oregon coasts from Hoko River to Cape Blanco. In 2005, the Evolutionarily Significant Units (ESUs) for the Lower Columbia River and Upper Willamette River were listed threatened, including all Chinook within the Columbia River and its tributaries from the mouth at the Pacific Ocean, upstream to just east of

Hood River and including the Willamette River up to Willamette Falls, and within the Clackamas River and Willamette River and its tributaries above Willamette Falls (NOAA 2005a). Critical habitat was designated in September 2005 to include all river reaches within these ranges, with the addition of the Lower Willamette and Lower Columbia River as a designated rearing/migratory corridor for Upper Willamette River Chinook (NOAA 2005b).

Chinook require clean, cool water and clean gravel to spawn. Females deposit their eggs in the gravel substrate in areas of relatively swift water, hatching approximately 6 to 12 weeks later. Chinook prefer to spawn in the mainstem of large tributaries (Healey 1991). Larvae remain in the gravel for another 2 to 4 weeks until the yolk is absorbed (Moyle 1976). For maximum survival of eggs and larvae, water temperatures must range between 41°F and 57°F (5°C and 14°C). Optimum rearing habitat for Chinook consists of pools and wetland areas with woody debris and overhanging vegetation. Chinook salmon from the Willamette basin are primarily stream-type, but also large numbers of sub-yearlings migrate to the Lower Willamette River and utilize the productive estuary and coastal areas as rearing habitat (Friesen 2005). Chinook salmon typically spend 2 to 4 years maturing in the ocean before returning to their native streams to spawn. All adult Chinook salmon die after spawning.

Chinook salmon of both ESUs occur in the project area. Chinook adults and juveniles are known to migrate through the Willamette River immediately adjacent to the site and may enter Oaks Bottom occasionally when it is accessible, although they likely become stranded under existing conditions, contributing to their overall declining population.

2.6.3 Lower Columbia River Coho Salmon, Threatened

The Lower Columbia River ESU of coho salmon (*Oncorhynchus kisutch*) was listed as threatened on September 2, 2005 (NOAA 2005b), and occurs in the Columbia River and its tributaries including the Willamette River below Willamette Falls. Critical habitat was proposed on January 14, 2013, and includes the Lower Willamette River, but it has not been finalized yet. Coho salmon typically spawn in small coastal rivers and smaller tributaries of large river systems. Spawning in Washington and Oregon generally occurs from late October to January. Most coho are typically 3 years old when returning to spawn, after spending 18 months in freshwater and 18 months in saltwater, although substantial numbers of jacks are also observed on the spawning grounds. Juveniles rear in small streams and larger rivers, preferring extensive cover (large woody debris and overhanging vegetation) and quiet pools, backwaters and side channels. A relatively even distribution of pools and riffles provides the maximum productivity for juvenile feeding. Coho juveniles overwinter in deep pools and stable side channels, and may move upstream moderate distances to find such habitat. They prefer habitat with complex structure (such as logs, bushes, etc.) that provides cover and more opportunity for territory (NOAA 1995; Sandercock 1991)

Coho salmon occur in the project area. Coho adults and juveniles migrate through the Willamette River immediately adjacent to the site and may enter Oaks Bottom occasionally when it is accessible, although they likely become stranded under existing conditions, contributing to their overall declining population. Coho salmon juveniles would likely utilize Oaks Bottom for rearing, although coho smolts do not utilize tidal off-channel habitats as extensively as Chinook salmon.

2.6.4 Columbia River Chum Salmon, Threatened

Columbia River chum salmon was listed as threatened on June 28, 2005 (NOAA 2005a). Columbia River chum salmon occur in the Lower Columbia River and its tributaries up to the Wind River (Wydoski and

Whitney 2003). They have primarily been observed in recent decades on the Washington side, but occur in some smaller Oregon streams. Chum salmon were not collected in Oregon Department of Fish and Wildlife (ODFW) sampling in the Lower Willamette River (Friesen 2005). Chum salmon typically spawn from October to December in medium to fine gravels at the head of riffles in typically lower velocity areas. Groundwater upwelling areas seem to be particularly attractive locations for spawning (Wydoski and Whitney 2003). Chum salmon fry migrate downstream to estuaries soon after emergence and may spend up to several months in and along shallow beaches or tidal sloughs and channels. Critical habitat for Columbia River chum salmon was designated on September 2, 2005, and does not include the Lower Willamette River (NOAA 2005b). Chum salmon may occur in the project area, but have not typically been captured in the Lower Willamette River (Friesen 2005).

2.6.5 Lower Columbia River and Upper Willamette River Steelhead, Threatened

The Lower Columbia River and Upper Willamette River ESUs of steelhead (*Oncorhynchus mykiss*) were listed as threatened on June 28, 2005 (NOAA 2005a). The Lower Columbia River ESU includes all naturally spawned populations of steelhead present in streams and tributaries of the Lower Columbia River between the Cowlitz and Wind Rivers in Washington and between the Willamette and Hood Rivers in Oregon. The Upper Willamette River ESU includes all steelhead in the Willamette River and its tributaries from Willamette Falls upstream to the Calapooia River (inclusive). Critical habitat was designated for the Lower Columbia River ESU to include all river reaches accessible to listed steelhead within the Lower Willamette River Basin (below Willamette Falls). Additionally, the Lower Willamette River and Lower Columbia River are designated as critical rearing/migration corridors for Upper Willamette River steelhead.

Steelhead in the Lower Columbia River ESU are anadromous, iteroparous salmonids. They prefer cool water with temperatures less than 70° F (21°C [Wydoski and Whitney 2003]). Preferred spawning habitat includes riffles with clean gravel. First-time spawners generally are 4 to 5 years old. Individuals are capable of spawning more than once before they die, though spawning more than twice is rare. Steelhead eggs incubate 1.5 to 4 months before hatching (varies with temperature). Juveniles spend 1 to 4 (generally 2) years in fresh water before migrating to the ocean as smolts. Steelhead typically spend 2 years in fresh water, migrate to marine waters, where they spend 2 to 3 years, then return to natal stream to spawn. Prey items include aquatic insects, amphipods, aquatic worms, fish eggs, and occasionally they are piscivorous (Wydoski and Whitney 2003). Riffles are preferred habitat during summer, while pools are selected during winter (Combs 1988).

Steelhead from both ESUs occur in the project area, but were only rarely collected by ODFW in the Lower Willamette River (Friesen 2005). Steelhead adults and juveniles are known to migrate through the Willamette River and may enter Oaks Bottom during the occasional periods when the refuge is accessible to salmonids. They would likely become stranded if they entered the refuge under current conditions, contributing to their overall declining population.

2.7 Cultural Resources

The Oaks Bottom Wildlife Refuge occurs in a small remnant of the cottonwood/willow bottomland riparian zone that historically lined much of the Lower Willamette River prior to urban development (Loy et al. 2001). Native vegetation communities mapped in the 1850s were composed of riparian woodlands, sloughs, and ponds, with prairies present on the higher terraces (Pacific Northwest Ecosystem Research Consortium 2011). The original bottomlands would have supported a variety of wetland plants that were important for native subsistence. A diverse array of mammals, fish, shellfish, and birds would have been present and important to the native inhabitants (Heritage Research Associates, Inc. 2010)

Chinookan peoples occupied the Lower Columbia valley at the time of Euro-American contact. The Chinookans inhabited areas along both banks of the river from the Pacific Ocean upstream to The Dalles (Silverstein 1990). Because of the favorable climatic and resource conditions, the region was estimated to have had one of the highest pre-contact native population densities in North America (Kroeber 1939). However, because Chinookan territory centered on the Columbia River, which was used as the main transportation route in the region during early Euro-American contact and settlement, the Chinookan peoples were dramatically affected and seriously reduced in population by introduced diseases.

Archaeological research in the Portland Basin indicates that Native American peoples have inhabited the area for at least the past 9,000 to 10,000 years. The best evidence of human occupation in the Portland Basin is represented at a handful of sites located in settings away from the major rivers. These sites are undated, but common artifacts include large leaf-shaped, broad stemmed, and corner-notched projectile points, unifacially flaked cobbles, foliate bifaces, and bola stones. These types of stone tools all suggest occupations prior to 3,000 years ago (Pettigrew 1990). The archaeological record for the Portland Basin during the last 3,000 years has better evidence and radiocarbon dating at many of the sites. The local cultural sequence, developed during the 1970s, begins with the Merrybell Phase (2,550-1,750 Before Present [BP]), characterized by broad-necked projectile points, followed by the Multnomah Phase (1,750-100 BP), characterized by narrow-necked points, and after historic contact, by the introduction of materials of Euro-American manufacture (Pettigrew 1981).

Early maps of the project area indicate that what is now Oaks Bottom Wildlife Refuge consisted of an interconnected network of sloughs, marshes, and ponds, with a large lake and the northern drainage channel (Ives 1852). The project area was part of the 640-acre Alfred Llewellyn Donation Land Claim (Claim 49), and the 1852 plat of survey shows the house and the field of Alfred Llewellyn on the upper terrace east of the project area (
Figure 2-7).

The 1914 U.S. Geological Survey (USGS) 15-minute Oregon City quadrangle shows the presence of an expansive lake and two other ponds in the project area, with higher ground separating the ponds in the area of the present drainage channel. The north floodplain area is shown as a large marsh. The railroad tracks are shown bordering the lake on the west. These maps indicate that the site has been fairly stable for at least the past 150 years. Thus, the banks along the drainage channel have the potential to contain intact cultural deposits.

A review of the archaeological site records indicates that no prehistoric or early historical sites have been recorded in the vicinity of the project area (Heritage Research Associates, Inc. 2010). The Oregon Pacific Railroad has not been designated as a historic resource. The nearest recorded sites are located across the Willamette River and a number of prehistoric sites have been reported on the terraces of the Willamette River south of the project area. This evidence indicates, although much of it is unsubstantiated, that a number of prehistoric sites were located along the banks of both the Willamette and Clackamas Rivers between Ross Island and Willamette Falls (Woodward 1974).

In 2010, Heritage Research Associates, Inc. conducted a pedestrian survey along both sides of the drainage channel, south duck pond, and culvert area. The ground was obscured by dense vegetation in much of the area, except for the mudflats to the south of the channel around the reservoir. A few items of recent discard such as beer cans and other garbage were observed, but no evidence of prehistoric or early historical artifacts or deposits were noted. If previously undiscovered resources are present, they are anticipated to remain undisturbed in their current condition under the No Action alternative.

2.8 Socioeconomic Resources

The majority of the project site is within public ownership, or otherwise publicly accessible. The Springwater Trail and Oaks Bottom Wildlife Refuge are heavily used for bicycling and walking, and passive recreational activities, respectively. Activities available at the park include walking, running, and nature watching.

The surrounding area includes the urban residential neighborhoods of Sellwood, Westmoreland, and Brooklyn with some industrial properties immediately north of the park (i.e., Ross Island Sand and Gravel). The Oregon Pacific Railroad is a privately owned commercial enterprise that carries freight to various customers in the industrial southeast neighborhoods of Portland and Milwaukie. On the west side of the park is Oaks Amusement Park, the Oregon Yacht Club, and several privately owned houseboats.

Data from the 2010 census (U.S. Census Bureau 2013) for the 97202 zip code that surrounds the site indicates that the surrounding neighborhood population is composed of 86.9 percent white, 5.2 percent Hispanic, 2.1 percent African American, 4.5 percent Asian, and 1.4 percent other ethnicity. This compares to the overall State of Oregon population of 83.6 percent white, 11.7 percent Hispanic, 1.8 percent African American, 3.7 percent Asian, and 1.4 percent Native American/Hawaiian. The population with a bachelor's degree or higher is 50.2 percent compared to the overall State of Oregon population of 29 percent. The median household income is $49,488 in the surrounding neighborhoods as compared to the State of Oregon median household income of $49,850. The surrounding neighborhoods do not contain any predominant minority or low-income populations that would require consideration under Executive Order 12898, Socioeconomics and Environmental Justice.

Without implementation of a restoration project, Oaks Bottom is anticipated to continue to provide an important green space in the otherwise highly urbanized area of southeast Portland. Those who value the area as a wildlife refuge with opportunities for passive recreation have clearly voiced their desire for the area to remain as it is, without further development or industrialization. The future conditions of the refuge are not anticipated to affect the economics of the city or region; however, without comprehensive restoration efforts the continued deterioration of habitat would result in diminished value of the area as a green space and wildlife refuge.

2.9 Resource Significance

2.9.1 Institutional Significance

Oaks Bottom Wildlife Refuge was designated as the City of Portland's first wildlife refuge and is one of the only remaining tidally influenced floodplain areas on the Lower Willamette River. The importance of restoring tidal floodplain areas along the Lower Willamette River was identified as a high priority action in the Willamette Subbasin Plan (WRI 2004). This project is being undertaken to specifically address fish passage, restoring lowland riparian areas, and restoring the site with the highest potential within the Lower Willamette River tidal floodplain for multiple fish and wildlife species.

Further, the Lower Willamette River and its adjacent riparian habitats are designated under the Endangered Species Act as critical habitat for Lower Columbia River ESUs of Chinook salmon and steelhead trout. NOAA and ODFW have been very supportive of restoring floodplain habitats that are so important to listed species.

2.9.2 Public Significance

The tremendous public interest in the protection of habitats for migratory waterfowl, songbirds, and raptors was one of the primary reasons why the City purchased various parts of Oaks Bottom in the 1950s and 1960s and then designated it as a wildlife refuge (Houck 1988). Since that time, the Audubon Society, the Nature Conservancy, the Sellwood-Moreland Improvement League (SMILE) and other community groups have participated in conducting tours of the refuge and in developing trails and other amenities for the public. The City of Portland has further engaged these community groups during this study due to the tremendous public interest in ensuring that any proposed restoration actions are compatible with the wildlife refuge's purpose. Oaks Bottom has very high public use (see Section 5) and is a tremendous educational resource to the City.

2.9.3 Technical Significance

Off-channel and floodplain areas typically provide very important rearing habitat for juvenile salmon as well as refuge from high flows in the mainstem Willamette River. Tidal off-channel and floodplain habitats along the Willamette River have been almost completely eliminated in the greater Portland metropolitan area. The restoration of rearing and winter refuge habitats, such as those at Oaks Bottom Wildlife Refuge, would benefit these species and contribute towards their recovery. Without Federal action, Oaks Bottom would continue to be restricted from natural tidal hydrology, have limited fish access, and continue to cause stranding and mortality of juvenile salmonids.

This restoration project would provide access to and restoration of over 60 acres of rare wetland, floodplain, and off-channel habitat. Additionally, wildlife species, including red-legged frog and Neotropical migratory birds, would benefit from restoration of preferred riparian and wetland habitats.

3. FORMULATION OF ALTERNATIVES

This chapter presents the plan formulation process used in the development and screening of alternatives for the study area. The process was followed to develop measures that address the goals and objectives identified for the site and to ultimately evaluate those measures against each other to select a plan recommended for implementation.

3.1 Problems, Opportunities, Constraints, and Objectives

This section identifies the problems and opportunities based on the assessment of existing and expected future without-project conditions in the study area. In the planning setting, a problem can be thought of as an undesirable condition, while the objective is the statement of overcoming the problem, and the opportunity is the means for overcoming that problem. Identification of problems and opportunities gives focus to the planning effort. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns.

3.1.1 Problems and Opportunities

1. *Tidal hydrologic connectivity with the Willamette River is impaired.*

Oaks Bottom is separated from the Willamette River by railroad tracks on a high berm and the perched 5-foot-diameter culvert is the only hydrologic connection between the river and floodplain. This disconnects Oaks Bottom from the river during approximately 50 percent of the tidal cycles and causes high velocities and turbulent flows whenever there is a head differential between the river and Oaks Bottom. The City periodically removes debris from the culvert, thus the primary issue with disconnection is related to the invert elevation and size of the culvert. The opportunity exists to replace and lower the culvert invert elevation to allow daily low-velocity tidal exchange throughout the entire tidal cycle into the refuge.

2. *Fish passage is currently limited and stranding and mortality is likely.*

Salmonids and other fish species may occasionally enter the channel through the culvert but cannot pass farther upstream during much of the year due to the presence of the water control structure immediately upstream of the culvert; only about 0.02 acre of habitat is accessible downstream of the structure. During flood events that raise water surface elevations above the water control structure, salmonids could enter the reservoir; however, once fish enter the reservoir, they likely become trapped behind the water control structure as there is limited outflow and subsurface piping of the flow. Furthermore, lethal or sub-lethal water temperatures (temperatures up to 90°F [32°C]), predators, and low water levels contribute to mortality if they do become trapped behind the water control structure. The opportunity exists at the refuge to replace and lower the culvert invert elevation and also modify or remove the existing water control structure to allow unimpeded fish passage into and out of the channel, reservoir, and wetland areas.

3. *Existing habitat within the refuge has been degraded.*

Currently, the refuge is composed of several habitat types, including an open water reservoir, emergent wetlands, scrub-shrub and forested wetlands, two higher elevation upland fill areas, and upland oak savannah (bluff slopes). Between and surrounding these areas are riparian and upland forests. Within the reservoir are a variety of habitats, including mudflats and emergent wetlands. Many of these habitats have been formed or degraded by disturbance and fill. Although numerous wildlife species such as native amphibians, migratory songbirds and waterfowl utilize the area, there are opportunities for the existing habitats to be improved to benefit native fish and wildlife species.

4. *Exotic plant and animal species are common throughout the project area.*

Exotic plants and animals are common throughout the project area, including bullfrogs, nutria, reed canary grass, purple loosestrife, English ivy, clematis, locust, and Himalayan blackberry. Portland Parks has previously operated the reservoir water level in an attempt to reduce the coverage and presence of non-native or pest species. In particular, the primary management concerns have been the control of mosquitoes, purple loosestrife and reed canary grass. An opportunity exists to remove non-native plant species and to create a more natural tidal hydrologic regime that would foster native species that prefer seasonal habitats and a more natural spring flooding regime.

5. *Habitat deterioration is resulting in diminishing functions for a variety of native bird species.*

The reservoir is increasingly becoming choked with purple loosestrife and reed canary grass, and the open water habitats that support waterfowl are becoming reduced. These non-native plant species also tend to prevent native shrub and tree species from becoming established and prevent the development of a diverse multi-story plant community to benefit multiple bird species for nesting, perching, and overwintering. The opportunity exists to preserve and improve these natural habitats by removing invasive species and restore native cottonwood forest and willow shrub communities for continued use by waterfowl, shorebirds, raptors, and songbirds.

3.1.2 Constraints and Considerations

Constraints represent restrictions that cannot be violated, such as the limits identified within Federal laws, Executive Orders and Corps regulations, or which are needed to maintain safety. Considerations are those issues that should be followed in order to meet the objectives identified above. Constraints specifically identified for this project include public safety, maintenance of the railroad operations, Clean Water Act, Protection of Wetlands (EO 11990), and the Endangered Species Act (ESA). Considerations identified by the project team and stakeholders include a desire for minimal operation or maintenance of the project, and the preservation of a small reservoir area as waterfowl and shore bird habitat.

3.1.2.1 Constraints

1. *Springwater Trail Use and Public Safety*

The most feasible access route during construction is via the Springwater Trail. In order to maintain public safety during construction, it will be necessary to close the Springwater Trail to accomplish the replacement of the culvert and to provide a haul route for equipment and materials. The only other option for access to the work area is by barge, and barge access would not provide a means to drive pilings through the embankment or bring in all equipment necessary. There is no reasonable on-site detour for the trail during construction without requiring extensive fill or construction in the Willamette River due to the high embankment and the proximity of the river and wetlands. Because the Springwater Trail is a heavily used commuter and recreational trail, it is highly desirable to ensure the closure period is as short as feasible to complete the construction. It will not be acceptable to have a closure longer than the 4-month fish window (July 1 to October 31), and it is desirable to have a shorter closure if possible. The City is developing a bike detour route on surface streets for temporary use, but these are considered much less safe and efficient for either commuter or recreational use.

2. Limit Disruptions to Railroad Operations

The Oregon Pacific Railroad line that runs along the embankment is a commercial freight line that needs to be accommodated during construction to avoid or minimize economic impacts.

3. Clean Water Act

The CWA regulates the discharge of pollutants into Waters of the U.S. The soil and water quality sampling conducted in the refuge has identified the presence of several contaminants of concern within the refuge, primarily DDT and its breakdown products; however, tissue analysis has shown there is limited uptake into the biota. During construction, practices should be implemented to ensure water quality standards are met and to avoid any potential contamination of adjacent areas.

4. Protection of Wetlands (EO 11990)

Restoration measures should not result in adverse changes to the existing groundwater table and surface water within the project area. Specifically, existing wetlands must not be altered to the point where they are no longer classified as wetlands. Measures that result in lowering of the water table or dewatering of a wetland are not desirable.

5. Endangered Species Act

Protection of fish and wildlife during restoration will be achieved through following the laws, executive orders, and Federal and permit regulations applicable to floodplain restoration plans, including working within the regulated fish window and implementation of BMPs. These measures would eliminate the potential for "take" or harm of a federally protected species.

3.1.2.2 Considerations

1. Operation and Maintenance

Restoration elements should be designed to minimize the need for subsequent operation and maintenance of the project. The non-Federal sponsors are slated to manage the area following restoration and, in the interest of conserving budget and resources, desire an outcome that requires minimal maintenance over time and is sustainable.

2. Reservoir Habitat and Desired Future Conditions

The intent and management plan for the wildlife refuge includes protecting and maintaining habitat for a variety of bird species including waterfowl. Further, Portland Parks' desired future condition for the refuge includes maintenance of open water to provide that habitat diversity. A charrette was conducted with a number of key stakeholders and agencies involved in the project in 2007, while the City was conducting additional analysis to further the tentatively selected plan. Concerns were voiced over the potential elimination of open water if the water control structure was simply removed via channel headcutting through the fine sediments and releasing large quantities of fine sediments and turbidity into the river. The consensus from that charrette was that the restoration plan should maintain a minimum area of open water and mudflat habitats (4 to 6 acres), which attract wading birds, shorebirds, and waterfowl and facilitate the major recreation and educational experience provided by the refuge. Four to six acres of open water is likely to be sustainable over time as this is what the current reservoir drains down to when no flashboards are installed in the water control structure and it would provide sufficient depth to prevent woody species from encroaching.

3.1.3 Risks

Risk is the chance of an undesirable outcome and a measure of the probability and consequences of uncertain events. Consequences can be social, environmental or economic. Risks can be encountered during all phases of project development and implementation. Risks or unseen circumstances encountered during planning and design can affect project schedule, budget, and project viability. In implementation of ecosystem restoration projects, risks may also include the uncertainty of achieving the benefits from the action.

The following summarizes the major potential risks for the implementation of the Oaks Bottom project.

- ***Railroad Operations***. The Oregon Pacific Railroad operates multiple deliveries each week of perishable frozen food items to warehouses south of Portland. Maintaining service or closing the railroad during construction both present risks to the overall construction schedule and budget that will need to be considered and negotiated with the railroad owner during the design phase.
- ***Real Estate.*** Risks to the project schedule and implementation budget may arise from real estate issues including LERRDs-or lands, easements, rights-of-way, relocations, and disposal areas-due to potential schedule delays and costs of acquisition. At this time, it is proposed for all construction staging, access, and work to be conducted on publicly owned properties (either Portland Parks or Metro) with the exception of the need to obtain a railroad crossing and use approval from the railroad owner. The City and Metro are entirely supportive of the work and will provide all necessary easements.
- ***Aquatic Invasive Species.*** Aquatic plant and fish species that are non-native are present in Oaks Bottom, including purple loosestrife, reed canary grass, carp, and other warmwater fish species. Currently, the seeds from plant species can pass readily out of Oaks Bottom and are present in other locations along the Lower Willamette and Lower Columbia Rivers. All of the warmwater fish species present in Oaks Bottom are also present in the Lower Willamette River. It is anticipated that the restoration project would reduce the overall populations of all of the invasive species and render the habitat less suitable for these species. The City of Portland will be undertaking actions to control the non-native plant species over the long-term operation and maintenance of the project. However, there is some risk that control would be difficult to sustain over the 50-year design life.
- ***Contaminated Sediments***. It is known that DDx contaminants are present in Oaks Bottom sediments. These contaminants have posed a risk to fish and wildlife species for many decades. The project includes the removal of low-level contaminated sediments in the channel and transporting them to an off-site upland disposal location. Based on the Ecological Risk Assessment and fish tissue sampling described in Section 2.4, the risk to fish and wildlife is low from the presence of DDx as native fish that use the reservoir (i.e., stickleback) have low tissue levels of DDx.

3.1.4 Objectives

In response to analysis of the problems and determination of their associated opportunities described above, a total of four primary objectives were identified for this restoration project. Objectives for this project result from a combination of reservoir management needs, fish and wildlife habitat improvement, and local stakeholder preferences. In designing restoration for Oaks Bottom, four primary objectives were identified, including: (1) restore natural tidal hydrology to provide salmonid access to suitable habitats and reduce the entrapment and mortality of salmonids caused by existing infrastructure, (2) improve fish and wildlife habitat, (3) control non-native or pest populations, and (4) maintain a minimum open water and mudflat area for water birds in the area. Each of these objectives, and the existing conditions that resulted in the need for these objectives, is described in more detail in the following sections.

3.1.4.1 Restore Natural Tidal Hydrology to Allow Salmonid Access and Minimize Stranding of Salmonids

The refuge is separated from the Willamette River by railroad tracks on a high berm that inhibits natural tidal fluctuations of surface waters. A 5-foot-diameter culvert below the railroad provides the only surface water connection between the river and the floodplain, and the invert is located at 7.2 feet in elevation that only allows tidal connection about 50 percent of the time. The tidal connection is further regulated with a water control structure that prevents natural hydrologic exchange and fish passage so only about 0.02 acre of habitat below the structure are accessible until water surface elevations exceed the 14-foot water control structure (5 percent of the time). Water flows out of the reservoir through a narrow channel year-round, except during summer when the surface water in the reservoir becomes too low to connect to the outlet channel. The outlet channel is spanned by a 6-foot-high water control structure that is located 50 feet upstream of the railroad berm culvert. The structure is equipped with 13 flashboards that can be added or removed to control the reservoir levels.

Salmonids may enter the channel through the culvert. However, passage up the channel to the reservoir is blocked at normal tidal fluctuations when the flashboards are in place in the water control structure (normally October through May, which is the primary rearing and refuge period for juvenile salmonids). During high water events that raise water elevations above the water control structure, salmonids could enter the reservoir. However, the culvert would be submerged under these conditions and salmonids would need to dive down to the culvert depth and swim through the culvert. This is assumed to occur only rarely. Salmonids may also enter the project area during flood events that overtop the railroad berm. However, according to the hydrologic analysis, the railroad berm is only overtopped by floods greater than the 100-year event. Passage into the reservoir is thus currently limited.

However, for those few fish that may enter the reservoir, passage out of the reservoir is very difficult. Once salmonids do enter the reservoir, they may become trapped behind the water control structure, since the outflow is very small and flow is often through leaks between flashboards or in channels undermining the structure. Furthermore, lethal water temperatures (up to 90°F [32°C]), predators, and low water levels contribute to mortality of salmonids if they do become trapped behind the water control structure.

Measures that would restore natural tidal fluctuations and improve fish passage include replacement of the existing culvert with a larger culvert that reduces high velocities and allows connections throughout the entire tidal cycle (ranges from about 5 feet to 18 feet in elevation), removal or modification of the water control structure to allow fish passage throughout the entire tidal cycle, excavation to expand or create freshwater tidal sloughs, and contouring of the reservoir bottom to facilitate fish movement outward from the reservoir as water levels decline.

3.1.4.2 Improve Habitat for Fish and Wildlife Species

Currently, Oaks Bottom has several habitat types, including the open water reservoir, a lower elevation scrub-shrub and semi-forested transitional area, and two higher elevation fill areas. Between and around these areas are riparian and upland forests. The south fill consists of open grassland habitat composed of upland weedy species. The north fill has a combination of riparian and upland species and has small seasonally ponded wetlands where soils are highly compacted and ephemeral ponds form during seasonal rainfall. Bluffs to the east of the refuge are composed of sparse Douglas fir and oak-madrone savannah, interspersed with many non-native and ornamental species. Within and around the reservoir are a variety of habitats, including mudflats, emergent wetlands, scrub-shrub wetlands, and forested riparian. Between the reservoir and north fill is a transitional area composed of trees, shrubs, wetlands, and ponds.

Each of these habitats has been degraded by historic motorized vehicle use, the placement of fill on the north and south areas of the refuge, and the introduction and spread of invasive species. Although native amphibians, migratory songbirds, and waterfowl utilize the area for foraging, nesting, stopovers, or overwintering, the habitats could be improved to attract a greater diversity of native fish and wildlife species and provide more habitat for nesting. Restoration measures that benefit wildlife species such as improved riparian habitats would also provide benefits to salmonids, and vice versa.

Proposed restoration measures include measures to create additional acres of specific habitats as well as improve the quality of several existing habitats. Potential restoration measures could include:

- Improving hydrologic connectivity of the refuge to the Willamette River, through modifications to the existing culvert and water control structure to restore natural inundation frequencies. Water depths of 6 inches or more would be provided in the culvert up to 95 percent of all flows.
- Increasing aquatic habitat diversity in the reservoir and at the ponds to the north of the reservoir, primarily through excavation of channels, creation of ephemeral ponds, and placement of large woody debris. This would provide multiple types of aquatic habitats interspersed with riparian and upland forest.
- Increasing terrestrial habitat diversity, through control of non-native plants and plantings of native riparian and upland species. This would restore the shrub and riparian forest communities as well as native wetland communities to provide nesting and foraging habitat for multiple native amphibians, birds, and mammals.

3.1.4.3 Control Non-Native or Pest Populations

Exotic plants and animals are common throughout the project area, including carp, nutria, reed canary grass, purple loosestrife, English ivy, clematis, locust, and Himalayan blackberry. The reservoir has been managed to reduce the coverage and presence of non-native or pest species. In particular, the primary management concerns have been the control of mosquitoes and reed canary grass.

In the late 1980s, the addition of the water control structure allowed filling of the approximately 40-acre reservoir area in the refuge. Inundation successfully suppressed certain nuisance mosquito populations and some areas of reed canary grass. Flooding is still used as a measure to suppress reed canary grass, which quickly becomes established in areas with little vegetation and only seasonal or shallow flooding. However, mosquito control has become much more difficult to achieve through reservoir management, as a result of the variety of species that breed at the refuge and their wide range of preferred habitats. Controlling reservoir water levels for one species of mosquito may now provide better habitat for another species. In particular, because of the concern about West Nile virus, it may be more effective to reduce open water areas to reduce breeding habitat for the species that carries West Nile virus.

Flooding of the reservoir can be used to suppress non-native plants, such as reed canary grass. However, purple loosestrife and some other invasive species prefer inundated areas and have now become dominant in the reservoir. It is an objective of this project to maintain flooding in some areas for control of these species, while introducing other options of control, such as: (1) mechanical removal of non-native plant species, (2) revegetation with native species that can outcompete non-native species, and (3) reduce the area of the reservoir and restore natural tidal fluctuations to reduce preferred habitat of non-native fish species.

The City tried the use of beetles as a biological control measure for purple loosestrife a few years ago, but the beetles generally died because the Willamette River experiences its highest stages during the late spring/early summer runoff from the Columbia River when the beetles need to hatch and feed on the loosestrife. This late spring high water stage delays leaf-out of the loosestrife and causes inundated conditions that do not favor the beetles. Thus, biological control is not considered as a primary control measure.

3.1.4.4 Maintain and Improve Quality of Bird Habitats

Oaks Bottom is a highly popular feature of the Sellwood-Moreland neighborhood in southeast Portland. It is a unique and popular recreation area with several trails, including the paved bike trail adjacent to the railroad line. The reservoir has become the centerpiece of the refuge, in particular, due to the large number of birds that visit the area throughout the year. Waterfowl, wading birds, shorebirds, songbirds, and raptors are all visitors to the refuge. The great blue heron is a common visitor and is the official bird of the City of Portland. It is an objective of this project to maintain the recreational and bird watching value of the refuge by enhancing habitat for these bird species. Also, key stakeholders in the local community have expressed a strong desire to maintain a suitable environment for bird watching by retaining some open water to allow viewing from hiking trails. For these reasons, the formulation of alternative measures includes maintaining a minimum of 4 to 6 acres of open water habitat by maintaining a high point in the outlet channel at about 9 feet in elevation to prevent channel headcutting. This high point could occur at a new water control structure or at the upper end of the channel through the use of step weirs/riffles.

3.2 Identification of Alternative Measures

Based on the objectives for habitat restoration at Oaks Bottom, a number of potential restoration measures were identified and are shown in Table 3-1. Many of the measures address particular opportunities, while others provide means of addressing multiple issues within the refuge. For each opportunity, a suite of potential restoration measures has been presented.

3.2.1 Preliminary Measures

A total of 14 preliminary restoration measures were identified from the potential restoration measures listed in Table 3-1. These measures are designed to meet the objectives while keeping within constraints and taking into account the identified considerations. Four of the measures address modifications to the water control structure, four address revegetation options, and two address various reservoir contouring configurations. Remaining alternative measures address culvert replacement, side channel construction, and ephemeral pond creation. Table 3-2 summarizes the objectives addressed by each measure. Because no individual measure addresses all project objectives, the recommended plan will be a combination of more than one measure. Figures 3-1 through 3-4 show the conceptual plan of the restoration measures.

Table 3-1 Summary of Objectives, Opportunities, and Potential Restoration Measures

Objective	Opportunity	Potential Restoration Measures
Restore Natural Tidal Regime to Improve Salmonid Access and Reduce Stranding of Salmonids	Restore tidal hydrologic connectivity with the Willamette River.	• Replace culvert with larger culvert or bridge to allow frequent low velocity movement (less than 2 fps) of tidal waters in and out of refuge throughout the 5 to 18 foot elevation range. • Reconfigure or remove water control structure to allow tidal exchange up the channel to the reservoir.
	Restore fish passage and reduce risk of entrapment and mortality.	• Remove water control structure and install step weirs to provide a minimum of 6 inches of depth at approximately 95 percent of all flows and fish access up to the reservoir. • Modify water control structure to promote salmon ingress and egress. • Excavate tidal slough channels to increase rearing habitat area by up to 2 acres and provide access to 88 acres at Ordinary High Water.
Improve Habitat for Fish and Wildlife Species	Enhance and improve degraded wetland, riparian, and floodplain habitat within the refuge.	• Replace culvert with larger culvert or bridge to allow unhindered fish and wildlife passage into and out of the refuge. • Excavate tidal slough channels to create 2 additional acres of off-channel habitat for fish. • Install downstream outlet to create flow-through side-channel to extend approximately 1,200 feet downstream from existing culvert, through existing ponds, and exiting at north end of wetland area. • Create ephemeral ponds in north part of park to increase nesting/egg habitat for native amphibians. • Emergent and scrub-shrub plantings throughout refuge to increase habitat for native wildlife. • Create islands within reservoir to create additional habitat for native fish, amphibians, and wildlife and provide shading of channels and ponds.
Control Non-Native or Pest Populations	Restore native plants and animals to the refuge through removal of exotics and creation of habitats preferred by native species.	• Emergent and scrub-shrub plantings to suppress non-natives. • Remove/modify water control structure to reduce reservoir to increase dry periods for suppression of non-native plants and pest species. • Riparian/upland deciduous and coniferous plantings around reservoir and wetlands to control non-natives and enhance native vegetation assemblage and create a buffer around aquatic habitats. • Non-native species mechanical removal for purple loosestrife and reed canary grass.
Maintain and Improve Quality of Bird Habitats	Increase diversity of plant communities to provide habitat for a variety of bird species	• Maintain channel high point at 9 feet elevation to maintain open water habitats and mudflat areas that attract wading birds, shorebirds, and waterfowl. • Riparian/upland deciduous and coniferous plantings around reservoir and wetlands to provide nesting and foraging habitats.

A1. Replace Culvert

In this measure, the existing culvert would be replaced with a larger culvert that more effectively conveys natural tidal and winter high flows from the Willamette River into the refuge over the range of 5 feet to 15 feet in elevation and meets current state and Federal fish passage requirements to have velocities less than 2 fps approximately 95 percent of the time. This measure is required to restore the tidal hydrologic connection and achieve the objective of connections throughout the tidal range. Initially, a 12-foot by 12-foot box culvert was considered as well as a bridge. Based on ODFW fish passage requirements for velocity and stream simulation considerations, a 10-foot-high by 16-foot-wide arch culvert is proposed, with 3-foot stem walls.

B1. Remove Water Control Structure

In this measure, the existing water control structure would be removed entirely to allow fish passage upstream into the channel and reservoir. Minor revegetation would occur in disturbed areas around the water control structure as part of this component. This measure is one of the two options developed to reduce fish stranding and allow unhindered fish passage into Oaks Bottom, once they pass the culvert. This measure is mutually exclusive of Measure C1 and would only be effective to restore fish access if implemented in conjunction with Measure A1.

C1. Replace Water Control Structure

In this measure, the existing water control structure would be replaced with a redesigned structure. The new structure would be located in roughly the same location as the existing one. It would be designed to regulate water elevation but allow fish passage via a fish ladder or roughened chute. This measure is one of the two options developed to reduce fish stranding and allow unhindered fish passage into Oaks Bottom once they pass the culvert. This measure is mutually exclusive of Measure B1 and would only be effective to restore fish access if implemented in conjunction with Measure A1.

D1. Construct Berm around Reservoir

This measure was developed early on in response to the known presence of contaminated sediments in the reservoir. This measure would also require the implementation of Measure C1 to replace and relocate the water control structure to the upstream-most end of the outlet channel. This configuration reduces fish stranding and allows unhindered fish access to the outlet channel, which provides a smaller area of off-channel backwater habitat for rearing and foraging juvenile salmonids, but would restrict passage into the reservoir below flood elevations. Large woody debris would be placed and a corridor of riparian vegetation would be planted along the channel to improve fish and wildlife habitat. The Ecological Risk Assessment and subsequent fish tissue analysis (GeoEngineers 2010, 2011) prepared for the City of Portland shows that there is a low risk to fish and wildlife from exposure to contaminants in the sediments and the potential for bioaccumulation up the food chain.

E1. Remove Invasive Species and Revegetate Perimeter of Reservoir

Revegetation around the reservoir would include emergent, scrub-shrub, and forested wetland plantings. Vegetation would provide a buffer between the reservoir and hiking trails, would provide increased shade and incrementally reduce water temperatures, contribute to the nutrient cycle, and provide increased nesting and foraging habitat to both fish and wildlife. This measure includes actions to remove non-native species via mechanical and other methods and also include placement of large woody debris into aquatic and terrestrial habitats.

F1. Remove Invasive Species and Revegetate around Ponds

Revegetation around the two ponds between the reservoir and north fill would include a variety of plantings and would provide similar habitat benefits as described above. This measure includes actions to remove non-native species via mechanical and other methods and also include placement of large woody debris in the ponds.

G1. Excavate Tidal Slough Channel to Reservoir with Step Weirs or Riffles

This measure would lower the existing channel from the proposed new culvert invert elevation to the reservoir and add reconnection of the existing remnant channel for added tidal slough channel length for a total of 2 acres of tidal slough habitat. The channel would slope up to the high point within the reservoir to maintain a minimum 4 to 6 acres of open water reservoir/pond year-round with 8 step weirs or riffles installed to control the grade and prevent headcutting of the channel up into the reservoir. Connecting this channel without step weirs or riffles could lead to headcutting and mobilization of reservoir sediments into the Willamette River, which is not desirable as low levels of DDx would be discharge into the river. Large woody debris and a riparian buffer would be installed along the entire length of the new channel, with vegetated mats installed along the upper end to reduce the chance for channel avulsion or flanking.

H1. Moderate Contour of Reservoir and Creation of Islands

Areas within the reservoir would be excavated to allow greater area of dendritic channel that would provide additional fish habitat even at low water. Excavated or imported clean materials would be used to form two small islands near the channel outlet.

I1. Extensive Contour of Reservoir and Creation of Islands

This measure of contouring includes excavation of several channels within the reservoir and formation of additional islands near the south end of the reservoir.

J1. Excavate Duck Ponds/Slough Channels

Two duck ponds are present in the reed canary grass dominated wetland area north of the reservoir. These ponds could be connected to the culvert via newly excavated channels. A first channel would be excavated between the existing reservoir outlet channel and the southern-most pond. The channel would start downstream of the water control structure and reach the pond in a fairly linear manner. A second channel would then be constructed between the south and north ponds. Multiple channel locations are possible, including a short straight channel or a channel that follows the meandering low contour line. Connecting these ponds to the slough channels would reduce habitat for nutria that currently dominate these ponds.

K1. Create Flow-Through Side Channel with Downstream Culvert Outlet

In this measure, the channels excavated between the outlet channel and north and south ponds would be continued to a downstream outlet (culvert back through the railroad berm) about 1,200 feet downstream of the existing culvert, which would form a side channel. A new culvert would be placed at the downstream end of the side-channel and provide an outlet to the Willamette River. The outlet would be located just south of the north fill, which would reduce the volume of required excavation.

L1. Create Ephemeral Ponds in North Fill

The North Fill area has become vegetated with both native and invasive trees and shrubs since placement of the compacted fill material from the construction of I-405. This area could be enhanced to provide additional ephemeral ponds (wetlands) for amphibian habitat between the wetlands to the north and south. Ephemeral ponds, also known as vernal or temporary, are depressions that temporarily hold water on top of poorly drained soils. Ephemeral ponds require sufficient catchment area for recharge and contours to hold water long enough to balance losses to infiltration or evaporation. They also require poorly draining soils to hold water. Total pond acreage is preliminarily estimated to be 1 to 5 acres.

M1. Revegetate North Fill

Revegetation efforts within the north fill would primarily include upland tree and shrub underplantings to provide a buffer on the north end of the park for the ponds and other aquatic habitats. Vegetation would provide increased cover for mostly wildlife species, which would help to shade out non-native species. Small ephemeral wetlands are present throughout the north fill and would also be revegetated in this measure. Plantings would include emergent plants such as rushes and sedges. Again, the removal of non-native plants and placement of large woody debris are included in this component.

N1. Revegetate Upland Areas

Upland areas below the toe of the steep bluffs would be underplanted with coniferous species, while non-native vines, trees, and shrubs would be removed to provide a quality buffer around the reservoir and other aquatic habitats. Native forests provide a greater buffer between the refuge and adjacent neighborhoods, additional perching sites for raptors foraging within the reservoir, and greater cover for wildlife within the project area. Some areas of oak-madrone savannah may also be further enhanced on the bluffs.

Table 3-2 Preliminary Restoration Measures and the Objectives Addressed

Restoration Measure	Objectives Addressed			
	Restore Tidal Hydrology and Minimize Stranding of Salmonids	Improve Habitat for Fish and Wildlife Species	Control Non-Native or Pest Populations	Maintain and Improve Quality of Bird Habitat
A1. Replace Culvert	X			
B1. Remove Water Control Structure	X	X		
C1. Replace Water Control Structure	X			X
D1. Construct Berm Around Reservoir	X			
E1. Remove Invasive Species and Revegetate Perimeter of Reservoir		X	X	
F1. Remove Invasive Species and Revegetate Around Ponds		X	X	
G1. Excavate Tidal Slough Channel to Reservoir with Step Weirs	X	X		X
H1. Moderate Contour of Reservoir and Creation of Islands		X		
I1. Extensive Contour of Reservoir and Creation of Islands		X		
J1. Excavate Duck Ponds/Slough Channels		X	X	
K1. Create Flow-Through Side Channel with Downstream Culvert Outlet	X	X		
L1. Create Ephemeral Ponds in North Fill		X		
M1. Revegetate North Fill		X		
N1. Revegetate Upland Areas		X		

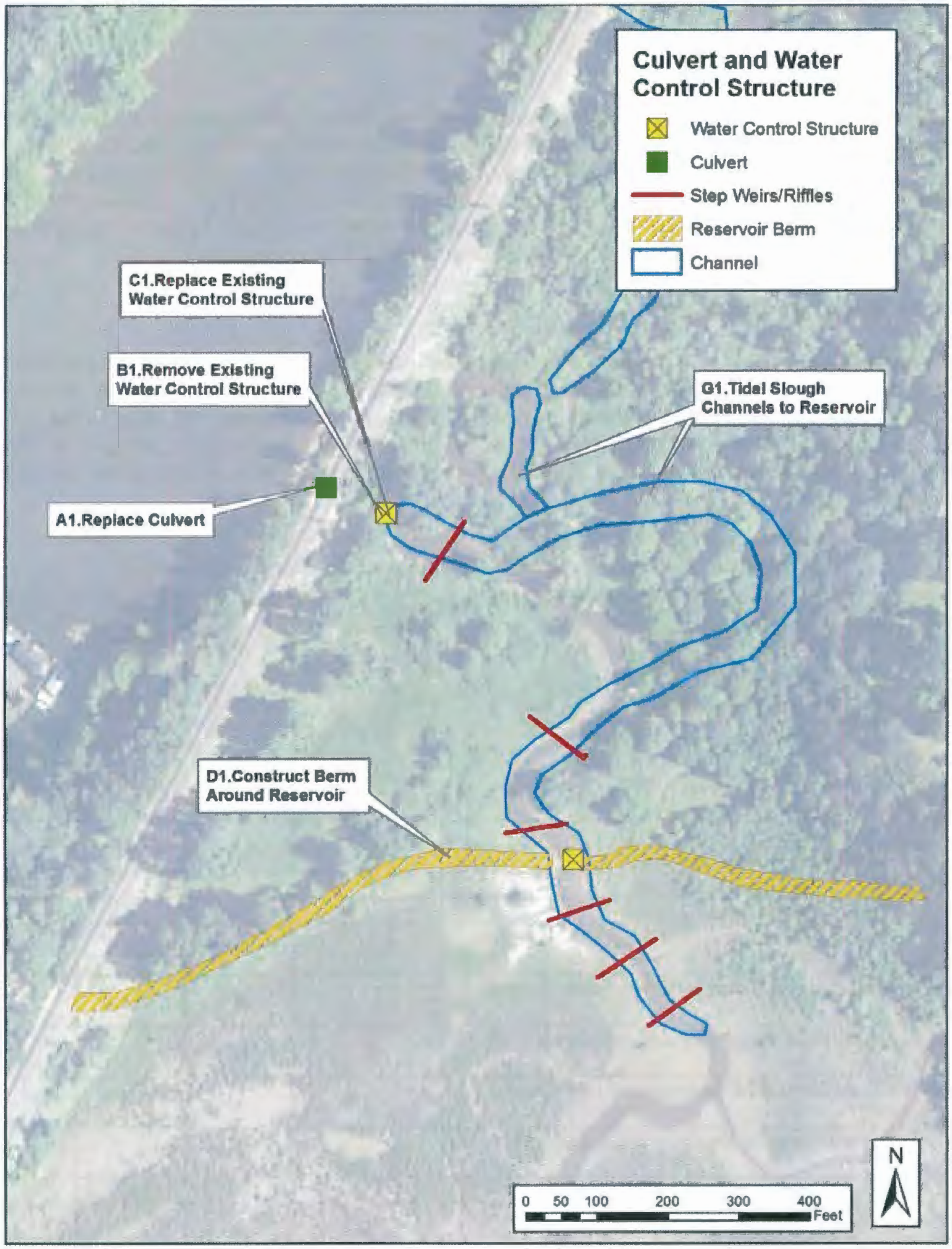


Figure 3-1. Preliminary Measures for Hydrologic Connections

Figure 3-2. Preliminary Measures for Habitat Improvement

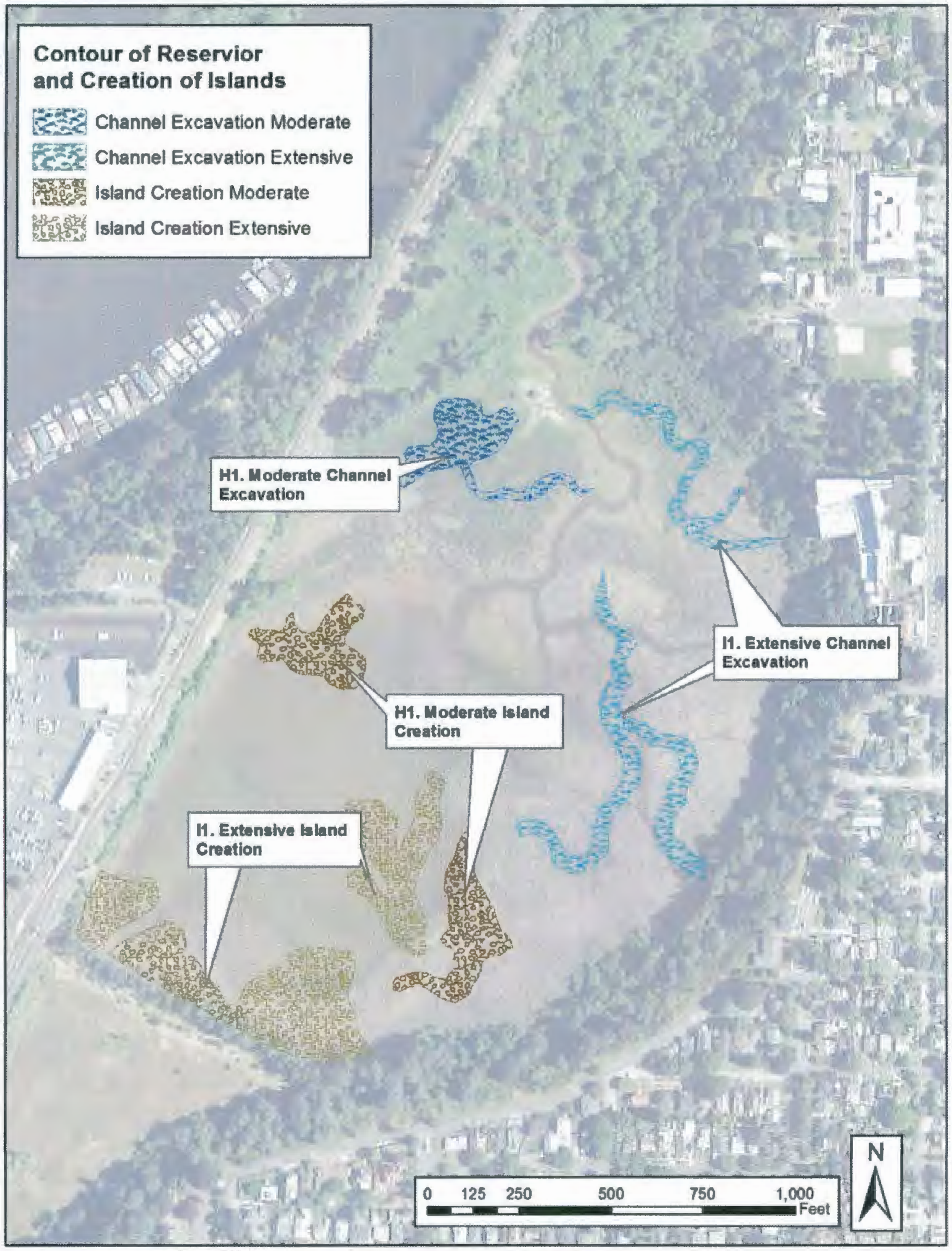


Figure 3-3. Preliminary Measures for Reservoir Improvement

Figure 3-4. Preliminary Measures for North Areas

The City conducted additional monitoring and data collection on the project site from 2008-2010 because a number of issues were raised about the feasibility of some of the proposed restoration measures, particularly Measure J1, which would be in close proximity to the one high quality native species dominated wetland on the site in the North wetland. Concerns included: (1) constructability in soft, mucky wetland soils; (2) potential effects on an existing high quality wetland in the north portion of the site; (3) contaminated sediment handling and disposal; and (4) timing for implementation. Because of these concerns, the preliminary restoration measures were pre-screened to eliminate measures that were likely to cause unwanted adverse effects. These are discussed in more detail below.

3.2.1.1 Restoration Measures Eliminated from Consideration

The following criteria were used to pre-screen the restoration measures:

- Constructability. How feasible is it to construct the measure in soft, saturated soils?
- Potential effects on the North wetland. The City does not want the groundwater table to be drawn down and adversely affect the hydrology of the North wetland.
- Timing for implementation. The City would like to enhance habitat sooner than Federal funding can be obtained for amphibians and reptiles; thus, measures related to their habitat specifically will be implemented sooner.
- Relationship to Corps' mission. Restoration that primarily benefits uplands was deemed not to be within the Corps' mission area.

H1. Moderate Contour of Reservoir and Creation of Islands. This measure was eliminated because it would require excavation in several areas of the reservoir where the ground is mucky and saturated year-round. Excavation in these conditions would likely result in significant adverse effects to the existing habitat quality and habitats specifically used by native amphibians.

I1. Extensive Contour of Reservoir and Creation of Islands. This measure was eliminated because it would require extensive excavation in several areas of the reservoir where the ground is mucky and saturated year-round. Excavation in these conditions would likely result in significant adverse effects to the existing habitat quality and habitats specifically used by native amphibians.

J1. Excavate North Channel/Slough Channel. This measure was eliminated because it was deemed to have the potential for significant adverse effects on the existing high quality north wetlands because it would excavate into the groundwater table and change the hydrology of the existing wetland (see Appendix A, Attachment B that shows City's groundwater modeling of this alternative and its potential effects on the groundwater table). While certain design features such as using an impervious layer in the channel could be feasible, Portland Parks and other stakeholders specifically requested elimination of this measure from consideration.

K1. Create Flow-through Side Channel with Downstream Culvert. This measure was eliminated because it was deemed to have significant adverse effects on the existing high quality north wetlands because it would excavate into the groundwater table and change the hydrology of the existing wetland. Additionally, it would have very high costs due to the need for a second culvert to outlet beneath the embankment that was very high in comparison to the potential benefits.

L1. Create Ephemeral Ponds in the North Fill. This measure was eliminated because the City implemented it already for amphibian habitat.

M1. Revegetate North Fill. This measure was eliminated because the City is doing extensive revegetation work here already.

N1. Revegetate Uplands. This measure was eliminated because it does not fit within the Corps' mission area and the City is already doing revegetation work in the uplands.

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4. EVALUATION AND COMPARISON OF ALTERNATIVES

Evaluation of the effects of the alternative plans was accomplished through the calculation of the environmental outputs (habitat evaluation) and cost analysis. The outputs of an ecosystem restoration project are not readily convertible to actual monetary units as is required for traditional benefit-cost analysis. Ultimately, the selected restoration plan will be the plan that provides the greatest habitat benefits for the least relative cost. A preliminary restoration plan has been identified through this process and is presented in this report. This process requires the following steps, which are further described below:

1. **Assessment of Habitat Benefits for Each Measure**. Assessment of habitat benefits calculated for each restoration measure based on best scientific data and field studies.

2. **Cost Estimates for Each Measure**. Development of cost estimates for each restoration measure based on preliminary designs.

3. **Cost Effectiveness and Incremental Cost Analysis**. Identification of the cost effective and incrementally justified restoration measure based on comparison of habitat outputs and cost estimates.

4. **Recommended Plan**. Identification of the recommended plan, which includes the combination of restoration measures that provides the greatest incremental habitat benefit for lowest relative cost, and is acceptable, complete, effective, and efficient.

4.1 Assessment of Habitat Outputs for Each Measure

4.1.1 Hydrogeomorphic Model

In order to select the most cost effective restoration plan, it is necessary to assign a quantitative numeric value to the habitat benefits for each measure. These habitat benefits are compared with costs to determine cost effective and incrementally justified alternatives. The project team selected the Hydrogeomorphic Model (HGM) to calculate the habitat benefits of each restoration measure and HGM models are approved for use in planning studies. This model was selected because the majority of the area under consideration for restoration is a diverse mix of wetland, channel, and open water features and it was important to the City to understand the existing quality of the site and the potential effects from a wetland community context. Additionally, the City is interested in restoring habitat quality and diversity for a wide range of native fish and wildlife species and did not want to focus on a narrow range of species (i.e., such as the HEP models for individual species).

HGM is a habitat evaluation procedure developed by the Corps, which provides a mathematical model based on the potential function and values of a restored wetland (Brinson 1993). The HGM used for this assessment is the *HGM-Based Assessment of Oregon Wetland and Riparian Sites: I, Willamette Valley Ecoregion, Riverine Impounding and Slope/Flats Subclasses* (Adamus and Field 2001). This model, which offers parameters specifically developed for riverine impounding sites including floodplain sloughs, beaver impoundments, some riparian areas, and many diked marshes, is appropriate for use at Oaks Bottom Wildlife Refuge. The HGM methodology is approved for use in Corps studies.

The HGM model combines the assessed mathematical values or "scores" for a given set of functions that wetlands provide. Scores are determined through field assessments, aerial photography, and other best available scientific data. The suite of wetland functions included for evaluation in the model is:

- Water Storage and Delay – The capacity of a wetland or riparian area to store or delay the downslope movement of surface water for long or short periods, and in doing so to potentially influence the height, timing, duration, and frequency of inundation in downstream or downslope areas.
- Sediment Stabilization and Phosphorus Retention – The capacity of a wetland or riparian area to intercept suspended inorganic sediments, reduce current velocity, resist erosion of underlying sediments, minimize downstream or downslope erosion, and/or retain any forms of phosphorus.
- Nitrogen Removal – The capacity of a wetland or riparian area to remove nitrogen from the water column and sediments by supporting temporary uptake of nitrogen by plants and by supporting the microbial conversion of non-gaseous forms of nitrogen to nitrogen gas (denitrification).
- Thermoregulation – The capacity of a wetland or riparian site to maintain or reduce water temperature.
- Primary Production – The capacity of a wetland or riparian area to use sunlight to create particulate organic matter (e.g., wood, leaves, detritus) through photosynthesis.
- Resident Fish Habitat Support – The capacity of a wetland or riparian site to support the life requirements of most non-anadromous (resident) fish species that are native to the Willamette Valley ecoregion.
- Anadromous Fish Habitat Support – The capacity of a wetland or riparian site to support some of the life requirements of anadromous fish species native to the Willamette Valley ecoregion.
- Invertebrate Habitat Support – The capacity of a wetland or riparian site to support the life requirement of many invertebrate species characteristic of such habitats in the Willamette Valley ecoregion, for example, midges, freshwater shrimp, caddis flies, mayflies, butterflies, water beetles, shore bugs, snails, and aquatic worms.
- Amphibian and Turtle Habitat – The capacity of a wetland or riparian site to support some of the life requirements of several species of amphibians and turtles that are native to the Willamette Valley ecoregion, such as northwestern salamander, long-toed salamander, roughskin newt, Pacific tree frog, red-legged frog, western pond turtle, and painted turtle.
- Breeding Waterbird Support – The capacity of a wetland or riparian site to support the requirements of many waterbird species during their reproductive period in the Willamette Valley ecoregion.
- Wintering and Migrating Waterbird Support – The capacity of a wetland or riparian site to support some of the life requirements of several waterbird species that spend the fall, winter, and/or spring in the Willamette Valley ecoregion.
- Songbird Habitat Support – The capacity of a wetland or riparian site to support the life requirements of many native non-waterbird species that are either seasonal visitors or breeders in the Willamette Valley ecoregion.
- Support of Characteristic Vegetation – The capacity of a wetland or riparian site to support the life requirements of many plants and plant communities that are native to the Willamette Valley ecoregion.

The project team visited the site to collect data on vegetation species and physical parameters that were used in addition to aerial photos and Geographic Information System (GIS) data layers as inputs required for the model. These parameters included the presence of permanent water, percentage of the site that is seasonally inundated, water depths, connection to adjacent waterbodies, distribution of pools, large woody debris, soil type, surrounding land uses/vegetation types, human use, and level of disturbance. The team input this data into the spreadsheet that accompanies the HGM manual and developed the scores for each of these functions for the existing and potential future without-project condition for the 50-year period of analysis by evaluating the approximately 100 acres of the existing floodplain site (not including the north and south upland fill areas). The evaluation of the entire wetland site is the most common method of using the HGM methodology as conditions are assessed for the interspersion of habitats and flows of water across all habitats within a site.

Input data was then developed for each proposed restoration measure by modifying parameters based on the predicted changes, such as connections to the adjacent waterbody (river), seasonality of inundation, and water depths. Each with-project measure is also scored based on its contributions to habitat conditions and water flows across the entire site as a whole. For example, the replacement of the culvert primarily affects the frequency and inundation depths of water on the site, thereby primarily affecting the functions of water storage and delay, thermoregulation, resident fish habitat support, and anadromous fish habitat support. Thus, the future with-project condition has improved values for these functions, while the other functions generally remain the same. The sum of the scores for each function is used as described below. A different measure, such as revegetation around the perimeter of the reservoir, has primary effects on different functions, such as songbird habitat support and support of characteristic vegetation. Thus, the measures are not double counted as they typically affect different functions.

As conditions continue to change into the future, both the without-project and with-project scores are in average annual habitat outputs over the course of the 50-year period of analysis, which is the period of assessment for the project and not the anticipated duration of project functioning.

The HGM model generates Functional Capacity Units (FCUs) for each of the 13 wetland functions listed above. As stated above, the habitat benefit of each measure was calculated for the entire site as a single large unit. For example, the scores for each of the functions for revegetating around the reservoir (Measure E1) have been calculated as a percentage for the overall condition at the entire site. The scores for each function are multiplied by 100 acres and then summed and averaged across the 50-year period of analysis resulting in Average Annual Functional Capacity Units (AAFCUs). Data were developed for years 1-10, 10-25, and 26-50 for each measure to develop the AAFCUs. Combining the individual function scores to create a single score, annualized over the life of the project, is a technique that allows a numerical value to be assigned to habitat benefits. Table 4-1 summarizes AAFCUs assigned to each restoration measure. More details on the habitat benefit scores are provided in Appendix D.

Table 4-1 Average Annual Functional Capacity Units for Each Measure

ID	Measure	AAFCU	Change from Future Without Project
No Action	Future Without Project	835	--
A1	Remove Culvert	928	93
B1	Remove Water Control Structure	900	65
C1	Replace Water Control Structure	874	39
D1	Construct Berm	889	54
E1	Revegetate Reservoir	917	82
F1	Revegetate Ponds	900	65
G1	Construct Tidal Slough	984	149

4.2 Cost Estimates for Each Measure

Selecting the best set of restoration measures requires that each measure be assessed for its total cost of implementation, operation, and maintenance. The cost estimate for each measure is based on preliminary design plans and includes the total construction cost plus a contingency on the construction costs of 25 percent (applied as a standard contingency for the preliminary designs), design costs, engineering during construction and construction management, post-construction monitoring, the cost for operation and maintenance of the project site once construction is completed, and real estate costs under the Fiscal Year (FY) 13 discount rate of 3.75 percent. These costs are then annualized over the course of the 50-year period of analysis and reported as average annual costs. The average annual costs are used in the incremental cost analysis and compared against the AAFCUs to determine which measures, and sets of measures, provide the greatest benefit for the least cost. Table 4-2 shows the preliminary cost estimate for each measure carried forward for further analysis. More detailed preliminary cost estimates for each measure are provided in Appendix B. The price level was for 2011.

Operation and maintenance costs were developed based on the type of maintenance typically required for habitat restoration projects, including vegetation irrigation and replanting, removal of invasive plant species, periodic removal of sediment/debris from culverts and channels after a high flow, and repair/maintenance of culverts and channels following a major flood event. All measures include at least a small value of vegetation maintenance as associated with the disturbed and revegetated areas; however, measures that are only revegetation have a large initial component of vegetation maintenance and removal of invasive species (based on acreage revegetated) over the first 5 years to ensure the plantings get well established and are not overwhelmed by weeds. The culvert and channel measures assume maintenance would be required every 10 years on average and one larger maintenance effort after a major flood event once during the period of analysis.

It is expected that once the recommended restoration plan is selected and detailed feasibility level designs and analysis are conducted, the cost estimates may change. However, this does not affect the results of the CE/ICA because all of the plans were initially compared against each other using the same unit costs.

4.3 Alternative Plans Formulation

The management measures outlined above were combined using the Institute for Water Resources Planning Suite. The software generates all possible combinations of measures. However, some measures may stand alone, some are dependent on other measures, and some cannot be combined with other measures. These relationships are determined based on the constraints within the plan formulation, as well as professional judgment regarding the effectiveness of a given set of measures. For example, if the culvert is removed in Measure A1, another measure must be taken in order to protect targeted fish species from entrapment. This means that Measure A1 must be combined with B1 or C1.

Table 4-3 shows the relationships derived for restoration measures at Oaks Bottom. Because the restoration measures do not individually meet all of the project objectives and some measures would not function without others, some measures *must* be combined with others to be considered. Of considerable importance is the need to remove the existing culvert and replace it with the proposed arch culvert. Without this component of the project, there would be few or no benefits to targeted fish species from the water control structure measures or the tidal slough channel measure because fish would still rarely be able to enter the refuge. Therefore, each measure related to fish must include Measure A1. Additionally, the water control structure should be modified for either the culvert replacement or the tidal slough channel measures in order for their benefits to be realized. Measures that cannot be combined are those that represent a different level of change to the same resource. For example, it is not possible to remove the water control structure and replace it at the same time.

Table 4-2. Cost Estimates for Measures									
ID	Description	Construction Costs	Design, RE and Other Costs [1]	First Cost Net Present Value	Average Annual First Cost	Net Present Value O&M	Average Annual O&M	Total Project Cost NPV	Average Annual Total Project Cost
A1	Replace Culvert	$2,470,200	$1,099,600	$3,569,800	$159,100	$32,400	$1,400	$3,602,100	$160,600
B1	Remove WCS	$349,900	$162,200	$512,100	$22,800	$20,200	$900	$532,200	$23,700
C1	Replace WCS	$844,400	$377,300	$1,221,700	$54,500	$132,300	$5,900	$1,354,100	$60,400
D1	Construct Berm	$421,400	$228,300	$649,700	$29,000	$213,000	$9,500	$862,800	$38,500
E1	Revegetate Reservoir	$225,500	$203,100	$428,600	$19,100	$336,200	$15,000	$764,800	$34,100
F1	Revegetate Ponds	$225,500	$203,100	$428,600	$19,100	$336,200	$15,000	$764,800	$34,100
G1	Tidal Slough	$956,400	$451,000	$1,407,500	$62,700	$28,400	$1,300	$1,435,800	$64,000

1 – Includes 25 percent construction contingency, design, real estate, engineering during construction, supervision and administration and post-construction monitoring.

Table 4-3 Measures and Combinations for Incremental Cost Analysis			
ID	Measure Description	Must Be Combined With	Cannot Be Combined With
A1	Replace Culvert	B1 or C1, and G1	No restriction
B1	Remove Water Control Structure	A1	C1
C1	Replace Water Control Structure	A1	B1 or D1
D1	Construct Berm	A1 and C1	B1 or G1
E1	Revegetate Reservoir	No restriction	No restriction
F1	Revegetate Ponds	No restriction	No restriction
G1	Construct Tidal Slough	A1 and B1-or- A1 and C1	D1

4.3.1 Cost Effectiveness Analysis

Traditional benefit-cost analysis is not possible for planning ecosystem restoration projects because the costs and benefits are expressed in different terms, with costs in dollars and benefits evaluated by the presence of appropriate habitat or ecosystem function. However, cost effectiveness and incremental cost analyses can provide decision makers with relative benefit-cost relationships of the various alternatives. While these analyses are not intended to lead to a single best solution, they do improve the quality of decision-making by ensuring that a rational, supportable, focused, and traceable approach is used for considering and selecting alternatives to produce ecosystem outputs.

Corps guidance requires cost effectiveness and incremental cost analyses for ecosystem restoration. First, a cost effectiveness analysis was conducted to ensure that the least cost solution is identified for each possible level of ecosystem output. Cost effectiveness means that no plan can provide the same benefits for less cost, or more benefits for the same cost. Table 4-4 and Figure 4-1 show the results of the cost effectiveness analysis, with the cost-effective plans highlighted and labeled with ID numbers. The no action plan was included for comparison ($0 cost and 0 outputs). Measure C1 is more costly than Measure B1 with fewer benefits and thus is not cost effective. Measure D1 is costly and only provides limited benefit and is also not cost effective. In addition, the non-Federal sponsor would prefer to remove the water control structure entirely to reduce their management costs and allow natural hydrologic fluctuations and unhindered fish passage.

Table 4-4 Cost Effective Plans

ID	Alternative	Cost	Net Output[1]	Average Cost/Output
1	No Action Plan	$0	0	$0
	F1	$34,090	65	$524.46
2	E1	$34,090	82	$415.73
3	E1F1	$68,180	147	$463.81
	A1C1G1	$284,920	281	$1,013.95
4	A1B1G1	$248,290	307	$808.76
	A1C1F1G1	$319,010	346	$921.99
	A1C1E1G1	$319,010	363	$878.81
	A1B1F1G1	$282,380	372	$759.09
5	A1B1E1G1	$282,380	389	$725.91
	A1C1E1F1G1	$353,100	428	$825.00
6	A1B1E1F1G1	$316,470	454	$697.07

1 – Net output represents the change from the No Action Plan output.

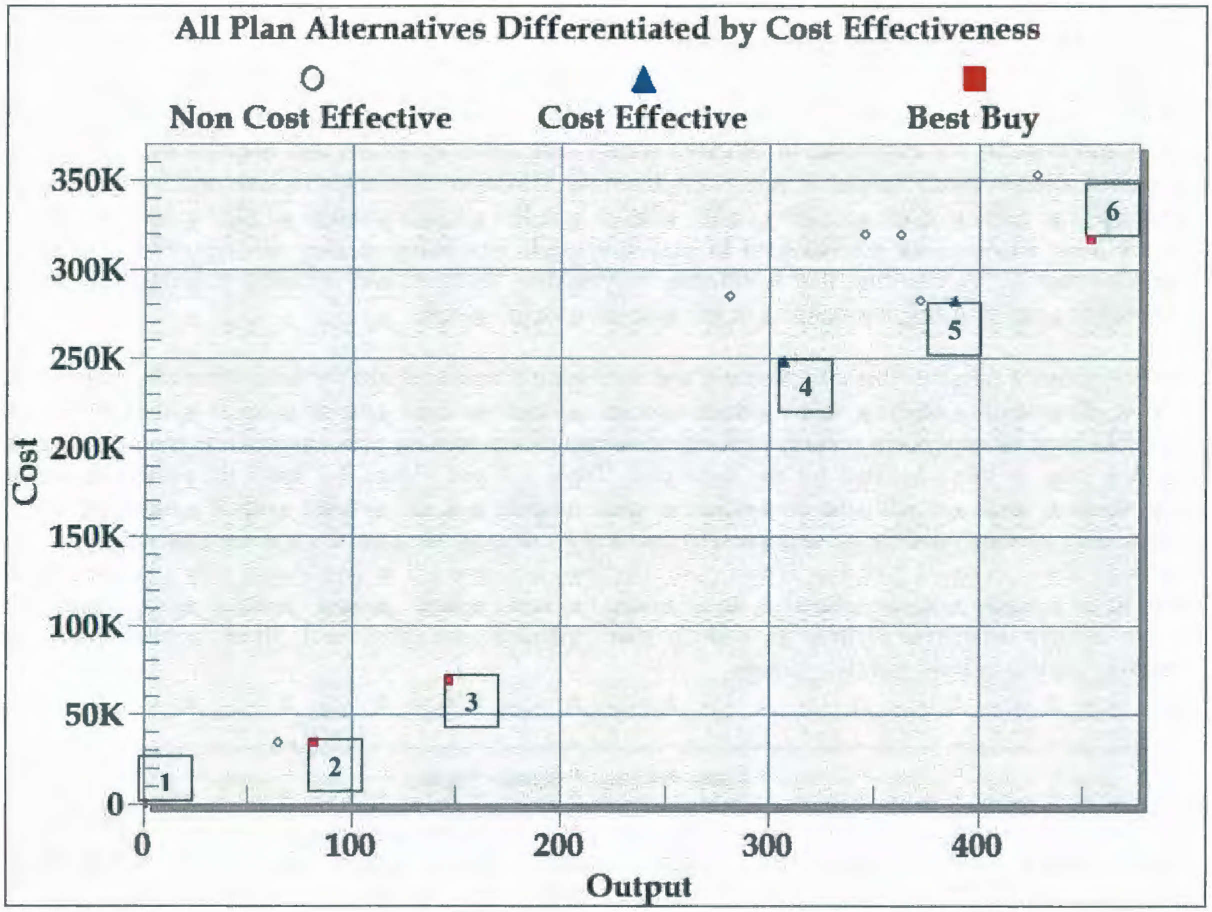

Figure 4-1. Cost Effective Plans

4.3.2 Incremental Cost Analysis

Incremental analysis of the cost effective solutions was conducted to reveal changes in cost for increasing level of outputs. Plans that provide the greatest increase in benefits for the least increase in costs were identified as "best buy" plans and are Plans 2, 3, and 6. Table 4-5 and Figure 4-2 show the results of the incremental analysis and the best buy plans.

Table 4-5 Best Buy Plans

ID	Alternative	Cost	Output	Incremental Cost	Incremental Output	Incremental Cost/Inc. Output
1	No Action Plan	$0	0	0	0	0
2	E1	$34,090	82	$34,090	82	$ 415.73
3	E1F1	$68,180	147	$34,090	65	$ 524.46
6	A1B1E1F1G1	$316,470	454	$248,290	307	$ 808.76

Following the identification of the best buy plans, interest during construction (IDC) was calculated for the 4-month construction period for each best buy plan (see Table 4-6) and then included into the average annual cost to rerun the CE/ICA. After rerunning the CE/ICA, it was confirmed that the plan ranking and selection is not affected by the addition of IDC.

Table 4-6 Interest During Construction								
ID	**Alt.**	**Const. Period (yrs)**	**Const. Cost**	**IDC**	**Const. Cost with IDC**	**Ann Const. Cost with IDC**	**Annual O&M**	**Total Annual Cost w/ IDC**
2	E1	0.33	$428,590	$2,638	$431,228	$19,222	$14,990	$34,212
3	E1+F1	0.33	$857,180	$5,276	$862,456	$38,443	$29,980	$68,423
6	A1+B1+E1+F1+G1	0.33	$6,346,490	$39,060	$6,385,550	$284,631	$33,580	$318,211

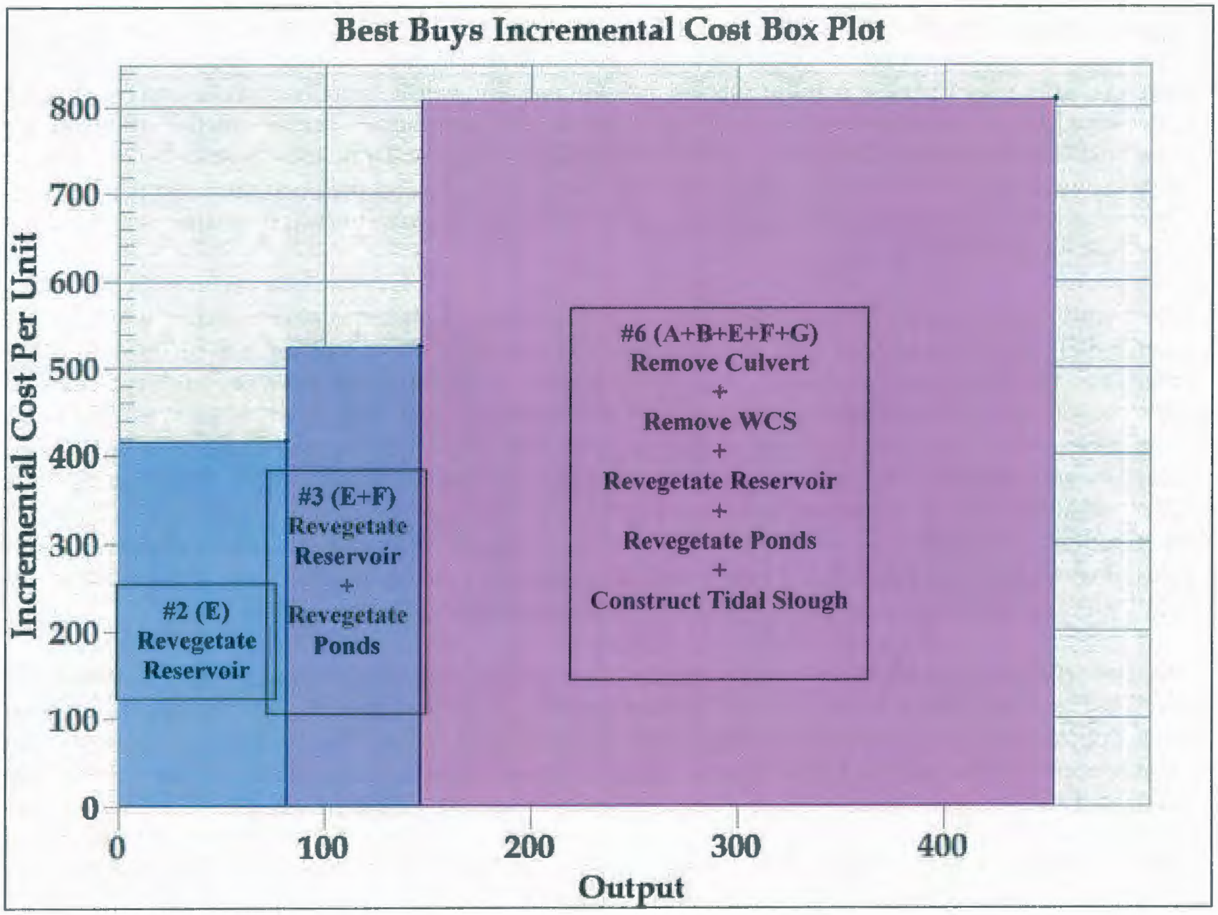

Figure 4-2 Best Buy Plans

4.4 Plan Selection

When evaluating the best buy plans shown in Figure 4-2, Plan 2 provides 82 units of benefit at an incremental cost per unit of $416; Plan 3 provides an additional 65 units of benefit (total of 147) at an incremental cost per unit of $524; and Plan 6 provides an additional 307 units of benefit (total of 454) at an incremental cost per unit of $809. Other cost effective plans that were not best buys would include the culvert replacement, removal of the water control structure, and construction of tidal sloughs, which would benefit fish but would not benefit wildlife species-and at a higher cost per output. No larger plans were identified that were cost effective, as they provided the same or lower level of benefits at a higher cost.

Selection of a recommended plan is done in a step-wise fashion to determine what amount of habitat output is worth it in coordination between the Corps and the non-Federal sponsor (City of Portland). Plan 2 provides a moderate level of output at a low cost and would only include revegetation around the reservoir. This would benefit wildlife species, but without removal of the culvert/water control structure, there would be no restoration of the tidal hydrologic regime and limited benefits to fish; thus, the plan would not fully meet project objectives. Plan 3 would add another moderate increment of benefit at only a slightly increased incremental cost and would add revegetation around the pond area. Similar to Plan 2, this would benefit wildlife species, but there would be limited benefits to fish; thus, this plan would not fully meet project objectives.

Plan 6 adds a large amount of additional benefit for an increase in incremental cost. Plan 6 would provide natural daily tidal fluctuations over the range of tidal cycles via the replacement of the culvert and removal of the water control structure. This would provide unhindered fish passage into the channel and up to the reservoir while simultaneously reducing fish stranding. Fish habitat would be improved via the excavation of the tidal slough channel to the reservoir with step weirs and the addition of large woody debris for an additional 3 acres of slough habitat plus access to up to 88 acres of the refuge during 2-year flows. Wildlife habitat, cover, native species, and long-term large wood input would be improved by revegetation around the reservoir and pond areas. The revegetation measures would include removal of non-native species and plantings of native species to suppress the non-natives. The recommended plan would meet all of the project objectives and provide substantial benefits at moderate cost.

This is worth it to meet all of the project objectives and realize substantial benefits to all fish and wildlife species. Therefore, Plan 6 is selected as the recommended plan and the NER plan for its ability to meet project objectives, provide notable benefits, and be cost effective. While Plan 6 is the most expensive plan on the cost-effectiveness and incremental analysis charts, more costly measures had already been eliminated due to such issues as their known adverse effects on existing high quality habitats or very difficult construction methods. Thus, all measures evaluated in the CE/ICA were already considered both effective and practical, leading to the ultimate selection of Plan 6 for meeting all project objectives, the provision of substantial benefits and justification via the CE/ICA.

4.4.1 Acceptability

An ecosystem restoration plan should be acceptable to state and Federal resource agencies, and local government. There should be evidence of broad-based public consensus and support for the plan. A recommended plan must be acceptable to the non-Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan. The recommended plan meets all of the project objectives, including: (1) allow salmonid access and reduce entrapment or stranding of salmonids; (2) improve habitat for fish and wildlife species; (3) control non-native or pest populations; and (4) maintain open water and mudflat habitats. The recommended plan meets these objectives, does not cause adverse effects to existing wetland habitats, and is constructible. Other agencies, including the Oregon Department of Fish and Wildlife and Oregon Department of State Lands, have expressed strong support for and provided approvals for the recommended plan. The community groups that have been involved in the plan formulation are also supportive of the recommended plan.

4.4.2 Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. The recommended plan would realize the predicted habitat outputs by providing the complete mix of measures that ensures that hydrologic, fish passage, wildlife, and vegetation objectives are met. The recommended plan appropriately minimizes future operation and maintenance by not including an active water control structure. The minimum desired reservoir area would be maintained by the passive step weirs or riffles that end at approximately 9 feet in elevation. The revegetation measures would require effort on the part of the City during the first 5 years, primarily, to ensure that non-native species do not re-establish and dominate the proposed plantings. However, once the native species become established, there would be minimal continued O&M over the period of analysis. The revegetation measures also promote establishing the long-term desired future conditions developed for the wildlife refuge. This project can be implemented without requiring other actions in the watershed in order to be successful.

4.4.3 Efficiency

An ecosystem restoration plan must represent a cost effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution. The recommended plan provides substantial benefits at a moderate cost. These benefits cannot be realized more effectively by the non-Federal sponsor or other stakeholders because they do not have the funds to construct the primary elements of the project that restore the natural tidal connections-namely, the culvert replacement and removal of the water control structure. Removal of the railroad embankment is not feasible due to the on-going use of the railroad and very high use of the Springwater Trail. A bridge would be more costly than a culvert and is thus not efficient.

4.4.4 Effectiveness

An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities. The recommended plan specifically reconnects and restores off-channel and floodplain habitats in the Lower Willamette River that would make a major contribution towards achieving key objectives of the Willamette River Subbasin Plan and Portland Parks' desired future condition. The selected plan provides unhindered fish access into and out of Oaks Bottom and provides approximately 80 acres of enhanced tidal rearing and refuge habitat for listed species of salmonids. The recommended plan would also reduce populations of non-native plants, fish, and bullfrogs by restoring more natural tidal fluctuations and the seasonal flooding regime. The project would reduce the area of warm water reservoir and promote spring-fed dominated channels that are more suitable for cold water species.

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5. RECREATIONAL FEATURES

In addition to the restoration features described in previous sections of this report, the City would like to include recreational features to the recommended plan. Under all alternatives, two cantilevered viewing platforms would be installed directly adjacent to the Springwater Trail to allow safe bird watching, fish watching, and other territorial views without impeding the busy bicycle traffic on the trail. Each platform would be approximately 8.75 feet wide by 30 feet long with an Americans with Disabilities or ADA-accessible ramp and a bike lock-up. One platform would be installed adjacent to the proposed culvert replacement for fish and channel viewing. The other platform would be installed further south to allow viewing of the main wetland area for bird watching.

Consistent with ER 1105-2-100 Appendix E, the proposed recreational features are compatible with the ecosystem restoration project, do not diminish the ecosystem restoration benefits, and are independently justified. The viewing platforms are considered to be consistent with the checklist of facilities which may be cost shared per ER 1105-2-100 Exhibit E-3. Per the exhibit, facilities may include accessible walks, steps, and ramps, as well as related directional/educational signage.

In addition to enhanced public safety, the cantilevered construction of the platforms minimize impact adjacent to the trail. The platforms would enhance the viewing and lines of sight at the ecosystem restoration site, improving the quality of existing viewing-related activities as well as providing an opportunity for environmental education through installation of interpretive signage. A schematic of the viewing platform is provided at the end of this section.

As described below, these recreation features were evaluated and determined to be economically justified. The recreation analysis is included as Appendix F and is summarized in this section.

5.1 Methods

Tetra Tech prepared a recreation analysis, which evaluated the recreation features' net benefit relative to the No Action alternative. The benefits of recreation features are measured through approximation of a visitor's willingness to pay for the recreation resource. Willingness-to-pay is assumed to represent the economic value, in dollars, that a visitor places on a recreation resource. Measuring the economic value of the recreation resource without the project first, then measuring with the project in place, allows for the calculation of net recreation benefits due to construction of the recreation alternative.

The Unit Day Value (UDV) method was selected as the appropriate valuation method for the Oaks Bottom study. The UDV relies on expert or informed opinion and judgment to estimate the willingness-to-pay. This method of annual recreation value estimate was completed for the without-project condition and then for the with-project condition. In each case, the evaluation of the alternative consists of two key components (visitation estimates and UDV scores), both of which relied on input from Portland Parks, as well as major user groups from the adjacent Oaks Amusement Park and Audubon Portland.

5.2 Visitation

Visitation estimates where developed for the without and with-project conditions. No official visitor counts were available by activity. However, coordination with representatives of key user groups yielded sufficient data to characterize present and potential future use of the site. Because Oaks Bottom has been operational for some time and because it is located within an already densely populated urban area, significant visitation growth due to implementation of the proposed recreation features is not expected.

Thus, visitation growth was estimated conservatively. Growth was estimated proportionally to projected population growth in the Portland area in both the without and with-project conditions. Projected growth rates were based on values published by Portland Metro[3]. Using an average value from the report, population is projected to grow at an annual rate of 1.54 percent through 2030, and then 1.22 percent after 2030. For the purposes of this recreation analysis, population growth was applied over the first 25 years of the period of analysis (2014 – 2038) and then flat-lined through the end of the period of analysis (2063).

5.2.1 Without Project

In the without-project condition, the site of the proposed recreation features already sees substantial visitation due to the traffic on the Springwater Trail, visitors to the Oaks Bottom Amusement Park, and visitors to Oaks Bottom Wildlife Refuge such as bird watchers, school groups, and other organized group visits. All user groups had growth in visitation applied in proportion to the projected population growth. The following table summarizes the without-project visitation estimate based on coordination with user groups.

Table 5-1. Without Project Visitation Summary

User Group	Annual Visits in 2014	Annual Visits in 2038	Annual Visits in 2063
Audubon	1,249	1,712	1,712
School/other groups	1,640	2,249	2,249
Oak Bottom Amusement Park	4,433	6,078	6,078
Trail walkers/joggers/bicyclists	12,159	16,671	16,671
TOTAL	19,481	26,710	26,710

Note: Estimates for 2038 and 2063 are the same because population growth adjustment is capped at year 25.

5.2.2 With Project

In the with-project condition, visitation is not expected to change drastically. Installation of the viewing platforms would not drastically alter the types of recreation activities or the capacity to perform those activities at the site. However, the viewing platforms would affect the quality of existing recreation at the site.

Some growth is expected in the Audubon user group (bird watching), as the viewing platforms would provide a prime location and site line for viewing. Also, Audubon may consider adding more organized group trips to the site to make use of the platforms (Audubon Portland, pers. comm. 2013).

All user groups had growth in visitation applied in proportion to the projected population growth. Due to the particular attractiveness of the viewing platforms for bird watching, it was assumed that visitation for bird watching would grow by an additional 5 percent per year for 5 years, and then level off after that. The following table summarizes visitation in the with-project condition for the years 2014 (base year), 2038 (midpoint), and 2063 (last year of period of analysis).

[3] Portland Metro. 2009. Executive Summary – Regional Population and Employment Range Forecasts. Accessed online January 2013 via http://www.oregonmetro.gov/index.cfm/go/by.web/id=29836 .

Table 5-2. With Project Visitation Summary

User Group	Annual Visits in 2014	Annual Visits in 2038	Annual Visits in 2063
Audubon	1,311	2,173	2,173
School/other groups	1,640	2,249	2,249
Oak Bottom Amusement Park	4,433	6,078	6,078
Trail walkers/joggers/bicyclists	12,159	16,671	16,671
TOTAL	19,543	27,170	27,170

Note: Estimates for 2038 and 2063 are the same because population growth adjustment is capped at year 25.

5.3 Unit Day Value Scoring/Point Assignment

Members of Portland Parks were the primary experts chosen to participate in the assignment of UDV scores for the without- and with-project conditions. Participants from Portland Parks included the Natural Areas Supervisor in charge of the study area and a natural resources ecologist experienced with the study area. From Tetra Tech, the senior biologist on the project and the economist participated. Two scores were created:

1. General recreation **without** project
2. General recreation **with** project

The five UDV criteria from the guidance, for which points are assigned, include the following items:

- Recreation Experience: Score increases in proportion to the number of available activities at the site.
- Availability of Opportunity: Score is based on availability of substitute sites; the fewer the sites in the region that offer comparable recreation experience, the higher the score.
- Carrying Capacity: Score rates level of facilities at the site to support the activities.
- Accessibility: Score rates ease of access to the site.
- Environmental: Rates the aesthetic/environmental quality of the recreation site/activities.

Scoring was based on the group of general recreation activities identified at the site that are relevant to the proposed recreation features, including nature and wildlife viewing, including but not limited to fish viewing, bird watching, wetland viewing, Willamette river viewing, photography, etc. Activities outside those considered, which would not be relevant to the proposed recreation features, include hiking, picnicking, or other activities that take place elsewhere in the park.

The table below summarizes the scores assigned. In the sections following the table, the rationale is provided for the point assignments according to the five UDV criteria.

Table 5-3. Unit Day Value Score Summary

UDV Criteria	General Recreation	
	Without Project	With Project
Recreation Experience	13	15
Availability of Opportunity	10	10
Carrying Capacity	5	7
Accessibility	14	14
Environmental	9	11
Total Score	51	57

5.4 Unit Day Value Conversion

For the with- and without-project conditions, the points were converted to a dollar value based on the current FY2013 UDV conversion table in EGM 13-03 (Corps 2013). The scores were interpolated linearly as necessary. The two tables below show the point conversion table from the guidance and the dollar values generated, respectively.

Table 5-4. Fiscal Year 2013 Unit Day Value Conversion Table

General Recreation	
Point Values	**Values ($)**
0	$3.80
10	$4.51
20	$4.98
30	$5.70
40	$7.12
50	$8.07
60	$8.78
70	$9.26
80	$10.21
90	$10.92
100	$11.39

Corps CECW-CP EGM 13-03 for FY2013

Table 5-5. Unit Day Value Dollar Summary

General Recreation	**Without Project**	$8.14 per visit
	With Project	$8.57 per visit

5.5 Expected Recreation Benefits

Using the UDV dollar values per visit and visitation estimates generated in the previous sections, recreation values for the with- and without-project conditions were calculated. Taking the difference between the with- and without-project conditions, net recreation benefits were estimated. The following table summarizes expected recreation benefits in terms of net present value (NPV) and annualized value (estimated annual dollars: EAD). Amortization over the period of analysis uses the FY2013 Federal discount rate of 3.75 percent over a 50-year period of analysis. The analysis estimates present value net benefits of $298,000.

Table 5-6. Summary of Recreation Value Calculation

	NPV ($)	EAD ($)
Without Project	$4,308,600	$192,100
With Project	$4,606,600	$205,300
Net Benefits	$298,000	$13,300

5.6 Benefit Cost Analysis

Construction costs were developed for the proposed recreation features. Costs are presented in Q1 FY2013 price level. The costs include O&M and real estate. For O&M an inspection cost of $2,500 per year was assumed. Additionally, it was assumed that $10,000 would be spent every ten years for periodic board/railing replacement. Real estate costs were estimated at $250. The preliminary estimated cost for the proposed recreation features is $201,200. See Section 8 for more detailed discussion of the feasibility level costs developed for the recommended plan.

Based on the results of the recreation analysis, net recreation benefits would be approximately $298,000 present value over the 50-year period of analysis. In this analysis, benefits exceed the cost, which is anticipated to be $201,200 in present value. The benefit cost ratio (BCR) is therefore estimated to be 1.48. The benefits exceed the costs for the proposed recreation features, and therefore the recreation features are economically justified.

Table 5-7. Benefit-to-Cost Ratio by Alternative

Alternative	Net Benefits ($)	Costs ($)	BCR
No Action	$0	$0	0.00
Proposed Viewing Platforms	$298,000	$201,200	**1.48**

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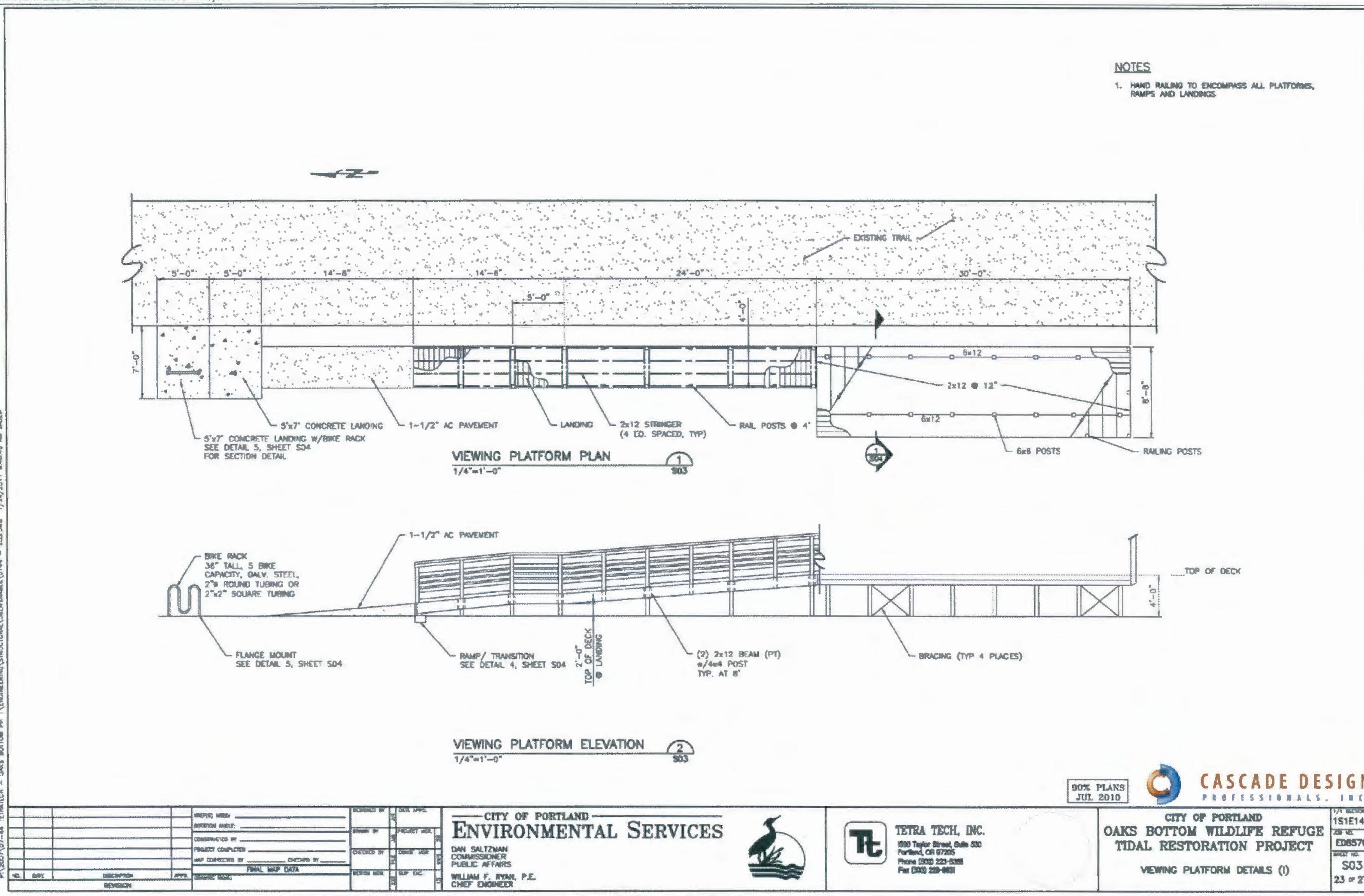

Figure 5-1 Viewing Platform Schematic

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6. DESIGN CRITERIA AND ANALYSIS

6.1 Fish Passage Criteria

Oregon Department of Fish and Wildlife Oregon Administrative Rules (Division 412) describe state fish passage regulations. Within Division 412, Oregon Administrative Rule (OAR) 635-412-0035 (4) and (5) specify fish passage criteria for **estuaries**, **floodplains** and **wetlands**. The most relevant portions of the regulations to the design are highlighted in blue below.

(5) Requirements for fish passage at artificial obstructions in estuaries, floodplains, and wetlands, and above which no stream is present, are:

(a) Downstream Fish Passage:

(A) Downstream fish passage shall be provided after inflow which may contain native migratory fish;

(B) Downstream fish passage shall be provided until water has drained from the estuary, floodplain, or wetland, or through the period determined by the Department which shall be based on one, or a combination of, the following:

- *(i) A specific date*
- *(ii) Water temperature, as measured at a location or locations determined by the Department;*
- *(iii) Ground surface elevation;*
- *(iv) Water surface elevation; and/or*
- *(v) Some other reasonable measure.*

(C) Egress delays may be approved by the Department based on expected inflow frequency if there is suitable habitat and as long as passage is provided by the time the conditions in OAR 635-412-0035(5)(a)(B) occur;

(D) A minimum egress flow of 0.25 cubic feet per second (cfs) at one point of egress shall be provided;

(E) Egress flow of 0.5 cfs per 10 surface acres, for at least the first 100 surface acres of impounded water, shall be provided;

(F) All plunging egress flows shall meet the requirements of OAR 635-412-0035(2)(1)(B);

(G) If egress flow is provided by a pump, it shall be appropriately screened;

(H) The minimum water depth and width through or across the point of egress shall be 4 inches;

(I) The ground surface above the artificial obstruction shall be sloped toward the point(s) of egress to eliminate isolated pools; and

(J) An uninterrupted, open connection with a minimum water depth of 4 inches shall be present from the point of egress to the downstream waters of this state, unless another connection is provided as per OAR 635-412-0035(2)(1)(A).

(b) Upstream Fish Passage: a fishway or road-stream crossing structure with or without a tide gate shall be provided during the period determined by the Department if there is current or historic native migratory fish spawning or rearing habitat within the estuary, floodplain, or wetland area impounded by the artificial obstruction.

The historic channels and sloughs that exist upstream of the culvert are fed by intermittent and perennial springs and seeps coming from the bluffs, by stormwater, and by surface water from the Willamette River. The 1852 General Land Office map shows an outflow channel from a pond in much the same location as the existing channel. However, there is not a stream, by traditional definition, that flows through the culvert. Thus, the project site does not neatly fit into one of the categories listed above, and the design will focus on providing fish passage to comply with the requirements for artificial obstructions above which there is no stream present. The elements highlighted in blue will be utilized as the primary design criteria, along with other reasonable measures to achieve the project goals.

The culvert invert and downstream passage design was guided by identifying elevation 5.5 feet (CPO datum) as an appropriate water surface elevation that provides a minimum of 6 inches of water depth at the upstream end of the culvert at a 95 percent exceedance frequency during the primary rearing season for juvenile salmonids in the Lower Willamette River. The rearing season of interest for juvenile salmonid rearing and refuge is winter and spring during their outmigration as fry or smolts into the Columbia. We have selected November 1 thru June 30 to generally encompass when flows increase on the Willamette through the peak of the outmigration. Note, the definition of rearing season excludes the summer and early fall months when the channel would not be accessible under natural conditions-also there is no expectation (or desire) to have the channel accessible during the summer when water temperatures are high and predators are present.

For fish habitat, an approximate 18-inch water depth at the culvert would optimize fish passage into Oaks Bottom and provide functional rearing habitat moving upstream from the culvert back into the historic and proposed channel sloughs. Note, the deepest water depths would be at the culvert, with the water depth becoming shallower from the culvert moving upstream into the channels/sloughs.

6.2 Fish Habitat and Use Criteria

The fish species of primary interest for using the Oaks Bottom Wildlife Refuge are salmonids including Upper Willamette stocks of Chinook salmon and steelhead trout, which are both listed as threatened under the Endangered Species Act. In addition, Lower Columbia stocks of Chinook, coho, chum, and steelhead include fish that utilize the Lower Willamette and its tributaries and are also all listed as threatened species. Salmonids utilize off-channel and floodplain habitats during winter seasons and their outmigration toward the ocean for both rearing and refuge from high flows, and lower tidal rivers and estuaries are particularly utilized by Chinook fry and juveniles (Healey 1991). Winter rearing habitats that typically exhibit low velocities are off-channel habitats. Studies of juvenile salmonids in the Lower Willamette River indicate they utilize slow velocity sloughs and channels ranging from 0.7 to 2.6 fps (Friesen et al. 2004). Other habitat factors include dense cover, overhanging vegetation, inundated floodplains, logs, and boulders. Other native fish species such as white sturgeon and lamprey may also utilize tidal floodplain habitats.

6.3 Wildlife Passage Criteria

Wildlife passage criteria have been developed based upon recommendations in Metro's wildlife crossings guide (Portland Metro 2009) and lists of species of interest from the City of Portland Terrestrial Ecology Enhancement Study workgroup. Wildlife of interest for passage between Oaks Bottom Wildlife Refuge and the Willamette River include raccoon, coyote, bobcat, beaver, deer, otter, snakes, turtles, and amphibians. Metro suggests that for large mammal crossings, the minimum size for box culverts should be at least 8 feet high and 16 feet wide (typical height/width for arch culverts). However, they also cite that urban adapted wildlife have been observed using smaller structures (i.e., 8- by 8-foot structures). They further recommend that a wildlife walkway be constructed that is a minimum of 18 inches wide and 12 inches high to allow dry passage for terrestrial wildlife adjacent to stream flows. Amphibians and reptiles will utilize moist and/or sandy substrates for passage through culverts. Additionally, it is beneficial to provide cover such as overhanging vegetation, logs, or boulders at the inlet and outlets of culverts to provide cover for the various species as they enter or exit the culvert.

6.4 Structural Design Criteria

The vertical loads for a railroad replacement structure would be based on Cooper E80 loading, which is standard for freight-carrying tracks. Horizontal (or lateral) loads will incorporate seismic effects and will be based on the current edition of the Oregon Structural Specialty Code. A temporary railroad structure would be designed in accordance with following loads, codes and standards:

- Vertical Loads – “Cooper” Class E-80
    - Wheel load per track = 80,000 lbs
- Seismic Loads – ground accelerations
    - 1-second duration = 1.0g
    - 0.2-second duration = 0.35g
    - Site Class D
    - Importance = 1.0
- Oregon Structural Specialty Code
- American Railway Engineering and Maintenance-of-way Association
- Oregon Department of Transportation, Rail Division

6.5 Parks Desired Future Condition Criteria

Portland Parks has developed a number of criteria related to the habitat types it would like to enhance and preserve within Oaks Bottom Wildlife Refuge for its “desired future condition” (see Section 3.1.2.2) as well as for the long-term operation and maintenance of the park. These criteria are used to inform the design features and construction methods.

- Maintain a minimum of 4 acres of open water habitat year-round for waterfowl, wading and shore bird use.
- Restore natural hydrologic conditions to the greatest extent possible, by allowing winter high water levels and summer low water levels, as dictated by the level of the Willamette River.
- Allow for the maintenance and establishment of open water, mudflat, emergent marsh, scrub-shrub wetland, and surrounding riparian forest in the reservoir area.
- Minimize operation and maintenance requirements at culvert and any grade control structures or other structures associated with the tidal channels/sloughs.
- Do not dewater existing wetlands, particularly the north *Polygonum* sp. dominated wetland (except per desired future condition for reservoir area).
- Minimize or preclude boater access into the park via either culvert or bridge opening.
- Minimize construction impacts and closures on the Springwater Trail.
- Include interpretive features along the Springwater Trail as part of the project.

6.6 Culvert Hydraulics

Hydraulic analysis was conducted to support design of the culvert and of the channel through the culvert connecting the Willamette River to the reservoir. A summary and review of this analysis is included in this section. This analysis determined flow velocities and water depths in the vicinity of the proposed culvert. Velocity and depth of water are the two primary ODFW criteria for fish passage culvert design.

A one-dimensional, unsteady Hydrologic Engineering Centers River Analysis System or HEC-RAS model (Corps 2008) was developed to predict culvert hydraulics under proposed conditions. The model geometry is based on the following topographic and bathymetric data:

- 2005 light detection and ranging (LiDAR) topographic data from the Puget Sound LiDAR Consortium,
- Supplemental topographic survey in the vicinity of the culvert and water control structure in 2007 by the City of Portland, and
- Supplemental bathymetric survey of the reservoir and drainage channel between the culvert and reservoir conducted by the City of Portland in 2009.

The topographic survey near the culvert and the bathymetric survey, both conducted by the City of Portland, were used to provide more detail and accuracy to the overall LiDAR coverage. The HEC-RAS model schematic is shown in Figure 6-1.

6.7 Culvert Sizing

Three potential culvert sizes were evaluated during the Feasibility Study: (1) a 12- by 12-foot box culvert; (2) a 16-foot-wide by 10-foot-high arch culvert; and (3) a 16-foot-wide by 10-foot-high arch culvert with added 3-foot stem walls. The 12- by 12-foot box culvert was initially identified as an appropriate width to roughly match the width of the channel upstream of the water control structure. However, as coordination occurred with ODFW to discuss fish passage criteria listed above, the culvert sizing was re-evaluated. ODFW requires that culverts be wider than the typical stream/channel size so as to not constrain flows or have channel flows impinging on concrete or other hard structures, and that velocities be less than 2 fps for the high design flow and the low design flow. The 16-foot width was determined to be an appropriate width to be wider than the typical channel width and meet ODFW requirements. The 10-foot height is the standard height for a 16-foot arch type culvert. A third option with the addition of the 3-foot stem walls to gain additional height was done for two reasons, to ensure that the culvert is not submerged during design flows and to provide suitable wildlife passage through the culvert for mammals to further meet City objectives for providing fish and wildlife habitat.

In the HEC-RAS model the culvert was incorporated using a net 16-foot by 11-foot opening size to account for the cobble and gravel backfill required as scour protection over the spread footings. A schematic of the 16-foot by 11-foot (net) culvert is shown in Figure 6-2. Note the details of the channel shape within the culvert are not represented in the model and are not believed to substantially affect culvert hydraulics, particularly during river stage periods when velocities are highest.

Figure 6-1 HEC-RAS Model Schematic for the Oaks Bottom Wetland and Culvert

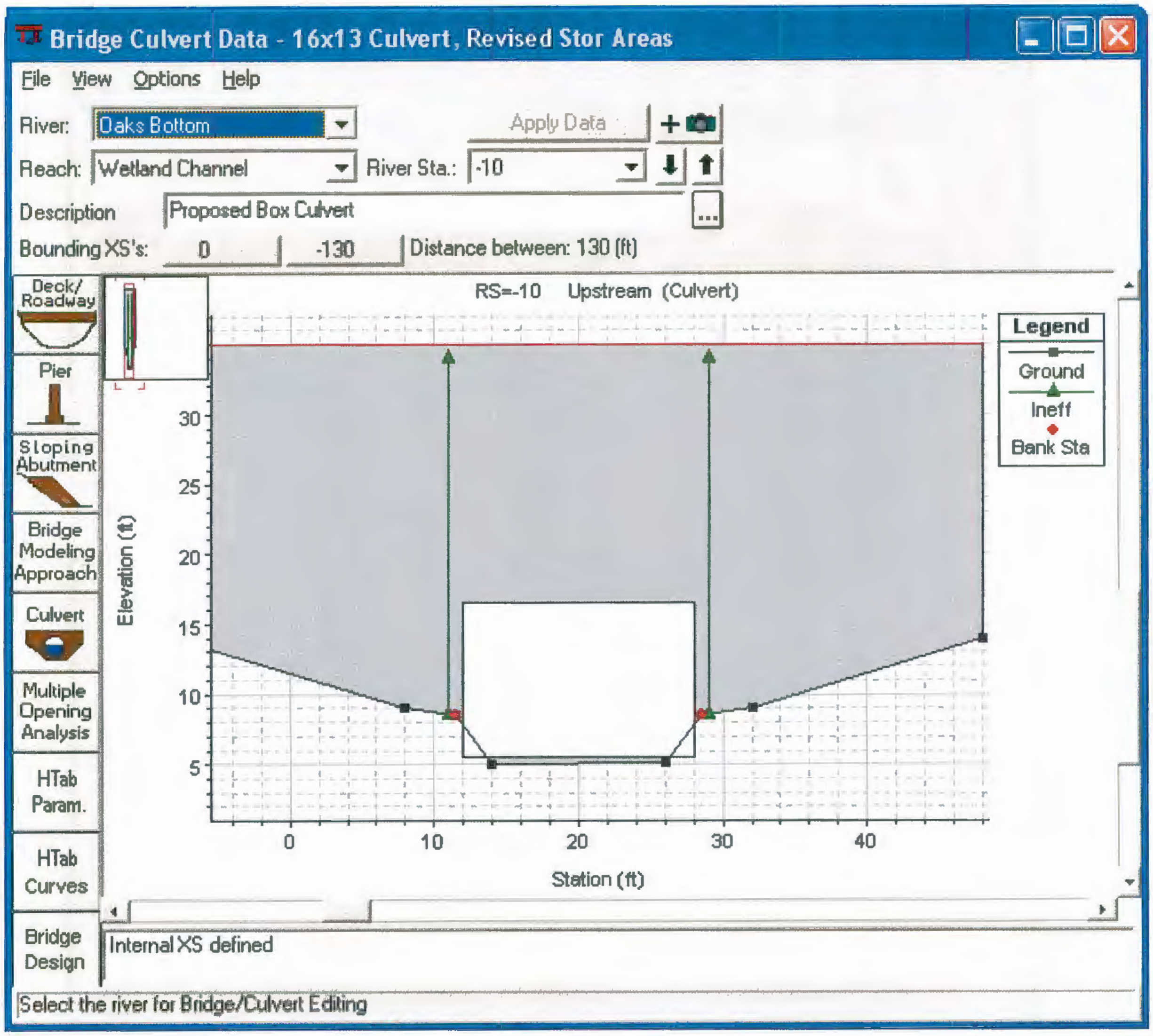

Figure 6-2 Schematic of the 16-foot Span by 11-foot (net) Rise Three-Sided Culvert in the HEC-RAS Model

Boundary conditions to the model include a small upstream inflow of 1 cfs to represent typical groundwater flow into the channel plus additional spring input between the reservoir and culvert, and time-varying downstream stages in the Willamette River. The refuge receives groundwater and spring inflow from the bluffs along the eastern boundary of the site. This inflow is not likely to impact hydraulic conditions in the channel and culvert, and is used primarily to allow the model to stay wet during periods when river stages are below the invert of the culvert.

Two storage areas are used in the model to represent the volume of water that enters and leaves the refuge when the Willamette River rises and falls. One storage area represents the small area to the north of the culvert, and another represents the main reservoir to the south of the culvert. These storage areas are connected by lateral overflow weirs along the main channel, and they are defined by stage-volume curves created using topography and bathymetry data. A color-shaded topography/bathymetry plot showing storage area boundaries is shown in Figure 6-3. The stage-volume curves used in the model are shown in Figures 6-4 and 6-5. Elevations shown in the figures are in feet relative to the project datum, City of Portland local datum (COP).

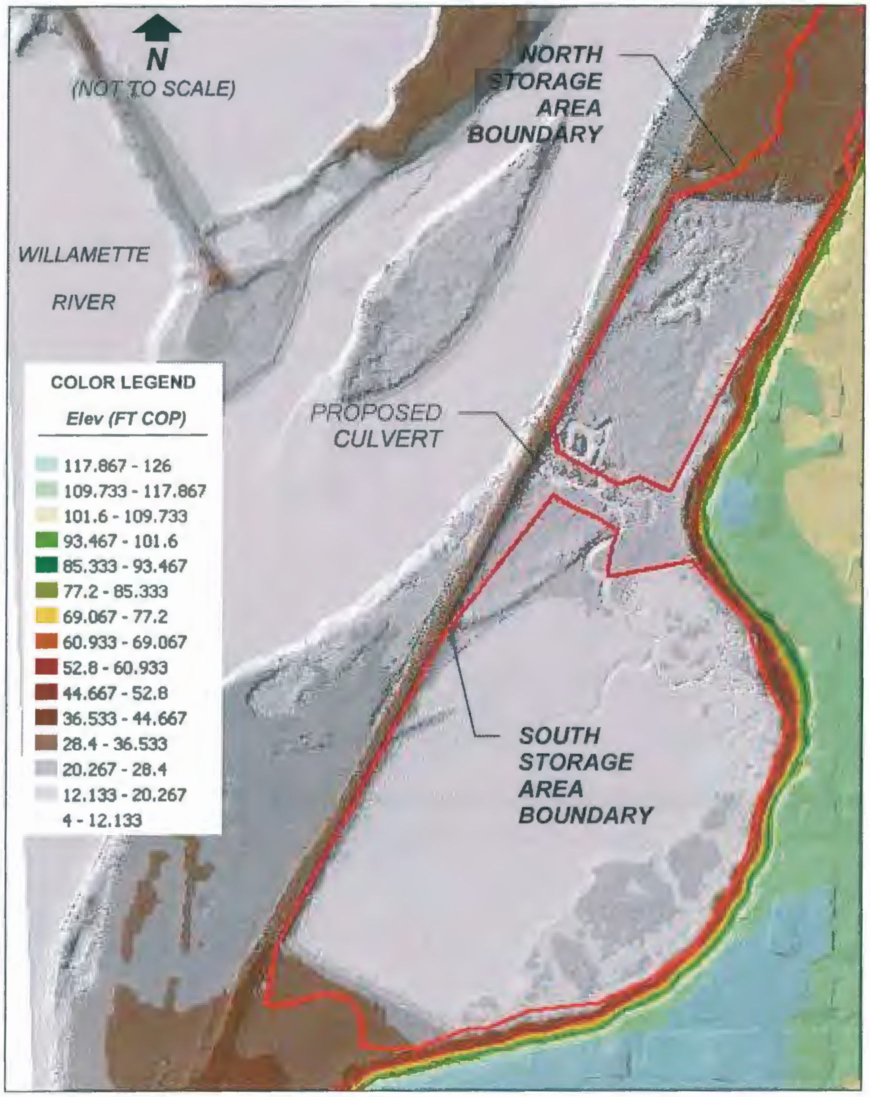

Figure 6-3 City of Portland Digital Elevation Data and Storage Area Boundaries Used to Revise Storage-Volume Curves in the HEC-RAS Model

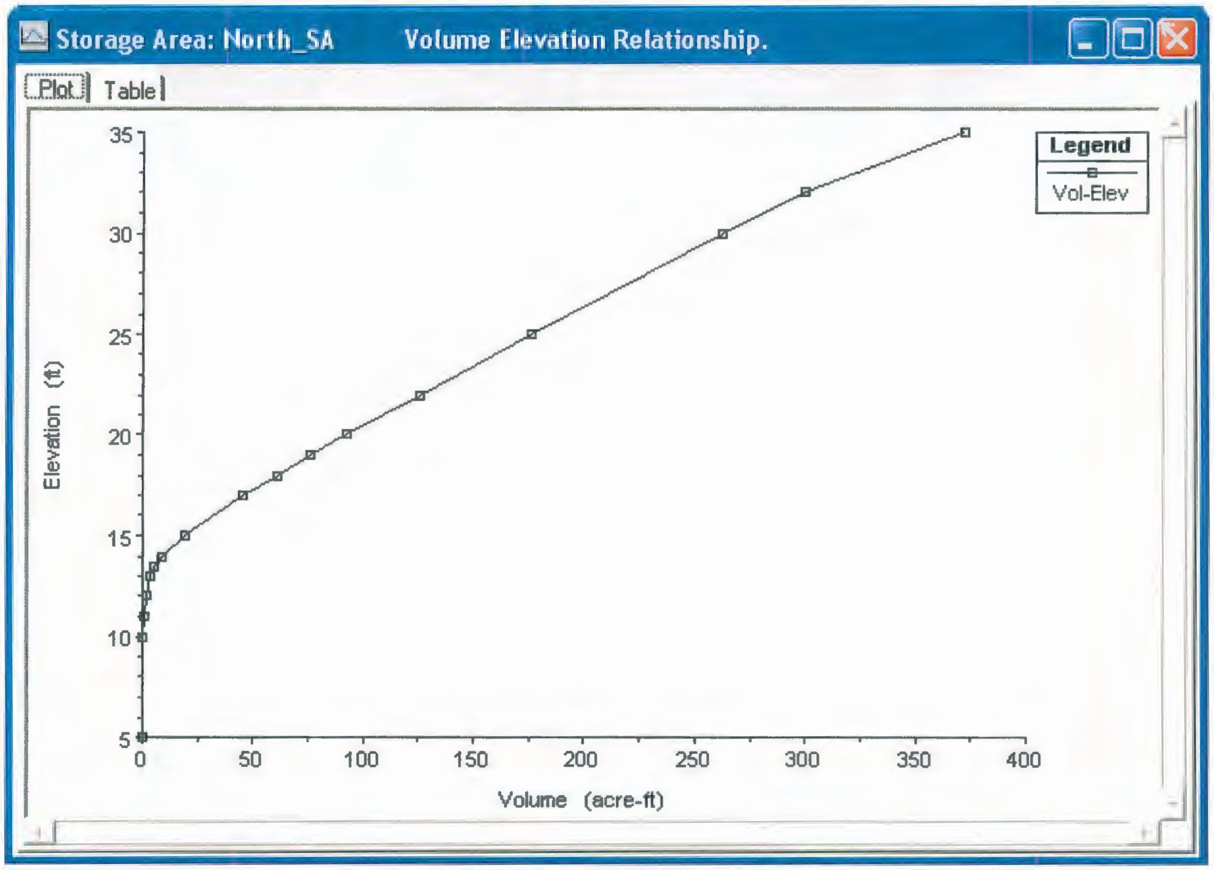

Figure 6-4 Stage – Volume Curve for the North Storage Area Element

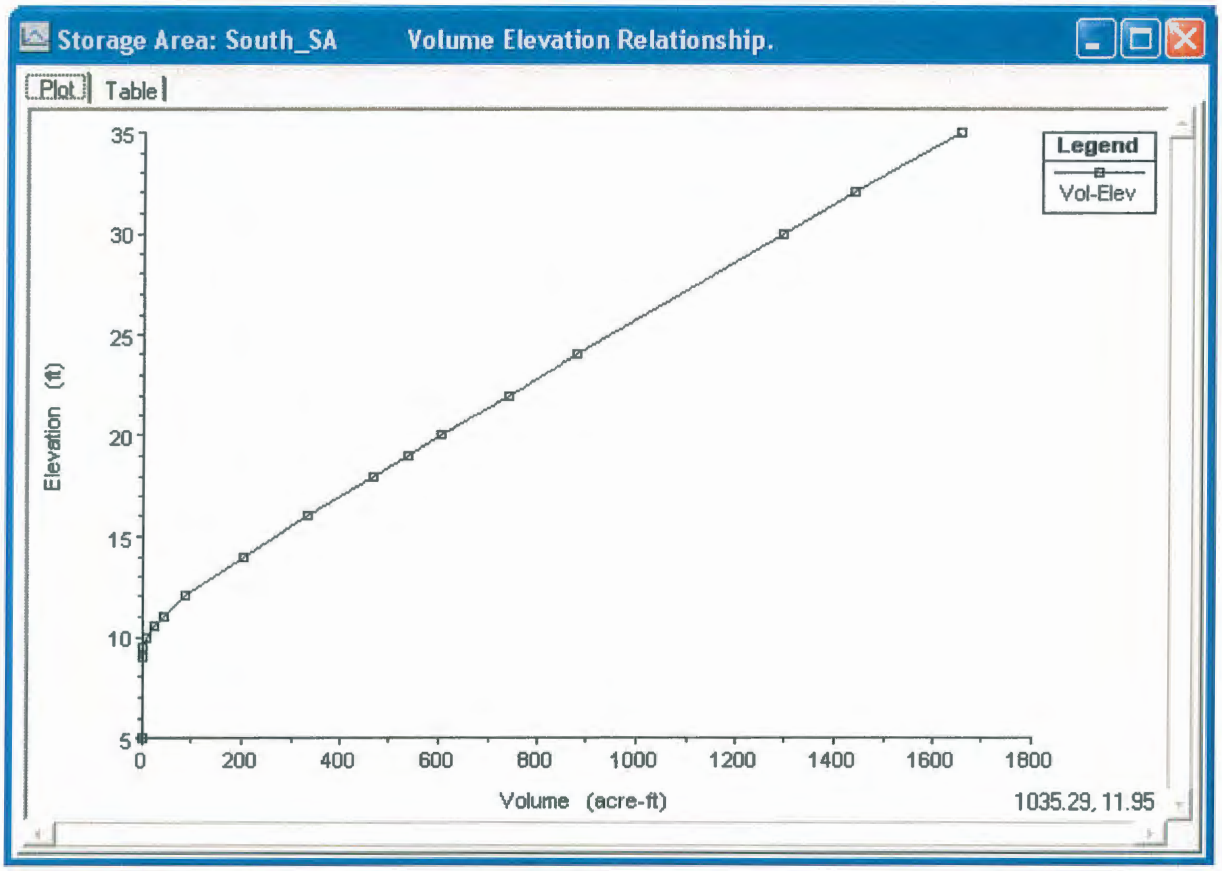

Figure 6-5 Stage – Volume Curve for the South Storage Area Element

To assess culvert hydraulics relative to fish passage criteria for water depth and flow, a range of historical hydrologic conditions were evaluated. Historical conditions are necessary so that model results can be tied to actual frequencies of occurrence. Low-runoff (low or dry), median-runoff (median or typical), and high-runoff (high or wet) water year types were selected because it is was not known which type of Willamette River stage and/or tidal exchange would govern culvert hydraulics for fish passage (e.g., high stage and relatively small diurnal tidal fluctuation vs. low stage and relatively large diurnal tidal fluctuation).

Total annual runoff volume in Oregon was used to rank water year types. Total runoff is recorded by the USGS for major drainage basins in Oregon. The USGS ranks water years by the sum total of runoff throughout the state. The summary of runoff volumes for the most recent 30 years is shown in Table 6-1 (USGS 2009a). The table lists the water year, the number of stream gages used to derive the runoff, the runoff volumes (in millimeters per day and inches per month), ranking based on the overall 100-year period of analysis, and ranking based on the most recent 30 years.

Table 6-1. Water Year Ranking by Total Runoff in the State of Oregon, Most Recent 30 Years

Year	No. of Stream Gages	Runoff (mm/day)	Runoff (in/ month)	100-Year Rank	30-Year Rank
1979	268	1.57	1.89	78	23
1980	260	1.87	2.24	61	19
1981	260	1.61	1.93	75	22
1982	240	2.93	3.51	8	4
1983	245	2.77	3.32	12	6
1984	250	2.66	3.19	15	7
1985	247	1.98	2.38	51	18
1986	239	2.01	2.41	50	17
1987	221	1.71	2.05	74	21
1988	234	1.39	1.67	89	26
1989	230	1.84	2.21	63	20
1990	233	1.39	1.66	91	27
1991	228	1.53	1.83	81	24
1992	180	1.24	1.49	96	28
1993	183	2.11	2.53	47	16
1994	184	1.13	1.36	97	29
1995	180	2.28	2.73	30	12
1996	176	3.32	3.98	3	2
1997	**178**	**3.45**	**4.13**	**2**	**1**
1998	175	2.37	2.85	24	10
1999	179	3.15	3.77	4	3
2000	180	2.24	2.68	33	13
2001	**179**	**1.03**	**1.24**	**100**	**30**
2002	184	2.37	2.85	25	11
2003	188	2.13	2.56	44	14
2004	**190**	**2.12**	**2.54**	**46**	**15**
2005	187	1.47	1.76	85	25
2006	197	2.81	3.37	10	5
2007	194	2.43	2.91	20	9
2008	187	2.62	3.14	16	8

USGS daily streamflow data for water years 1900-2005 were used to estimate average runoff (streamflow per unit area) for the state. For each stream gage, the average daily flow for each water-year was computed and then divided by the stream gage drainage basin area to calculate average runoff for the water-year. Average annual runoff for the Willamette River may differ from the state-wide average because annual precipitation and runoff vary considerably from relatively wet coastal drainage basins to relatively dry basins east of the Cascade Range. The Willamette River Basin lies somewhere in the middle of the spectrum and it is reasonable to use the state-wide average to generally characterize year-types of the Willamette Basin.

Based on Table 6-1, 2001 was selected as the dry year because it ranked last in runoff and it occurred relatively recently (data is more likely to be available). Water year 2004 was selected as the typical year because runoff during this year ranked 15th, approximately the median over the 30-year period. Water year 1997 was selected as the wet year; it ranked first in runoff over the past 30 years and second over the previous 100 years.

For the dry (2001), typical (2004), and wet (1997) water years, hourly stage data for the Willamette River at Morrison Bridge were obtained from the USGS (USGS 2009b). The Morrison Bridge is approximately three river miles downstream of the project site; however, there is limited gradient between these locations. River stages for these years are shown in Figure 6-6. During 2001 stages vary between approximately 3 to 10 feet COP. In 2004, levels vary from approximately 3 to 14 feet COP. In 1997 the wet year, levels were much higher; they ranged from 4 to 26 feet COP. In 1997 there were substantial periods of time, particularly in January and again from May to June, when river stages were above normal wet-period stages of 10 to 14 feet COP.

The hourly Willamette River stage data were input into the HEC-RAS model as the downstream boundary condition. Simulations for each of these years were run from November to June, the selected juvenile salmonid rearing season. Culvert velocity results were analyzed, and frequency distributions of velocity magnitudes (absolute value) were created. The frequency distributions (November to June rearing season only) for the dry (2001), typical (2004), and wet (1997) water years are shown in Figure 6-7. These figures show velocities at the upstream face of the culvert, though they were in generally similar and slightly higher than at the downstream face of the culvert.

In Figure 6-7, the curve for each water-year period slopes down and to the right, indicating that velocities near zero occur for a relatively high percent of the time, and velocities above 2 fps are exceeded a low percent of the time. There is also an apparent discontinuity particularly during 2001 and 2004, the dry and typical years, respectively. The curves show a drop in percent exceedance at a velocity of approximately 0.4 fps. This discontinuity is more apparent in the dry year, which also shows higher velocities at a given percent exceedance than in the typical year. At first glance, this result is unexpected, since the wet year shows the highest stages and corresponding highest velocities. The expected trend would be for the typical year to have the next highest velocities, and the dry year to show the lowest velocities.

The explanation for the trend reversal and the sudden drop in percent exceedance is that during the dry year, the Willamette river stage is below the culvert invert the highest percent of the time. When the river stage is below the culvert invert, the flow in the culvert experiences normal depth hydraulics, i.e., it is not controlled by the river stage at the downstream end of the culvert. Rather, it is controlled by the flow upstream, and the geometry, slope and roughness of the culvert. The culvert velocity during normal depth conditions is slightly higher than it typically is when the culvert is connected to the river (i.e., when culvert hydraulics are controlled by the rising/falling river stage); thus the velocity exceedance distribution is higher (to the right in Figure 6-7) during the dry year. The discontinuity occurs at approximately 0.4 fps because this is the velocity during normal depth flow conditions in the culvert, and the upstream flow boundary in the model was set to be constant at 0.2 cfs.

The water-year conditions showing the occurrence of highest velocities is the wet year, 1997. During this period, culvert velocities range from 0 to 2 fps. The 95 percent, 50 percent (median), 5 percent exceedance values from this curve are 0.05 fps, 0.3 fps, and 1.1 fps, respectively. During extreme (wet) periods, cullvert velocities are less than 1.1 fps 95 percent of the time. This is within the fish passage criteria for velocity which allows for 2 fps up to 95 percent of the time. Thus, the design parameter of culvert span or width, along with the selected culvert invert elevation of 5.5 feet COP, meets fish passage requirements for flow velocities. It should be noted that peak velocities occur for brief periods during a rising tide, before and after which there are periods of slack water when velocity in the culvert goes to zero.

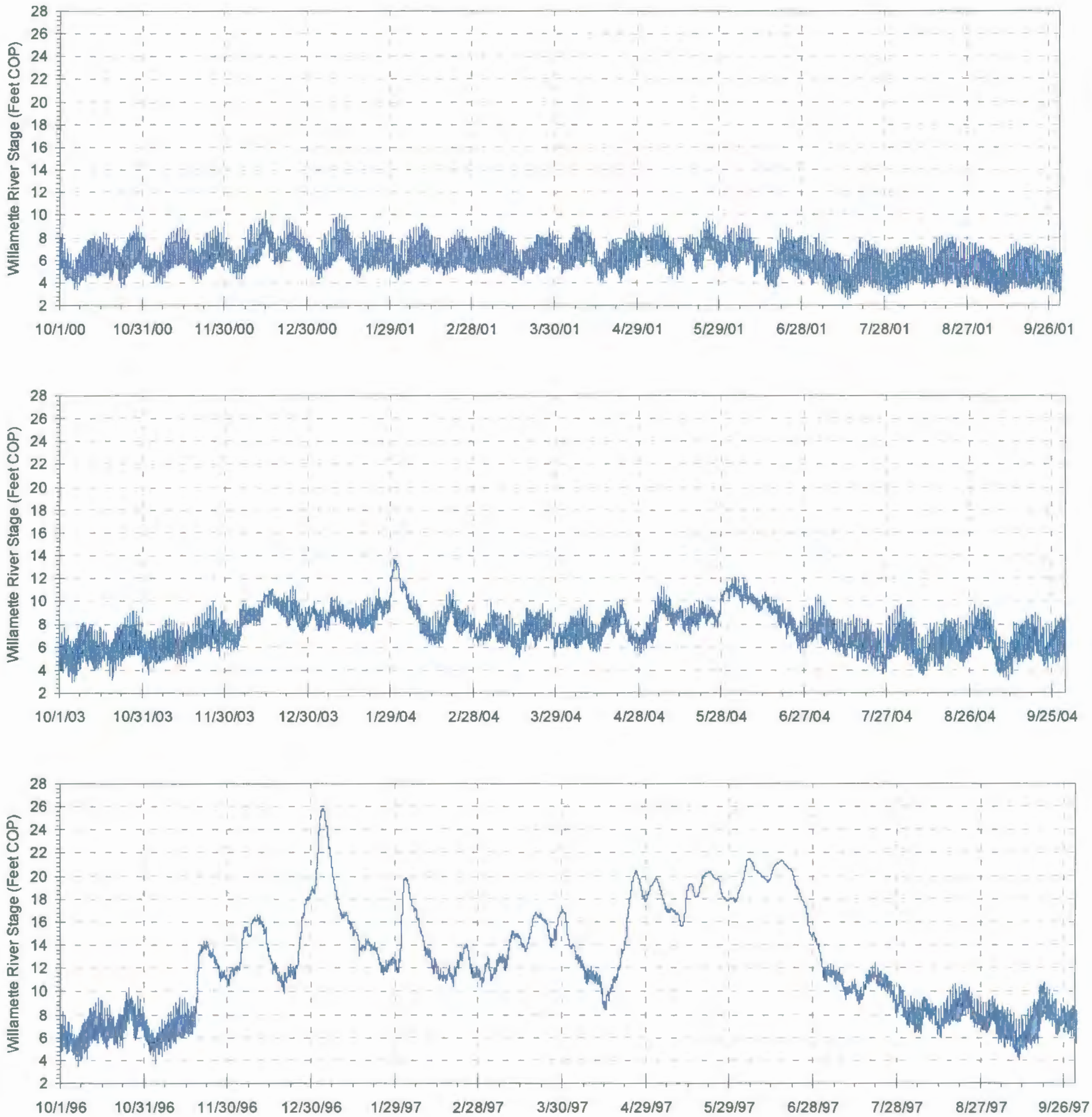

Figure 6-6. Hourly Stage of the Willamette River for 2001 (Dry Year – Top), 2004 (Typical Year – Middle), and 1997 (Wet Year – Bottom)

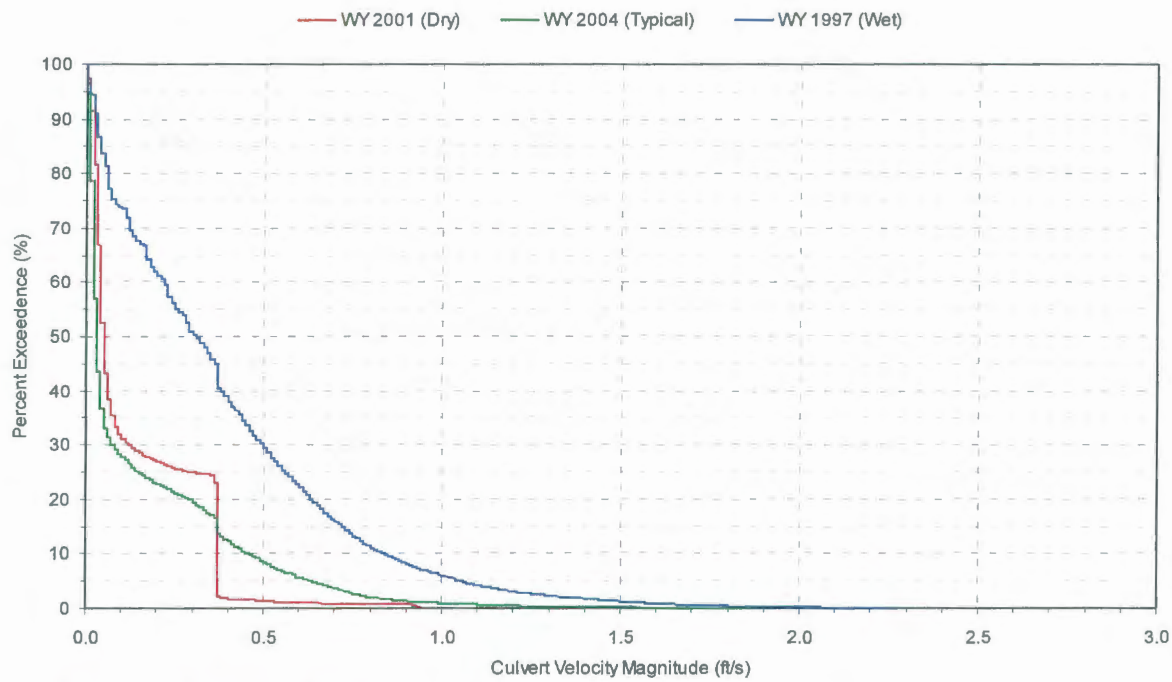

Figure 6-7. Frequency Distribution of Culvert Velocity for the Selected Dry, Typical and Wet Years (Nov. through June Rearing Season Only)

The culvert wingwalls have been designed with footings installed to a sufficient depth and width to resist overturning. Willamette River velocities are typically 2 fps or less (a HEC-RAS model prepared by the City of Portland for another project across the river from Oaks Bottom was reviewed and velocities were typically 2 fps or less at 2-year flows and less frequent events) so scour should not be an issue.

6.8 Grade Control Riffles and Minimum Reservoir Size

A primary purpose of the grade control riffles along the main tidal slough channel that connects the culvert to the reservoir is to ensure a desired minimum open water area in the reservoir. The City of Portland conducted reservoir and channel bathymetric surveys in 2009 to supplement the existing ground elevations, particularly within the channel and reservoir. These bathymetric survey data were combined with topographic information (based on LiDAR survey data) to develop a combined topographic/bathymetric characterization of the project site. This data supports the design for the required ground elevation, controlled by the riffles, to achieve the desired reservoir size.

One result of the analysis is a stage versus reservoir area (storage or surface area) curve. This curve plots surface area of the reservoir in acres as a function of water surface elevation (WSE in feet COP) of the reservoir and is shown in Figure 6-8. This figure includes surface area curves for the south pond (reservoir), the north wetland area, and a curve that combines these two areas. At low stages, the reservoir and the combined curve overlap because the reservoir area is very large relative to the north wetland area.

At low WSEs the area curves are relatively flat, indicating that small changes in WSE result in large changes in reservoir size. The size of the reservoir is sensitive to WSEs approximately from 9 feet COP to 11 feet COP, before the blue and red curves begin to show a greater slope. In addition, from the combined curve (blue curve that overlaps the red reservoir curve), a WSE of approximately 9.5 feet COP results in a reservoir surface area of approximately 4-6 acres. At a WSE of 10 feet COP, the reservoir size increases considerably to just over 20 acres. Guidance from the project team has indicated that a minimum reservoir pool size of approximately 4 to 5 acres is desired. Thus a control elevation of 9.5 feet COP was selected as the elevation of the upstream-most riffle to help maintain minimum reservoir size when river stages drop below this level.

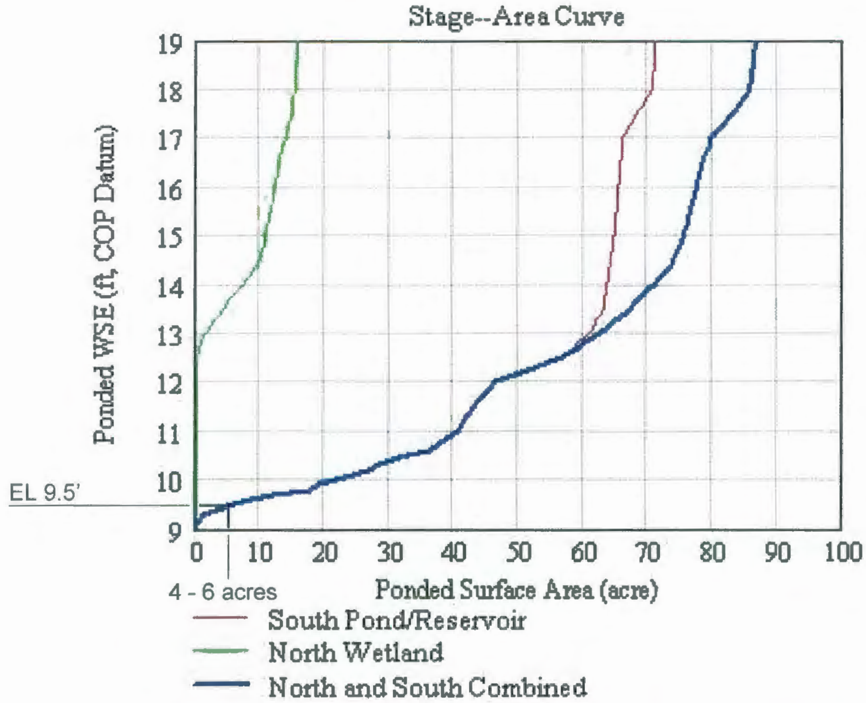

Figure 6-8 Revised Reservoir Stage versus Storage Area Curve

6.9 Evaluation of Floodplain Effects

All of the wetland and channel/pond areas of the project footprint are within the Federal Emergency Management Agency (FEMA) 100-year floodplain (FEMA Zone AE). The railroad berm is not within the 100-year floodplain. The site is currently inundated much more frequently than the 100-year event. With the proposed project, there would be a net removal of material from the floodplain from both the berm and the tidal slough channels of approximately 9,000 cubic yards. The project would not increase the water surface elevation during the 100-year event and would reduce velocities and turbulence during more frequent flows as described in Section 7.7 above.

6.10 Geotechnical Investigation

Northwest Geotech conducted a geotechnical investigation of the site in October 2009. The Geotechnical Report is included in Appendix C. The results are briefly summarized here.

A ground-penetrating radar survey was conducted along approximately 300 feet of the railroad berm (centered on the existing culvert) to identify if a buried trestle was present below the ground. The results of this survey showed two parallel lines of anomalies (material that does not match the soil properties) that indicate that there are very likely to be timbers and pilings underneath the soil of the embankment. Thus, it is highly likely that there is a buried trestle structure present. This buried trestle will likely be encountered during excavation of the embankment. The trestle should not pose any major issue for pile driving, but additional shoring/backfill may need to be provided during excavation and removal of the shoring to ensure the embankment immediately adjacent to the cut/backfill zone does not experience unanticipated settlement from removal of the timbers.

Two borings were completed from the top of the railroad embankment to a depth of 120 feet below ground surface. The embankment soils are primarily composed of silty, gravelly sands of varying compaction. The side slopes of the existing embankment are steeper than would be recommended for slope stability and erosion and slumping is evident in several locations. Beneath the embankment, soils consist of plastic, clayey silts, underlain by more granular alluvium including silty sands and silty sandy gravels.

The embankment and underlying soils would be subject to liquefaction under seismic conditions. It is likely that the embankment and its associated structures would be damaged due to liquefaction, land-sliding, and settlement during a significant seismic event. The proposed culvert would be present in the same conditions and could be damaged under seismic conditions. However, due to the depth of embedment of the culvert, there is lower risk of damage.

During construction, the underlying soils should be removed and replaced with suitable granular base material to support the footings and culvert and minimize the potential for any settling of the culvert that could affect the railroad tracks above. The site should be dewatered to ensure the soils do not heave while placing the footings. Suitable excavated embankment materials may be used for backfill over the culvert. Two to one slopes (2H:1V) are recommended for slope stability. Geotextile reinforcement is recommended for slopes and foundations.

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7. DESIGN ELEMENTS AND COST ESTIMATE

The recommended restoration plan as evaluated and derived from the project design criteria, supplemental technical studies, and project team review is presented in this section by key design element.

7.1 Culvert Replacement

The proposed replacement culvert is a precast, reinforced 16-foot span by 13-foot rise (including 3-foot stem wall) concrete three-sided arch culvert. The culvert is to be furnished by a culvert manufacturer/vendor according to design criteria specified in the final version of this report and the plans and specifications. The proposed culvert is 90 feet long and would be placed horizontally (with no slope) to facilitate construction. The inside of the culvert is to be back-filled with two feet of streambed material including a mixed gradation of gravel and cobbles with boulders placed throughout. The slope and grade of the streambed inside the culvert is to match that of the continuous tidal channel on the upstream and downstream ends. The streambed material would be stable under expected velocities (typically less than 2 fps); some seasonal deposition of sand is likely under low flow conditions.

The Springwater Trail and Oregon Pacific Railroad berm is to be reconstructed with a top of berm elevation and slopes (side slopes) similar to those of the existing berm in order to match grades and slopes on either side of the construction limits. The existing and proposed top of berm elevation at the proposed culvert crossing is at an elevation of approximately 34 feet COP and the existing and proposed slope along the trail and railroad alignment is flat (zero slope). The proposed berm side slopes on the downstream (west) and upstream (east) sides are 2 horizontal to 1 vertical (1.5H:1V) to conform to permanent fill slope recommendations in the geotechnical report (see Appendix C).

7.1.1 Structural Design

7.1.1.1 Culvert

Several options have been reviewed for the proposed culvert system, consisting of the following:

- Steel plate rectangular three-sided arch (with an open bottom) set on precast footings
- Precast concrete box culvert
- Precast concrete arch culvert (shown on the drawings in Appendix C)
- Precast concrete clamshell (two 3-sided boxes)
- Corrugated metal arch culvert

In all cases, a criterion of selection is the ease and speed of installation. A cast-in-place option was considered less desirable because it requires a longer construction period (to allow the concrete to cure), whereas the other options do not require curing in-place. Most of the potential options offer the desired width of channel and overhead clearances (8 to 10 feet measured at the center). Box-shape culverts are generally difficult to find in spans greater than 12. The advantage of the square box and rectangular 3-sided culverts is a uniform vertical ceiling in the culvert section. However, these sections are not preferred by some agencies due to a history of cracking in the corners and the resulting maintenance issues.

There is also a difference in costs between the precast concrete and the corrugated metal arch options. The metal culvert would be approximately 30 percent of the cost of the precast concrete arch option. There could be concerns related to corrosion from a metal culvert as well, thus the concrete culvert is proposed in this study.

In all of the potential options, the design criteria include earth-loading, train loads from the railroad tracks, and pedestrian/vehicle loads from the Springwater Trail. The anticipated structural design criteria are listed in Section 6.4.

7.2 Tidal Slough Channels and Grade Control Riffles

Proposed tidal slough channels (channels) are to be excavated. Channel A would connect the culvert to the reservoir, and Channel B splits from Channel A and extends north for approximately 300 feet (see Plans, Sheet C01). Both channel alignments are to follow the existing wetland channels. Channel A is to include grade control structures (riffles) to provide positive drainage from the reservoir to the culvert, while Channel B would have a constant slope without grade control structures. Channel A would have a bottom width of 12 feet for continuity with the channel through the proposed culvert. Channel B would be regraded for positive drainage to Channel A, and thus would require excavation from its intersection with Channel A to the end of the channel at approximately elevation 10 feet COP. The channels and their design features are described in more detail in the following sections.

7.2.1 Channel to Reservoir – Channel A

Channel A begins downstream of the proposed culvert at Station 10+84.49 where it intersects the existing ground, extends through the culvert, and ends slightly upstream of Station 27+00, where its elevation is set at 9.5 feet COP (see Plans, Sheet C01). The downstream control elevation is at the upstream face of the culvert (Station 12+28.55), where the elevation is set at 5.5 feet COP to meet fish access requirements. The resulting slope between these locations is 0.003 feet per feet (0.3 percent).

7.2.1.1 Grade Control Riffles

Grade control riffles constructed of rock are proposed along Channel A to control the grade to ensure positive drainage out of the culvert as the water level recedes and to prevent headcutting of the channel in order to preserve the minimum 4 acre reservoir. The rock riffles are designed so that the maximum vertical drop between adjacent riffles is approximately 0.5 feet (see Plans, Sheet C07). The tops of the riffles are to be constructed flush with the finish grade of the channel so that the structure is in line with the overall channel slope of 0.003 ft/ft. The drop may be exposed if the channel incises over time. The elevation of the rock riffles are set to limit changes in channel bed elevation to approximately 0.5 feet or less.

The actual locations and vertical drops of the riffles along the Channel A alignment were designed to:

- Approximately match the 0.5 feet elevation drop target, and
- Be correctly located in planform from a geomorphic perspective.

Riffles are located at inflection points of adjacent curves along the alignment because this is typically where grade control points occur in natural channels. Placement of riffles at inflection points also reduces the risk of scour along the outside of a meander bend where hydraulic shear forces are greatest. In order to meet these objectives, in some cases it was necessary to space adjacent riffles slightly farther apart such that the vertical drop would be greater than 0.5 feet (yet still not greater than 0.6 feet). A list of the riffle numbers and the Channel A stationing and elevations are given in Table 7-1. The maximum potential drop between adjacent riffles is 0.54 feet (6.5 inches), and the minimum drop is 0.41 feet (5.0 inches).

The riffle structure is composed of 2 parts riprap (D-100 of 14 inches, D-50 of 8 inches) to one part of 8-10 inch minus cobbles and gravels on top of a 4 inch thick layer of bedding material (3/8 inch minus) and geotextile. The cobble/gravel mix with boulders has been designed to resist scour at design velocities of 3 fps. Boulders are to be placed throughout the riffle as shown on the Plans. Boulders are to continue up the side slopes and provide a key-in to the bank to prevent scour around the structure.

Over time, sediment is likely to deposit on some of the riffles so that they are not visible. At locations that may become slightly scoured, portions of the riffle may be visible.

Table 7-1. Grade Control Riffle Locations along Channel A

Overall Slope:		0.003			
Riffle No.	Station (Ft)	Elev. (Ft PDX Datum)	Spacing (Ft)	Grade Rise (Ft)	Notes
(Culvert)	12+28.55	5.5			U/S face
1	14+00.00	5.97	171.45	0.47	
2	15+50.00	6.37	150.00	0.41	
	15+67.25	*6.42*			*Elevation at Channel B Split*
3	17+20.00	6.84	170.00	0.46	
4	19+10.00	7.35	190.00	0.52	
5	21+10.00	7.90	200.00	0.54	Inflection of small radius-curves (fixed pt.)
6	23+10.00	8.44	200.00	0.54	
7	25+10.00	8.98	200.00	0.54	
8	27+00.00	9.50	190.00	0.52	

7.2.2 Channel to the North – Channel B

The primary purpose of Channel B is to reconnect the southern duck pond and regrade for positive drainage towards the culvert to minimize fish stranding as well as reducing habitat suitability for nutria. Excavation would be required in Channel B to connect to Channel A at the location where they intersect; however, the extent of excavation in the channel is minimized to reduce impacts to wetland areas north of Channel B.

Channel B begins at station 15+67.25 of Channel A, and continues upstream approximately 300 feet, from Station 2+00 to Station 4+92.79 of Channel B (see Plans, Sheet C01). This channel is 12-feet wide for continuity with Channel A, and it has a constant slope of 0.012 ft/ft (1.2 percent). Channel B begins at an elevation of 6.77 feet COP, and ends where it intersects the existing ground at an elevation of 10.0 feet COP and Station 4+92.79.

Channel B construction would also include re-grading the pond to the west of Channel B near Stations 3+00 to 4+50. The existing channel at this location would be excavated to match the proposed invert elevation of Channel A for continuity in slope. The high islands within the pond would be excavated to create a lower wetland area that would be revegetated with willows.

7.2.3 Vegetative Berms – Margins of Channel A

As part of the construction of Channel A, vegetated margins at the tops of the left and right bank of the channel would be constructed to reduce the risk of flanking or avulsion of the channel during high river stage events. Vegetated margins include the placement of prevegetated mat strips, approximately 5-feet wide of relatively dense emergent vegetation seeded and grown into a coir fabric mat with the specific purpose to resist erosion at the tops of bank of the channel until the vegetation can naturally grow in densely to resist erosion. Channel avulsion and the potential for formation of other drainage channels outside of the designed riffles might cause headcutting and the drainage of the reservoir, potential stranding issues, and other problems. The earthen berms that were previously considered to prevent channel flanking are not necessary because they would not be more effective than vegetated margins, and would be much more difficult to construct and have higher impacts to the existing wetland habitat.

The vegetated margins would be constructed approximately six inches above existing grade and would include stripping off the reed canary grass rootmat, placement of prevegetated coir mats (with the wetland seed mix pre-grown to minimum 2 inch height). Willow and cottonwood cuttings would also be installed along the channel slopes. The margins would parallel the proposed channel top of bank for approximately 275 feet of Channel A on the left bank (looking downstream) and for approximately 400 feet along the right bank. Downstream of the sections where the prevegetated mats would be installed, the channel banks would be revegetated with seeding of native grasses and sedges and willow cuttings.

7.2.4 Large Wood and Boulders within the Channels

Large woody debris (LWD) and boulders would be placed within the wetland channel as habitat features to enhance stream complexity. Wood could be either imported or from salvage. Trees removed and salvaged during grading activities that meet specified requirements and approved by the City of Portland construction manager would be reused as LWD. These trees would have rootwads intact, and would be either Douglas fir or Oregon ash. The number and arrangement of logs would be varied throughout the channel to mimic naturally occurring woody debris. Current plans show one to three logs per cluster. Logs would be buried into the channel bank and ballasted with boulders (referred to as Ballast Boulders on the Plans) to prevent movement when inundated. Mechanical anchoring of the logs is not necessary in the relatively low-energy channel system.

Boulders would also be placed adjacent to the LWD clusters to promote varying areas of scour (pools) and deposition within the channel. These boulders are referred to as Habitat Boulders on the Plans. These boulders vary in size from approximately two to five feet in diameter. Boulders salvaged during channel and embankment excavation may be used for habitat boulders as approved by the Government.

7.2.5 Boulders for Boater Exclusion

In order to deter boaters from entering the culvert, several large boulders (Boater Exclusion Boulders) and a few pieces of large wood would be placed at the mouth of the culvert along the bank of the river. Several boulders (same size as Habitat Boulders) and boulder clusters would be placed in a natural orientation and also somewhat offset relative to adjacent boulders over a width of 20 feet. The spacing would be such that canoe, kayaks and similar small watercraft would have difficulty navigating through the field of boulders (i.e., maximum distance about 4 feet apart). The appearance and layout of the boulders would be as natural as possible. The existing large boulders currently at the culvert mouth would be reused if possible.

7.3 Removal of Invasives and Revegetation

The overall revegetation plan for the reservoir will be prepared by the City of Portland staff (including both Parks and Recreation ecologists and Environmental Services revegetation staff) as in-kind services during design. Included in this design is revegetation of all areas disturbed during construction and around the perimeter of the reservoir. In general, an approximately 100-foot-wide zone along the proposed Channels A and B would be cleared of reed canary grass during the channel excavation activities and then replanted with native species to achieve an appropriate native plant community for the ground elevation and flooding frequency. The channel margins would be seeded with a native grass and sedge mix and then willow and cottonwood cuttings would be installed along the channel slopes and tops of banks. At the area of the access ramp off of the embankment, the ramp would be removed and restored to the original contours and then replanted with a native grass seed mix and native Pacific willow and black cottonwood woodland plant communities. The willow community could include Oregon ash, Pacific willow, Scouler's willow, Columbia River willow, red osier dogwood, and ninebark. The cottonwood community could include Oregon ash, Douglas' hawthorn, red osier dogwood, elderberry, and peafruit rose. The railroad embankment area disturbed during construction would be protected with jute matting and seeded with a native upland grass mix following completion of grading.

Invasive species control and revegetation would occur around the perimeter of the reservoir. The Parks Desired Future Condition plan for the area calls for the re-establishment of three plant communities: willow and cottonwood woodlands and emergent marsh. More details on revegetation, including a site plan and species list, will be provided by the City during design.

7.4 Recreation Features and Springwater Trail Repaving

Viewing platforms features are proposed at two locations within the project. One location is immediately south of the proposed culvert, at the southwest edge of the Springwater Trail as shown on the plans in Appendix C. A second platform and interpretive station is proposed immediately north of the trail ramp from Oaks Amusement Park. Construction access to both platforms would be the same as that for the culvert construction. Current plans have the viewing platforms at 30 feet in length by 8.75 feet in width with an ADA accessible ramp up to the elevated platform, approximately 40 feet in length. They would include railings and bike lock-ups and the City will design and install interpretive signage and information after the project is complete.

The Springwater Trail will need to be repaved along the entire access route to the culvert following construction to repair damages associated with truck traffic and other construction equipment.

7.5 Utilities

Various utilities are known to be present in the project vicinity. These include a power transmission tower located at the eastern toe of the embankment, just south of the proposed culvert. The tower supports overhead transmission lines that run parallel to the embankment. The lines are likely high enough that they will not impact crane operation during construction, but staging and access would need to be designed to avoid impacts to the tower and lines.

There is also an abandoned gas main pipeline to be demolished and capped. The gas main is a steel pipe, approximately 18 inches in diameter. The pipe is exposed on the east side of the embankment, located above the existing culvert. Roughly 100 feet of this line would be demolished, and the opposing ends would be capped and remain in place.

7.6 Risk Management

Management of the risks associated with the project is considered in this section. The risks are grouped into two categories: those pertaining to design, and those pertaining to construction. The various design and construction risks are identified, and mitigation and management measures are described.

7.6.1.1 Design-Based Risk Considerations

Important design-related risks involve natural/physical processes acting on and within features of the project. These include evolution of the tidal channel connecting the culvert to the reservoir. The geometry of this channel will likely change somewhat in response to the increased connectivity (tidal prism) with the Willamette River. There is some risk that the channel could avulse and bypass the sequence of riffles within the designed channel. The result could be a channel that develops distinct drop(s) with greater height than that is appropriate for juvenile fish passage, or the channel could headcut into the reservoir thus reducing the open water area of the reservoir. Densely vegetated channel banks would be utilized to mitigate the risk of channel avulsion by making it difficult for a new channel to be cut through the proposed channel.

Culvert scour is another risk associated with natural processes that is mitigated through design measures. The risk of scour of the culvert and wingwall foundations would be mitigated by use of properly designed rock channel protection. The channel protection has been designed according to EM 1110-2-1601, Hydraulic Design of Flood Control Channels and with an average channel design velocity of 3 fps. A conservative peak runoff discharge was calculated for design storms corresponding to the 25-year, 50-year, and 100-year recurrence periods. The peak discharge computed for each of these events was 54.6 cfs (25-year event), 62.1 cfs (50-year event), and 67.9 cfs (100-year event). These discharge values were applied as upstream boundary conditions to the proposed channel HEC-RAS model and a normal depth downstream boundary condition was applied to focus the computed velocities on the upstream discharge effect rather than backwater effects from the Willamette River stage which are likely to be higher during less frequent higher intensity storm events. The average channel velocities obtained from the model were 3.25 fps (25-year event), 3.4 fps (50-year event), and 3.51 fps (100-year event), which are similar to that used for material sizing.

Another related risk is that of stranding of fish that utilize the newly constructed habitat. Stranding could occur if fish are unable to exit the reservoir and channel before the river stage recedes. Rock riffles are designed to control the grade of the channel so that the channel drains as the river stage recedes.

A key risk is whether non-native plant species can be effectively controlled in order to realize the anticipated benefits of the project. When the City was operating the water control structure to impound the large reservoir, purple loosestrife and reed canary grass were reduced in area compared to existing conditions but could not be eliminated. In recent years, since the City has stopped artificially impounding the reservoir, purple loosestrife has spread significantly. The City's plan to restore both native forested and shrub habitats that would provide shade and reduce the vigor invasive emergent vegetation and to supplement the plantings with 5 years of control measures such as cutting and applying herbicides would reduce populations, although it is unlikely these species can be eliminated. The City will continue to monitor invasive species for 10 years associated with this project and over the long-term as part of their refuge management and take adaptive management actions as needed to ensure invasive species do not become dominant on the site.

7.6.1.2 Construction-Based Risk Considerations

Construction-related risks are those occurring during construction of the project. Some construction risks involve the closure and detouring of the Springwater Trail, closure or allowed operations of the railroad, shoring of the excavation, removal of the existing culvert and placement of the proposed culvert units by crane from the top of the embankment, risks associated with the difficulties in construction vehicle and equipment access to the site (ingress and egress), and the potential for encountering additional pollutants that had not been previously identified. There may also be risks associated with dewatering and hauling excavated materials, requiring special methods of dewatering or disposal.

The Springwater Trail will be closed both north and south of the work area during construction (at Tacoma Street on the south end and at the bluff trail undercrossing on the north end. A detour route for bicyclists would be provided around the east side of Oaks Bottom on City streets and bicyclists would be able to access down the bluff trail from Milwaukee Avenue to get onto the trail north of the work area.

Several options for the railroad are being considered, including the potential for the railroad owner to install and removal a temporary bridge to allow rail line use on weekends during culvert construction An alternative option to the weekly installation of the temporary bridge could be a plan to dramatically expedite the culvert replacement work to occur in less than 1 month to allow the railroad to have only a short complete closure. Incentives or penalties could be built into the construction contract to ensure the rapid culvert construction work.

Shoring to reduce excavation and backfill quantities will also be challenging because of the height of the embankment and excavation depths required. Approximately 35 vertical feet of embankment will require shoring or stabilization for construction of the culvert. This could pose risks and challenges to the contractor. Risks related to shoring would be mitigated through allowing contractors to implement methods with which they are familiar and requiring them to demonstrate experience in similar projects.

The excavation of the embankment material for the culvert replacement would remove a minimum of 2,000 cubic yards of existing material. Much of this material is suitable for reuse in backfilling the embankment after placement of the new culvert. There is a risk that the buried railroad trestle may affect backfill by leaving open windows where timber members are encountered. Excess material would be hauled away to avoid filling in wetlands or waters of the U.S. Various methods may be viable including truck haul along the Springwater Trail or removal by barge. Because the trail and railroad would have an open cut during construction of the culvert, removal of the material would need to be facilitated to the south of the culvert (shortest haul distance) for the truck haul scenario, or be stockpiled on site until the cut is backfilled.

The potential for encountering previously unidentified pollutants during construction is low because the site has been extensively sampled and analyzed during multiple years of this study. If any previously unidentified items of trash or areas where unknown pollutants are discovered, the City would immediately conduct sampling and analysis to determine how to dispose of these materials.

7.7 Cost Estimate

The estimated total project first cost is $7,140,195 at the effective price level of 1 October 2012. Monitoring is not identified as a specific line item in the total project cost summary (Appendix C), but is well within the contingency of the project, and is identified as $100,000 in the tables below. This cost estimate includes the recreational components, which are estimated to cost approximately $132,000 and are cost shared 50:50, as well as the cost of the Feasibility Study that was already cost-shared 50:50. Table 7-2 shows the first cost estimate and fully funded estimate for the project and Table 7-3 shows the anticipated cost-sharing requirements for the project.

Table 7-2 Recommended Plan Cost Estimate.

Project Element	Cost Estimate
Construction	$4,208,000
Section 206 Feasibility Cost	$146,396
Planning, Engineering & Design	$388,799
Construction Management and Engineering During Construction	$543,000
LERRDs	$1,160,000
Monitoring	$100,000
Contaminated Sediment Disposal	$462,000
Recreation	$132,000
TOTAL COST	$7,140,195
NER Plan Cost Sharing	
Federal Share (65%)	$4,621,326
Non-Federal Share (35%)	$2,518,869

Final cost estimates are shown at the October 2012 and subsequent escalation to 2015 price levels. Due to delays in project implementation, the current estimated midpoint of construction is July 2017. The City is responsible for the disposal of contaminated sediments; the incremental difference between disposal of clean material versus disposal of contaminated sediments is $462,000. The City plans to provide work-in-kind during the design and construction phase such as fish salvage, permitting, public involvement, traffic control, construction management support, engineering during construction, and revegetation.

7.7.1 Lands, Easements, Rights-of-Way, Relocations, and Disposal (LERRDs)

The non-Federal Sponsor currently owns the majority of the lands within the project boundary. Other properties that are required for access to the site include the railroad embankment, owned by Metro, and Oaks Parkway, owned by the Oaks Park Association. The real estate interest proposed for the project consists of 62.1 acres within Oaks Bottom Wildlife Refuge, a three-year temporary work easement for site access on City-owned property (1.36 acres), temporary work area easement to access the site via Oaks Parkway (0.01 acres), a perpetual pipeline easement (0.74 acres) to remove an abandoned pipeline, a perpetual pipeline and utility easement to the Metro embankment (3.46 acres), a perpetual utility easement to maintain the new culvert (0.06 acres), and a temporary crossing authorization from the railroad owner. Further, the relocation of the railroad or other compensation or routing during construction will be required and considered part of the LERRDs. If applicable under current laws and regulations, the non-Federal Sponsor may receive credit towards its share of project costs for the value of the LERRDs provided for project purposes. The estimated costs of the LERRDs required for the project is approximately $1,160,000. See Appendix E for more details on real estate requirements for the project.

Table 7-3 Cost-Sharing Summary Table

	Federal	Non-Federal	Federal Funding Requirements			Totals
			Spent Through FY15	FY16	FY17+	
Section 206 Feasibility	$95,157	$51,239	$95,157	$0	$0	$146,396
P&S	$268,799	$100,000	$0	$268,799	$0	$368,799
Env. Compliance	$10,000	$10,000	$0	$10,000	$0	$20,000
Construction	$3,898,370	$309,630	$0	$0	$3,898,370	$4,208,000
Construction Mgmt	$183,000	$100,000	$0	$0	$183,000	$283,000
Construction EDC and Sponsor	$100,000	$160,000	$0	$0	$100,000	$260,000
Monitoring[1]	$0	$100,000	$0	$0	$0	$100,000
LERRDs	$0	$1,160,000	$0	$0	$0	$1,160,000
Contaminated Soil Disposal	$0	$462,000	$0	$0	$0	$462,000
Recreation	$66,000	$66,000	$0	$0	$66,000	$132,000
Totals	$4,621,326	$2,518,869	$95,157	$278,799	$4,247,370	$7,140,195

[1] Monitoring will be cost shared 65 percent federal and 35 percent non-Federal, the same as other project costs. The funding is shown entirely in the non-federal column to indicate that the City intends to conduct the monitoring in Years 1, 3, 5, and 9 following construction.

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8. ENVIRONMENTAL EFFECTS

Environmental impacts for the No Action alternative and recommended plan have been identified below. Restoration features that were not selected are not included in the analysis of impacts. Overall, the project is designed to have positive benefits on the environment.

8.1 Hydrology

8.1.1 No Action

The No Action alternative would continue the existing condition where the culvert is disconnected from the Willamette River approximately 50 percent of the time. Although the water control structure management can be changed by the City (via removal of flashboards), without fundamental modifications, the culvert and water control structure would continue to preclude fish ingress and egress to Oaks Bottom, except at high flows, and would continue to be a stranding hazard. It is likely that this hydrologic regime would result in further increased densities of non-native fish and plant species that are able to out-compete native species and salmonids would generally not be able to use the site.

8.1.2 Recommended Alternative

The recommended alternative would include the replacement of the existing 5-foot-diameter culvert with a 16-foot-wide by 10-foot-high culvert to provide unhindered fish and wildlife passage between the Lower Willamette River and Oaks Bottom. The water control structure would be removed, and the channels and reservoir would flood and drain based on natural hydrologic cycles from the river and tides. This would cause more frequent wetting and drying of the floodplain as opposed to the relatively static regime that now occurs when the flashboards impound water and then the rapid drying that occurs when the flashboards are removed. Overall, the project is specifically intended to restore this more natural hydrologic regime to the project area and these effects are expected to be beneficial. The proposed change to a more natural hydrologic regime may require that Multnomah County Vector Control provide more spot treatments of mosquito larvae during the spring to control floodwater mosquitoes. The proposed hydrologic regime would tend to discourage the mosquito species that spreads West Nile virus and may have beneficial effects.

8.2 Geology/Soils

8.2.1 No Action

The No Action alternative would not affect geology and soils at Oaks Bottom.

8.2.2 Recommended Alternative

The project would include the removal of sediment from the channel and southern duck pond and placement of rock/cobble/gravel riffles, streambed mix in the culvert, and large boulders riverward of the culvert and in a few locations in the channel. Overall, there are not expected to be any significant adverse effects on geology or soils, and the channel sediments would become more representative of Lower Willamette River tidal sloughs (likely to be dominated by sand).

8.3 Water and Sediment Quality

8.3.1 No Action

The No Action alternative would continue the current condition with low levels of DDT contamination present within the soils and high water temperatures during summer and fall. Over time, it is expected that the DDT and its breakdown products would continue breaking down and have reduced concentrations. However, because the reservoir is frequently ponded due to the presence of the water control structure, sediment is only exposed seasonally. Based on the current rate of contaminant breakdown, it could take another 50 years for the DDx levels to fall below regulatory screening thresholds. The invertebrates, fish and birds using the refuge would continue to be exposed, although tissue sampling results indicates their uptake is generally low.

8.3.2 Recommended Alternative

A major goal of this project is to reduce water temperatures during the time period when juvenile salmonids are likely to be present. Reducing the size of the reservoir is expected to dramatically reduce the heating that currently occurs in the wide shallow impoundment and allow the spring flows with cool temperatures to contribute more to the overall conditions in the channel. Additionally, by allowing daily tidal and river exchanges, the river will also dominate water quality conditions more under the proposed conditions.

Also, approximately 4,500 cubic yards of sediments would be excavated from the tidal slough channels to remove currently low-level contaminated sediments and leave a clean surface. This would remove contamination from the area likely to be used most frequently by fish species, although the fish tissue sampling indicates that there is only low risk to fish from exposure to the concentrations found in the sediments. The wetting and drying hydrologic cycle that would be reintroduced to the project area is further expected to help in the breakdown of the remaining DDT and its breakdown products. Overall, the project would have a beneficial effect on water and sediment quality.

8.4 Vegetation and Wetlands

8.4.1 No Action

With the No Action alternative, non-native invasive species, primarily purple loosestrife and reed canary grass, are expected to increase further. These species have thrived under the existing hydrologic regime and would likely increase in area. The City would likely continue to undertake native plantings and continue invasive species control efforts including cutting, clearing, and herbicide applications. Bio-control introduction (beetle that feeds on purple loosestrife) has already been tried and was unsuccessful due to the existing hydrologic regime. It appears that without the proposed culvert replacement and large-scale planting efforts that invasive species control will be difficult and unsustainable.

8.4.2 Recommended Alternative

The project would restore approximately 32 acres of forested, scrub-shrub, and emergent wetlands and riparian areas. Approximately 0.1 acres of wetlands would be converted into a tidal channel and approximately 2 acres of waters below the Ordinary High Water Mark (OHWM) would be deepened to meet the new culvert invert elevation and to allow more frequent tidal exchange. Clean natural substrate (gravel/sand) would be placed as channel backfill in approximately 0.2 acres of wetland and 0.1 acres of waters below OHW. These effects are minor and revegetation with native species would improve the quality of the wetlands and tidal channels within the project area. Overall, the project is expected to have an important beneficial effect on native plant communities and wetlands.

8.5 Fish and Wildlife

8.5.1 No Action

With the No Action alternative, the City would continue native plantings and invasive plant species control efforts that would benefit wildlife species. Other restoration efforts elsewhere in the Columbia and Willamette estuary are expected to slowly increase wetland and off-channel floodplain habitats necessary for recovery of listed salmon species. However, within the Oaks Bottom Wildlife Refuge, listed salmon species would still generally not have access and thus have reduced rearing/refuge opportunities and increased mortality from entrapment that occasionally may occur. Overall, the availability of off-channel habitats along the Lower Willamette River would remain limited, as most areas of the floodplain are developed. Without the proposed comprehensive restoration of floodplain habitats within the refuge, the largest area of tidal wetland in the lower river would continue to be largely inaccessible to salmonids and generally decline in habitat quality over time due to invasive species.

8.5.2 Recommended Alternative

Two major objectives of this project are to restore rearing and refuge habitat for native salmon species and enhance wildlife habitat within the refuge. The project would allow much more frequent connection to the Willamette River throughout the range of tidal cycles by lowering the invert elevation of the culvert and also by providing a much larger and higher culvert to prevent high velocities or submerged conditions. The project would allow unhindered fish passage through the culvert and water control structure that are now barriers, reduce water temperatures making the tidal slough channels more suitable for fish throughout much of the year, create more diverse aquatic habitat by placing LWD and boulders, and restore the riparian zone along the channels and around the reservoir which will provide cover, shading and LWD (and small woody debris). During construction, the outflow from the springs will need to be diverted around the work areas in a temporary pipe. Prior to diversion, any fish observed in the area to be dewatered would be removed and placed downstream of the diversion. The diversion would minimize effects of turbidity and other water quality issues on fish. All in-water work will be done during the designated fish window (July 1 to October 31).

The project would include the removal of invasive species in the area of construction, restore a riparian corridor along the slough channels and also enhance wetlands around the reservoir and pond areas. This could provide greatly enhanced habitat for native amphibians. It is expected that bird species, particularly neotropical migratory birds, would be the primary beneficiaries of this project. Waterfowl habitat would be reduced as a result of reducing the size of the reservoir. However, the reservoir would still seasonally flood to its existing maximum extent and promote a more natural distribution of plant communities and their associated wildlife species.

During construction there would be increased disturbance. The City has conducted monitoring of wildlife in the project area to identify which species may be present and to identify methods to minimize effects during construction. Otters, beaver, and mink are present near the culvert outlet, but also appear to use a larger area of the refuge and river, including Ross Island. To minimize effects on these species, the City will conduct some disturbance actions early in the spring to help prevent these species from denning in the project area. Fencing or other features may be installed as well to help prevent these species from utilizing the area. If any native amphibians or other wildlife species are observed during construction they will be removed, as necessary, and relocated upstream in the refuge. Overall, this project is expected to greatly benefit native fish and wildlife species and open up a large quantity of rearing and refuge habitat that is currently inaccessible for juvenile salmon.

8.5.3 Threatened and Endangered Species

This project has been designed to specifically benefit threatened and endangered fish and wildlife, particularly Chinook salmon and Neotropical migratory songbirds. This project would restore off-channel tidal slough habitat for winter/spring rearing and refuge habitat within the Lower Willamette River system. Additionally, this project would eliminate several highly unnatural features within the refuge including the water control structure and the perched culvert. The riparian zone would be restored to a natural plant community and be allowed to function for cover, shading and LWD recruitment. This project would also benefit fish and wildlife species already present at the site because it would reduce temperatures that are currently well above optimal for native species and provide much enhanced native plant communities for cover, foraging, and nesting habitats.

8.5.3.1 Listed Wildlife and Plant Species

No effects are expected to any of the listed wildlife and plant species because none of them are known to occur in the project area. Critical habitat either does not occur in the project area or would not be adversely affected due to the project actions. See Table 8-1 for a summary of the preliminary determination of effects.

8.5.3.2 Listed Salmonid Species

The proposed project may affect all of the listed salmonid species because they are known to be present in the Lower Willamette River and may be present in the project area after restoration when fish passage is restored. Chinook salmon are the most likely to use the site after restoration because Chinook juveniles extensively use estuarine and tidal habitats for rearing during their migration out to the ocean. Thus, they would be most likely to be present on the site for days or months at a time. Because of the presence of contaminants in the reservoir area that would not be removed as a result of this project, Chinook could be exposed to the contaminants, but the risk of uptake and effects are low. The fish tissue analysis (GeoEngineers 2011) indicates that existing resident fish (stickleback) have very low tissue levels, thus no accumulation of toxins are expected on salmon. It is also expected that DDT and its breakdown products would decline more rapidly in concentration over time as a result of this project. The project would restore a more natural hydrologic regime with wetting and drying cycles that will likely accelerate the breakdown and decomposition process (DDT has remained persistent primarily in wetland areas with anaerobic conditions). Additionally, because Chinook are only present seasonally, even their exposure before the DDT breaks down more completely is likely to be minimal.

A Biological Opinion dated August 27, 2012 has been received and is included in Appendix D. Due to the potential effects during construction such as fish removal/handling, turbidity, pile driving, and other disturbance, the project may affect and is likely to adversely affect Upper Willamette Chinook and steelhead, and Lower Columbia Chinook, coho, and steelhead. No adverse effects are likely to occur to critical habitat. The project is also likely to adversely affect essential fish habitat. Reasonable and prudent measures required within the Biological Opinion and to essential fish habitat are summarized by the following primary categories:

1. *Minimize incidental take from project-related activities by applying conditions to the proposed action that minimize adverse effects to water quality and ecology of aquatic systems.*
2. *Ensure completion of a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.*
3. *The Corps should consider (or encourage applicants to) undertaking enhancement or restoration activities in the Lower Willamette River to increase shallow water habitat, restore/create off-channel habitat, remove old docks/pilings, protect/restore riparian areas, improves streambanks, restores instream habitat complexity, and/or removes/controls invasive plant species.*

8.5.3.3 Species of Concern and Candidate Species

This project would improve habitats for all of these species by the removal of invasive plant species and plantings of native riparian and wetland species. Conservation measures during construction such as working within the designated in-water work period, work area isolation/dewatering, fish salvage within the work area, and having a biologist do a pre-construction walk-through of the work area to identify any wildlife species present that can be removed, would avoid and minimize effects to species of concern.

Table 8-1. Determination of Effects Summary

Species	Effect Determination	Critical Habitat Determination
Columbian white-tailed deer	No effect	--
Northern spotted owl	No effect	No effect
Streaked horned lark	No effect	No effect
Oregon spotted frog	No effect	No effect
Lower Columbia River Chinook salmon	Likely to adversely affect	Not likely to adversely affect
Upper Willamette River Chinook salmon	Likely to adversely affect	Not likely to adversely affect
Lower Columbia River Coho salmon	Likely to adversely affect	--
Lower Columbia River steelhead trout	Likely to adversely affect	Not likely to adversely affect
Upper Willamette River steelhead trout	Likely to adversely affect	Not likely to adversely affect
Willamette daisy	No effect	No effect
Water howellia	No effect	--
Bradshaw's lomatium	No effect	--
Kincaid's lupine	No effect	No effect
Nelson's checker mallow	No effect	--

8.6 Cultural Resources

8.6.1 No Action

The No Action alternative is not anticipated to have any effects on cultural resources. While the City will likely undertake continued native plantings and control of invasive species, this would generally occur within soils/sediments deposited recently and in areas where no cultural resources have been identified.

8.6.2 Recommended Alternative

Oaks Bottom Wildlife Refuge may have historic surfaces that existed in nearly the same form over 150 years ago near the beginning or before Euro-American contact. Thus, there may be cultural resources present in the project site. There are no records of cultural or historic resources. The railroad embankment and buried trestle are more than 50 years old and may be eligible for National Register listing. However, both the embankment and trestle have been substantially modified during their lifetimes.

Archaeological studies have been conducted by Heritage Research Associates, Inc. and reported in Letter Reports 10-19 and 10-25 with field work for both conducted in 2010. Surface investigations and subsurface shovel test probes were conducted and negative results were found for the area of proposed work. The findings resulted in the recommendation that no further archaeological investigations are recommended prior to construction of the habitat enhancement project.

A summary of the cultural resources investigations were provided to the Oregon State Historic Preservation Office for its review and comment regarding the Area of Potential Effect and concurrence for the finding of No Historic Properties Affected on August 25, 2015, per the National Historic Preservation Act, Section 106, 36 CFR 800. Concurrence for a No Historic Properties Affected was obtained on September 29, 2015 in accordance with 36 CFR 800 4[d](1) and is attached in Appendix D. Consultation was initiated with the Confederated Tribes of the Grande Ronde, the Confederated Tribes of Siletz Indians and the Confederated Tribes of Warm Springs on August 25, 2015. No comments were received from any of the contacted Tribes.

During construction, the City will provide an archaeological monitor during work at the rail line and trestle. Following construction, the City will provide a monitoring report with a recommendation on whether any of the materials observed during construction may be eligible for listing on the National Historic Register. If any unanticipated cultural or historic resources are discovered during construction, then work will be halted until a qualified archaeologist can investigate the site to document any artifacts inadvertently discovered. The State Historic Preservation Office will be immediately contacted if any artifacts are discovered.

8.7 Socioeconomic Resources

8.7.1 No Action

With the No Action alternative, Oaks Bottom would continue to provide an important green space and educational resource in an otherwise highly urbanized area of southeast Portland. However, the potential for decline in the quality of the habitats from invasive species would result in diminished value of the area as a wildlife refuge. Overall, there are no major effects expected on socio-economics from the No Action alternative.

8.7.2 Recommended Plan

The project will require the temporary closure of the Springwater Trail and the Oregon Pacific Railroad. The construction phase would be expedited to minimize these closure periods to the shortest period feasible. However, because the Springwater Trail is a major bicycle commuter route, it will be necessary to provide a detour route through the Sellwood neighborhood. The City is currently working with bicycle advocacy groups and the Portland Bureau of Transportation to identify the best detour route and will publicize it widely for users. Additionally, during construction, extensive signage will be used to direct bicyclists onto the detour route and to warn motorists of the detoured bicycle route.

The City may separately undertake some improvements on bike routes in the Sellwood neighborhood such as updated lane painting and bike boxes at intersections to help facilitate this temporary detour. The effects on bicycle commuters is likely to be temporary and should not discourage commuting because the detour route would provide an effective alternate way to reach downtown. The effect of the trail closure on weekend recreational bicyclists and pedestrians would be disruptive for one summer season. Bicyclists and pedestrians would still be able to use other trails in the park and other portions of the Springwater Trail, but could result in reduced use of the area for the construction season. It will be necessary to provide extensive signage and fencing to prevent accidental bicycle or pedestrian ingress onto the site during construction due to safety concerns. Bike users of Oaks Amusement Park would still be able to access the park via bicycle from the south end of the project (Spokane Street to Oaks Park Way) and signage will be provided to indicate routing.

The Oregon Pacific Railroad provides weekly shipments of perishable products between Portland and Milwaukee. It will be necessary to use an alternate means to accommodate these shipments or otherwise ensure the temporary closure of the railroad line does not cause large economic impacts to the railroad company. The City is currently working with the railroad owner to identify the most reasonable solution. One option being considered is to allow the railroad to install a temporary bridge structure for operation on the weekends when other construction activities are not occurring. This would allow the weekly shipments to occur with minimal disruption.

Once the culvert replacement is complete, the uses of the trail and railroad would not be changed from their existing condition. The portion of the Springwater Trail that is used for access by construction vehicles would be entirely repaved to bring the trail back to its existing condition. The project would additionally provide viewing platforms and interpretive signage that would enhance the educational opportunities at the park.

There would be minor traffic effects to adjacent businesses, primarily Oaks Amusement Park when trucks are importing or removing material. These roadways are not major arterials and impacts to traffic would be minimized to the maximum extent practicable by timing of use, traffic control signage, and flagging or other methods as necessary. The City is currently coordinating with the adjacent landowners to identify methods to minimize any traffic impacts and to obtain a temporary construction easement for staging of equipment and materials. It is not expected that significant adverse economic effects would occur to these businesses from the trail closure since most of the customers arrive via automobile.

The removal of the water control structure would eliminate the artificial impoundment of the reservoir that has occurred for the past 20 to 30 years. The initial rationale for the impoundment was to reduce nuisance mosquito populations for the surrounding neighborhood. However, the mosquito species that spreads the West Nile virus prefers laying eggs in impounded water bodies. Thus, the removal of the water control structure is desired to reduce the spread of the West Nile virus mosquito. The Multnomah County Vector Control has indicated that they may need to provide more applications of the bacteria that kill larval mosquitoes once the water control structure is removed to ensure the neighborhood is not adversely affected by increase mosquito populations. The County will continue to monitor the situation and make adaptive management recommendations.

8.8 Cumulative Impacts

The project would restore fish and wildlife habitat in an area that has experienced substantial negative cumulative impacts over the past 150 years. This project would incrementally reverse those cumulative impacts by restoring a more natural hydrologic connection to the Lower Willamette River, providing fish and wildlife passage to and from the refuge, reducing water temperatures, and providing much higher quality aquatic and riparian habitat than currently exists. Oaks Bottom represents the largest potential floodplain reconnection in the southern portion of the Lower Willamette River. Restoration and reconnection actions would restore a large area of off-channel and tidal floodplain habitat that is currently rare in the watershed.

Other reasonably foreseeable future actions are likely to occur in the broader Lower Willamette River watershed including the Lower Willamette Ecosystem Restoration General Investigation Study that is proposing shallow-water and alcove habitat restoration, the Portland Harbor Superfund clean-up and mitigation project would also include restoration actions downstream of Oaks Bottom to increase shallow-water habitat and instream habitat complexity (large wood, etc.). The Sellwood Bridge project is currently rebuilding the Sellwood Bridge and includes removal/control of invasive species on disturbed areas, plantings of native species along the river bank, and wetland mitigation at other sites along the Lower Willamette. Other development and redevelopment is likely to occur north of Oaks Bottom in the industrially zoned areas of the Lower Willamette River, but these future developments will be required to off-set any potential adverse effects on the river. Combined with these reasonably foreseeable future and on-going actions, this project would have a positive cumulative effect on the quality of habitat along the Lower Willamette River.

There could potentially be increased traffic congestion at Tacoma Street associated with construction traffic headed to/from Oaks Bottom interacting with the detour for the Sellwood Bridge construction. However, this is expected to be minor as there would only be limited traffic for the majority of the Oaks Bottom construction-typically fewer than 25 truck trips/day and not requiring truck traffic during all weeks of construction (primarily associated with mobilization/demobilization, delivery of materials, and haul of excavated materials). Overall, there should be no substantial cumulative effects associated with the Oaks Bottom project.

9. IMPLEMENTATION RESPONSIBILITIES

9.1 Federal

Studies under Section 206 are subject to the cost sharing requirements of Section 105 of WRDA 1986, as amended. For projects implemented on non-Federal lands, costs are shared with the non-Federal sponsor. The Federal Government will provide 65 percent of the first costs of the recommended plan; the Federal portion of this project is estimated at $4,321,027. The Corps is responsible for project management and coordination with Federal and State agencies. The Portland District will submit the Feasibility Report for approval, design, prepare plans and specifications, complete all National Environmental Policy Act (NEPA) requirements, execute a Project Partnership Agreement (PPA) with the sponsor, advertise and award construction contract(s), and perform construction contract supervision and administration.

9.2 Non-Federal

The City of Portland Bureau of Environmental Services is the non-Federal sponsor for this project, and is responsible for 35 percent of the project costs. Up to 50 percent of the non-Federal share of project implementation costs can be provided as in-kind services, and operation and maintenance of those projects is a non-Federal responsibility. This section describes the primary non-Federal Sponsor responsibilities in conjunction with the Federal Government to implement the recommended plan.

A model PPA has been reviewed by the non-Federal Sponsor and its legal representative. The non-Federal Sponsor is aware of its responsibilities. The PPA will be executed prior to implementation.

The Feasibility Study and plans and specifications costs shall be included as part of the total project costs to be shared 65 percent Federal and 35 percent non-Federal. The non-Federal Sponsor shall:

- Provide all LERRDs.
- The non-Federal sponsor shall not use any element included in this project for the purposes of mitigation banking or mitigation crediting, including Natural Resource Damage Assessment (NRDA) credits.
- Provide, during construction, any additional costs as necessary to make the total non-Federal contributions equal to 35 percent of the total project costs. The City will provide work in kind during final design and construction as well as providing the post-construction monitoring. The non-Federal share is estimated at $2,819,168. The value of the LERRDs needed for the project will be deducted from this amount. The sponsor anticipates contributing the balance of funds from their capital improvement funding.
- Operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the completed project at no cost to the Federal Government, in accordance with the applicable Federal and State laws and any specific directions prescribed by the Federal Government for so long as the project is authorized. The annualized operation and maintenance costs are estimated at $7,100.
- Hold and save the Federal Government harmless from damages due to the construction and operation and maintenance of the project, except where such damages are due to the fault or negligence of the Federal Government or its contractors.
- Grant the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon land which the non-Federal Sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purposes of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

- 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 for a minimum of three years after completion of the project construction for which such books, records, documents, and other evidence are required.
- Perform, or cause to be performed, any investigations for 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 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 Federal Government determines to be subject to the navigation servitude without prior specific written direction by the Federal Government.
- 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 Federal Government determines are necessary for construction, operation, and maintenance of the project.
- Agree that, as between the Federal Government and the non-Federal Sponsor, the non-Federal Sponsor shall be the operator of the project for the purpose of CERCLA liability, and 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.
- Prevent obstructions of, or encroachments on, the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the aquatic ecosystem restoration, hinder its operation and maintenance, or interfere with the proper function such as any new development on project lands or the addition of facilities that would degrade the benefits of the project.
- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 USC 4601-4655), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, maintenance, repair, replacement, and rehabilitation of the project, including those required for relocations, the borrowing of material, or disposal of dredged or excavated material, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.
- Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements, including, but not limited to, 40 USC 3141-3148 and 40 USC 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 USC 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 USC 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 USC 276c).
- Provide the non-Federal share of that portion of the costs of data recovery activities associated with historic preservation that are in excess of the 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the Project Cooperation Agreement.
- Not use Federal funds to meet the non-Federal Sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

9.3 Design and Construction Schedule

The following preliminary schedule is provided, shown with construction in 2017.

	2015						2016												2017										
Work Item	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Public Review of Draft Report	■	■																											
Final Report/NWD Approval			■	■	■																								
Sign PPA					■																								
Permitting						■	■	■	■	■	■																		
Final Design						■	■	■	■	■	■																		
Finalize Funding												■	■																
Advertise																■	■												
Award Contract																		■	■	■									
Construction Submittals																					■	■	■						
Mobilize																								■					
Culvert Replacement																								■	■				
Channel Excavation																									■	■			
Trail Paving and Recreation																										■	■		
Reopen Park																												■	
Demobilization																													■
Revegetation																												■	■

9.4 Operation and Maintenance

Maintenance of the project site should be performed to ensure the success of these functions as shown by the various indicators that will be monitored. At this time, maintenance activities are expected to include periodic inspections of the culvert, overlooks, and restoration features, continued invasive species removal for the first five years after construction, plant maintenance/replanting, periodic rock riffle maintenance, and periodic sediment/debris removal.

9.5 Monitoring

This monitoring and adaptive management plan has been developed to assess the success of the recommended restoration plan in meeting project objectives and a process to identify if any adaptive management actions are warranted. The Corps will participate in monitoring and adaptive management for up to 10 years post-construction, but all operation and maintenance as well as adaptive management beyond 10 years post-construction will be the responsibility of the non-Federal sponsor. The proposed monitoring plan measures the following key elements: vegetation, tidal hydrology and hydraulics. The methods are described in this section. Photo-monitoring will also be conducted to document site changes over time including vegetation establishment and physical habitat features.

Project Objectives:

1. Restore natural tidal regime to improve salmonid access and reduce stranding of salmonids
2. Improve habitat for fish and wildlife species
3. Control non-native or pest populations
4. Maintain and improve quality of bird habitats

The monitoring elements described below are proposed for monitoring the success in meeting each objective.

Restore natural tidal regime to improve salmonid access and reduce stranding of salmonids

<u>Target(s):</u>

1. Match tidal elevations and frequencies upstream and downstream of the culvert within 1 year of completion of construction.
2. Remove fish passage barriers at the culvert and tidal slough channel within 1 year of completion of construction and maintain for lifetime of project.

<u>Monitoring Protocol:</u>

1. Install continuously logging pressure transducers at downstream end of culvert and approximately 100 feet upstream of the culvert for two years following construction. Data should be collected on an approximate 15 minute interval. Tidal elevations will be plotted to compare the two locations and identify differences in elevations and timing. This information will also be used to develop a depth/frequency curve for the culvert and lower tidal channel to compare to modeled output.
2. Install velocity meter in the culvert/low-flow channel to record velocities for one year following construction. Develop velocity/frequency curve for output.
3. Conduct channel cross-section and profile surveys in Years 1, 5, and 10 following construction. Document changes and identify frequency of connection based on elevation and velocity data. Identify causal factors for changes observed.

Adaptive Management Trigger(s):

1. If channel connection frequency and fish passage requirements are not met at least 90 percent of the time during design flows, then the Corps and non-Federal sponsor will review the data and causal factors to identify preferred management actions. Possible management actions could include installation of large wood or boulders to promote scour (i.e., if sediment deposition has occurred) or reduce channel velocities (via increased roughness); additional excavation if frequency targets are not met but no substantial channel deposition has occurred; or additional revegetation (to increase roughness or provide sediment trapping capacity).

Improve habitat for fish and wildlife species
Control non-native or pest populations
Maintain and improve quality of bird habitats

Target(s):

1. Achieve 80 percent cover of native vegetation species planted per design at designated representative monitoring plots within 5 years post-construction and sustain for lifetime of the project.
2. Reduce non-native vegetation species to less than 35 percent cover within 5 years post-construction and sustain for lifetime of the project.
3. Document changes in habitat suitability via the HGM model in Year 9 following construction. Compare scores to the baseline condition and predictions for Year 10 post-construction.

Monitoring Protocol:

- Establish minimum of five permanent vegetation plots to be representative of the plant communities and restored areas within the project site. Permanent plots shall be 33 foot diameter circular plots (center point of each plot will be documented via GPS coordinates to reoccupy in each of sampling). Percent cover will be visually assessed and documented for each stratum (herbs, shrubs, trees, woody vines) and each species with more than 5 percent cover. Sampling will occur in Years 1, 3, 5, and 9 following construction. Percent survival of planted stock should be a minimum of 80 percent during Years 1 and 3 otherwise supplemental plantings will be required to replace plants that have died. Percent cover of native species will be measured in the permanent plots and should reach 30 percent in year 1, 50 percent in year 3, and 80 percent in years 5 and 9 (total percent cover in all strata).
- Map non-native vegetation species throughout restored areas on each site in Years 1, 3, 5, and 9 after construction and document percent cover in all locations with more than 100 square feet of presence. Document average percent cover by species across the site and estimate total area of infestation.
- Conduct habitat evaluation using HGM in Year 9 following construction at each site. Document changes from baseline.

Adaptive Management Trigger(s):

1. If native plant survival or percent cover does not meet targets in any year of monitoring then the non-Federal sponsor will undertake supplemental plantings to achieve the targets. The Corps and non-Federal sponsor will evaluate at the end of 9 years the overall quality of habitat in each restored plant community.
2. If average non-native invasive species cover exceeds 35 percent cover in any of the monitoring years then the non-Federal sponsor will undertake invasive species removal actions such as pulling, mowing, and spot application of herbicide.
3. Corps and non-Federal sponsor to evaluate habitat quality and determine if actual quality in Year 9 varies substantially from predictions. Identify causal factors and any appropriate adaptive management actions such as additional invasive species removal, fencing, or other measures.

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10. COORDINATION AND REGULATORY COMPLIANCE

10.1 Public and Agency Coordination

Environmental coordination with permitting agencies and stakeholders has been ongoing throughout the project development. The agencies and stakeholders have been invited to comment on the alternatives and aid in determining effects of the project on fish and wildlife species. The Draft Integrated Feasibility Report/Environmental Assessment was circulated for a 30-day public review on July 14, 2015 to the following agencies, tribes, stakeholders and members of the public.

Agencies

- US Environmental Protection Agency
- US Fish & Wildlife Service
- NOAA Fisheries
- USDA Natural Resources Conservation Service
- Oregon Department of Environmental Quality
- Oregon Department of Fish & Wildlife
- Oregon Department of State Lands
- Multnomah County Vector Control
- Multnomah Soil & Water Conservation District
- Portland Bureau of Transportation
- Portland Parks & Recreation
- METRO Parks
- TriMet

Tribes

- Cowlitz
- Grand Ronde
- Warm Springs
- Siletz
- Yakama

Stakeholder and Neighborhood Groups

- Bicycle Transportation Alliance
- Bikeportland.org
- Brooklyn Action Corps
- The Freshwater Trust
- ONI Portland Citizens Disability Advisory Committee
- Oregon Nature Conservancy
- Portland Audubon Society
- SE Uplift
- SMILE (Sellwood-Moreland Improvement League)
- Sellwood Westmoreland Business Alliance
- Surfrider Foundation
- Urban Greenspaces Institute
- Willamette Riverkeepers
- Willamette Pedestrian Coalition

Citizens and Neighbors

- Cleveland High School
- GeoEngineers
- Llewellyn Elementary School
- Oaks Amusement Park
- Oregon Pacific Railroad
- Oregon Yacht Club
- S. Portland Neighborhood
- Sellwood Moreland resident
- Tetra Tech, Inc.
- Winterhaven Elementary School

The comment period ended August 14, 2015. Two comment letters were received during the comment period and are provided in Appendix H. Both comment letters expressed support for the project. Concerns about the potential for transport of sediments out of the refuge and possible contamination in the river were raised. The Corps and the City have evaluated these concerns and per analyses conducted for this study have demonstrated that the project will leave behind a clean surface in all excavated areas and will remove any low-level contaminated materials off-site to an approved landfill. The project overall will also tend to reduce the potential for transport of sediment out of the park due to reduced velocities through the culvert and by reducing habitat for non-native species such as carp that feed on the bottom of the existing reservoir. The Corps and the City will continue to coordinate with stakeholders and adjacent landowners during the design and construction phases.

Specific other coordination points and meetings are described below.

10.1.1 City Streamlining Meetings

Presentations were made to the City of Portland Agency Streamlining Team that includes representatives from the U.S. Army Corps of Engineers; NOAA Fisheries; U.S. Fish and Wildlife Service; Oregon Departments of State Lands, Fish and Wildlife, and Environmental Quality; and City of Portland Bureau of Planning. Based on the streamlining meetings, the ODFW has approved the fish passage plan for replacement of the existing culvert and water control structure with the proposed 10-foot by 16-foot arch culvert.

10.1.2 Project Review Group

Due to concerns regarding contaminants in the sediments of the project area, an early permit application was provided to the U.S. Army Corps of Engineers in 2007 to open a permit file and allow the Project Review Group that includes representatives from the Corps, NOAA Fisheries, U.S. Environmental Protection Agency (EPA), ODEQ, and Washington Department of Ecology, to review existing sediment and water quality sampling data and provide feedback and guidance on the development of several documents including the Level 1 Assessment (City of Portland 2010c), Sampling and Analysis Plan (City of Portland 2010b) and to conduct sampling and develop further recommendations for project implementation. The Project Review Group reviewed the Ecological Risk Assessment (GeoEngineers 2010) and has approved the project.

10.1.3 Stakeholder Meetings

Two meetings were held with a larger group of stakeholders that includes ODFW, EPA, Multnomah County Vector Control, Audubon Society, Willamette Riverkeeper and others, in 2007 and 2009. Currently, the stakeholder group supports the project and does not foresee any long-term adverse effects on the environment.

10.1.4 Public Meetings/Workshops

A public meeting was held in April 2010 to discuss the project at the 60 percent design phase. Additional public meetings will be held at the 90 percent designs and during the permitting process. Coordination with bicycle advocacy groups has been occurring since early 2010 to notify them of the proposed closure of the Springwater Trail and to identify safe detour routes. The bicycling community has expressed concerns regarding the summertime closure of the trail, but is working with the City to develop a suitable detour route and potential upgrades to bike lanes or other features in the Sellwood neighborhood. Additionally, coordination is ongoing with the railroad owner to identify methods to minimize effects on his operations.

10.2 Status of Compliance with Applicable Laws and Regulations.

Compliance has been completed with all relevant Federal laws and regulations. The City of Portland will obtain remaining approvals per City requirements and for construction stormwater management. Specific to the Fish and Wildlife Coordination Act, the U.S. Fish and Wildlife Service provided a letter with attached recommendations (Appendix D) that will be considered and incorporated, as appropriate, into the final design and specifications. Recommendations are as follows:

1. Incorporate relevant project design criteria (PDCs) from the programmatic consultation for the Partners for Fish and Wildlife, Fisheries, Coastal and Recovery Programs in Idaho, Oregon and Washington into the design and specifications.
2. Incorporate conservation measures and best management practices from the NOAA Biological Opinion provided for this project into the design and specifications.
3. Develop a plan to avoid and minimize disturbance and/or mortality to native turtles and other reptiles and amphibians during construction.
4. Avoid and minimize disturbance to migratory birds during construction such as by following the City of Portland's bird nesting guidelines. If yellow-billed cuckoo are observed in the action area, please contact the U.S. Fish and Wildlife Service prior to construction activity.
5. Avoid and minimize disturbance to bald eagles, if present in the project area, by following the U.S. Fish and Wildlife Service's guidelines.
6. Minimize the dewatering area to the smallest extent practicable. Survey for lamprey prior to construction and if found to be present, follow the guidance *Best Management Practices to Minimize Adverse Effects to Pacific Lamprey*.
7. Minimize recreational access in high value habitats. Keep artificial lighting and human activity away from areas that are important for wildlife use and movement.
8. Recommending adding tree snags and large wood throughout the site to enhance aquatic and terrestrial habitats for wildlife.
9. Recommend that post-construction monitoring be conducted to confirm that contaminant levels are below those that could threaten juvenile salmonids or remain similar to or below current conditions.

Table 10-1 shows the relevant laws and regulations and the status of compliance.

Table 10-1. Status of Compliance with Applicable Laws and Regulations

Relevant Law or Regulation	Requirements	Compliance Status
National Environmental Policy Act (NEPA) 42 USC 4321 et seq.	Requires federal agencies to consider the environmental effects of their actions and to seek to minimize negative impacts.	Compliance complete. The draft Feasibility Report/EA was circulated for public and agency review in July 2015. A Finding of No Significant Impact has been prepared and is attached to this document.
Clean Water Act (CWA) 33 USC 1251 et seq.; Section 404	Requires federal agencies to protect waters of the United States. Requires that the discharge of dredged or fill material complies with the 404(b)(1) guidelines and other substance requirements of the CWA.	A Section 404(b)(1) equivalency analysis has been completed and public comments were solicited during the review of the draft report. Section 404 compliance is complete.
Clean Water Act Section 401	Requires federal agencies to comply with state water quality standards.	Water Quality Certification received dated April 9, 2012. This certificate will be extended as needed for construction in 2016 or 2017.
Clean Water Act Section 402	Gives EPA the authority to regulate discharge of pollutants into Waters of the U.S.	City of Portland to obtain Construction General permit under NPDES from Oregon DEQ prior to starting construction.
CERCLA, 42 USC 9601, et seq.	Gives U.S. EPA authority to clean up orphaned hazardous waste sites and seek reimbursement from potentially responsible parties.	Not applicable. No CERCLA sites within or adjacent to project area.
Resource Conservation and Recovery Act, 42 USC 6901, et seq.	Set requirements for generation, transport and disposal of hazardous materials.	The City of Portland will dispose of the sediments at an appropriate landfill to comply with RCRA.
Fish and Wildlife Coordination Act 16 USC 661 et seq.	Requires federal agencies to consult with the U.S. Fish and Wildlife Service on any activity that could affect fish or wildlife.	FWCA letter and recommendations received in Sept 2015 (Appendix D). Recommendations to be incorporated into final design and specifications.
Endangered Species Act 16 USC 1531 et seq.	Requires federal agencies to protect listed species and consult with U.S. fish and Wildlife or NOAA Fisheries regarding the proposed action.	Biological Opinion received from NOAA on 8/27/12. No effects identified for USFWS managed species.
Magnuson-Stevens Fishery Conservation and Management Act 50 CFR 600.05-600.930	Requires federal agencies to consider impacts on Essential Fish Habitat to conserve and manage important fish species.	Completed as part of Biological Opinion dated 8/27/12.
Migratory Bird Treaty Act 16 USC 703	Prohibits the taking of any migratory bird or the parts, nests, or eggs of such birds, except by permit issued by the U.S. Fish and Wildlife Service.	This project will benefit migratory bird species overall and the City will conduct actions to discourage nesting in the project area in the spring immediately prior to construction to avoid construction disturbance.
Clean Air Act USC 7401	Requires federal agencies to control and abate air pollution.	In compliance per minimal generation of air pollution from construction

Relevant Law or Regulation	Requirements	Compliance Status
		equipment. No long term source of pollutants.
Rivers and Harbors Acts 33 USC 403	The creation of any obstruction to the navigation of any waters of the United States is prohibited without congressional approval.	N/A. Project is not in a navigable waterway.
Coastal Zone Management Act	Requires an evaluation of consistency with state and local shoreline master programs and effects on coastal zones and shorelines.	N/A. Project is not within a Coastal Zone.
National Historic Preservation Act 16 USC 461	Requires federal agencies to identify and protect cultural and historic resources.	No historic or cultural resources identified during feasibility study. If any resources are discovered during construction, immediate coordination with SHPO and relevant tribes will occur. Letter of concurrence received in September 2015 (Appendix D). Compliance complete.
Executive Order 11988, Floodplain Management, 24 May 1977	Requires federal agencies to consider how their activities may encourage future development in floodplains.	In compliance. Project will not encourage future floodplain development and is restoring floodplain habitat.
Executive Order 11990, Protection of Wetlands	Requires federal agencies to protect wetland habitats.	In compliance. Project has avoided adverse impacts to wetlands and will restore and enhance wetland habitat.
Executive Order 12898, Environmental Justice	Requires federal agencies to consider and minimize potential impacts on low-income or minority communities.	In compliance. Project will not have any effects on low-income or minority communities.
Executive Order 11593, Protection and Enhancement of the Cultural Environment	Requires federal agencies to preserve, restore, and maintain the historic and cultural environment of the U.S.	No historic or cultural resources identified during feasibility study. If any resources are discovered during construction, immediate coordination with SHPO and relevant tribes will occur. Compliance complete.
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Requires federal agencies to consult and coordinate with the appropriate tribal governments.	The Draft Feasibility Report/EA was circulated to appropriate tribes and no issues were identified.
Native American Graves Protection and Repatriation Act	Protects Native American and Native Hawaiian cultural items.	An inadvertent discovery plan will be implemented during construction.
American Indian Religious Freedom Act 42 USC 1996	Requires federal agencies to insure that religious rights of Native Americans are accommodated during project planning, construction, and operation.	Project will not affect religious rights of Native American tribes.
Oregon Water Quality Standards	Requires that actions that may affect water quality of waterbodies in the state comply	Water Quality Certification received from ODEQ dated April 9, 2012. City

Relevant Law or Regulation	Requirements	Compliance Status
	with water quality regulations.	will request extension of this permit due to delays that have changed proposed construction date.
Oregon Threatened and Endangered Species	Requires an evaluation of effects on listed threatened and endangered species	In compliance. No anticipated adverse effects to state listed threatened and endangered species. ODFW has been coordinated with throughout the project.
Oregon Removal/Fill Permit	Requires an evaluation of effects on wetlands and waterbodies within the state of Oregon	The City has received permit #: 45925-GA from the Oregon Department of State Lands. City will request extension of this permit due to delays that have changed proposed construction date.

11. RECOMMENDATIONS

11.1 Conclusions

This study has included an examination of all potential and practicable alternatives for meeting the study objectives of restoring tidal connections, providing unhindered access and improved habitat for salmon, Neotropical migratory birds and native amphibians and reducing non-native pest populations. The recommended alternative is an incrementally justified and cost effective alternative that also meets the sponsor and public needs. This alternative provides important fish and wildlife benefits at a reasonable construction and O&M cost. The plan does not increase flood surface elevations. The plan is consistent with national policy, statutes and administrative directives. The plan has been reviewed in light of overall public interest, which includes the views of the non-Federal sponsor and interested agencies. The District has concluded that the City of Portland, Oregon, is capable of meeting their financial obligations and that the total public interest would be served by implementation of the recommended plan.

11.2 Recommendations

It is recommended the proposed work be authorized and funding allotment of $278,799 be made available in FY16 for design. A second allotment of $4,247,370 will be required in FY17 to complete construction and project close-out. The proposed work would include restoration of fish and wildlife habitat within the City of Portland, as generally described in this report, with such modifications by the Chief of Engineers as may be advisable to meet provision of Section 206 of the 1996 Water Resources Development Act, as amended. Authorization is subject to cost sharing and financing arrangements with the non-Federal sponsor, the City of Portland, Oregon, and is based on the cost sharing and financing requirements of the Section 206 program. Prior to construction, and during the Plans and Specifications phase, the non-Federal sponsor will: (1) provide all lands, easements, and rights of way necessary for project construction and operation and maintenance; and (2) hold and save harmless the United States from damages due to the construction or operation and maintenance of the project. The non-Federal sponsor will also operate and maintain the project after construction for the life of the project (50 years).

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