LOWER WILLAMETTE RIVER ENVIRONMENTAL DREDGING AND ECOSYSTEM RESTORATION PROJECT

INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

DRAFT FINAL REPORT

March 2015

US Army Corps of Engineers®
Portland District
BUILDING STRONG®

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

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EXECUTIVE SUMMARY

This Integrated Feasibility Study and Environmental Assessment (FS-EA) evaluates ecosystem restoration actions in the Lower Willamette River, led by the U.S. Army Corps of Engineers (Corps) and the non-Federal sponsor, the City of Portland (City). The study area encompasses the Lower Willamette River Watershed and its tributaries, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26. The goal of this study is to identify a cost effective ecosystem restoration plan that maximizes habitat benefits while minimizing impacts to environmental, cultural, and socioeconomic resources.

This report contains a summary of the feasibility study from plan formulation through selection of a recommended plan, 35% designs and cost estimating, a description of the baseline conditions, and description of impacts that may result from implementation of the recommended plan. This integrated report complies with NEPA requirements. Sections 1500.1(c) and 1508.9(a) (1) of the National Environmental Policy Act of 1969 (as amended) require federal agencies to “provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact” on actions authorized, funded, or carried out by the federal government to insure such actions adequately address “environmental consequences, and take actions that protect, restore, and enhance the environment."

The Willamette River watershed was once an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forests, and adjacent upland forests. Modifications needed to provide ship access to Portland Harbor required construction and maintenance of a navigation channel between RM 0 and 11.6. The development of navigational channels, docking facilities, and bulkheads reduced the amount and quality of native floodplain habitats. In addition, the river became heavily polluted beginning in the early 1900s from industrial and urban waste discharges.

In the 1960s, the river was targeted for remediation and protection, and more recently, habitat and natural resources restoration efforts have been undertaken. However, the river continues to suffer from poor water and sediment quality, diminished riparian zones, and reduced shallow water and wetland habitat areas. Despite best efforts, fish and wildlife populations, especially those protected under the ESA, have undergone dramatic declines.

Based on an assessment of the problems and opportunities in the project area, a set of goals and objectives were established for this feasibility study. These are:

- Reestablish Riparian and Wetland Plant Communities
- Improve Aquatic and Riparian Habitat Complexity and Diversity
- Restore floodplain function and connectivity

Restoration management measures were developed that could be applied to potential sites and achieve project objectives. These include: Remove invasive species and minimize disturbance of native habitats; revegetate riparian zones and wetlands with an appropriate mix of native species; restore hydrological aspects of each site to encourage survival of appropriate plant communities; Restore streambeds by placing wood and debris jams for habitat diversity; encourage or install communities of overhanging streamside vegetation to reduce water temperatures and provide nutrients/food source, stabilize shorelines, and provide wildlife cover; Reconnect side channels and

backwater wetlands to streams and rivers where possible; Remove barriers to fish access to spawning and rearing areas; Slope steepened banks to a gentler angle to allow floodwaters to spread out and to provide shallow water and wetland habitat; Remove revetments and fill by excavation, and use bioengineering methods for bank stabilization where possible.

Many restoration sites which were included in the conceptual watershed management plans developed by the City for the Lower Willamette River Basin were initially proposed for restoration in this study. Of an initial list of approximately 50 sites, after several iterations evaluating and comparing sites' potential for benefits, availability, and cost effectiveness, 5 sites were evaluated, determined to be best buys, and carried forward as the recommended plan.

Given the variety of aquatic, terrestrial, and transitional habitat types present across the spectrum of the 50 original sites under consideration, the Habitat Evaluation Procedure (HEP) model was selected as the most appropriate model to quantify habitat benefits. Habitat benefits were evaluated using a modified HEP for the following six species or groups of species: western pond turtle, beaver, wood duck, yellow warbler, native amphibians, and salmonids. These species were selected to represent the range of riparian, aquatic and/or shallow water riverine habitats that would be encountered in the study area.

Cost-effectiveness and incremental cost analyses (CE/ICA) were performed using the certified Institute for Water Resources (IWR)-Planning Suite software version 1.0.11.0. The evaluation identified the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the added cost. The "best buy" plans, or the alternatives that provide the highest habitat value output for the least cost were considered for the final alternatives evaluation.

Following the iterative evaluation process and CE/ICA, the project team identified a Recommended Plan. It includes restoration components at five separate locations, including two on the Willamette River, two on the Columbia Slough, and one at the confluence of the Willamette and Columbia Rivers. The locations of the sites appear in Figure ES 1.1, and conceptual restoration features are shown in Figures ES 1.2 – ES 1.6. Below is a description of the recommended plan by site.

- **Kelley Point Park** (Off-Channel and Riparian Restoration, Floodplain Restoration): This site plan would restore by excavating two off-channel backwater areas, remove invasive plants, revegetate with native species, regrade steep banks for floodplain restoration, and place LW to restore habitat complexity. Trails throughout the park would be adjusted to allow for restoration. To reduce the amount of fill to be removed, rather than excavating large areas of floodplain, meandering channels would be cut along existing swales to allow for off-channel refugia. Implementation of the project would result in the creation of approximately 4,500 linear feet of side channels to allow rearing and refugia for juvenile salmonids and fish usage. Habitat complexity and riparian vegetation would be restored on approximately 5,000 feet of shoreline by grading banks to a gentler gradient, removing invasive species, and revegetating with riparian shrubs and trees.
- **Oaks Crossing/Sellwood Riverfront Park** (Off-Channel and Riparian Restoration, Wetland Restoration): This site plan would restore the floodplain habitat for salmonids and other wildlife by reconnecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species. Sandy beach habitat diversity would be improved by the addition of LW.

- **BES Plant** (Off-Channel and Riparian Restoration, Bank Restoration): This site plan would improve the hydroperiod to a floodplain backwater/swale area, and restore the riparian zone along Columbia Slough. Bank slopes would be reduced and large wood (LW) added along the banks to increase habitat complexity. Off-channel rearing and high-water fish refugia would be restored by excavating a connection from Columbia Slough to the low swale at the southeast end of the site and by excavating an alcove at the base of the slope near the northwest end of the site. Habitat quality would be increased by removing invasive species and revegetating with native trees and shrubs. Pond turtle habitat would be restored by addition of LW and boulders near the mouth of the channel between the slough and the low swale.

- **Kenton Cove** (Off-Channel and Riparian Restoration): This site plan would diversify instream habitat in this backwater cove by adding LW, removing invasive species, and revegetating with native riparian species. Because the edges of the cove are very even and offer very little habitat complexity, the plan includes creating small habitat islands at the location of each woody debris jam, with the wood as the centerpiece of the habitat island.
- **Tryon Creek, Highway 43** (Stream and Side Chanel Connectivity for fish passage): This site plan would replace the culvert under Highway 43 and the train line, which is a fish barrier under most flow conditions and restore fish passage and natural stream functions. The construction area would be revegetated with native riparian species, and rocks would be placed in the streambed to create natural weirs for grade control to reduce velocities and facilitate fish passage. The new culvert would simulate the natural stream dimensions, allowing for sediment and debris to pass through and give fish unhindered passage beneath the roadway and railroad line. Implementation of this project would allow unhindered fish passage into approximately 2.7 miles of stream within Tryon Creek State Natural Area (TCSNA).

The recommended restoration plan with the 5 site components has a total cost of $30,376,000 to be cost-shared between the Corps and the City of Portland. This plan provides an increase of 1,430 habitat units over the 50-year life of this project. An estimated 123 acres of riparian, wetland, and backwater habitat will be improved under this plan. The project would be implemented in four phases from 2015 through 2018.

Additionally, development of this report applied the recent Lessons Learned resulting from Hurricanes Katrina and Rita. They are as follows:

- Point 1 – Employ Integrated, Comprehensive and Systems-Based Approach
- Point 2 – Employ Risk-Based Concepts in Planning, Design, Construction, Operations and Maintenance
- Point 3 – Continuously Reassess and Update Policy for Program Development, Planning
- Guidance, Design and Construction Standards
- Point 4 – Dynamic Independent Review
- Point 5 – Employ Adaptive Planning and Engineering Systems
- Point 6 – Focus on Sustainability
- Point 7 – Review and Inspect Completed Works
- Point 8 – Assess and Modify Organizational Behavior
- Point 9 – Effectively Communicate Risk
- Point 10 – Establish Public Involvement Risk Reduction Strategies
- Point 11 – Manage and Enhance Technical Expertise and Professionalism
- Point 12 – Invest in Research

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ACRONYMS AND ABBREVIATIONS

AAHUs	Average Annual Habitat Units
AOI	Area of interest
AQCR	Air Quality Control Regions
AQMA	Air Quality Management Area
APE	Area of Potential Effects
ASA	Assistant Secretary of the Army
BA	Biological Assessment
BES	Bureau of Environmental Services (also listed as PBES)
BiOp	Biological Opinion
BMP	Best management practices
BNSF	Burlington Northern Santa Fe
BPA	Bonneville Power Administration
CAR	Coordination Act Report
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
City	City of Portland
CNN	Central Northeast Neighbors
CO	Carbon monoxide
CRBG	Columbia River Basalt Group
CSO	Combined Sewer Overflow
CWA	Clean Water Act
dB	Decibels
dBA	A-weighted decibels
DDE	dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DPS	Distinct Population Segment
EA	Environmental Assessment
ECO-PCX	Center of Expertise for National Ecosystem Planning USACE
EDR	Environmental Data Resources
EFH	Essential fish habitat
EIS	Environmental Impact Statement
ELJs	Engineered log jams
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPNO	East Portland Neighborhood Office
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Endangered Species Act
ESU	Evolutionarily significant units
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FS-EA	Feasibility Study and Environmental Assessment
FWCA	Fish and Wildlife Coordination Act
FY	Fiscal year
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
GSI	Green stormwater infrastructure

HEP	Habitat Evaluation Procedure
HQ	Headquarters
HSI	Habitat suitability index
HTRW	Hazardous, toxic, and radioactive waste
HU	Habitat Unit
HWTM	Hazardous Wastes and Toxic Materials
IC	Incremental cost
IDC	Interest During Construction
IDEP	Illicit Discharge Elimination Program
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
IWR	Institute for Water Resources
LERRD	Land, Easements, Rights of Way, Relocation, and Disposal Areas
Large wood	Large woody debris
MCACES	Microcomputer Aided Cost Estimating System
Metro	Metro Council
MS4	NPDES Municipal Separate Storm Sewer System
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NECN	Northeast Coalition of Neighborhoods
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration Fisheries Service
NPCC	National Policy Consensus Center
NPDES	National Pollutant Discharge Elimination System
NPNS	North Portland Neighborhood Services
NRDA	Natural Resources Damage Assessment
NWI	National Wetlands Inventory
NWNW	Neighbors West/Northwest
O_3	Ozone
O&M	Operations and maintenance
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODSL	Oregon Division of State Lands
OEA	(Oregon) Office of Economic Analysis
OHW	Ordinary High Water
OSE	Other Social Effects
P&G	Principles and Guidelines
PAHs	Polycyclic aromatic hydrocarbons
PBES	(City of) Portland Bureau of Environmental Services
PBPS	Portland Bureau of Planning Services
PCBs	Polychlorinated biphenyls
PDC	Portland Development Commission
PDT	Project development team
PDX	Portland International Airport
PED	Preconstruction engineering and design
PM	Particulate matter
Port	Port of Portland
PPR	Portland Parks and Recreation

PROJECTS	Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
PRP	Primary Responsible Party
PWRR	Portland and Western Railroad
RED	Regional Economic Development
RM	River mile
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
S&A	Supervisory and administrative
SEUL	Southeast Uplift Neighborhood Coalition
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMART	Specific, measurable, attainable, relevant and time-sensitive
SVOCs	Semi volatile organic compounds
SWNI	Southwest Neighborhoods Inc.
TCSNA	Tryon Creek State Natural Area
TMDL	Total maximum daily load
TMP	Transportation management plan
TPH	Total petroleum hydrocarbons
UGB	Urban Growth Boundary
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
WQI	Water Quality Index
WRDA	Water Resources Development Act
μg/L	Micrograms per liter

1. STUDY INFORMATION

1.1 Study Overview

This Feasibility Study/Environmental Assessment (FS-EA) evaluates ecosystem restoration actions in the Lower Willamette River, in collaboration with U.S. Army Corps of Engineers (Corps) along with its non-Federal sponsor, the City of Portland (City). The study area encompasses the Lower Willamette River and its tributaries, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26. The goal of this study is to identify a cost effective ecosystem restoration plan that maximizes habitat benefits while minimizing impacts to environmental, cultural, and socioeconomic resources. The period of analysis for this study is 50 years from the end of the first construction season.

1.2 Study Authority

Below are the study authorities that initiated the *Lower Willamette River Environmental Dredging and Ecosystem Restoration Study* Section 905(b) Analysis. This feasibility study is an interim response to the study authorization.

General authority for environmental dredging is contained in Section 312 of the Water Resources Development Act (WRDA) of 1990 as amended by Section 205 of WRDA 1996 and Section 224 of WRDA 1999. Specific authority for the Willamette River, Oregon was added when the Willamette River was listed as a priority site in Section 224 of WRDA 1999. The combined text of the three legislative acts is as follows:

ENVIRONMENTAL DREDGING.

(a) OPERATION AND MAINTENANCE OF NAVIGATION PROJECTS- Whenever necessary to meet the requirements of the Federal Water Pollution Control Act, the Secretary, in consultation with the Administrator of the Environmental Protection Agency, may remove and remediate, as part of operation and maintenance of a navigation project, contaminated sediments outside the boundaries of and adjacent to the navigation channel.

(b) NONPROJECT SPECIFIC-

(1) IN GENERAL- The Secretary may remove and remediate contaminated sediments from the navigable waters of the United States for the purpose of environmental enhancement and water quality improvement if such removal and remediation is requested by a non-Federal sponsor and the sponsor agrees to pay 35 percent of the cost of such removal and remediation.

(2) MAXIMUM AMOUNT- The Secretary may not expend more than $50,000,000 in a fiscal year to carry out this subsection.

(c) JOINT PLAN REQUIREMENT- The Secretary may only remove and remediate contaminated sediments under subsection (b) in accordance with a joint plan developed by the Secretary and interested Federal, State, and local government officials. Such plan must include an opportunity for public comment, a description of the work to be undertaken, the method to be used for dredged material disposal, the roles and responsibilities of the Secretary and non-Federal sponsors, and identification of sources of funding.

> *(d) DISPOSAL COSTS- Costs of disposal of contaminated sediments removed under this section shall be a shared as a cost of construction.*
>
> *(e) LIMITATION ON STATUTORY CONSTRUCTION- Nothing in this section shall be construed to affect the rights and responsibilities of any person under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
>
> *(f) PRIORITY WORK- In carrying out this section, the Secretary shall give priority to work in the following areas:*
>
> *(1) Brooklyn Waterfront, New York.*
> *(2) Buffalo Harbor and River, New York.*
> *(3) Ashtabula River, Ohio.*
> *(4) Mahoning River, Ohio.*
> *(5) Lower Fox River, Wisconsin.*
> *(6) Passaic River and Newark Bay, New Jersey.*
> *(7) Snake Creek, Bixby, Oklahoma.*
> *(8) Willamette River, Oregon.*

The Portland District of the U.S. Army Corps of Engineers conducted the reconnaissance phase of study and developed a Project Study Plan for the feasibility phase.

The Section 905(b) report, *Willamette River Environmental Dredging, Oregon (Environmental/Ecosystem Restoration)* was completed in 2000; the identified non-Federal sponsor at the time was the Port of Portland. The 905(b) report determined there was a "…Federal interest in pursuing environmental dredging for ecosystem restoration and for reduction in navigation maintenance costs. Optimization and incremental cost and benefit analyses will be developed in the cost-share feasibility phase of study."

Specific recommendations were not made in the reconnaissance report for addressing contaminated sediments or conducting ecosystem restoration studies. However, the report did specify that:

> *Environmental dredging authority for general ecosystem restoration, otherwise known as 312(b), could be used in any location in the study area to remediate ubiquitous contamination that is orphaned and not allocable to specific parties under the cleanup authorities. Use of this authority in conjunction with a cleanup under CERCLA authority will potentially allow for remediation of a greater volume of sediments and potentially manage the material in such a manor to improve aquatic habitats.*

The 905(b) report, initiated under Section 312(b) of WRDA 1990, also identified issues relative to environmental dredging and coordination with the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigations/Feasibility studies, and described a need and a federal interest for an overarching project to identify, evaluate, prioritize, and coordinate ecosystem restoration opportunities within the Lower Willamette River. In 2002 the original study authority was expanded to include ecosystem restoration within the Lower Willamette River watershed, under the authority of House Resolution Docket 2687, adopted June 26, 2002, by the U.S. House of Representatives, Committee on Transportation and Infrastructure, and entitled *Lower Willamette River Watershed, Oregon*. The text of the resolution is as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review the report of the Chief of Engineers on the Columbia and Lower Willamette Rivers below Vancouver, Washington and Portland, Oregon published as House Document Number 452, 87th Congress, 2nd Session, and other pertinent reports, to determine the feasibility of providing ecosystem restoration measures in the Lower Willamette River watershed from the Willamette Locks to [the] confluence of the Willamette River with the Columbia River through the development of a comprehensive ecosystem restoration strategy development in close coordination with the City of Portland, Port of Portland, the State of Oregon, local governments and organizations, Tribal Nations and other Federal agencies.*

The study expanded to be a mix of aquatic ecosystem restoration and Section 312(b) sites and both the Port of Portland and the City of Portland were the non-Federal sponsors of the feasibility study. In December 2000 Portland Harbor was added to US Environmental Protection Agencies (USEPA) National Priorities List (Superfund). The current Superfund study area extends from the Columbia Slough to the Broadway Bridge. USEPA and the Oregon Department of Environmental Quality are working with potentially responsible parties to clean up contaminated sediment and control sources of additional contamination. The USEPA Record of Decision is anticipated in 2017.

In 2008 the National Marine Fisheries Services (NMFS) produced a Biological Opinion for the Willamette Basin for ESA listed species. The listing of a portion of the study area by USEPA as a Superfund site, the listing of ESA species by NMFS, and the changes to the Corps planning process have caused significant delays in the completion of this study. This Feasibility study has moved between the legacy planning process, to SMART planning under 3x3x3, back to the legacy process. In 2012 a Charrette was conducted with the Corps, and the Port of Portland and the City Portland. One outcome of the Charrette was to seek clear guidance on whether the Corps was willing to continue with this feasibility study using Section 312(b) authority on sites that are designated Superfund sites in the Lower Willamette River.

May 10, 2013, the Corps determined that the feasibility should not include Section 312(b) sites, but could continue with only ecosystem restoration sites, as a result in September 20, 2013 the Port of Portland withdrew as a non-Federal sponsors.

The remainder of this report will describe only the process related to, the reduced scope of, only ecosystem restoration in the Lower Willamette River.

1.3 Study Purpose and Need

The study area for the Feasibility study was established in the authority cited above and is defined as, the Lower Willamette River watershed from the Willamette Locks to the confluence of the Willamette River with the Columbia River, approximately river mile 26.6. The watershed boundaries include the Willamette River, Columbia Slough, Johnson Creek, Tryon Creek and Fanno Creek.

The Lower Willamette River has experienced the effects of development and industrialization over the past 150 years. Historically, the Willamette River watershed in the Portland area was an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forests, and adjacent upland forests. Modifications to the river to improve navigation and provide ship access to Portland Harbor included construction and maintenance of a navigation channel between RM 0 and 11.6. Extensive alterations in natural riverine and floodplain processes have occurred in the study area, and are generally related to development of floodplain habitats, improper management of aquatic ecosystems, removal of woody debris in the river and tributaries, and altered flow patterns from upstream dams. The construction of docking facilities and bulkheads created steep, armored shorelines. The associated development of navigational channels, along with shoreline development, greatly reduced the amount and quality of open slack water areas, side channels, and wetland habitats. As a result, both the availability and quality of habitats that sustain fish and wildlife populations is reduced.

The purpose of this project is to restore ecosystem structure and function, to the degree possible, within the Lower Willamette River watershed in accordance with the Corps' mission statement. The purpose of this FS-EA is to: (1) identify and evaluate substantial ecosystem degradation problems in the Lower Willamette River; (2) formulate, evaluate, and screen potential solutions to these problems; and (3) recommend solutions that are in the federal interest and are supported by a local entity or entities willing to provide the items of local cooperation (*i.e.*, a non-Federal sponsor).

This project is needed to help restore the ecosystem structure, function, and dynamics that have been lost in the Lower Willamette River watershed due to the practices identified above. These functions include providing fish and wildlife habitat, flood storage, and sediment and erosion processes. Dynamics in this case refers to the interrelationship of hydrology, vegetation, water quality, and habitat diversity that formerly combined to make the Lower Willamette River watershed a highly productive ecosystem that supported numerous fish and wildlife species during all or part of their life history. Under current conditions, the dynamic relationships in the watershed must include the extensive past and ongoing changes to the watershed that have occurred over the previous 150 years, which have upset the balance that formerly created a stable and rich environment for plants, fish, and wildlife.

This project will help to address the need to restore wetland and off-channel habitat to contribute to the recovery of sensitive fish and wildlife species that depend on properly functioning conditions in the Lower Willamette River for all or part of their lifecycles. Reconnection of side channels and floodplains, addition of large wood, and revegetation of riparian areas is needed to restore the natural formation of habitats and provide important off-channel rearing and refuge habitats for multiple species and to address the problems identified in Section 3.

This project is not intended to fulfill the requirements of any Biological Opinions (BiOp) or recovery plans that have been prepared for listed species, although it is expected that these species may benefit from the actions of this project.

1.4 Study Stakeholders and Other Coordinating Agencies

Stakeholders include the State of Oregon, local governments and organizations, Tribal Nations, and other federal agencies. The study area is within the following congressional districts:

Senators	**Representatives**
Jeff Merkley (D)	Susan Bonamicci (D) 1st District, Portland
Ron Wyden (D)	Earl Blumenauer (D) 3rd District, Portland
	Kurt Schrader (D) 5th District, West Linn

On February 14, 2014, a workshop was held with staff from US Fish and Wildlife Service (USFWS) to discuss project features, possible effects, and methods of describing the project and potential effects. Recommendations from that workshop have been incorporated into this FS-EA. To date, the only other stakeholder that has taken an active role in planning for this study is Metro Council (Metro), which is the elected regional government for the Portland metropolitan area. Metro has continued to be involved with planning for shared natural resources that could be improved through the actions assessed in this study.

1.5 Study Sponsorship

The non-Federal sponsor for the *Lower Willamette River Ecosystem Restoration General Investigation Feasibility Study* is the City of Portland Bureau of Environmental Services (PBES). The Feasibility Cost Sharing Agreement was executed on September 22, 2003.

1.6 Resources of National Significance

The Willamette River Basin is a nationally and regionally significant watershed and ecosystem. In 1987 it was designated a National Natural Landmark because the basin has 713 acres remaining of unplowed native grassland, the largest in the Pacific Northwest. In 1998 it was named an American Heritage River; 1 of 14 in the Nation. In 2012 the Willamette River was awarded the Thiess International River Prize as a high profile watershed for restoration. The Willamette River Basin is one of four national migratory bird flyways. The Willamette River is the 10^{th} largest river in the United States based on average annual flow. The basin drains 12,000 square miles of Oregon (12%), is one of the largest tributaries to the Columbia River and is the home for about 70% of Oregon's population. The Willamette Valley provides critical floodplain and wetland habitat and ecosystem functions and processes. This is important, because nationally over half of the original wetlands in the lower 48 states drained and converted to other uses, and substantial loss of floodplain connections on all major U.S. rivers that have reduced floodplain storage, sediment erosion and deposition, water quality functions and habitats.

This study will propose a plan to restore habitats in the Lower Willamette River. The Willamette River is a major tributary of the Columbia River, accounting for 12 to 15 percent of the Columbia's flow. The Willamette River drains a total of 11,475 square miles, which is approximately 12 percent of the total area of Oregon. All ESA Willamette Basin stocks pass through and use this reach of the basin through multiple life stages.

1.6.1 Institutional Significance

The importance of the Willamette River as an environmental resource is recognized institutionally through a plethora of laws, adopted plans, and other policy statements of public agencies, tribes and private groups.

Federally, several laws provide environmental protection of the Willamette River. Though these laws were not enacted specifically for the Willamette River, their frequent application by state and federal regulatory agencies with regulate use of and impacts to the Willamette River support the river's institutional significance. The Endangered Species Act of 1973 and the Anadromous Fish Conservation Act of 1965 protect several species of plant and animals that rely on the Willamette River for habitat.

The Willamette River Valley is a major contributor to the Pacific Flyway and birds migrating via this flyway are protected under the Migratory Bird Treaty Act of 1918. Its wetlands provide essential habitat for migrating and wintering ducks, geese swans, and many shorebirds and wading birds. Also, the Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River under Executive Order 13061.

The State of Oregon has enacted several laws to protect flows that support water allocations, pollution. In addition, the Willamette River Legacy Program was initiated in 2004. Three priority areas of focus for the *Willamette River Legacy Program*, including;

1. Repair – Clean up the industrial pollutants and toxins that have contaminated the river.
2. Restore – Return the river to its natural state, restoring its abundant wildlife and pristine riverbanks.
3. Recreate – Address the role that the Willamette River plays in Oregon's quality of life so Oregonians can enjoy the many activities the river offers, and to do so responsibly so that it will be here for future generations.

Regionally, several plans are in existence to study, protect and restore the natural resources of the Willamette River. The *Willamette River Basin Planning Atlas* is a product of the Pacific Northwest Ecosystem Research Consortium, a regional research consortium involving researchers at Oregon State University, the University of Oregon, the University of Washington, and the EPA supported under cooperative agreement between the U.S. Environmental Protection Agency (EPA) and the universities (Hulse *et al.* 2002). The intent of the research is to: (1) create a regional context for interpreting trajectories of landscape and ecosystem change, (2) identify and understand critical ecological processes, and (3) develop approaches for evaluating outcomes of alternative future land and water use, management, and policy. The Planning Atlas provides current available information about critical natural and cultural factors influencing land and water use decisions in the Willamette River Basin. The information was used to create a set of mapped depictions of plausible future configurations of land and water use for the basin in the year 2050. These alternative futures were then scientifically evaluated for their effects on important environmental and ecological processes.

River Renaissance Initiative is a citywide initiative to reclaim the Willamette River as Portland's uniting community centerpiece. River Renaissance engages the public, connects community partners, coordinates the City's river-related work, and creates innovative urban solutions. Central to this initiative approach is the belief that urban development, healthy natural systems, and a sustainable economy are complementary goals. The River Renaissance Initiative celebrates the Willamette River by promoting a comprehensive approach to river issues, enhancing public awareness of critical issues, and highlighting progress and achievements. The initiative is led by a collaborative team of city bureaus including Planning, Environmental Services, Parks & Recreation, Sustainable Development, Transportation, Development Services, Water, and the Portland Development Commission.

The River Plan is a comprehensive multi-objective plan for land along the Willamette River. It is an update of the Willamette Greenway Plan, zoning code and design guidelines, which serve as Portland's compliance with State Planning Goal 15 and were last updated in 1987. The width of the planning area varies from place to place but generally includes all land within approximately 0.25 mile of the river.

1.6.2 Public Significance

The Willamette River is recognized as publically important as an environmental resource. Along the Willamette River Valley, which hosts 70% of the state of Oregon's population, there exists a strong citizen involvement in the uses and activities of the river. The Willamette River is one of ten rivers included in the Sustainable Rivers Project between the Corps and the Nature Conservancy. A wide variety of groups have interest in protecting the habitat along the Willamette River, for the purpose of protecting fish and wildlife, but also to improve recreational and aesthetic value of the river, which is a centerpiece of sociocultural activities in Portland. Local interest groups will be given the opportunity to review proposed ecosystem restoration plans and will benefit from completion of these plans.

1.6.3 Technical Significance

The Willamette River is recognized as technically important and is one of the top environmental resources researched in the Pacific Northwest and in the State of Oregon. The Willamette River Basin supports a variety of plant and wildlife species, some of which are listed as threatened or endangered under the federal Endangered Species Act. Important habitats were lost as the Willamette Valley developed to support its growing population and economy. 97-99% of the prairie habitat has been lost, 80% of the riparian forests have been lost and over half the original wetlands have been lost. Many nonnative invasive plant and animal species have taken hold in the basin, to the detriment of native species.

1.7 Report Contents

This report contains a summary of the feasibility study and an integrated feasibility report with an Environmental Assessment (EA) to comply with National Environmental Policy Act (NEPA) requirements. The purpose of the feasibility study is to identify the plan that reasonably maximizes ecosystem restoration benefits, is technically feasible, and preserves environmental and cultural values. The purpose of the EA portion of the report is to identify and present information about environmental effects of the alternatives and to incorporation environmental concerns into the decision-making process. The six steps of the Corps planning process each align with a NEPA requirement. The planning steps are listed in Table 1-1 with the document chapter and NEPA element to which they relate:

Table 1-1. Contents of FS-EA

Planning Step	Document Chapter and Analogous NEPA Requirement
Step One – Specify Problems and Opportunities	Appears in Chapter 3, as described in the purpose and need for action.
Step Two – Inventory and Forecast Conditions	Appears in Chapter 4 which describes the existing conditions of the study area and the likely future without project conditions (the no-action alternative) in the study area.
Step Three – Formulate Alternative Plans	Appears in Chapter 5 in the description of the screening process and the formulation of alternative plans.
Step Four – Evaluate Effects of Alternative Plans	Appears in Chapter 5 with the analysis of how each alternative plan improves habitats and continues to Chapter 7 that describes the potential effects of the recommended ecosystem restoration plan on the environment.
Step Five – Compare Alternative Plans	Appears in Chapter 5 with the comparison of how each alternative plan improves habitats.
Step Six – Select Recommended Plan	

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2. PROJECT OVERVIEW

2.1 **Project Location**

The Lower Willamette River, the focus of this study, is generally defined as the area downstream, and north, of Willamette Falls, which occurs at RM 26.6 in Oregon City. The study area also includes four key tributaries; Columbia Slough, Johnson Creek, Tryon Creek and Fanno creek. Most of the study area is within the city limits of Portland (Figure 2-1). To more effectively describe the conditions in the Lower Willamette River mainstem and its tributaries, the study area has been broken into the reaches outlined below and shown in Figure 2.1. Reaches have been distinguished from each other primarily to orient the reader to the location of the proposed ecosystem restoration sites and to allow more specific descriptions of conditions in the area surrounding the site locations.

- Lower Willamette Mainstem This reach stretches from RM 0 to Willamette Falls. The floodplain widens from north to south in this reach, but also becomes highly developed from south to north. The main exception to this is Kelley Point Park, which is relatively undeveloped and publically owned. Habitat is generally less disturbed a in the south end of this reach. Portland Harbor, generally located between RMs 2 and 11, is a Superfund cleanup site, and numerous sites in need of remediation are found there.
- Columbia Slough This reach extends along the Columbia Slough from near its confluence with the Willamette River to Kenton Cove (RM 0 to RM 9.0). Columbia Slough is a former side channel of the Columbia River that now drains localized areas to the northeast of the Willamette River and enters the Willamette at RM 1. Most of the northern end of Columbia Slough is relatively undeveloped, although floodplains in most areas appear to have been filled or otherwise modified and the slough is typified by high, steep banks.
- Johnson Creek This reach extends from the Willamette River and travels approximately 26 miles through Clackamas and Multnomah counties to its headwaters in Boring Oregon. Johnson Creek passes through upland forests, farms, residential communities, wildlife refuges, industrial enclaves, along trails and through golf courses.
- Tryon Creek This reach consists of Tryon Creek from its confluence with the Willamette River to Boones Ferry Road (RM 0 to RM 2.9), which is a fish barrier. The Tryon Creek reach offers the most undeveloped area for ecosystem restoration of any of reach in the project area.
- Fanno Creek This reach extends of Fanno Creek from its confluence with the Willamette River to its headwaters in the Tualatin Mountains approximately 15 miles. The watershed covers about 32 square miles in *Multnomah*, *Washington*, and *Clackamas* counties, including about 7 square miles within the *Portland* city limits. The creek supports aquatic life, including *coastal cutthroat trout* in its upper reaches. This reach provides opportunity to restore native vegetation in *riparian* zones.

This area was chosen due to the unique opportunity for ecosystem restoration in a major metropolitan area, the extensive partnerships and stakeholder involvement in restoration and the desires of the non-Federal sponsor, the City of Portland.

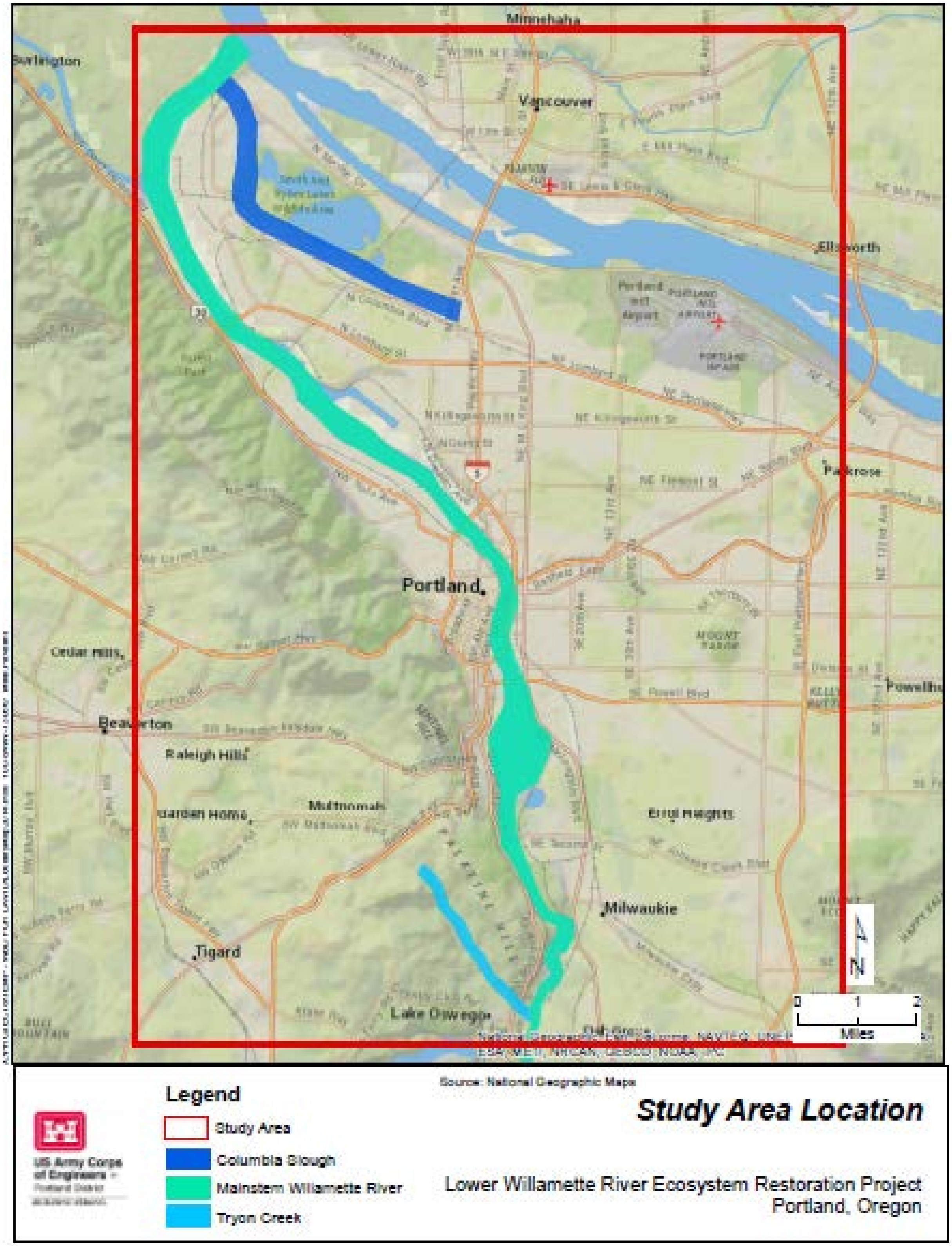

Figure 2-1. Study Area

2.2 Prior Reports, Projects, Initiatives, and Activities

The following is a list of recent or ongoing programs and studies in the study area that are relevant to ecosystem restoration of the Lower Willamette River watershed.

2.2.1 Federal

Corps' Willamette Valley Projects The Corps manages a system of 13 multiple purpose dams and reservoirs in the overall Willamette River Basin. The projects are Big Cliff, Blue River, Cottage Grove, Cougar, Detroit, Dexter, Dorena, Fall Creek, Fern Ridge, Foster, Green Peter, Hills Creek, and Lookout Point. Each project contributes to an overall water resource plan designed to preserve the quality of the valley's environment, providing flood damage reduction, power generation, irrigation, recreation, and navigation on the Willamette River and many of its tributaries (USACE 2006). The annual weather patterns and runoff characteristics of the Willamette Basin make the multiple purpose operation of the reservoir system possible. The well-defined limits of the flood season allow the reservoirs to be drawn down in the fall and winter to catch flood flows. The reservoirs are then filled in the spring and held full as long as possible in the summer so that water stored in, or released from the reservoirs can serve a variety of beneficial uses. Each reservoir is operated on the basis of a water control plan (rule curve) which establishes the elevation at which the pool is to be maintained during various seasons and seasonal transitions.

The original authorized plan for the Willamette projects is described in House Document 544, 75th Congress, third session, March 16, 1938. The plan for open-river navigation improvement above Willamette Falls stipulated a minimum flow of 5,000 cubic feet per second (cfs) between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively. House Document 544 also recognized that these navigation flows would increase flows during the low-water period and would "benefit sanitary conditions along the main stream" by diluting wastes and would increase "the dissolved oxygen content of the stream with a resultant beneficial effect on fish life."

Navigation is currently a minor purpose of the system, and the navigation flow requirements originally established at Albany and Salem are now utilized as control points for fishery and water quality objectives. Minimum authorized instream flows are required for fish and other aquatic life below each dam and are higher than historic flows during the summer. These flows serve indirectly as partial mitigation for effects of each dam and reservoir complex on the aquatic ecosystem (Corps 2000a). The rest of the mitigation for aquatic impacts of the Coast and Middle Forks dams is met through production of salmon and trout at the Willamette Hatchery in Oakridge, operated by the Oregon Department of Fish and Wildlife (ODFW).

The Corps coordinates an annual summer flow augmentation plan with federal, state, and local agencies. The coordination process attempts to balance the state's water management objectives for the Willamette with Corps policy, flexibility, and project authorizations. The flexibility to manage any one reservoir is influenced both by project authorizations and the Corps' discretionary authority. There also are provisions for adjustments to the state's water management objectives for flow conditions in terms of average, better, or below normal water conditions.

Willamette Project Operations Biological Opinion A Biological Assessment (BA) was prepared by the Corps (USACE 2000b) to assess the ongoing operation and maintenance of the Willamette projects in accordance with Section 7 of the Endangered Species Act (ESA). The BA included the Bureau of Reclamation and Bonneville Power Administration (BPA) as action agencies. The BA evaluated the likely effects of the Willamette projects for species listed under the ESA and their critical habitats. The BA concluded that continued operation and maintenance of the projects was likely to adversely affect several listed species. On the basis of this finding, the action agencies requested formal Section 7 consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

The services prepared a draft joint Biological Opinion in 2000. In 2001 and 2002, the services worked with the action agencies to define a Reasonable and Prudent Alternative (RPA) that would reduce effects on listed species. In 2003, the services determined that they should prepare separate Biological Opinions for the project and included an Updated Proposed Action proposed by the action agencies. Revised draft Biological Opinions were completed in 2003 and 2004. A supplemental BA was prepared in 2007 (USACE 2007).

The NMFS and USFWS completed final separate but coordinated Biological Opinions (BiOp) in 2008 addressing the effects of the operation and maintenance of the Willamette Project on the respective listed species for which they are responsible (NMFS 2008, USFWS 2008). In its BiOp, NMFS determined that the continued operation of the Willamette Project was likely to jeopardize continued existence of the Upper Willamette spring Chinook and winter steelhead and adversely modify their critical habitat. Thus, this required the development and inclusion of a RPA to the proposed action. The USFWS agreed to use the RPA developed by NMFS in the preparation of its BiOp. The following measures have been included in the RPA for the action agencies to implement in addition to those actions already proposed in the BA. A total of 10 major components were included:

1. Creation and coordination of a multi-agency action team for ecosystem restoration to oversee flow management activities and other interim measures to avoid jeopardy to the listed species.
2. Operational modifications to modify flows to provide more natural seasonal fluctuations and access to riverine/floodplain habitats and provide suitable flows for out-migrating juveniles in the spring and summer and also to provide adequate rearing habitat and temperatures for fish during the summer/fall months. Additional monitoring activities such as the installation of new gages and instream flow studies will help to inform and revise minimum flow targets in future years.
3. Evaluate and update water contracts and require fish screening at all diversions receiving federally provided water.
4. Provide fish passage at the dams through a variety of methods including outplanting, trap and haul, fish collection, downstream passage through dams, and other methods to be identified through the development of a Willamette Fish Operations Plan. Upgrade facilities to comply with the plan.
5. Improve water quality downstream of the dams by operational activities and facility upgrades/construction at dams to provide more normative water temperatures and reduced total dissolved gas in the tributaries and mainstem Willamette.
6. Evaluate and modify hatchery operations through Hatchery and Genetic Management Plans and other measures such as upgrades to facilities and mass-marking of hatchery releases.
7. Implement habitat mitigation and ecosystem restoration measures throughout the basin (at both off-site and on-site locations). Collect and make large woody debris available and restore habitat at existing Corps revetments. Funding to be provided through existing funding programs such as the:
    - Columbia Basin Fish and Wildlife Program,
    - Continuing Authorities Programs,

- General Investigation Studies (applicable GI studies include the Willamette Floodplain Restoration Study, Eugene-Springfield Metro Area Watershed Feasibility Study, and Lower Willamette Ecosystem Restoration Feasibility Study),
- Planning Assistance to the States,
- Upper Willamette Watershed Ecosystem Restoration Authority (Section 3138, Water Resources Development Act [WRDA] 2007),
- Ecosystem Restoration and Fish Passage Authority (Section 4073, WRDA 2007), and
- Sustainable Rivers Partnership with The Nature Conservancy.

8. Conduct ESA compliance and coordination activities with NMFS and USFWS.
9. Develop and implement a comprehensive research, monitoring and evaluation plan.
10. Identify fish protection maintenance needs.

Although the purpose of this report is for ecosystem restoration, the action is consistent and supports the Willamette BiOp.

<u>Willamette River Federal Navigation Channel</u> The Corps monitors and maintains a 40 foot deep navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to 11.6) as part of the Columbia and Lower Willamette Rivers (C&LW) federal navigation project. From the Broadway Bridge to the Ross Island Bridge (RM 11.6 to 16) the C&LW is 30 feet deep, maintained by the Port of Portland. The Willamette River transitions to an 8 foot deep shallow draft navigation channel from the Ross Island Bridge to Oregon City at Willamette Falls Lock (RM 14 to 26.6). This portion of the river to its upstream extent is not maintained. The Federal navigation channel extends from Oregon City to RM 132 to Corvallis. The channel transitions from the 8 foot depth to a controlling depth of approximately 3.5 feet.

<u>Columbia Slough Section</u> Columbia Slough was authorized by the River and Harbors Act of 17 May 1950. It provided for a 10 foot deep channel between the mouth and Union Avenue, Portland, 7.7 miles. This project was subsequently reauthorized 20 October 1978. The Corps, in partnership with the City and the Multnomah County Drainage District #1, constructed, the Section 1135 Ecosystem Restoration Project Columbia Slough ecosystem restoration project (USACE 2001). Previously constructed Corps levees and other channelization and development had caused ecosystem degradation in the Columbia Slough portion of the Columbia River floodplain. Project elements included reshaping the slough’s straight channel, and creating wetland benches and islands planted with native plants. The changes to the channel created a greater diversity of habitats, increased the water flow, and restored the riparian buffer along the slough.

<u>Oaks Bottom Section 206 Ecosystem Restoration Project</u> The Corps, in partnership with the City of Portland, is preparing an ecosystem restoration study at the Oaks Bottom Wildlife Refuge within the floodplain of the Lower Willamette River, southeast of Ross Island. Objectives include: (1) providing salmonid access to suitable habitats and reducing entrapment and mortality of salmonids caused by existing infrastructure, (2) ecosystem restoration of fish and wildlife habitat, (3) control of non-native or pest populations, and (4) maintaining an open water and mudflat area for waterbirds. This project is currently anticipated for construction in 2017.

<u>Westmoreland Park Section 206 Ecosystem Restoration Project</u> Westmoreland Park is located along Crystal Springs Creek, which is a tributary to Johnson Creek. The purposes of this project, which has been completed, are: (1) to provide juvenile fish passage from Johnson Creek to the upper end of Westmoreland Park, (2) improve aquatic habitat for salmonid rearing and refuge, (3) provide riparian corridor and wetland habitat for wildlife, and (4) improve water quality conditions by

eliminating a duck pond (which causes heating of water), reducing excessive waterfowl use, and reducing runoff of other contaminants by providing a buffer for the creek and wetlands. Construction was completed in 2014.

<u>Portland Harbor Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund)</u> Portland Harbor, a roughly 10-mile stretch of the Lower Willamette River, was added to the USEPA National Priorities List in December 2000 due to the discovery of highly contaminated sediments. A draft Feasibility Study was published in March 2012, which presented alternatives to the clean-up and management of contaminated soil and river sediments (Lower Willamette Group 2012). The next steps in the process include the issuance of a proposed plan, the opportunity for public comment, and issuance of a Record of Decision (ROD), anticipated in 2017. This became a critical component to this study, and reason that the study was re-scoped to only include ecosystem restoration sites outside of the Superfund area.

<u>Willamette Subbasin Plan</u> The Northwest Power Act directs the National Policy Consensus Center (NPCC) to develop a program to protect, mitigate, and enhance fish and wildlife of the Columbia Basin and to make annual funding recommendations to BPA for projects to implement the program. The NPCC designated the Willamette Partnership as the lead entity for developing the *Willamette Subbasin Plan*, which was completed in May 2004. The plan includes a compendium of current knowledge about basin conditions, particularly fish and wildlife and their habitats, an inventory of existing plans and programs, and strategies and actions to implement the plan. This plan identifies overall objectives for the recovery of fish and wildlife and is the basis for developing more detailed studies and ecosystem restoration designs in the basin.

<u>Willamette and Lower Columbia River Basins Recovery Plan</u> National Oceanic and Atmospheric Administration Fisheries Service (NMFS), in partnership with Oregon Department of Fish and Wildlife (ODFW), developed a recovery plan for salmon and steelhead populations listed under the ESA in the Northwest Region. The Willamette/Lower Columbia recovery domain includes the Willamette River Basin and all Columbia River tributaries from Hood River downstream in Oregon and from the White Salmon River downstream in Washington. Recovery planning for listed salmon and steelhead started in the summer of 2000, when the Willamette/Lower Columbia Technical Recovery Team was formed. The Executive Committee for Lower Columbia and Willamette River Salmonid Recovery, a coordinating policy forum, began work on recovery planning in the summer of 2001. In 2008, NMFS issued a biological opinion that determined that the Action Agencies' (Corps, BPA and Bureau of Reclamation) proposed action, as described in the biological assessments would jeopardize both Upper Willamette River spring Chinook and winter steelhead. The BiOp included a Reasonable and Prudent Alternative to the proposed action, including 90 specific actions. USFWS issued a no-jeopardy Biological Opinion, assuming that the Action Agenciess implemented the actions required by the NMFS RPA. This BiOp contained seven reasonable and prudent measures, with non-discretionary terms and conditions, to minimize take on bull trout and Oregon Chub. In 2014 bull trout was delist. Although the purpose of this report is for ecosystem restoration, the action is consistent and supports the Willamette and Lower Columbia River Basin recovery plan.

<u>American Heritage River</u> The Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River. The American Heritage Rivers initiative was established in 1997 by Executive Order (EO) 13061 and is administered by EPA. The American Heritage Rivers initiative has three objectives: (1) natural resource and environmental protection, (2) economic revitalization, and (3) historic and cultural preservation. The initiative is an innovative response to assist communities seeking federal resources to protect their local river environments (EPA 2003).

2.2.2 State of Oregon

Statewide Planning Goals Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of that program is a set of 19 Statewide Planning Goals. The goals express the state's policies on land use and related topics, such as citizen involvement, housing, and natural resources management.

Oregon Plan for Salmon and Watersheds In April 1997, the Oregon Legislature adopted the *Oregon Plan for Salmon and Watersheds* (the Oregon Plan). The Oregon Plan represents commitments on behalf of government, interest groups, and citizens from all sectors of the state to protect and restore watersheds for the benefit of salmon, and the economy and quality of life in Oregon. The Oregon Plan originally evolved from two components: (1) the Healthy Streams Partnership, a cooperative effort among landowners, government, and interest groups aimed at improving and preserving water quality in water quality limited streams in Oregon, and (2) the Coastal Salmon Ecosystem Restoration Initiative, which guides habitat ecosystem restoration efforts for coastal coho salmon in an effort to restore populations to sustainable levels. The Oregon Plan also serves as a federally recognized ecosystem restoration plan for coastal coho salmon. In December 1997, a steelhead supplement was added to the Oregon Plan and addressed salmonid ecosystem restoration within the context of watershed health.

Willamette River Legacy Program On March 5, 2004 the State of Oregon adopted the Willamette River Legacy Program. The geographical extent of the plan extends from the headwaters of the Willamette River, east of Eugene to the Columbia River. The Plan identified three priority areas of focus for the Willamette River, including;

1. Repair – Clean up the industrial pollutants and toxins that have contaminated the river.
2. Restore – Return the river to its natural state, restoring its abundant wildlife and pristine riverbanks.
3. Recreate – Address the role that the Willamette River plays in Oregon's quality of life so Oregonians can enjoy the many activities the river offers, and to do so responsibly so that it will be here for future generations.

2.2.3 Regional Plans

Metro Regional Framework Plan Metro is a directly elected regional government that serves residents in Clackamas, Multnomah and Washington counties, and the 25 cities in the Portland metropolitan area. The *Metro Regional Framework Plan*, updated in 2011, unites all of Metro's adopted land use planning policies and requirements including: the Regional Urban Growth Goals and Objectives, 2040 Growth Concept, Metropolitan Greenspaces Master Plan, and Regional Transportation Plan. The Metro 2040 Growth Concept defines regional growth and development in the Portland metropolitan region. Policies in the 2040 Growth Concept encourage efficient use of land, protection of farmland and natural areas, a balanced transportation system, a healthy economy, and diverse housing options. It includes land use and transportation policies that will allow Portland metropolitan area cities and counties to manage growth, protect natural resources, and make improvements to facilities and infrastructure while maintaining the region's quality of life.

Willamette River Basin Planning Atlas The Willamette River Basin Planning Atlas (Hulse *et al.* 2002) is a product of the Pacific Northwest Ecosystem Research Consortium, a regional research consortium involving researchers at Oregon State University, the University of Oregon, the University of Washington, and the EPA supported under cooperative agreement between the EPA and the universities. The intent of the research is to: (1) create a regional context for interpreting trajectories of landscape and ecosystem change, (2) identify and understand critical ecological processes, and (3) develop approaches for evaluating outcomes of alternative future land and water use, management, and policy. The Planning Atlas provides current available information about critical natural and cultural factors influencing land and water use decisions in the Willamette River Basin.

2.2.4 City of Portland

The City of Portland, as the non-Federal sponsor, has previously taken steps to identify a citywide approach to improving watershed health in the Lower Willamette River. The *Framework for Integrated Management of Watershed Health* (PBES 2005a) establishes four citywide watershed health goals. Based on the framework, the City developed *Actions for Watershed Health, 2005 Portland Watershed Management Plan* (PBES 2005a). Based on the watershed characterizations, the City of Portland and its partners, along with public input, prepared the Portland Watershed Management Plan (PBES 2005a). The City Council adopted the plan in March 2006. The Portland Watershed Management Plan describes the priority strategies being used to improve watershed health through the work of the PBES Watershed Services Group, River Renaissance, other City bureaus, agencies, and citizens' groups, all of which share the watershed health goals described in the framework. The plan also includes citywide objectives based upon the framework goals (Figure 2.2).

Figure 2-2. Portland Watershed Management Plan Citywide Goals and Objectives (2005)

Goals	**Objectives**
Hydrology Move toward normative flow conditions to protect and improve watershed and stream health, channel functions, and public health and safety.	**Stream Flow and Hydrologic Complexity** Increase rainfall interception, infiltration, and detention to normalize stream hydrographs, reduce stormwater input into the sewer systems, and reduce basement flooding. **Channel and Floodplain Function** Protect and restore the extent, connectivity, and function of streams, other open drainage ways, wetlands, riparian areas, and floodplains to improve stability and natural hydrologic functions and reduce risk to development and human safety. **Stormwater Conveyance** Maintain stormwater collection and conveyance infrastructure capacity.
Physical Habitat Protect, enhance, and restore aquatic and terrestrial habitat conditions to support key ecological functions and improve productivity, diversity, capacity, and distribution of native fish and wildlife populations and biological communities.	**Aquatic Habitat** Protect and improve aquatic, riparian, and floodplain habitat extent, quality, and connectivity that support the persistence of native fish and wildlife communities. **Terrestrial Habitat** Protect and improve upland habitat extent, quality, and connectivity that support the persistence of native terrestrial communities and connectivity to aquatic and riparian habitat.
Goals	**Objectives**

Water Quality Protect and improve surface water and groundwater quality to protect public health and support native fish and wildlife populations and biological communities.	**Stream Temperature** Protect and improve stream temperatures, dissolved oxygen, and pH to levels that protect ecological health and achieve applicable water quality standards. **Pathogens** Maintain and manage sewer infrastructure, stormwater inputs, and runoff to limit sewage overflow and the delivery of pathogens to waterways and achieve applicable water quality and sewer design manual standards. **Urban Pollutants** Manage the sources and transport of industrial and non-industrial pollutants and nutrients to limit surface water, groundwater, soil, and sediment contamination to levels that protect ecological and human health and achieve applicable water quality standards.
Biological Communities Protect, enhance, manage, and restore native aquatic and terrestrial species and biological communities to improve and maintain biodiversity in Portland's watersheds.	**Fish and Other Aquatic Organisms** Implement watershed actions to maximize the persistence of native Willamette and Columbia River fish and other aquatic organisms and assist with species recovery and potential population productivity by protecting and improving hydrology, habitat, and water quality. **Terrestrial Wildlife and Vegetation** Implement watershed actions to restore populations of terrestrial organisms to healthy, self-sustaining levels, protect and restore the composition and structure of native vegetation communities, and reduce populations of non-native plants and organisms to levels where they do not compete with native species.

<u>River Renaissance Initiative</u> River Renaissance Initiative is a citywide initiative to reclaim the Willamette River as Portland's uniting community centerpiece. River Renaissance engages the public, connects community partners, coordinates the City's river-related work, and creates innovative urban solutions. Central to this initiative approach is the belief that urban development, healthy natural systems, and a sustainable economy are complementary goals. The River Renaissance Initiative celebrates the Willamette River by promoting a comprehensive approach to river issues, enhancing public awareness of critical issues, and highlighting progress and achievements. The initiative is led by a collaborative team of city bureaus including Planning, Environmental Services, Parks & Recreation, Sustainable Development, Transportation, Development Services, Water, and the Portland Development Commission. This initiative was important for bringing together major entities to develop a common vision for the Willamette River in the metropolitan area.

<u>River Plan</u> The River Plan is a comprehensive multi-objective plan for land along the Willamette River. It is an update of the Willamette Greenway Plan, zoning code and design guidelines, which serve as Portland's compliance with State Planning Goal 15 and were last updated in 1987. The width of the planning area varies from place to place but generally includes all land within approximately 0.25 miles of the river.

The River Plan is divided into three reaches of the Willamette River: the North Reach, Central Reach, and South Reach. The North Reach of the Willamette was the first to receive detailed planning, and the City Council adopted the River Plan North Reach in 2010. The South and Central Reach plans will follow, allowing the River Plan to synchronize with projects and planning efforts that affect specific reaches such as Portland Harbor Superfund cleanup (North Reach), Central City planning (Central Reach), and the acquisition of Ross Island (South Reach) (PBES 2012a). This plan shows the accumulative benefits for the actions being conducted across the study area.

Framework for Integrated Management of Watershed Health The *Framework for Integrated Management of Watershed Health* describes Portland's scientific foundation for managing the conditions and ecological functions of its urban-area watersheds (PBES 2005a). The framework describes a science-based approach to:

- Generate information to guide City government decisions that affect watershed health.
- Integrate the City's responses to regional, state, and federal environmental laws.
- Establish goals, objectives, measurable indicators of watershed health, and target values and benchmarks for each indicator.
- Guide the identification, analysis, selection, implementation, and monitoring of actions to improve watershed health.
- Ensure that City activities not directly related to improving environmental conditions are consistent with the City's watershed health goals.

The framework documents the City's definition of healthy urban watersheds, a vision for the future of Portland's watersheds, and watershed health goals related to hydrology, physical habitat, water quality, and biological communities. Salmon are of particular interest because of their special legal, economic, and cultural status in the Pacific Northwest. The framework process also applies to riparian and terrestrial wildlife and habitats. This framework was instrumental to the development of sites evaluated under this feasibility study.

Watershed Characterization Reports Based on the scientific guidance provided by the framework, Portland developed a series of watershed characterization reports for the Fanno and Tryon Creeks (PBES 2005b), Johnson Creek (PBES 2005c), Columbia Slough (PBES 2005d), and Willamette River (PBES 2006) watersheds. The characterizations describe existing and historic conditions in each drainage area within the City of Portland, and highlight areas of remaining high quality that warrant continued and/or additional protection and areas that represent the best opportunities for ecosystem restoration. Similarly, the characterizations identify key limiting factors that are used to guide the development and prioritization of management objectives and actions.

Combined Sewer Overflow Program In 2011, the City's Combined Sewer Overflow (CSO) program was completed, reducing CSOs to the Columbia Slough by 99 percent and Willamette River by 94 percent (PBES 2011). During a CSO, stormwater quickly fills the combined sewers, which carry both sanitary sewage and runoff from streets, parking lots, and rooftops. The overflows carried bacteria from the untreated sewage as well as other pollutants in the stormwater directly into the river, and would occur every time it rained. About half of Portland's residents are served by combined sewers and overflows occur nearly every time it rains. Under the program, instead of overflowing nearly every time it rains, combined sewers overflow to the river only during major rain storms, which happen on average four times each winter and once every third summer. The program includes projects to remove stormwater runoff from sewers and construct facilities to collect and convey combined sewage to the Columbia Boulevard Wastewater Treatment Plant.

3. NEED FOR AND OBJECTIVES OF ACTION

The Willamette River watershed in the Portland area was once an extensive and interconnected system of multiple active channels, sloughs and slack waters, sandflats, emergent wetlands, riparian forests, and adjacent upland forests. The settlement and development of the City of Portland modified and removed many of these habitats. Modifications needed to provide ship access to Portland Harbor required construction and maintenance of a navigation channel between RM 0 and 11.6. The development of navigational channels, docking facilities, and bulkheads reduced the amount and quality of native floodplain habitats. In addition, the river became heavily polluted beginning in the early 1900s from industrial and non-industrial waste discharges, resulting in an almost dead river by the 1930s (Dean Smith & Associates 1998). In the 1960s, the river was targeted for remediation and protection, and more recently, habitat and natural resources ecosystem restoration efforts have been undertaken. However, the river continues to suffer from poor water and sediment quality, diminished riparian zones, and reduced shallow water habitat areas. Despite best efforts, fish and wildlife populations, especially those protected under the ESA, have undergone dramatic declines.

3.1 National Objectives

Eecosystem restoration is one of the primary missions of the Corps' Civil Works program. Guidance document ER 1165-2-501 states:

"The purpose of the Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded...The intent of ecosystem restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system."

The Federal objectives for the ecosystem restoration mission differ slightly from other missions. Evaluation and comparison of ecosystem restoration alternatives necessitates both monetary and nonmonetary metrics. As such, the guidance in ER 1165-2-501 states:

"Consistent with the analytical framework established by the P&G, plans to address ecosystem restoration should be formulated and recommended, based on their monetary and non-monetary benefits. These measures do not need to exhibit net national economic development (NED) benefits and should be viewed on the basis of non-monetary outputs compatible with the P&G (Planning and Guidance) selection criteria."

The aquatic and riparian ecosystem restoration evaluated in the study is consistent with the Corps ecosystem restoration mission, as well as the Federal objective.

3.2 Problems and Opportunities

3.1.1 Problems

Numerous studies cited in this report have identified the limiting factors contributing to a lack of habitat for fish and wildlife in the Lower Willamette River and its tributaries. Key factors adversely affecting natural riverine functions in the mainstem of the river are:

- **Altered Hydrology** The marked reduction in peak flows from upstream dams and other water uses has altered the timing, size, and frequency of runoff and flood events that are critical for maintaining healthy riparian, floodplain, in-channel, and off-channel habitats.

- **<u>Loss of Habitat Complexity</u>** Dredging, channel straightening, and bank stabilization have all changed the main channel of the Willamette River from a multiple channel, structurally complex system dominated by shallow water areas to a deep, steep-banked channel with little diversity in structure or depth. Loss of channel complexity, woody material, and shallow water habitats adversely affect a wide range of fish and wildlife species. In many locations, invasive species have replaced diverse native plant communities, with a resulting decrease in ability to support a wide diversity of fish and wildlife species or species that are highly specialized.

- **<u>Loss or Degradation of Off-channel Habitats</u>** Extensive fill, development in the floodplain, and alterations in channel banks have destroyed or degraded floodplain and off-channel habitats by filling them or by reducing or eliminating the frequency with which floodplain habitats are inundated.

- **<u>Reduction in Nutrients and Woody Material</u>** As a result of the loss of riparian vegetation, stabilization of shorelines, and the development of the floodplain, the input of naturally derived nutrients and woody debris has been reduced. Reduced input of woody debris is detrimental to aquatic habitat quality as wood provides habitat diversity, cover, and sediment retention. There has also been a loss of nutrient input from salmonid carcasses, although this source of nutrient input would generally occur in the tributaries or higher in the Willamette River system where spawning grounds are found.

- **<u>Degraded Water Quality</u>** Water quality has been adversely affected by urbanization and agricultural land uses over the last 150 years. Industrial and non-industrial wastes, along with contaminants in agricultural and urban runoff have contributed to degraded water quality. Water temperatures have also increased due to impacts from major dams, reservoirs, and loss of riparian vegetation. Warming water temperatures have contributed to the decline of cold water fisheries (*i.e*., salmonids), while favoring non-native warm water species (*i.e*., northern pike, crappie, and bass).

- **<u>Contaminated Sediments</u>** Portland Harbor was added to EPA's National Priorities List of contaminated sites in December 2000 because river sediments are contaminated with metals, pesticides, polychlorinated biphenyls (PCBs), and petroleum products. Ecosystem restoration work proposed under this study will be coordinated with the Portland Harbor superfund site and comply with Corps guidance for Civil Works projects with hazardous, toxic, and radioactive wastes (*e.g.*, ER 1165-2-132).

Tributaries to the Lower Willamette River also have contributing factors that affect the health of the mainstem river. Problems within tributaries include:

- **<u>Changes in bank gradient and channel substrate</u>.** Due to development of the urbanized watersheds in which tributaries are found, the streams' hydrographs have been altered significantly. Stream velocities are high relative to original conditions, and water surface elevations increase and decrease far more rapidly than under undeveloped conditions. The altered hydrograph has led to channel incision in most tributaries, with corresponding steepened banks and coarser substrate.
- **<u>Excessive sediment deposition.</u>** Alterations of landforms and development of the watershed described above have altered sediment transport patterns, causing excessive erosion of the stream channel and banks, with consequent high sediment loads during high

flows. Excessive sediment loads are deposited where stream energy dissipates, often leading to excessive fine sediment in pools and glides.

- **A lack of species and structural diversity within all habitat types in too narrow riparian corridors.** Historic logging and development patterns have narrowed riparian areas and in many cases only a low ground layer and a canopy layer are found in the riparian zones, where several layers of structure would normally be expected. A fully functioning riparian zone would have mid-story layers to support neotropical migrant songbirds and contribute to deposition of materials into the stream.
- **Limited connection or linkage between riparian habitats and upland habitats.** Channel dredging, development in the riparian transition zone, and steepened bank angles have contributed to reduced linkage between upland and riparian habitats. Numerous species move regularly between riparian and upland areas as part of their lifecycle, a process that is interrupted when the linkage between these habitats is lost.
- **Disturbance due to the proximity of urban development, domestic animals, and recreational trails.** Development has encroached on the upland and riparian buffers surrounding tributaries to the Willamette River, leading to increased habitat disturbance from traffic noise, recreational users, dogs, feral cats, and other users. In addition to disturbance from noise and presence of humans and dogs, users accessing streams can also negatively affect bank stability or increase turbidity by entering the streams directly.
- **Presence of fish barriers.** Fish barriers in the form of perched culverts, utility pipelines, streets, and small dams limit fish passage in various tributaries. In many cases, the original design of these structures may have allowed fish passage, but geomorphological changes in the stream may have reduced direct connectivity to culverts or exposed buried pipelines.

3.2.1 Opportunities

While numerous problems have been identified, there are also many opportunities for ecosystem restoration to benefit fish and wildlife. Numerous sites within the Lower Willamette River watershed have been identified by the non-Federal sponsor and others as offering opportunities for implementation of ecosystem restoration measures that would make substantial, measurable improvements in watershed health and habitat quality. Given that numerous such projects are being implemented by the City of Portland, watershed groups, and other federal agencies, there is clearly public support for such projects.

Opportunities for habitat ecosystem restoration in the Lower Willamette River watershed include:

- Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows;
- Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and off-channel habitat;
- Improve access for fish and wildlife to existing habitat;
- Add complexity to diminished riverine and riparian habitats; and
- Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
- The metropolitan area is highly urbanized there are small unique areas available for restoration.

3.3 Goals and Objectives

Based on an assessment of the problems and opportunities along with the City-wide watershed framework and in consideration of Corps ecosystem restoration mission, a set of primary project goals and key objectives were established for the Lower Willamette feasibility study. These objectives are intended to be met over the 50-year planning horizon set for this study, which commences in 2017 and ends in 2066.

The overall goal of this project is to improve aquatic habitat structure and function. A fundamental component of meeting this goal is to reestablish, in measurable terms, the dynamic balance between the physical, chemical, and biological habitat components that formerly existed in the watershed. Although the watershed has been modified extensively and it is unlikely that the habitat that once existed can be fully restored, the functions that arise from the interplay of the habitat components can be restored. The objectives and actions that are proposed to achieve this goal are described below.

3.3.1 Reestablish Riparian and Wetland Plant Communities

The diversity and extent of native plant communities throughout the study area have been diminished through past and current land use practices including deforestation and development, and by competition from invasive plant species. Restored native plant communities will benefit wildlife by providing greater diversity of forage, cover, and breeding habitat; support a more diverse and stable food web; and benefit aquatic organisms by providing increased and more diverse nutrient input. Specific ecosystem restoration measures that have been developed to help accomplish this objective include:

- Remove invasive species and minimize disturbance of native habitats,
- Revegetate riparian zones and wetlands with an appropriate mix of native species, and
- Restore hydrologic aspects of each site to encourage survival of appropriate plant communities.

Measures of Success: Restore mix of understory and canopy species that reflect conditions in control locations (areas with relatively undisturbed habitat), and maintain at least 75 percent native species in restored areas.

3.3.2 Increase Aquatic and Riparian Habitat Complexity and Diversity

The study area wetlands, aquatic zones, and riparian areas support a variety of species that were once widespread throughout floodplain wetlands along the mainstem Willamette River and its tributaries. Active ecosystem restoration at these sites will return much of the complexity and diversity of wetland types, transitional zones, and plant communities that are needed to support a stable fish and wildlife community, including several listed species. Specific ecosystem restoration measures that have been developed to help accomplish this objective include:

- Restore streambeds by placing large wood for habitat diversity.
- Encourage or install communities of overhanging streamside vegetation to reduce solar gain, stabilize shorelines, and provide wildlife cover.
- Remove barriers to fish access to spawning and rearing areas.

Measures of Success: Improved habitat complexity as measured by habitat units.

3.3.3 Restore Floodplain Function and Connectivity

Reconnecting floodplains to the river will help to attenuate flows and contribute organic matter, substrate, and large wood to the stream system. Sloping back banks and creating side channels will allow for the development of a wider riparian zone, more shallow water habitat, and more natural formation of aquatic functions. Specific ecosystem restoration measures that have been developed to help accomplish this objective include:

- Slope steepened banks to a gentler angle to allow floodwaters to spread out and to provide shallow water habitat.
- Remove revetments and fill, and use bioengineering methods for bank stabilization where possible.
- Reconnect side channels and backwater wetlands to streams and rivers where possible.

Measures of Success: 2.9 stream miles reconnected to the Main stem Willamette River. This is some of the last opportunities in this highly developed study area.

3.4 **Planning Constraints**

Constraints and assumptions were identified early in the planning process to form the sideboards in which the alternatives would be developed. The general criteria below were considered as constraints when formulating the ecosystem restoration measures:

- **Infrastructure** Project features should not permanently affect the function of infrastructure such as drainage outlets, sewer lines, bike or hiking trails, roads, etc.

- **Aesthetics** Features should be designed to minimize negative impacts on aesthetics.

- **Hazardous, Toxic, and Radioactive Waste** Features cannot cause disturbance of hazardous, toxic, and radioactive waste (HTRW), and project planning must minimize and prevent federal liability under the CERCLA. Any ecosystem restoration measures implemented as part of this project should not negatively affect the Superfund site.

- **Flood Elevations/Damages** Project features must not increase flood elevations or the potential for flood damages.

- **Water Quality** Project features must not degrade water quality conditions.

- **Construction** periods in aquatic environments will be limited to in-water work windows that have been designated for each water body. The in-water work window for the Main stem Willamette is July 1 through October 31, Tryon Creek is July 15 through September 30, and Columbia Slough is Jun 15 through September 15.

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4. CHARACTERIZATION OF BASELINE CONDITIONS

The following sections provide descriptions of each resource area or existing condition. The information provided in this section provides an overview of conditions throughout the study area as the context for plan formulation.

4.1 Historic Conditions

The landscape of the Lower Willamette River Basin has been shaped primarily by events of the Pleistocene and Holocene periods, extending 2.5 million years into the past. This includes repeating glacial advance and retreat, and catastrophic flooding. Over time, the Lower Willamette River evolved into a braided, low gradient river with tidal influence.

Fur traders and trappers begin inhabiting the Lower Willamette River area in the early 1800s and Fort Vancouver was constructed in 1824. Farming began to develop in the area including a dairy on Sauvie Island to support Hudson's Bay Company employees and their families (Ellis *et al.* 2005). In the mid-1800s, the first Europeans settled in Portland because the site offered deep water moorage for sailing ships journeying up the Columbia River (PBPS 2001). Portland was platted in 1844-1845 and the floodplain was cleared for buildings and fields.

Figure 4-1. Swan Island in 1920

Historically, the lowlands adjacent to the Willamette River consisted of a series of ponds, lakes, sloughs, and wetlands, which were often prone to flooding (Figure 4-1). Seasonal flooding of the Willamette resulted in the development of flood control works by towns along the river by the late 1800s, including revetments and other bank treatments. In the 1930s, industrial, commercial, and agricultural interests had joined forces with local political leaders and the Corps to promote the Willamette Plan. The plan called for a system of dams on the Willamette and its major tributaries for flood control, irrigation, and power. Over the next 40 years dam construction changed the natural flow regime of the basin, eliminating both the flood waters of the winter and spring, and the low flows of the summer and fall (PBES 2006).

Most of the historic off-channel habitat (*i.e.*, side channels, oxbow lakes, and marshes) have long since been cut off from the channel and filled. The width and area of the river have both declined, as a result of diking and filling of shallow areas and navigational dredging. More importantly, in the lower reach of the river the amount of shallow areas (less than 20 feet) has declined by about 80 percent while the amount of deep water habitat (more than 20 feet) has increased by about 195 percent (Table 4-1).

In Table 4-1, changes to the amount of shallow water habitat in the Willamette River were determined by comparing original reference points and breaklines digitized and interpolated from U.S. Coast and Geodetic Survey, 1888, Columbia River chart (Fales Landing to Portland) and Corps

1895 surveys of the Upper Willamette to current information on bathymetry in the Willamette River from the City's Bureau of Environmental Services and Bureau of Planning.

Table 4-1. Summary of Changes in Lower Willamette River Habitats[1]

Measurement	Existing	1881	Change
Total Length (mi.)	18.6	19.0	-2%
Total Area (sq. ft.)	144,989,601	170,124,319	-15%
Total Shallow (sq. ft.)	27,386,401 (19%)	130,056,733 (76%)	-79%
Total Deep (sq. ft.)	117,603,200 (81%)	40,067,585 (24%)	194%
Average Width (ft.)	1,479	1,698	-13%
[1]From the mouth of Johnson Creek to the Columbia River. PBES 2006.			

4.2 Geology, Topography, Geomorphology and Soils

4.2.1 Geology

The geologic units found in the vicinity of the study area are described below, in chronological order of deposit (Beeson *et al.* 1991, Swanson *et al.* 1993).

The northern two-thirds of the Willamette Valley is underlain by Columbia River Basalt that flowed over southern Washington and northern Oregon during the Miocene era, between 16.5 and 12 million years ago. The Columbia River Basalt Group (CRBG) reaches the surface in many places in the Willamette Valley, and may form the bed of the river in some instances. The top of this unit is found to occur at greater depths as distance from the river increases (Beeson *et al.* 1991).

Sandy River Mudstone is a fine-grained equivalent of the lower Troutdale Formation that overlies the CRBG in the center of the basin and at the margins of the basin away from the axis of the Columbia River. The lower Troutdale Formation/Sandy River Mudstone is present in places under the Lower Willamette River (Swanson *et al.* 1993) and borders the Portland Hills, but is not considered a substantial hydrogeologic unit within the study area.

The upper Troutdale Formation in the vicinity of the Lower Willamette River includes cemented and uncemented alluvial sand, gravel, and cobbles deposited by the ancestral Willamette and Columbia Rivers. The Troutdale Formation comprises the Troutdale Gravel Aquifer hydrostratigraphic unit. This unit is present in some places on the west side of the study area to thicknesses of 100 feet and is present along the entire length of the east side of the study area at thicknesses of up to 200 feet (Swanson *et al.* 1993).

Human modification of the river and its surroundings has resulted in the placement of fill materials throughout much of the lowland. Dredged river sediment of fine and silty sands was used to fill portions of the floodplain in order to facilitate development. Doane Lake, Guild's Lake, Kittridge Lake, Mocks Bottom, Rivergate, and a number of sloughs and low-lying areas were completely or partially filled. Fill also was used to connect Swan Island to the east shore of the Willamette River, and to further elevate or extend much of the Willamette River banks along both sides of the riverfront. Rocks, gravel, sand, and silt also were used to fill low-lying upland and bank areas. The thickness of fill generally ranges from 0 to 20 feet, but may be much deeper. The permeability varies with the type of dredged or fill material. Where composed of clean dredge fill sand, permeability is higher than the natural fine-grained alluvium, but where silt or a silty matrix in the sand fill is present, permeability is reduced.

4.2.2 Topography

The Lower Willamette River watershed within the study area encompasses approximately 61 square miles. The west side of the Lower Willamette River watershed covers a drainage area of about 25 square miles and includes the steep-sided feature of the Tualatin Mountains (West Hills). The east side has a drainage area of approximately 36 square miles and has relatively flat topography except for volcanic features such as Mt. Tabor and Rocky Butte. Several tributaries join the Lower Willamette River, including Tryon Creek and the Columbia Slough, and most of the tributaries flow through pipes, culverts, or other flow modification features before they reach the river.

The west side of the Lower Willamette River watershed covers a drainage area of about 25.5 square miles and includes the steep-sided feature of the Tualatin Mountains. The land cover and use associated with the west side includes forested areas with rural residential and natural parks, as well as the urbanized Portland downtown. The east side has a drainage area of approximately 36 square miles and has relatively flat topography except for volcanic features such as Mt. Tabor and Rocky Butte.

Tryon Creek, with a watershed area of approximately 6.5 square miles, can be divided into approximately five separate reaches with varying geomorphic characteristics such as stream gradients and valley widths. Typical stream gradients range from 0.6 percent to 2.9 percent, with the exception of a short stretch of the Highway 43 culvert that is sloped at 5.94 percent.

The Columbia Slough has a watershed area of 51 square miles and flows through a relatively uniform topography, which gives a very gentle stream gradient of less than 1 percent.

4.2.3 Geomorphology

Riverine and floodplain morphology is developed by the natural processes of sediment erosion and deposition. Spatial and temporal patterns of erosion and deposition come from a combination of controlling factors: hydrologic regime, sediment and wood supply, and bed and bank erodability. River movement and fluvial landform and bedform development result from a combination of these controlling factors. Native species are adapted to, or dependent upon, an array of habitat types that are formed and reformed by the natural fluvial geomorphic regime of a river.

Human activities have changed riverine and floodplain habitats by altering the controlling factors. For example, dams have reduced peak flood flows which diminish a river’s capacity to erode, transport and deposit sediment; riprap hardens banks reducing sediment supply; and gravel mining also removes the sediment supply and changes the channel morphology. Disruptions to the natural hydrologic and sediment regimes change the rate and types of habitat forming processes.

Channel Bed and Sediment Transport The historical channel bed material characteristics of the Lower Willamette River are not known, but they were likely comprised of sand and fine-grained sediments along much of its length. The extensive changes in flow patterns, construction of dams, and extensive changes in channel structure and floodplain connection in both the Columbia and Willamette have likely had an effect on sediment transport and deposition through the lower river, but the data to verify or quantify these potential changes are lacking (PBES 2006).

Because the stretch of river encompassed in this study is a slow moving and tidally influenced, it is considered a deposition reach. This means that any coarse materials that erode and move through upstream stretches of the Willamette River system into the study area will mostly settle out in the study reach, with only fine sediments passing completely through the system. Evidence of this historic trend is found in the gravel islands that historically formed in the Lower Willamette, including Ross Island, located at river mile 15.

The processes by which any coarse materials erode and move through the Willamette River system and into the Lower Willamette have been compromised by bank armoring and construction of dams on tributaries to the Willamette. As an example, one of the main tributaries to the Willamette River, the North Santiam River, is sediment-starved downstream of a large dam that creates Detroit Lake, and a smaller re-regulating dam just downstream of Detroit Dam called Iron Cliff Dam. Because most coarse sediments settle out into Detroit Lake, spawning-sized gravel no longer enters the system in quantities great enough to sustain spawning beds or to perform other habitat-forming functions such as gravel bar formation. This trend affects channel bed formation throughout all parts of the system downstream of the dams.

Presently, the sediments throughout the Lower Willamette River vary from coarse sand in the upstream portions near its confluence with the Clackamas River to mainly sandy mud near the mouth where it joins the Columbia River. Sand, sandy mud, and muddy sand comprise the vast majority of the sediment types, accounting for over 80 percent of the sediment composition through the lower river (Hill and McLaren 2001). Bedrock comprises 10 percent of the bottom with the majority of the bedrock located between Willamette Falls and Portland (PBES 2006).

Channel Form The Lower Willamette River is currently a single-thread river channel with low gradients, and limited lateral changes. The extensive braiding, islands, and sloughs of the historic delta are mostly gone. The lower reach of the Willamette River has remained relatively constant geomorphically over the last 150 years (Hulse *et al.* 2002). However, current and past human activities in the study area have altered the geomorphic processes. The riverbanks of the mainstem Willamette in the project area are mostly non-natural: rip rap, structures, unclassified fill, and sea walls which comprise approximately 72 percent of the existing bank. Twenty-six percent consist of natural and river beach banks. Bio-technical and bio-engineered banks constitute only two percent of existing bank types (PBPS 2001).

There are a number of tributaries that join the Willamette at near the confluence of the Columbia River. The largest of these by far is the Columbia Slough, a 19-mile waterway with a 32,700 acre watershed. The watershed was originally a large series of wetlands, lakes and channels which formed the floodplain of the Columbia mainstem and the Willamette Mouth. Although the slough has undergone extensive structural alterations, historic records indicate that a channel existed in the approximate location of the present confluence with the Willamette (PBES 2006).

Additional data regarding geomorphology of the specific ecosystem restoration areas is given in the geomorphology appendix (Appendix A).

4.2.4 Soils

Five soil types are found within the study area.

Pilchuck-Urban Land Complex, 0-3 Percent Slopes Pilchuck-Urban Land Complex, 0 to 3 percent slopes (33A), soils consist of excessively drained soil on floodplains of the Columbia and Willamette Rivers, formed in sandy alluvium or sandy dredge spoils (Farrelly 2008).

Sauvie-Rafton-Urban Land Complex, 0-3 Percent Slopes This soil type consists of very deep, poorly drained Sauvie soils and very poorly drained Rafton soils (Farrelly 2008).

Sauvie Silt Loam These soils are found on floodplains along the lower Columbia River and its tributaries. The soils formed in recent alluvium with some mixing with volcanic ash (USDA 2013).

Laurelwood Silt Loam, 15-30 Percent Slope This soil consists of very deep, well drained soils with slow to rapid runoff and moderate permeability. Laurelwood soils are on hills with long, convex, slopes that are gently sloping to very steep and have gradients of 3 to 60 percent and elevations of 200 to 1,600 feet (National Cooperative Soil Survey 2006)

Xerochrepts and Haploxerolls, Very Steep This soil type complex consists of deep, well drained soils with moderate to moderately slow permeability. Slopes range from 20 to 60 percent. These soils formed in colluvium derived from igneous rock and occur on terrace escarpments. Xerochrepts and Haploxerolls are used for timber production, wildlife habitat, and home sites (USDA 2013).

4.2.5 Future Without Project Conditions

Soils in the floodplain will likely degrade due to erosion from natural and human forces, and will not be replaced to the degree that they would under an un-regulated system that would inundate floodplains annually. This will lead to soil degradation over time. No substantial changes to geological layers or topography are anticipated to occur during the planning horizon. Soils will continue to degrade naturally through erosion and as a result of human modifications within the project area. No substantial changes to geological layers or topography are anticipated to occur in the future.

Sediment transport processes will continue to be interrupted as a result of upstream revetments and dams. This will continue the trend of allowing less coarse sediment to move through the system, with one result being that sediments transported into the study area will continue to be comprised of a higher percentage of fines than of coarse sediments. Formation of gravel bars and islands in the Lower Willamette, which occurred under conditions previous to regulation of the Willamette River system, will likely be very minimal.

4.3 **Water Resources**

4.3.1 Hydrology

The study area is located within U.S. Geological Survey (USGS) Hydrologic Units 1709007, 17090011, and 17090012. Detailed hydrology by reach is provided below. Watershed boundaries are shown in Figure 4-2, below.

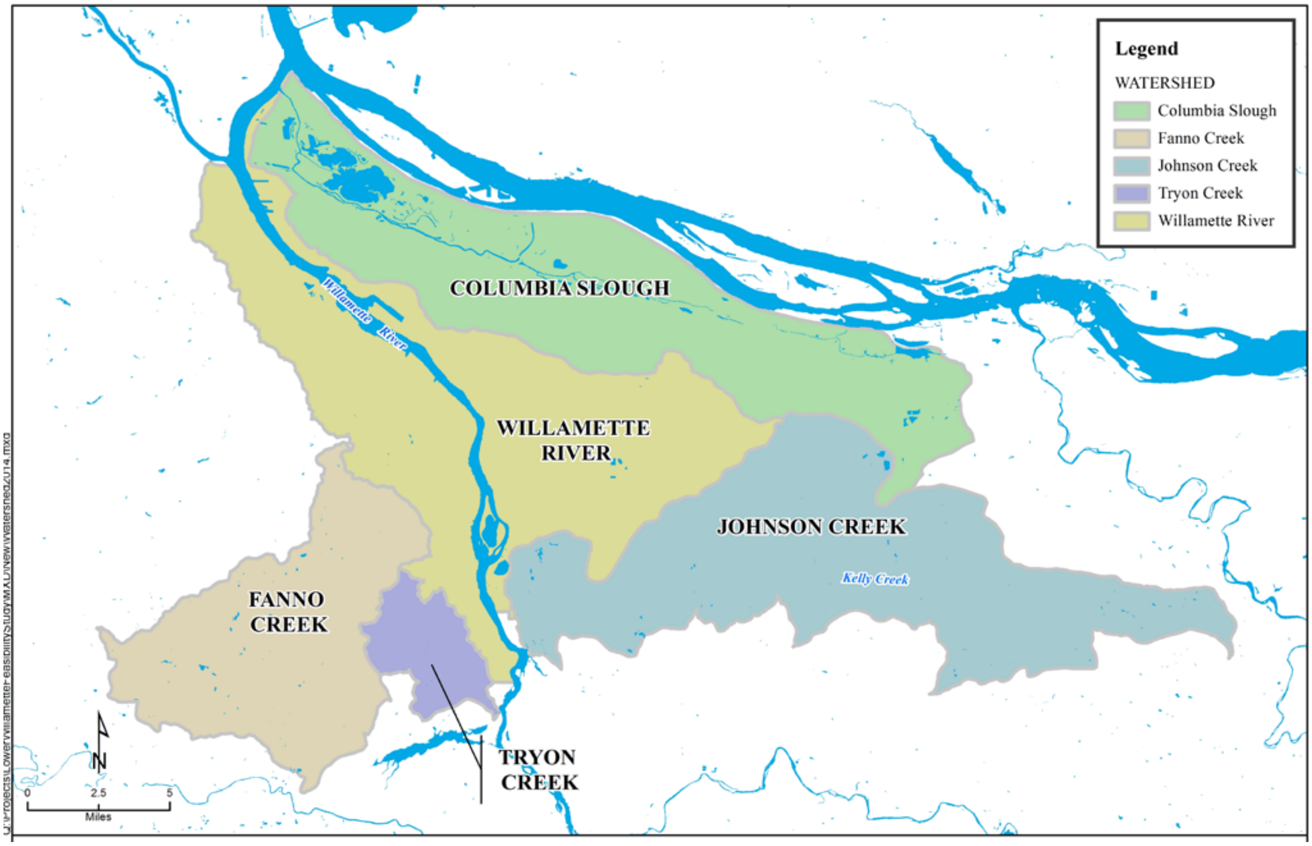

Figure 4-2. Watershed Boundaries in the Project Area

Lower Willamette River

Hydrology in both study reaches of the Lower Willamette River is driven by upstream reservoir regulation of the Willamette and Columbia Rivers, natural stream flows, climatic patterns, and tidal effects. The degree to which these variables affect hydrologic conditions in the watershed varies by season and the nature and magnitude of storm events (USACE 2004). Nearly all precipitation within the area of interest (AOI) falls as rain, although a few isolated snow events can occur. Average annual precipitation is 40 to 45 inches. Approximately 95 percent of annual precipitation occurs from October through June and the remaining 5 percent occurs from July through September.

The average annual daily discharge recorded at USGS Gage No. 14211720, Willamette River at Portland (Morrison Bridge) from 1973 to 2011 is 33,160 cubic feet per second (cfs). A maximum discharge of 420,000 cfs was recorded on February 9, 1996, and a minimum discharge of 4,200 cfs was recorded on July 10, 1978 (USGS 2012a). Peak flows after heavy rains can range from 200,000 to 400,000 cfs (Hulse *et al.* 2002).

Hydrologic processes in the Lower Willamette River have changed in response to construction of dams, irrigation diversions, and dredging for navigation. Winter flood flows have been reduced and summer low flows have increased (PBES 2004). Wetland losses, diking and bank hardening, vegetation removal, impervious surfaces and regional changes in hydrology have altered the temporal and spatial patterns of groundwater inflows and in general reduced levels of groundwater input, although there is little quantitative information to assess the specific nature of these changes.

There are dozens of federal, local, utility, private, and state dams and reservoirs in the greater Willamette River Basin with a collective storage capacity of over 2.7 million acre-feet (Hulse *et al.* 2002). Most notable of the federal projects is the Willamette River Basin Project, which consists of 13 dams built by the Corps beginning in the 1960s, in addition to various bank protection structures for flood control and hydropower production (Willamette Ecosystem Restoration Initiative 2004).

The Lower Willamette River is a tidally influenced freshwater estuary that is influenced by Pacific Ocean tidal fluctuations transmitted upstream in the Columbia River. When the water surface level of the Columbia River exceeds that of the Lower Willamette River, water from the Columbia River enters the Willamette River and the net flow direction of the Willamette River is negative (upstream). This condition occurs when Portland Harbor stages are less than 12 feet National Geodetic Vertical Datum of 1929 (NGVD 29) and is most pronounced when harbor stages are less than 5 feet NGVD29; the latter stages commonly occur in late summer and early fall (USACE 2009). Tidal influences in the Lower Willamette River extending to the Morrison Bridge typically fluctuate between 0 to 3 feet mimicking the mixed semi-diurnal ocean tide patterns (two unequal high tides and two unequal low tides daily) (Limno-Tech 1997).

The extent of impervious surfaces is an important consideration, since it may extensively alter the hydrology of a river system. Paved roads, driveways and parking lots prevent rainfall from seeping into the soil and moving subsurface toward streams and rivers. Instead, stormwater is conveyed rapidly and at much higher volume, impacting the natural flow and altering physical and biological conditions. Within the Lower Willamette River watershed, intensive urbanization has resulted in a high percent of impervious surfaces. However, the impact of impervious surfaces on the hydrology of the Lower Willamette River is muted by the more substantial influence of the upstream dams, large river volume and tides. The tributaries of the Willamette River are more affected by impervious surfaces.

Johnson Creek

The Johnson Creek Watershed varies from heavily developed urban areas in the lower and middle reaches (Milwaukie, Portland and Gresham) to rural and agricultural areas in the upper watershed. The area north of the Johnson Creek mainstem is mostly flat, with large floodplain areas, particularly in Lents. These floodplains are thought to be a remnant of large glacial floods that occurred about 15,000 years ago. Johnson Creek floods on average every other year. It is one of the last free-flowing streams in the Portland area and provides important habitat for coho and Chinook salmon, steelhead and cutthroat trout. During the last 200 years, people have altered the Johnson Creek watershed in an attempt to reduce flood impacts and to make it easier to develop the land near the creek. In the 1930's the Works Progress Administration (WPA) widened, deepened and rock-lined 15 miles of Johnson Creek in an effort to prevent future flooding. Despite that effort, Johnson Creek has flooded 39 times in the last 60 years. Current efforts to restore Johnson Creek focus on restoring its natural resource functions. This type of restoration provides flood storage, water quality benefits, and increases fish and wildlife habitat by returning some of the natural historic conditions and functions to the watershed. Johnson Creek provides important habitat for coho and Chinook salmon, steelhead and cutthroat trout. While these species still exist in Johnson Creek and its tributaries, their long-term survival depends on our ability to restore habitat and improve water quality (PBES 2005b).

Fanno Creek

Fanno Creek was eliminated from the study based on size, potential opportunities, multiple municipal jurisdictions, private land holdings and not entirely within the boundaries governed by the City of Portland.

Tryon Creek

The historic hydrology of Tryon Creek is typical of a low to moderate gradient Willamette River Valley stream, with steep landscape slopes that have been modified by the effects of development and urbanization. The annual hydrograph for Tryon Creek reflects local precipitation patterns, with high flows and frequent storm flow events during the wet period from approximately October through May, followed by low flows during the summer dry period (June through September) (PBES 2005b).

Tryon Creek hydrology has been altered due to the increase in impervious surfaces throughout the watershed. Although there are no quantified historic data to compare to, it can be inferred from similar streams in the Pacific Northwest that the climatic precipitation pattern has not changed. Instead, daily and monthly stream flow events and volumes likely have changed due to land development. Extensive urbanization has created an estimated 23% coverage of impervious surfaces throughout the Tryon Creek watershed (Rhodes 2002, PBES 2005b). However, total impervious area is likely higher than 25%, if including smaller features such as driveways and sidewalks. Further, “effective” impervious area is still higher, because areas converted to lawns or where forest cover have been removed also increase runoff, acting as less permeable areas that contribute to the total “effective impervious area” (Rhodes 2002). An impervious surface results in a rapid delivery of stormwater from watershed to creek; in turn resulting in a hydrograph that rises steeply during rain events, creating a “flashy” system. Sudden high water flows mean increased chances of flooding, unnatural erosion and changes to creek morphology, adverse effects to native fish and wildlife, and increased input of pollutants into the system from unfiltered stormwater runoff.

The average annual daily discharge recorded at USGS Gage No. 14211315 (Tryon Creek near Lake Oswego) for years 2002 to 2011 is 8.7 cfs. A maximum discharge of 1,210 cfs was recorded on December 9, 2010, and a minimum discharge of 0.09 cfs was recorded on September 4, 5, and 12, 2002 (USGS 2012b). Figure 4-3 is a hydrograph that displays median mean daily discharge rates for Tryon Creek for a 10-year period starting in 2002.

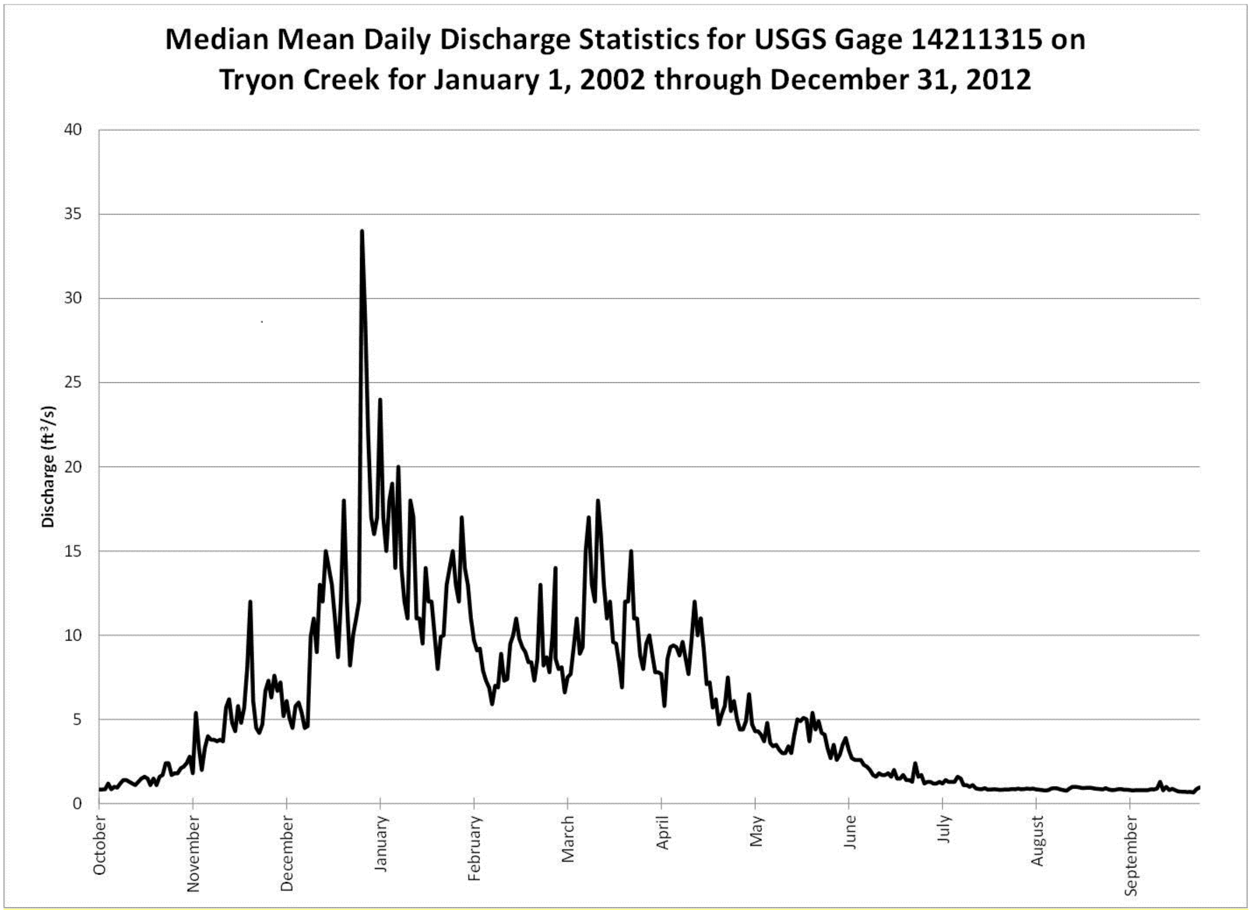

Figure 4-3. Median Mean Daily Discharge Statistics

Columbia Slough

Hydrology within the Columbia Slough watershed has also changed from historic conditions. Levee construction; filling of lakes and wetland complexes with dredge materials; draining of wetlands and other adjacent low-lying areas; and heavy industrial, commercial, residential, and agricultural development have all occurred within and around the slough (PBES 2005d).

Again, a high percentage of impervious surfaces occur within the area. A 1999 study estimated that 54 percent of the Columbia Slough watershed consists of paved surfaces (Evonuk 1999). The impacts to hydrology include a disconnection of the slough from its floodplain and a much reduced connection to the Columbia River (only seasonal). Impervious surfaces have also contributed to diminished water quality in the slough.

Average annual daily discharge and stage (water elevation) have been recorded at USGS Gage No. 14211820 (Columbia Slough at Portland) for years 1990 to 2015, although these data have not been recorded continuously. A maximum water elevation of 27.26 was observed on February 9, 1996 (USGS 2015), which corresponds to record flooding.

4.3.2 Oregon Water Quality Index

The EPA delegated authority to the Oregon Department of Environmental Quality (ODEQ) to implement the federal Clean Water Act (CWA) and parts of the federal Safe Drinking Water Act in Oregon. Per this authority, ODEQ maintains the Oregon Water Quality Index (WQI), which sets the limits of pollution in waters of Oregon, and maintains hundreds of water quality sampling sites to monitor regulated pollutants. Water quality is generally degraded in the baseline.

The WQI analyzes a set of water quality parameters and produces a score describing general water quality. Those parameters include temperature, dissolved oxygen, biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorous, and fecal coliform. Index scores range from 0-100. Scores of less than 60 are considered indicative of very poor water quality, 60-79 are poor, 80-84 are fair, 85-89 are good, and 90-100 are excellent (ODEQ 2009).

Among the many water quality monitoring sites, four have been selected as representative of water quality conditions within the mainstem Willamette River and Columbia Slough. Three sites are within the mainstem of the Willamette River, including the Swan Island Channel midpoint (RM 0.5), Southern Pacific Railroad Bridge (RM 7.0), and the Hawthorne Bridge (RM 13.2). A fourth site is located on the Columbia Slough at Landfill Road (RM 2.6). The latest Ambient Water Quality Index Results (ODEQ 2010) scores and tracks trends for each of these sites using data collected between 2001 and 2010 (Table 4-2).

Table 4-2. Ambient Water Quality Index Results

Station	**RM**	**Station Number**	**1986-1995 WQI**	**2001-2010 WQI**	**2001-2010 Description**
Willamette R. @ Swan Island Channel	0.5	10801	63	77	Poor
Columbia Slough @ Landfill Rd.	2.6	11201	22	45	Very Poor
Willamette R. @ SP&S RR Br.	7.0	10332	74	83	Fair
Willamette R. @ Hawthorne Br.	13.2	10611	74	84	Fair
Source: ODEQ 2010					

Results from 2001 to 2010 show that water quality ranges from fair to very poor in the project area, generally decreasing downstream. However, when compared to the period from 1986 to 1995, water quality has improved (Table 4-2). The greatest increases have occurred where sites had the most room for improvement (ODEQ 2010), and in some cases the changes have been substantial enough to reclassify the indices into the next higher category (ODEQ 2010). This improvement is the direct result of the actions taken by a variety of government and local agencies responsible for water quality. The watershed approach presented in the *Portland Watershed Management Plan*, guides activities of all City of Portland bureaus and programs that affect watershed health. Specific measures taken include those by the ODEQ, which has worked to establish a total of 10 Total Maximum Daily Loads (TMDLs) for the watershed that specify pollutant loading limits and require pollution reduction programs for pollutant sources.

In addition, the City of Portland has recently completed a complete retrofit of their combined sewer outfalls (CSOs), reducing sewage and other stormwater pollutants entering the rivers by 99.6 percent. The City has also invested in aggressive revegetation efforts, naturescaping to create catchment basins that filter water, and citywide public outreach and education. The Multnomah Country Drainage District partnered with the Corps to complete an 1135 project, restoring fish and wildlife habitat along the Columbia Slough. The Port of Portland (Port) has worked with ODEQ to reduce pollution entering the slough as a result of de-icing at the Portland Airport. Each of these agencies has worked together and along with local groups, such as the Columbia Slough and Fairview Creek Watershed Councils, to protect and improve water quality. Although these efforts are not necessarily coordinated, they are all being performed to address and reduce the various causes of compromised water quality in the Lower Willamette River watershed.

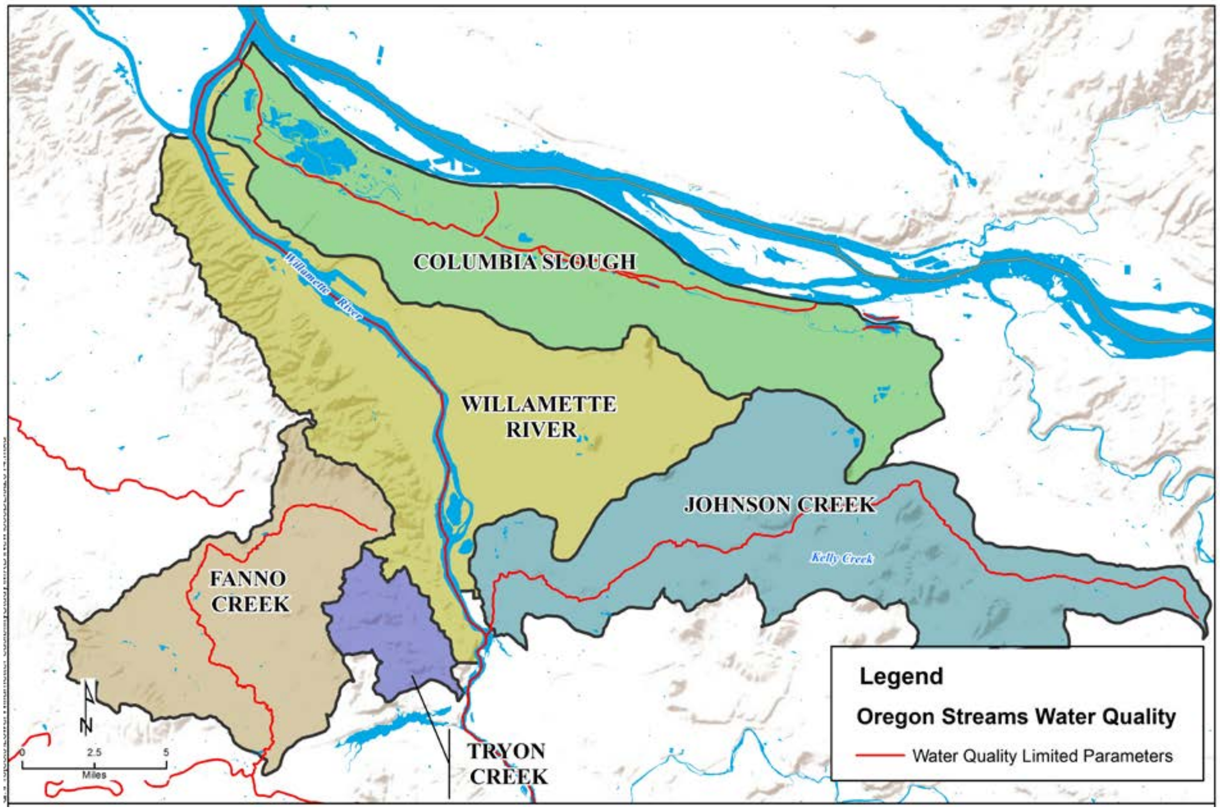

Figure 4-4. 303(d) Listed Waterbodies

There are a number of pollutants of concern in the study area. Heavy metals (including copper, lead, and zinc) have attracted long-standing attention with regard to potential effects on salmonids and other fish. Of these, copper is the most toxic to salmonids as it causes reduced growth and survival rates and altered blood chemistry, respiration, and physiology plus reproductive effects. Researchers at the NOAA Northwest Fisheries Science Center have recommended a salmonid effect threshold for dissolved copper found in stormwater effluent of 5 micrograms per liter (μg/L) (N. Scholz, NOAA, pers. comm. with M. Reed, City of Portland, February 7, 2006). Sampling performed by the City in 2005-2006 found that pollutants were below threshold values in all but one sample (PBES 2006).

Table 4-3. Approved TMDLs within Proposed Study Area

Waterbody Segment	RM	Parameter	Season
Willamette River (1991)	0 to 187	Dioxin	Annual
Columbia Slough (1998)	Entire Length	Bacteria	Annual
		pH	Spring – Fall
		Dissolved Oxygen	Annual
		Nutrients	Spring – Fall
		Phosphorous	Spring – Fall
		Temperature	Spring – Fall
		Lead	Annual
		DDE, DDT	Annual
		PCBs	Annual
		Dioxin	Annual
Willamette River (2006)	0 to 24.8	Fecal Coliform	Fall – Spring
	0 to 24.8	Mercury	Annual
	0 to 24.8	Temperature	Summer
	24.8 to 54.8	Fecal Coliform	Fall – Spring
	24.8 to 54.8	Mercury	Annual
	24.8 to 54.8	Temperature	Summer
Tryon Creek (2006)	0 to 5	Temperature	Summer

Source: ODEQ 2006
Note: DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane; PCBs = polychlorinated biphenyls

4.3.3 Stormwater

In addition to measurable water quality parameters, there are other considerations important to water quality in the Lower Willamette River and its tributaries within the study area. These include discharge of industrial wastewater under the National Pollutant Discharge Elimination System (NPDES), discharges identified through the City's Illicit Discharge Elimination Program (IDEP), combined sewer overflows, stormwater discharges, and stormwater sumps, also known as underground injection control wells (PBES 2006b).

Stormwater from streets and developed areas is difficult to manage because it comes from countless diffuse sources. It is also called non-point source pollution. In addition to direct discharges to waterways, stormwater is managed through a system of more than 9,000 sumps and test wells located in many parts of Portland's Willamette watershed. Protecting and improving the quality of stormwater entering sumps helps protect groundwater, which often returns to local waterways.

Portland Bureau of Environmental Services owns and operates more than 2,200 miles of pipes and 93 pump stations that transport sewage to two treatment plants and has the responsibility of coordinating the City's actions to reduce stormwater pollution as required for a federal stormwater permit issued by ODEQ. This permit is directed under the federal CWA and is formally titled the Phase I NPDES Municipal Separate Storm Sewer System (MS4) Permit. The only stormwater or sewage structure identified as occurring at the ecosystem restoration sites in this study is a sewage pipeline that runs parallel to the Highway 43 Tryon Creek culvert.

The City of Portland completed a 20-year Combined Sewer Overflow (CSO) Control Program in December 2011. The program reduced CSOs to the Columbia Slough by more than 99% and to the Willamette River by 94%. Instead of an average of 50 Willamette River CSO events each year, there are now an average of four CSO events each winter and one event every third summer during only very heavy rain storms. The city met all of its required CSO program milestones on. The City completed Columbia Slough CSO projects in 2000. They included the Columbia Slough Big Pipe, a 3.5-mile long, six and 12-foot diameter pipeline to collect combined sewage and transport it to the Columbia Boulevard Wastewater Treatment Plant. The City expanded plant capacity to accommodate the extra flow. The slough projects controlled 13 CSO outfalls and reduced CSOs to the slough by 99%.

- The City completed the West Side Big Pipe *a*nd the Swan Island CSO Pump Station in 2006 to control 16 CSO outfalls on the west side of the Willamette River. The 3.5-mile, 14-foot diameter tunnel carries combined sewage to Swan Island and the CSO pump station pumps it to the Columbia Boulevard Wastewater Treatment Plant.
- Also in 2006, the City began construction of the East Side Big Pipe, a six-mile long, 22-foot diameter tunnel to collect sewage from the east side of the Willamette. The city completed tunneling in October 2010 and completed connecting combined sewers to the east side tunnel in September 2011 to control the 19 remaining Willamette River CSO outfalls.

The City of Portland has invested millions of dollars to improve the CSO into the Willamette River.

4.3.4 Navigation

The Willamette River is navigable 132 miles upstream from its mouth. Navigation facilities in the basin include the Willamette Falls Locks (now closed to navigation due to the degraded condition of the infrastructure) and the Navigation Channel (Portland Harbor) in the lower basin. Farther upstream, the Willamette River carries shallow-draft river traffic. Water stored in reservoirs upstream can be released to maintain navigation depth in the downstream reaches.

The Lower Willamette River is used for navigation by pleasure craft, small fishing boats, local drayage companies, barges hauling wheat, gravel, and other materials into Portland Inner Harbor, and by ocean-going cargo ships. Although most heavy cargo ships use the Port of Portland facilities located on the Columbia River upstream of the confluence with the Willamette River, between 30-45 grain ships navigate to grain silos located just downstream of the Broadway Bridge each year. Three terminals, including T-2, T-4, and T-5 are located on the Willamette River.

The Lower Willamette River is dredged periodically between its confluence with the Columbia River (river mile 0) and the Broadway Bridge, located at river mile 11.6, which is the extent of the federal navigation channel, maintained by the Corps. The Corps maintains depths of 42 feet in the shipping channel, which at 600 feet wide is intended to allow 2-way shipping traffic. Dredging operations last occurred in 2011, when 50,000 cubic yards of materials were dredged and taken to the dredge material placement facility at West Hayden Island, located on the Columbia River at river mile 105 (Port of Portland 2014). This site was selected because it is authorized to accept materials dredged from the Portland Harbor Superfund site. Materials dredged from the Superfund site are not used for habitat features at ecosystem restoration sites, as they would need to be extensively sampled before they could be approved for use in habitat areas. Any sand or gravel needed for habitat features in the study area is imported from upstream of the Superfund site, or brought in from outside of the area.

4.3.5 Future Without Project Conditions

Continued development in the watershed and operation of dams in the Willamette River Basin will affect hydrology as described above into the future. However, the City and a host of other municipal, regional, state, and tribal agencies, as well as conservation organizations (*e.g.*, Willamette Partnership, The Nature Conservancy) have been working to reduce, restrict, and/or mitigate stormwater and hydrologic effects within the Lower Willamette and greater Willamette and Columbia River watersheds.

The City has prioritized implementation of green stormwater infrastructure (GSI), riparian and aquatic ecosystem restoration, and CSO control projects in order to address hydrologic and other watershed-health issues. The City's Grey to Green initiative, a 5-year, $55 million program, is aimed at constructing vegetated "ecoroofs" and green streets, acquiring and protecting sensitive natural areas, planting trees and controlling invasive plants, and replacing culverts that block fish passage (PBES 2012b). Within the Tryon Creek watershed there are more than 15 stormwater management projects ongoing (PBES 2012c). While continued dam and reservoir operation within the greater Willamette and Columbia River Basins will ultimately still regulate flows, comprehensive ecosystem restoration efforts planned and already implemented throughout the river network will help restore some hydrologic processes.

The potential effects of climate change may include sea level rise, which would affect tidal processes within the Columbia and Lower Willamette Rivers. The average sea-level rise prediction based on numerical modeling by the International Panel on Climate Change and adjusted by the Climate Impacts Group range is approximately 11 inches for the northern Oregon/southern Washington Pacific Ocean coasts by the year 2100 (Mote *et al.* 2008). The Corps's Sea Level Change Curve Calculator (USACE 2014) presents sea level rise estimates corresponding to 3 different scenarios: low, intermediate, and high. Under the low rise scenario, and assuming project construction is completed in 2020, sea levels at the NOAAs Astoria, OR gauge (Gauge 9439040) would decrease by 0.05 feet relative to NAVD88 by 2070; would increase by 0.42 feet NAVD88 by 2070 under the intermediate scenario; and increase by 1.92 feet NAVD88 by 2070 under the high scenario.

4.4 Biological Resources

Four segments of the Lower Willamette River were described in the Willamette River Inventory (Adolfson Associates 2000). Two of those are key to this study, including the North and South Segments. The North Segment begins at the confluence of the Columbia and Willamette Rivers and extends upstream (south) 8 miles to the Saltzman Creek confluence (RMs 0 to 8). The North Segment provides diverse and extensive habitat types as a result of its location at the juncture of two major river systems (PBES 2006b). Habitat types present in the segment include bottomland forest, scrub/shrub, and grassland. Within this reach, seven areas were identified that provide extensive high quality habitat in the North Segment including: the Willamette River Confluence, Kelley Point Park, Terminal 5 Riparian Forest, South Rivergate Corridor, Harborton Forest and Wetland, Edison Street Forest, and Willamette River-Linnton (Adolfson Associates 2000).

The Willamette River Inventory identified the important wildlife linkages provided by this segment that offer wintering and breeding habitat for waterfowl, shorebirds, and neotropical migrants along the Pacific Flyway. The presence of waterfowl and shorebirds including sandhill cranes (*Grus* *canadensis*) in this tidally influenced North Segment is unique to the study area. Bottomland forests and wetlands in places like Kelley Point Park, Sauvie Island, and Smith and Bybee Lakes offer wintering and/or breeding habitat for waterfowl, shorebirds, and neotropical migrants. Kelley Point Park and Smith and Bybee Lakes provide critical breeding and nesting habitat for declining populations of neotropical birds. The travel corridors along Columbia Slough are important for dispersion of mammalian species such as deer, coyote, fox, and beaver, as well as reptilian species (Adolfson Associates 2000).

The South Segment extends from the Ross Island Bridge to the Urban Services Boundary south of the Sellwood Bridge (RMs 14 to 16.5). Within the South Segment major habitat areas include Oaks Crossing, the River View Cemetery, Ross Island, and Oaks Bottom complexes. This segment provides one of the largest contiguous stretches of riparian forest in the Lower Willamette watershed, found on the east bank south of the Sellwood Bridge, and also contains a large, off-channel wetland complex at Oaks Bottom. On the right bank, a relatively narrow stretch of riparian forest is found between the ordinary high water (OHW) mark and Highway 43. These sites are frequent stopover and forage sites for many wildlife species (Aldolfson Associates 2000). Along the banks of the river, many large and small holes above the ordinary high water mark indicate the utilization of the shoreline by common river birds and mammals.

General vegetation types in the south and north segments of the study area are shown in Figures 4.5 and 4.6.

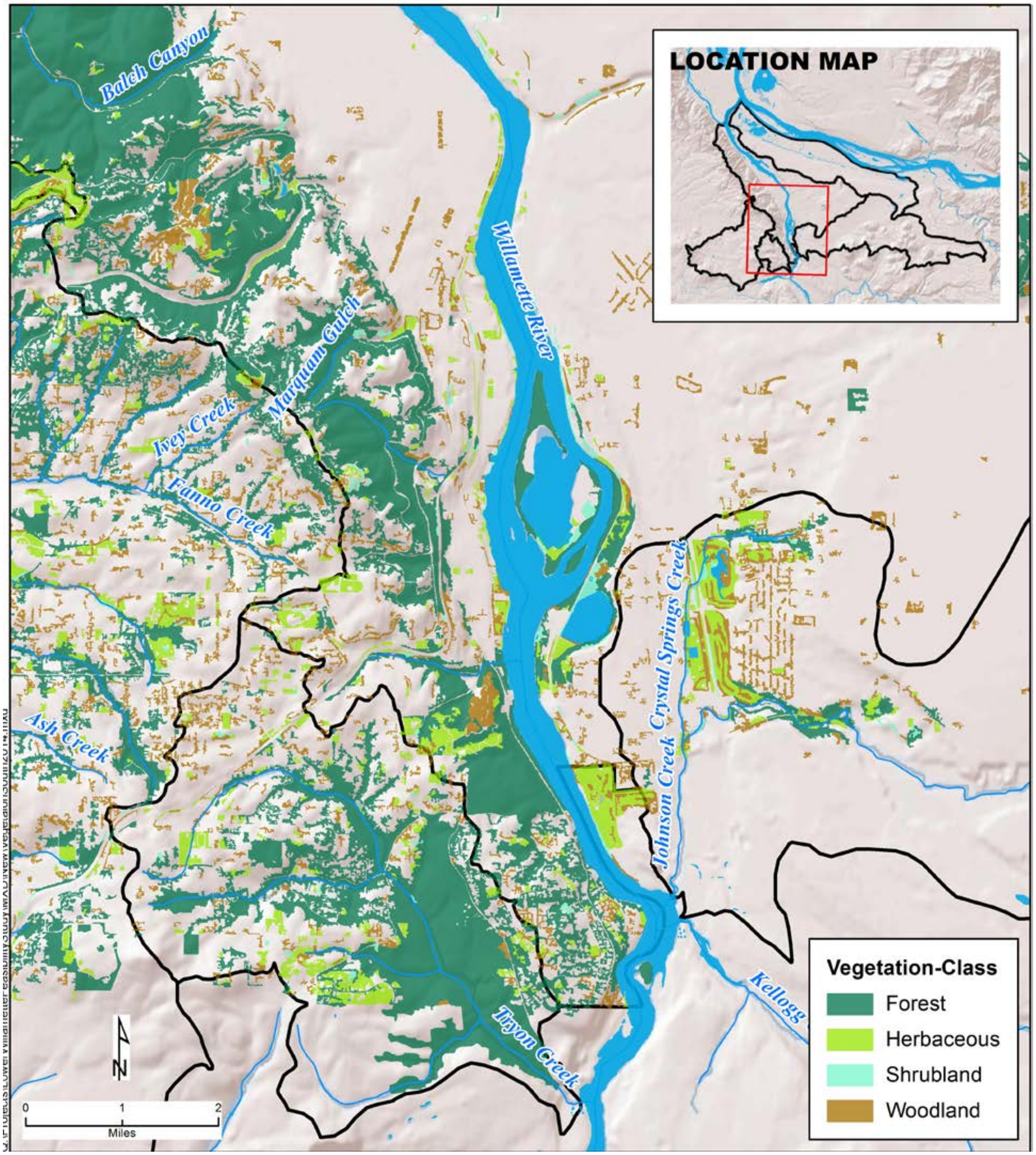

Figure 4-5. Vegetation Types, South Segment of Study Area

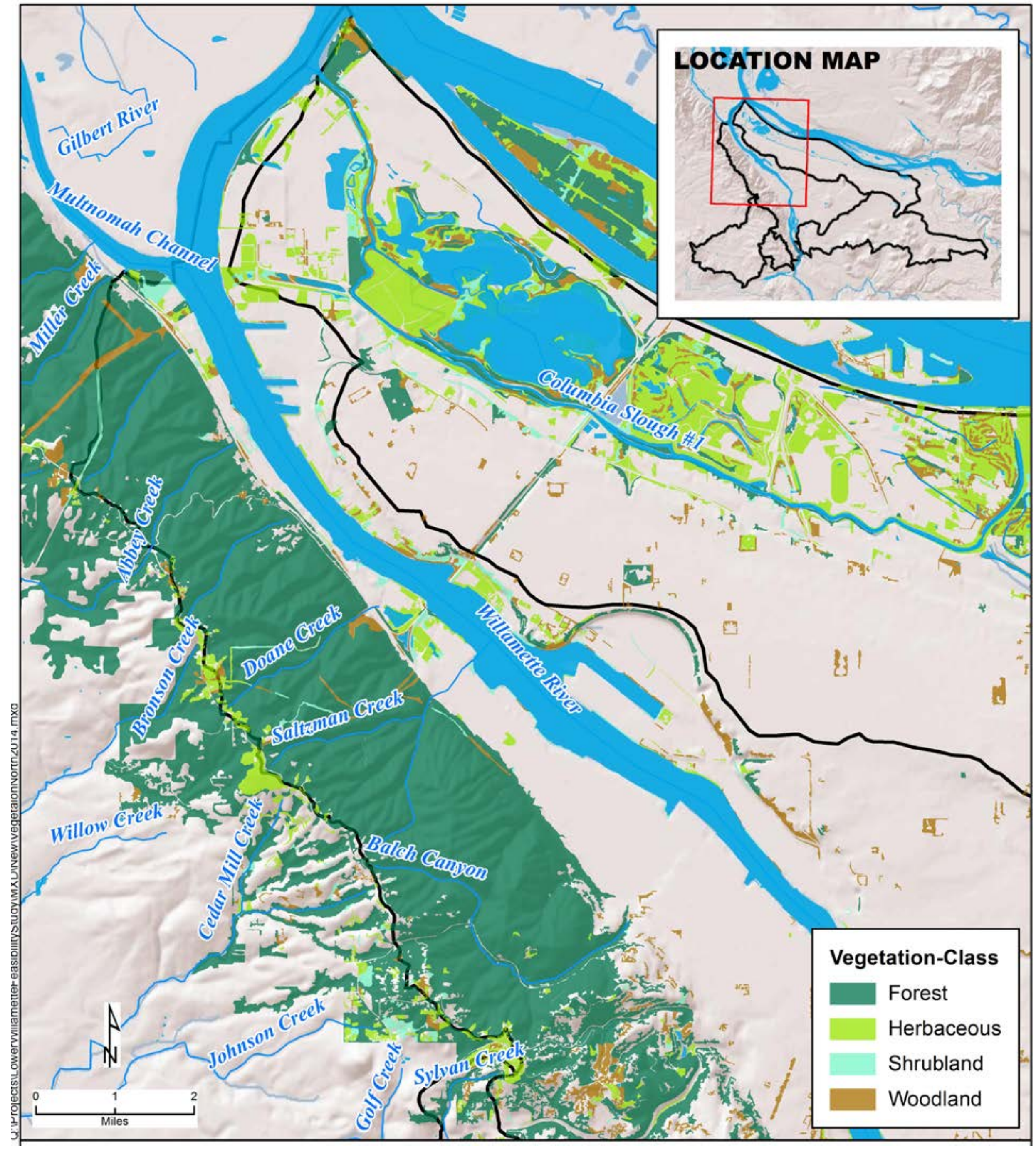

Figure 4-6. Vegetation Types, North Segment of Study Area

4.4.1 Aquatic Habitat

The draft Willamette Subbasin Plan and corresponding analysis identified key limiting factors in the Lower Willamette River subbasin, including a lack of habitat diversity and quantity, and chemical pollutants (NPCC 2004).

Quality habitat for salmonids and other native fish species is limited in the Lower Willamette River. Key habitat types and features such as off-channel habitat, shallow water habitat, channel and bank complexity and large woody debris are insufficient to support the migratory and rearing life stages of the focal species, including numerous Federal and state listed species. Spawning habitat for coho and steelhead exists in Tryon Creek and other tributaries to the Lower Willamette, but often times, as in Tryon Creek, access to this habitat is partially blocked by barriers. Rearing habitat is found in Columbia Slough and the mainstem Willamette River. Changed flow regimes and water temperature patterns have altered the availability and quality of off-channel habitat including backwater sloughs, floodplain ponds, and other slow-moving side-channel habitat. Overall, native species that are adapted to a fast moving river of cooler temperatures have declined in the warmer, slower moving river (ODFW 2001, 2002; Farr and Ward 1993).

4.4.2 Wetlands and Riparian Zones

Wetland plant communities differ between the various sites depending on their location relative to the river. Riparian wetland plant communities are found at Kelley Point Park and Oaks Crossing, and are dominated by black cottonwood and Oregon ash. Fringing wetlands are generally found at or near the mean higher high water line in the riverine areas, and are dominated by small willows, sedges and rushes, with occasional patches of cattails or bulrush where shallow water predominates. Off-channel wetlands occur where water ponds from runoff or where there is a high water table, for example in the off-channel swale at the BES Plant site. Such wetlands are dominated by spikerush and reed canarygrass. Reed canarygrass, a widespread invasive weed, is found at most sites from just above the waterline to the uplands.

The riparian plant community surrounding and upstream of the Tryon Creek Highway 43 is typical for floodplains of small streams, and is dominated by alders, black cottonwood, and Oregon ash. The understory is dominated by sword fern, salal, and other species that can thrive in areas with low amounts of direct sunlight. Wetlands exist in all of Portland’s watersheds and contribute an invaluable function to the general health of the environment in the area. Wetlands serve important functions including intercepting and storing surface runoff and groundwater, and containing floodwaters. By moderating stream flows, wetlands can reduce bank erosion (City of Portland 2010). They also store and filter sediments, cycle nutrients, decompose organic waste and prevent heavy metals from entering streams. Evaporation from wetlands contributes to maintaining local humidity levels and air and soil temperatures. Forested wetlands contribute large wood to nearby streams offering habitat for wildlife. Wetlands provide food, water, refuge from summer heat, shelter from winter cold, and cover for a variety of wildlife including juvenile salmon amongst other species (City of Portland 2010).

Formal importance has been put on wetlands in and around Portland. The City has established policies that recognize the importance of wetlands in its Comprehensive Plan and in the Portland Watershed Management Plan (PBES 2006) and has established zoning to protect wetlands. The Willamette Subbasin Plan identifies focal habitats in the Willamette Basin. Focal habitats are land cover or vegetation classes that are considered to be the most important in the basin because of their scarcity, rate of decline from their historical extent, exceptional wildlife or plant diversity, and/or consistent use by a relatively large number of plant and wildlife species that are threatened, endangered, sensitive, or declining in the basin. The following focal habitats are or historically were present in the project area: perennial ponds and their riparian areas; and riparian areas of rivers and streams.

<u>Perennial Ponds and Riparian Areas</u> This habitat type includes all lentic (non-flowing) areas that are inundated year-round, extending spatially to include riparian and floodplain areas that are inundated seasonally by other lentic water bodies or by rivers. It includes natural ponds, sloughs, lakes, and perennially-inundated marshes, as well as lakes, regulated reservoirs, irrigation ponds, log ponds, beaver-created ponds, and other human-created ponds. This habitat type also includes riparian vegetation (woody or herbaceous) (NPCC 2004).

Ponds and most other lentic waters have not been accorded a priority for protection and ecosystem restoration in ecological assessments for the Willamette Basin. This may be due to their relative abundance, lack of evidence of major decline from historical extent, apparent absence of any endemic species, and lack of ecological survey effort. Nevertheless, ponds and their riparian areas provide a remarkable contribution to regional biodiversity (NPCC 2004).

Ponds, lakes, sloughs, and other lentic waters of the Willamette Basin have been ecologically degraded to varying degrees. Exotic species of fish (especially bass, carp) and wildlife (bullfrog, nutria) are believed to be at least partly responsible for decline of some native species (e.g., Oregon spotted frog). Some of the ponds also have become degraded by invasive aquatic weeds (NPCC 2004).

<u>Riparian Areas of Rivers and Streams</u> This habitat type includes all lotic (flowing water) areas and their adjoining riparian areas, as well as natural and artificial channels (rivers, streams, and ditches; NPCC 2004). The importance of perennial streams, rivers, and riparian areas for aquatic animals (notably salmon and trout) are widely recognized by laws, policies, and science for the Willamette Basin (NPCC 2004). Less often noted is the importance of this habitat type for wildlife.

As a result of river regulation and land development, major changes in wildlife habitat have occurred within the channels and riparian zones of many of the basin’s rivers and streams. In addition, although there has been considerable success in protecting and restoring riparian areas on public lands (e.g., the Willamette River Greenway), riparian protection on private lands not under active forest management has been limited (NPCC 2004).

Wetland locations in the study area were compiled and mapped primarily from National Wetlands Inventory (NWI) Geographic Information System (GIS) data (USFWS 2011) and also from the City (City of Portland 2010) and Metro (Metro 2004, Metro 2009) GIS data. Tetra Tech staff verified wetland conditions at reconnaissance site visits between 2009 and 2011. Figure 4.7 displays wetland areas mapped by NWI.

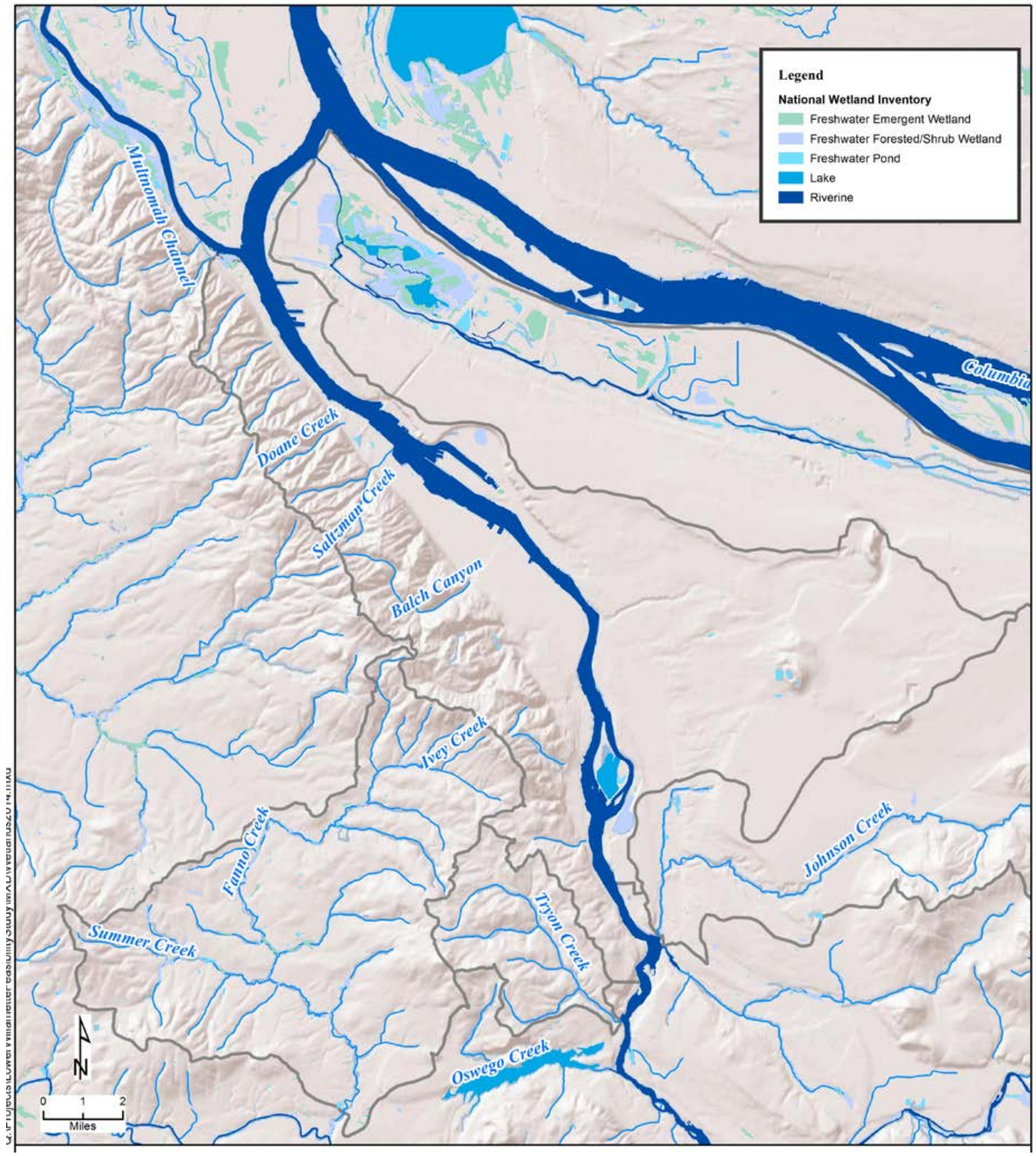

Figure 4-7. NWI Wetlands and Other Waters in the Study Area

The mainstem Willamette River hosts a diversity of habitats including various wetlands. A freshwater forested/shrub wetland has been mapped near the confluence of the Willamette River and Columbia Slough. Although no other wetland has been mapped in the northern part of this reach, two riverine aquatic habitats are present. These include riverine tidal unconsolidated shore regularly flooded and riverine tidal unconsolidated shore seasonal tidal. Both likely host fringe riparian wetlands. Freshwater emergent wetlands, freshwater forested/shrub wetland, and riverine habitat are mapped in the south end of the mainstem Willamette reach.

No wetlands have been mapped on Tryon Creek. However, NWI maps would generally not identify wetlands in an area such as Tryon Creek that is covered by a riparian canopy, so these data are inconclusive. Reconnaissance-level surveys have identified areas that have strong wetland indicators at this site, including fringing fresh emergent wetlands and riparian wetlands.

Freshwater emergent wetlands and freshwater forested/shrub wetlands are found along Columbia Slough. Most soils in the area are hydric. Although not a designated wetland, Columbia Slough is mapped as a riverine system and fringing wetland has been observed along its shores.

4.4.3 Terrestrial Habitat

Terrestrial habitat in the study area has been extensively modified from its historical condition and distribution. Historically, dense riparian gallery forests lined the Willamette River and its tributaries with associations of Douglas-fir, Oregon ash, black cottonwood, alder, bigleaf maple, western red cedar, and willows. Dense patches of Douglas-fir forest and oak forest were locally found in ravines, on hillslopes, and on the floodplain (Hulse *et al.* 2002). On average, these forests ranged from one to two miles wide throughout the basin, except for areas where the floodplain of the Lower Willamette River was confined by steep hills. Today, approximately 20 percent of the area occupied by riparian vegetation remains, and much of it is only one to two tree lengths in width. According to the Willamette Subbasin Plan (NPCC 2004), the loss of habitat has been and continues to be among the most important factors that limit terrestrial wildlife populations in the Willamette River Basin. Fragmentation and of terrestrial habitat and human disturbance are also common in the study area, and contribute to the degradation of ecosystem quality.

4.4.4 Fish

A diverse assemblage of fish utilizes the habitats within the Lower Willamette River. These species include anadromous or resident and native or non-native species (Figure 4.8). ODFW and the City conducted a 4-year study of fish species in the Lower Willamette River (PBES 2006). In the first 2 years of the study, 37 native fish species were found from 15 families, along with 17 introduced species from 7 families (ODFW 2001, 2002). The list of species is provided in Table 4.4.

Table 4-4. Fish Species of the lower Willamette River

FAMILY	SPECIES	COMMON NAME	NATIVE
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey	Native
	Lamptra ayresi	River lamprey	Native
	Lampetra pacifica	Pacific brook lamprey	Native
	Lampetra richardsoni	Western brook lamprey	Native
Acipenseridae	*Acipenser transmontanus*	white sturgeon	Native
	Acipenser medirostris	green sturgeon	Native
Clupeidae	*Alosa sapidissima*	American shad	Non-native
Salmonidae	*Oncorhynchus tshawytscha*	chinook salmon	Native
	Oncorhynchus kisutch	coho salmon	Native
	Oncorhynchus nerka	sockeye salmon	Native
	Oncorhynchus mykiss	steelhead, rainbow trout	Native
	Oncorhynchus clarki	cutthroat trout	Native
	Prosopium williamsoni	mountain whitefish	Native
Cyprinidae	*Ptychocheilus oregonensis*	northern pikeminnow	Native
	Mylocheilus caurinus	peamouth	Native
	Acrocheilus alutaceus	chiselmouth	Native
	Cyprinus carpio	common carp	Non-native
	Ctenopharyngodon idella	grass carp	Non-native
	Carassius auratus	goldfish	Non-native
	Richardsonius balteatus	redside shiner	Native
	Rhinichthys cataractae	longnose dace	Native
	Rhinichthys osculus	speckled dace	Native
Osmeridae	*Thaleichthys pacificus*	Eulachon	Native
Catostomidae	*Catostomus macrocheilus*	largescale sucker	Native
	Catostomus commersoni	bridgelip sucker	Native
	Catostomus platyrhynchus	mountain sucker	Native
Ictaluridae	*Ameiurus natalis*	yellow bullhead	Non-native
	Ameiurus nebulosus	brown bullhead	Non-native
	Ictalurus punctatus	channel catfish	Non-native
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback	Native
Percopsidae	*Percopsis transmontana*	sand roller	Native
Poeciliidae	*Gambusia affinis*	western mosquitofish	Non-native
Cyprinodontidae	*Fundulus diaphanus*	banded killifish	Non-native
Centrarchidae	*Pomoxis annularis*	white crappie	Non-native
	Pomoxis nigromaculatus	black crappie	Non-native
	Micropterus dolomieu	smallmouth bass	Non-native
	Micropterus salmoides	largemouth bass	Non-native
	Lepomis macrochirus	bluegill	Non-native
	Lepomis gibbosus	pumpkinseed	Non-native
	Lepomis gulosus	warmouth	Non-native
Percidae	*Stizostedion vitreum*	walleye	Non-native
	Perca flavescens	yellow perch	Non-native
Cottidae	*Cottus asper*	prickly sculpin	Native
	Cottus bairdi	Mottled sculpin	Native
	Cottus beldingi	Paiute sculpin	Native
	Cottus confuscus	Shorthead sculpin	Native
	Cottus gulosus	Riffle sculpin	Native
	Cottus perplexus	Reticulate sculpin	Native
	Cottus rhotheus	Torrent sculpin	Native
Plueuronectidae	*Platichthys stellatus*	starry flounder	Native
ODFW 2001, 2002, Farr and Ward 1993			

Several fish passage barriers are present in the study area. Access to the middle and upper Columbia Slough is prevented by the Multnomah County Drainage District dike and pumping system. It is not known whether fish historically could access this portion of the slough during non-flood periods, since the historic channel configuration of the slough is unknown (PBES 2006). A fish ladder installed at Willamette Falls allows fish that move through the Lower Willamette to pass upstream of the falls, allowing introduced salmon stocks to enter the upper basin. Historically, only spring Chinook and winter steelhead could naturally pass the falls.

Culverts on Tryon Creek at (from downstream to upstream) Highway 43 (creek mile 0.2), Boones Ferry Road (creek mile 2.9), and on its tributary, Arnold Creek (Arnold Creek mile 0.1), partially or completely block fish passage into the upper reaches of these streams. In all, approximately 7 miles of spawning and rearing habitat is blocked by these culverts. The most extensive of these obstructions is the Highway 43 culvert on Tryon Creek, which was classified in 2005 as a high priority for fish passage improvements by the Oregon Department of Transportation (ODOT). Subsequently, this culvert has been retrofitted with baffles intended to improve fish passage and a roughened chute was designed and installed downstream of the culvert outfall to create a backwater into the lower entrance of the culvert and eliminate an entrance jump barrier. Also, in 2011, the City of Portland installed a boulder weir below the mouth of the culvert to raise the water surface elevation. These project were intended to restore fish passage to the 2.7 mile stretch of Tryon Creek between the Highway 43 culvert and the Boones Ferry culvert. These projects are small scale and have not been shown to significantly increase fish passage.

Ongoing USFWS-initiated field surveys have found adult lamprey and fish only below the culvert, and juvenile fish above the culvert, but also did so prior to culvert reconstruction (USFWS 2012). A study by Oregon Department of Fish and Wildlife and Portland BES found that no fish passed the culvert (ODFW and PBES 2002), and a report from 2007 also indicated no fish passage at the culvert (HLS 2007). A monitoring study by U.S. Fish and Wildlife found that although some fish entering Tryon Creek from the Willamette River could pass the culvert, most were blocked (USFWS 2012). Furthermore, it is not clear from the USFWS study under what flow conditions fish were able to pass the culvert, or what life stages may pass, and some of the fish detected above the culvert in the USFWS study may have been resident fish that did not pass the culvert. Therefore, although it does appear that some fish may pass through the culvert under optimal flow conditions, under most flow conditions the culvert is considered impassible.

Reduction of native fish populations has resulted in the listings of many Lower Willamette River fish species under the ESA. A total of 15 fish evolutionarily significant unit’s (ESU) composed of seven different species may use or migrate through watercourses in the study area (Figure 4-8).

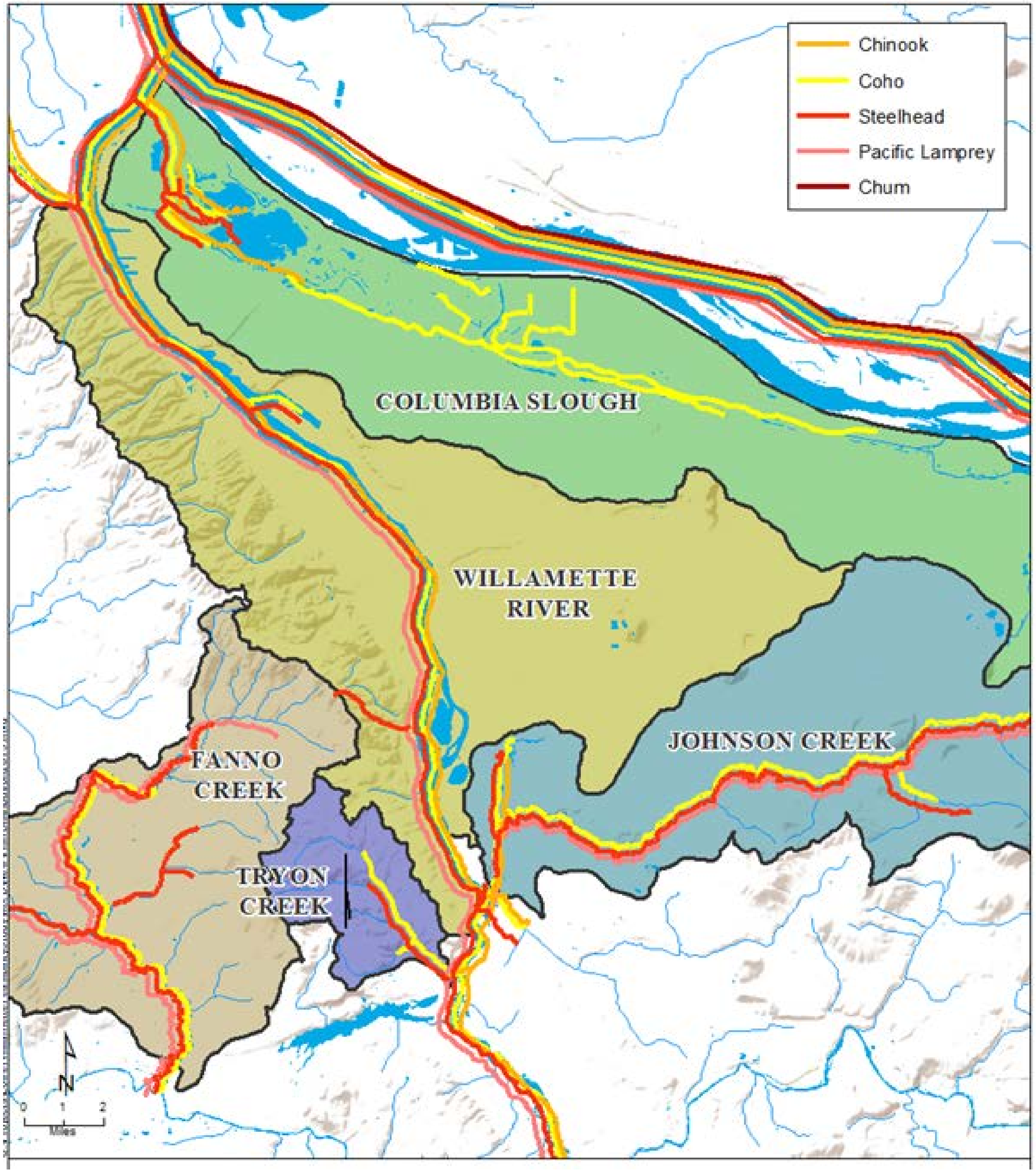

Figure 4-8. Anadromous species distribution in the Study Area.

4.4.5 Wildlife

The Lower Willamette River floodplain once had a rich variety of terrestrial animal and plant species due to its extensive wetlands, riparian forests, and upland transition zones. It is estimated that approximately 18 species of amphibians, 15 reptile species, 154 bird species, and 69 mammal species are native to the basin (Hulse *et al.* 2002). A number of species have sharply declined, including over 60 percent of amphibian species, and are now the focus of conservation concerns. The area suffering the greatest divergence from native conditions is likely the urban environment of the City of Portland. Some typical species in the area include mammals such as raccoon (*Procyon lotor*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), river otter (*Lontra canadensis*), North American beaver (*Castor canadensis*), and moles (Talpidae); birds including American crow (*Corvus brachyrhynchos*), western scrub-jay (*Aphelocoma californica*), black-capped chickadee (*Poecile atricapillus*), dark-eyed junco (*Junco hyemalis*), red-tailed hawk (*Buteo jamaicensis*), Cooper's and sharp-shinned hawk (Accipitridae), osprey (*Pandion haliaetus*), and Canada goose (*Branta canadensis*); and amphibians and reptiles including pacific tree frog (*Pseudacris regilla*), rough-skin newt (*Taricha granulosa*), and common garter snake (*Thamnophis sirtalis*). Several terrestrial wildlife species currently residing in the Willamette Basin are non-native. It has been estimated that approximately 17 non-native wildlife species have been introduced (Hulse *et al*. 2000) and include wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*), European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), eastern gray squirrel (*Sciurus carolinensis*), nutria (*Myocastor coypus*), and bullfrogs (*Rana catesbeiana*) (Hulse, *et al*. 2000; Willamette Partnership 2004).

The Willamette River Inventory (Adolfson Associates 2000) summarizes the most recent detailed description of the wildlife and wildlife habitat throughout the study area. Wildlife observations through the study area between summer 1999 and January 2000 documented birds, reptiles, amphibians, and mammals, which are listed in Table 4.5, below.

Table 4-5. Species Likely to be Present in the Study Area (Non-native Species are Identified)

American bittern	Golden-crowned kinglet	Raccoon
American crow	Golden-crowned sparrow	Red crossbill
American goldfinch	Great blue heron	Red-breasted sapsucker
American kestrel	Hammond's flycatcher	Red-eyed vireo
American robin	Hermit thrush	Red-legged frog
Bank swallow	Hermit warbler	Red-tailed hawk
Barn swallow	Herring gull	River otter
Beaver	Hoary bat	Rock dove (non-native)
Belted kingfisher	Hooded merganser	Rufous-sided towhee
Bewick's wren	House sparrow	Sandhill crane
Black-capped chickadee	House wren	Sharp-shinned hawk
Black-headed grosbeak	Hutton's vireo	Short-eared owl
Black-throated grey warbler	Lesser goldfinch	Song sparrow
Brown creeper	Lincoln's sparrow	Starling (non-native)
Bufflehead	Long toed salamander	Swainson's thrush
Bull frog (non-native)	Macgillivray's warbler	Townsend's solitaire
Bullock's oriole	Mallard	Townsend's warbler
Bushtit	Merlin	Varied thrush
Canada goose	Mink	Vaux's swift
Chipping sparrow	Mourning dove	Warbling vireo
Common garter snake	Mule deer	Western red-backed salamander
Common merganser	Nashville warbler	Western scrub-jay
Coyote	Northern flicker	Western tanager
Dark-eyed junco	Northern harrier	Western wood-pewee
Double-crested cormorant	Northwestern garter snake	White-breasted nuthatch
Douglas' squirrel	Nutria	White-crowned sparrow
Downy woodpecker	Orange-crowned warbler	Widgeon

Dunlin	Osprey	Wilson's warbler
Dusky flycatcher	Pacific chorus frog	Winter wren
Field mice	Pacific-slope flycatcher	Woodrat
Fox	Pine siskin	Yellow warbler
Fox sparrow	Pocket gopher	Yellow-rumped warbler
Gadwall	Purple finch	

4.4.6 Listed and Sensitive Species

The Endangered Species Act of 1973 (ESA) is intended to conserve endangered and threatened species and the ecosystems on which they depend as key components of America's heritage. A protected species is listed under one of two categories; endangered or threatened, depending on its status and the degree of threat it faces. An "endangered species" is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened species" is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Several ESA-listed species are identified for Multnomah County, however, only the fish species listed in Table 4.6 and discussed below have potential to be present in the proposed project area. Given the best scientific information available (ODA 2010, ODFW 2010, USFWS 2010, NMFS 2011, NOAA 2014), it was determined that either extant populations or the necessary habitat requirements for all other ESA-listed species (presented in Table 4-6 along with state-listed species) are not present in the project area and individuals are therefore absent. Therefore, there are no listed plants, amphibians, reptiles, or mammals known to occur or that have the potential to occur in the study area.

Table 4-6. ESA-Listing Status of Species Likely to Occur in the Study Area

Species	**Scientific Name**	**Evolutionarily Significant Unit**	**ESA Listing Status**
Chinook salmon	*Oncorhynchus tshawytscha*	Lower Columbia	Threatened
		Upper Columbia Spring-run	Endangered
		Upper Willamette	Threatened
		Snake Spring/ Summer-run	Threatened
		Snake Fall-run	Threatened
Coho salmon	*Oncorhynchus kisutch*	Lower Columbia / Southwest Washington	Threatened
Steelhead	*Oncorhynchus mykiss*	Lower Columbia	Threatened
		Middle Columbia	Threatened
		Upper Columbia	Threatened
		Upper Willamette	Threatened
		Snake	Threatened
Bull trout	*Salvelinus confluentus*	Willamette Recovery Unit	Threatened
North American green sturgeon	*Acipenser medirostris*	Southern Distinct Population Segment	Threatened

Species	Scientific Name	Evolutionarily Significant Unit	ESA Listing Status
Pacific lamprey	*Lampetra tridentate*	NA	Species of Concern
Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	NA	Species of Concern
NOAA 2011, PBES 2006			

4.4.7 ESA Listed Fish Species

Lower Columbia River Coho Salmon ESU (*Oncorhynchus kisutch*) The Lower Columbia coho salmon ESU was listed as threatened on June 28, 2005 (70 FR 37160); critical habitat is currently under development for this species. The ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, the Willamette River to Willamette Falls, Oregon, as well as 25 artificial propagation programs (NOAA 2005).

Lower Columbia River Chinook Salmon ESU (*Oncorhynchus tshawytscha*) and Upper Willamette River Chinook Salmon ESU (*Oncorhynchus tshawytscha*) Both the Lower Columbia River Chinook salmon ESU and Upper Willamette River Chinook salmon ESU were listed as threatened on March 24, 1999 (64 FR 14329) with the threatened status reaffirmed on June 28, 2005 (70 FR 37160); critical habitat for these ESUs was designated on September 2, 2005 (70 FR 542488). The Lower Columbia River Chinook ESU includes all naturally spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River (64 FR 14208) (NOAA 2005). The Upper Willamette River Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon, as well as seven artificial propagation programs (64 FR 14208) (NOAA 2005).
Upper Willamette River steelhead ESU (*Oncorhynchus mykiss*) and Lower Columbia River steelhead ESU (*Oncorhynchus mykiss*) The Upper Willamette River steelhead ESU and Lower Columbia River steelhead ESU were listed as a threatened species on March 19, 1998 (50 C.F.R. Part 227) and the threatened status was reaffirmed on January 5, 2006; critical habitat for these ESUs was designated on September 2, 2005 (70 FR 542488). The Upper Willamette River steelhead ESU includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River, inclusive. The Lower Columbia River steelhead ESU includes all naturally spawned populations of steelhead (and their progeny) in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington, inclusive, and the Willamette and Hood Rivers, Oregon, inclusive. Excluded are steelhead in the Upper Willamette River Basin above Willamette Falls, Oregon, and from the Little and Big White Salmon rivers, Washington (NOAA 2005).

Southern DPS of North American Green Sturgeon (*Acipenser medirostris*) The southern Distinct Population Segment (DPS) of North American green sturgeon was listed as threatened on October 9, 2009 (50 C.F.R. 223); critical habitat has been designated for this species (50 C.F.R. 226). The DPS includes all coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San

Pablo, and San Francisco bays in California; the lower Columbia River estuary (to upstream to Bonneville Dam); and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) (NOAA 2006).

4.4.8 Protected Species Unlikely to Occur in the Project Area

Table 4-7 presents other ESA-listed and/or state-listed species identified as potentially occurring in the project area. All Federally protected ESA-listed species identified below are unlikely to occur in the project area and were not considered further in the Biological Assessment prepared for this project (Appendix C).

Table 4-7. Other Sensitive Species That May Occur in the Study Area

Species	**Federal Status**	**State Status**
Birds		
Bald eagle (*Haliaeetus leucocephalus*)	Fully Protected, De-listed	Threatened
Band-tailed pigeon (*Patagioenas fasciata*)	Species of Concern	N/A
Northern goshawk (*Accipiter gentilis*)	Species of Concern	N/A
Olive-sided flycatcher (*Contopus cooperi*)	Species of Concern	N/A
Oregon vesper sparrow (*Pooecestes gramineus affinis*)	Species of Concern	N/A
Purple martin (*Progne subis*)	Species of Concern	N/A
Streaked horned lark *(Eremophila alpestris strigata)*	Threatened	N/A
Tricolored blackbird (*Agelaius tricolor*)	Species of Concern	Species of Concern
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Threatened	N/A
Yellow-breasted chat (*Icteria virens*)	Species of Concern	N/A
Mammals		
Camas pocket gopher (*Thomomys bulbivorus*)	Species of Concern	N/A
Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	Endangered	Endangered
Fringed myotis (*Myotis thysanodes*)	Species of Concern	N/A
Long-eared myotis (*Myotis evotis*)	Species of Concern	N/A
Long-legged myotis (*Myotis volans*)	Species of Concern	N/A
Pacific western big-eared bat (*Corynorhinus townsendii*) (AKA Townsend's big-eared bat)	Species of Concern	N/A
Yuma myotis (*Myotis yumanensis*)	Species of Concern	N/A
Reptiles and Amphibians		
Coastal tailed frog (*Ascaphus truei*)	Species of Concern	N/A
Northern red-legged frog (*Rana aurora*)	Species of Concern	N/A
Northwestern pond turtle (*Actinemys marmorata marmorata*)	Species of Concern	N/A
Invertebrates		
California floater mussel (*Anodonta californiensis*)	Species of Concern	N/A
Columbia Gorge neothremman caddisfly (*Neothremma andersoni*)	Species of Concern	N/A
Columbia pebblesnail (spire snail) (*Fluminicola fuscus / F. columbianus*)	Species of Concern	N/A
Oregon giant earthworm (*Driloleirus macelfreshi*)	Species of Concern	N/A
Plants		
Cold-water corydalis (*Corydalis aquae-gelidae*)	Species of Concern	N/A
Howell's bentgrass (*Agrostis howellii*)	Species of Concern	N/A
Nelson's checker-mallow (*Sidalcea nelsoniana*)	Threatened	N/A

Oregon fleabane (*Erigeron oreganus*)	Species of Concern	N/A
Species	**Federal Status**	**State Status**
Pale larkspur (*Delphinium leucophaeum*)	Species of Concern	N/A
Peacock larkspur (*Delphinium pavonaceum*)	Species of Concern	Endangered
Thin-leaved peavine (*Lathyrus holochlorus*)	Species of Concern	N/A
Water howellia (*Howellia aquatilis*)	Threatened	N/A
Whitetop aster (*Sericocarpus rigidus*)	Species of Concern	N/A
Willamette Valley larkspur (*Delphinium oreganum*)	Species of Concern	N/A

4.4.9 Future Without Project Conditions

In the future without-project condition, small-scale habitat restoration actions by a variety of state and local agencies and groups would continue to occur. The Federal Action Agencies will continue to implement a number of restoration actions associated with compliance with the 2008 Biological Opinions (NOAA 2008, USFWS 2008), and the City will play a key role in establishing priorities on the Lower Willamette. The Oregon Watershed Enhancement Board would continue to provide funding and technical assistance for watershed and stream restoration projects in the study area.

Additional factors will continue to degrade habitats, such as continued growth and development, likely continued armoring of river and tributary channels to protect residences and infrastructure, and climate change. Even though the Corps will take actions to improve habitats as required for compliance with the 2008 Biological Opinions (NOAA 2008; USFWS 2008), these actions will primarily be focused on actions that compensate for adverse effects from dam operations. On balance, it is likely that the future without-project condition will slightly improve localized areas, but not likely to the level required to recover fish and wildlife species. The *Willamette River Basin Planning Atlas* (Hulse *et al.* 2002) scenarios predict that aquatic habitat quality and quantity will stay about the same, or improve somewhat (20 to 60 percent) depending on whether a development-oriented or conservation-oriented future scenario occurs.

Thus, the key assumptions that are made in this study regarding the likely future condition of habitat conditions is that trees and shrubs in the riparian zone and floodplain will continue to mature and get larger, but non-native invasive species will continue to expand their range, density, and size. Large wood recruitment into the river will continue to be limited compared to natural conditions as a result of land clearing and development and native trees will be unable to recruit into areas dominated by non-native species. In areas where localized ecosystem restoration occurs, these areas will contribute large wood to the rivers within the 50-year period of analysis, but this is expected to be much less than would occur with more extensive floodplain and riparian ecosystem restoration.

4.5 Cultural Resources

The following is summary of the history of the area based on information in the *Cultural Resource Analysis Report for the Portland Harbor Superfund Site, Portland, Oregon* (Ellis *et al.* 2005).

In North America, the Paleo-Indian stage represents the earliest known settlement of humans in the New World. Artifacts associated with the Paleo-Indian stage have been found in the Willamette Valley, but no evidence of their presence has been found in the Portland Basin. Data suggest that the first human groups in the area were small, mobile bands of hunter-gatherers about 9,000 to 10,000 years ago, corresponding to the Archaic stage. Rectangular houses in the Portland Basin date back to about 2,000 years ago. This is believed by some researchers to be evidence of sedentary villages and the development of the Formative stage. The period following the Archaic stage is the Pacific period, which recognizes the change to a complex hunter-gatherer society with permanent villages, social hierarchies and status differences, and extensive networks of kinship and exchange between communities. The people shifted from being more foragers (not storing food and being opportunistic) to being collectors. The Pacific period ranges from 4400 BC to 1775 AD.

A number of archaeological sites in the Portland Basin have been identified and the artifacts radiocarbon-dated. The oldest of these sites are all along the Columbia River floodplain near the mouth of the Willamette River, with the oldest being 3,510 years before present. A fairly extensive record of the past 2,000 years exists with the identification of a number of sites. Information on the past 1,500 years is well represented with evidence of villages on the banks of the Columbia and Clackamas Rivers, and along the major drainages of the Columbia River floodplain.

The Lower Willamette River lies within the traditional homeland of the Chinookan people, while most of the Willamette Valley upstream of the falls was the homeland of Kalapuyan groups. The Chinookans occupied the Columbia River Valley from the Pacific Ocean up to The Dalles. Two groups occupied the Portland area, the Multnomah and the Clackamas. Multnomah villages were concentrated on Sauvie Island, along the Multnomah Channel, and along the northern bank of the Columbia River downstream of the mouth of the Willamette River. The Clackamas were found primarily along the Clackamas River, at Willamette Falls, and along the Lower Willamette River. Some evidence suggests both groups occupied the areas around the mouth of the Willamette River and the southern shore of the Columbia River between the Willamette and Sandy Rivers. At the time of Lewis and Clark, native populations in the Portland Basin were estimated to be about 3,400, with seasonal fluctuations to just over 8,000. During the 19th century, disease spread throughout all of the Pacific Northwest native populations.

In the middle part of the 19th century, the Willamette Valley's fertile soils, pleasant climate, and abundant water attracted thousands of settlers from the eastern United States, mainly the borderlands of Missouri, Iowa, and the Ohio Valley. Many of these emigrants followed the Oregon Trail, a 2,170-mile trek across western North America that began at Independence, Missouri, and ended at various locations near the mouth of the Willamette River. Subsequently, settlers were increasingly encroaching on Native American lands in the Willamette Valley. Skirmishes between natives and settlers resulted in the Oregon state government removing the natives by military force.

In the early 1840s, Oregon City began to grow and in 1848, became the first capital of the Oregon Territory. Oregon City prospered because of the paper mills that were run by the water power of the Willamette Falls. Beginning in the 1850s, steamboats began to ply the Willamette, but Willamette Falls formed an almost impassable barrier to river navigation. In 1873, the construction of the Willamette Falls Locks bypassed the falls and allowed easy navigation between the upper and lower river. The capital was moved to Salem in 1852.

The original claim for Portland was filed in 1844 and the first 16 blocks were surveyed in 1845. After Portland was incorporated in 1851, it quickly grew into Oregon's largest city. The low areas and sloughs on the east side of the river were filled as the city grew, especially after the consolidation of East Portland and Albina into Portland in 1891. Portions of Mocks Bottom and Swan Island were filled to facilitate industrialization of these areas. The east bank of the Willamette moved westward, and the river channel narrowed through downtown. Swan Island was once a real island that separated two channels of the Willamette River. Prior to 1920, the eastern, deeper Swan Channel was the river's main channel. The current channel on the west side of the island was wide and shallow. A massive dredging project shifted the river channel and filled the causeway that now connects Swan Island to North Portland (Ellis *et al.* 2005).

4.5.1 Future Without Project Conditions

Appropriate cultural resource protective measures, to be determined, will be developed prior to project implementation. These measures, including avoidance, establishment of buffer areas and/or mitigation, will be designed in consultation with SHPO, affected Tribes and property owners, to ensure that existing cultural resources are preserved to the extent possible. Federal, state, and local laws require identification, analysis, protection where possible, and full documentation of important cultural resources where disturbances are unavoidable. These efforts will be designed to help minimize impacts to archaeological and historic resources, identify important historic properties and ensure their protection into the future.

4.6 Land Use and Zoning

4.6.1 Land Use

Land use and zoning categories are found in Portland's Comprehensive Plan (PBPS 1980, with revisions through 2011). Only categories that occur in the study area are described in the following paragraphs.

<u>Open Space</u> This category includes parks, greenways, and undeveloped areas. These areas are generally accessible for public uses.

<u>Commercial</u> This land use category identifies activities associated with retail trade and services for the general public, offices, and lodging.

<u>Industrial (General and Heavy)</u> This category identifies activities associated with repair or service related to machinery, equipment, products, or by-products. Waterfront examples identified in the inventoried area include ship repair, barge services, and dredge facilities.

<u>Residential</u> This category identifies activities associated with household and group living facilities where tenancy is arranged on a month-to-month or longer basis, including houseboats.

<u>Institutional</u> This category identifies activities associated with community services (typically by public or non-profit providers), including schools, colleges, medical centers, parks and open spaces, and religious institutions.

4.6.2 Zoning

Zoning is the legal designation placed on the land that determines what types of land uses can be developed on specific pieces of property. Zoning designations by Portland and other jurisdictions within Metro are to be consistent with the Urban Growth Boundary (UGB) (Figure 4.9). Zoning designations for the affected reaches of the Lower Willamette River and Columbia Slough are described as follows:

The North Zoning Reach is primarily zoned for heavy industrial land uses in the immediate river corridor with the exception of Kelley Point Park. Just outside of the immediate river corridor, zoning is primarily for open space on the west bank with pockets of residential zoning, and transitions from industrial to residential zoning toward the south end of the east bank.

The South Zoning Reach exhibits more diversity in zoning than in the downstream reaches. Lands adjacent to the river's west bank are zoned for commercial, medium density residential, single-family residential and open space. Zoning designations for lands adjacent to the river's east bank include commercial, industrial, residential, and open space land uses. Lands designated as open space within this reach include Sellwood Riverfront Park, Oaks Bottom Wildlife Refuge, and Ross Island.

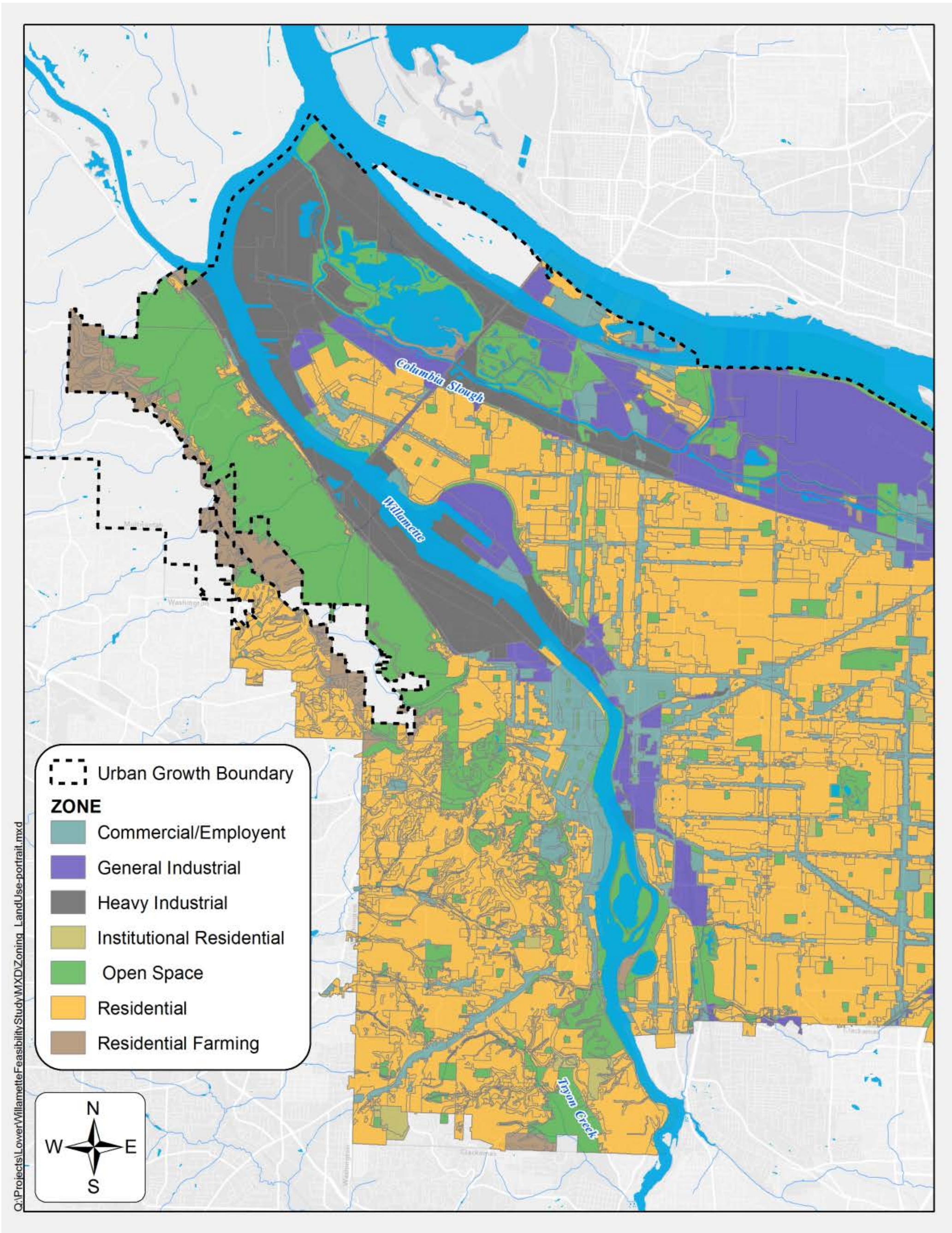

Figure 4-9. Zoning Designations in the City of Portland (PBPS 2006)

4.6.3 Future Without Project Conditions

Control of urban growth, promotion of urban renewal, and protection of open space are components of the Portland Comprehensive Plan. As the population increases over the 50-year horizon, zoning needs may change. The Portland Comprehensive Plan will continue to evolve with population growth, defining the UGB, and aiding in determining the best possible land uses and zoning options for the city. If population grows rapidly without these protections, open space and other protected natural areas may decline, while high pressure land uses increase (*e.g.*, high density or heavy industrial).

4.7 **Transportation**

The study area's transportation system integrates local access, highway, railroad, airport, and river barge facilities to support commercial and public transportation needs. The transportation network in the river corridor by study reach is shown in the zoning and land use maps presented above. The following transportation infrastructure data comes from local mapping and Portland Development Commission (PDC 2006).

Navigation Portland Harbor's 40-foot-deep shipping channel for ocean-going vessels is maintained along the Willamette River to the Broadway Bridge, encompassing about two-thirds of the Willamette River's length through Portland, and along the Columbia River to the Port's Terminal 6. Barge transportation extends farther upriver on the Willamette and Columbia Rivers. The Port owns four marine terminals and industrial property adjacent to the harbor. Rail and highway networks efficiently service harbor facilities. Containers may be loaded directly from ship to railcar, eliminating cross-town drayage expenses. The Port is the largest one in Oregon, largest auto port on the West Coast, fourth largest auto port in the U.S., largest wheat export port in the U.S., and third largest port in total tonnage on the west coast. Supporting Portland's economic role as an industrial and freight distribution center, the working harbor area is a hub for marine, rail, and truck transportation.

Freight Rail The Portland metropolitan region is the western terminus for the east-west rail corridor that runs along the Columbia River. The region is served by two transcontinental railroads, including Burlington Northern Santa Fe (BNSF) Railway and Union Pacific. Portland handles vast quantities of all types of cargo, including containers, automobiles, and bulks (agricultural and mineral), as well as all merchandise cargo.

Highways and Trucking Two major interstate highways, I-5 and I-84, pass through the region. I-5 is the main north-south route from Canada to Mexico, connecting Seattle, Portland, Sacramento, Los Angeles and San Diego. I-84 is the principal route east from Portland to Salt Lake City, Utah, and on to the Midwest and East Coast.

Public Transportation Network The region is an interconnected system of cities, counties, and states linked by a public transportation system serving Multnomah, Clark, Clackamas, and Washington counties. TriMet provides public transportation service and serves 575 square miles of the Portland metropolitan area. Ridership has increased in each of the past 17 years, to the current record level of 96 million rides per year. TriMet operates the 44-mile MAX light rail line, along with 92 bus routes and additional services for seniors and people with disabilities.

4.7.1 Future Without Project Conditions

The transportation network within the project area is expected to expand to accommodate a growing population under the future without-project condition. In particular, highways and public transportation will continue to need expansion and upgrades. Navigation through the Willamette River will also continue, requiring ongoing dredging. Expansion of transportation and dredging activities are all regulated by federal, state, and local agencies and adverse effects require mitigation.

4.8 Socioeconomics and Environmental Justice

4.8.1 Current and Future Population

The Portland-Vancouver-Beaverton, OR-WA Metropolitan Statistical Area (Portland MSA) consists of Clackamas, Columbia, Multnomah, Washington, and Yamhill Counties of Oregon; and Clark and Skamania Counties of Washington. The 2010 population of the MSA is 2,226,000 and the largest population center is in Portland, with approximately 584,000 residents (2010 Census estimate). The next four largest cities are much smaller than Portland, with between 90,000 and 162,000 residents. The Portland MSA supports strong manufacturing, distribution, information, and finance industries. The U.S. Bureau of Economic Analysis estimates approximately 1.3 million people are employed in the Portland MSA, making it the 23rd largest MSA in the country (U.S. Bureau of Economic Analysis 2010).

The regional population grew rapidly in the 1980s and 1990s, but has experienced slower growth since 2000 (Table 4.8). The State of Oregon Office of Economic Analysis's (OEA's) latest report indicates that the recent recession was responsible for the slowdown in growth in the region, with the slow economy, small net migration, and high unemployment all contributing to low population growth. However, recovery is beginning and growth is forecasted between 2010 and 2020. The most recent estimates of future growth for the State of Oregon are 0.5 percent growth in 2011, 0.8 percent in 2012, 0.9 percent in 2013, and about 1.25 percent annually thereafter through 2020 (Oregon OEA 2012). Applying these state-level estimates to the Portland MSA, Table 4.9 summarizes projected population through 2020.

It is projected that the Portland MSA will have a population of 2,482,000 in 2020, an increase of about 256,000 people, or 11.5 percent over the population in 2010. This projection indicates higher growth from 2010-2020 than observed from 2000-2010, but it is not projected to reach the high levels observed in the 1980s and 1990s.

Table 4-8. Observed and Projected Population Growth in the Portland MSA

	Observed Growth*			**Projected Growth****			
County	**1980-1990**	**1990-2000**	**2000-2010**	**2012**	**2013**	**2015**	**2020**
Clackamas (OR)	15%	21%	8%	381,000	384,000	394,000	419,000
Columbia (OR)	5%	16%	8%	50,000	50,000	52,000	55,000
Multnomah (OR)	4%	13%	-1%	745,000	752,000	771,000	820,000
Washington (OR)	27%	43%	11%	537,000	541,000	555,000	591,000
Yamhill (OR)	18%	30%	3%	100,000	101,000	104,000	111,000
Clark (WA)	24%	45%	16%	431,000	435,000	446,000	474,000
Skamania (WA)	5%	19%	4%	11,000	11,000	12,000	12,000
MSA Total	14%	27%	7%	2,255,000	2,275,000	2,333,000	2,482,000
*U.S. Census Bureau 2010a, 2010b **Oregon OEA 2012							

4.8.2 Demographic Trends

A Portland State University study of demographics in the Portland MSA in May 2010 documented important demographic trends in Portland and the region, including an increase of the Hispanic population (Table 4.9), a shift from family to non-family households within the city, a decline in the number of households with children, the overall decline in median household size, and a downward shift in the median age of residents in Portland neighborhoods. It also noted patterns in distribution of age and race across the Portland MSA (Sprague *et al.* 2010; U.S. Census Bureau 2010a).

Table 4-9. Portland MSA Race Demographics

County	Race [1]					
	White	Black or African American	Am. Indian and Alaska Native	Asian	Native Hawaiian /Other Pacific Islander	Other
Clackamas (OR)	91.1%	1.4%	1.9%	4.8%	0.5%	3.7%
Columbia (OR)	95.8%	0.9%	3.2%	1.8%	0.4%	1.6%
Multnomah (OR)	80.5%	7.1%	2.5%	8.2%	0.9%	5.9%
Washington (OR)	80.4%	2.7%	1.7%	10.6%	0.9%	8.4%
Yamhill (OR)	88.5%	1.4%	2.9%	2.4%	0.4%	7.9%
Clark (WA)	89.1%	3.1%	2.1%	5.5%	1.1%	3.6%
Skamania (WA)	95.7%	0.8%	3.4%	1.4%	0.3%	1.6%

[1]Utilizes “alone or in combination” race data and may not add to 100%.
Source: U.S. Census Bureau 2010b

4.8.3 Economy

As measured by the Bureau of Economic Analysis, in 2010 the Portland metropolitan region had the 21st largest economy in the U.S. at $121.7 billion Gross Domestic Product (GDP; O’Connor 2012). As experienced across the country, the late-2000s recession affected the Portland MSA economy (Figure 4.10). Census figures estimated a 12 percent unemployment rate for the Portland MSA in 2010 (U.S. Census Bureau 2010). However, the most recent reports from the Oregon Office of Economic Analysis indicate that positive growth has resumed slowly, led by gains in business investments and exports. Oregon is not expected to recover all of the jobs lost in the recession until the end of 2014. However, recent gains in employment are led by the Portland MSA, with the most gains seen in the construction, manufacturing, business services, and trade/ transportation/utilities sectors. The City of Portland unemployment rate in the fourth quarter of fiscal year (FY) 2011 was 7.7 percent, down from 9.2 percent in the fourth quarter of FY2010 (Oregon OEA 2012).

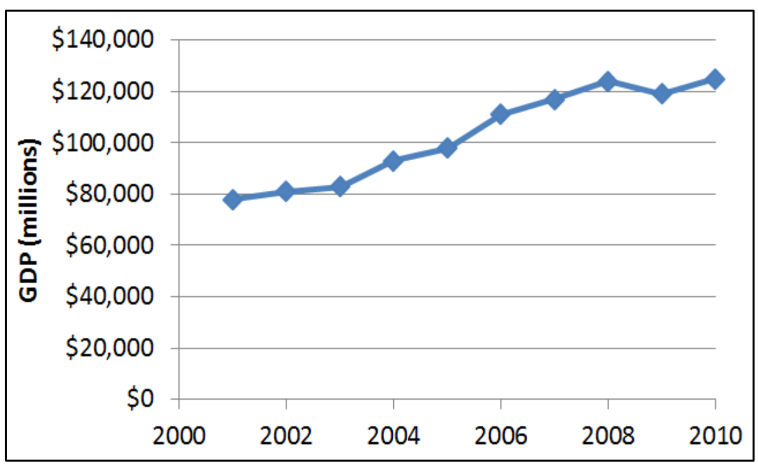

Figure 4-10. Portland MSA GDP Summary (U.S. Bureau of Economic Analysis 2012)

Median household income increased by 14 percent between 2005 and 2010 to approximately $56,000 (U.S. Bureau of Economic Analysis 2010, Table 4.10).

As a result of the region's economic expansion in the 1990s and early 2000s, the average personal income in Portland exceeded the national average (U.S. Bureau of Economic Analysis 2010). Despite this strong growth, the total number of people living in poverty increased in many Portland neighborhoods, particularly in east Multnomah County as well as in inner ring suburbs west and east of the city. Overall, however, the percentage of the total city population living in households below the poverty line declined slightly from 13 percent in 2000 to 11.9 percent in 2010. Despite this decline, a larger share of children under the age of 18 are now living in poverty (U.S. Census Bureau 2010b).

Table 4-10. Median Household Income in Portland/Vancouver MSA

County	2000	2005	2010
Washington (OR)	$55,000	$53,000	$63,000
Clackamas (OR)	$53,000	$54,000	$62,000
Clark (WA)	$50,000	$51,000	$58,000
Columbia (OR)	$47,000	$50,000	$55,000
Yamhill (OR)	$45,000	$46,000	$52,000
Multnomah (OR)	$43,000	$43,000	$50,000
Skamania (WA)	$41,000	$43,000	$49,000
U.S. Bureau of Economic Analysis 2010			

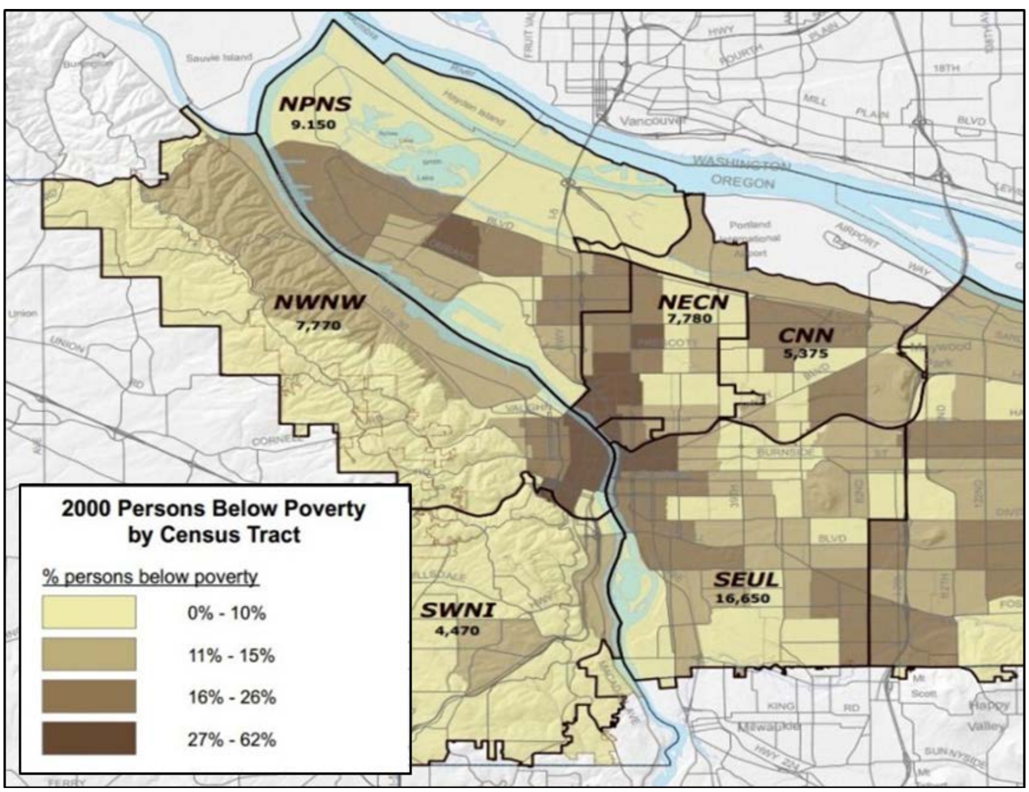

Figure 4-11. City of Portland Poverty by Census Tract and Neighborhood (City of Portland 2012)

4.8.4 Environmental Justice

Executive Order (EO) 12898 requires federal agencies to identify and address disproportionate impacts to minority and low-income populations to the degree possible. This section summarizes existing data regarding low-income populations in the study area.

Poverty by census tract for the City of Portland (based on 2000 Census data) is shown graphically in Figure 4-11. The four-letter neighborhood name codes are shown in bold type and include NPNS (North Portland Neighborhood Services), NWNW (Neighbors West/Northwest), NECN (Northeast Coalition of Neighborhoods), CNN (Central Northeast Neighbors), SWNI (Southwest Neighborhoods Inc.), SEUL (Southeast Uplift Neighborhood Coalition), and EPNO (East Portland Neighborhood Office). Beneath the names are the number of people in poverty in that neighborhood.

4.8.5 Future Without Project Conditions

The analysis of existing and future conditions does not indicate any specific resource constraint on continued growth. As described in the previous sections, the Portland MSA is expected to continue a trend of positive growth in population, employment, and income throughout the period of analysis.

4.9 Parks and Recreation

Figure 4.12 displays parks and those areas designated as “Park Deficient.” Portland Parks and Recreation (PPR) has developed a vision for future park development in the city called the *Parks 2020 Vision* (PPR 2000). In the report, the value of area parks is emphasized as Portland is a destination for visitors seeking outdoor experiences and is also home to a population that values its outdoor opportunities. In general, the Parks 2020 Vision illustrates that the City of Portland has a wide variety and large area of parks, but that optimum conditions remain to be achieved. Specifically, two of the main concerns include the aging infrastructure at many of Portland’s parks and the inaccessibility of parks in many of Portland’s neighborhoods, particularly those that have a high percentage of residents living below the poverty level. In 2009, a review of progress of that vision was made and it was found that the City has made successful strides in adding to the acreage of parks, but that accessibility of parks to all Portlanders remained a challenge (PPR 2009).

4.9.1 Future Without Project Conditions

The Portland Plan’s medium estimate of growth projects an increase of 46 percent in the number of households by 2035 compared to 2005 data (City of Portland 2012). While the North Reach is expected to grow slightly slower than the rest of the City, it is expected that park visitation will continue to grow through the period of analysis. Demand for park facilities and access to open space is strong among residents of Portland, and is not expected to decline, suggesting that an increase in population is likely to result in proportional increase in visitation to local parks in the future, and a potentially declining ability to maintain availability and condition of parks to keep up with the pace of growth.

Projections indicate that the communities around the parks in the south end of the study area will continue to grow and become denser over the period of analysis. As such, continued and increased use of the parks is expected in the without-project condition.

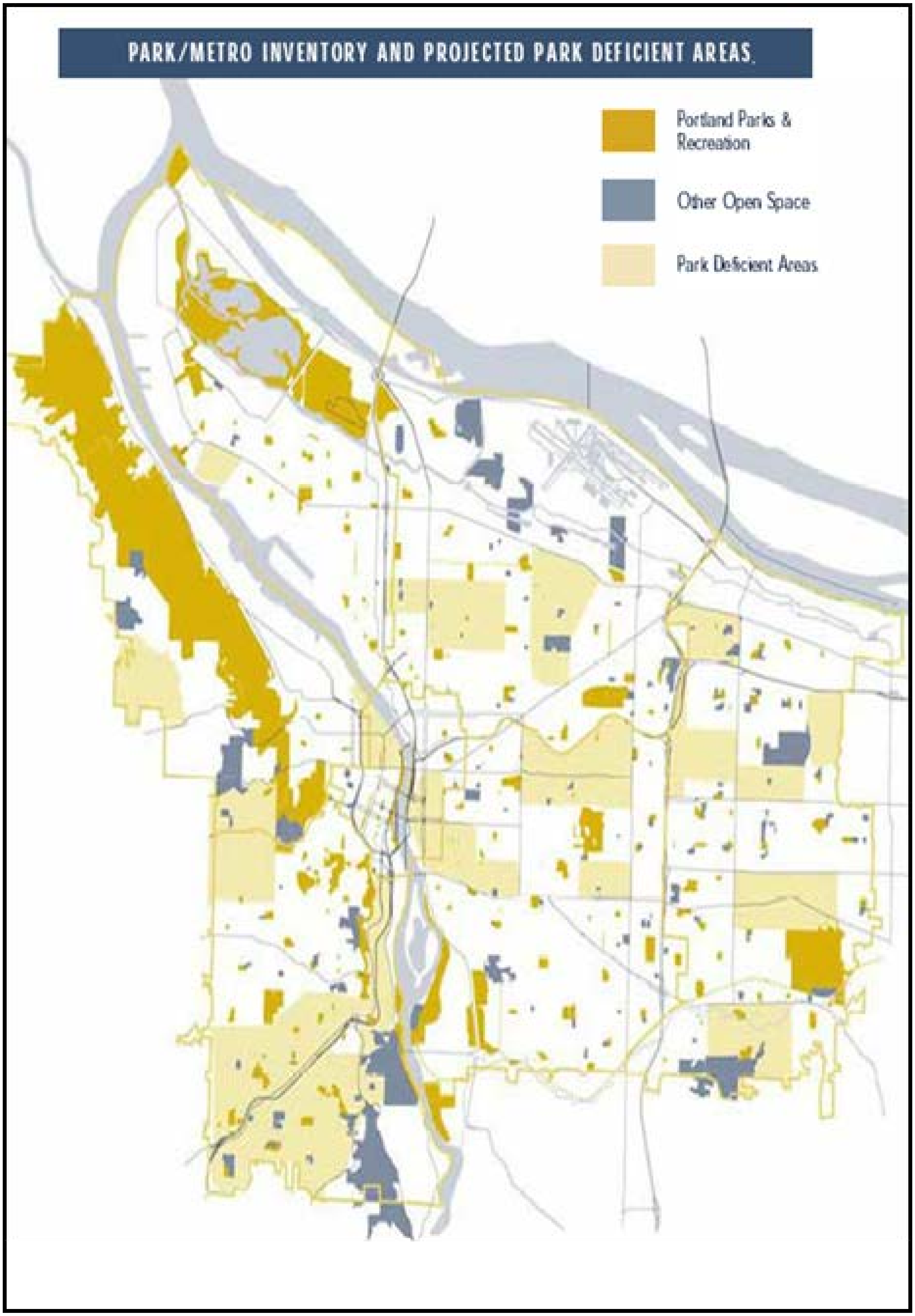

Figure 4-12. Parks and /or open space and amenities found in the Study Area.

4.10 Air Quality

The EPA sets national air quality standards for six common pollutants (also referred to as “criteria” pollutants. These standards, known as National Ambient Air Quality Standards (NAAQS), are shown in Table 4.11. Areas where air quality conditions violate these standards are classified as “non-attainment” and are subject to special air quality controls. Though non-attainment areas do occur in Oregon and previously have occurred in the study area (for both ozone and carbon monoxide), the current conditions of the study area are entirely within attainment of these standards (ODEQ 2013).

The Air Quality Index provides a daily account of air quality based on levels of particulate matter (PM), ozone, and carbon monoxide (EPA 2012). For the Portland-Vancouver-Beaverton area, during calendar years 2010 through 2012 (1,096 days total) there were 169 days of moderate air quality and only 12 days of air quality considered to be unhealthy for sensitive groups (EPA 2012). All other days were considered to have good air quality.

Table 4-11. National EPA Ambient Air Quality Standards

Pollutant	**Average Time**	**National Ambient Air Quality Standard (NAAQS) Violation Determination1**	**Federal Primary Health Standard (NAAQS) Exceedance Level**	**State Standard Exceedance Level**
Carbon monoxide	1-hour	Not to be exceeded more than once/year	35 ppm	35 ppm
	8-hour	Not to be exceeded more than once/year	9 ppm	9 ppm
Lead	Calendar Quarter	Quarterly arithmetic mean	0.15 µg/m3	0.15 µg/m3
	Annual	Annual arithmetic mean	53 ppb	53 ppb
Nitrogen dioxide	1-hour	3-year average of the maximum daily 98th percentile one hour average	100 ppb	NA
	8-hour	3-year average of the annual 4th highest daily maximum 8-hour average concentration	75 ppb	75 ppb
Ozone	24 hour	98th percentile of the 24-hour values determined for each year. 3-year average of the 98th percentile values.	35 µg/m3	35 µg/m3
	Annual Average	3-year average of the annual arithmetic mean	15 µg/m3	15 µg/m3
PM2.5	24 hour	The expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than 1 over a 3-year period.	150 µg/m3	150 µg/m3
	1 hour	3-year average of the maximum daily 99th percentile one hour average	75 ppb	NA
PM10	1-hour	Not to be exceeded more than once/year	35 ppm	35 ppm
	8-hour	Not to be exceeded more than once/year	9 ppm	9 ppm
Sulfur dioxide	Calendar Quarter	Quarterly arithmetic mean	0.15 µg/m3	0.15 µg/m3
	Annual	Annual arithmetic mean	53 ppb	53 ppb
Source: EPA 2013				

In response to these NAAQS, the State of Oregon Clean Air Act Implementation Plan (SIP) was adopted under OAR 340-200-0040 (ODEQ 2013). It defines the Air Quality Control Regions (AQCR) and Air Quality Maintenance Areas (AQMA) throughout the state. Portland is within the Portland Interstate AQCR. In previous years, air quality conditions in Portland resulted in its classification as non-attainment for ozone (O_3) and carbon monoxide (CO). As a result, though these areas are now in attainment, they are classified as an area that must be maintained (e.g. AQMA). The study area is within the Portland/Vancouver AQMA, and as such, is subject to specific air quality standards for ozone and carbon monoxide (CO). In addition, according to the 2010 annual report, particulate matter (PM) levels (for PM2.5) are regularly above 25ug/m3, making the Portland/Vancouver AQMA an area of concern.

4.10.1 Future Without Project Conditions

Air quality programs have resulted in the improvement of air quality through the Air Quality Management District. Existing conditions are expected to continue through on-going air quality monitoring and control programs.

4.11 Noise

Throughout the project area, noise levels can vary widely. Ambient noise levels may be intermittently high in urban areas, particularly near industrial and commercial uses and highways, but consistently low or moderate elsewhere, depending on suburban and rural population, wind levels, aircraft traffic, and recreation, forest, or agricultural activities (PBDS 2013).

The sustainability of Portland's residential communities relies on planning decisions based on a well-defined understanding of the sound characteristics of the community. Community noise is defined by the World Health Organization as "noise emitted from all sources except noise at the industrial workplace. Main sources of community noise include road, rail and air traffic, industries, construction and public work, and the neighborhood."

In 2008, a noise study was conducted that involved collecting sound measurements in North Portland to document and quantify the dominant sources of sound in the North Portland neighborhood (The Greenbusch Group, Inc. 2008). The noise study areas overlapped to some degree with this study's footprint, including areas east of the Willamette River from the confluence of the Columbia River south to downtown Portland and around Columbia Slough. The study reports that the most common loud noise sources in the ecosystem restoration project footprint includes railways, freight corridors, I-5 traffic, and Portland International Airport (PDX) (The Greenbusch Group, Inc. 2008). Noises that were recorded above 60 decibels (dB) included train brakes, and air traffic, while events greater than 70 dB included train horns, roadway traffic, and fireworks.

The PDX noise contours overlap a small portion of the study area at the confluence of the Willamette with the Columbia River and are adjacent to the study area near the upstream portion of the Columbia Slough (PBDS 2013). PDX air traffic resulted in measurements within the study area over 70 dB (The Greenbusch Group, Inc. 2008).

4.11.1 Future Without Project Conditions

Noise conditions are not expected to change noticeably under future without-project conditions. Population growth and increased use of railways or roadways in the project area may incrementally increase noise levels. However, City noise ordinances will continue to ensure that ambient noise does not increase over time.

4.12 Hazardous Waste and Toxic Materials

Pollutants in water often bind to sediment. Because of the level of pollution in Lower Willamette River sediments, the Portland Harbor from downtown Portland to the confluence with the Columbia River was added to the federal Superfund cleanup list in December 2000. Pollutants generated throughout the Willamette River Basin, including industrial discharges, toxics carried by stormwater, and other sources, have contributed to highly elevated levels of dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals in Lower Willamette River sediment.

A search of potentially contaminated areas and sources in the study area revealed several sources and locations of sediment contaminants, primarily from industrial sources within Portland Harbor. Areas of ship-related activities including building (1800s–present), repair (1800s–present), and dismantling (1960s–1979) located within and outside the harbor are known to have deposited chemicals such as volatile organic compounds (VOCs), Semi volatile organic compounds (SVOCs), PAHs, PCBs, TPH, copper, zinc, chromium, lead, mercury, phthalates, and butyltins. The anti-fouling paint applied to ships locally during World War I contained extensive amounts of both zinc oxides and mercury oxides. The wood product and treating industry was largely responsible for the deposition of phenol-formaldehyde resin, sodium hydroxide, and petroleum hydrocarbons such as oil, diesel, and kerosene in plywood manufacturing. Other chemical byproducts from this industry include VOCs, SVOCs, total petroleum hydrocarbons (TPH), and various metals, as well as possibly pesticides and fungicides. Many of the same chemicals also were deposited into sediments by other industry such as chemical manufacturing and distribution, metal recycling, production, and fabrication, manufactured gas production, electrical production and distribution, bulk fuel distribution, storage and asphalt manufacturing, steel milling, smelters, and foundries, and commodities.

A preliminary HTRW investigation was conducted to determine if there is any current and/or historical contamination that could adversely influence the implementation of any future planned ecosystem restoration measures. Relevant environmental databases included lists compiled by EPA and the State of Oregon (EDR 2009). The Environmental Data Resources (EDR) database results indicated that HTRW sites are found in all reaches of the study area as shown in Figure 4.13. Database search details are provided in Appendix E. Potential ecosystem restoration locations that were identified as having potential HTRW issues were removed during the screening process.

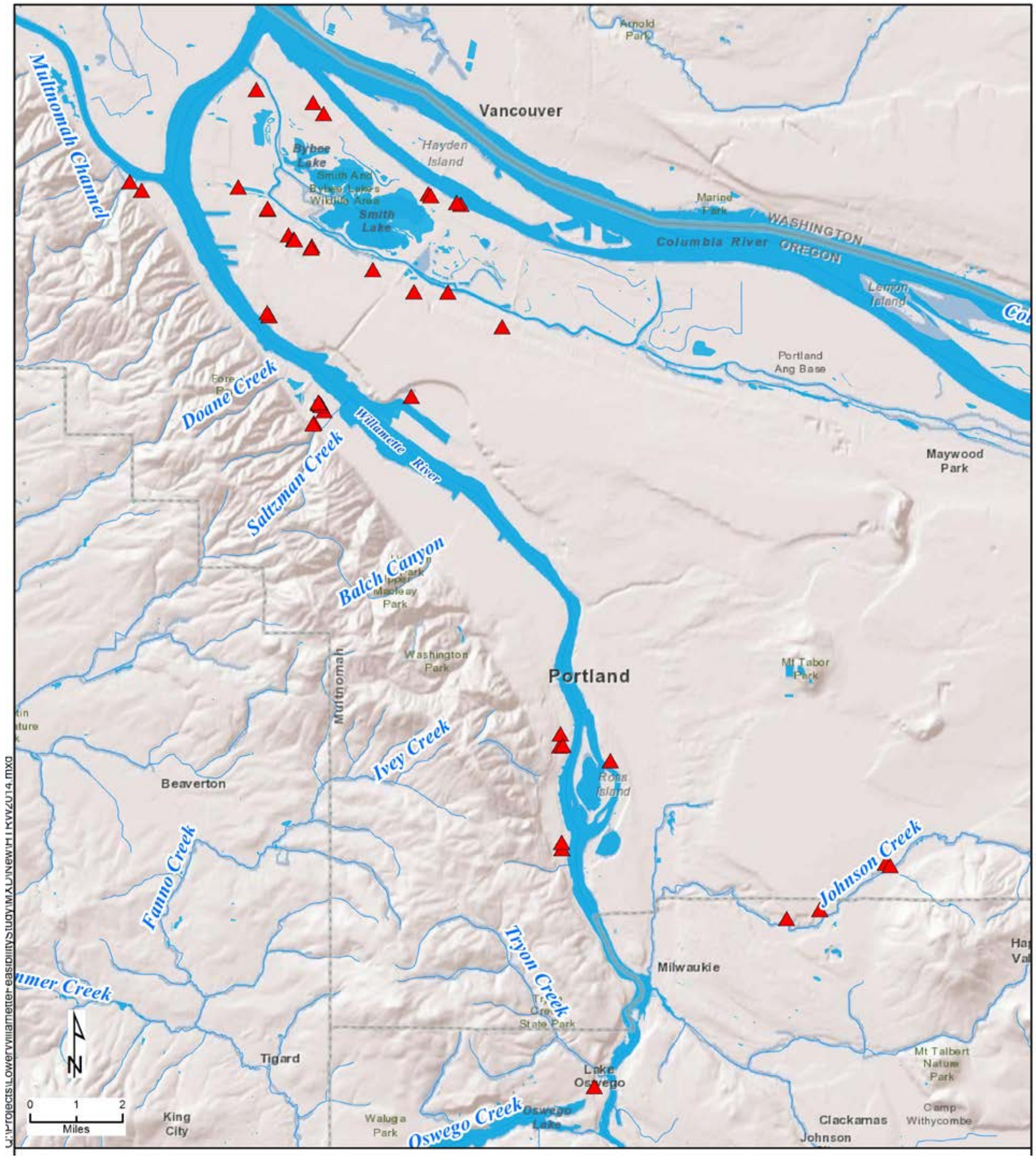

Figure 4-13. HTRW Sites identified in the Study Area

4.12.1 Future Without Project Conditions

Hazardous and toxic wastes and materials may continue to be present in the study area into the future. Additional hazardous materials may also be introduced as a result of ongoing dredging. However, remediation of existing hazardous wastes is ongoing, and in the future it is anticipated that conditions will improve with these efforts. Federal, state, and local protection protocols will assist in preventing new sources of HTRW from entering the system.

4.13 Visual Resources

The project area aesthetics are driven by a variety of factors and vary from site to site. On a local scale, the Lower Willamette River and Columbia Slough both flow through highly developed portions of Portland where urbanization and commercialization have dramatically changed the visual resources from their historic condition. Both waterways have narrow or absent riparian zones and developments frequently built right up to the edge of the river. On a grander scale, views from the river and slough may include the City of Portland and its bridges, Forest Park and the West hills, the City of Vancouver or even the distant Cascade Mountains dominated by Mt. Hood. Detailed aesthetic conditions of the study area are given in Section 7.13.

4.13.1 Future Without Project Conditions

Visual resources throughout the study area will continue to degrade without specific measures taken to protect their condition. Continual maintenance to remove non-native plants will be necessary to protect habitat and aesthetic value and areas without regular maintenance will become less and less attractive. The cumulative loss of natural conditions will continue to affect aesthetic values.

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5. PLAN FORMULATION

Plan formulation is the process of identifying specific ways to achieve planning objectives while avoiding constraints so as to solve the problems and realize opportunities identified earlier in this report. This step of the planning process produces solutions that achieve all or part of one or more of the planning objectives.

In addition to the problems, opportunities and constraints, Corps Planning Principles and Guidelines (P&G) were considered during the plan formulation process. Per ER 1105-2-100, plans should be evaluated for completeness, effectiveness, efficiency, and acceptability.

- **Acceptability** An ecosystem restoration plan should be acceptable to State and Federal resource agencies, local governments and stakeholders in the area. 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.

- **Completeness** A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned ecosystem restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the ecosystem restoration objective. Real estate, O&M, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain ecosystem restoration features and an adaptive management plan has been proposed it must be accounted for in the plan.

- **Effectiveness** An ecosystem restoration plan must represent a cost effective means of addressing the ecosystem restoration problem or opportunity. It must be determined that the plan's ecosystem restoration outputs cannot be produced more cost effectively by another agency or institution.

- **Efficiency** An ecosystem restoration plan must make a substantial contribution to addressing the specified ecosystem restoration problems or opportunities.

5.1 Preliminary Site Identification and Screening

Numerous possible ecosystem restoration sites were initially proposed by the City of Portland. Many of the sites were included in the conceptual watershed management plans developed for the Lower Willamette River watershed (Section 2.2.4). Forty-five sites were selected for additional investigation based on ecological restoration opportunities present that matched project objectives, consideration of how each site fits into the overall watershed, and unique features or functions that may not be feasible to restore or retain at other sites.. These project sites were then reviewed to ensure they did not violate project planning constraints. The initial array of preliminary ecosystem restoration sites are summarized in Table 5-1, and displayed in Figure 5-1.

Table 5-1. Initial Array of Possible Ecosystem Restoration Sites

Mainstem Willamette River			
Site Number	**Site**	**General Location**	**Opportunities**
1	Kelley Point Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
2	Miller Creek Confluence	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
3	Powerline Crossing	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
4	Doane Creek	Willamette Mainstem	Daylight lower stream. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
5	MarCom	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
6	Cathedral Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
7	Willamette Cove	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat.
8	Saltzman Creek	Willamette Mainstem	Daylight mouth of creek. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
9	Balch Creek	Willamette Mainstem	Daylight lower Balch Creek. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
10	Swan Island Beach South	Willamette Mainstem	Maintain habitat values at this site. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat.
11	Waterfront Park Bowl	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
12	Centennial Mills	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Daylight Tanner Creek. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

Site Number	Site	General Location	Opportunities
13	Woods Outfall	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
14	Eastbank Crescent	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
15	Oregon Yacht Club	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
16	Oaks Bottom Wildlife Refuge	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
17	Willamette Park	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
18	Oaks Amusement Park	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
19	Stephens Creek Mouth	Willamette Mainstem	Maintain off-channel habitat; expand on existing high quality functions.
20	Oaks Crossing/Sellwood River front Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
21	Powers Marine Park	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
22	Elk Rock/Spring Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Columbia Slough			
23	City Banks opposite Kelley Point	Columbia Slough	Reconnect adjacent lands to tributaries to allow for inundation and creation of wetland and instream habitat. Location at major confluence provides important connections to both Willamette and Columba River fish populations.
24	Ramsey Refugia	Columbia Slough	Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

Site Number	Site	General Location	Opportunities
25	Smith and Bybee Lakes	Willamette Mainstem	Improve access for fish and wildlife to existing habitat. Re-establish of native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
26	Blind Slough	Columbia Slough	Valuable off-channel habitat with good existing riparian canopy and shrub vegetation. Increase habitat value by increasing habitat complexity, increasing area of off-channel habitat, and improving vegetation diversity.
27	St. John's Landfill Boat Launch	Columbia Slough	Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
28	BES Plant Banks	Columbia Slough	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity. Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat.
29	Wright and Moore Islands	Columbia Slough	Reconnect adjacent lands to rivers and streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
30	Kenton Cove	Columbia Slough	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Johnson Creek			
31	Crystal Springs Culvert Replacements	Johnson Creek	Improve access for fish and wildlife to existing habitat.
32	Westmoreland Park	Johnson Creek	Improve access for fish and wildlife to existing habitat.
33	Errol Creek Confluence	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity. Reconnect adjacent lands to rivers and streams to allow for inundation and creation of wetland and instream habitat.
34	Errol Creek Headwaters	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
35	Bell Station	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
36	West Lents	Johnson Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat.

Site Number	Site	General Location	Opportunities
37	Freeway Land Company/East Lents	Johnson Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
38	Lower Powell Butte	Johnson Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
39	Alsop-Brownwood	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Tryon Creek			
40	Tryon Creek Confluence	Tryon Creek	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
41	Tryon Highway 43 Culvert	Tryon Creek	Improve access for fish and wildlife to existing habitat.
42	Middle TCSNA Habitat Ecosystem Restoration	Tryon Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
43	Marshall Park Channel Ecosystem Restoration	Tryon Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
44	Boones Ferry Culvert Retrofit	Tryon Creek	Improved access for fish and wildlife to existing habitat.
45	Arnold Creek Culvert	Tryon Creek	Improve access for fish and wildlife to existing habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

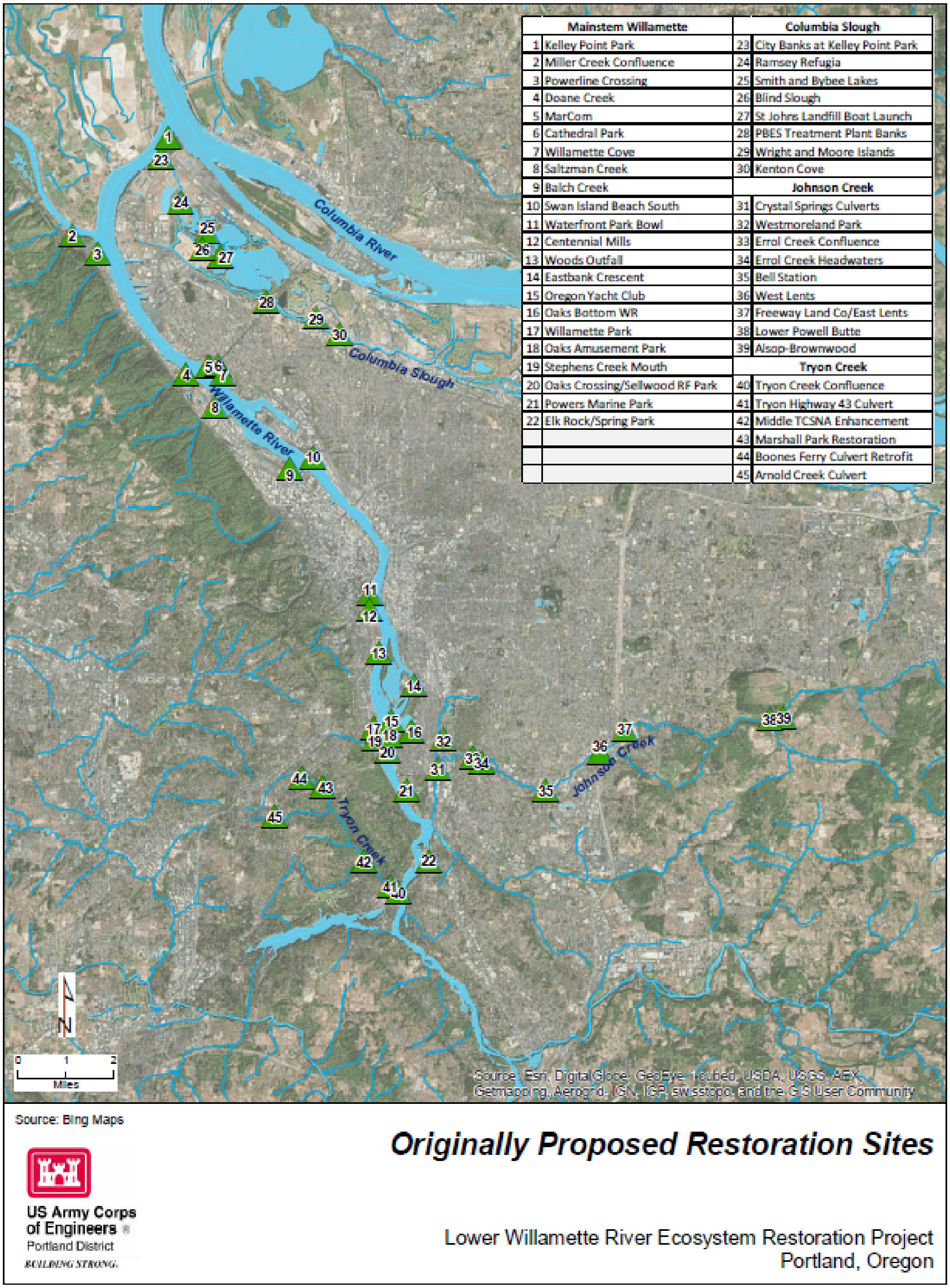


Figure 5-1. Originally Proposed Ecosystem Restoration Sites

5.2 Preliminary Screening of Sites

Initial criteria were developed to screen 45 sites. It included: potential real estate concerns); whether or not the sites potentially lend themselves to proven ecosystem restoration techniques with a proven long-term success; whether or not other entities had already planned or had construction underway at the site; and constructability concerns or problems. Table 5-2 summarizes the screening criteria and description. Any site that violates one of these criteria was removed from further consideration.

Table 5-2. Initial Site Screening Criteria

Screening Criteria	Description
Real estate	Lands under multiple ownership, where owners were clearly not supportive of implementation of ecosystem restoration measures, or where the long-term preservation of restored habitat was in question, were removed or site plans were scaled back to exclude such areas.
Limited ecosystem restoration potential (long-term success)	Several sites initially appeared to offer opportunities for ecosystem restoration, but upon closer inspection were found to be compromised by issues including poor water quality, poor sediment quality, upstream conditions that compromised habitat quality and which were beyond the reach of the proposed project, or where the benefits of ecosystem restoration would be otherwise limited.
Work Underway by Others	In some cases, sites were found to be under planning for ecosystem restoration by other entities, or ecosystem restoration measures had already been implemented.
Constructability	Sites where construction would be very complicated, where access would be especially difficult, or where it appeared that contamination may be present were removed from consideration. Not Cost effective

Two events occurred during the course of this General Investigation Study: in 2000 the Willamette River, Portland Harbor was listed as a Superfund Sites, and in 2008 the Nation Marine Fisheries Services (NMFS) produced a Biological Opinion for the Willamette Basin for ESA listed species. Both of these events resulted in an extended planning process due to the time it took to determine how those decisions affected this study.

Members of the Product Development Team (PDT) which also included project stakeholders conducted reconnaissance-level surveys at all 45 sites. The purposes of the surveys were to gather data to establish baseline conditions and to conduct secondary screening to eliminate sites where constraints made ecosystem restoration potential limited or clearly infeasible.

Field investigations began in November and December, 2007. Table 5-3 indicates the primary reasons and challenges that led the PDT to screen sites from further analysis in the Feasibility Study.

Table 5-3. Sites Eliminated from Consideration

Site	**Reason for Removal from Consideration**	**Initial Screening Criteria Violated**
Mainstem Willamette		
2. Miller Creek Confluence	Private ownership	Real estate
3. Powerline Crossing	Land owned by unwilling landowner	Real estate
4. Doane Creek/Railroad Corridor	Environmental contamination; private ownership; high cost of ecosystem restoration	Limited ecosystem restoration potential (long-term success), Constructability
5. MarCom	Site showed limited ecosystem restoration potential and high possibility of need for remediation	Limited ecosystem restoration potential (long-term success), Constructability
7. Willamette Cove	Emerging evidence of contamination rendered this site infeasible until remediation had been completed	Constructability
9. Balch Creek	Environmental contamination; minimal ecosystem restoration opportunities	Limited ecosystem restoration potential (long-term success), Constructability
10. Swan Island Beach South	Site was slated for remediation, poor water quality	Limited ecosystem restoration potential (long-term success), Constructability
11. Waterfront Park Bowl	Land use and recreation requirements minimized area of potential ecosystem restoration to less than desirable.	Limited ecosystem restoration potential (long-term success)
12. Centennial Mills	Site was planned for redevelopment, future of restored habitat could not be guaranteed	Limited ecosystem restoration potential (long-term success)
13. Woods Outfall	Site showed limited ecosystem restoration potential and likely high maintenance requirements over time	Limited ecosystem restoration potential (long-term success)
14. Eastbank Crescent	Site did not appear to offer substantial potential for successful ecosystem restoration	Limited ecosystem restoration potential (long-term success)
15. Oregon Yacht Club	Land owned by multiple unwilling landowners	Real estate
16. Oaks Bottom Wildlife	Project was moved forward as	Work Underway by Others

Site	Reason for Removal from Consideration	Initial Screening Criteria Violated
Refuge	a separate Corps Section 206 ecosystem restoration project	
17. Willamette Park	Site considered for ecosystem restoration as part of separate project	Work Underway by Others
18. Oaks Amusement Park	Perceived issues due to private ownership.	Real estate
19. Stephens Creek Mouth	Very limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
21. Powers Marine Park	Site showed very limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
22. Elk Rock Island	Site did not appear to offer substantial potential for successful ecosystem restoration	Limited ecosystem restoration potential (long-term success)
Columbia Slough		
23. City Banks opposite Kelley Point Park	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
24. Ramsey Refugia	Work already completed by Portland Bureau of Environmental Services	Work Underway by Others
25. Smith and Bybee Lakes	Ecosystem restoration work already occurring under separate contract	Work Underway by Others
26. Blind Slough	Limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
29. Wright and Moore Islands	Site showed very limited ecosystem restoration potential and difficult construction access	Limited ecosystem restoration potential (long-term success), Constructability
Johnson Creek		
31. Crystal Springs Culvert Replacement	Culvert replaced as part of separate project	Work Underway by Others
32. Westmoreland Park	Project was moved forward as a separate Corps Section 206 ecosystem restoration project	Work Underway by Others
33. Errol Creek Confluence	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
34. Errol Heights (Headwaters)	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
35. Bell Station	Private ownership; requires purchase of property and	Real estate

Site	**Reason for Removal from Consideration**	**Initial Screening Criteria Violated**
	residential relocation for floodplain project	
36. West Lents	Private ownership would require purchase of property and residential relocation for floodplain project	Real estate
37. Freeway Land Company	Site was subsequently considered for a flood control project rather than an ecosystem restoration project	Limited ecosystem restoration potential (long-term success)
38. Lower Powell Butte	Some landowners did not appear to be willing to participate in the proposed project	Real estate
39. Alsop-Brownwood	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
Tryon Creek		
40. Tryon Creek Confluence	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
42. Middle TCSNA	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
43. Marshall Park	Ecosystem restoration measures were implemented under a separate project	Work Underway by Others
44. Boones Ferry Culvert	Culvert retrofit being designed as part of a separate project	Work Underway by Others
45. Arnold Creek Culvert	City considering this project under a different program	Work Underway by Others

As depicted, the Mainstem Willamette started with 22 sites, 4 sites were screened out for real estate concern, 2 of the original site have ecosystem restoration measures implemented or are being planned as separate projects, therefore they are no longer available for consideration, and 12 sites were screened out for limited ecosystem restoration potential (long-term success), or constructability, leaving 4 sites for further consideration. These 4 sites are: Kelley Point Park, Cathedral Park, Saltzman Park and Oaks Crossing. Columbia Slough started with 8 sites, 0 sites were screened out for real estate concern, 3 of the original site have ecosystem restoration measures implemented or are being planned as separate projects, therefore they are no longer available for consideration, and 2 sites were screened out for limited ecosystem restoration potential (long-term success), or constructability, leaving 3 sites for further consideration. These 3 sites are: St John's Landfill, BES Plant, and Kenton Cove.

Johnson Creek started with 9 sites, 3 sites were screened out for real estate concern, 5 of the original site have ecosystem restoration measures implemented or are being planned as separate projects, therefore they are no longer available for consideration, and 1 site was screened out for limited

ecosystem restoration potential (long-term success), or constructability, leaving 0 sites for further consideration.
Tryon Creek started with 6 sites, 0 sites were screened out for real estate concern, 5 of the original site have ecosystem restoration measures implemented or are being planned as separate projects, therefore they are no longer available for consideration, and 0 sites were screened out for limited ecosystem restoration potential (long-term success), or constructability, leaving 1 site for further consideration. This site is Tryon Creek, Highway 43.

Therefore, in summary, 37 of the original 45 sites were screened out; 7 sites were screened out for real estate concerns, 15 of the original site have ecosystem restoration measures implemented or are being planned as separate projects, therefore they are no longer available for consideration, and 15 sites were screened out for limited ecosystem restoration potential (long-term success), or constructability, leaving 8 sites for further consideration.

The remaining 8 sites (Figure 5-2) are: Mainstem Willamette Sites; Kelley Point Park, Cathedral Park, Saltzman Creek and Oaks Crossing, Columbia Slough Sites; St John’s Landfill, BES Plant, and Kenton Cove, and Tryon Creek Sites; Tryon Creek, Highway 43.

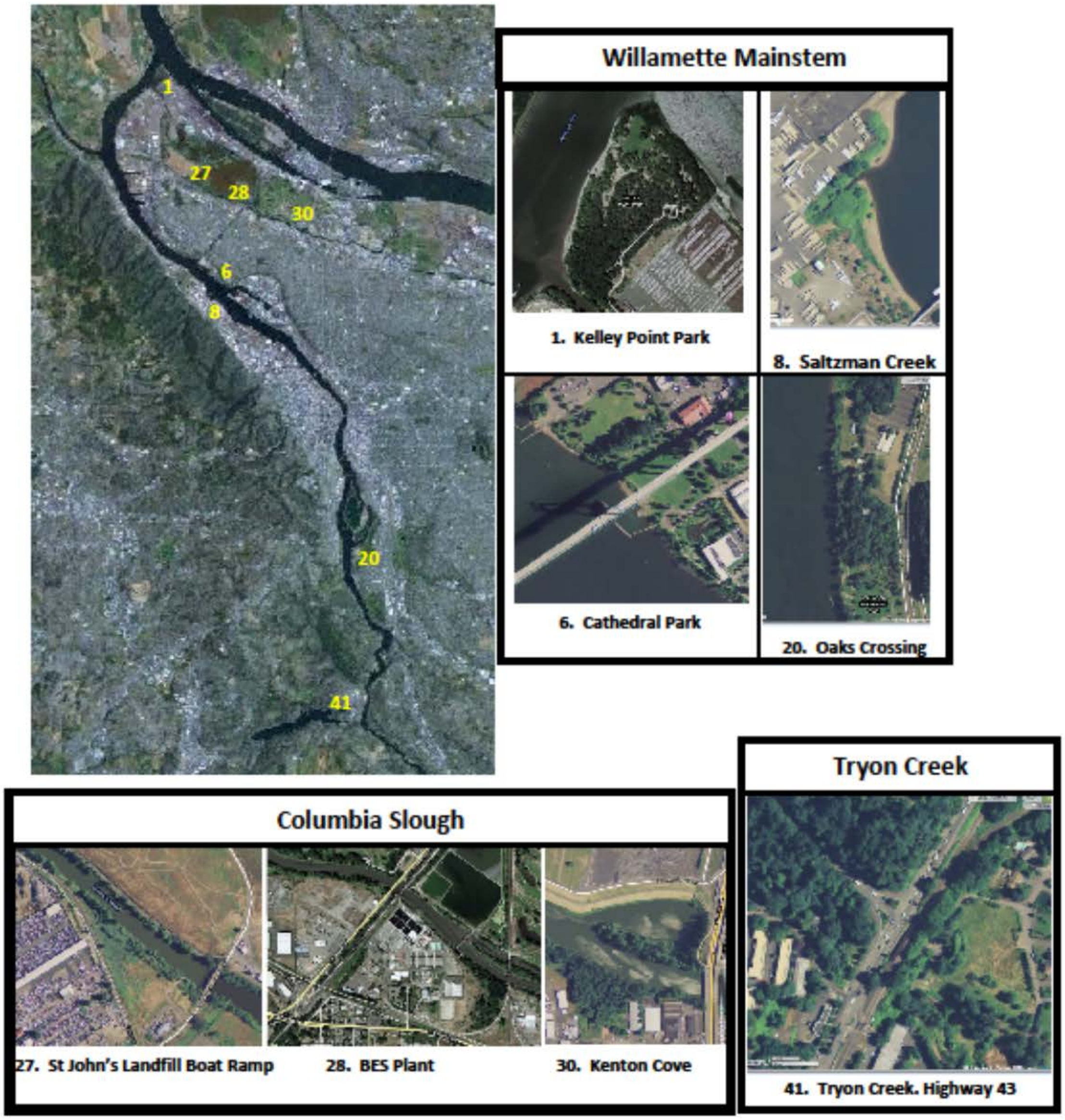


Figure 5-2 Remaining Eight Sites

5.3 Development of Ecosystem Restoration Measures

Ecosystem restoration measures were developed supporting the following three planning objectives:

- Reestablish riparian and wetland plant communities;
- Increase aquatic and riparian habitat complexity, connectivity, and diversity; and
- Restore floodplain function and connectivity.

Each of these objectives is proposed to address a problem or take advantage of an opportunity introduced earlier in Chapter 3 within the project area. The measures listed in Table 5-4 were identified as measures that could be implemented at the 8 remaining sites to achieve these planning objectives.

Table 5-4. Ecosystem Restoration Measures

Measure	General Description	Objective Achieved
Large wood Placement	Large wood is a naturally occurring component of streams in the Lower Willamette River ecosystem. Large wood has been removed from streams for a variety of reasons including improved navigation, reduction of flow resistance, flood control, and perceived fish passage problems (Fischenich and Morrow 1999). Placement of large wood is proposed as a technique to restore stream channel morphology and fish and wildlife habitat forming functions such as pool creation, sediment and organic matter retention, and habitat complexity and refugia ecosystem restoration (PBES 2006). Strategic placement of large wood can promote channel scour or bar formation, or can be used to protect restored bank features from the full force of the river's current.	Increase aquatic and riparian habitat complexity and diversity
Riparian revegetation	Riparian areas shade streams, moderate stream temperatures, provide overhead cover, filter sediments and runoff, control streambank erosion, and provide a terrestrial source of organic matter and insects that support aquatic food chains (PBES 2006). Riparian plantings along river banks and floodplains also restore natural recruitment of large woody debris to the system. Urbanization and development of riparian areas have reduced the quantity and quality of riparian zones throughout the Lower Willamette Basin. Riparian plantings would include tree, shrub, and herbaceous species as appropriate for site conditions.	Reestablish riparian and wetland plant communities Increase aquatic and riparian habitat complexity and diversity Restore floodplain function and connectivity
Invasive species removal	The composition, age, and spatial structure of tree and shrub species are important indicators of the health of a riparian area. Properly functioning riparian ecosystems have the appropriate combination of mature and developing vegetation, species diversity, and levels of	Reestablish riparian and wetland plant communities

	structure, all of which can be disturbed by the presence of invasive species. Invasive species often out-compete native species, reducing the productivity and function of riparian areas, altering wildlife habitat, and in some instances changing soil characteristics. Invasive species removal is proposed in combination with riparian planting projects to fully restore riparian function. This ecosystem restoration measure would involve the active removal of non-native vegetation, including Himalayan blackberry, reed canary grass, yellow flag iris, holly, and English ivy from the riparian zone and floodplain. Removal could be done by mechanical means (plowing, disking, and mowing), hand removal (cutting), and/or spot applications of herbicides where the risk of contamination of waterways is limited.	Increase aquatic and riparian habitat complexity and diversity
Floodplain Reconnection	Connected floodplains attenuate high flows, store water and recharge groundwater tables, and both retain and contribute organic matter, substrate, and large wood to the stream system. Steepened banks are often a result of fill placement, bank stabilization and channelization activities, which cause channel incision and floodplain disconnection. Grading banks to gentler slopes is proposed to allow for restored floodplain connections and increased floodplain area with shallow water habitat, and to allow riparian and aquatic habitats to form more naturally along the river corridor.	Restore floodplain function and connectivity
Off-channel habitat development	Side channel and off-channel habitats are important feeding, resting, and rearing areas for aquatic species and, by providing protected areas with lower flow velocities, serve as key refugia during flood events. A study by the Oregon Department of Fish and Wildlife and the City of Portland (Friesen 2005) found that all off-channel habitats currently present along the Lower Willamette River were used by juvenile salmonids for forage and refuge. The creation and reconnection of side channels, alcoves, and backwater habitats is proposed to increase the quantity of this important habitat to aquatic species. To be most effective, this measure should be combined with other measures including invasive species removal and revegetation with native species.	Reestablish riparian and wetland plant communities Increase aquatic and riparian habitat complexity and diversity Restore floodplain function and connectivity
Fish Barrier Removal	Undersized or poorly designed culverts or other artificial fish passage barriers affect the number of salmonids that can return to spawn, the temporal and spatial distribution of salmonids throughout a subbasin and, ultimately, the nutrient balance of that freshwater system (PBES 2006). This measure would remove fish passage barrier culverts and replace them with a new wider culvert meeting ODFW fish passage rules.	Restore floodplain function and connectivity

These measures would help to:

- Achieve one or more of the planning objectives
- were scaled using the Habitat Evaluation Procedures (HEP) model (see 5.4.3) for each site;
- were proven to have been effective on other, similar projects

- covered the range of life stages that would occur in the study area
- Be implementable given the size of the available ecosystem restoration area at the site.

As opposed to single large ecosystem restoration sites, this study includes numerous small sites throughout the lower Willamette River watershed area where the cumulative effect of implementing numerous projects is significant on a watershed scale. Scalability in application of the measures was achieved with the use of the HEP model.

5.4 Development of Conceptual Ecosystem Restoration Site Plans

To help determine the potential ecological lift at each site, the PDT mapped each site and recorded data regarding vegetation, hydrologic features, topography, substrate, and land use on a standard data sheet. Base maps were obtained from the City of Portland or created for the river, floodplain, and tributary sites using aerial photographs and topographic maps. Specific features such as locations of wetland features were recorded by use of Geographic Positioning System (GPS) equipment. GIS base layers showing the project locations and boundaries were later modified to reflect more precise boundaries or areas of influence for the ecosystem restoration features.

The PDT conducted additional site visits at each of the 8 sites and identified what project objective(s) could be reasonably obtained, and what measures as listed in table 5-4 could be applied to achieve those objectives. Of the 8 sites at least two of the three project objectives could be reached at each site with 4 sites meeting all 3 objectives.

Initial identification of measures that could be applied at each site was to establish the minimum area, lineal feet, lump sum, and acres, of that measure that could be applied at each site to register a meaningful change in habitat scoring from its existing condition. Most of the measures identified by the team to be effective for habitat benefit were dependant on application of other measures at the site to optimize those benefits. Measures, or combinations of measures, were considered appropriate for each site if they appeared to have the potential to address one or more of the habitat ecosystem restoration objectives; if they could be implemented at a scale to cause a measurable difference in the habitat value at that site; and if they were ecological feasible, defined as having high ecosystem restoration opportunity using known scientific effectiveness. The small size of a number of the sites made incremental analysis of each measure per site not meaningful when applied separately for habitat benefits. Measures recommended at each site are dependent on each other to restore the range of habitat values that each site offers, and, cumulatively, to achieve restoration of habitat components on a watershed scale. In areas where implementation of measures could reasonably be measured incrementally or separate from other measures HEP analysis were performed and noted in the site descriptions.

The focus of the combination of measures at each site was to enhance habitat value for the life stage or stages of the species that were most likely to be found at the site. The HEP model was used to determine the extent of adding additional measures at each of the eight sites. The PDT added the next logical measure incrementally to attain additional measurable ecological output from the HEP model. For example, sites on the mainstem Willamette River were assumed to support juvenile salmonids during their outmigration period, therefore measures recommended for implementation at these sites included features that would provide forage opportunities, high-flow refugia, and cover for small fish.

In order to establish the maximum measures, the HEP model and professional judgement was used. For example, when considering revegatation, the PDT started with the minimum measures at the site, and then incrementally added plantings until the ecological outputs diminished. This represented the maximum measures per site. At Kenton Cove areas around the water were considered necessary for riparian plantings, as compared to those areas farther up the slope. At Tryon Creek, the primary issue affecting habitat quality was lack of access by adult fish into the stream; therefore the primary ecosystem restoration measure of culvert replacement was developed to facilitate passage of this life stage into the stream.

Table 5-5. Measures Applied at Each Site to Meet the Objectives

Site	Objective 1	Objective 2			Objective 3
	Revegetation	Large Wood	Off-channel habitat	Fish barrier removal	Floodplain reconnection
Willamette Mainstem					
Kelley Point Park	X	X	X		X
Cathedral Park	X	X	X		
Saltzman Creek	X	X	X		
Oaks Crossing	X	X	X		X
Columbia Slough					
St. Johns Landfill BR	X	X	X		X
BES Plant	X	X	X		X
Kenton Cove	X	X			
Tryon Creek					
Tryon Creek, Highway 43	X			X	

5.4.1 Dependency of Measures applied to meet project objectives

In many cases measures that were recommended for application at a site were tied into the application of another measure therefore being dependant on each other to obtain the habitat benefit potential at that site. At the same time, the full range of measures that has been developed for this project are not proposed at each site, generally because they would not be cost effective, would be redundant, or not needed to meet the objectives for that site, or because the size of the site would not allow them to be implemented at a scale that would be effective. Therefore measures at each site were identified by the PDT to be dependant or independent of each other and run through the HEP and incremental cost analysis based on this dependency. This methodology was the main component for achieving the most effective habitat value per site and on a watershed scale.

Mainstem Willamette Sites

Kelley Point Park

Kelly Point Park is owned and operated by the City of Portland, Parks and Recreation Department. This 100-acre park is located at the tip of a peninsula bounded by the Columbia slough on the south, the Willamette River on the west and the Columbia River on the North. Adjacent surrounding lands are primarily used for industrial purposes. Ecosystem restoration portion at this site is 47.37 acres. A recreation component includes providing pedestrian access by placement of bridges over constructed swales that otherwise would limit park uses.

Kelley Point Park (Figure 5-3) was once a very complex, tidally-influenced wetland-riparian area of high importance due to its location at the confluence of the Willamette and Columbia Rivers. Historic placement of fill and its conversion to a park have reduced this complexity and steepened its banks, diminishing the riparian corridor and blocking fish from accessing the interior area of the site and its historic tidal sloughs.

Habitat components that would be improved at this site include the banks and riparian areas along the Willamette River, and a large component of the interior of the park where tidal channels and riparian habitat would be constructed. Both of these areas at Kelley Point Park will provide for much needed off-channel and high flow refugia for juvenile anadromous fish that may be moving downstream from either the Willamette River or the Columbia River and enhance ecosystem functions to support other target species and guilds that may rely on riparian areas found on the Willamette River and inland tidal areas.

Proposed at Kelley Point Park are the construction of tidal channels and their associated riparian areas, layback of the bank along the Willamette River, riparian planting, large wood and boulder placement. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Using these areas, the total restored area would be approximately 47.37 acres.

The primary component of restoring off-channel habitat for juvenile fish is to create access to areas that have been cut off from river flow due to placement of fill, channel incision, or other geomorphological changes. In this instance, the primary feature is to excavate tidal channels in existing swales found in the interior of the site. Although tidal channels are the primary component, they do not provide all the features needed to support juvenile fish. Other habitat features (measures) are necessary to provide cover, forage, thermal regulation, and other variables that collectively contribute to an environment that will support juvenile fish. A healthy riparian zone is needed to provide shading, detrital input, large wood, edge cover, and to assist with sediment retention. Without a healthy riparian zone, fish in the side channels may find some refugia from high-flows in the mainstem, but the other features needed for the side channels to provide temporary rearing will not be present. Large wood is needed within the channels to moderate channel velocities, provide cover from predators, and create scour pools that may support small fish during low tides. Large wood is also needed along the edges of Kelley Point Park to support small fish by providing cover when the tidal channels are not accessible.

In the mainstem of the Willamette River locations for high flow refugia needed to support juvenile salmanoids is limited, laying back of bank slopes, placement of large wood and riparian plantings are needed for this projects target species. Kelley Point Park site has the potential to provide for this rare opportunity and in conjunction with these sites also provide for the off channel habitat Listed above), the combination of these measures create a huge ecological benefit.

For the benefit of other target species and guilds that are likely present at this site, side channels may provide some benefits, but once the species are present, other habitat components are necessary to fully support them and their lifecycles. As an example, the western pond turtle relies on boulders by water or surrounded by water for haul out sites and mating, therefore side channels, while good for overall pond turtle habitat they do not provide the required habitat benefit that large wood/boulders would provide. Amphibians including salamanders and various frog species, rely on healthy riparian areas that provide leaf litter and downed wood for cover and forage, in proximity to water sources.

In all of these cases, implementing only a single measure would not provide the habitat features needed to fully support these species. Excavating side channels and restoring riparian forest would more fully meet the habitat requirements of the target species, but would not provide the instream structure needed to support fish and turtles and other amphibians. Only by implementing all three restoration measures can the objectives at this site be met. Anything less than this combination of measures may initially attract these species, but if they do not find fully functioning habitat, partial implementation could prove to be detrimental to species that try to survive there.

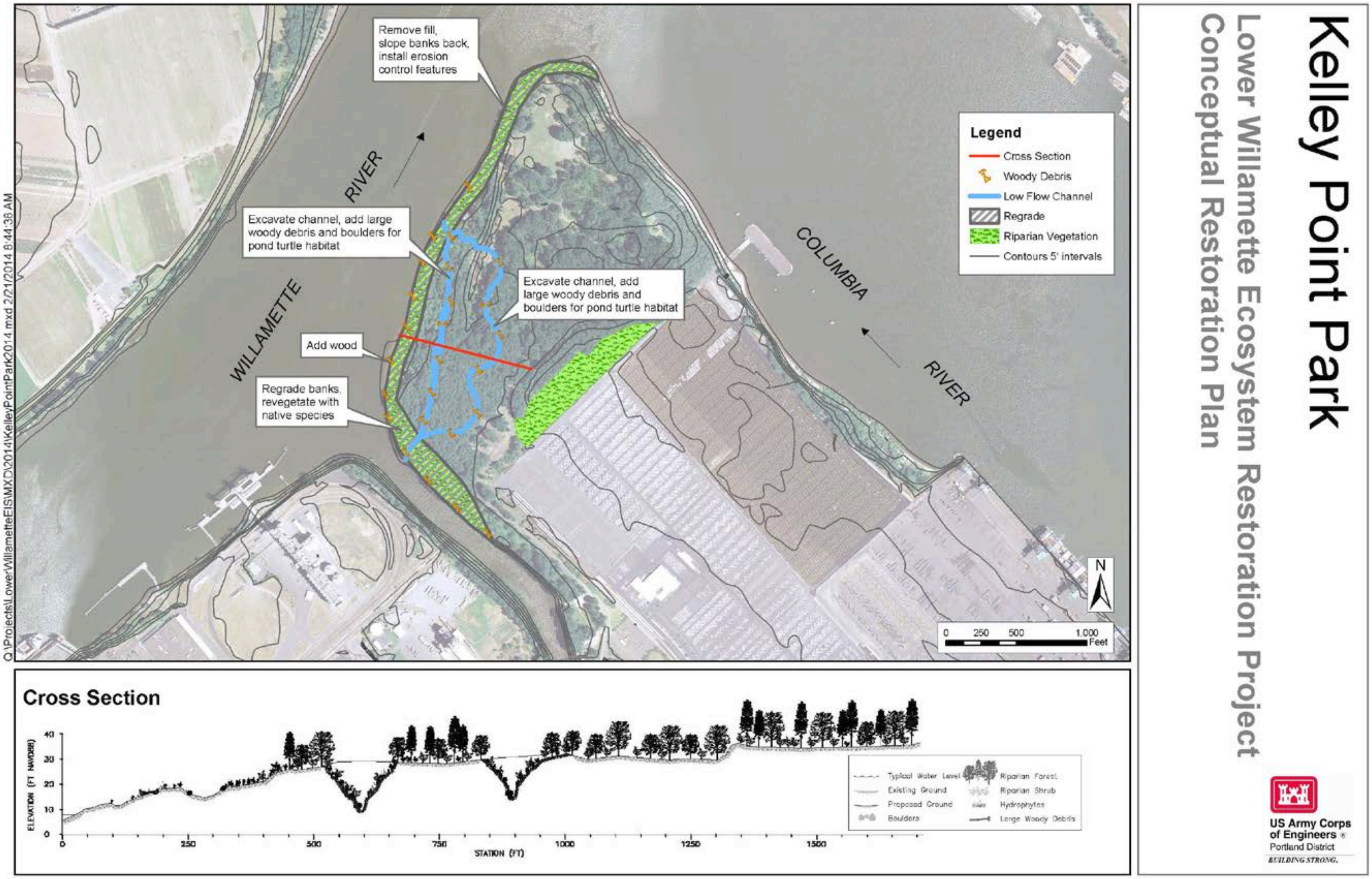


Figure 5-3. Kelly Point Park

Cathedral Park

Cathedral Park is located on the east bank of the Willamette River Mile 6, and is situated beneath the historic St Johns Bridge. It is a 23-acre park owned by the City of Portland. Currently, the site is a public park and green space with multiple uses. The Project area encompasses 3.79 acres.

Cathedral Park (Figure 5-4), habitat complexity has been diminished due to its conversion to a park. Runoff is channelized, and historic swales which would have supported seasonal wetland habitat and stored storm runoff has been converted to lawn, and topographic features allow runoff to flow directly to the Mainstem river. The historic riparian and wetland areas near the banks of the river have also been diminished or removed. The intent of this project is to revegetate river banks with native trees and shrubs, increase stormwater retention, and create off-channel wetland habitat. The parking lot and existing swale would be modified to detain stormwater runoff and provide additional wetland habitat. Vegetated wetland deltas would be created at the mouth of the swale and at a similar location just north of the mouth of the swale to provide off-channel refugia for juvenile fish.

Habitat components that would be created or restored at this site include ecosystem restoration of approximately 0.75 acre of riparian forest, 1.1 acres of created wetlands, grading to convert drainage into a swale where seasonal wetlands would form over approximately 0.75 acre, and addition of root wads along the Willamette River (area of influence approximately 0.5 acre). Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements total approximately 3.79 acres.

The main objectives of implementing restoration measures at Cathedral Park are to take advantage of existing contours to restore wetlands for amphibian species and water quality; provide critical riparian habitat, which is lacking in this reach of the Willamette River; and to provide structure to shelter small fish during high-flow events.

Historically, the site on which Cathedral Park is now located supported off-channel wetlands in swales that gathered and retained storm runoff. Although the swale topography is still present, the swales have been drained and vegetation within them has been replaced by lawn and ornamental species.

Restoration of wetlands will provide aquatic habitat required by amphibians, species which would generally not enter a large water body such as the Willamette River. However, such species also require riparian habitat for cover once they leave the wetlands; to provide detrital input for food-web support; and to provide nesting and breeding habitat. For this reason, the actions of restoring wetlands and restoring riparian forest are interdependent. Implementing one action without the other would not provide the habitat characteristics necessary to support these species.

Since this reach of the Willamette River has been heavily industrialized, most of the riparian habitat and structure at the edge of the river has been removed. Fish and neotropical migrant species have little habitat for forage or cover. Therefore, the PDT recommended that large wood be added to the edge of the river in combination with restoration of riparian forest. Large wood jams or rootwads will provide cover to fish during high flows, and the restored riparian forest is deemed necessary to contribute large wood over time, to provide detrital input, and to provide cover in addition to the large wood.

The PDT assessed the possibility of expanding the areas to be restored as wetlands and riparian forest, but this was deemed infeasible due to other uses of the site. Additional large wood was considered but the PDT determined that significant habitat benefits would occur by adding the amount of wood currently recommended, and the benefits of adding more wood would not be significant.

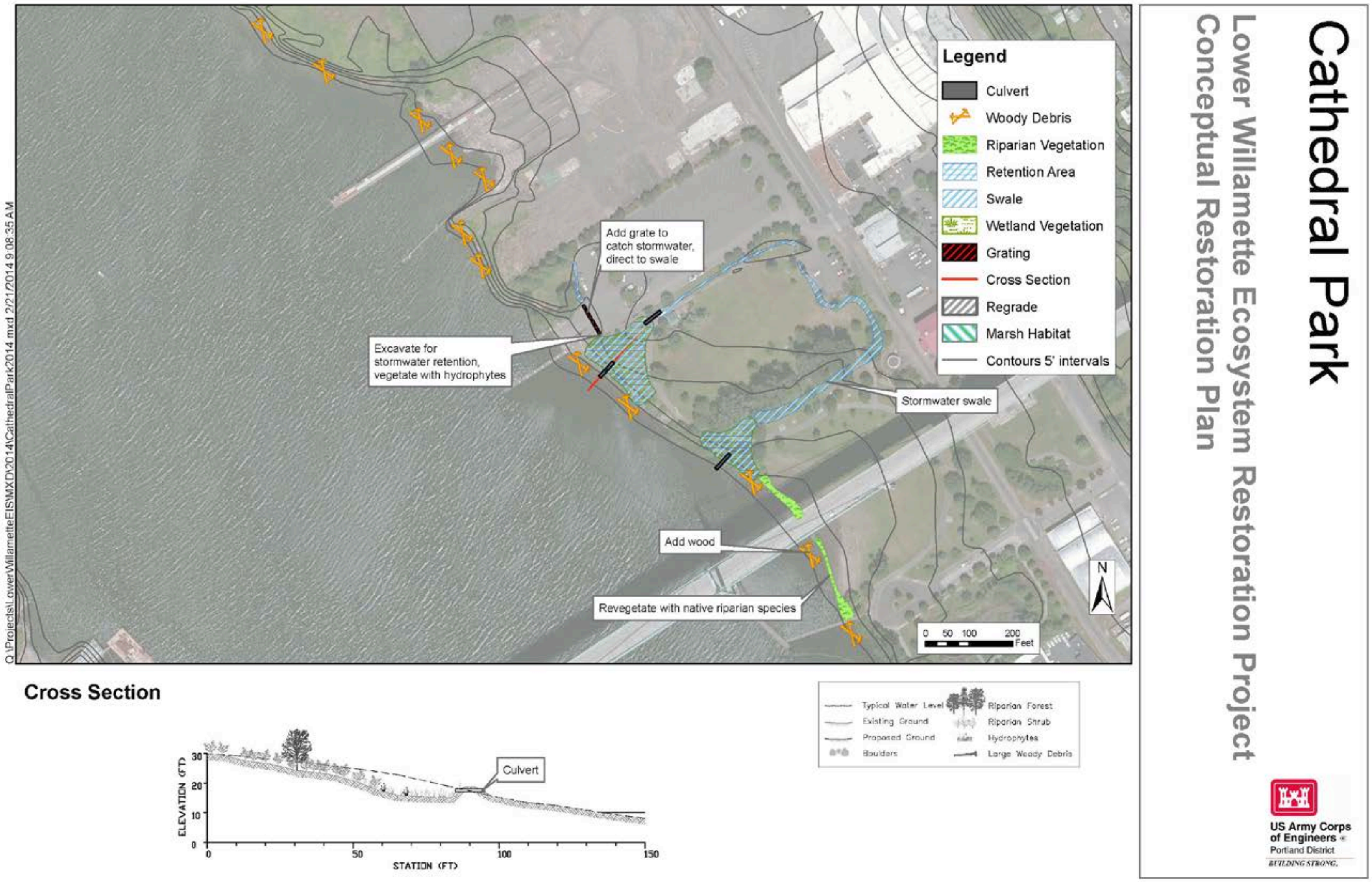


Figure 5-4. Cathedral Park

Saltzman Creek

The Saltzman Creek site is located on west bank of the mainstream Willamette River at RM8. The creek flows between two large areas of fill with a narrow corridor into the Willamette River. It is bordered to the west by a highly developed industrial area. Total project area is 5 acres with the area above ordinary high water in private ownership, and below OHW the site is owned by Oregon Department of State Lands.

Saltzman Creek (Figure 5-5) has been channelized and its banks have been drastically steepened by fill. It currently has no riparian area or wetlands, and virtually no habitat complexity. A small inlet off of the Willamette River at the mouth of Saltzman Creek would offer very good habitat for juvenile fish seeking shelter from the current in the mainstem thalweg, but the quality of this inlet is diminished due to its having little shallow water habitat preferred by juvenile fish. The intent of this project is to slope back banks of fill along Saltzman Creek at its confluence with the mainstem Willamette River to create a wider creek corridor and floodplain, as well as a restored riparian vegetation community; and to restore shallow water habitat. The riparian zone would be restored and large wood would be placed at the confluence for habitat complexity and cover. Restoring the riparian zone would involve recontouring the banks to a gentler gradient to prevent bank erosion, removing invasive species, and revegetating with native species.

Habitat components that would be created or restored at this site include 0.75 acre of invasive species removal and revegetation with native riparian species of existing habitat, creation of 0.5 acre of shallow water habitat, laying back the banks of Saltzman Creek and revegetating over 0.5 acre, and addition of root wads along the edge of the Willamette River and Saltzman Creek (area of influence of approximately 0.15 acre). Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements would occur over approximately 5.0 acres.

The primary objectives of implementing restoration measures at the Saltzman Creek site are to support juvenile fish by providing off-channel stream habitat and enhancing shallow water habitat, and to restore critical riparian forest habitat in a stretch of the mainstem river where such habitat is lacking. The Saltzman Creek site offers a rare opportunity for such restoration, given that it is effectively a cove that is protected from high flows of the mainstem river and because a small tributary stream (Saltzman Creek) enters the river at this location.

Four primary restoration measures were proposed for this site. Those include grading banks to create shallow water habitat and to create bank angles that are gentle enough to allow establishment of riparian vegetation; addition of large wood; revegetation with native riparian species; and addition of sand and gravel to create proper substrate for juvenile fish to thrive. These measures are considered dependent on each other since the range of objectives at this site is narrow, and all of these measures are needed to meet the objectives.

Bank angles along Saltzman Creek are approximately 1:1, which is too steep to plant into and also too steep to support large riparian species which are typical under normal conditions, therefore the measure of grading the banks is considered essential. Restoration of riparian and wetland habitat along the stream channel is considered essential to restoring habitat for fish along the available stretch of Saltzman Creek since the stretch now has virtually no riparian habitat and receives no shading, detrital input, contribution of large wood, or sediment stabilization or other critical riparian functions; and to provide habitat for neotropical migrant species, beavers, and amphibians. Addition of large wood is necessary to shelter small fish in Saltzman Creek during high flows and to provide habitat diversity in what is now an impoverished stretch of stream; to moderate flows and reduce damage to the stream channel during high flows; and to provide cover for small fish in the shallow water habitat that will be enhanced at this site. Without addition of large wood, fish that may enter the cove at the mouth of Saltzman Creek, or enter the stream itself, will find habitat that is not suitable to fully support them during the key life stage during which they would likely be present. Finally, addition of sand and gravel at and below the waterline of the cove is necessary to improve substrate that will allow small fish to hide from predators, allow formation of benthic communities that will serve as prey species, and help to provide some hyporheic benefits to water quality. These qualities will attract small fish, but to retain them and provide the minimum habitat requirements for the target life stage, addition of large wood is needed immediately and contribution of large wood will be needed to sustain the habitat value over time, meaning that the long-term value of the site is dependent on establishment of a riparian zone.

The PDT assessed the possibility of scaling up the amount of shallow water habitat to be created and the amount of large wood to be placed, but found that since the primary site objectives could be met by enhancing a relatively small amount of shallow water habitat and adding the minimum amount of wood as specified in the proposed plan, increasing the scale of the measures would not significantly increase HEP scores.

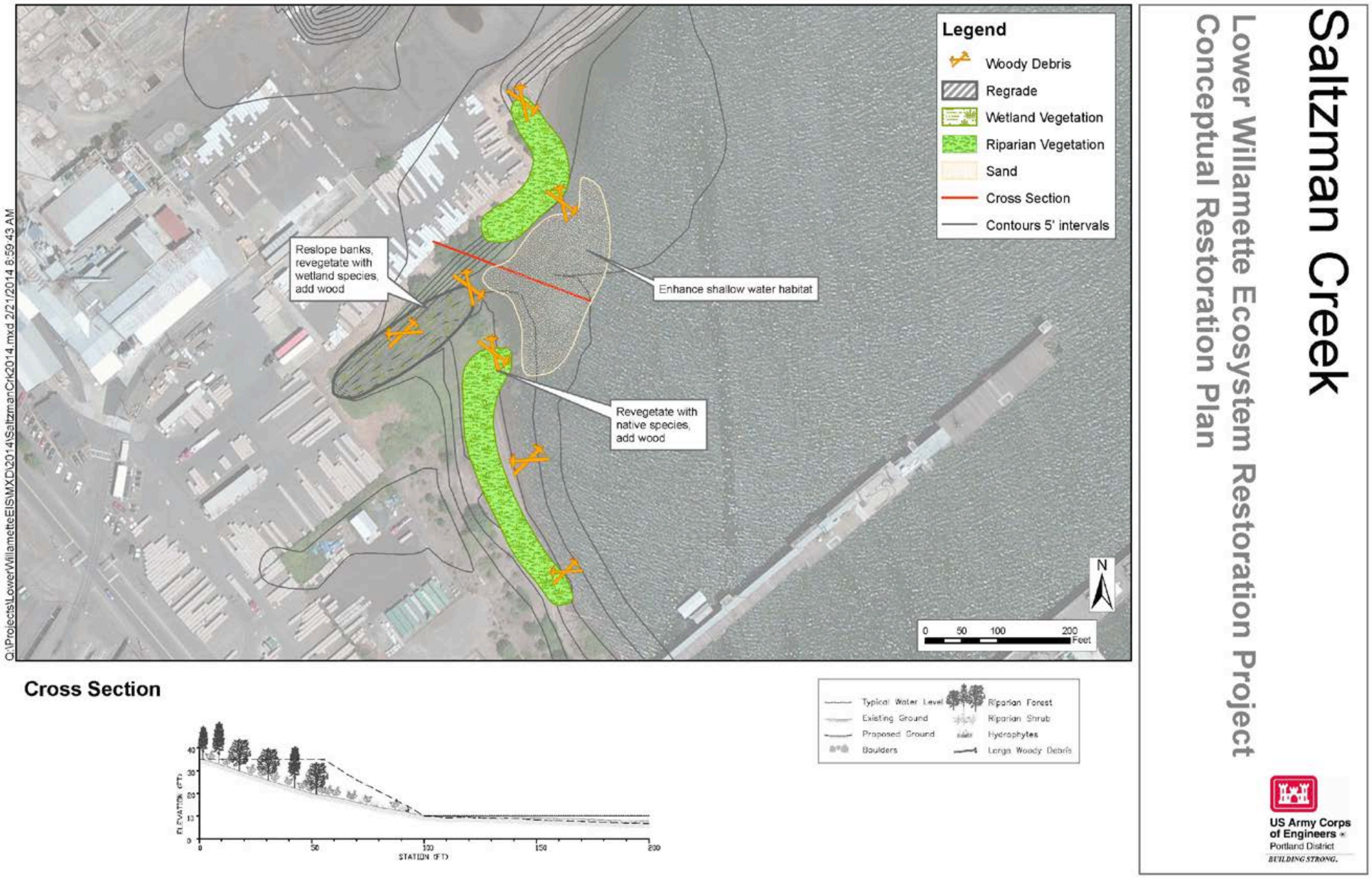


Figure 5-5. Saltzman Creek

Oaks Crossing

The Oaks Crossing site (Figure 5-6) is located on the east bank of the Willamette River at RM 16, within a multi-use park setting. Ownership is mainly the City of Portland, with METRO, and a small parcel owned by the adjacent Oak Park Amusement Association. The site is in close proximity to Oaks Bottom Wildlife Refuge and even though there is no hydrologic connection between these two sites, migration of amphibians and waterfowl is likely to occur between the two areas.

The former floodplain areas of the Lower Willamette have been significantly reduced in size and complexity. There are few opportunities to restore them since most of the floodplain areas have been developed. The Oaks Crossing/Sellwood Riverfront Park site offers a contiguous area of approximately 10 acres where off-channel habitat could be restored, but has been cut off due to berming and changes to hydrology in the lower river. The intent of this project is to restore and reconnect salmonid habitat in the floodplain by connecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species for birds, amphibians, and other guilds that may access this site during various lifecycle stages. Habitat at this site consists of gallery riparian forest with both native and invasive understory species. Sandy beach habitat would be improved by addition of large wood.

Habitat components that would be created or restored at this site include excavation of side channels, revegetation of wetlands and riparian forest, and installation of root wads along the Willamette River. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these areas total approximately 10 acres.

At this site, benefit scoring assumed that existing off-channel wetlands and ponds would be connected to the river by excavating side channels. In addition to providing access to the existing off-channel areas, the side channels themselves are intended to rearing habitat and high-flow refugia for juvenile fish. Similarly to Kelley Point Park, side channels alone only provide partial habitat value, and structure is needed within the channels to moderate flow velocity, provide cover from predators, and diversify substrate conditions. Therefore, the PDT determined that it was necessary to add large wood to the side channels. Since this area is within the tidal zone, the side channels may be inaccessible during very low tides so some addition of large wood on the edge of the Willamette River was also deemed necessary to provide refugia from river currents if juvenile fish are forced out of the side channels into the mainstem river. Additionally, a functional riparian zone is needed to provide cover at the edge of the channels, contribute detritus and large wood, and provide shading. Collectively, these three measures will provide the habitat features needed to support juvenile fish, but implementation of any one or two of them would only partially meet the objectives at this site.

The lengths of the side channels recommended at this site are largely due to the need to excavate far enough to access the off-channel wetlands and to take advantage of existing contours. The extent of riparian revegetation was determined based on the need to provide shading, leaf litter, downed logs, and detrital input across the side channels and wetlands, and across areas that would normally support salamanders and neotropical birds.

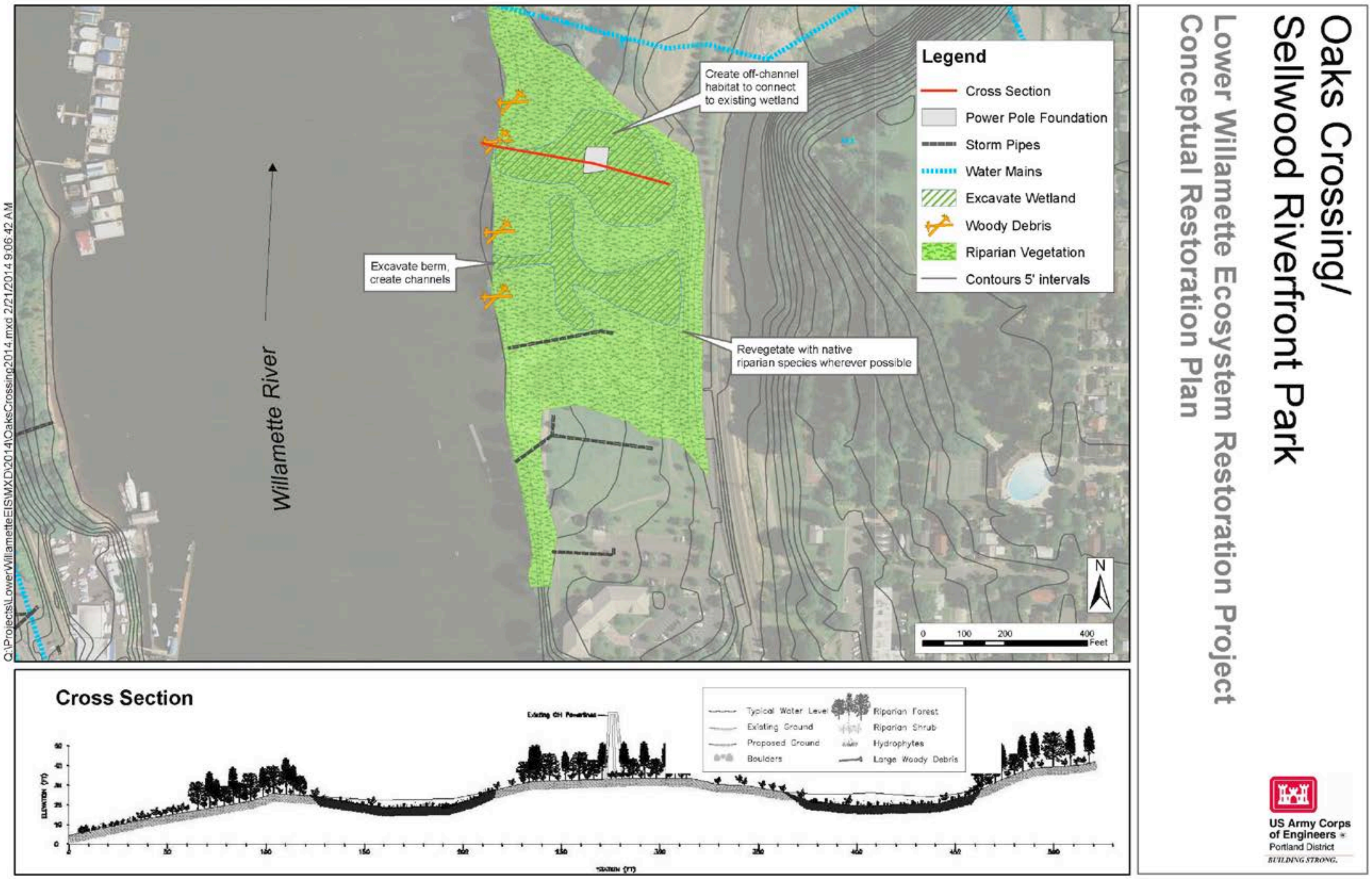


Figure 5-6. Oaks Crossing/Sellwood Riverfront Park

Columbia Slough Sites

The Columbia Slough enters the Willamette River at River mile 1 and runs east paralleling the Columbia River. It is a narrow waterway about 19 miles long in the floodplain of the Columbia River and is a remnant of the historic wetlands between the mouth of the Sandy River to the east and the Willamette River to the west. Levees surround much of the main slough and tidal fluctuation causes reverse flow on the lower slough which is where the following three sites are located.

St. Johns Landfill Boat Ramp:

St. Johns Landfill Boat Ramp (Figure 5-7) is located on the west bank of the Columbia Slough at RM 3 from its confluence with the Willamette River. The boat ramp located here provides for kayak and canoe launching to access the slough and the nearby Smith and Bybee Lakes wetlands. The entire site borders an industrial area and reclaimed landfill. Most of the property is owned by METRO and the City of Portland with a few private ownership parcels. The restoration site at this location is 7 acres.

Columbia Slough, on which this site is located, has been disconnected from its floodplain in many locations by placement of fill on the banks. Fish and aquatic wildlife in Columbia Slough have little off-channel habitat, as is needed during various life stages. This site is currently undeveloped and offers an opportunity to create off-channel wetland habitat. Although marshy habitat exists at the site, it is of poor quality . Similarly to the proposed BES Plant site, the measures proposed for the St. Johns Boat Ramp site are intended to restore off-channel habitat and shallow water habitat for juvenile fish and improve habitat conditions for amphibians, beavers, songbirds, and waterfowl. Measures proposed at this site include bank laybacks, installation of large wood, riparian and wetland revegetation, and excavation of sediments to restore off-channel wetlands

Habitat components that would be created or restored at this site include bank layback and riparian revegetation along approximately 1,100 linear feet of Columbia Slough (1.3 acres), addition of rootwads at the edge of Columbia Slough (area of influence approximately 1.0 acre) , and excavation of approximately 0.5 acre of off-channel wetland habitat. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements would occur over approximately 3.10 acres.

The success of these measures is largely dependent on the implementation of the other measures. Restoring off-channel habitat by excavating sediments is necessary to provide juvenile fish with high-flow refugia and to provide turtles and amphibians with accessible aquatic habitat in proximity to riparian vegetation. Restoring aquatic habitat for amphibians would only provide part of the habitat they would need to complete their lifecycles; without access to leaf litter, downed logs, and other riparian functions, the action of restoring aquatic habitat would be only of moderate value. Likewise, restoring off-channel habitat for juvenile fish would be of moderate value for juvenile fish in and of itself, but is of high value when combined with actions to create shallow water habitat and structure to allow juvenile fish to survive when tides are low and the off-channel habitat is inaccessible. Revegetation with riparian species in the bank layback areas is necessary to complete the habitat needs of juvenile fish, and will create overhanging vegetation needed by fledging wood ducks. Without restored riparian forest, newly-restored shallow water habitat will not have detrital input, long-term contribution of woody debris, and provision of shade needed to sustain habitat quality for fish, amphibians, and birds.

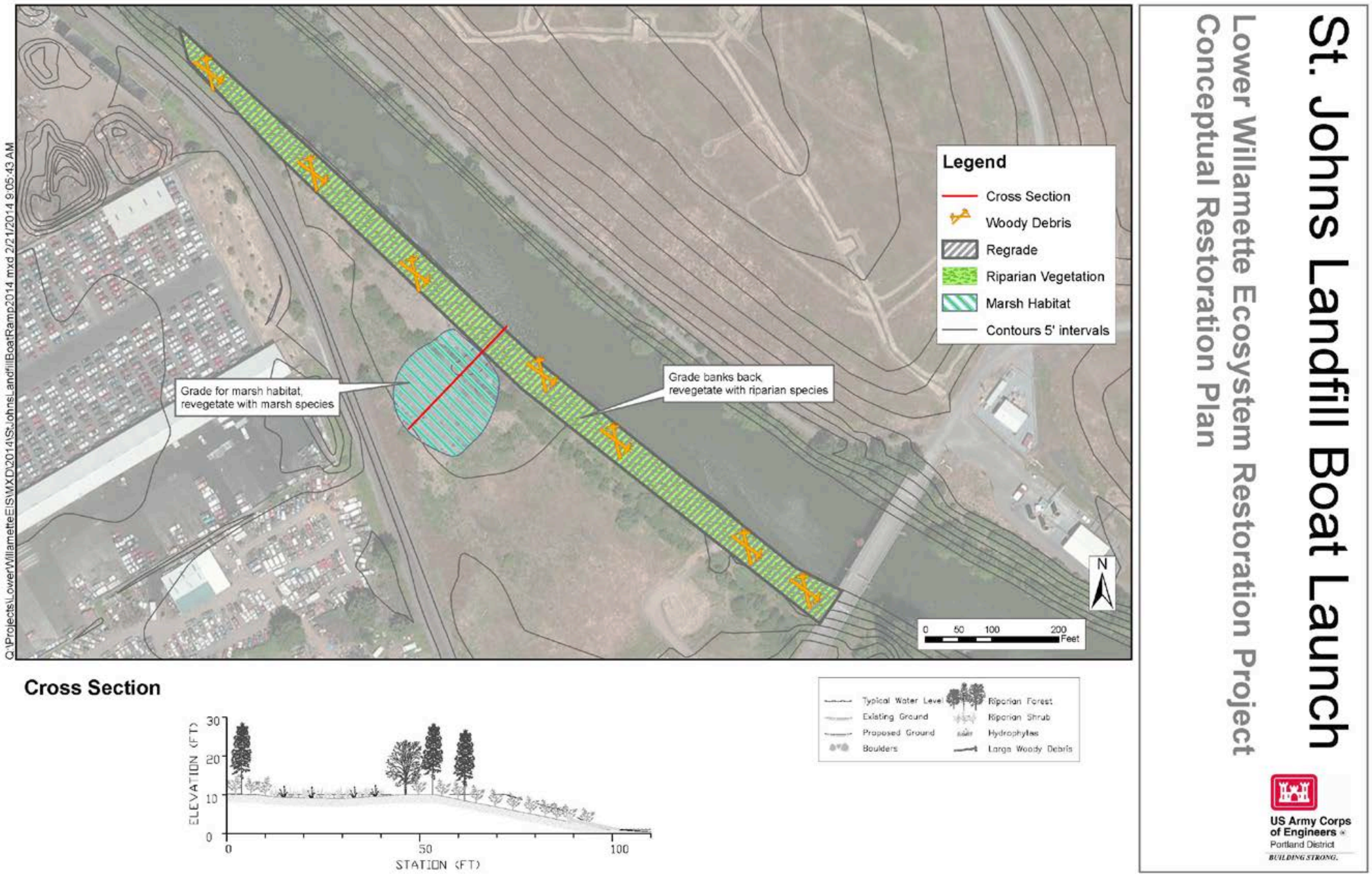


Figure 5-7. St. Johns Landfill Boat Launch

BES Plant

The BES site is located on the west bank of the Columbia Slough at RM 5 from its confluence with the Willamette River. The site consists of a City owned trail and park that parallels the slough. The property is owned by Multnomah County and the City of Portland. The restoration site at this location is 11.6 acres.

The BES Plant site (Figure 5-8) has been altered from historic conditions by placement of fill, including an access road and culvert which have isolated it from Columbia Slough. The banks along Columbia Slough at this location have been steepened by placement of fill, reducing shallow water habitat and diminishing its riparian zone. The intent of this project is to excavate a more frequent connection to a floodplain backwater/swale area and restore the riparian zone along Columbia Slough. Steepened bank slopes would be reduced and large wood added along the banks to increase habitat complexity. Habitat quality is currently moderate to good, but opportunities to improve and expand wetland and backwater habitats exist in several parts of the project site. Off-channel rearing and high-water refugia would be restored by excavating a connection from Columbia Slough to the low swale at the southeast end of the site and by excavating an alcove at the base of the slope near the northwest end of the site. Habitat value would be increased by removing invasive species and revegetating with native trees and shrubs. Pond turtle habitat would be improved by addition of large wood and boulders near the mouth of the channel between the slough and the low swale.

Habitat components that would be created or restored at this site include banks that would be laid back along the Columbia Slough, riparian plantings at the bank lay back location, reconnection of a wetland area and surrounding riparian area, creation of an alcove for high flow, and addition of root wads along the Columbia Slough and boulder placement. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these areas of restored habitat totaled approximately 11.6 acres.

BES Plant is located on Columbia Slough, where the key factors that limit habitat value for fish and other target guilds are lack of shallow water habitat on the slough itself, and off-channel refugia. Bank angles are too steep for turtles and amphibians to access the water and then return to the riparian zone where they may find cover in leaf litter and downed trees. An existing swale that has been cut off from Columbia Slough can easily be made accessible to fish, turtles, and amphibians by removing a small culvert and berm at the edge of the slough. However, the swale contains no structures that would provide cover for fish or haul out sites for turtles, and there is little riparian canopy around the swale. Therefore, simply reconnecting the swale to the slough hydraulically would only provide a portion of the off-channel habitat needs of these species. Large wood and boulders need to be installed to provide haul out sites and cover, and riparian forest is needed to contribute detritus and large wood to maintain habitat value over time. Therefore, restoring flow to this swale by itself would only provide partial habitat value, while adding large wood and boulders and restoring riparian habitat will provide little benefit if flow is not restored to this swale.

Shallow water habitat would be provided by laying back the banks of the slough, and excavating a small alcove to a level near the normal winter water surface elevation. The amount of bank layback recommended is relatively minimal compared to the available area in which this measure could be implemented. However, it was determined by the PDT that the amount of shallow water habitat that would be created or restored by implementing this measure at the scale recommended would be sufficient to support populations of juvenile fish, assuming that large wood would be added throughout the bank layback area. In this case, the habitat benefits that were calculated at this site were based on the assumption that laying the banks back was sufficient to create the additional shallow water area, but shallow water in itself is not sufficient to support these fish. Likewise, adding large wood to a near-vertical bank will do little to support small fish, but will be very effective if implemented in combination with creation of shallow water.

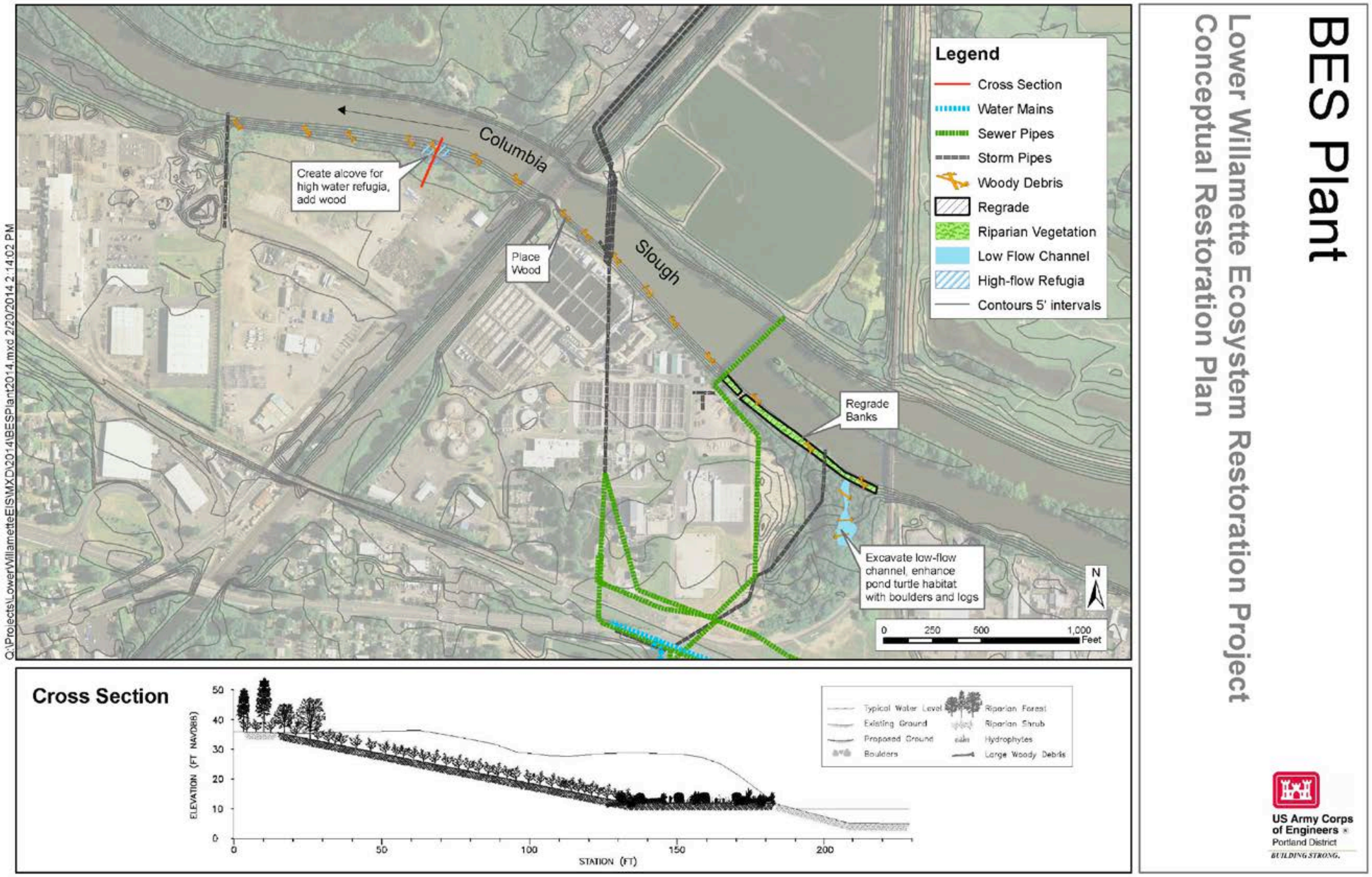


Figure 5-8. BES Plant

Kenton Cove

The Kenton Cove site (Figure 5-9) is located on the east bank of the Columbia Slough at RM 7 it is bounded by Interstate 5 and Portland International Raceway. The site consists of open channel cove connecting to the slough. The property is owned by the City of Portland, and small portion is in private ownership. The restoration site at this location is 3.1 acres.

Kenton Cove offers refugia from high-flows due to its location off of Columbia Slough. However, there is no habitat complexity within the cove due to historic efforts to remove woody debris, and the riparian zone which once allowed for contribution of wood to the cove and other functions has been removed. In this condition, it offers low-quality habitat for juvenile fish, birds, and aquatic wildlife. The intent of this alternative is to increase complexity with large wood, remove invasive species, and revegetate with native trees and shrubs. Because the edges of the cove are very uniform and offer very little habitat complexity, small habitat islands are proposed at the location of each wood cluster, with the wood as the centerpiece of the habitat island.

Habitat components that would be created or restored at this site include a restored riparian zone, creation of wetland islands, and enhancement of shallow water habitat. Installation of root wads and a mixture of sand and gravel will create wetland islands, enhance shallow water habitat, and create a safe zone for juvenile fish. Additional benefits were assumed outside of the construction footprint due to shading, detrital input, and contribution of woody debris provided by the restored riparian zone. Cumulatively, these features total approximately 5.9 acres.

Habitat value at Kenton Cove is impoverished due to lack of structure and diversity within the aquatic area and lack of functions that would normally be provided by an intact riparian forest. These functions include detrital input, shading, and contribution of woody debris over time.

Addition of large wood and enhanced substrate around the large wood, as recommended in the FS, will attract and shelter juvenile fish, but in order for the habitat at this site to fully support juvenile fish over time, a restored riparian forest that contributes detritus and large wood, and provides shading, is necessary. The minimum amount and scale of large wood determined by the PDT as being necessary to provide a measurable degree of aquatic habitat complexity at this site was recommended, and since the width of the area around the cove that would be restored with riparian forest is much narrower than what is normally recommended for a riparian zone on western streams, the entire width available was deemed necessary for revegetation. Without restoration of the riparian forest around the cove, HEP scores for future with-project conditions would have been lower. Without addition of large wood and varied substrate, the instream habitat would continue to be impoverished, so fish that would normally benefit from the measure of restoring riparian forest would not likely stay in the area to begin with. In either case, eliminating any restoration measure from this site would provide only partial habitat value for the target species and would not support key life stages.

Figure 5-9. Kenton Cove

Tryon Creek Sites

Tryon Creek, Highway 43

The Tryon Creek, Highway 43 (Figure 5-10) site is located on the west bank of Willamette River at RM 20. The Tryon Creek reach includes all areas at RM 0 .05 upstream of the confluence with the Willamette River upstream to Marshall Park, above which the headwaters are highly developed. Although the primary restoration action on Tryon Creek will occur where Tryon Creek passes beneath Highway 43, near the mouth, the proposed action at this site will allow fish access to the rest of the stream up to Marshall Park and Arnold Creek. The property is owned by the City of Portland, City of Lake Oswego, METRO, State of Oregon, and a small portion is in private ownership. The restoration site begins downstream of the existing culvert and extends upstream about 2.7 miles.

Tryon Creek, Highway 43sites offers extensive spawning and rearing habitat that is very rare in Lower Willamette River watershed. This stream was once a highly productive anadromous fish habitat, but with the installation of a four hundred foot long, 8-foot by 8-foot box culvert in the 1930's this has become a full barrier to fish passage under most conditions. There is extensive public interest in restoring fish passage to this area, and some small-scale projects have been implemented to address this issue, with little success. The intent of this project is to replace the culvert under Highway 43 and the railroad line. The new culvert would simulate the natural stream dimensions, allowing for water, sediment and debris to pass downstream and give fish unhindered passage beneath the roadway and railroad line. Implementation of this project would allow unhindered fish passage into the Tryon Creek State Natural Area, where high quality fish habitat remains. The culvert designs are consistent with the State of Oregon's fish passage criteria based on the stream simulation option for an open-bottomed road-stream crossing structure (OAR 2013a). Hydraulic models have been performed for existing and proposed conditions, and indicate that the water depths and velocities predicted inside of the proposed culvert fall within the range of the surrounding stream, in compliance with the fish passage criteria. The hydraulic models also indicate that, due to a gentler slope within the culvert and addition of bed roughening features, stream velocities will be reduced under median summer, median winter, and median annual flows. The complete hydraulic models are detailed in Appendix B, and project drawings are provided in Appendix H.

Habitat components at this site include the stream bed and banks, and the riparian zone on either side of the stream. Habitat benefits would occur throughout the 2.7 mile stretch of stream found between the mouth of the Highway 43 culvert and the next fish barrier upstream. Based on multiple field visits and GIS mapping, the functional riparian zone including the stream bed and banks averaged approximately 150 feet wide. This width takes into account the active channel, the channel migration zone, and riparian forest on either side of the stream. This measure only includes the portion of the riparian zone that can reasonably provide shading, detrital input, and water quality benefits, and which will contribute large wood into the stream over time. Multiplying this width by the length of the reach that would become accessible to fish indicated that approximately 49 acres of habitat would be restored by this action.

This is the last stream in the Portland area to be opened up The Tryon Creek Watershed spans approximately 4,200 acres across two cities, including 3,300 acres in Southwest Portland and 900 acres in Lake Oswego, and is the largest forested urban watershed in Oregon that can support anadromous and resident native migratory fish. Restoring fish passage to this watershed is vitally important to establish rearing habitat to ESA listed species.

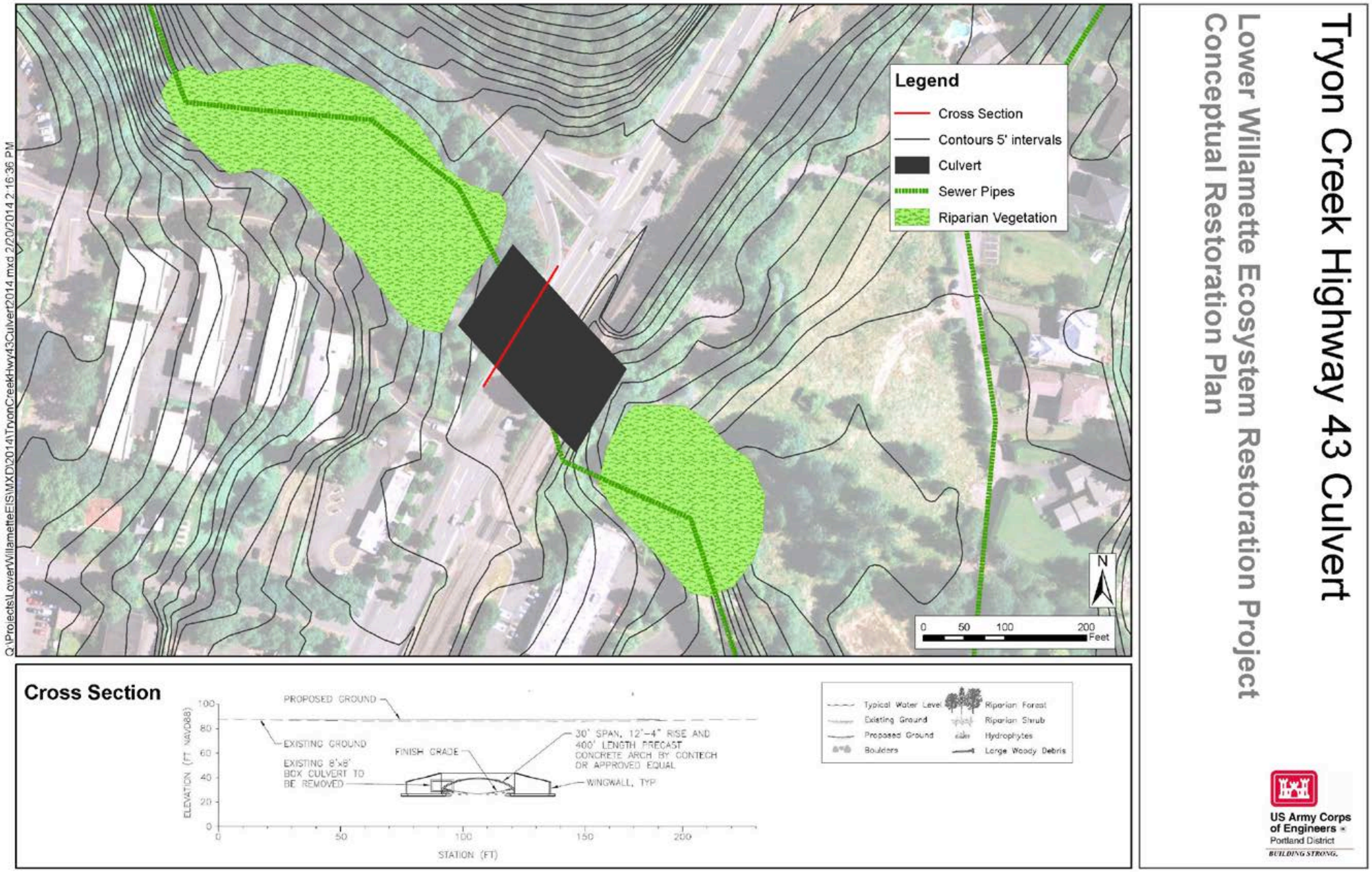


Figure 5-10. Tryon Creek Highway 43

5.4.2 Final Array of Site Plans

Table 5-6 Summary of ecosystem restoration measures and problems and objective addressed at each sites.

Table 5-6. Summary of Ecological Measures

Site	Restoration Measures	Problems Addressed	Objectives Addressed
Kelley Point Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Grade banks with gradual slopes to provide a suitable area for planting • Install LW	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Cathedral Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Grade banks with gradual slopes to provide a suitable area for planting • Install LW	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Saltzman Creek	• Create shallow water habitat • Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Revegetate with native riparian and wetland species	• Loss of Channel Complexity • Reduction in Nutrients and Woody Material • Loss or Degradation of Off-channel Habitats	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity.
Oaks Crossing/Sellwood Riverfront Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Install LW	• Reduction in Nutrients and Woody Material • Loss or Degradation of Off-channel Habitats	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.

St. Johns Landfill Boat Launch	• Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Revegetate with native riparian and wetland species	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Restore floodplain function and complexity.
BES Plant	• Reconnect or create side channel or backwater features • Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Install species-specific features such as wood clusters for pond turtles	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Kenton Cove	• Install LW • Revegetate with native riparian and wetland species	• Loss of Channel Complexity • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity.
Tryon Creek Highway 43	• Culvert removal • Plant riparian vegetation • Restore streambed conditions	• Reduction in Nutrients and Woody Material • Diminished health of tributaries	• Increase aquatic and riparian habitat complexity and diversity.

In order to evaluate potential ecosystem restoration alternatives for this study, and identify cost effective solutions, the PDT conducted a cost-effectiveness and incremental cost analysis (CE/ICA) to identify the best investment decision for the ecological output. The HEP model was used to quantify habitat benefits and estimates outputs to input into CE/ICA. Field reconnaissance were done at each site along with gathering other pertinent site information such as topography, soils and hydrology maps to determine the project objectives and associated measures that could be applied at the individual sites. Preliminary cost estimates were developed based on this information and standard unit costs and estimations for applying each measure using the following: area, length, width, density and potential depths of excavation. Preliminary estimates of costs to acquire fee title or easements on the land and Operation and Maintenance cost for the life of the project were also incorporated. These cost estimates, were intended to be preliminary to allow comparisons between alternatives. Unit costs, quantity estimates, assumptions, and markups used to develop the cost estimates are shown in the Design Report (Appendix H sub-appendix C "Preliminary Cost Estimate").

5.4.3 Habitat Evaluation Procedure

Given the variety of aquatic, terrestrial, and transitional habitat types present across the spectrum of the original sites under consideration, the Habitat Evaluation Procedures (HEP) model was selected as the most appropriate model to quantify habitat benefits. The HEP provides a measure of how each site plan performs with regard to planning objectives. The selection of species to include in the HEP model was based on several criteria. First and foremost, the species' geographic range had to include the project area. The species must also utilize the habitat type or types that are currently present, or are proposed for ecosystem restoration. Species with existing Habitat Suitability Indices (HIS) models were preferred, and use of previously developed and verified models provided a greater level of scoring certainty. Suitable HSI models also had to include habitat variables for which data collection was possible, given the availability of time and resources. Finally, variables also had to show a change in score between the existing and proposed condition. If the project did not affect the suitability index (SI) score for a species, it was not possible to quantify an effect. Habitat variables that did not meet the above requirements were omitted. Additional information regarding selection of species to represent the habitat types at the proposed ecosystem restoration sites is given in the HEP report, Appendix F. For the feasibility study the following six species or groups of species were used: western pond turtle, beaver, wood duck, yellow warbler, native amphibians, and salmonids. These species were selected to represent the range of riparian, aquatic and/or shallow water riverine habitats that would be encountered in the study area.

The HEP rates habitat based on its potential to support each species or group of species during part of, or all of their lifecycle. This potential is reported as Habitat Units (HUs). HUs occurring under without project conditions are compared to estimated HUs that would occur under the with-project condition at set time intervals, in this case 5 years, 10 years, and 25-50 years, to calculate the rise in ecological output due to project implementation. Because this model was prepared to evaluate resource conditions at a watershed scale, it takes into account that various habitat types at any given site may overlap, and is therefore integrative of all habitat types found at any given site.

Typically, input variables were measured at multiple locations on the project site and then averaged to yield an overall percent canopy cover, diameter of trees, water depth, water velocity, number of pieces of downed wood, vegetation composition, or similar value. These measured variables were then assigned an SI value (unitless number from 0 to 1) based on the suitability curve or discreet suitability values or thresholds developed in the model. Acreages for the model were developed by mapping the area at each site where ecosystem restoration actions were both implementable and would affect habitat quality. In many cases, ecosystem restoration measures influence conditions beyond the construction footprint, and this increased area was included in the acreage tabulations. For example, riparian revegetation provides shading, detrital input, and woody debris beyond the immediate limits of construction.

The HEP was submitted to Center of Expertise for National Ecosystem Planning USACE (ECO-PCX) for planning model review and policy compliance, and all models have been approved for one-time use on this project (Appendix F). Also, in the case of the Tryon Creek, Highway 43 project, only habitat variables for the adult fish (tributary) model were scored, since replacing the culvert would not make a measurable difference in the life stage of any of the other species included in the HEP model.

After developing the HEP model and developing preliminary cost estimates, each alternative was evaluated according to a CE/ICA model. The CE/ICA is an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of ecosystem restoration output and to provide information about whether increasing levels of ecosystem restoration are worth the added cost. The CE/ICA is a planning tool to help identify cost-effective plans which provide a certain level of habitat output at the least cost. The software expedites this effort of testing each combination of measures and tabulating the resulting costs and environmental benefits. This process is described in greater detail in Section 5.4.5.

5.4.4 Future Without Project Condition Assumptions

The assumptions used to score the future without project conditions of the ecosystem restoration sites are as follows:

- **Vegetation** Riparian and wetland zones are dominated by invasive species which limits the habitat complexity and cover potential of the sites. Dominant invasive species that are present throughout the project area include Himalayan Blackberries, English Ivy and Reed Canary grass. The composition of the riparian community would remain similar to existing conditions. Although riparian zones are dynamic ecosystems, most areas surveyed either displayed stable, mature ecosystems (for example, sites along Tryon Creek) that are unlikely to change extensively over the projected time period without an event such as devastating wildfire, massive flood, or infestation by disease or pest, or are so constrained by revetments, development, and hardscape in the floodplain that the natural cycle of regeneration and maturation no longer occurs.

- **Water Quality** Although localized water temperature decreases may occur as a result of increased canopy cover along some stretches of stream, overall water temperatures are expected to increase by up to 1 degree due to continued development of the watershed and climate change effects. Other water quality parameters including level of dissolved oxygen, turbidity, and pollution from stormwater and industrial outputs are expected to improve over time due to increased regulation of water resources and better management of stormwater.

- **Large Wood** Large wood accumulation would remain similar to existing conditions. Narrow riparian zones in most areas do not promote woody debris recruitment, and although some woody debris may accumulate over the projected time period, a net gain of large wood is not expected.

- **Percent Ground Cover at Water's Edge** The percentage of ground cover composed of materials such as logs and brush at the waters' edge is not expected to increase extensively.

- **Side Channels and Alcoves** Available off-channel habitat would remain the same as existing conditions or would decrease as streams further incise or further development occurs.

- **Fish Passage Barrier Removal** Fish passage would remain mostly blocked as no other plans for removal/replacement exist.
-

5.4.5 With Project Condition Assumptions

The assumptions used to establish the future with project conditions of the ecosystem restoration sites after implementation of ecosystem restoration measures are as follows:

- **<u>Revegetation</u>** Five years after construction, a rapid increase in the number of small diameter trees, canopy cover and density, and understory shrub height over current conditions is expected with the planting and re-establishment of native species. This increase is expected to continue for approximately 10 years, after which the rate of increase of these parameters would likely decrease. Shrub canopy growth would not increase as rapidly due to the lower amount of sunlight coming through the upper canopy, and shrub heights would not increase. Maximum cover over the stream and along the water's edge would be expected by this time. The increase in cover over the stream will produce a minimal reduction in the localized water temperature.

- **<u>Water Temperature</u>** Water temperature benefits are not expected to occur as a result of project alternatives, due to their limited size in comparison to the size of the waterbodies. Other water quality parameters including level of dissolved oxygen, turbidity, and pollution from stormwater and industrial outputs may be slightly improved on a site-specific scale by the proposed ecosystem restoration measures, but these improvements are not expected to be measureable.

- **<u>Large wood</u>** Upon implementation of the project, complexity and instream cover is expected to increase substantially with the placement of large wood. Pools would scour in association with the wood and sediment and debris deposition would also occur, locally reducing channel incision and maintaining or improving connections to the floodplain. Over time, additional instream cover would develop with the potential of additional debris collecting in the piles and further recruitment of gravels as pools developed. Recruitment of large wood would increase during this time period due to revegetation of the riparian zone during project construction. Instream cover would further increase.

- **<u>Percentage of Ground Cover at Water's Edge</u>** The percentage of ground cover would increase substantially in some areas immediately upon completion of the project due to placement of large wood and revegetation, and is expected to further increase as restored vegetation matures and fills in available spaces.

- **<u>Side Channels and Alcoves</u>** Immediately upon project implementation, additional habitat would be created for fish rearing during high water events. Communities of hydrophytic plant species would be developing in these areas. Twenty-five years after the project, habitat would still be available for fish rearing during high-flow events. Further development of hydrophytic plant communities would be observed in these areas.

- **<u>Fish Passage Barrier Removal</u>** Immediately upon project implementation, fish access would be restored to habitat upstream for both rearing and spawning. The fish passage barrier removal project on Tryon Creek was scored by assessing the existing conditions of the habitat upstream that would be made accessible to salmonids. Since this project is specifically a fish passage project, the only habitat suitability index (HSI) that the project was evaluated for was tributary salmonids. It is not assumed that additional ecosystem restoration of the habitat upstream would occur, therefore the project conditions remained constant over the 50 year projected life cycle of the project.

For each group of species, a Habitat Suitability Indices (HSI) was derived (between 0 and 1). For this project, the HSI scores for the species were then averaged. The overall resulting index score was multiplied by the acreage of the alternative to yield habitat units. Because this plan is being formulated as an ecosystem restoration project and is not focused on restoring habitat for any given species or group of species, scores were not weighted. HSIs were calculated for existing conditions, conditions at 1-5 years, 6-10 years, and at 11-50 years without the project; and at 1-5 years, 6-10 years, and 11-50 years after ecosystem restoration.

Table 5-7 summarizes the scores under existing conditions and after ecosystem restoration. The highest possible index score is a 1.0 and indicates the best possible conditions for each group of species. Scores between 0.7 and 1.0 indicate good to excellent quality habitat. Sites scoring below 0.3 are not considered to have suitable habitat for the species selected.

Table 5-7. HSI Scores Under Existing Conditions and After Ecosystem restoration

Project Site	**Existing HSI (No Action)**	**HSI After Ecosystem restoration (11-50 years) (With Project)**	**Habitat Benefit Acres**	**Real Estate Acres Required**
Mainstem Willamette River				
Kelley Point Park	0.48	0.86	47.37	47.37
Cathedral Park	0.40	0.61	3.79	3.79
Saltzman Creek	0.37	0.69	5.0	5.0
Oaks Crossing/Sellwood Riverfront Park	0.44	0.73	9.97	9.97
Columbia Slough				
St. Johns Landfill Boat Ramp	0.29	0.54	7.0	7.0
BES Plant	0.41	0.70	11.6	11.6
Kenton Cove	0.40	0.60	5.90	3.1
Tryon Creek				
Tryon Creek, Highway 43	0.00	0.82	49	2.7

5.4.6 Cost - Effectiveness and Incremental Cost Analysis

Rather than putting a monetary value on habitat benefits, the focus of the alternatives evaluation is on the relationship of habitat benefits to project costs to ensure cost-effective and justified plans are put forth for recommendation for implementation. This process is described below. Cost-effectiveness and incremental cost analyses (CE/ICA) were performed using the IWR-Planning Suite software version 1.0.11.0. The analysis was conducted in the following steps:

1. Tabulate average annual cost and average annual environmental outputs of each ecosystem restoration alternative.
2. Identify any sites whose implementation is dependent upon implementation of others.
3. Identify any sites that are not combinable with others.
4. Identify all potential combination of sites.
5. Calculate cost and output estimates for each alternative.
6. Identify any sites that provide the same output at greater cost than other combinations.
7. Identify any sites that provide less output at the same or greater cost as other combinations.
8. Evaluate changes in incremental costs for remaining combinations.

9. Identify most efficient set of remaining combinations (“best-buys”).
10. Display changes in incremental cost for best-buy combinations.

Annualization was performed within the IWR Planning Suite Annualizer Module. The Annualizer is intended to be a consistent method of estimating Average Annual Habitat Units (AAHUs). It provides an interface where the habitat output for a site is entered for multiple years of the period of analysis. The software will plot these points as a curve and compute the AAHU’s. Therefore, for any given site, the inputs are point estimates of habitat output across the period of analysis, which are entered into the Annualizer, and the output is AAHU’s. These AAHU’s are then inputs to the CE/ICA module of IWR-Plan.

For each site, both future without project, and future with project Average Annual Habitat Units (AAHU’s) were calculated within the Annualizer. Then, in Excel, the difference between the future without and future with AAHU’s was calculated to yield the net AAHU value for each site which was used in the CE/ICA.

To calculate the AAHU’s in the Annualizer, three Habitat Units (HU) control points were used: the existing HU’s (Year 0), the HU’s in Year 5, and the HU’s in Year 25. These three control points were entered into the Annualizer, and the Year 25 HU value was set as the “Max Output” in the Initial Terms box of the Annualizer screen. The period of analysis was set at 50 years, and the Annualizer was set to calculate by Linear Interpolation.

5.4.7 Costs/Output

This section summarizes the cost estimates and environmental output estimates associated with implementation of ecosystem restoration measures at each of the ecosystem restoration sites. The cost estimates, are summarized in Table 5.8 and shown in Appendix H, account for the following:

- **Preconstruction engineering and design (PED)** This cost item includes preparation of final plans and specifications, geotechnical investigations, permitting, preconstruction surveying, staking, and preparation of as-built drawings, and was estimated at 20% of construction costs, including site preparation markups.
- **Construction, supervisory and administrative (S&A) support** This cost item includes construction oversight, inspections, administration, and engineering during construction, and was estimated at 15% of construction costs, including site preparation markups.
- **Operation and maintenance (O&M)** This cost item includes inspections, maintenance, revegetation, replacement, and operations, and was estimated at 9% of construction costs, including site preparation markups. No features included in the conceptual designs would require operation, and replacement of features is likely to be minimal. Maintenance and revegetation assumptions are included in the Monitoring and Adaptive Management Plan (Section 10).
- **Monitoring** This cost item includes development of site specific monitoring plans, annual monitoring surveys, and annual reporting, and was estimated at 1% of construction costs, including site preparation markups. Items to be monitored may include revegetated areas, flows through side channels, fish passage, and wildlife use. Additional details of monitoring and adaptive management are included in Section 10.

- **Generalized costs associated with real estate acquisition, easements, or rights of way** Real estate costs are from the Baseline Cost Estimates for Lands, Easements and Right-Of-Ways, and relocations summarized in Appendix I.
- **Interest during construction (IDC).** IDC and annualization calculations were performed using the FY13 rate of 3.75%. IDC was not applied to the initial cost estimate, but was added to the cost as a component of the CE/ICA.

It was assumed that construction would be completed at all sites in a 12-month period, except at the Tryon Creek, Highway 43 Culvert site, where a 24-month construction period was assumed. Base year for the construction estimate was 2017. No indirect or opportunity costs were identified.

Output estimates are measured in habitat units, which provide quality- and quantity-based estimates of environmental benefits at each potential ecosystem restoration site. Table 5-8 summarizes the cost and 50-year output estimates for ecosystem restoration at each of the sites in the final array of site plans.

Table 5-8. Cost and Output of Ecosystem Restoration at Each Site in the Final Array of Sites

Project Site	AAC ($)	AAHU's	Net Present Value (NPV) Cost ($)	Total HU
Kelley Point Park	$354,975	14.93	$13,030,000	804.58
Cathedral Park	$50,873	0.74	$1,141,317	36.92
Saltzman Creek	$25,325	0.59	$568,143	29.43
Oaks Crossing/Sellwood Riverfront Park	$29,027	2.69	$1,263,000	134.58
St. Johns Landfill Boat Ramp	$46,940	0.69	$1,053,078	34.65
BES Plant	$25,946	1.69	$3,756,000	84.68
Kenton Cove	$10,311	1.00	$725,000	50.10
Tryon Creek, Highway 43	$642,666	39.65	$11,000,000	1982.65

Relationships

Under the current array of alternatives, all sites are fully combinable with any other site. In most cases, these measures have been designed to build upon each other, meaning that increased functionality is a product of the interactions of all measures proposed at a given site.

For each site, the PDT developed the minimum measures that would be needed to register a meaningful change in the HEP scores. The PDT then looked at additional measures that could be implemented at each site, and found that implementing them would lead to diminishing returns, and would not be effective from a biological and economic standpoint. At each of the sites in the final array of site plans, each of the recommended measures is designed to be combined with other measures to meet the objective or objectives that will be addressed at that site. For example, at the Oaks Bottom site, if the wetland ecosystem restoration component were implemented but construction of swales to allow fish to access the restored wetland was not included, the objective of restoring floodplain connections would not be met. As another example, if the only measure implemented at the Kenton Cove site was riparian revegetation, the objective of increasing aquatic and riparian habitat complexity and diversity would only be partially met. Examples like these could be given for each site, and underscore the point that anything less than implementing all of the measures recommended in this report at each site will not be sufficient to meet the goals and objectives.

At the same time, the full range of measures that has been developed for this project are not proposed at each site, generally because they would not be cost effective, would be redundant and were not needed to meet the objectives for that site, or because the size of the site would not allow them to be implemented at a scale that would be effective. As an example, the main objective that would be met by implementing measures at the Tryon Creek, Highway 43 site is to restore aquatic and riparian habitat complexity and diversity. Since riparian zone complexity in Tryon Creek was not identified as a limiting factor but fish access to upstream areas is a limiting factor, by far the most effective measure that could be implemented at this site is to replace the culvert with one that allows for fish passage. Therefore, additional measures such as upstream riparian ecosystem restoration would not have substantially helped to meet the objectives and were not recommended for this site.

Measures recommended at each site are dependent on each other to restore the range of habitat values that each site offers, and, cumulatively, to achieve ecosystem restoration of habitat components on a watershed scale. As an example, at the Kenton Cove site, addition of large wood and enhanced substrate around the large wood will attract and shelter juvenile fish. The minimum amount and scale of wood determined by the PDT as being necessary to provide some degree of habitat complexity at this site was recommended, but it is assumed that in order for the habitat value at this site to reach its full potential as modeled in the HEP, additional wood would be contributed by the restored riparian area around the cove, and detrital input from the riparian canopy would increase as the restored riparian forest matures. Without ecosystem restoration of the riparian forest around the cove, HEP scores for future with-project conditions would have been lower. At the BES Plant site, laying back steepened banks along Columbia Slough is considered necessary to provide shallow water habitat and to provide a suitable base for revegetating with riparian and wetland species. Excavating a channel to what is now an inaccessible swale would allow fish access to the swale, but woody debris and revegetation is needed to provide suitable habitat for fish that do access this site. In these instances, the PDT determined that these were the minimum measures that would be needed to make a measurable change in HEP scores, and although additional measures such as excavation of a larger off-channel ponded area were considered, they were not incorporated as they did not appear to offer cost-effective benefits.

5.4.8 Cost Effectiveness Analysis

The cost effectiveness analysis is the first step in the CE/ICA, and compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a "cost per AAHU." This cost provides a means to compare the cost-effectiveness of each plan. The three criteria used for identifying non-cost effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at the least cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of the National Ecosystem Restoration (NER) Plan. Non-cost effective combinations of plans are dropped from further consideration.

A total of 255 possible plans were identified in the CE/ICA model run. Of these, 41 plans were cost effective but not best buys, and nine plans were best buy plans, including the No Action (Table 5-9). The incremental cost analysis compares the rate of increase in cost and the rate of increase in output between the cost effective plans providing the least output to all other cost effective plans producing more output. The larger plan that provides the greatest increase in output for the least increase in cost is identified as the "best buy." Figure 5-9 shows all 255 plans graphically by identifying the not cost effective, cost effective, and best buy plans on a scatter plot of average annual output versus average annual cost.

Table 5-9. Cost Effective and Best Buy Plans

Plan Name	AAC ($)	AAHUs	Type
No Action Plan	$0	0.0000	best buy
B1	$10,311	1.0020	best buy
H1	$25,947	1.6935	cost effective
G1	$29,027	2.6915	cost effective
B1H1	$36,258	2.6955	cost effective
B1G1	$39,338	3.6935	best buy
G1H1	$54,974	4.3850	cost effective
B1G1H1	$65,285	5.3870	best buy
B1G1H1A1	$90,610	5.9760	cost effective
B1G1H1O1	$112,225	6.0800	cost effective
B1G1H1P1	$116,158	6.1255	cost effective
B1G1H1A1O1	$137,550	6.6690	cost effective
B1G1H1A1P1	$141,483	6.7145	cost effective
B1G1H1P1O1	$163,098	6.8185	cost effective
B1G1H1A1P1O1	$188,423	7.4075	cost effective
K1	$354,975	14.9300	cost effective
B1K1	$365,286	15.9320	cost effective
H1K1	$380,922	16.6235	cost effective
G1K1	$384,002	17.6215	cost effective
B1H1K1	$391,233	17.6255	cost effective
B1G1K1	$394,313	18.6235	cost effective
G1H1K1	$409,949	19.3150	cost effective
B1G1H1K1	$420,260	20.3170	cost effective
B1G1H1K1A1	$445,585	20.9060	cost effective
B1G1H1K1O1	$467,200	21.0100	cost effective
B1G1H1K1P1	$471,133	21.0555	cost effective
B1G1H1K1A1O1	$492,525	21.5990	cost effective
B1G1H1K1A1P1	$496,458	21.6445	cost effective
B1G1H1K1P1O1	$518,073	21.7485	cost effective
B1G1H1K1A1P1O1	$543,398	22.3375	cost effective
Z1	$642,666	39.6530	cost effective
B1Z1	$652,977	40.6550	cost effective
H1Z1	$668,613	41.3465	cost effective
G1Z1	$671,693	42.3445	cost effective
B1H1Z1	$678,924	42.3485	cost effective
B1G1Z1	682004	43.3465	cost effective
G1H1Z1	697640	44.038	cost effective
B1G1H1Z1	$707,951	45.0400	best buy
B1G1H1Z1A1	733276	45.629	cost effective
B1G1H1Z1O1	754891	45.733	cost effective
B1G1H1Z1P1	$758,824	45.7785	cost effective
B1G1H1Z1A1O1	$780,216	46.3220	cost effective
B1G1H1Z1A1P1	784149	46.3675	cost effective
B1G1H1Z1P1O1	805764	46.4715	cost effective
B1G1H1Z1A1P1O1	$831,089	47.0605	cost effective
K1Z1	$997,641	54.5830	cost effective
B1K1Z1	$1,007,952	55.5850	cost effective
H1K1Z1	1023588	56.2765	cost effective
G1K1Z1	$1,026,668	57.2745	cost effective
B1H1K1Z1	$1,033,899	57.2785	cost effective
B1G1K1Z1	$1,036,979	58.2765	cost effective
G1H1K1Z1	1052615	58.968	cost effective
B1G1H1K1Z1	$1,062,926	59.9700	best buy
B1G1H1K1Z1A1	$1,088,251	60.5590	best buy
B1G1H1K1Z1O1	$1,109,866	60.6630	cost effective
B1G1H1K1Z1P1	$1,113,799	60.7085	cost effective
B1G1H1K1Z1A1O1	$1,135,191	61.2520	best buy
B1G1H1K1Z1A1P1	$1,139,124	61.2975	cost effective
B1G1H1K1Z1P1O1	$1,160,739	61.4015	cost effective
B1G1H1K1Z1A1P1O1	$1,186,064	61.9905	best buy

5.4.9 Incremental Cost Analysis

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify "best buy" plans. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify large increases in cost relative to output. The cost and output information presented in the previous section is the input for cost effectiveness and incremental cost analyses to evaluate the relative effectiveness and efficiency of the proposed ecosystem restoration at sites and combinations of sites relative to producing environmental outputs (in Habitat Units).

Incremental cost per unit output was calculated for the best buy plans by ranking them in order of increasing average annual output, as shown in Table 5-11. Figure 5-12 compares incremental cost of the best buy plans graphically with a box plot, which compares the incremental increase in average annual habitat units to the increase in incremental cost per unit output.

Table 5-10. Incremental Cost Analysis – Best-Buy Combinations of Ecosystem Restoration Sites

Plan Code	*Plan #*	*Description*	*Inc. AAC ($)*	*Inc. AAHUs*	*Inc. Cost per HU ($)*
No Action	1	No Action	$0	0.00	$0
B	2	Kenton Cove	$10,311	1.00	$10,290
B + **G**	3	Plan 2 + Oaks Crossing	$29,027	2.69	$10,785
B + G + **H**	4	Plan 3 + BES Treat. Plant South	$25,947	1.69	$15,322
B + G + H + **Z**	5	Plan 4 + Tryon Hwy 43 Culvert	$642,666	39.65	$16,207
B + G + Z + H + **K**	6	Plan 5 + Kelley Point Park	$354,975	14.93	$23,776
B + G + Z + H + K + **A**	7	Plan 6 + Saltzman Creek	$25,325	0.59	$42,997
B + G + Z + H + A + K + **O**	8	Plan 7 + St. Johns LF/BR	$46,940	0.69	$67,734
B + G + Z + H + A + K + O + **P**	9	Plan 8 + Cathedral Park	$50,873	0.74	$68,887

Legend for Table 5-9 and 5-10

Project Site	**Code**
Kenton Cove	B
Oaks Crossing/Sellwood Riverfront Park	G
BES Treatment Plant South	H
Kelley Point Park	K
Tryon Highway 43 Culvert	Z
Saltzman Creek	A
Cathedral Park	P
St. Johns Landfill Boat Ramp	O

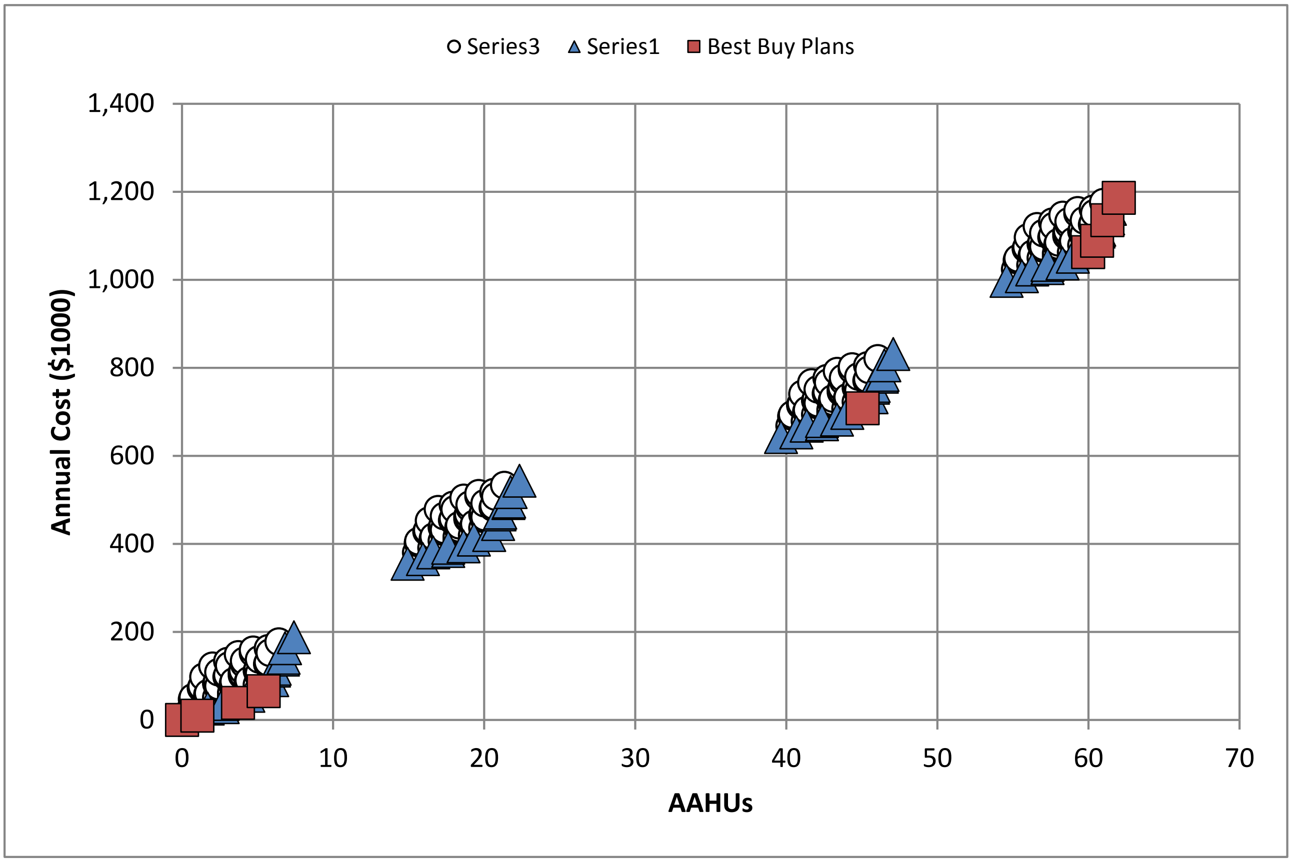
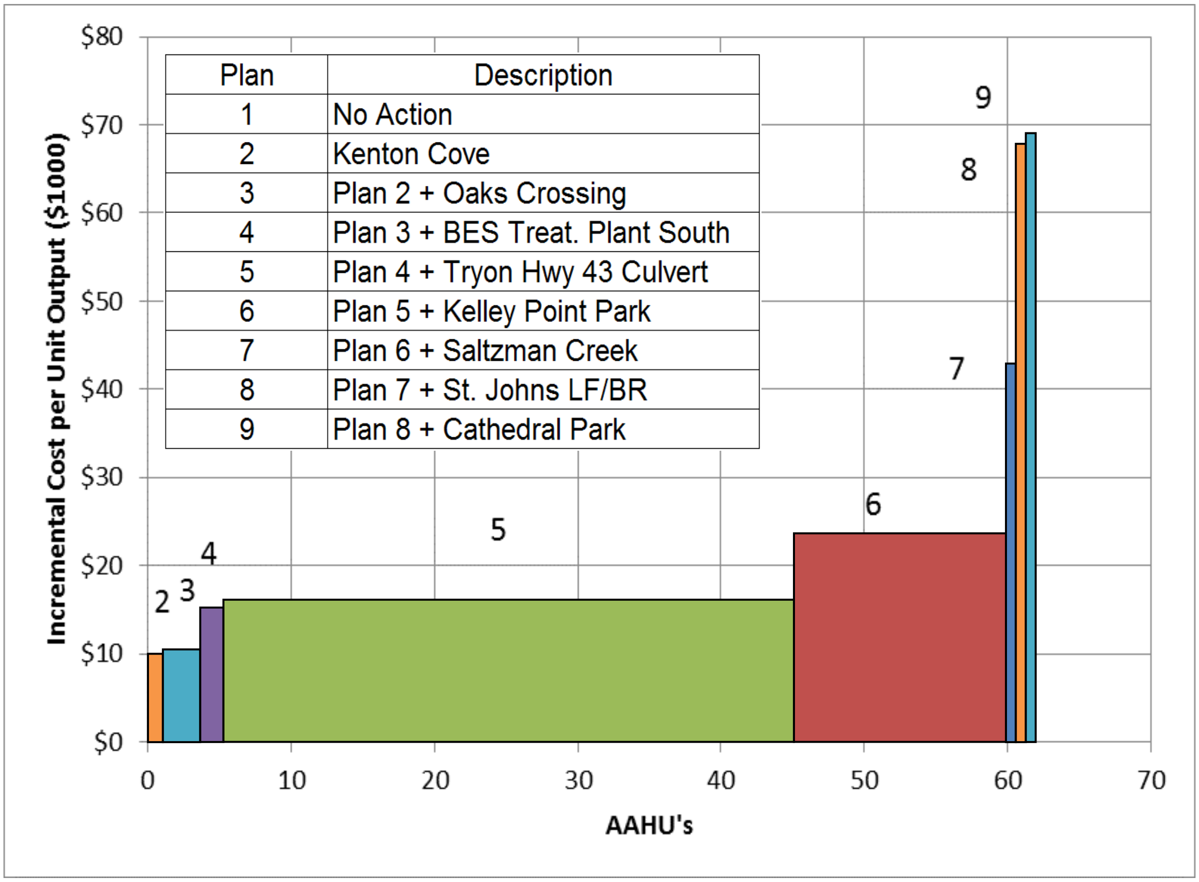


Figure 5-11. All Plans Summary: Annual Cost vs. Annual Output

Figure 5-12. Best Buy Plans Incremental Cost Box Plots



Plan	Description
1	No Action
2	Kenton Cove
3	Plan 2 + Oaks Crossing
4	Plan 3 + BES Treat. Plant South
5	Plan 4 + Tryon Hwy 43 Culvert
6	Plan 5 + Kelley Point Park
7	Plan 6 + Saltzman Creek
8	Plan 7 + St. Johns LF/BR
9	Plan 8 + Cathedral Park

5.5 Selection of the National Ecosystem Restoration (NER) Plan

After discussions with the project sponsors, Plan 6 was selected as the NER plan based on the total cost, the projects' distribution throughout the City's priority habitat areas, and consistency with the selection criteria described in Section 5.7. It is also the City's preferred alternative. At all of these sites, ecosystem restoration efforts would complement previous or ongoing ecosystem restoration efforts implemented by the sponsors or other entities, and in the case of the Tryon Creek, Highway 43 Culvert project, ecosystem restoration of fish passage may provide the impetus for stakeholders to complete additional ecosystem restoration projects in the watershed above the culvert. Plans 7-9, although best buy plans, offer minimal additional habitat benefits at a relatively high cost compared to Plan 6,

5.6 Recommended Plan

The Recommended Plan is Plan 6, which includes 5 site plans in the Lower Willamette Basin Watershed, as shown in Figure 5.12 and Table 5.10. This combination of ecosystem restoration sites has a total cost of $30,376,000 and provides an increase in habitat units from 1,627 under existing conditions to 3,057 habitat units over the 50-year period of analysis starting in 2017, ending in 2066. An estimated 123 acres of riparian, wetland, shallow water, and backwater habitat will be restored under this plan. Descriptions of the recommended measures for each site are given below, and conceptual overview figures for proposed ecosystem restoration features at each site are included in Appendix G.

The average annual cost of $1,062,000 and average annual cost per AAHU of $17,727 for the Recommended Plan. The costs are associated with constructing in an urbanized environment, high costs of real estate and labor compared to more rural or less developed areas, and high mobilization/demobilization costs associated with constructing at multiple sites rather than a single site. Construction of the Tryon Creek culvert is the single item that most contributes to the high average annual costs. The costs associated with replacement of this structure are unavoidable due to the extensive overburden that would need to be excavated and replaced during construction, and because its location below a busy roadway and railroad line would require extensive traffic control and possible rail diversions. However, replacement of this structure would also offer the greatest degree of beneficial effects in terms of the number of habitat units that would be restored under this project. Furthermore, there is considerable public interest in replacing the Tryon Creek culvert, due to the high-value fish habitat that would become fully accessible if it were replaced. This will benefit upstream project that are either pending or completed, Boones Ferry Culvert Replacement, Tryon Creek State Natural Area Habitat Enhancement, and Arnold Creek Culvert Replacement.

This project is a crucial component of efforts to restore habitat that has mostly disappeared from this watershed for use of aquatic and riparian species that were once commonplace here. The project's location near the confluence of the Willamette and Columbia Rivers makes it extremely important for species that will make their upriver to spawn or which will need stable habitat in which to rest, forage and rear before entering the increasingly saline environment in the Columbia River estuary. Although this project is not directed towards specific endangered species recovery, it will provide extensive habitat benefits for listed species and will complement other recovery efforts for listed salmon runs in the area.

Measures applied at each site to achieve the objectives are shown in Table 5-6. These measures reflect the best and highest use of each site, and will achieve the objectives if all measures are implemented.

5.7 Other Evaluation Accounts

Ecosystem restoration projects are evaluated for NER benefits. The plans formulated and evaluated for this project were all developed to provide ecosystem restoration benefits.

"Other social effects" describes the potential effects of project alternatives in other areas not explicitly in the other accounts. This would include effects on the community, health and safety, displacement, energy conservation, environmental justice, and other non-monetary effects. Other social effects are summarized briefly by a variety of categories, below, but generally result in no measureable changes to other social considerations.

- **Displacement/Impacts to Residences** There would be no displacement of residences as implementing the RECOMMENDED PLAN would not require removing any residences from the floodplain.

- **Displacement/Impacts to Minority or Low Income Populations** There would be no displacement effects on minority or low income populations as implementing the TRP would not require removing existing structures or residences.

- **Public Health and Safety** There would be very minor benefits to public health and safety under both the NER plans as a result of removal of debris and trash from the sites. The No Action alternative would maintain the existing condition with debris and trash on some sites. The installation of engineered log jams (ELJs) in the river will be designed to avoid effects to public health and safety (i.e. by positioning to allow boaters to get around the feature and not leaving sweeper logs, branches, etc. that could snag boaters).

- **Displacement/Impacts to Businesses** There would be no displacement or other effects on businesses as none of the TRP sites would be located on parcels with businesses and the project is designed to not increase the flood water surface elevations of the river or tributaries.

- **Displacement/Impacts to Recreation** Recreational use occurs on some of the sites considered. The project would not change any recreational uses, but maintain existing compatible recreational uses.

- **Community Growth** There would be continued community growth under the No Action and TRP, but this growth is not related to any action. The ecosystem restoration of aquatic habitats would have incremental benefits to the community and future development by maintaining and improving fish and wildlife populations.

- **Community Well Being** The No Action alternative would not change community wellbeing. The TRP would provide restored aquatic habitats, some of which would be publicly accessible, that could provide improved educational opportunities and also fishing opportunities.

- **Aesthetics** The No Action alternative would not change existing aesthetics. The ecosystem restoration alternatives would restore most sites to more natural looking riparian and wetland habitats.

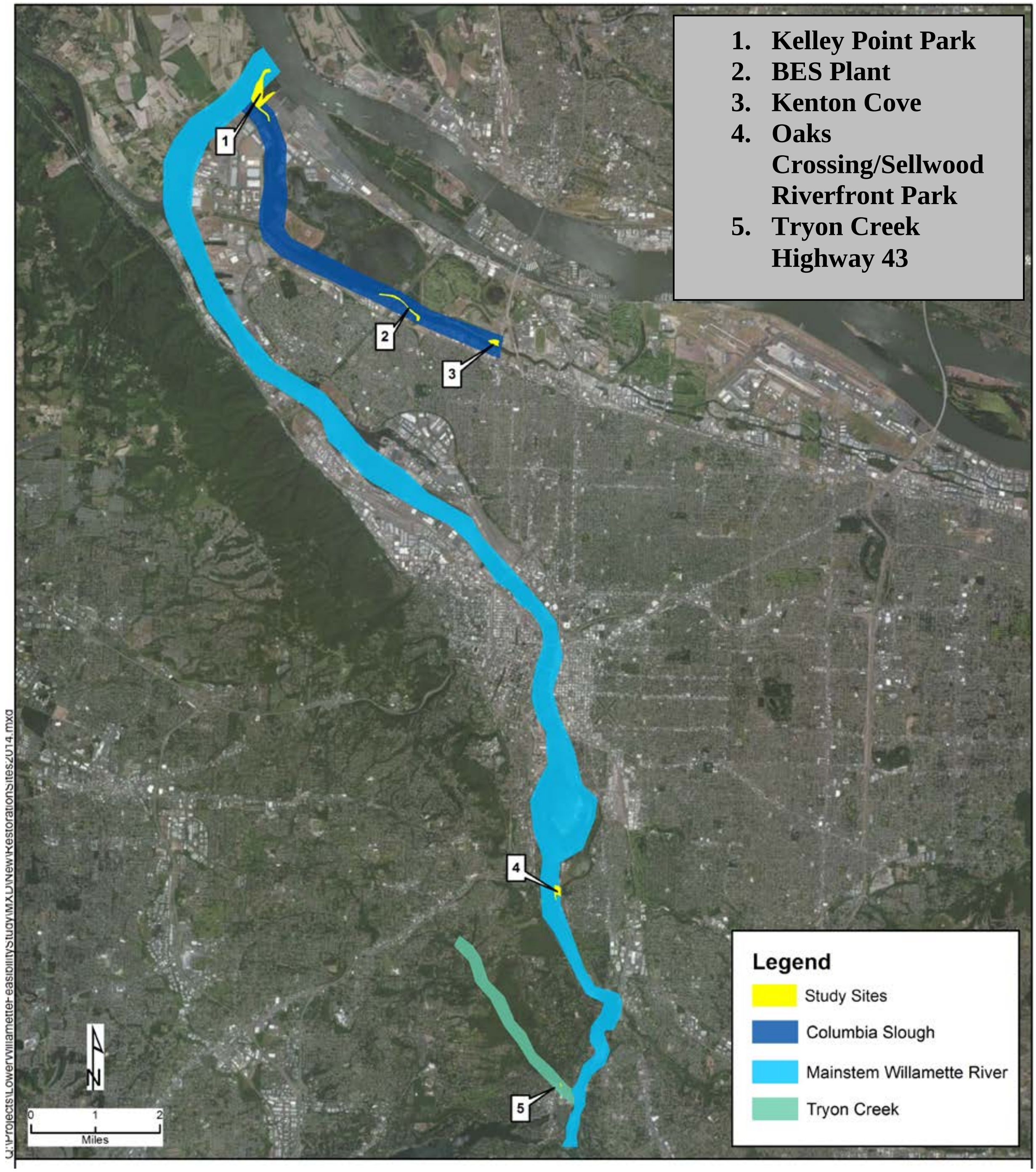


Figure 5-13. Ecosystem Restoration Sites included in the Recommended Plan

6. RECOMMENDED PLAN

6.1 Design Features

Feasibility level designs were created for each site. The design features are displayed in detail in the design plans that are included as Appendix H. Results of HEC-RAS modeling and additional hydraulic analysis is provided in Appendix B.

Successfully completed ecosystem restoration project at the 5 sites included in the RECOMMENDED PLAN would have the following features:

Kelley Point Park

- Excavate approximately 4,500 linear feet of tidal channels, with 10-foot bottom widths, sloping up at bank angles of 5H:1V to existing grade. Width of channel and riparian zone is estimated to be approximately 300 feet.
- Restore 16.9 acres of riparian forest by removing invasive species and revegetating with a mix of fast-growing and slow-growing native riparian trees and shrubs.
- Slope banks to a maximum 5H:1V slope along approximately 5,000 lineal feet of the Willamette River to create shallow water habitat and platform for establishment of riparian vegetation. Approximately 100-feet wide including riparian zone. Revegetate the areas above median winter flow with riparian species.
- Install 50 root wads along the edges of the Willamette River and in the newly-created side channels. Wood would be keyed into the bank with 75-80% of the wood or root wad buried. Large wood elements are designed so that the maximum elevation of the center of the rootwad would be approximately 1 foot below median winter flow. Additional design specifications appear in the Design Technical Memo, Appendix H.
- Install fourteen boulders in the side channel areas, with the top of each being one foot above median summer water surface elevation
- Install 3 pedestrian bridges to maintain the same access to the site. Required to maintain existing visitor access to areas of the park.

Oaks Crossing/Sellwood Riverfront Park

- Excavation of approximately 1,250 lineal feet of side channels of approximate average width of 100-feet (2.86 acres), to connect existing backwater areas to the Willamette River at median winter flows. Bottom elevations of the side channels would be set at 9.4 feet NAVD88 to allow water depths of at least 6 inches during median flows. Side channels would have a minimum 10-foot bottom width, sloping up at a 5H:1V gradient to existing ground.
- Eight root wads would be installed in the side channels to provide cover and habitat complexity, and to slow velocities in the side channels. Wood would be keyed into the bank with 75-80% of the wood or root wad would be buried. Large wood elements are designed so that the maximum elevation of the center of the rootwad would be approximately 1 foot below median winter flow. Additional design specifications appear in the Design Technical Memo, Appendix H.
- Approximately 2.7 acres of wetland and 4.5 acres of riparian areas would be planted or revegetated with native species. Invasive species would be removed prior to revegetation. Riparian species selected for this project include fast growing species such as alders and willows, and slower-growing species such as black cottonwood and ash. The purpose of this

mix is to allow riparian functions to develop quickly while the species with longer life spans, such as cottonwood and ash, are maturing.

BES Plant

- A low-flow channel would be excavated to reconnect a shallow swale to the Columbia Slough. The bottom width of the channel would be approximately 10 feet, and it would slope up at a gradient of 5H:1V to match existing grade.
- Wetland habitat would be restored in the swale by allowing inundation of this area and planting native wetland vegetation around the perimeter (0.8 acres).
- Three root wads would be installed in the shallow ponded area, with approximately 75 percent of the wood buried in the bank. An additional sixteen root wads would be installed in a similar manner along the edges of Columbia Slough approximately 3,500 lineal feet by 40-foot wide area in this stretch (3.2 acres) to diversify wetlands and help to enhance shallow water habitat.
- Fourteen boulders would be placed to create pond turtle habitat and to help anchor large wood. The boulders would be installed so that the tops of each one is at least one foot above the median summer water surface elevation.
- Banks would be excavated to an angle of 3H:1V along approximately 800 feet of Columbia Slough (1.83 acres) and revegetated with native riparian vegetation (0.8 acres). This would also help to create shallow water habitat.
- Invasive species would be removed around the swale and the area revegetated with native riparian species.

Kenton Cove

- Riparian plant species will be installed between the median winter flow elevation of 9.7 feet NAVD and 13.2 feet NAVD, restoring native riparian vegetation (3.1 acres).
- Nine wood clusters or root wads would be installed with deposition of sand and gravel mix to form habitat islands at the edges of the cove, creating wetland and shallow water habitat (2.0 acres).

Tryon Creek, Highway 43 Culvert Replacement

- Culvert slope would be constructed at a constant 3.4% to reduce the steeper 5.9% slope of the upper portion of the existing culvert, and to more closely match the previous and overall natural channel slope of 3.5%.
- Remove existing 8-foot by 8-foot concrete box culvert replace with a pre-cast arch culvert measuring 30 feet wide and 12 feet high by 400 feet long. This culvert will pass the 100-year discharge, and provide a minimum of 3 feet of additional freeboard. The culvert is sized to allow some lateral movement of the streambed, consistent with conditions immediately upstream and downstream of the culvert, but a wider culvert was deemed inefficient from the standpoints of cost and constructability. The downstream end of the culvert would tie into typical summer and fall water surface elevations.
- 18 to 20-inch rock, designed to withstand movement under the 100-year discharge condition, and meeting State of Oregon fish passage design criteria, would be used to create weirs at 25-foot intervals for grade control and to help control velocities. Water passing over the weirs would create downstream scour pools conducive for fish passage over the grade control structures.
- The streambed would be natural, and finished with cobble.
- Areas immediately upstream and downstream of the culvert would be significantly disturbed during construction, and would be revegetated with native riparian plant species.

Construction will entail the following components:

6.1.1 Clearing

Clearing includes the removal of large rocks, boulders, riprap, and debris from land for access and in advance of vegetative ecosystem restoration. Although removal of invasive species may occur incidentally as a result of clearing, it is described in greater detail below.

Clearing will be accomplished by hydraulic excavators, dozers, front end loaders, and dump trucks. Unusable rocks and debris will be removed to an off-site landfill or reuse site.

6.1.2 Removal of Invasive Vegetation

The purpose of removing invasive vegetation is to allow native vegetation to gain a competitive foothold in the project area. To this end, it is neither generally feasible nor necessary to remove all invasive vegetation, but its density and areal extent must be reduced to the point where native vegetation can establish itself as the dominant vegetation type.

Hand labor and small equipment will be used to cut and/or pull to remove invasive vegetation, and solarization may be used in areas where cutting or pulling are not appropriate. Spot application of herbicide is appropriate after cutting to kill or reduce the vigor of the invasive plant stems, while also minimizing any potential for spills or over-application. The removed vegetation will be disposed of off-site, such as at a compost facility, or chipped and composted on-site. It is expected that this would occur prior to planting, and then maintenance to continue to cut and/or apply herbicide to the invasive species would be conducted for up to 5 years following construction.

6.1.3 Excavation

Excavation will occur where it is needed to remove a culvert, to develop side channels and backwater connections and to regrade bank slopes to more natural angles. Excavation limits are determined by the design details at each ecosystem restoration site or where sensitive cultural or natural resources prohibit grading.

Excavation will be accomplished by hydraulic excavators, dozers, front end loaders, and dump trucks. Excavated materials will be placed at both on-site and off-site disposal locations. Care and diversion of water will be needed for excavations that are in or adjacent to water. This will be accomplished by placement and maintenance of temporary coffer dams and pumps. Best management practices for erosion control will be placed and maintained to avoid excessive turbidity in adjacent waterways. Except at the Tryon Creek, Highway 43 site, work areas will generally be isolated from the rivers, with final connections made during the allowed in-water work windows (coordination with ODFW will be required to determine site-specific in-water work windows).

6.1.4 Construction of Side Channels and Backwaters

Side channel construction involves the placement of one or more of the following: bank stabilization measures, streambank vegetation ecosystem restoration, and riparian vegetation ecosystem restoration. Channel invert grades are designed to provide a backwater connection during the typical winter/spring flows (November to June) at the channel outlets, so grade control measures are unnecessary. Bank stabilization is accomplished using vegetation, large woody debris and root wads, and fabric as necessary. Bank and riparian ecosystem restoration will include the planting of local, native vegetation species.

Backwater connections such as those that will be created at, BES Plant and Oaks Crossing/Sellwood Riverfront Park sites will include elements of side channel construction, but are typically shorter because they will be designed to achieve a backwater connection or connections between ponds using existing topographic features (following overflow channels or other existing channels), and may not typically include riparian ecosystem restoration features if an existing overflow channel is simply widened and/or deepened. These channels may include roughness features to slow velocities. Construction of the side channel and backwater habitat elements will be staged to follow clearing and excavation. Bed material will be placed with excavators, front end loaders, and dump trucks. Large woody debris, root wads, and native rock materials will be placed by using a combination of machines and hand labor. Streambank and riparian vegetative plantings will be accomplished using hand labor during the fall after other construction activities are complete.

6.1.4.1 Pedestrian Bridges at Kelley Point Park

Administered by Portland Department of Parks and Recreation, Kelley Point is a popular park and receives extensive use for hiking, bird-watching, dog-walking, outdoor education, and other uses. Although the park offers multiple uses including fish and wildlife habitat, as a facility that is actively managed for recreation, deference must be given to that use. Since the proposed side channels could restrict access to some parts of the park, the local sponsor requested that multiple bridges be installed to ensure continued access to all areas of the park. These have been included as foot bridges near the ends of the side channels. The bridges have been designed to allow pedestrian access over the side channels, and will not restrict flow through the side channels. The cost of the proposed bridges is less than 10% of the total construction cost.

6.1.5 Placement of Large Wood in Floodplains and Backwater Areas

Large wood will be placed in floodplain areas to provide habitat diversity and cover for amphibians, reptiles, and other wildlife species. Wood will be anchored with large rock or keyed into banks. This wood will provide cover for fish species as well as perching or basking habitat for wildlife.

Rootwads and large wood, cut to specified dimensions, will be obtained from a local source. The rootwads will be placed using an excavator, dump truck, small equipment, and hand labor. Large woody debris will be placed using small equipment and hand labor.

6.1.6 Riprap Installation

Riprap may be used, only as necessary, to protect the footing of the culvert at the Tryon Creek, Highway 43 site. Riprap will only be used following the guidelines in PROJECTS. Riprap will be placed using a hydraulic excavator.

6.1.7 Culvert Installation

At the Tryon Creek, Highway 43site, the stream will continue to be passed under the road in a culvert. The existing culvert will be replaced by one of sufficient size to allow woody debris to pass, improve hydraulic capacity, and provide a natural bottom and room for the channel to meander slightly. A general discussion of the analysis and design criteria that were used to identify the size of the culvert that would be needed to pass the design flows, pass large debris that may enter the system from higher in the watershed, and maintain fish-passable velocities and depths is presented below. Additional details of the hydraulic modeling that was performed appear in the Hydrology and Hydraulics Technical Memorandum (Appendix C) and in the Design Technical Memorandum (Appendix H).

The culvert size was determined with hydraulic design calculations to meet the State of Oregon's and NMFS's recommendations for fish passage (OAR 2013a). This analysis is presented in the Hydrology and Hydraulics Technical Memorandum (Appendix C). The minimum criteria applicable to the open-bottomed culvert replacement design for the Tryon Creek, Highway 43 culvert on based on the stream simulation option are:

- **Velocities and depths:** Maintain average water depth and velocities that simulate those in the surrounding stream channel.
- **Width**: Equal to or greater than the active channel width, as determined by the OAR (2013a and 2013b), and conservative guidance (ODOT 2011).
- **Minimum vertical clearance**: 3 vertical feet from the active channel width elevation to the inside top of the structure.
- **Maximum jump height**: 6 inches.
- **Minimum jump pool depth**: Greater of 2 feet or 1.5 times the jump height.
- **Slope**: Equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile.
- **Streambed Material:** Composed of material that is maintained through time, is either similar in size of composition as the surrounding stream or supplemented to address site specific needs that may include bed retention and hydraulic shadow, contain partially-buried over-sized rock since the road-stream crossing structure is greater than 40 feet in length, is mechanically placed during structure installation.
- **Debris Passage**: Active channel shall not be obstructed by trash racks or other debris accumulation structure so as to allow passage of wood and other large debris.

The fish passage criteria require the culvert to span the active channel width, which was determined from the bankfull elevations (OAR 2013b) determined by HEC-RAS modeling of the 2-year recurrence discharge for the existing channel geometry upstream of the culvert. The active channel width was determined as 20.2 feet. Chapter 6 of the ODOT Hydraulics Manual (ODOT 2011) further specifies culvert spans to be larger than the active channel width to provide an engineering factor of safety to pass lower frequency high discharge events. The method described by Case 2 (ODOT 2011) determines the conservative culvert span as 125% of the active channel width plus 2 feet, which results in a minimum design span of 27.25 feet. In order to provide a more cost conscious and construction efficient preliminary design for the Feasibility Study, a pre-cast arch culvert is recommended for evaluation in the subsequent design phases for this project. The pre-cast arch culvert size was selected as readily available size large enough to accommodate the conservative width of 27.25 feet, and has a width of 30 feet with a rise of 12.3 feet (CONTECH 2013).

The selected pre-cast arch culvert was evaluated by modifying the HEC-RAS model with a cross section representative of the proposed streambed within the culvert. The streambed will be composed of oversized rock and have a substrate that will be maintained through time to meet the State of Oregon's design requirements. Streambed grade control features will be constructed of oversized rock to ensure stability. Debris passage is unobstructed for the proposed culvert design, and no trash racks or other debris accumulation structures are specified for the culvert. The proposed cross section was tested for its ability to provide a minimum vertical clearance of 3 feet between the active channel width elevation and the inside top of the structure, and it was determined to exceed this requirement.

An incipient motion analysis was conducted utilizing the HEC-RAS results for the proposed culvert that are presented in the Hydrology and Hydraulics Technical Memorandum (Appendix B of the Feasibility Study). This analysis determined that the minimum rock sizes that will resist movement within the channel were 11 inches for the 100-year and 8 inches for the 2-year discharge conditions.

Culvert construction will be staged during the appropriate in water work window. Culvert installation will be conducted with mechanized equipment, and when necessary will include the pouring of concrete footings below the soil surface. Traffic control plans and designs will require approval by Oregon Department of Transportation (ODOT). Additional studies that may be needed during later stages of engineering and design are described in the Design Technical Memorandum, Appendix H.

6.1.8 Vegetative Plantings

Native vegetation species will be planted at all sites. The primary plant community that will be planted will be the riparian community, dominated by black cottonwood, red alder, Oregon ash, incense cedar, Douglas-fir, and a variety of shrub species. At sites with extensive tree cover, currently, the invasive understory will be removed and then replanted with appropriate riparian underplantings of shrub and conifer species. The shallow water and wetland zones will be planted with native emergent wetland vegetation.

6.2 Monitoring and Adaptive Management

Monitoring and adaptive management will be incorporated into all projects. Features that may be monitored for include fish passage, wildlife use, invasive plant species, and flows through side channels. An adaptive management plan will be developed in instances where features are not performing as expected or where the outcome does not appear to be meeting the objectives for that site. Additional information about monitoring and adaptive management appears in Section 10.

6.3 Cost Estimate

A certified cost estimate using the Corps's Micro-Computer Aided Cost Estimating System (MCACES) was developed in 2013 updated in 2015, and is attached to the Design Report (Appendix H). Real estate costs including a gross appraisal and estimate of Lands, Easements, Rights-of Way, Relocation, and Disposal Sites (LERRDs) has been developed by the Corps (Appendix I). The preliminary cost estimate for implementation of the RECOMMENDED PLAN with the Federal and non-Federal costs are shown in Table 6-1.

Table 6-1. Estimated Project Costs

Item	**Federal Cost**	**Non-Federal Sponsor Cost**	**Total**
Planning, Engineering, Design, Construction,	$18,822,050	$10,134,950	$28,957,000
LERRDs*	$0	$9,337,000	$9,337,000
Total Cost-Shared Implementation Costs			$28,957,000
Percentage of Total Cost-Shared Amount – Ecosystem Restoration (per Section of WRDA 1996) The Non-Federal Sponsor Cost for Ecosystem Restoration is 35 percent of all Planning, Engineering, Design, Construction Cost including LERRD	65%	35%	100%

Recreational Facilities**	$709,500	$709.500	$1,419,000
Percentage of Total Cost-Shared Amount - Recreational Facilities, The Non-Federal Sponsor Cost for Recreational Facilities is 50% of all cost	50%	50%	100%

Total Project Costs – (Planning, Engineering, Design, Construction) + LERRD + Recreational Facilities	**$30,376,000**

*LERRDs = lands, easements, right-of-ways, relocation, and disposal sites
**Recreational Facilities are less than 10% of total project cost.

6.4 **Construction Issues**

Construction is anticipated to be relatively straightforward at all sites, with the exception of the Tryon Creek, Highway 43 site. All sites are accessible to heavy construction machinery and staging areas are available at or near all sites.

Due to the heavily used highway that passes over the Tryon Creek Highway, culvert, as well as the train tracks, construction at this site is likely to temporarily impact car and rail traffic. Although construction can likely be accomplished without completely closing the highway, it will likely need to be narrowed to one lane in each direction or possibly one lane used alternately by traffic traveling in opposite directions. Further coordination with the Portland and Western Railroad is required to determine acceptable measures during construction.

6.5 **Elements for Detailed Design**

Several design elements need to be developed in order to advance the project from feasibility to final design. These elements include but are not limited to the following;

- Supplemental bathymetric and topographic surveying
- Detailed hydraulic analysis for:
  - Large wood sizing and placement
  - Sizing of side channels
- Detailed design of the Tryon Creek, Highway 43 site
- Detailed planting plans
- Traffic control plan

6.5.1 Schedule

Final review and approval of the project is expected in early 2015, followed by planning, engineering, and design (PED) in 2016 and groundbreaking in 2017. An estimate schedule for remaining planning tasks, PED, and construction appears in Table 6-2.

Table 6-2. Tentative Planning and Construction Schedule

Milestones	2014	2015	2016	2017	2018
District Quality Control/Limited Agency Technical Review (DQC/ATR)	■				
Alternative Formulation Briefing (AFB)	■				
Public Review – Draft Feasibility Report/EA	■				
Agency Technical Review (ATR)		■			
Civil Works Review Board		■			
Project Approval		■			
Project Partnership Agreement (PPA) signed			■		
Planning, Engineering, and Design (PED)			■	■	
Construction Phase 1				■	■
Construction Phase 2					■

6.6 **Risk and Uncertainty**

A certain degree of risk and uncertainty is inherent in any ecosystem restoration project. Risk in terms of public health and safety is reduced to the degree possible during the planning and design process, and known risks are described in associated environmental documentation. Uncertainty is found where some factors are beyond the control of the project design team, for example precipitation rates, new types of invasive species, or changes in human use of the site. Risk and uncertainty translate to project constraints, which provide the sideboards that guide the extent to which ecosystem restoration can occur.

6.6.1 Risk Register

Earlier in the planning process, a risk register was developed to serve as a tool for identifying risks throughout the feasibility study and implementation. The risk register is a spreadsheet where the risks associated with the study outputs and project outcomes are documented based on input from the PDT and feedback from a risk specialist and other vertical team members.

The main item identified as a risk in the risk register for the ecosystem restoration project was in regard to screening that resulted in the original list of projects being narrowed from 45 possible sites to the final array of eight sites. The identified risk was that the list of sites would narrow even further. This risk is low, since the current list of projects included in the recommended plan are those that the City considers to be critical to meeting its objectives in the Lower Willamette River watershed.

Although not identified in the risk register, the items below present topics that have been considered as risks in the planning study, and have been incorporated into the design and planning of this project.

Invasive Species Reed canary grass is widespread in the Lower Willamette River study area and without active intervention will likely outcompete native species after the sites are disturbed during construction. This species is very competitive and can out-compete most native species without active intervention. The most feasible and successful measures to control of reed canary grass are incorporated into the design and construction features of each plan, and long-term measures designed to track populations and keep them under control will be developed during preparation of a long-term monitoring and adaptive management plan.

Contaminated Sediments Three of the proposed ecosystem restoration sites are located downstream of the Portland Harbor Superfund site, which contains numerous "hotspots" of sediments contaminated with PCBs, industrial solvents, and other by-products of industrial activities and shipbuilding in the harbor. Although no contamination was identified at the ecosystem restoration sites identified in the recommended plan, disturbance of upstream sediments during dredging, remediation, or ecosystem restoration of other sites can mobilize contaminants and allow them to settle in downstream areas. The risk of contamination occurring at the ecosystem restoration sites from mobilization of contaminated sediments is considered to be low due to containment requirements during sediment-disturbing actions.

Several areas near the Oaks Crossing/Sellwood Riverfront Park site are known to contain DDT residue from past pest-control practices. Sediment testing conducted as part of the Oaks Bottom Ecosystem restoration Project indicated that DDT is present in the sediments at that site, which is located within a mile of the Oaks Crossing/Sellwood Riverfront Park site. DDT residue has also been identified in sediments excavated during dredging at the nearby Oaks Bottom Yacht Club. Sampling of fish tissue collected at the Oaks Bottom site has been performed by NOAA Fisheries, and results indicated that concentrations of DDT were below threshold levels and therefore did not constitute a threat to fish using that particular area.

Changed Climatic Conditions Causing Changed Hydrologic Conditions Possible effects of climate change include increased average tidal elevations, which would affect all sites included in this plan except for the Tryon Creek Highway 43 site. The ecosystem restoration plan includes a range of native plant species so communities can adapt to changed hydrologic and climatic conditions. In general, it is expected that wetland and riparian plant communities will respond to higher tidal elevations by forming at higher elevations in the floodplain.

Potential Adverse Effects on Species or Water Quality Conditions During Construction The risk of harm to anadromous fish species will be reduced to the degree possible by working within specified work windows, when fish are least likely to be present. Best management practices will be implemented to ensure water quality standards are met during construction. For other sensitive species, protection plans will be developed during later stages of design and during the permitting phase and implemented during construction.

Potential for Failure of Project Features Ecosystem restoration measures proposed in this plan are established and have been implemented at numerous sites around the Pacific Northwest and elsewhere. A geomorphic assessment of the proposed project sites that was performed to identify geomorphic features that may contribute to failure of any ecosystem restoration measures found a low risk of failure at all sites (Appendix A). Additional detailed hydraulic modeling and engineering during design will further refine the features to withstand anticipated flows and velocities.

Competing Uses Kelley Point Park is a popular location for walking, bird-watching, and other forms of recreation. Construction of channels at this location has been mentioned as a potential user conflict, with the premise that the channels would reduce the area available for pedestrians or other users. Crossing structures will be provided wherever necessary.

Competition for Restorable Sites Risk to the implementation of ecosystem restoration projects at the selected sites is related to competition for viable aquatic ecosystem restoration sites in the Lower Willamette River. Due to extensive pending Natural Resource Damage Assessment (NRDA) mitigation needs by entities that are identified by EPA as Primary Responsible Parties (PRPs) for cleanup in the Portland Harbor Superfund site, competition amongst the PRPs for sites that provide opportunities for ecosystem restoration and thus mitigation credits may increase as EPA gets closer to issuing its final ROD. This increases the risk that over time, some of the sites that are now part of the recommended plan could be purchased or placed under an easement by a PRP, which would eliminate it as an ecosystem restoration site under this plan.

Water Quality in Columbia Slough Poor water quality in Columbia Slough may reduce the efficacy of ecosystem restoration projects in this water body. Problems that were identified in this water body include high pH levels, low dissolved oxygen levels, high water temperatures, and algal blooms (Wells 1997). The ODEQ listed the Columbia Slough as water quality limited for beneficial uses including salmonid rearing, resident fish and aquatic life, wildlife and hunting, fishing boating, recreation, and aesthetic quality and subsequently developed TMDLs for Chlorophyll A, pH, phosphorus, dissolved oxygen, bacteria, DDE, DDT, PCBs, dioxin, and lead (USACE 2001). Stormwater runoff, leaching septic system contributions to base and shallow groundwater flows, combined sewer overflow events have been identified as sources for the constituents that trigger poor water quality. Development and urbanization within the Columbia Slough watershed has caused a loss of riparian vegetation and pervious surface area which has resulted in a reduction of the assimilation capacity associated with the vegetative buffer area that historically would have been present around Columbia Slough. Some of these issues are seasonal and occur primarily in the summer. Efforts to restore ecosystem functions in the Columbia Slough watershed have been made by the Corps and the City, and ongoing efforts to improve water quality throughout the Lower Willamette River basin may help to alleviate this issue. The proposed projects at BES Plant and Kenton Cove are not extensive enough to make a difference in these issues on their own, but will add to the cumulative effect of other, more comprehensive efforts to improve water quality.

Rail Disruption Although the Corps has commenced discussions with the Portland and Western Railroad regarding potential disruptions to rail traffic as a result of replacing the culvert at Tryon Creek, Highway 43, the Railroad to date has not given permission to use their property in such a manner. Therefore, there is a risk that permission will not be granted and this project will not be possible as designed. Additional design options may exist that would be less disruptive to rail service, including use of a temporary rail bridge during construction rather than possible temporary closure of the rail lines. This risk will be reevaluated periodically during the planning process, as talks with the railroad are ongoing. If the Railroad does not agree to allow construction at this location, the project objectives would still be met, but not to the extent that they would be with this project.

Occurrence of Cultural Resources At least three of the proposed ecosystem restoration sites may contain cultural resources. If buried cultural resources are identified during construction, construction may need to be stopped at the location of the resources until the materials can be assessed and protected. Therefore, the potential for occurrence of cultural resources poses a risk to the cost of the project, as construction teams may be shut down and need to demobilize, and conducting discovery of the extent of the resources may pose considerable expense. It also poses a risk to the schedule of the project, since it may mean that construction would need to be postponed until the resources are fully excavated and protected. The District has initiated consultation with the SHPO and tribes to ensure that the proposed project is in compliance with federal regulations regarding cultural resources and to ensure that cultural resources are protected from effects during construction.

6.7 Significance of the Recommended Plan

Non-monetary values associated with ecological resources are required to be documented per ER 11-5-2-100 Appendix C. These values are based on technical, institutional, and public recognition of the ecological, cultural and aesthetic attributes of resources within the study area. Per this direction, this section provides narrative and tabular descriptions of non-monetary values (Table 6-3).

The recommended plan will create or restore off-channel habitats at Kelley Point Park, Oaks Crossing, Kenton Cove, and BES Plant, reconnect upstream habitat through culvert replacement at Tryon Creek, and restore aquatic habitat at all sites through placement of wood and revegetation with native species. These measures will expand and restore essential rearing and refuge habitats for multiple ESA listed fish and wildlife species and species of concern that occur in the Lower Willamette Basin and contribute toward their recovery. Of primary focus are the species included in the HEP analysis; including those species dependent on suitable aquatic conditions such as salmonids and Western pond turtle, and riparian dependent wildlife such as beaver and wood duck, yellow warblers, and native amphibians.

Specifically, the types of improvements that this project will make to their habitats include provision of fish access to off-channel habitats, improvements in quality to the off-channel habitats including provision of more suitable off-channel water depths that vary naturally with the seasons (deeper depths in winter, shallower water in summer), improvements in cover and shading, increases in large wood and small woody debris, removal of invasive species and revegetation with native species, and interspersion of habitat types.

Key agencies, including NOAA Fisheries, USFWS, EPA, ODFW, and others are looking to projects such as this to provide valuable habitat. This project, as proposed, would provide key aquatic habitat ecosystem restoration projects along the Lower Willamette River and contribute to the recovery of sensitive species.

6.7.1 Institutional Significance

Institutional recognition is based on the significance of resources acknowledged in laws, adopted plans and policy statements by agencies both public and private. The plans and programs listed in Section 2 demonstrate the significance of the resources to multiple agencies.

This project will restore and reconnect off-channel and floodplain habitats for several species listed under the ESA, including the following ESUs; Lower Columbia Chinook salmon, Upper Columbia spring-run Chinook salmon, Upper Willamette Chinook salmon, Snake spring and summer-run Chinook salmon, Snake fall-run Chinook salmon, Columbia Chum salmon, Lower Columbia/Southwest Washington Coho salmon, Snake Sockeye, Lower Columbia steelhead, Middle Columbia steelhead, Upper Columbia steelhead, Upper Willamette steelhead, Snake steelhead, Willamette Recovery Unit bull trout, Southern Distinct Population Segment (DPS) of North American green sturgeon, and species of concern including the Pacific lamprey and Coastal cutthroat trout. The project will improve habitat, in some cases including habitat designated as critical, and contribute toward their recovery. In addition, this project will restore suitable floodplain and riparian habitats for species of concern identified by the USFWS, including Western pond turtle and Pacific lamprey. This project will also contribute toward meeting key objectives of the *Willamette Subbasin Plan* (NPCC 2004) developed as part of Phase 1 of this study, but involving multiple federal, state, regional, and local agencies to set priorities for fish and wildlife conservation throughout the basin. Key aquatic habitat strategies that this project will address include: 1) increase interaction of rivers and floodplains; 2) increase and restore off-channel and wetland habitat; and 3) control the most damaging terrestrial and aquatic invasive species (NPCC 2004).

6.7.2. Public Significance

Public significance means that some segment of the public recognizes the importance of an environmental resource. In the case of the Willamette River Valley, which hosts 70% of the state of Oregon's population, there exists a strong citizen involvement in the uses and activities of the river. The Willamette River is one of ten rivers included in the Sustainable Rivers Project between the Corps and the Nature Conservancy. A wide variety of groups have interest in protecting the habitat along the Willamette River, for the purpose of protecting fish and wildlife, but also to improve recreational and aesthetic value of the river, which is a centerpiece of sociocultural activities in Portland. Local interest groups will be given the opportunity to review proposed ecosystem restoration plans and will benefit from completion of these plans.

6.7.3 Technical Significance

Technical significance of the ecosystem restoration is determined through review of relevant published and non-published literature and documents that provide a scientific (or technical) basis for the value of the proposed ecosystem restoration. Numerous scientific analyses and long-term studies through Oregon State University and the University of Oregon have documented the significance of the resources in the Willamette River basin, of which the *Willamette Basin Planning*

Atlas provides the most comprehensive review of how resources have been lost, while laying out scenarios to guide future development for restoring natural resources.

The recommended plan will restore connectivity between the deepwater channels of the Lower Willamette River and Columbia Slough and the off-channel habitats that they have become separated from. This connectivity is a key component of natural processes that have been substantially altered by the presence and operation of upstream dams, revetments, land use and infrastructure. Ecosystem restoration will also provide improvements to water quality and riparian habitat, which will further improve fish and wildlife habitat.

Table 6-3. Non-monetary Significance of Ecosystem Restoration in the Lower Willamette River

Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek	**Sources of Significance**		
	Institutional Recognition	**Public Recognition**	**Technical Recognition**
ESU Salmonids	ESA listing of numerous ESUs of salmon throughout the Lower Willamette River and its tributaries. House Resolution Docket 2687 identified the importance of ecosystem restoration along the Lower Willamette River watershed. Corps has prepared a BA in coordination with NOAA and USFWS to evaluate the impacts of the operation of the Willamette projects on species listed under the ESA. Magnuson-Stevens Fishery Conservation and Management Act requires measures to protect essential fish habitat during any water resources development project.	Historically, the area has supported an important recreational fishery. Component of local tribal value, both culturally and economically. The public has become increasingly aware that protection of threatened and endangered fish is an essential component of greater overall sustainability of fish and wildlife habitat throughout the region.	Reduced stocks of salmon have been extensively documented and resulted in listing of particular stocks as protected. Project area is essential migratory route for all ESA recognized ESUs of salmon. Upstream passage above culverts is essential to restoring lost spawning grounds.

Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek	**Sources of Significance**		
	Sources of Significance	**Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek**	**Sources of Significance**
Fish and Wildlife Habitat; Floodplains, Wetlands and Off-Channel Aquatic Habitat	EO 11998 requires agencies to take steps to restore and preserve the natural and beneficial values served by floodplains, which includes off-channel habitats. EO 11990 requires protection of wetlands. Fish and Wildlife Coordination Act requires habitat conservation to be equally considered along with water resources development projects.	There is an increasing understanding that flooding damage results from altered river systems and loss of floodplain connectivity. Willamette Riverkeeper and partner associations include thousands of volunteer river advocates who work for conservation and protection of fish and wildlife habitat.	Floodplain connectivity is essential to exchange of nutrients, recruitment of wood, flood buffering, and preservation of dynamic natural processes that create native habitat complexity and diversity and support fish and wildlife. Off channel aquatic habitat and wetlands provide refugia and rearing habitat for native fish and wildlife essential for support of all life cycles. Wetlands provide habitat, water cycling, and flood buffering.
Water Quality	Portland Harbor has been added to EPA's National Priorities List of contaminated sites (Superfund). TMDLs have been developed for EPA's 303(d) listed stream segments with pollutant exceedances.	Organizations such as Willamette Riverkeeper, Citizens for Safe Water, and others bring the health of the river into the political spotlight.	Clean water is essential for drinking, municipal, agricultural, and other human uses. It is also needed for protection of fish and wildlife species. The ODEQ reports that water quality in the AOI is very poor to fair, based on a suite of water quality parameters.
Cultural	National Historic Preservation Act provides for protection of culturally valuable sites and artifacts.	River Renaissance Initiative is citywide collaboration for returning Willamette waterfront to cultural centerpiece.	Data from a variety of sources indicates that artifacts and structures of historic value may be present.
Aesthetic	Oregon Statewide Planning Goals 5 and 15 guide the protection of aesthetic qualities in the city of Portland and along the Willamette River Greenway.	The Greenway Plan and advocates for open space demonstrate the public's sense of valuing natural spaces for their aesthetic appeal.	Visual appeal of outdoor spaces has been shown to improve the health of those who have the opportunity to experience it regularly.

7. ENVIRONMENTAL EFFECTS OF THE RECOMMENDED PLAN

NEPA Sections 1500.1(c) and 1508.9(a) (1) require federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment." This section identifies the expected environmental effects of implementing the recommended plan, which are primarily beneficial, although there will be short-term adverse effects during construction.

Because this project is at an early stage of design, certain components of the proposed ecosystem restoration projects may change during later stages of design. If these changes appear to be substantial enough to change the effects determinations below, or give reason to believe that additional effects analysis is warranted, project specific NEPA documentation will be performed for any affected sites prior to project implementation.

7.1 Soils and Geology

Under the No Action Alternative, no construction would be undertaken and therefore, no direct impacts would affect soils or geology. Natural erosive forces, such as tidal action, high flows, or storms would erode soils locally, particularly along river banks or where vegetation is not well established and cannot stabilize soil. Over time, river banks in project areas that are steep will continue to erode, further disconnecting wetlands from riverine influence. Riverbanks that are not yet eroded may become steepened as well.

The geomorphic assessment performed for the feasibility study (Appendix A) indicates that the proposed ecosystem restoration sites are generally stable and not subject to streambed, bank, or floodplain change under the current conditions. Additionally, this assessment determined that the potential for change of the streambed, adjacent banks, and floodplains is relatively low for the proposed conditions. However, localized bank failure was noted downstream of the proposed Tryon Creek, Highway 43 site due to the undersized channel and alignment of the overbank flow path. It is anticipated that this failure will continue with no action applied. As cited in the geomorphic assessment, the Lower Willamette River generally has a low-gradient single channel thread that is confined by development including bank and floodplain modifications and stability projects. Changes to the flow regime due to dams and development have likely impacted sediment transport and deposition within the Lower Willamette River, a condition that is likely to persist under the no action alternative.

Under the recommended plan, construction of proposed ecosystem restoration will require use of heavy equipment for clearing vegetation, excavating channels and wetlands, removing the Tryon Creek culvert, and relocating excavated materials. These activities will result in exposed soils, potentially leading to erosion or dust generation. If in-water machinery is used for bank sloping or if terrestrial equipment is operated in nearshore locations, the potential for soils to enter the water column and create turbidity is increased. Fish and wildlife would be indirectly affected by turbid waters that block sunlight and reduce sight for foraging, or impede respiration in fish. This effect will be offset by isolating the work area to the degree possible, and containing erosion using a combination of methods including silt fences, straw bales or berms, temporary dewatering, and surface stabilization including use of mulches. Implementation of these methods along with turbidity monitoring by an on-site observer will reduce this effect to less than significant.

Operation of the restored sites will not have direct effects on soils or geology. Once fill is removed from the site, the physical condition of remaining soils will only change incrementally as natural erosive forces occur; however, establishment of vegetation will be designed as part of the ecosystem restoration to stabilize soils wherever necessary. Indirect effects on soils may include chemical changes from increased hydrologic connection and increased erosion due to increased visitation. Over time, non-wetland soils that become newly located adjacent to backwater channels or ponds will take on characteristics of wetland soils, ultimately beginning to exhibit hydric qualities. If restored areas result in increased visitation, particularly where ecosystem restoration sites are already popular recreational spots (Kelley Point Park and Oaks Crossing), it is possible that trampling of vegetation or off-trail hiking could lead to increased soil erosion.

The proposed action is intended to restore off-channel and floodplain habitat that is effective at flows greater than those that create water surface elevations higher than 6 inches below the median winter water surface elevation, and for the Tryon Creek, Highway 43 site, to restore fish passage. These features are not intended to increase geomorphic change of Columbia Slough, the Mainstem Willamette River, or Tryon Creek. The geomorphic assessment performed for the feasibility study indicated that although the two sites along Columbia Slough have remained relatively stable over the last 30 years, there is a potential for sediment deposition for the side channel connections and particularly so at the confluence of these connections with Columbia Slough. Occasional maintenance to remove deposited sediment may be required to ensure these connections remain open. Similar potential effects at the two Willamette River sites were noted, due to substantial amounts of sand observed at these sides and in the vicinity of the proposed inlets and outlets of the side channels. Maintenance may be required at these two sites, and careful consideration of the side channel design, including gradient of the channels, should be applied to ensure that the connections and side channels are not blocked by deposited sand. For the Tryon Creek, Highway 43 site, the geomorphic assessment indicated that the channel and banks of Tryon Creek upstream and downstream of the culvert are stable.

Boulders and streambed material for the bottom of the Tryon Creek, Highway 43culvert bottom will meet state and federal regulations and guidance. The streambed will be designed so that it is stable, and thus require a minimal amount of maintenance and minimize adverse erosion and scour effects. Both energy dissipation and fish passable step-pools will be designed to meet stability and fish passage criteria. The boulders will protect the base of the culvert and the streambed material from erosion during high flow events, and is not washed downstream out of the culvert. Step-pools will be constructed of boulders to provide slower moving holding water areas that fish can rest in during upstream or downstream migratory passage through the culvert.

7.2 Water Resources

7.2.1 Water Quality

Under the No Action Alternative, minimal changes in water quality conditions would occur under future without-project conditions. The TMDLs developed for the Lower Willamette River will improve water quality conditions in the subbasin. Continued development in the watershed may lead to minor reductions in water quality, by increasing the potential for chemicals and sediment to be conveyed from street, sidewalk, and lawn areas into stream and riparian habitat areas. An increase in the supply and concentration of chemicals and sediment to streams and riparian areas can result in siltation of spawning gravels.

Under the recommended plan, while water quality improvements are not a project purpose, there may be some incidental water quality improvements that occur as a long-term result (i.e. localized reduced temperatures and increased dissolved oxygen concentrations). These benefits are not considered to be measurable at the scale of assessment provided in this EA, and the overall water quality and temperature regimes in the river will not be substantially changed as a result of the recommended ecosystem restoration plan.

Temporary impacts to water quality, mainly turbidity, may occur during construction of the project, due to sediment disturbance. Impacts on fish and other aquatic organisms will be temporary and will occur during the in-water work window, which for the lower Willamette River begins on July 1 and ends on October 31 of each year, to avoid adverse effects. These impacts will be further minimized by isolating construction activities from adjacent receiving waters by primarily working on the sites prior to making connections to the rivers and implementing construction best management practices (BMPs) to the maximum extent practicable. These BMPs will likely include surface stabilization (i.e. mulches), silt fence and other sediment barriers, and maintaining booms, silt curtains, and absorbent pads on site and implementing a source-control program to prevent the generation or release of potential pollutants. Water quality monitoring will take place during and after construction to meet permit requirements. If the standards are exceeded then construction will be halted until additional measures can be installed to ensure standards are met.

Construction equipment may release small amounts of pollutants into the water, including oils and grease or other contaminants, as a result of spills and leakages or the existence of contaminants on machinery that is used within the water column. Staging areas will be contained by straw bales or berms to ensure that sediment-laden or contaminated runoff does not leave the site. Pollution prevention plans will be used to identify methods and procedures to control contaminants from entering the water through leaks or spills. Prior to construction site use, machinery used for ecosystem restoration will be cleaned of harmful chemicals, soil from offsite areas, and invasive weed seeds to prevent negative and adverse impacts associated with the introduction of these pollutants to the ecosystem restoration sites. Materials selected for construction of the ecosystem restoration measures, not limited to plants specified for revegetation plans, large wood and habitat logs, boulders and streambed rock, and soils will originate from pre-approved sources to minimize the potential for import of pollutants to the site that may be adhered to these materials. During the design phase, detailed erosion and pollution control plans will be developed for each site.

7.2.2 Hydrology/Hydraulics

Under the No Action Alternative, analyses of hydrologic and hydraulic conditions, including statistical and physically based numerical modeling to understand seasonal, annual, and peak discharge and water surface elevations were prepared as Appendix B to the feasibility study. Implementing the no action alternative will result in continuation of current hydrologic and hydraulic conditions present at each of the ecosystem restoration sites. The no action alternative will provide no change to flood storage and conveyance. Without the proposed alternative action the inundation of side channels and floodplains will be less frequent, and to lesser extents and depths, than with the proposed alternative action.

For the recommended plan, alteration of hydrologic and hydraulic features at each site is limited to those actions needed to restore habitat. No large-scale alterations are proposed. Direct hydrologic effects at individual sites include more frequent inundation, and greater extents and depths of inundation. The increased frequencies, extents, and depths of inundation are targeted for the proposed floodplain, side channel, off-channel, wetland, and riparian restored habitat area actions. Activation of these restored habitat areas is designed to occur at and above median wintertime discharge of 34,000 cfs for the lower Willamette River and 10 cfs for Tryon Creek. During the wintertime native fish are migrating within the lower Willamette River. The inundation anticipated is for newly created side channel and off channel habitat areas that will be developed using the design criteria developed from the hydrologic and hydraulic analyses presented in Appendix B and detailed in Appendix H. The proposed minimum elevation design criteria for side channels and floodplain connections is specified as 6 inches below the median winter water surface elevation. This is a positive benefit for creating habitat by increasing flood frequency of the side channel and off channel areas. The off channel habitat and side channel areas will also provide minor reductions to flood flows and water surface elevations. These reductions are anticipated due to detention, or the short term storage of water volume, associated with flows high enough to inundation these areas.

Water velocities in these designed habitat areas are expected to be minimal since these areas are not aligned with the primary flow direction of either the lower Willamette River or Columbia Slough. The proposed habitat areas will be inundated by backwater and slower moving water along the sides of the Willamette River and Columbia Slough. Similarly, scour or erosion at these sites is not expected to be an issue, but rather deposition of sand sediment may occur at these sites and particularly at the connection point of these sites to the mainstem Willamette River or Columbia Slough. Deposition of sediment may necessitate maintenance of the connection points by mechanical removal, and further analyses at later stages of design will evaluate the potential for deposition and frequency of maintenance.

Sea Level Rise

Because the proposed projects are located on a tidally-influenced riverine system upstream of the Astoria gauge, from which data used to compute the sea level rise estimates reported in Section 4.3.7 were derived, a direct correlation cannot be drawn between elevations at both locations. However, assuming average water surface elevations at the project locations changed to a similar degree as reported in Section 4.3.7, the likely scenarios are as follows:

Low: Under the low scenario, water surface elevations would be slightly lower and side channels would be inundated less frequently. This effect would be negligible, as bottom elevations of proposed side channels are designed to be accessible well below the median winter flow, and a change of less than one inch would not prohibit fish use or have a significant effect on the duration of inundation.

Intermediate: Under the intermediate scenario, water surface elevations would increase by up to 5 inches by 2070. This increase would lengthen the period and depth of inundation of the side channels. It is expected that side channels would become inundated earlier in the winter or perhaps even in fall, and would be inundated later in the spring. This effect could be offset by smaller spring freshets, as more precipitation would fall as rain than would fall as snow. In this case, later side channel inundation in the late spring is unlikely.

High: Under the high scenario, water surface elevations would increase by up to 1.92 feet by 2070. At this elevation, side channels would likely be inundated for much of the year, and parts of the floodplain areas would likely be inundated during part of the year. Depending on tidal variation, velocities in side channels may increase significantly due to increased flows through them. Increased side channel velocities would reduce or eliminate the value of these areas to juvenile salmonids. Furthermore, increased water surface elevations of this degree would narrow the riparian area by inundating what is now the lower elevation of the riparian zones and making them uninhabitable to riparian plant species. In areas where riparian zones are already narrow, this would be a significant effect.

7.2.3 Floodplains

Under the No Action Alternative, the direct effect of not performing the alternative action at the ecosystem restoration sites is continuation of the same flood levels, storage, and conveyance.

Implementing the recommended plan at the ecosystem restoration sites will increase backwater and side channel storage volumes which will likely cause minor reductions in base flood elevations. The connection elevations and excavation quantities for off-channel and side-channel areas are not intended to serve the purposes of flood control or reduction. For the current level of design, the criteria used to specify the connection elevations was the median winter water surface elevation, and flood elevations and discharges have not been evaluated..

In accordance with 44 C.F.R. 60.3(d) (3), projects and design elements that are specified within the regulatory floodway delineated by the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Study for the City of Portland (FEMA 2010) require an encroachment review, or a review of potential negative impacts on conveyance of the 100 year flood or increases in the water surface elevation associated with the 100 year flood. This analysis is commonly referred to as a no-rise analysis and entails detailed hydrologic and hydraulic analyses utilizing the models used to specify the regulatory floodway and comparing the with- and without-project conditions. Executive Order (EO) 11988, issued in 2012, requires federal agencies to avoid to the extent possible the long-term and short-term adverse impacts associated with occupancy or modification of floodplains and avoiding support of floodplain development if there is a practical alternative. No permanent structures are proposed for the floodplain other than installation of large wood, and floodplain modifications in general are designed to take advantage of existing swales or disconnected side channels. Thus, any work in the floodplain associated with the recommended alternative will be consistent with the EO.

The Lower Willamette River has a defined floodway that encompasses design elements at the Kelley Point Park and Oaks Bottom/Sellwood Park sites. Base flood elevations, defined by the water surface elevations associated with the 1-percent annual chance flood also commonly referred to as the 100-year flood elevation, delineate the outer boundary of the flood plain. The floodway is defined as an area that can fully contain and convey the 1-percent annual chance flood without raising the associated flood elevation more than one foot above the base flood elevation. For waterways that have regulatory floodways, the areas between the floodway and the outer boundary of the base flood elevation are defined as the flood fringe. The flood fringe is an area defined such that development projects do not increase flood heights, and therefore encroachment review of projects and design elements within the flood fringe do not need to be assessed for impacts on flood flows or water surface elevations. Project sites that contain elements within the flood fringe include Kenton Cove, BES Plant banks, and Tryon Creek, Highway 43.

7.3 Biological Resources

7.3.1 Wetlands

Under the No Action Alternative, no new wetland areas will be created and no improvements will be made to degraded wetlands. Over time, continued degradation will directly result in the loss of additional abundance and diversity of native fish, wildlife, and plant species. Indirect effects of diminishing wetland area and function may result in reduced water quality. The health and function of known wetlands in the project area have not been assessed. Loss and degradation of wetland habitat throughout the lower Willamette River system has been a substantial cause of fish and wildlife decline, reductions in water quality, and increase in non-native species. The remaining wetlands in the project area are fragmented, small, disconnected from the river, and may not provide the beneficial functions typically associated with wetlands.

The recommended plan includes the creation of a variety of wetland types or the rehabilitation of existing wetland habitat at each of the 5 proposed sites. New wetlands will be created through excavating new emergent wetlands, low flow channels, and high-flow refugia. In addition, steep slopes will be graded to facilitate gentler transitions from upland to backwater or river flows and large wood will be placed to restore wetland habitats. These measures will directly improve the essential rearing and refugia habitat that benefits native fish assemblages in the river, as well as increases habitat for native wildlife that rely on riparian and wetland habitats. As increased wetland areas provide water filtering and flood buffering, water quality may be indirectly and incrementally improved as well.

According to NWI maps, few existing wetlands occur where construction is proposed, and a formal wetland delineation has not been conducted. However, site reconnaissance indicates that additional wetlands may be present beyond those identified in NWI maps, primarily as fringing wetlands found along the edges of the Lower Willamette River and Columbia Slough. If construction occurs in areas where wetlands already exist, construction could temporarily adversely affect the quality and functioning of the wetland. Clearing of vegetation, particularly mature trees, would remove existing habitat and excavating soils would alter hydrologic wetland conditions. Other direct impacts could occur if construction equipment oils and grease were released into the wetlands, or if erosion caused turbidity in backwater or wetland waters. It is estimated that temporary losses of wetlands during construction will total less than 1 acre, based on site surveys.

Overall, wetlands that may be impacted by construction are very small at all sites and/or are not providing substantial habitat or function. The construction of larger wetlands vegetated with native plants will substantially improve habitat where small and fragmented wetlands are now present. At larger wetlands, such as those at Oaks Crossing, mature trees will be protected, or if removed, will be utilized as large wood clusters and replaced in kind. Long-term beneficial impacts are expected to result for wetlands and their associated species as a result of ecosystem restoration.

Mitigation for wetland losses or impacts typically requires the construction of additional wetland acreage as compensation. In this case, wetland creation is one of the purposes of the project and therefore, no mitigation would be necessary. Any loss to existing wetlands or function would be immediately compensated for through the construction of new wetlands. However, the implementation of several BMPs would be necessary to protect wetlands from direct and indirect adverse impacts that may result during construction. These include construction during the dry season, placement of erosion controls, and establishment of spill remediation protocols prior to construction. With proper construction phasing design and controls, impacts to wetlands will be temporary and minor.

7.3.2 Vegetation

Under the No Action Alternative, the condition of vegetation would remain unchanged, in a degraded state with most of the riparian areas affected by invasive species, steepened banks, or revetments.

Ongoing development of the Lower Willamette River watershed would continue to negatively affect conditions in riparian zones. However, other ecosystem restoration programs in the study area are intended to restore habitat structure, function, and processes. As a result, there is potential for both negative and positive influences on native habitat in the project area.

During construction of the recommended plan, required vegetation clearing may reduce the availability of foraging, resting, or nesting habitat. Any clearing conducted for the purpose of access would be carefully planned, leaving important trees or communities intact, whenever possible. Under the recommended plan, mature trees will be protected to the extent possible. Trees removed during construction would be used to create an in-stream or terrestrial habitat structure whenever possible. Sensitive habitats and species that must be protected, including trees, would be clearly marked. Additional native riparian trees and shrubs will be planted in floodplain, riparian, and wetland habitats. To the extent possible, staging areas shown in design plans have been situated in areas of non-native vegetation or where little or no native vegetation would have to be cleared Due to these measures, impacts to vegetation are expected to be less than significant.

A Biological Assessment (BA) has been completed for the recommended plan and is included as Appendix C. No special status vegetation species are likely to be found in the project area. The proposed ecosystem restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, and will therefore help contribute to the recovery of these species. Therefore the indirect effects of this project will be positive.

During construction there will likely be short-term adverse effects from vegetation clearing that may temporarily reduce the quality and function of habitat. However, any clearing conducted for access would be carefully planned, leaving important trees or communities intact, whenever possible. All disturbed areas will be replanted with native vegetation supporting a community of higher quality habitat and function.

7.3.3 Fish and Wildlife Species

Under the No Action Alternative, fish and wildlife habitat in the watershed will continue to degrade from the effects of development and ongoing regulation or flows. However, ongoing ecosystem restoration actions conducted by the City of Portland and other organizations will improve the condition of fish and wildlife habitat. These actions will reduce toxins, partially restore floodplain connectivity, riparian vegetation, and more natural hydraulic and morphologic conditions; reduce bank erosion and sedimentation; create off-channel habitat; improve in-stream structure; and remove fish passage barriers.

During construction of the recommended plan, most work will be phased to isolate the construction area from adjacent receiving waters in order to protect aquatic biota (i.e. avoid connections to the rivers until other work is complete). In addition, construction stormwater best management practices (BMPs) will be implemented to the maximum extent practicable in order to preserve local water quality, especially with respect to turbidity effects. These BMPs will include surface stabilization (i.e. mulching), silt fence and other sediment barriers, and a source-control program to prevent the generation or release of potential pollutants.

All work in-water work will take place only during work windows designated by the Oregon Department of Fish and Wildlife (ODFW) to minimize possible harm to fish species. Fish salvage and removal will occur as necessary. Overall, adverse impacts to fish during construction are expected to be minor and temporary. Although fish may be temporarily excluded from habitats, the areas of exclusion would be minimal and restrictions to passage up- and down-stream would be short-term. Overall, long-term benefits to fish and aquatic habitats from the ecosystem restoration plan are expected. Specifically in regards to the focal wildlife species in this study including native amphibians, pond turtles, and migratory bird species, this plan will restore habitats that are limited for all of these species such as off-channel habitat, wetlands, riparian habitats, cover and large wood.

During construction, terrestrial wildlife may be affected by the action alternatives primarily by disturbance. Construction equipment, human presence, and increased noise may disturb resident wildlife or discourage migrating wildlife from utilizing the surrounding habitats. Wildlife may also be affected if their habitats are altered during the construction process. Vegetation clearing, earthwork, and debris removal may directly impact foraging or nesting grounds for amphibians, reptiles, birds, and small mammals.

Construction activities may require wildlife exclusion or protection. Additionally, during the design phase, supplemental environmental documents would be completed for each project site to identify construction phasing and likely wildlife that may be encountered on each site, and to provide a set of guidelines for their protection. In this way, disturbance to species present in the area proposed for restoration can be avoided or reduced. Wildlife would have many available habitats to disperse to temporarily and would return once construction is complete.

Overall, although there may be minimal displacement of resident wildlife and temporary exclusion of wildlife during construction, there are not expected to be significant adverse impacts. The riparian plantings would increase the habitat value of the site by creating additional opportunities for foraging, nesting, cover, and refuge for a wide variety of species.

7.3.4 Threatened, Endangered, Candidate, and Rare Species

Under the No Action Alternative, continued development of the Lower Willamette River watershed would continue to negatively influence conditions for protected fish and wildlife species. However, other ecosystem restoration programs within the project area intend to restore habitat structure, function, and processes within the Lower Willamette basin. Overall, cumulative effects are expected to be beneficial to salmonids and other native species found in the project area.

A BA has been completed for the recommended plan and is included as Appendix C. Most listed and candidate species that may occur in Multnomah County do not occur in the study area. Of those that do occur in the study area, the recommended plan may have direct, adverse effects on Chinook salmon, coho salmon, and steelhead as a result of construction. Ecosystem restoration measures proposed as part of this study align with the 18 project categories of aquatic ecosystem restoration actions covered under the Programmatic Ecosystem restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program (NMFS 2013a). The PROJECTS Biological Opinion (BiOp) is a joint programmatic conference and biological opinion prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Action consultation on the effects of implementing aquatic ecosystem restoration actions proposed to be funded or carried out by the USFWS and the NOAA Ecosystem restoration Center in the States of Oregon, Washington and Idaho. Limited incidental take is allowed under this BiOp, therefore these types of impacts are less than significant.

The proposed ecosystem restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, and will help contribute to the recovery of these species. Therefore the indirect effects of this project will be positive. The NMFS and USFWS are charged with recovery of these species and this plan is not intended to be the primary element of that recovery, but will contribute to their recovery.

Construction activities will likely cause short-term adverse effects such as temporary increases in turbidity, fish salvage and handling, and general disturbance. BMPs will be implemented during construction to avoid and minimize potential effects, such as work area isolation by the use of coffer dams and/or silt curtains, requiring that fish salvage be conducted in accordance with an approved fish salvage plan and Scientific Collection Permit by experienced fish biologists, installation of erosion and pollution control measures, and compliance with all permit requirements.

A summary of the preliminary determination of effects to listed species is provided in Table 7-1, below.

Table 7-1. Determination of Effects to Listed Species in the Study Area

Species	**ESA Status**	**Effect Determination**	**Critical Habitat Determination**
Coho salmon (*Oncorhynchus kisutch*); Lower Columbia River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Chinook salmon (*Oncorhynchus tshawytscha*); Lower Columbia River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Chinook salmon (*Oncorhynchus tshawytscha*); Upper Willamette River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Steelhead (*Oncorhynchus mykiss*); Lower Columbia River DPS	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Steelhead (*Oncorhynchus mykiss*); Upper Willamette River DPS	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
North American green sturgeon (*Acipenser medirostris*); Southern DPS	Threatened	No effect	N/A
Bull trout (*Salvelinus confluentus*); Mainstem Lower Columbia River (Unit 8)	Threatened	No effect	No effect
Bull trout (*Salvelinus confluentus*); Clackamas River NEP	Non-Essential	No effect	No effect

7.4 Cultural and Historic Resources

Under the No Action Alternative, potential impacts on cultural resources that may be associated with the proposed ecosystem restoration project would not occur. There would be no potential impacts resulting from the ground disturbing activities and alterations of infrastructure at these locations. Cultural resource compliance actions would continue for other projects and ongoing operations and maintenance channel and infrastructure actions that are Federal undertakings or that require NEPA review. For these actions, surveys would be conducted (as needed), impacts would be assessed, and avoidance measures would be developed.

In 2010 a record search and site reconnaissance was conducted at the locations of the original 23 potential habitat ecosystem restoration projects. Confidential site and survey records relevant to

each potential project location were reviewed and each location was visually inspected by an archaeologist for surface archaeological resources and the likelihood for encountering buried archaeological deposits.
Shovel tests were performed at three of the locations, where a records search indicated moderate or high probability of the occurrence of cultural resources. The scope of the investigation did not include Oregon State Historic Preservation Office (SHPO) or Native American consultation, consideration of the built environment, or delineation of the full extent of potential disturbance areas that would be associated with the ecosystem restoration project construction and operation (Tetra Tech 2013).

The sites of the five projects included in the recommended plan have been surveyed in their entirety to the level needed to begin SHPO consultation. None of the locations have been coordinated with interested Tribes to determine if any of them may contain areas of traditional and/or substantial cultural interest, although this consultation has been initiated by the Corps. Based on the reconnaissance in 2010, the archaeologist concluded that two of the locations had a low probability of retaining intact archaeological deposits that could be disturbed by ecosystem restoration projects, and two of the locations had a moderate probability. One of the locations has a high probability to retain intact archaeological materials and/or features due to the presence of known archaeological resources and potential for buried resources in unexamined areas (Tetra Tech 2013).

Four prehistoric archaeological sites have been recorded: Site 35MU47 is described as a deposit of two 5-10 cm bands of charcoal and thermally altered rock interspersed with a 10 to 15 cm thick layer of silt. Portions of the site were excavated in 1983 with the conclusion that this may have been a seasonally used village site, based on the variety of artifacts found in the thin deposits. Materials recovered included an array of different kinds of burned animal bones and plant foods, projectile points, tools and chipping waste of diverse stone, ocher pigment, and fire-cracked rock (Woodward 1983).

Sites 35MU48 and 35MU49 were originally recorded in 1979 as two discrete seasonal campsites consisting of light scatters of fire-cracked rock and charcoal. When the area was examined in 1983, these sites could not be relocated where mapped. The researcher at that time concluded that there may have been an error in mapping or that the sites observed years earlier had subsequently eroded. Because of their proximity, he considered these sites as components of Site 35MU50 (Woodward 1983). However, none of these three sites were remapped, nor were the site forms updated.

Site 35MU50 was originally recorded in 1979 as a seasonal campsite consisting of a small, discrete cluster of fire-cracked rock. Based on an attempt to reconcile previous site records, the presumed dimensions of site were enlarged to include Sites 35MU48 and 35MU49. Portions of the site were excavated in 1983. A small number and variety of worked stone artifacts were recovered, but the bulk of the cultural material was fire-cracked rock and charcoal. One feature is consistent with use as a pit oven of the type known ethnographically for roasting bulbs. Another hearth feature with burned animal bone fragments was also recorded (Woodward 1983).

None of these sites have been evaluated for listing on the National Register of Historic Places, although it appears that material was recovered that could contribute to addressing regional research questions about time of occupation, subsistence, settlement, and season of use. It is not apparent from the record search whether there was further analysis of recovered materials. Evidence of these sites was not observed during the reconnaissance in 2010, but vegetation has grown back over the sites and likely hides any cultural materials from view.

Potential impacts on cultural resources could result from ground or streambed disturbance associated with the implementation of the recommended plan and removal of infrastructure. Ground or streambed disturbance could result from site preparation, installation of large wood , removal of invasive species, bank lowering and grading, off-channel habitat development, culvert removal and revegetation. If prehistoric or historic archaeological sites are present, ground disturbance can directly damage artifacts and features or alter the spatial relationship of artifacts, features, and other deposits and destroy their research potential. This can result in the permanent loss of information relevant to the site function, dates of use, plants and animals used, past environments, ethnicity and other important research questions. Ground and streambed disturbance can also damage unmarked burials or other sites that may be important to contemporary Native Americans as ancestral locations or for traditional cultural or religious purposes. Infrastructure planned for removal has not been evaluated, but does not appear to be historic.

As outlined in Section 4.5, cultural resource identification efforts to date have consisted of a record search and site visits in 2009 to gather initial information regarding the known presence or absence of historic properties at the potential ecosystem restoration locations. The goal was to document the status of identification and evaluation efforts, assess the potential for encountering unrecorded or subsurface archaeological resources and provide information about the types of resources that may be encountered (See Appendix D, Tetra Tech 2013). This represents a phased approach to compliance with the National Historic Preservation Act (NHPA) and other cultural resource requirements that parallel the Corps ecosystem restoration feasibility study. As such, additional required cultural resource identification, evaluation, and resolution of any adverse effects are anticipated in subsequent phases. The scope of the investigation did not include Native American consultation by the Corps, consideration of effects on the setting of building or structures or the delineation of the full extent of potential disturbance areas and depths that would be associated with ecosystem restoration projects construction and operation. No historic properties have been identified to date.

Inventory, identification and evaluation of the cultural resources that may be encountered are incomplete and a fully-informed assessment of impacts on historic properties is not possible. Based on the work to date, the following preliminary assessments have been made regarding the possibility of disturbing intact archaeological resources that may be at the proposed ecosystem restoration areas.

Based on the results of the records search, a previous partial archaeological survey, and the reconnaissance study, areas of low probability of disturbance of cultural materials include Kenton Cove and Tryon Creek culvert, because of previous extensive subsurface disturbance associated with installing the culvert originally. Areas of moderate probability of disturbance of cultural materials include the PBES Plant on the basis of minimal previous subsurface disturbances and the Oaks Crossing/Sellwood Riverfront Park because of minimal subsurface disturbances and possible historic-era archaeological resources nearby. The Kelley Point Park site is considered a high probability area for the disturbance of cultural materials because of nearby prehistoric archaeological resources.

Impacts on cultural resources are possible. The Section 106 process for implementing these proposed ecosystem restoration measures requires further inventory and evaluation efforts to determine whether historic properties are present and would be adversely affected. The Corps, in consultation with the Oregon State Historic Preservation Officer (SHPO) and other parties defined in 36 C.F.R. 800, would resolve any identified adverse effects and complete the Section106 process, reducing or avoiding any significant impacts on cultural resources. Additionally, an archaeological monitor would be present during construction, and would have the authority to stop construction in the event that cultural resources were encountered. These processes will reduce the potential for impacts to less than significant. No adverse effects are anticipated from the long-term operation or maintenance of the ecosystem restoration projects, after resolution of construction-related adverse effects.

7.5 Land Use and Zoning

Land uses are primarily regulated at the local level through general and specific plans, site-specific zoning, overlay zones and districts, and other state and local policies. Under the doctrine of federal supremacy, actions of the federal government are not subject to state or local land use or zoning regulations unless specifically consented to by Congress. However, the federal government is subject to federal regulations requiring consideration of impacts on the environment and does take into account state and local land use and zoning policies in order to avoid conflicts where possible. Four of the five alternative sites are within the City of Portland and are subject to Portland planning and zoning policies. The Tryon Creek, Highway 43 alternative is located just south of the Portland city limits in Lake Oswego, which has its own planning and zoning policies.

Land use and zoning impacts are assessed by analyzing and comparing current land use with the proposed change in land use. The proposed land use is also compared to uses that are specified in planning documents or policies, or local zoning maps. The objective is to identify whether there are any incompatibilities or inconsistencies with adjacent land uses or with adopted land plans or policies.

The area of consideration for direct impacts on land use minimally includes the proposed ecosystem restoration project sites, construction support areas, and adjacent properties.

Under the No Action Alternative, potential positive and negative impacts on land use and zoning that may be associated with the proposed ecosystem restoration projects would not occur. Land use and zoning would continue to be guided by existing planning documents and regulations in the two jurisdictions. To the extent that current planning and existing zoning is consistent with habitat ecosystem restoration, these benefits would not be realized through these projects. Other actions would likely be taken by the federal government or other entities on an incremental basis to implement river ecosystem restoration and conservation land use planning goals.

The recommended plan includes feasibility level designs of an array of ecosystem restoration measures tailored to each site. The design features are displayed in detail in the plans that are included as Appendix H. The analysis of the potential direct impacts on land use and zoning is based on these plans and the level of information available for each of the sites. During construction there would be temporary impact on land use resulting from construction activity in the immediate vicinity of the ecosystem restoration sites.

The PBES Plant site is located adjacent to the Columbia Slough and is zoned as Heavy Industrial with an Environmental Conservation Overlay Zone. The southeastern part of the site is a mostly undeveloped floodplain backwater/swale which includes a portion of the Columbia Slough Trail. The western part of the site is in the undeveloped riparian zone adjacent to the slough north of the plant. The site is owned by the City of Portland and the Port of Portland. Adjacent zoning is primarily Heavy Industrial and land uses include the wastewater utility, a rail line, a sewage lagoon north of the slough and an island in the slough within an Environmental Preservation Overlay Zone. Although the site is zoned for Heavy Industrial, the proposed ecosystem restoration measures would have a positive effect on land use by enhancing the current conservation land uses on the site.

Current utility and industrial uses on adjacent lands would not be impacted by the ecosystem restoration.

The small Kenton Cove site is located off-channel along the north side of the Columbia Slough. It is zoned as Open Space and is within the Environmental Conservation Overlay Zone. The Columbia Slough Trail passes through the site. The site is owned by the City of Portland. Adjacent zoning includes Open Space/Conservation, and General and Heavy Industrial. Adjacent land uses include the Portland International Raceway, parklands, paved parking areas and roads. The proposed ecosystem restoration measures would have a positive effect on land use by enhancing the current conservation land uses on the site. Land uses on adjacent lands would not be impacted by the ecosystem restoration.

The Kelley Point Park site is located at the confluence of the Willamette and Columbia Rivers. The southern part of the site includes the confluence of the Columbia Slough with the Willamette River. It is zoned as Open Space within the River Recreation and Water Quality Greenway Overlay Zones. The current land use is as a city park with trails, roads and some facilities. The site is owned by the City of Portland and the Port of Portland. Adjacent zoning includes Open Space and Heavy Industrial. Adjacent land uses include parking, marine cargo, warehousing, railroads, and industrial services. The proposed ecosystem restoration measures include features such as crossing structures that would maintain recreational access while improving habitat and water quality. The ecosystem restoration would have a positive effect on land use. Land uses on adjacent lands would not be impacted by the ecosystem restoration.

The Oaks Crossing/Sellwood Riverfront Park site is located on the east bank of the Willamette River. It is zoned as Open Space within the River Recreation and Water Quality Greenway Overlay Zones. The current land use is as a park with a boat ramp and limited amenities. The Willamette Greenway Trail passes through the site, which is owned by the City of Portland. Adjacent zoning includes Open Space, Residential Farm and Forest, Commercial Office, and Mixed Commercial /Residential. Adjacent land uses include parkland, offices and an amusement park Wetland and floodplain habitat would be restored and have a positive effect on water quality. Land uses on adjacent lands would not be impacted by the ecosystem restoration.

The Highway 43/Tryon Creek culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The site is zoned primarily as Park/Natural Areas but includes small portions zoned as Residential and Industrial. Infrastructure right-of-ways by the Oregon Department of Transportation, Portland & Western Railway, and the City of Lake Oswego occur at this location. With limited exceptions, Tryon Creek’s entire lower reach is in public ownership from the Willamette River confluence upstream through the Tryon Creek State Natural Area. Downstream of Highway 43 to the Willamette River, adjacent lands are both publicly and privately owned. Adjacent zoning is Park/Natural Areas, Residential, and Industrial. Adjacent land uses also include commercial, transportation and utilities. The proposed ecosystem restoration measures would have a positive effect on land use by enhancing the natural areas and recreational opportunities at the park. Current transportation and utility uses may be inhibited during construction but would be reinstated after ecosystem restoration. Other land uses on adjacent lands would not be impacted by the ecosystem restoration.

Indirect effects could occur if it is reasonably foreseeable that the ecosystem restoration projects would induce or inhibit growth or result in future changes in land use on or near the sites. The proposed ecosystem restoration work is largely consistent with current zoning, land uses and plans. Environmental ecosystem restoration is likely to decrease potential growth and density in the affected areas, although there may be some conversion of existing uses such as from industrial to commercial or residential in the long-term resulting from enhancing habitat and recreational opportunities. More recreational use may increase demand near the sites for parking, security and other services. Potential impacts are speculative and would generally be positive if they do not displace high value industries or activities along the river and slough.

7.6 Transportation

Area of potential impact to transportation includes those roadways, river channel, and trails that are 1) within the project footprint, 2) outside of the project footprint but used during construction efforts, and 3) outside of the project footprint but impacted by changes in circulation resulting from the project. Under the No Action Alternative, no construction would occur and no changes or impacts to traffic or circulation would result.

Direct impacts of the recommended plan may occur to transportation facilities during construction as a result of construction vehicles using the roadways within or adjacent to the site. In the event that barges or other river vehicles are used to access the sites during construction, direct impacts could occur to traffic navigating along the river. If local trailways are present, construction may temporarily impact their use. There are no indirect effects expected to result from construction.

Operation of the project could directly impact transportation if there are substantial changes to the access roads leading to the restored sites. If roads are expanded or reduced in size or redirected during construction, it may result in detrimental slowing of circulation. If the final condition of the restored site is more attractive to visitors, it may indirectly draw a greater number of visitors and thereby increase traffic in the area. Permanent changes to access roads are not planned at this stage of design, and substantial increases in human use of these sites are not likely to occur as a result of the proposed ecosystem restoration measures. Therefore, significant adverse impacts from these sources are not likely to occur.

In most cases, construction access points are well defined and construction routes will be along roadways that will easily accommodate the extra construction equipment and vehicles without creating changes to circulation. Kelley Point Park, the BES Plant site, Kenton Cove, and Oaks Crossing are easily accessible by local roads that can accommodate additional construction traffic. Furthermore, staging areas are available in close proximity and can be located in areas that will not obstruct traffic or circulation.

The exception is at the Tryon Creek Highway 43 culvert site. Due to the heavily used highway that passes over the Tryon Creek Highway 43 culvert, as well as the train tracks, construction at this site is likely to be disruptive to car and rail traffic. Although construction can likely be accomplished without closing the highway entirely, it will likely need to be narrowed to one lane in each direction or possibly one lane used alternately by traffic traveling in opposite directions. Rail traffic may need to be re-routed during construction. Based on preliminary design plans, the estimated project duration for replacement of the Tryon Creek Highway 43 culvert is approximately 6 months.

Though Highway 43 may experience delays to vehicular traffic or closures to rail traffic, this direct impact will be both short-term and temporary, reducing its impact to less than significant. A traffic control plan will be created to reduce potential delays at all times, and particularly during key times such as the morning and evening commute. The traffic control plan will also contain measures to minimize traffic impacts on surrounding roadways.

It is possible that river-based transport will require access to some of the sites in order to slope banks of the river or slough and to place large woody debris. If barges are used for ecosystem restoration construction, it will be necessary to coordinate with the Port of Portland to ensure that shipping channels are not obstructed.

Prior to breaking ground, a construction management plan would be prepared and submitted to ODOT for approval. The plan would include the following measures to minimize impacts to traffic and circulation:

- Designated routes and access points for construction vehicles and equipment including terrestrial and in river machinery, as necessary,
- Travel time restrictions to avoid peak travel periods on selected roadways, and
- Designated staging and parking areas for workers and equipment.

With implementation of a traffic management plan and traffic control plan, and the appropriate BMPs, additional construction traffic and temporary closures and diversions would have a minimal impact on affected roadways and intersections. Following completion of the projects, if it is determined to be necessary, access parking and trails will be created and clearly marked to control increased traffic resulting from visitation.

7.7 Socioeconomics

Under the No Action Alternative, no construction would occur. Socioeconomic conditions would continue per the future without project condition and no direct or indirect effects would occur from the project.

The recommended plan includes ecosystem restoration and associated construction at each site. Construction funds expended in the regional economy may result in minor temporary beneficial socioeconomic income and employment effects for contractors and related industries. These benefits would last until construction was complete.

At the Hwy 43 Tryon Creek site, construction may result in temporary disruption of road and rail traffic along the highway where culvert placement must take place. Temporary lane or track closures would likely result in delays to vehicles and trains. Detours, if required, might induce additional operating costs. Any adverse effects from detour and delay would be temporary.

The recommended plan may result in beneficial indirect socioeconomic effects in the form of increased quality of recreation adjacent to the ecosystem restoration sites. These effects would likely be minor, as some project sites already offer recreation opportunities, and the recommended plan does not include a component to construction additional recreation features where none exist currently.

7.8 Environmental Justice

Under the No Action Alternative, no construction would occur. Environmental justice conditions would continue per the future without project condition and no direct or indirect effects would occur from the project.

It is not expected that the recommended plan will directly affect environmental justice communities in the project area because the recommended plan focuses on sites currently in open space or existing parks. Ecosystem restoration construction in these areas is not expected to directly or indirectly affect income, employment, or other socioeconomic indicators disproportionately in environmental justice communities. Improvements in the Elliott and St. Johns neighborhoods, which have a higher proportion of minority and Hispanic residents than the City as a whole, would have a long-term beneficial effect on environmental justice communities, though there may be some minor temporary construction-related effects.

7.9 Parks and Recreation

As the purpose of this study is ecosystem restoration and not recreation improvement, the area of consideration for parks and recreation is limited to those parks or open spaces that could be impacted by construction of the proposed project.

Under the No Action Alternative the areas identified for ecosystem restoration under this study will not be restored with aquatic and terrestrial habitat improvements. The areas that already serve as park or open space, such as Kenton Cove, Kelley Point, Oaks Crossing, or Tryon Creek sites, will remain as they are.

No new parks will be created as a result of the recommended plan. However, at sites that are comprised of parkland, such as Kelley Point Park, Kenton Cove, and Oaks Crossing, ecosystem restoration will provide direct benefits to recreation seekers. At each of these sites, ecosystem restoration of aquatic habitat and removal of invasive species will provide the benefit of improved aesthetic condition and increased habitat value, which translates into an improved recreation experience. However, since this project is not intended to create new recreation areas, there will be no direct benefit of improving park availability in park-deficient neighborhoods.

Construction efforts may temporarily impact recreational use of PBES Plant lands, Kelley Point Park, and Oaks Crossing, and may also discourage use of Tryon Creek State Park. While construction vehicles are onsite they may obstruct trailways and create noise and dust conditions that would deter visitors from enjoying the park’s recreational opportunities. In the case of the Tryon Creek Highway 43 Culvert, an extended period of road construction may deter those who would normally visit the park. The Willamette Greenway Trail, which passes through the Oaks Crossing/Sellwood Riverfront Park site, may be temporarily closed or diverted during construction, along with a nearby boat ramp. Other opportunities for similar recreational access are found nearby, therefore these impacts are expected to be temporary and less than significant. Other proposed sites do not actively promote visitation for recreation and would not experience changes to recreational use due to construction.

7.10 Air Quality

The project areas are located within the Portland CO and ozone maintenance areas, making the primary pollutants of concern CO and ozone creating compounds such as NOx and VOCs. Other pollutants of concern include fine particulate matter and air toxics. No long-term impacts to air quality are expected from implementing the No Action Alternative.

During the construction phase, there are likely to be short-term air quality impacts resulting from temporary changes in traffic patterns, construction equipment emissions, and dust generated during earthwork. Traffic congestion increases idling times and reduced travel speeds, which increases vehicle emission levels. However, traffic congestion and the presence of construction traffic are not expected to substantially raise emissions in the proposed ecosystem restoration areas, where current roadway use is heavy and is already contributing to emissions. If there is a high potential for traffic congestion, particularly at Highway 43, road or lane closures should be restricted to non-peak traffic periods when possible. In all ecosystem restoration areas, additional construction emissions are not expected to substantially increase the already high emissions of the area.

Additionally, BMPs would be put in place to ensure that fugitive dust would be limited to acceptable levels as defined by current air quality standards and attainments for the region. Construction plans will comply with state regulations requiring mitigation of fugitive dust (OAR 340-208-0210). These measures may include applying water or other dust suppressants during dry weather, as well as maintaining clean construction equipment to prevent the transport of dust and dirt from construction areas to nearby roads.

No long-term impacts to air quality are expected from implementing the recommended ecosystem restoration plan. Air quality will continue to be monitored and maintained by ODEQ into the future and no changes to air quality conditions are expected. The completed ecosystem restoration would not result in increased traffic or changes to traffic patterns and therefore would not result in impacts to air quality.

7.11 Noise

Title 18 of the City of Portland Code and Charter provides noise control guidelines (City of Portland 2014). Maximum permissible sound levels set in the code are divided by land use of source and receiver of noise (Table 7-2). Noise sensitive receivers are defined as any residential home or dwelling, schools, churches, hospitals, and libraries; maximum permissible sound levels are designed to reduce noise impacts to these sensitive receivers.

Construction noise is subject to the same levels (Chapter 18.10.060), but is not allowed to occur outside of the hours between 7am and 6pm on weekdays and Saturday (City of Portland 2014). No Sunday or holiday construction is permitted. Maximum permissible construction noise level is 85dBA when measured at 50 feet from the source; exemptions include trucks, pile drivers, pavement breakers, scrapers, concrete saws and rock drills. Exemptions are only allowed during permissible construction hours as noted above. Variances to these rules may be permitted.

Table 7-2. Permissible Sound Levels

Zone Categories of Source	Zone Categories of Receiver (7am-10pm, otherwise minus 5 dBA)			
	Residential	Open Space	Commercial	Industrial
Residential	55	55	60	65
Open Space	55	55	60	65
Commercial	60	60	70	70
Industrial	65	65	70	75

No substantial changes in noise levels are expected under the recommended plan. Noise levels may rise in the future due to increasing population and the resulting increases in air and road traffic.

Noise associated with construction equipment, similar to road maintenance or utility projects, would affect localized areas for limited time periods as ecosystem restoration is implemented. Sensitive receptors that could be affected by construction noise include adjacent residents and protected wildlife. Sensitive species in the construction areas are primarily fish species, which can easily move away from the noise source. Construction activity noise levels at and near the study area would fluctuate depending on the particular type, number, and duration of uses of various pieces of construction equipment. Construction related material haul trips and construction workers commuting to the project site could raise ambient noise levels along haul routes and area roadways. However, in comparison to current noise levels and because these effects would be temporary and short-term, they are not considered significant.

The Tryon Creek Highway 43 culvert is located beneath a roadway that receives continual or intermittent traffic near residential, open space, and commercial land uses. Sensitive receptors in the area include residential homes and the Lake Oswego Public Library. The PBES Plant ecosystem restoration site is adjacent to heavily industrialized land, as well as North Portland Road, a railroad line, and near the Moore Island City Park open space and Heron Lakes Golf Club. Kelley Point Park is a somewhat more isolated site, though the potential for increased noise levels occurs at the Port of Portland, located to the southeast. Kenton Cove is immediately adjacent to the Portland International Raceway and Interstate 5, which are two of the greatest sources of noise pollution in the Portland area (The Greenbusch Group, Inc. 2008). At Oaks Crossing, ambient noise levels are determined by traffic levels along nearby local access roads, including SE Oaks Park Way and the Sellwood Bridge, and on the Willamette River. Sensitive receivers include the open space of Sellwood Riverfront Park and Oaks Pioneer Church, as well as the Riverview Cemetery and Willamette Moorage Park across the river.

In areas where sensitive receivers are present, the proposed construction zone is generally at least 100 feet from any dwellings, churches, libraries, or hospitals; a distance that allows for adequate attenuation of noise that may result from construction (FHWA 2006). In all cases, with adherence to noise control regulations, construction is not expected to substantially increase the level of ambient noise beyond threshold levels. Protection of sensitive species and sensitive receptors will be managed through proper seasonal, weekly, and daily construction scheduling per Title 18 (City of Portland 2014).

7.12 Hazardous Waste and Toxic Materials

Hazardous Waste and Toxic Materials (HWTM) impacts are assessed by first identifying where there have been recent or historical unauthorized releases of hazardous materials or hazardous waste, where hazardous materials may have been used or stored, or locations that may be generators and/or transporters of hazardous wastes. The proposed ecosystem restoration actions are then assessed to determine whether implementation would be inhibited or delayed by the presence of the materials, whether implementation could result in exposures to existing hazardous materials, or whether implementation would interfere with ongoing or planned site remediation. The analysis also takes into account the potential for hazardous waste generation resulting from ecosystem restoration construction.

Appendix E details the methods and results of a database investigation of the study area and visits to each proposed ecosystem restoration site for current and/or historical contamination that could adversely influence the implementation of the planned ecosystem restoration measures (EDR 2009). It should be noted that the same locations and releases can be recorded on multiple databases. The investigation includes an assessment of the database information to determine those locations that are most relevant to the ecosystem restoration project sites and that would warrant additional investigation prior to implementation. The intent of these additional investigations would be to compile additional information such as: (a) the nature and type of hazardous materials involved; (b) the potential for contamination at these sites to limit or eliminate the possibility of habitat ecosystem restoration actions; (c) the current regulatory status of each site, as applicable; and (d) the extent and type of remedial action that has been or is being taken, or may be planned at these sites. In addition to documented releases or the known presence of hazardous materials, consideration is also given to the potential for unknown sources to be present and the potential for hazardous releases or exposure to result from ecosystem restoration construction.

The area of consideration for direct impacts on and from HWTM minimally includes the proposed ecosystem restoration project sites, construction support areas, material disposal and borrow areas, and adjacent properties and waterways. A broader area was assessed to determine possible indirect effects at some of the ecosystem restoration sites.

Under the No Action Alternative, potential positive and negative impacts that may be associated with the proposed ecosystem restoration projects would not occur. The regulations governing the reporting and remediation of hazardous sites would continue and the known sites would not be disturbed by construction. There would be no potential for hazardous releases or exposure resulting from construction. Further investigations and possible remedial actions at known site in the vicinity of the proposed sites would not occur in support of this effort. No indirect effects are anticipated under the No Action Alternative.

The recommended plan includes feasibility-level designs of an array of ecosystem restoration measures tailored to each site. The analysis of the potential direct impacts on and from Hazardous Waste and Toxic Materials is based on these plans and the level of information available for each of the sites from the database search.

The PBES Plant site is primarily in an industrial zone adjacent to the Columbia Slough. Actions proposed at PBES Plant site include bank laybacks, installing large wood , invasive species removal, native plant revegetation and excavations to provide a more frequent connection to a floodplain backwater/swale area. Excavation, bank lowering, grading, channel alteration and plant removal would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 43 initial findings in the broad vicinity of the ecosystem restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project, therefore no further investigation is recommended.

The Kenton Cove site is an off-channel cove surrounded by a maintained levee along the north side of the Columbia Slough. Actions proposed at this site include adding habitat complexity by creating small habitat islands using large wood and revegetating the shore with native riparian plants. Placement of large wood and planting could result in minor disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 14 initial findings in the broad vicinity of the ecosystem restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project, therefore no further investigation is recommended.

The Kelley Point Park site is located at the confluence of the Willamette and Columbia Rivers. The southern part of the site includes the confluence of the Columbia Slough with the Willamette River. Much of the park is built on fill and is surrounded by industrial uses along the waterways. Actions proposed at this site include excavation of two off-channel backwater areas, removal of invasive plants, revegetation with native species, bank lowering and placement of large wood . Excavation, bank lowering, grading, channel alteration and plant removal would result in extensive disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 12 initial findings in the broad vicinity of the ecosystem restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project, therefore no further investigation is recommended.

The Oaks Crossing/Sellwood Riverfront Park site is located along on the east bank of the Willamette River. Actions proposed at this site include excavation to create off-channel habitat, placement of large wood and revegetation with native riparian species. Excavation, grading, and planting removal would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 25 initial findings in the broad vicinity of the ecosystem restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project, therefore no further investigation is recommended.

The Highway 43/Tryon Creek culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The culvert replacement would pass under and existing highway and rail lines. Actions proposed at this site include creation of a wider channel for Tryon Creek, excavation of a low flow channel and riparian revegetation above and below the culvert. Excavation, grading, and planting would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 17 initial findings in the broad vicinity of the ecosystem restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project, therefore no further investigation is recommended.

Once the final design and all construction support areas, material disposal and borrow areas are defined for each of the proposed sites, subsequent environmental reviews should be conducted to further characterize potential impacts from HWTM. Impacts could occur if subsequent environmental reviews identify the presence of hazardous materials at the ecosystem restoration sites that would preclude habitat ecosystem restoration, result in exposure to or transport of the materials, or would interfere with ongoing or planned site remediation.

Construction and maintenance of the ecosystem restoration of the project would involve the use of hazardous materials, such as fuel, oil, solvents, and lubricants. During these activities, the public and workers could come into contact with or be exposed to hazardous materials during the routine transport, use, or disposal of hazardous materials, or as a result of an accidental release. However, standard operating procedures and best management practices would be implemented and would minimize the potential for impacts.

7.13 Visual Quality

Area of consideration for visual quality includes the specific project sites as observed from within and from a distance. It is as essential to protect the visual quality within the local area as it is to protect the aesthetic appeal of the landscape as a whole.

Over time, lack of ecosystem restoration efforts under the No Action Alternative at the proposed sites will result in continued degradation of visual quality. Growth of non-native plants and the spread of weeds will directly reduce the aesthetic appeal of all sites. As the sites become less appealing, it is possible that indirect effects could include additional trash or debris found in the area, graffiti, or trampling of soils and river banks and increases in erosion.

The BES Plant site is along the south bank of the Columbia Slough. From the project footprint, one may see the North Portland Road (State Route 120) and its adjacent railway passing over the site, the narrow and mostly immature riparian zone on both banks, and the BES Plant itself. The Columbia Slough Trail bridge also passes over the slough and a second set of railroad tracks marks the furthest east that the project footprint extends. A narrow vegetated island occurs in the center of the slough between the trail bridge and east rail bridge. Those that observe the site include employees of the plant, other local landowners, recreationists at the Heron Lake Golf Club, and those traveling through the site by roadway, boat, or rail.

Kelley Point Park is a green space at the convergence of the Willamette and Columbia Rivers. Riparian vegetation, forested wetland, and the two rivers are the dominant visual resources from within the park. The park has a high percent of forest cover, except where park grass, cleared areas, and banks of sand, gravel, and cobble slope down to the rivers. Several commercial or private docking facilities can be seen within both rivers from the park and commercial developments are visible south of the park. Observation of the site from outside the project footprint occurs from water traffic on either river, vehicle traffic on North Lombard Street and North Marine Drive, from commercial enterprises to the south of the park, and from mostly privately owned farmland on the far banks of the rivers to the north.

Kenton Cove lies on the north shore of the Columbia Slough, just west of North Denver Avenue (Figure 7-1). From within the cove, visual resources include gently to moderately sloping banks covered with grasses or riparian forest that lead down to the backwater cove, as well as the adjacent Columbia Slough Trail, North Denver Avenue, MAX light rail line, and the Portland International Raceway. An overhead power line also runs to the east of the cove along the roadway. Distant views to the west are of the West Hills. Aesthetic condition at the site can be viewed by those passing along the various traffic corridors or via boat on the slough.

Figure 7-1. View of Kenton Cove Looking Southwest from Denver Ave.

The Oaks Crossing/Sellwood Riverfront Park site is on the north shore of the Willamette River (Figure 7-2). Local views are of greenspace, the river, and the traffic corridor comprised of SE Oaks Parkway, the Springwater bicycle trail, and rail line. Businesses and commercial developments are also visible from within the site, looking in every direction. The Sellwood Bridge crosses the river and dominates views to the south. The project footprint is comprised mostly of forest cover with small patches of bare ground or grass/lawn. Distant views include the City of Portland and River View Cemetery on the west shore of the river. Those observing the site include local residents and business employees, those visiting the park and those passing through via road, bicycle, rail, or boat.

Figure 7-2. View of Oaks Crossing/Sellwood Riverfront Park on Right Looking Downstream

Aesthetics at the Tryon Creek Highway 43 Culvert site are defined primarily by the complex intersection of SW Terwilliger Blvd and SW Riverside Drive (Hwy 43). Also visible around this intersection are the trees that comprise Tryon Creek State Park to the west, vegetation along Stampher Road to the east, and the rail line along the east side of Highway 43. Distant views are limited from within the site due to trees and the topography. Some local businesses and neighborhoods may also be visible from portions of the site. Those that view the site on a regular basis include the local residents of Lake Oswego and those traveling through the area via roadway.

The aesthetic value of the sites selected for ecosystem restoration under the recommended plan will be affected during the construction period. Construction vehicles, cleared ground, vegetation removal, generation of dust or trash, turbidity, or the presence of equipment or flagging will substantially reduce the visual quality of proposed sites. This will be particularly apparent at sites that appear natural or less developed than others, such as Oaks Crossing, Kenton Cove, or Kelley Point Park.

Following construction, visual appeal will be directly improved over time through creation of native wetland and off-channel habitats. Non-native plants will be removed and sites will be restored to conditions that blend into the natural aesthetic of the riverine system. Visually appealing sites attract a greater number of visitors and may indirectly result in more debris or trash on the site, trampling of vegetation from visitors wandering off trails, and additional vehicle trips to the site.

Implementation of BMPs during construction will reduce the visual impacts to the area. Construction equipment presence will be minimized and screens may be used to shield equipment from view, if necessary. Erosion control measures will prevent or minimize loss of topsoils and construction phasing will be designed to minimize area of clearing. If necessary, signage and trail markers may be installed to discourage off-trail use or littering.

Due to the temporary nature of the aesthetic impacts and the resulting improvement in visual quality to all proposed ecosystem restoration sites, impacts resulting from construction are not expected to be significant. Instead, visual appeal will improve with each year as newly established vegetation grows and matures. Where wetlands are restored, species abundance and diversity will increase over time and further improve natural sites for bird-watching and wildlife appreciation.

7.14 Cumulative Effects in Study Area

7.14.1 Definitions and Overview

A cumulative effect occurs when the effects of an action, when added to other past, present, or reasonably foreseeable future actions, results in further environmental effects. These additional actions can be taken by the same federal agency, a different agency, or a public or private entity. A cumulative effects analysis is viewed as the total effects on a resource, ecosystem, or human community of the proposed action and all other actions affecting that resource regardless of who undertakes the actions. The Council on Environmental Quality (CEQ) requires the cumulative effects be examined as part of the NEPA analysis (40 C.F.R. Parts 1500-1508).

Historically, the lowlands adjacent to the Willamette River consisted of a series of ponds, lakes, sloughs, and wetlands, which were often prone to flooding. This seasonal flooding resulted in the development of flood control works by towns along the river by the late 1800s, including revetments and other bank treatments. The Willamette Plan, developed in the 1930s, called for a system of dams on the Willamette and its major tributaries for flood control, irrigation, and power. Over the next 40 years dam construction changed the natural flow regime of the basin, eliminating both the flood waters of the winter and spring, and the low flows of the summer and fall. Most of the historic off-channel habitat have long since been cut off from the channel and filled. The width and area of the river have both declined, as a result of diking and filling of shallow areas and navigational dredging. More importantly, in the lower reach of the river the amount of shallow areas (less than 20 feet) has declined by about 80 percent while the amount of deep water habitat (more than 20 feet) has increased by about 195 percent.

7.14.2 Impacts from Cumulative Actions

The following past, present, and reasonably foreseeable future actions in the Lower Willamette study area are considered in the Cumulative Effects analysis:

<u>Federal Navigational Channel, Present</u> The Coprs monitors and maintains the navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to 11.6) as part of the Columbia and Lower Willamette Rivers federal navigation project. From RM 11.6 to RM 14 (Ross Island), the channel is maintained by the Port.

<u>Columbia Slough Section 1135 Ecosystem Restoration Project, Past</u> The project created 7.5 miles of wetland benches and a deeper meandering channel, 25 acres of emergent wetlands, 6 acres of riparian scrub-shrub habitat, 5 acres of riparian forest habitat, and 3 acres of open water habitat. Project elements included reshaping the slough’s straight channel, and creating wetland benches and islands that will be planted with native plants. The changes to the channel created a greater diversity of habitats, increased the water flow, and restored the riparian buffer along the slough.

<u>Oaks Bottom Ecosystem Restoration Project, Future</u> This is an ecosystem restoration study at the Oaks Bottom Wildlife Refuge within the floodplain of the Lower Willamette River, southeast of Ross Island.

<u>Westmoreland Park Section 206 Ecosystem Restoration Project, Past</u> Westmoreland Park is located along Crystal Springs Creek and is a tributary to Johnson Creek. Past – Project elements included provision of juvenile fish passage from Johnson Creek to the upper end of Westmoreland Park, (2) improved aquatic habitat for salmonid rearing and refuge, (3) riparian corridor and wetland habitat for wildlife, and (4) improved water quality conditions by eliminating a duck pond (which causes

heating of water), reducing excessive waterfowl use, and reducing runoff of other contaminants by providing a buffer for the creek and wetlands.

Willamette River Floodplain Ecosystem Restoration, Future A Feasibility Study has been performed to investigate improving flood storage and restoring natural floodplain function along the Willamette River and its tributaries. The study identified opportunities for the ecosystem restoration of aquatic and riparian ecosystems, recovery of proposed and listed threatened and endangered species, reduction of flood damage, and improvement of water quality. The study area is the entire Willamette River Basin. The initial planning phase, currently underway, does not overlap with the Lower Willamette River Ecosystem Restoration Feasibility Study area.

Portland Harbor Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) Portland Harbor, Future Portland Harbor, a roughly 10-mile stretch of the Lower Willamette River, was added to the EPA National Priorities List in December 2000 due to the discovery of contaminated sediments. A draft Feasibility Study was published in March 2012, which presented alternatives to the clean-up and management of contaminated soil and river sediments.

Willamette Subbasin Plan, Present and Future The plan, completed in 2004, includes a compendium of current knowledge about basin conditions, particularly fish and wildlife and their habitats, an inventory of existing plans and programs, and strategies and actions to implement the plan. This plan is the basis for developing more detailed studies and ecosystem restoration designs in the basin.

Willamette and Lower Columbia River Basins Recovery Plan**,** Present and Future NMFS, in partnership with ODFW, is developing a recovery plan for salmon and steelhead populations listed under the ESA in the Northwest Region. The Willamette/Lower Columbia recovery domain includes the Willamette River Basin. Recovery planning for listed salmon and steelhead has been underway in this domain since the summer of 2000.

American Heritage River, Present and Future The Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River. The American Heritage Rivers initiative, administered by EPA, has three objectives: (1) natural resource and environmental protection, (2) economic revitalization, and (3) historic and cultural preservation.

Oregon Plan for Salmon and Watersheds, Present and Future The Oregon Plan represents commitments on behalf of government, interest groups, and citizens from all sectors of the state to protect and restore watersheds for the benefit of salmon, and the economy and quality of life in Oregon. The Plan includes several components, including (a) the Healthy Streams Partnership aimed at improving and preserving water quality in water quality limited streams in Oregon, (2) the Coastal Salmon Ecosystem restoration Initiative, which guides habitat ecosystem restoration efforts for coastal Coho salmon in an effort to restore populations to sustainable levels, and (3) a steelhead supplement addressing salmonid ecosystem restoration within the context of watershed health.

Willamette Partnership: Willamette River Legacy, Present and Future Three priority areas of focus for the Willamette River Legacy Program, including 1) Repair (cleaning up the industrial pollutants and toxins that have contaminated the river), 2) Restore (returning the river to its natural state, restoring its abundant wildlife and pristine riverbanks), and 3) Recreate (addressing the role that the Willamette River plays in Oregon's quality of life).

River Renaissance Initiative River Renaissance, Past River Renaissance Initiative was a City of Portland initiative to reclaim the Willamette River as Portland's uniting community centerpiece.

<u>The River Plan, Present and Future</u> The River Plan is a comprehensive multi-objective plan for land along the Willamette River. The River Plan is divided into three reaches of the Willamette River: the North Reach, Central Reach, and South Reach. The North Reach of the Willamette was the first to receive detailed planning, and the City Council adopted the River Plan North Reach in 2010. The South and Central Reach plans will follow.

<u>Portland Watershed Management Plan, Present and Future</u> The Portland Watershed Management Plan, adopted in 2006, describes the priority strategies being used to improve watershed health through the work of the PBES Watershed Services Group, River Renaissance, other City bureaus, agencies, and citizens' groups, all of which share the watershed health goals described in the framework

<u>Combined Sewer Overflow, Past</u> In 2011, the City's CSO program was completed, reducing CSOs to the Columbia Slough and Willamette River by 94 percent.

The No Action alternative will not see the implementation of the five specific elements called for in the recommended plan. The Past, Present, and Reasonably Foreseeable Future Projects, however, would provide some positive benefits on the study area's geology, hydrology and hydraulics, water quality, fish and aquatic habitat, wetlands, and floodplains. The construction activities associated with these projects would have some short-term adverse effects and could possibly overlap with one another, though the Lower Willamette project would not contribute to these effects since it would not be implemented. Overall, the cumulative effects under the No Action alternative would be minor and positive, since the Reasonably Foreseeable Future Projects are design to provide benefits as outline above.

The timeframe for the cumulative effects analysis extends from the early developments along the river in the late 1800's to fifty years in the future, the time horizon for the feasibility study. The geographic limit of the analysis is the Lower Willamette River watershed and its tributaries. It is acknowledged that improvements upstream from the Lower Willamette, such as those proposed in the Willamette Floodplain Ecosystem Restoration Plan (USACE 2013), would also have cumulative benefits to aquatic life and habitat in the river.

The implementation of the recommended plan would incrementally reverse some of the adverse effects of past developments along the Lower Willamette River that began in the late 1800's. Specifically, the plan would address the loss or degradation of off-channel habitats, the reduction in nutrients and woody material, the loss of channel complexity, the reduced wild stocks of salmonids, and the diminished health of tributaries in one or more of the five project areas.

Construction of the recommended plan would have temporary adverse effects on water quality, but it is unlikely to have cumulative effects (such as increased turbidity, disturbance, fish handling, etc.) since other reasonably foreseeable future projects are unlikely to occur in reasonably proximity to components of the recommended plan in the same timeframe.

7.14.3 Soils and Geology

The recommended plan would minimize erosion potential in the five specific project areas. Combined with other present and reasonably foreseeable future projects along the Lower Willamette River, there is likely to be better overall erosion protection and provide improvement over past actions.

7.14.4 Water Resources

Improvement in water quality is not a project purpose, and any improvements would be minor. Other past, present and reasonably foreseeable future projects, such as the recently completed Portland CSO project, have more specific beneficial effects on water quality. Thus the cumulative effects of all projects would be beneficial.

During construction, there may be temporary adverse effects on water quality, including from the recommended plan. It is not expected that there would be temporal or geographic overlap during the construction phase of the reasonably foreseeable future projects that would amplify the temporary, minor adverse effects.

Floodplains

The direct effects of performing the recommended plan at the ecosystem restoration sites will increase backwater and side channel storage volumes which will likely cause reductions in base flood elevations. This coupled with other reasonably foreseeable future projects, such as Willamette River Floodplain Ecosystem Restoration, and the Oak Bottom Ecosystem Restoration, would have cumulative beneficial effects on floodplains.

7.14.5 Biological Resources

Wetlands and Riparian Areas

The recommended plan includes the ecosystem restoration or creation of a variety of wetland and riparian types, including tidal sloughs, at the 5 proposed sites. The proposed project would result in the creation, reconnection, or ecosystem restoration of approximately 8 acres of wetlands, approximately 5,500 linear feet of new or reconnected tidal channels, and approximately 45 acres of riparian habitat. Additionally, shallow water habitat would be created or restored over approximately 9.5 acres cumulatively, and fish access would be restored to 2.7 miles of spawning habitat in Tryon Creek. When combined with other reasonably foreseeable future projects, such as the Westmoreland Park Section 206 Ecosystem Restoration Project, the cumulative effects will result in a significant increase in wetland, riparian, and off-channel habitat along the Lower Willamette River.

H**ydrology**

The five projects within the recommended plan are expected to have minimal effects on overall river hydrology and hydrodynamics. There would be a positive benefit for creating habitat by increasing flood frequency of the side channel and off channel areas. The off channel habitat and side channel areas will also provide minor reductions to flood flows and water surface elevations. These reductions are anticipated due to detention, or the short term storage of water volume, associated with flows high enough to cause inundation of these areas. Such minor, though positive effects, would contribute to overall river hydrology when combined with other past, present and reasonably foreseeable future projects, including the Columbia Slough Section1135 Ecosystem Restoration Project and the Oak Bottom Ecosystem Restoration Plan.

Vegetation

No special status vegetation is expected to be found in the project areas. During construction there will likely be short-term adverse effects from vegetation clearing that may reduce the quality and function of habitat temporarily. Other reasonably foreseeable future projects would likely have similar effects during construction but are unlikely to occur in temporal or geographic proximity and thus not result in an adverse cumulative effect. New native vegetation, added as a result of the habitat improvements proposed in this and other reasonably foreseeable future projects could result in a cumulative increase in vegetation and, thus, habitat along the river corridor.

Fish and Wildlife Species

Overall, long-term benefits to fish and aquatic habitats from the recommended plan are expected through ecosystem restoration of habitats that are limited for existing species such as off-channel habitat, wetlands, riparian habitats, cover and large wood. Other past, present, and reasonably foreseeable future projects also have habitat ecosystem restoration components, including the recently completed Columbia Slough Section 1135 Ecosystem restoration and the Westmoreland Park Section 206 Ecosystem Restoration Projects, and the future Willamette River Floodplain Ecosystem Restoration Project. Beneficial cumulative effects on fish and wildlife species are expected.

Threatened, Endangered, Candidate, and Rare Species

The proposed ecosystem restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, including Chinook salmon, Coho salmon, and steelhead, and will help contribute to the recovery of these species. The Lower Willamette project is but one of several present or reasonably foreseeable future projects that would improve habitat along the Willamette and aid in the protection and growth of the various species.

Construction effects are generally adverse to species, though BMPs are implemented to reduce adverse effects. Similar BMPS are implemented with other projects, reducing the likelihood of increased short-term adverse effects.

7.14.6 Cultural and Historic Resources

While cultural or archaeological resources may be discovered during the course of implementing the Lower Willamette project, it is unlikely that any of the other reasonably foreseeable future projects would overlap spatially with the recommended plan. Thus, no cumulative effects are anticipated.

7.14.7 Land Use and Zoning

The implementation of the recommended plan would have minor, and generally beneficial, effect on land uses at and adjacent to the five sites. All reasonably foreseeable future projects would need to be consistent with area land use plans and zoning requirements and thus no adverse cumulative effects are anticipated.

7.14.8 Transportation

Transportation effects on the recommended plan are limited to construction effects involving transport of workers, materials, and construction equipment to the sites. A transportation management plan (TMP) would be prepared prior to start of construction. Concurrent construction of any of the reasonably foreseeable future projects, though unlikely, could be reflected in the TMPs for both the recommended plan and the concurrent projects. This would mitigate to a large extent any cumulative adverse transportation effects.

7.14.9 Socioeconomics

The social and economic effects of the recommended plan are at most minor, with the possible exception of the culvert replacement at Tryon Creek. As most of the reasonably foreseeable future projects are along the river or its tributaries, impacts on adjacent residents and businesses are likely be to minor as well, so no adverse cumulative effects are anticipated.

7.14.10 Environmental Justice

Ecosystem restoration construction in the five areas proposed in the recommended plan is not expected to directly or indirectly affect income, employment, or other socioeconomic indicators disproportionately in environmental justice communities. When viewed with the present and reasonably foreseeable future projects, improvements (and the construction-related minor and temporary adverse effects) impact a variety of communities along the Willamette River with no one area singled out for disproportional effects, either beneficial or adverse.

7.14.11 Parks and Recreation

While there may be some minor disruption on access to portions of several recreational facilities during construction (Kenton Cove, Kelley Point Park, Oaks Crossing, and potentially Tryon Creek State Park), there would also be long term benefits of improved habitat and aesthetic conditions, which could lead to a more positive recreational experience. Several reasonably foreseeable future projects would have direct or indirect beneficial effects on parks and recreational facilities. These include implementation of the Willamette Subbasin Plan, the Willamette River Legacy effort, the River Renaissance Initiative, and the River Plan.

7.14.12 Air Quality

No adverse effects to air quality are expected from the completed project. A similar situation is likely for any of the reasonably foreseeable future actions; therefore, no adverse cumulative effects to air quality as expected.

During construction, there may be temporary air quality effects in terms of dust or construction vehicle emissions (The exception would be the construction of the culvert at Tryon Creek that would have more noticeable effects on air quality due to traffic capacity constraints). These would be short-term and best management practices would be implemented to reduce their effect. It is unlikely that other reasonably foreseeable future projects would have in the same temporal or spatial proximity. Should this circumstance occur, construction BMPs could be used to reduce the cumulative effect.

7.14.13 Noise

The completed projects would generate no noise, other than during periods of routine maintenance. The same would be true for most if not all of the reasonably foreseeable future actions. Thus no cumulative effects would be likely.

During construction, it is unlikely that work would occur on more than one project in one area at the same time; therefore, cumulative noise effects are also unlikely to occur.

7.14.14 Hazardous Waste and Toxic Materials

Cumulative effects on hazardous waste and toxic materials would only occur if work on multiple projects were occurring at the same or adjacent locations and at or around the same time, which is not anticipated. Any contamination that is encountered during implement of projects would be handled according to standard protocols and would result in less contaminated material still in the ground post-construction. Implementation of the reasonably foreseeable future projects could further reduce overall incidents of contaminated materials in or near the river and its tributaries.

7.14.15 Visual Quality

Implementation of the recommended plan, in addition to reasonably foreseeable future projects such as the Willamette River Legacy effort, the River Renaissance Initiative, could result in cumulative beneficial effects on the visual environment along the Willamette River.

7.15 Relationship between Short-term Uses and Long-term Productivity

The short-term use of construction equipment and various construction materials, required for implementing the recommended plan, would have relatively minor energy, noise, air quality, and transportation effects compared to the long-term benefits of the proposed habitat ecosystem restoration. The ecosystem restoration sites would have increased ecological function and increased recreational use.

7.16 Unavoidable Adverse Impacts

The ecosystem restoration and rehabilitation of aquatic and riparian habitats in the study area will result in an irreversible commitment of resources, as well as irretrievable use of resources. Construction activities would require the use of fossil fuels for operation of vehicles and equipment and use of water for dust abatement, both of which would be irreversible.

Construction at all proposed sites under the recommended alternative requires clearing of biological resources and earthwork that may result in losses to cultural resources. Though adherence to federal law and implementation of BMPs is intended to protect sensitive plants and animals and also to protect historic artifacts, there is some potential for incidental loss that would be irreversible. However, the completion of the proposed project is intended to restore proper functioning of biological resources, and therefore an improvement in their condition. Furthermore, this project is in compliance with all federal regulations that are intended to protect sensitive cultural, socioeconomic, and environmental resources.

Completion of the proposed ecosystem restoration is intended to protect the sites from further loss of biological, recreational, and visual resources. Continued degradation of native fish and wildlife populations results from decreases in the size and function of wetlands. Under the No Action Alternative, non-native and invasive species will continue to become established and outcompete native species, while native fish and wildlife will continue to suffer from lack of suitable habitat. Under the No Action Alternative, irreversible and irretrievable losses of native species and habitats will continue.

7.17 Mitigation Measures and Best Management Practices

As there is no activity that occurs with the No Action Alternative, no mitigation is required.

The recommended alternative, as a ecosystem restoration project, is itself mitigation for the existing conditions along the Lower Willamette River and its tributaries. No mitigation actions are needed after completion of the ecosystem restoration; however, an operations and maintenance plan will be developed and followed post construction of the ecosystem restoration sites. The operations and maintenance plan will provide guidance on the frequency and methods for inspecting the ecosystem restoration sites to ensure that the design elements are functioning properly. Periodic maintenance may be required for the ecosystem restoration sites, including removal of sand sediment from the connection points of side channels and off channel habitat areas. The operations and maintenance plan will be developed during future design and planning phases for the ecosystem restoration sites. BMPs that will be implemented as necessary to avoid or minimize soil erosion can include the placement of in-water silt fences to control movement of soils into water and containment of turbidity within localized areas, placement of mulch or other ground cover to reduce soil movement as dust or during rain events, and a construction design plan that minimizes the area to be cleared of vegetation.

The construction of backwater channels at Kelley Point Park could potentially reduce the area available for pedestrians or other users. Mitigation of this potential impact has been resolved through including several crossing structures in the design of the project. These structures will ensure that all areas will be accessible after the side channels are constructed and will further improve the recreational value of the site.

The Corps will continue to work with the local planning entities and stakeholders to identify any short and long term conflicts with land use and zoning issues as the final designs and construction plans are developed.

The Corps will complete ESA consultation with USFWS and NMFS prior to completion of this feasibility study process. This will include issuance of an incidental take statement consistent with actions allowed under the PROJECTS biological opinion.

As a prelude to construction, the Corps will complete the Section 106 process for implementing these proposed ecosystem restoration measures in consultation with the Oregon State Historic Preservation Officer (SHPO) and other parties defined in 36 C.F.R. 800. The level of effort for assessing each ecosystem restoration location would be determined based on the preliminary information that has been developed in consultation with the SHPO. Anticipated actions include:

- Further refinement of the vertical and horizontal, direct and indirect Area of Potential Effects (APE) for each ecosystem restoration measure and location;
- Additional archival research into past uses and depths of previous disturbance;
- Further site-specific inventory, identification and evaluation efforts for archaeological, built environment and traditional cultural properties;
- Subsurface testing where buried resources may be anticipated and to define the boundaries of the known sites;
- Consultation with relevant Native American groups; and
- Determination of effect and resolution of adverse effect on a project basis or through an agreement document.

After completion of the Section 106 process, a discovery plan will be developed to establish protocols for handling and protecting cultural materials that may be found during construction. Components of the protocol will specify that if an accidental discovery is made during ground-disturbing activity, work will be stopped immediately, and a qualified archaeologist will assess the find and decide upon the nature and extent of future investigation and recovery. If human remains are discovered, the Multnomah County Coroner's Office will be contacted immediately.

Onsite personnel will be familiar with the discovery plan protocol and will have a copy on site. This plan will be reviewed ahead of time so the project managers may address questions regarding the identification of cultural material or the process to follow if any questionable material be encountered during construction. The unanticipated discoveries protocol will be provided to contractors during the bid process so they are aware of this requirement when they develop their estimates. Archaeological monitoring may be warranted in areas where there is a high probability for encountering archaeological materials.

During construction, to prevent or minimize potential impacts resulting from ecosystem restoration construction and maintenance the Corps will:

- Incorporate waste minimization and pollution prevention processes into the design and construction of the ecosystem restoration projects.
- Require that construction contractors prepare and implement pollution prevention plans with clearly specified lines of authority and responsibility and defined procedures.
- Prepare a Spill Control plan that includes the procedures, instructions, and reporting requirements for emergency response and cleanup measures that would be used in the event of an unforeseen spill of a substance regulated by 40 C.F.R. 68, 40 C.F.R. 302, 40 C.F.R. 355, and/or regulated under State or Local laws and regulations.
- Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing.
- Segregate hazardous waste from other materials and wastes; protect it from the weather by placing it in a safe covered location, and take precautionary measures such as berming or other appropriate secondary containment measures to contain accidental spillage. All storage, packaging, labeling, marking, and placarding of hazardous waste and hazardous material should be in accordance with 49 C.F.R. 171 - 178, State, and local laws and regulations.
- Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked corrosion-resistant containers and recycled or disposed in accordance with40 C.F.R. 279, State, and local laws and regulations.
- Storage of fuel on the project site should be avoided, but if necessary would be in accordance with all Federal, State, and local laws and regulations.
- Waste water from construction activities will not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants.
- Minimize the usage of hazardous materials to the extent practicable by equivalent product substitution.
- Treat or recycle of hazardous wastes onsite, wherever feasible and allowed by regulations.
- Transport hazardous wastes to approved off-site recycling, treatment, and disposal facilities.

7.18 Environmental Operating Principles

The Corps Environmental Operating Principles were developed to ensure that the Corps missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the Corps role in, and responsibility for, sustainable use, stewardship, and ecosystem restoration of natural resources across the Nation and, through the international reach of its support missions.

Since the Environmental Operating Principles were introduced in 2002 they have instilled environmental stewardship across business practices from recycling and reduced energy use at the Corps' facilities to a fuller consideration of the environmental impacts of the Corps actions and meaningful collaboration within the larger environmental community.

The concepts embedded in the original Principles remain vital to the success of the Corps and its missions. However, as the Nation's resource challenges and priorities have evolved, the Corps has responded by close examination and refinement of work processes and operating practices. This self-examination includes how the Corps considers environmental issues in all aspects of the corporate enterprise. In particular, the strong emphasis on sustainability must be translated into everyday actions that have an effect on the environmental conditions of today, as well as the uncertainties and risks of the future. These challenges are complex, ranging from global trends such as increasing and competing demands for water and energy, climate and sea level change, and declining biodiversity; to localized manifestations of these issues in extreme weather events, the spread of invasive species, and demographic shifts. Accordingly, the Corps is reinvigorating commitment to the Environmental Operating Principles in light of this changing context.

The Environmental Operating Principles relate to the human environment and apply to all aspects of business and operations. They apply across Military Programs, Civil Works, Research and Development, and across the Corps. The Principles require a recognition and acceptance of individual responsibility from senior leaders to the newest team members. Re-committing to these principles and environmental stewardship will lead to more efficient and effective solutions, and will enable the Corps to further leverage resources through collaboration. This is essential for successful integrated resources management, ecosystem restoration of the environment and sustainable and energy efficient approaches to all Corps' mission areas. It is also an essential component of the Corps risk management approach in decision making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure.

The recommended plan will be consistent with the current Corps Environmental Operating Principles as identified below.

1. *Foster sustainability as a way of life throughout the organization.* This project is intended to contribute to the ecosystem restoration of natural habitat formation processes and reconnect off-channel habitats of the Lower Willamette River. This is to allow sustainable processes to continue into the future with limited necessary human intervention and management. This will help restore habitats for sensitive fish and wildlife species and contribute to the recovery of these species populations.
2. *Proactively consider environmental consequences of all Corps activities and act accordingly*. As identified above, this project is intended to allow natural physical processes to function more effectively to create and form habitats for fish and wildlife. This will incrementally address some of the consequences that past Corps programs have caused to aquatic and riparian habitats throughout the Willamette River system.

3. *Create mutually supporting economic and environmentally sustainable solutions.* This project will restore aquatic and riparian habitats to the study area. The project will not have adverse effects on residents or infrastructure and may incidentally increase recreational use of the restored areas.
4. *Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.* – This project provides ecosystem restoration of watershed functions while avoiding adverse effects on cultural, socioeconomic, and natural resources.
5. *Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs*. This project has been designed in the context of ongoing watershed processes including hydrology and sediment transport. It is designed to function over the long-term with consideration of potential changes in immediate and surrounding land uses.
6. *Leverage scientific, economic, and social knowledge to understand the environmental context and effects of the Corps' actions in a collaborative manner.* The recommended plan reflects the latest design and evaluation strategies for ecosystem restoration of aquatic and riparian habitats, and has been reviewed and vetted by highly experienced environmental scientists as well as civil and hydraulic engineers. It reflects a collaborative approach between the Corps, the non-Federal sponsor, and federal resource agencies.
7. *Employ an open, transparent process that respects views of individuals and groups interested in Corps' activities.* The Coprs and the non-Federal sponsor will continue to work with stakeholders and the public to ensure that the completed project reflects the concerns of the public and those with specific understanding of the watershed processes of the Lower Willamette River and its tributaries.

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8. PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

On February 14, 2014, a workshop was held with staff from USFWS to discuss project features, possible effects, and methods of describing the project and potential effects. Recommendations from that workshop have been incorporated into the Biological Assessment (BA) and designs for this project. A similar meeting was held with staff from NMFS on March 4, 2014, and similar recommendations were given.

The BA was submitted to initiate formal consultation with USFWS and NMFS. The consultation process and results are described in Section 9.2, below.

Consultation with Portland and Western Railroad, which is the railroad company that uses the railroad tracks crossing the Tryon Creek Highway 43 Culvert project site, was initiated by the Corps in February of 2014. The intent of coordination to date is to inform the railroad of the project and start initial conversations of what the project would entail. Coordination is at a preliminary phase and is ongoing.

Consultation with the City of Lake Oswego was initiated by the Corps and occurred in August of 2014. The intent of coordination was to inform the City of the proposed project and start initial conversations of what the project would entail. Coordination will continue through the course of the planning process.

This FS-EA was made available for a 30-day public review period from September 23, 2014 to October 23, 2014. At the end of the public comment period, no comments had been received from the public. It was determined that the proposed action would result in no significant impacts to the human environment, therefore a draft Finding of No Significant Impact (FONSI) has been prepared, and is also available for review and public comment under separate cover.

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9. ENVIRONMENTAL COMPLIANCE REQUIREMENTS

This section describes some of the primary environmental regulations that the Corps and the project partners will comply with during the planning process. Table 9-1 will be updated at appropriate milestones to reflect compliance status.

9.1 National Environmental Policy Act

This EA describes environmental conditions within the study area (subbasin scale), the proposed action and alternatives, potential environmental impacts of the proposed ecosystem restoration plan at the subbasin and ecosystem restoration measure scale, and measures to minimize environmental impacts. No significant impacts have been identified, nor were any comments submitted during the public review period; therefore the Corps has prepared a draft Finding of No Significant Impact (FONSI).

9.2 Endangered Species Act

The ESA of 1973, as amended, declares that all federal agencies "…utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act." Section 7 of the ESA requires federal agencies to ensure that any agency action (any action authorized, funded, or carried out by the agency) is not likely to jeopardize the continued existence of any threatened, endangered, or proposed species.

In accordance with Section 7(a)(2) of the ESA of 1973, as amended, federally funded, constructed, permitted, or licensed projects must identify and evaluate any threatened and endangered species, and their critical habitat, that may be affected by an action proposed by that agency. A Biological Assessment (BA) has been prepared for formal consultation, and is included in Appendix C. In this BA, determinations of effects arising from the Recommended Plan were made, and conservation measures were identified to offset adverse effects to the degree possible. Upon review of the BA, NMFS issued a Biological Opinion (BiOp) and Incidental Take Statement (ITS) that concurred with the Corps' findings that the project is likely to adversely affect listed salmonid species or their critical habitat, during construction, but is not likely to jeopardize the species (NMFS 2014). The BiOp and ITS are provided in Appendix B of the attached Biological Assessment (Attachment C).

9.3 Clean Water Act

Section 404 of the Clean Water Act authorizes a permit program for the disposal of dredged or fill material into waters of the United States, and defined conditions which must be met by federal projects before they may make such discharges. The Corps retains primary responsibility for this permit program. The Corps does not issue itself a permit under the program it administers, but rather demonstrates compliance with the substantive requirements of the Act through preparation of a 404(b)(1) evaluation. If needed, a Section 404(b)(1) evaluation will be prepared to document findings regarding this proposed ecosystem restoration plan pursuant, although if the project qualifies under a Nationwide Permit (NWP) a 404(b)(1) evaluation may not be needed.

Section 401 of the Clean Water Act requires federal agencies to comply with EPA, state, or tribal water quality standards. EPA has delegated implementation of Section 401 to the ODEQ. Implementation of this project will require 401 certification from the ODEQ for compliance with

Section 401 of the Clean Water Act for work below the Ordinary High Water (OHW) line. If the proposed project moves forward under a NWP, a Section 401 certification would be pre-approved. The Corps will abide by the conditions of the water quality certification to ensure compliance with Oregon water quality standards. During the design phase, further coordination with ODEQ will be conducted to document the proposed work area isolation and dewatering plans at each individual site and to develop construction water quality monitoring plans.

Section 402 of the act requires a NPDES permit and the associated implementing regulations for General Permit for Discharges from large and small construction activities for construction disturbance over one acre. This permit will be obtained for each project site during the design phase.

9.4 **Fish and Wildlife Coordination Act**

The Fish and Wildlife Coordination Act (16 U.S.C. 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through USFWS producing a Coordination Act Report (CAR), which provides the basis for recommendations for avoiding or minimizing such impacts. Coordination with USFWS has been ongoing throughout the study process and USFWS has provided a number of proposed conditions and other recommendations in-lieu of a CAR (USFWS 2014). These recommendations have been incorporated into this FS by reference, and will satisfy USFWS's FWCA goals for the report. The recommendations are provided in Appendix C of the attached Biological Assessment (Attachment C).

9.5 **National Historic Preservation Act**

The National Historic Preservation Act (16 U.S.C. 470) requires that the effects of proposed federal undertakings on sites, buildings structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. This project is a federal undertaking and a preliminary evaluation has been conducted to determine if historic structures are located within or adjacent to the undertaking area of potential effect, or if the projects are within immediate view sheds that are eligible for the National Register. Coordination is ongoing with the State Historic Preservation Office (SHPO) and affected tribes.

9.6 **Magnuson-Stevens Fishery Conservation and Management Act**

The evaluation of project impacts to essential fish habitat (EFH) was conducted as part of the Section 7 consultations with NMFS described in Section 9.1.2 above. Conservation measures were included as part of the proposed action in order to adequately avoid, minimize, or otherwise offset potential adverse effects to EFH. The BiOp for this project indicated that although the proposed action is likely to have adverse effects on EFH due to temporary loss of riparian vegetation, temporary loss of water quality from sediment disturbance, and harassment/displacement from disturbance caused by construction. The BiOp also indicates that many long-term beneficial effects from the proposed action are expected.

9.7 **Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)**

The Bald and Golden Eagle Protection Act prohibits the taking, possession or commerce of bald and golden eagles, except under certain circumstances. Amendments in 1972 added penalties for violations of the act or related regulations.

Although bald eagles may occur in the study area, no take of either bald or golden eagles is likely during project construction. No nests are known to be present. Therefore, no adverse effects to eagles are anticipated. The act's management guidelines (USFWS 2007) will be followed if any bald eagle nests are identified during the design or construction phases. Buffers of 660 feet should be maintained around nests if the construction work is visible from the nest. Buffers of 330 feet should be maintained around nests if the construction work is not visible from the nest.

9.8 Executive Order 12898, Environmental Justice

EO 12898 directs every federal agency to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The federal government has this goal for all communities and persons across this nation. It would be achieved when everyone enjoys the same degree of protection from environmental and health hazards, equal access to the decision-making process, and the opportunity to have a healthy environment in which to live, learn, and work. There are no disproportionate effects to environmental justice communities, therefore the proposed action is compliant with EO 12898.

9.9 Executive Order 11988, Floodplain Management, 24 May 1977

EO 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of the floodplain, and to avoid direct and indirect support of floodplain development where there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains." The proposed project will not result in development within the floodplain and modifications will result in increased water storage capacity in the floodplain, therefore the project is compliant with EO 11988.

Table 9-1 describes the environmental documents needed prior to construction, and the status of preparation of those documents.

Table 9-1. Environmental Compliance with Applicable Requirements

Relevant Law/Regulation	**Requirements**	**Compliance Status**
NEPA 42 U.S.C. 4321 et seq.	Requires federal agencies to consider the environmental effects of their actions and to seek to minimize negative impacts.	EA prepared as part of this study.
CWA 33 U.S.C. 1251 et seq.; Section 404	Requires federal agencies to protect waters of the United States. Disallows the placement of dredged or fill material into waters (and excavation) unless it can be demonstrated there are no reasonable alternatives.	Corps will prepare a wetland delineation and submit it to Oregon DSL in accordance with permitting requirements. Corps will prepare a Section 404(b)(1) evaluation to assess project effects on wetlands.
CWA Section 401	Requires federal agencies to comply with state water quality standards.	A Section 401 Water Quality Certificate will be obtained from ODEQ prior to completing the final design plans. This project will likely qualify for a pre-certified 401 WQC, which is generally issued for projects covered by NWPs.
Fish and Wildlife Coordination Act 16 U.S.C. 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.	Coordination with the U.S. Fish and Wildlife Service is complete. A set of recommendations in-lieu of a Coordination Act Report has been issued and is provided as Appendix C of the Biological Assessment.
ESA 16 U.S.C. 1531 et seq.	Requires federal agencies to protect listed species and consult with USFWS or NOAA Fisheries regarding the proposed action.	A BA has been prepared. Coordination with fish and wildlife agencies has occurred and a Biological Opinion and Incidental Take Statement have been issued.
Clean Air Act U.S.C. 7401	Requires federal agencies to control and abate air pollution.	Project is in compliance with the Clean Air Act.
Rivers and Harbors Acts 33 U.S.C. 403	The creation of any obstruction to the navigation of any waters of the United States is prohibited without congressional approval.	Section 10 review will occur at same time as determination of Section 404 compliance.
National Historic Preservation Act 16 U.S.C. 461	Requires federal agencies to identify and protect cultural and historic resources.	The District has initiated consultation with SHPO and affected Tribes. Consultation will continue with SHPO and Tribes throughout all project phases in an effort to maintain no adverse effects to historic properties and areas of substantial cultural interest. The compliance process will continue until SHPO and Tribal concurrence has been achieved.
EO 11988, Floodplain Management, 24 May 1977	Requires federal agencies to consider how their activities may encourage future development in floodplains.	Project will not induce development in floodplains, is therefore in compliance.
EO 11990, Protection of Wetlands	Requires federal agencies to protect wetland habitats.	Corps will prepare a wetland delineation and submit it to Oregon DSL in accordance with permitting requirements. Project will avoid impacts to wetlands to degree possible, and will result in increase in amount and quality of wetland habitat. Project is in compliance.
EO 12898, Environmental	Requires federal agencies to consider and	Project is in compliance.

Relevant Law/Regulation	Requirements	Compliance Status
Justice	minimize potential impacts on low-income or minority communities.	
EO 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.	Compliance determination to be made after NEPA impact assessment and Section 106 consultation is complete.
EO 13175, Consultation and Coordination with Indian Tribal Governments	Requires federal agencies to consult and coordinate with the appropriate tribal governments.	District has initiated consultation with tribes regarding potential effects to cultural resources.
Native American Graves Protection and Repatriation Act	Protects Native American and Native Hawaiian cultural items.	Compliance determination to be made after completion of NEPA impact assessment, public involvement process, SHPO and Tribal consultations and final construction implementation.
American Indian Religious Freedom Act 42 U.S.C. 1996	Requires federal agencies to insure that religious rights of Native Americans are accommodated during project planning, construction, and operation.	Compliance determination to be made after completion of NEPA impact assessment, public involvement process, SHPO and Tribal consultations and final construction implementation.
Oregon Water Quality Standards	Requires that actions that may affect water quality of waterbodies in the state comply with water quality regulations.	Will be in compliance per Section 401 Water Quality Certification.
ODFW Fish Passage Policy	Fish passage is required in all waters of this state in which native migratory fish are currently or were historically present; Projects that construct, install, replace, extend, repair or maintain, and remove or abandon dams, dikes, levees, culverts, roads, water diversion structures, bridges, tide gates or other hydraulic facilities are triggers to Oregon's fish passage rules and regulations.	Integral to this proposed project is to incorporate ODFW fish passage policy to all designs.
Oregon Threatened and Endangered Species	Requires an evaluation of effects on State-listed threatened and endangered species	The project will be coordinated with the ODFW.
Oregon Removal/Fill Permit	Requires an evaluation of effects on wetlands and waterbodies within the State of Oregon	Will be in compliance per submittal of a General Authorization Notification submittal to Oregon Division of State Lands (ODSL).

10. MONITORING AND ADAPTIVE MANAGEMENT PLAN

Monitoring and adaptive management will conform to requirements of Section 2039 of WRDA 2007 and subsequent Corps implementation guidance, and monitoring will be conducted until such time as the Corps determines that the project has achieved success.

This monitoring and adaptive management plan has been developed to ensure the success of the recommended ecosystem restoration plan in meeting project objectives and a process to identify if any adaptive management actions are warranted during the 10-year period. Monitoring is proposed to occur for 10 years as geomorphic changes and vegetation community conditions develop slowly and a shorter period of monitoring may not detect sufficient changes or threats to the success of the project. The proposed monitoring plan will measure the following key elements: vegetation, connector channel hydrology and hydraulics, river and floodplain morphology, wildlife, physical habitat, and fish and typical methods are described as the basis for the monitoring cost estimate in this section. Detailed protocols (including specific sampling locations) will be developed further for each site during the design phase. Photo-monitoring will also be conducted to document site changes over time including vegetation establishment and physical habitat features.

The non-Federal sponsor will conduct all monitoring activities for 10 years after completion of construction at each site as part of the total project cost-share. The total estimated monitoring costs are $85,000 and are based on actual costs from similar activities conducted during the feasibility phase. Any monitoring conducted after 10 years would not be part of the total project cost and will be 100% non-Federal costs.

This section describes the components of a monitoring plan that will be developed during the design phase. The detailed monitoring plan will be used to determine the success of the ecosystem restoration measures in meeting project objectives and, if needed, to establish adaptive management measures. Methods are outlined below in Table 10-1.

Table 10-1. Specific Monitoring Plan Elements and Methods

Monitoring Element	Methods
Vegetation	• Revegetated sites will be monitored for 5 years to remove invasive plants around the base of new plantings in order to allow them to become established. • Survival rates of vegetation installed will be determined and supplemental plantings will be installed on an as needed basis. • Over several years following construction (typically during years 1, 2, 5, and 10), riparian vegetation plantings are evaluated for percent cover, canopy cover over-water, and overall percent survival.
Hydrology/Hydraulics	• Flows through the side channels will be monitored to track frequency of connections.
Physical Habitat	• Cross-sectional surveys in selected locations of the newly excavated channel connections will be conducted for 3 years after construction to determine if sediment deposition or erosion has occurred, and if so, determine the cause and magnitude. • Aquatic features such as pools and large wood would be monitored to determine: (1) physical measurements (*e.g.*, maximum depth, residual depth and surface area); (2) if hydraulic conditions have been created that affect their function; and (3) if additional pools have been created. • Large wood would be monitored to determine if it has moved or caused any bank erosion or other changes. Side channels will be monitored to ensure that inlets and outlets remain open.

Wildlife	• Wildlife use of riparian areas, wetlands, side channels, and in-stream locations will be monitored. Small mammals and amphibians will be monitored to evaluate potential impacts during construction; and monthly waterfowl monitoring and nesting bird surveys will be conducted for five years.
Fish	• Pre- and post-construction fish surveys will be conducted in the project area to document assemblage data on a quarterly basis. Active sampling methods may include beach seining, and passive methods will include minnow trapping. Multiple habitat features and life stages will be targeted. • Fish passage at the Tryon Creek/Highway 43 site will be monitored during the fall and winter migration periods.

General Targets:

- Achieve 75 percent cover of native vegetation species per design at each site within 5 years post-construction and sustain through life of project.
- Reduce non-native vegetation species to less than 25 percent cover per design at each site within 5 years post-construction and sustain through life of project.
- Document changes in habitat suitability for wildlife species included in habitat model. Compare and correlate presence/absence of native fish, amphibians, and native songbirds to habitat suitability parameters.

Monitoring Protocol:

- Establish minimum of five permanent vegetation plots on each site to be representative of the plant communities and restored areas within the project site. Permanent plots shall be 33 foot diameter circular plots (centerpoint of each plot will be documented via Global Positioning System (GPS) coordinates to reoccupy in each of sampling). Percent cover will be visually assessed and documented for each strata (herbs, shrubs, trees, woody vines) and each species with more than 5 percent cover. Sampling will occur in Years 1, 3, 5, and 10 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 10 (total percent cover in all strata). Estimated cost $10,000 per year; total $40,000.
- Map non-native vegetation species throughout restored areas on each site in Years 1, 3, and 5 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. Estimated cost $5,000 per year; total $15,000.
- Conduct habitat evaluation using multi-species HEP model in Years 5 and 10 following construction at each site. Document changes from baseline. Estimated cost $5,000 per year; total $10,000.
- Conduct fish, amphibian, and songbird surveys in Years 5 and 10 following construction at each site. Standardized targeted fish survey will be followed at all times. Amphibian surveys to be conducted during breeding season to document all species observed. Conduct bird nesting surveys in summer at each site in Years 5 and 10 following construction. Document amphibian and bird survey data to habitat model parameters (i.e., quantify water temperatures, shrub height and density and other parameters where species observed). Estimated cost $10,000 per year; total $20,000.

Adaptive Management Trigger(s):

- 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 10 years the overall quality of habitat in each restored plant community to identify if the project met this criteria.
- If average non-native invasive species cover exceeds 25 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.
- Corps and non-Federal sponsor to evaluate habitat suitability indices and presence/absence of native fish, amphibians, and birds and modify models as appropriate based on quantitative data of presence relative to specific model parameters.

Adaptive management would be triggered by the above identified conditions if the monitoring targets are not met. At this time, it is difficult to predict which specific triggers might not be met, but for the purposes of estimating an adaptive management cost, it is assumed that a potential condition that could result is the closure of the mouths of side channels due to sediment accretion. Thus, for purposes of estimating the potential cost of adaptive management, it has been assumed that occasional removal of sediment at each ecosystem restoration site where side channels would be excavated, which include Kelley Point Park, Oaks Bottom/Sellwood Riverfront Park, and BES Plant, may be needed. The average cost of this excavation is estimated at approximately $5,000 at each of the inlets and outlets of the side channels every three years, including revegetating areas affected during the excavation. Thus, the potential cost of adaptive management is estimated at $90,000 over the 10-year period of this monitoring and adaptive management plan.

Adaptive management actions may be identified prior to completion of the 10-year monitoring, or could also be identified later during any extended non-Federal sponsor monitoring.

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11. CONCLUSIONS AND RECOMMENDATIONS

This FS-EA has presented a set of recommended ecosystem restoration measures for the Lower Willamette River, Tryon Creek, and Columbia Slough based on the Corps plan formulation process. The recommended ecosystem restoration plan is an incrementally justified and cost-effective approach, and meets the study objectives for ecosystem restoration of national and regionally significant resources and there is a demonstrated federal interest in restoring these resources.

Though short-term impacts could result to soils, air quality, water quality, vegetation, noise, and aesthetics, these impacts will be avoided or reduced through the implementation of BMPs and will be temporary. Long-term benefits over the life of the project are expected to result to floodplains, wetlands, wildlife populations including endangered fish species, vegetation, socioeconomics, parks and recreation, and visual quality.

The recommended ecosystem restoration plan will increase the quality of aquatic and riparian habitats. The plan not only provides positive ecosystem benefits in terms of aquatic and riparian habitat ecosystem restoration, but also provides a variety of social benefits in line with federal and local orders and initiatives, including improved natural quality of open spaces, visual quality, and wildlife viewing opportunities.

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

The non-Federal sponsor shall:

- Provide 35 percent of total project costs as cash or in-kind services, as further specified below:
  - Provide the required non-Federal share of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
  - Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
  - Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project.
  - Provide, during construction, any additional funds necessary to make its total contributions equal to 35 percent of total project costs.
- Provide work-in-kind during final design and construction as well as providing the post-construction monitoring. The value of the LERRDs needed for the project will be credited against the non-Federal sponsor's cost-sharing requirement. The sponsor anticipates contributing the balance of funds from grant funding that will not include funds from Federal agencies.

- Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
- Not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank;
- Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. §§ 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, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
- For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;
- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- Hold and save the United States free from all damages arising from construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
- Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management;
- 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 U.S.C. § 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, "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 U.S.C. §§ 3141-3148 and 40 U.S.C. §§ 3701-3708;
- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. §§ 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the

non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
- Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and,
- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. § 1962d-5b), and Section 103(j) of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C. § 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

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