B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

In cooperation with the U.S. Army Corps of Engineers

Columbia Estuary Ecosystem Restoration Program

Draft Environmental Assessment

April 2016

DOE/EA-2006

BONNEVILLE POWER ADMINISTRATION
DOE/BP-2006 • April 2016

Table of Contents

List of Figures

List of Tables

Appendices

Abbreviations and Acronyms

agencies Bonneville Power Administration and U.S. Army Corps of Engineers

BiOp Biological Opinion

BPA Bonneville Power Administration

BMPs Best Management Practices

CAP Continuing Authorities Program

estuary restoration program Columbia Estuary Ecosystem Restoration Program

CFR Code of Federal Regulations

cfs cubic feet per second

Corps U.S. Army Corps of Engineers

CRE Columbia River Estuary

DDT dichlorodiphenyl trichloroethane

DDE dichlorodiphenyldichloroethylene

DPS distinct population segment

EA Environmental Assessment

EPA U.S. Environmental Protection Agency

ERTG Expert Regional Technical Group

ESA Endangered Species Act

estuary Columbia River estuary

ESU evolutionary significant unit

FCRPS Federal Columbia River Power System

FCRPS Action Agencies Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation

ft feet

HIP Habitat Improvement Program

mcy million cubic yards

mg/l milligrams per liter

NEPA National Environmental Policy Act

NOAA Fisheries Formerly National Marine Fisheries Service [NMFS], a division of the National Oceanic and Atmospheric Administration

NPCC Northwest Power and Conservation Council

NTU nephelometric turbidity unit

NWP Nationwide Permit

PAHs polycyclic aromatic hydrocarbons

PCBs polychlorinated biphenyls

RM river mile

RPA Reasonable and Prudent Alternative

SBU survival benefit unit

SLOPES Standard Local Operating Procedures

USC United States Code

USFWS U.S. Fish and Wildlife Service

WDFW Washington Department of Fish and Wildlife

WRDA Water Resources Development Act of 2000

Chapter 1 Purpose of and Need for Action

1.1 Introduction

Bonneville Power Administration (BPA) and the United States Army Corps of Engineers (Corps) are proposing to implement a programmatic approach to environmental review for a suite of ecosystem restoration projects under the Columbia Estuary Ecosystem Restoration Program (estuary restoration program) in the Columbia River estuary (estuary)[1] to restore aquatic habitats for the benefit of fish and wildlife. The estuary restoration program was collaboratively instituted by the BPA and the Corps, referred to as the agencies[2], in 2011 to undertake the activities necessary to evaluate, protect, monitor, and restore fish and wildlife habitat in the estuary (Figure 1).

The estuary restoration program was developed to assist the agencies in meeting their commitments under the National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) Biological Opinion (BiOp) for the operation and maintenance of the Federal Columbia River Power System (FCRPS) as supplemented in 2010 and 2014 (NOAA Fisheries 2008; 2010; 2014). In this BiOp, Reasonable and Prudent Alternative (RPA) Actions 36 and 37 set targets for improvements in juvenile and adult fish survival in estuary habitat through ecosystem restoration of floodplain habitats in the Columbia River estuary[3]. The RPA, which includes estuary ecosystem restoration actions along with RPA actions addressing other freshwater lifestages, is intended to ensure that operation of the FCRPS is not likely to jeopardize the continued existence of salmon and steelhead species listed as threatened or endangered under the Endangered Species Act (ESA) or destroy or adversely modify designated critical habitat. Implementation of the suite of estuary restoration and related research, monitoring, and evaluation actions is an important element of the Action Agencies' commitments to implement the BiOp and fulfill their responsibilities under the Endangered Species Act. This programmatic Environmental Assessment (EA) is being prepared to help facilitate the timely environmental review of these actions.

In accordance with the National Environmental Policy Act (NEPA), the agencies are preparing this EA to evaluate the environmental impacts of programmatically implementing restoration and related research, monitoring, and evaluation actions in the estuary. BPA is the lead agency

---

[1] In this document "estuary" denotes the entire zone of tidal influence within the Columbia River estuary and all tributaries in Oregon and Washington from the mouth of the Columbia River at River Mile (RM) 0, upstream to Bonneville Dam at RM 146.

[2] BPA and the Corps are referred to as agencies in this document. While the Bureau of Reclamation is a Federal Columbia River Power System (FCRPS) Action Agency for the FCRPS Biological Opinion (BiOp), BPA and the Corps have agreed to implement the estuary restoration program. FCRPS Action Agencies in this document refers to all three agencies.

[3] An RPA is an economically and technically feasible alternative to the proposed action that is within the Action Agency's legal authority, is economically and technically feasible, and NOAA or FWS determines is not likely to jeopardize ESA-listed species or result in the destruction or adverse modification of designated critical habitat.

for this effort due to the number of and complexity of projects that it anticipates to fund as part of the estuary restoration program. The Corps is a cooperating agency due to its role in authorizing modifications to federally authorized levees, issuing permits pursuant to Clean Water Act and Section 10 permits under the Rivers and Harbors Act, and implementing its own ecosystem restoration projects. The Corps may undertake projects that tier to this EA. This EA describes the process by which future individual restoration projects would be identified and developed to meet the goals and objectives of the estuary restoration program and the FCRPS BiOp and how the analysis of those future projects would tier to the analysis in this EA. In addition, this section discusses the need and purposes for action; describes related plans and environmental laws; and summarizes jurisdictional authority, funding sources and general background information.

1.2 Need

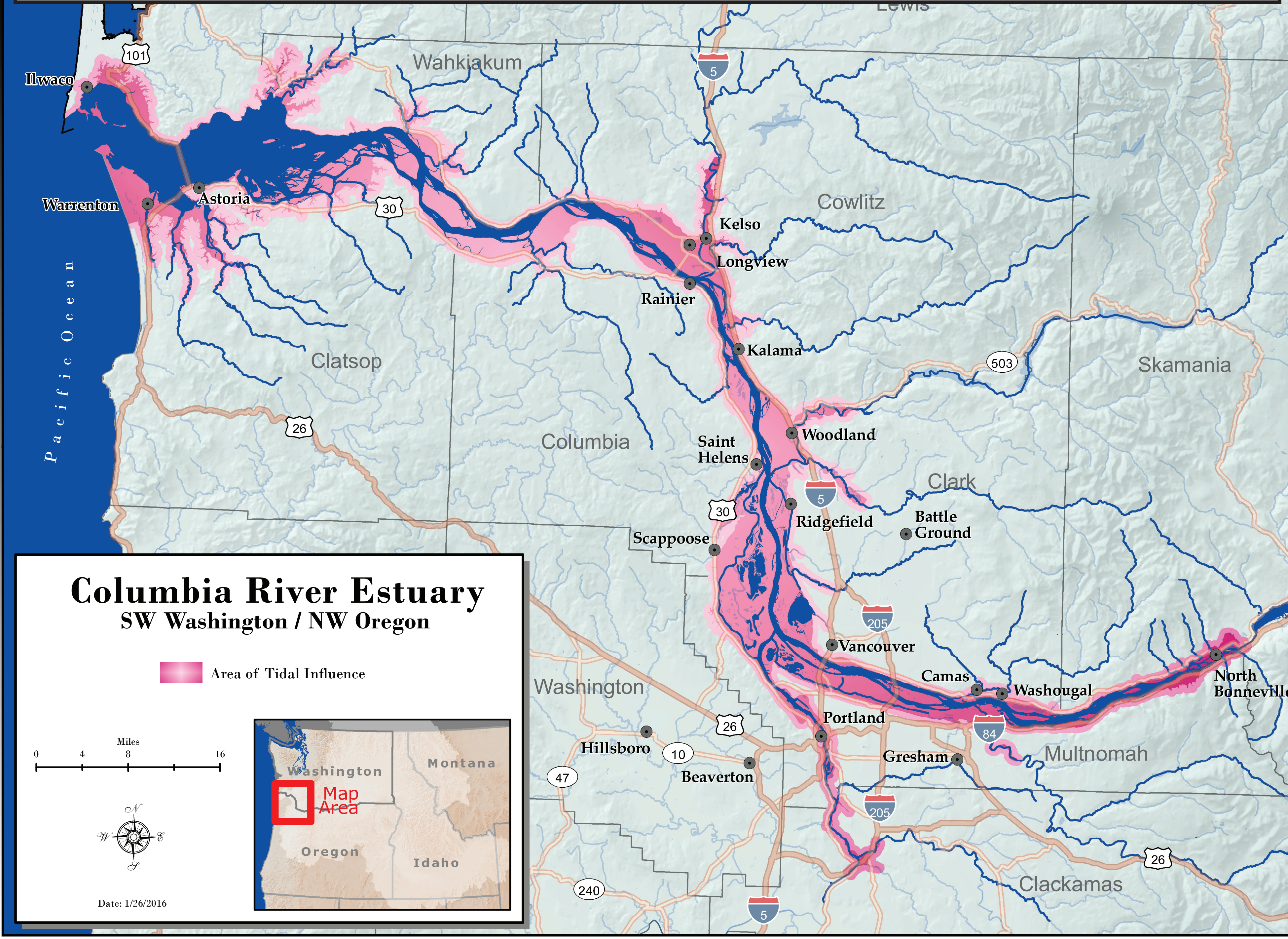
BPA and the Corps need a coordinated approach to evaluate the environmental impacts of estuary restoration projects in Columbia River estuary. The Action Agencies have committed to restore habitat in the estuary to improve fish habitat quality and fish survival. Numerous estuary restoration projects have been completed, are currently proposed, and will continue to be identified over the coming years. At present, the agencies conduct environmental review of all estuary projects on a project-by-project basis. These projects include many routine actions with well-understood and predictable environmental effects common to restoration projects in tidal and riverine ecosystems. This approach is inefficient because the agencies must analyze these routine actions and predictable impacts repeatedly with each successive project. This inefficiency can delay implementation of projects that have little controversy or impact, but provide long-term ecosystem benefits to fish and wildlife.

1.3 Purposes

In meeting the need for action, the agencies seek to achieve the following purposes:

- Implement projects in a timely manner to secure and claim survival benefits to help fulfill the Action Agencies' commitments under the FCRPS BiOp, as supplemented in 2010 and 2014 (NOAA Fisheries 2008; 2010; 2014).
- Assist in carrying out commitments related to estuary habitat actions contained in the State of Washington's Memorandum of Agreement (Washington Fish Accord) to conserve salmon and steelhead through improvement of conditions in the estuary.
- Support efforts to mitigate for the effects of development and operation of the FCRPS on fish and wildlife in the mainstem Columbia River and its tributaries, under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) (16 U.S.C. § 839b(h)(10)(A)) in a manner consistent with the Northwest Power and Conservation Council's Fish and Wildlife Program.
- Support the Corps authorities to implement estuary ecosystem restoration projects under the Water Resource Development Act (Sections 206, 536, and 1135) and the Estuary Ecosystem Restoration General Investigations Study.
- Minimize adverse effects to the human environment, avoid jeopardizing the continued existence of ESA-listed species and avoid adverse modification or destruction of designated critical habitat.

Figure 1. Columbia River Estuary



1.4 Background

1.4.1 Federal Columbia River Power System

The FCRPS comprises 14 federal multipurpose hydropower projects. The 12 projects operated and maintained by the Corps are: Bonneville, The Dalles, John Day, McNary, Chief Joseph, Albeni Falls, Libby, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak dams. Reclamation operates and maintains the following FCRPS projects: Hungry Horse Project and the Columbia Basin Project, which includes Grand Coulee Dam. The FCRPS BiOp consultation also includes the mainstem effects of other tributary projects in the Columbia Basin.

1.4.2 Status of the Columbia River Estuary

Today, the structural and functional integrity of the estuary is fundamentally altered. The entire Columbia River watershed has undergone tremendous change in the last 100 years as a direct result of people living, working and recreating in the basin (NOAA Fisheries 2011b). Many floodplain habitats in the estuary are functionally degraded ecosystems, altered by development activities including diking, draining, and clearing tidal swamp forests and altering land uses (e.g., floodplains converted to agriculture, forestry, etc.). The main factors limiting the distribution of and access to high-quality habitats important to fish and wildlife include altered flow regimes in the mainstem Columbia River and its tributaries, sediment transport, physical structures such as levees and dikes, food web, water quality, fragmented habitats, and land use practices. Additional information regarding the different reaches within the Columbia River estuary and their historical significance and structure is provided in Appendix A.

The physical changes, including floodplain development, dredging of the navigation channel and harbors, and flow regulation, significantly altered the estuary. While the rate of physical alteration has apparently slowed compared to the late 19th and early 20th century, physical changes are still occurring. The navigation channel was deepened (1−3 ft) early in the present century, and channel maintenance, including dredge material disposal in the estuary is conducted routinely. The habitat complexes within the present floodplain are altered compared to historical conditions. Non-native species are abundant and dominate vegetation, plankton, fish, and benthic assemblages. Very few "historical" (i.e., late 1800s) wetland habitats remain intact in the system. The biological communities and geomorphology of the system were strongly structured by natural disturbances (e.g., floods). Reduction in the timing, magnitude, and duration of flood events has removed the fundamental disturbance regime. Additional alterations, such as pile dikes designed to maintain the navigation channel location and depth have resulted in the deposition of sediments and formation of shallow-water habitats. Through alteration in river flow dynamics and volumes, increases in water temperature, and sea-level rise, climate change is expected to affect the ecological processes of shallow-water habitats, and the capacity of the habitats to support young salmon (Thom 2013).

Lack of access to functional habitat increases competition between juvenile salmon and steelhead in the estuary and can result in greater predation on juvenile salmon and steelhead. Approximately, two-thirds of the estuary's historical wetland habitat has been lost to development, but monitoring demonstrates that fish quickly make use of reopened and restored wetlands (FCRPS 2013). Restoring estuary habitat and ecosystem processes would benefit and support juvenile salmon and steelhead by: providing access to additional feeding areas; exporting food into the larger ecosystem; providing habitat refugia during flood events and cover to avoid predators; and improving water quality by restoring natural filtering processes that remove nitrogen, phosphorous and suspended sediments.

Individual habitat restoration projects have the greatest likelihood of success when they are implemented with a perspective toward promoting the long-term sustainability and resilience of natural resources in a landscape, which in turn promotes healthy ecosystem processes supporting fish and wildlife (Johnson 2003). Restoring habitat in the estuary with an eye toward landscape ecology increases the likelihood of project success and cumulative benefits to the region's fish and wildlife. Implementing estuary restoration projects would restore the physical or structural factors controlling the development, dynamics and maintenance of tidally-influenced aquatic habitats in the estuary.

Thus, the restoration of estuarine habitats, including floodplains and associated wetland and upland riparian areas, is an important component for aquatic and terrestrial wildlife. In addition, the restoration of estuarine habitats is critical to the regional recovery for species listed under the ESA, including 13 species of Pacific salmon and steelhead in the Columbia River ecosystem (NOAA Fisheries 2013). The restoration of tidally influenced floodplain habitats contemplated under the estuary restoration program supports the successful reestablishment of healthy self-sustaining populations of salmonids in the wider ecosystem.

1.4.3 Federal Columbia River Power System Biological Opinion

Under the ESA and its implementing regulations, federal agencies must ensure that their actions are not likely to jeopardize the continued existence of ESA-listed species or result in the destruction or adverse modification of designated critical habitat. When a federal agency determines that its proposed action may affect listed species or critical habitat,[4] it must initiate interagency consultation.

Currently, there are thirteen species of anadromous salmon and steelhead in the estuary listed as threatened or endangered under the ESA, with designated critical habitat for all thirteen species. Beginning in 1992, the FCRPS Action Agencies have initiated Section 7 consultations with NOAA Fisheries and U.S. Fish and Wildlife Service (USFWS) on the effects of the operation and maintenance of the FCRPS on these and other listed species and their designated critical habitat. NOAA Fisheries and USFWS have issued biological opinions and incidental take statements on the operation of the FCRPS and related actions since that time.

In its BiOp dated December 21, 2000, NOAA Fisheries concluded that the Action Agencies' proposed operation of the FCRPS was likely to jeopardize ESA-listed fish and included an RPA to the proposed action that reflected a life cycle management approach, incorporating habitat restoration together with hydro system mitigation actions (NOAA Fisheries 2000). Under the 2000 BiOp, the Action Agencies committed to restore 10,000 acres of habitat in the lower 46 miles of the river to benefit salmon and steelhead. The area of restored habitat was intended to serve as a proxy for measuring the progress toward enhancing estuary habitat with the ultimate goal of increasing the survival of out-migrating juvenile salmon and steelhead.

---

[4] Species under NOAA's jurisdiction include marine mammals, turtles, marine and anadromous fish (including Pacific salmon and steelhead), and marine invertebrates and plants. Species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) include all birds, terrestrial animals, and freshwater fish and plants.

In its BiOp dated November 30, 2004, NOAA Fisheries added greater focus on efforts to protect and enhance habitat along and adjacent to the mainstem Columbia River below Bonneville Dam (RM 0 – 146) to provide survival improvements for ESA-listed salmon and steelhead.

Following litigation challenging the 2004 BiOp, NOAA Fisheries issued a revised BiOp on May 5, 2008, which included and RPA consisting of refinements to the configuration and operation of the FCRPS hydropower projects designed to improve juvenile and adult fish passage, as well as a number of non-hydropower actions intended to benefit ESA-listed species (NOAA Fisheries 2008). The interagency consultation leading to the development of the 2008 BiOp was informed by extensive regional collaboration to identify and address factors affecting salmon and steelhead survival and recovery during freshwater life stages. This process culminated in an integrated approach in the 2008 BiOp RPA, with actions addressing the hydro system, habitat, hatcheries, and predation, all supported by an extensive program of research, monitoring, and evaluation. As part of this approach, the RPA includes strategies to improve the productivity and survival of ESA-listed species and habitat function in the upstream tributaries and estuary, including specific estuary survival improvement targets. The 2008 RPA currently guides operaton of the FCRPS, and the Action Agencies will continue to implement its recommended actions through the end of 2018.

In 2010, NOAA amended the 2008 BiOp with a supplemental BiOp, and under court order, the 2008/2010 BiOp was supplemented again in 2014 (NOAA Fisheries 2010 and 2014, respectively). The 2010 supplemental BiOp enhanced adaptive management provisions within the RPA based on the results of research and monitoring actions implemented in the first two years after the 2008 BiOp was issued.

Additionally, the 2014 BiOp (hereafter referred to as the FCRPS BiOp) evaluated the effects to species listed under the ESA since the issuance of the 2008 BiOp, namely the southern distinct population segment (DPS) of eulachon, also known as smelt (*Thaleichthys pacificus*) and the southern DPS of North American green sturgeon (*Acipenser medirostris*).[5]

Relevant to this EA, the RPA includes two broad habitat strategies:

Strategy 1: implement actions designed to improve the quality and quantity of spawning and rearing habitat for specific populations of Snake River and Upper Columbia River Chinook and steelhead and Middle Columbia steelhead,.

Strategy 2: implement habitat improvement projects in the estuary to improve the survival of juvenile migrants during passage through and residence in the estuary and thus increase the proportion and fitness of juvenile migrants that leave the estuary to begin their ocean life stage

Programmatic NEPA implementation of the estuary restoration program would help fulfill Habitat Strategy 2, by facilitating the timely improvement of habitat conditions in the estuary through the restoration and reconnection of floodplain habitats, thereby fulfilling the Action Agencies' responsibilities under the FCRPS BiOp. Under Habitat Strategy 2, RPA Actions No. 36

---

[5] A distinct population segment (DPS) is a group of populations which is discrete from other populations of the same species due to physical, physiological, ecological, or behavioral factors, and which is significant to the entire species. A DPS is the smallest taxonomic division which can be listed under the ESA (includes species, sub-species, DPS).

and 37 call for the Action Agencies to implement a sufficient number of projects in the estuary to achieve estimated percentage survival benefits of 9.0% for ocean-type fish and 6.0% for stream-type fish[6]. To fulfill commitments to implement these improvements under the FCRPS BiOp, the Action Agencies use a method to quantify habitat metrics and show a relative benefit to juvenile salmon from implementing restoration actions in the Columbia River estuary, called a survival benefit unit (SBU) (see Section 1.4.5). Consistent with the BiOp, the Action Agencies enlist the assistance of an Expert Regional Technical Group (ERTG) to support project selection and estimate changes in survival using this methodology (see Section 1.4.5).

1.4.4 Columbia Estuary Ecosystem Restoration Program

The estuary restoration program was created by the Action Agencies in 2011 to undertake the activities necessary to evaluate, protect, monitor, and restore fish and wildlife habitat in the estuary. The purpose of implementing the estuary restoration program is to restore ecosystem processes to tidally influenced regions of the Columbia River, which shape and influence the structure and function of the river and support natural processes such as nutrient exchange and sediment transport in the estuary.[7] These processes improve overall habitat quality and increase the quantity and access to high quality habitats for the benefit of estuarine fish and wildlife, including species listed under the ESA. The over-arching premise for implementing the estuary restoration program is that an ecosystem-based approach to restoration is necessary to support and maintain natural habitat types and functions which are important to the region's native species.

1.4.5 ERTG and SBUs

The ERTG is comprised of regional experts in estuarine, riverine, and ocean ecology, fisheries biology, and restoration science. Using the best available science, their collective experience and professional judgement, the ERTG is tasked with evaluating the relationship between restoration actions, habitat change, and the expected resultant survival benefits to juvenile salmonids in the Columbia River estuary. Based upon current knowledge of how juvenile salmon and steelhead use and transit through the estuary, the ERTG evaluates proposed restoration projects and assigns SBUs for the relative contribution each project makes toward increasing the survival and production of juveniles, as directed in the FCRPS BiOp. *The History and Development of a Method to Assign Survival Benefit Units* provides additional details on the history and development of the ERTG and its relationship to the agencies (ERTG 2010-03).

The ERTG developed criteria for scoring three factors: certainty of success, potential benefit for habitat access/opportunity, and potential benefit for habitat capacity/quality. The *ERTG*

---

[6] Ocean-type juveniles are commonly found throughout the estuary and coastal zone, using these habitats more extensively than stream-type juveniles which spend more time in their natal streams before out-migrating to the ocean.

[7] For the purpose of this document, ecosystem *structure* is defined as the manifestation of the factors influencing and controlling the physical condition of the river, namely the types, distribution, abundance and physical attributes of habitat types, plants and animal species and communities comprising the estuary and estuary ecosystem. Ecosystem *function* is further defined as the output or characteristic of the system's structure, such as the role plant and animal species play in the ecosystem, including primary production, prey production, refuge, water storage, nutrient cycling, etc. (Johnson 2003).

Scoring Criteria provides additional details on the scoring criteria used to assign SBUs for independent project actions. The purpose of the *ERTG Scoring Criteria* is to provide standard criteria for the ERTG to apply when it scores projects as part of the process to assign SBUs to proposed restoration projects (ERTG 2010-02).

In developing individual estuary restoration projects, the agencies would evaluate a site's needs and design a project to restore natural riverine and estuarine processes in a manner that is appropriate and feasible for the site. As such, each proposed project is likely to include a combination of the management actions listed below in Section 2.3. Different habitat types (tidal slough, marsh wetland, swamp, etc.) support different densities, species, or life-stages of salmonids. Management actions identified in Section 2.3 can be implemented across a multitude of habitat types to benefit specific species or juvenile salmonid life-stages. As a result, the restoration of specific habitat types contributes differently to the overall survival of an evolutionarily significant unit[8] (ESU) (ERTG 2013a). Proposed restoration projects, which include these management actions, can be evaluated by the ERTG and the resulting SBU score can be applied to the agencies' BiOp commitments for habitat restoration.

At a given site, the agencies or their partners may implement activities that are not specifically identified in Section 2.3 but are still necessary parts of the overall action. For example, utilities, roadways, or recreational facilities (trails) may need to be maintained at project sites, and in some cases these structures may need to be elevated or relocated to improve overall habitat quality at a project site or protect infrastructure. In other cases, a fish ladder may need to be removed or retrofitted to allow salmon and steelhead to access tributary habitats for spawning and rearing. The total project costs, including all management actions would be used to evaluate the potential benefits that could be provided at a project site and contribute to the SBU score and used to meet the agencies' BiOp commitments.

1.4.6 Columbia Estuary Ecosystem Restoration Program Management Actions

Under Section 4(f) of the ESA, NOAA Fisheries is charged with developing recovery plans for ESA-listed species. In 2011, NOAA Fisheries released an updated version of the *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (CRE Module), which encompasses all tidally-influenced areas downstream of Bonneville Dam. (NOAA Fisheries 2011b). The Columbia River estuary (CRE) Module identified a series of 23 independent management actions intended to address specific threats and limiting factors in the estuary to aid in the recovery of salmon and steelhead throughout the region (NOAA Fisheries 2011b). Of the 23 management actions in the CRE Module, six actions directly address habitat quality in the estuary and would be implemented under the estuary restoration program. These CRE management actions include:

- CRE – 1: Protect intact riparian areas in the estuary and restore riparian areas that are degraded.

[8] An evolutionary significant unit (ESU) is a population of organisms that is considered distinct from other populations of the same species for the purpose of conservation. An ESU is considered distinct from other populations by geographic separation, genetic differences, or local adaptations so that it is reproductively isolated from other populations of the same species. An ESU is equivalent to a DPS (see footnote 5).

- CRE – 3: Protect or enhance estuary instream flows influenced by Columbia River tributary or mainstem water withdrawals and other water management actions in tributaries.
- CRE – 6: Reduce the export of sand and gravels from dredge operations by using dredged material beneficially.
- CRE – 9: Protect remaining high-quality off-channel habitat from degradation and restore degraded areas with high intrinsic potential for high-quality habitat.
- CRE – 10: Re-establish or improve access to off-channel habitats.
- CRE – 15: Reduce the introduction and spread of invasive plants.

Under each of these management actions, the CRE Module provides specific activities which contribute to the overall restoration objective. Not all of the specific activities are applicable to federal agencies implementing estuary restoration, as some actions are aimed at private landowners, or local and state regulatory entities. Those activities which apply to federal agencies and their partners/sponsors implementing restoration actions in the estuary are identified and discussed further in Chapter 2. To date, the following non-federal sponsors have proposed to implement restoration projects in the estuary to benefit fish and wildlife, in coordination with the Action Agencies: Columbia Land Trust, Columbia River Estuary Study Taskforce, Cowlitz Indian Tribe, Lower Columbia Estuary Partnership, and the Washington Department of Fish and Wildlife (WDFW).

1.4.7 The Council's Fish and Wildlife Program

The Northwest Power and Conservation Council (Council) is an interstate agency established under the authority of the Northwest Power Act to develop and maintain a regional power plan and a fish and wildlife program to balance the Northwest's environment and energy needs. The Northwest Power Act directs the Council's Fish and Wildlife Program to develop a program to *"protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries . . . affected by the development, operation, and management of hydroelectric projects while assuring the Pacific Northwest an adequate, efficient, economical, and reliable power supply"* (NPCC 2014). Under this program, the Council makes recommendations to BPA about which projects to fund to aid in the protection, mitigation, and enhancement of fish and wildlife and their habitats. The Council's Fish and Wildlife Program acknowledges the importance of the Columbia River estuary as an ecological feature that is adversely affected by upriver management actions and local habitat conditions. BPA funds projects consistent with the Council's Program, including projects that help satisfy RPA actions 36 and 37under the FCRPS BiOp.

The Council's subbasin plan for the estuary includes strategies to protect, mitigate, and enhance salmon and steelhead spawning and rearing habitat (NPCC 2002). One strategy includes recommendations to restore ecosystem structure and function by removing or lowering dikes and levees that block access to habitat and protecting or restoring off-channel habitat. These actions benefit not just salmon and steelhead, but also other regional fish and wildlife including eulachon, sea-run cutthroat trout (*Oncorynchus clarkia clarkii*), Pacific lamprey (*Entosphenus tridentatus*), sturgeon, amphibians, reptiles, eagles and other raptors, waterfowl, and migratory songbirds.

1.5 Lead and Cooperating Agencies

1.5.1 Bonneville Power Administration (Lead Agency)

BPA is, a federal power marketing agency within the U.S. Department of Energy with responsibility for marketing and selling power generated by the FCRPS . It operates and maintains about three-fourths of the high-voltage transmission lines in Idaho, Oregon, Washington, western Montana and small parts of eastern Montana, California, Nevada, Utah and Wyoming. BPA's operations are governed by several statutes, including the Pacific Northwest Electric Power and Conservation Act (Northwest Power Act). Among other things, this act directs BPA to protect, mitigate, and enhance fish and wildlife affected by the development and operation of the FCRPS as well as other hydroelectric projects on the Columbia River and its tributaries such as the Willamette River Basin Project. To assist in accomplishing this, the act requires BPA to fund fish and wildlife protection, mitigation, and enhancement actions consistent with the Council's Fish and Wildlife Program. Under this program, the Council makes recommendations to BPA concerning which fish and wildlife projects to fund.

BPA's funding of the program would assist in meeting its mitigation duties and commitments in the FCRPS BiOp. These projects would restore estuarine habitat by removing or lowering dikes and levees that block access to salmonid habitat as well as protecting and restoring off-channel habitat. Thus, the proposed estuary restoration program actions would be consistent with the Council's Fish and Wildlife Program.

1.5.2 U.S. Army Corps of Engineers (Cooperating Agency)

The Corps is a federal agency under the U.S. Department of the Army responsible for protecting and maintaining the navigable capacity of the nation's waterways (also referred to as "*waters of the U.S."*). The Corps' missions span a wide range of civil and military works, including environmental restoration, hydropower generation, navigation, recreation, and emergency response.

The Corps has a wide range of legislative authorities to develop ecosystem restoration projects under various Water Resource Development Acts (WRDAs). The WRDA was initially enacted by Congress in 1974, Public Law 93-251, to address environmental, structural, navigational, flood protection, and hydrologic resources.

All Corps-developed restoration projects proposed for implementation under its WRDA authorities would fulfill the agency's ESA responsibilities under the FCRPS BiOp (RPA Action No. 37). These projects would be tiered to this EA. Site-specific analyses would be documented in subsequent NEPA documents which would discuss any new impacts or effects analysis not contained in this EA. Subsequent NEPA documents would also document compliance needs for site-specific projects..

The Corps has regulatory authority over Section 10 and Section 14 of the Rivers and Harbors Act of 1890 (superseded) and 1899, 33 U.S.C. § 401 *et seq.* The Rivers and Harbors Act established requirements to prevent the unauthorized obstruction or alteration of navigable waters of the United States (U.S.). Section 10 of the Act addresses the construction, excavation, and deposition of materials in, over, or under waters of the U.S. and any work which affects the course, location, condition, or capacity of those waters. Section 14 of the Act gave the Corps the authority to grant permission for alterations of federally authorized Corps projects (navigational aids, pile dikes, levees, dikes, dams, etc.) as long as it would not impair the usefulness of the project or be injurious to the public. The Corps has the authority to approve alterations to federally authorized Corps projects even when they are owned, operated and maintained by a non-federal sponsor, such as a local diking district, as long as they were built wholly or in part by the Corps for the preservation and improvement of any of its navigable waters or to prevent floods.

For BPA-sponsored projects that propose to alter a federally authorized project, the Corps would require an evaluation under Section 14 of the Rivers and Harbors Act of 1899, codified in 33 U.S.C. § 408 (commonly referred to as "*Section 408*").

The analysis required for the Corps' Section 408 review would follow Engineering Circular (EC) 1165-2-216 and would be documented in subsequent NEPA documents tiered to this EA. The tiered document would accompany the Corps' Section 408 decision whether to approve or deny the alteration of a federally-authorized project. While the Corps does not grant itself Section 408 approval, an analysis commensurate with that required under EC-1165-2-216 would be undertaken for all Corps projects which involve modification to federally-authorized facilities and the analysis would also be documented in subsequent NEPA documents tiered to this EA.

The Corps also has jurisdiction under Section 404 of the Clean Water Act for regulating discharges of dredged or fill material into waters of the United States. Ecosystem restoration projects typically involve restoring wetlands and rivers which require Section 404 permits and/or Section 10 of the Rivers and Harbors Act permits. For restoration projects that require both a Section 408 review and Corps Regulatory permits, coordination with the Regulatory Branch would occur throughout the Section 408 review. The Corps' decision on a permit application pursuant to Section 404 of the Clean Water Act or Section 10 of the River and Harbors Act cannot be rendered prior to the decision on the Section 408 request. Decisions on permit applications under Section 404 or Section 10 for BPA proposed restoration projects may tier to this NEPA analysis.

1.6 Public Involvement

1.6.1 Scoping

To help determine the issues that should be addressed in this EA, BPA conducted public scoping outreach to solicit comments. On October 5, 2015, BPA sent a letter to parties potentially interested in, or affected by the project, including, public interest groups, non-profits and non-governmental organizations, local governments, state and federal agencies, and tribes. The letter explained the proposal, the environmental review process, and how to participate. BPA posted the public letter on the project website at *www.bpa.gov/goto/EstuaryRestorationProgram* and ran ads in local newspapers.

BPA identified eight federally-recognized tribes that have a potential interest in the project based on their historical or current use of land in the project area: the Cowlitz Indian Tribe, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe of Idaho, the Confederated Tribes of the Grand Ronde Community of Oregon, and the Shoalwater Bay Tribe. In addition to the federally-recognized tribes, the Clatsop-Nehalem Confederated Tribes and the Chinook

Indian Nation may also have an interest in the proposed project. BPA included the tribes in the public scoping and will also provide the tribes with the draft EA and offer them an opportunity to comment.

1.6.2 Responses to Scoping

Nine parties responded during the scoping period, providing multiple comments. Some proposed specific projects, some made suggestions beyond the scope of this analysis, and one was simply supportive. Others addressed issues relating directly to this analysis.

Two respondents raised points that concerned the overall scope of the project. One noted that Skamania County (which includes Bonneville Dam) was not included in the list of affected counties in the scoping information. This was a clerical error in the scoping letter; Skamania County is included in this analysis and was included in the project scoping.

Another respondent encouraged the inclusion of purchasing intact natural areas and conservation easements along with the restoration of degraded and converted wetlands (though as a lower priority).

Five respondents focused on considerations for site-specific projects. Their comments addressed:

- Concerns for adverse off-site effects, primarily the possible flooding of adjacent properties
- Providing public access to waters and wetlands in all projects, and linking these via roads or trails as much as possible
- The efficient 'bundling' of multiple projects whenever possible
- Avoiding adverse impacts to currently existing high quality wetlands and uplands; and
- The value and importance of restoring off-channel refugia

Two respondents suggested specific projects for consideration. One encouraged projects that restore habitats on islands in the mainstem of the Columbia River; the other proposed a project that would increase flows through Lake River in Clark County to address siltation, water quality and temperature concerns.

Chapter 2 Proposed Action and Alternatives

This chapter describes the Proposed Action (using this EA to help efficient environmental analysis of site-specific estuary projects) and the No Action Alternative (continuing to review projects without use of a program-level analysis). This chapter also describes the estuary management actions inherent to both alternatives, and identifies mitigation measures appropriate for site-specific projects.

2.1 Proposed Action

Under the Proposed Action, the agencies would use this EA to help evaluate the potential environmental impacts and support NEPA responsibilities for their decisions on proposed estuary restoration projects.

This EA evaluates the typical environmental effects and identifies mitigation measures for estuary improvement actions or projects that will continue to be proposed as part of the Columbia River Estuary Ecosystem Restoration Program. Under the Proposed Action, the agencies would tier environmental analyses for site-specific projects to this environmental assessment.

2.1.1 Tiering under NEPA

The Council on Environmental Quality's implementing regulations for NEPA encourage tiering "to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review." (40 Code of Federal Regulations §1502.20; 1502.28). The regulations also describe the interplay between a programmatic document, such as this EA and subsequent site-specific NEPA documents:

Whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment is then prepared on an action included within the entire program or policy (such as a site specific action), the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action. (40 CFR §1502.20).

The Council on Environmental Quality also recently provided guidance to federal agencies on the effective use of programmatic NEPA evaluations and tiering future NEPA analyses to the programmatic evaluation (2014)[9]. The guidance states, "programmatic NEPA reviews add value and efficiency to the decision-making process when they inform the scope of decisions and subsequent tiered NEPA reviews. Programmatic NEPA reviews can facilitate decisions on agency actions that precede site- or project-specific decisions and actions, such as mitigation alternatives, commitments for subsequent actions or narrowing future alternatives. They also

[9] Per the Council on Environmental Quality guidance, "tiering" refers to an approach where the general impacts of a suite of actions, management plan or program are broadly considered and then subsequent narrower reviews are conducted on project-specific actions within the program area (CEQ 2014). Tiering has the advantage of expediting the NEPA process by eliminating redundant analyses when environmental effects can be captured programmatically, and subsequent NEPA analyses address only project- or site-specific issues not captured or evaluated in the programmatic document.

provide information and analysis that can be incorporated by reference in future NEPA reviews" (CEQ 2014, page 13). The public can participate in the programmatic review process and provide meaningful insight and new ideas in evaluating the program before agency decisions are made that would shape the review process and how those determinations affect future proposals.

Thus, subsequent NEPA documents tiered to this EA could rely on the analysis included in Chapter 3, provide a brief synopsis of this information if necessary and then focus on the site specific impacts from the individual restoration actions. The programmatic and tiered two-step NEPA approach would provide general and site-specific environmental analysis, while simultaneously modernizing and expediting on-the-ground implementation and benefits to fish and wildlife. The next section outlines how the analysis of potential future actions or projects would tier to the analysis in the EA.

2.1.2 Tiering Future Projects to this NEPA Document

This initial, broad evaluation of the range of common impacts expected from estuary restoration projects will be followed up with focused project-specific evaluations, as appropriate under NEPA. This approach to evaluating projects incorporates guidance on preparing efficient and timely NEPA reviews, including tiering of environmental documents and incorporation by reference.[10]

The agencies' subsequent NEPA analyses for site-specific actions would be prepared as they are identified through the planning process, and would tier to this EA by:

- Consulting the EA to ensure the types of effects on the human environment are consistent with those previously analyzed
- Undertaking additional environmental analysis and public outreach if anticipated effects, project actions, knowledge, or circumstances differ substantially from those evaluated in the EA
- Completing the site- or project-specific tiered NEPA document to identify and evaluate the effects of individual estuary restoration program projects, including effects to hydrology (water depth) and hydraulics (water volume and velocity), levee safety, adjacent properties, and socioeconomics
- Complementing the EA analyses by conducting any additional needed consultations or coordination required by law (such as the ESA, Clean Water Act, or National Historic Preservation Act)
- Including the best management practices, standard conditions, or other appropriate mitigation measures

The extent of site-specific project NEPA analyses would be commensurate with the size, scope and potential environmental impacts of the specific estuary restoration proposal. Site-specific

[10] See March 6, 2012, Memorandum from Nancy H. Sutley, Chair, Council on Environmental Quality, on this topic.

NEPA analyses could be documented in a categorical exclusion, a supplement analysis[11], an EA, or an environmental impact statement, as appropriate for the specific proposal. All these douments could reference or tier to the analysis in this EA.

As part of the NEPA review, all proposals would also be reviewed to ensure compliance with all applicable laws and regulations—including, but not limited to the ESA, National Historic Preservation Act, Clean Water Act, and the Migratory Bird Treaty Act.

In addition, public notification or involvement would be conducted, as appropriate, for projects with potential affects to landowners, local governments, tribes, or interest groups to inform these potential stakeholders of proposed actions, to help determine the suitable level of NEPA analysis to be conducted, and/or to identify issues to be addressed.

2.2 No Action Alternative (status quo)

Under the No Action (status quo) Alternative, the agencies would not make changes from the current approach of complete and duplicative NEPA evaluations of each estuary restoration project, having no programmatic evaluation to which to tier. The agencies would not utilize analysis in this EA (tiering) to help expedite site-specific project environmental review.

Currently, the agencies evaluate habitat improvement projects as they are advanced by different sponsors or proponents at different times. These projects are rarely packaged or timed in a manner that facilitates coordinated efforts to satisfy environmental review under NEPA. Different projects may arise in close proximity to one another with similar actions producing similar effects. The agencies, therefore, often conduct complete environmental evaluations and produce duplicative NEPA documentation for similar projects in close proximity with nearly identical environmental effects. The No Action Alternative continues this practice.

2.3 Estuary Management Actions and Activities common in Both Alternatives

To implement the estuary restoration program, the agencies consider specific management actions identified in NOAA Fisheries' 2011 CRE Module. These management actions provide specific "Project" categories which contribute to the overall restoration objective. Not all of the specific Projects are applicable to federal agencies implementing estuary restoration, as some are aimed at private landowners, or local and state regulatory entities. Those Projects which apply to federal agencies and their partners/sponsors implementing restoration actions in the estuary are listed in Table 1 and discussed in greater detail below.

---

[11] BPA may prepare a Supplement Analysis to an existing NEPA document under Department of Energy NEPA implementing regulations (10 CFR 1021.314).

Table 1. CRE Actions and Project Categories for Estuary Restoration Projects

Management Actions	Project Categories	
CRE 1	1.3	Purchase and protect intact riparian areas or areas which are degraded but have restoration potential
	1.4	Restore and maintain ecological benefits in riparian areas, and manage vegetation on dikes and levees
CRE 3	3.2	Protect or enhance instream flows to support fish and wildlife
CRE 6	6.2	Beneficial use of dredged materials, including notching or scraping-down of existing materials; also includes placement of new materials for habitat enhancement or creation
	6.3	Beneficial use of dredged materials, including disposal of materials
CRE 9	9.3	Purchase off-channel habitats that are degraded but have restoration potential and could benefit from long-term restoration solutions
	9.4	Restore degraded off-channel habitats with high intrinsic potential for increasing habitat quality
CRE 10	10.1	Improve access to off-channel habitats by breaching, lowering the elevation, or relocating dikes and levees to restore tidal marsh and shallow-water habitats and tidal channels
	10.2	Removing tide gates to improve hydrologic connection between wetlands and mainstem channel to provide juveniles salmonids with access to off-channel habitats
	10.3	Upgrade or retrofit tide gates or perched culverts to provide juvenile salmonids with access and improve ecosystem function
CRE 15	15.3	Implement projects to reduce the introduction and spread of invasive plants.

Inherent in almost all estuary restoration projects is the acquisition of lands, including riparian areas (CRE 1.3) and off-channel habitats (CRE 9.3), which have the potential to provide high quality habitat for juvenile salmon and steelhead in the estuary. The agencies have the authority to provide funding for local sponsors to purchase land from willing sellers for the purpose of habitat restoration. Land and easement purchase (land acquisition) is an active and ongoing BPA program with public outreach occurring at the time of acquisition. BPA funded land acquisitions are typically covered under a categorical exclusion under NEPA. Following land acquisition, the agencies could implement or fund a range of management and estuary restoration actions on the land acquired, depending on site-specific needs and objectives.

To protect intact and restore degraded riparian areas, the agencies could manage vegetation through mechanical or chemical means (CRE 1.4). This action would enhance ecological function, increase shoreline or instream habitat complexity, and improve juvenile salmonid refugia. The agencies could also implement CRE 15.3, by using mechanical or chemical means to prevent the spread and establishment of invasive plant species on public and private lands.

The beneficial use of dredged materials aims to reduce the loss of sand and gravels from this sediment-deprived estuary. Dredging to maintain navigation channels will continue in the estuary, thus productive placement of dredged material will be a continuing consideration. Habitat-forming processes could be achieved by either (1) strategic placement of materials to enhance or create wetlands or tidal marsh (CRE 6.2), or (2) relocation of previously placed materials to increase inundation or access to off-channel habitat. The strategic disposal of dredged materials (CRE 6.3) could benefit sediment transport processes and support habitat development in the estuary, plume, and nearby coastal areas of the Pacific Ocean.

A common objective for all estuary restoration projects would be the protection of high-quality off-channel habitat[12] and the restoration of degraded areas that have a potential to become high-quality habitat. Restoring off-channel habitats (CRE 9.4) increases habitat quality and enhances juvenile salmonid growth by increasing their access to food sources and provides refugia from high flows and predation. Restoration of off-channel habitat could be achieved through the excavation or re-establishment of historical tidal channels by removing, filling, or plugging ditches or other artificial drainages, and the excavation of new tidal channels to initiate channel formation and restore hydraulic processes. Addition methods include re-contouring of floodplains (including soil scraping and mounding), installation fencing to protect in-stream and riparian habitat from livestock or wildlife damage, or other means which increase and maintain the complexity and functional use of off-channel habitats.

Restoring the natural flow regime and tidal connectivity to areas that have been isolated from the mainstem or tributary rivers and streams provides fish and wildlife access to off-channel areas. Breaching, lowering the elevation of, or relocating dikes and levees (CRE 10.1) supports fish access into off-channel habitats and the establishment of tidal marsh, shallow-water habitat, and tidal channels in historical floodplains of the estuary. Tide gates, weirs, diversions, pumps, impassable culverts, or other water control structures (plugs, ditches, etc.) (CRE 10.2) could be removed to improve hydrology at project sites where dikes or levees cannot be fully breached. In instances where water-control structures cannot be fully removed, they could be retrofitted, relocated, or upgraded (CRE 10.3) to improve access to off-channel habitats and improve existing ecosystem function.

Estuary improvement or restoration projects implemented by the agencies to date routinely include many of the same activities. These all fall within the "Project" categories listed in the table above and are described below with reference to their applicable CRE Module Project categories.

- Research, monitoring, and evaluation of estuary habitats, restoration sites, and species. (all Project categories)
- Conduct hazardous material, archaeological and biological investigations to support environmental reviews and monitoring efforts. Conduct applicable engineering studies including sub-surface geotechnical investigations to support the design of project plans and specifications. (all Project categories)

[12] Off channel habitats are those bodies of water adjacent to the main river channel that have surface water connections to it. Examples include, side channels and alcoves.

- Retrofit, relocate, maintain, or upgrade existing water-control structures to improve access to off-channel habitats and improve existing ecosystem function. (9.4, 10.2, 10.3)
- Placement and maintenance of habitat features to provide structural complexity via the addition of large wood, rock, or other natural materials. (3.2, 6.2, 6.3, 9.4)
- Installation and maintenance of fencing to protect wetlands and riparian habitat from livestock or inadvertent wildlife damage. (1.4, 9.4, 15.3)
- Removal of invasive emergent and upland plants and weeds by chemical or mechanical means (chemical treatment for control of floating-leaved or submerged invasive plants is not included). (1.4, 9.4, 15.3)
- Plant and protect native vegetation. (1.4, 15.3)
- Implement practices to beneficially use dredged material by removing/relocating previously placed materials to increase inundation or access to off-channel habitat or by strategically placing dredged materials to enhance or create wetlands or tidal marsh. (3.2, 6.2, 6.3, 9.4, 15.3)
- Channel excavation and grading with localized effects on hydrology. Channel work would usually include excavation in floodplains to restore historical tidal channels previously modified through grading, drainage tiles, and linear drainage ditch networks. (3.2, 6.2, 6.3, 9.4)
- Ditch filling and drainage tile removal/disabling. Drainage ditch systems, usually installed for the purposes of dewatering wetlands, would be filled or otherwise rendered non-functional. Drainage tile systems would be removed or mechanically disrupted to negate their function. (3.2, 6.2, 6.3, 9.4)
- Long-term maintenance of completed estuary restoration projects. (1.4, 3.2, 10.3, 15.3)
- Tide gate and culvert removal/replacement. (9.4, 10.2, 10.3)
- Levee and dike removal and breaching. This work entails the removal of water-excluding structures that results in the flooding of previously dewatered lands. It also includes the removal of flow-controlling structures not associated with dewatered sites. These actions restore hydrologic processes during high flow (riverine or tidal) and may include entire removal, or strategically located breaches, with the intent that natural erosional processes would complete the action. (9.4, 10.1, 10.2, 10.3)
- Restoration related ground disturbance and earthwork associated primarily with levee removal, ditch filling, and tidal channel creation. (1.4, 6.2, 6.3, 9.4, 10.1, 10.2)
- Infrastructure protection or improvement associated with restoration projects to ensure the continued safe and reliable condition of existing infrastructure and utilities such as gas and electrical lines, roads, buildings, and in-water structures such as docks. (6.2, 9.4, 10.1, 10.2, 10.3)
- Construction related fish salvage and in water work (6.2, 6.3, 9.4, 10.1, 10.2, 10.3).

At a given site, the agencies or their partners may implement activities that are not specifically identified in the CRE Module as restoration actions but are still necessary parts of the overall project. For example, utilities, roadways, or recreational facilities (trails) may need to be maintained at project sites, and in some cases these structures may need to be elevated or relocated to maintain or improve overall habitat quality at a project site or to protect existing infrastructure. In other cases, a fish ladder may need to be removed or retrofitted to allow salmon and steelhead to access tributary habitats for spawning and rearing.

To date the agencies have completed restoration projects that protected or restored over 7,000 acres of habitat within the estuary implementing the types of actions described above and are currently evaluating several additional projects for implementation.

A summary of select properties that have been acquired and projects that have been implemented or are proposed are included in Appendix B. Also included in the appendices are conceptual designs for select upcoming projects.

2.4 Mitigation Measures

When implementing the types of actions described above, project-specific, resource-protection measures, and best management practices (BMPs) would be applied to minimize impacts to environmental resources. Many of these resource protection measures would come from those specified in the applicable authorizations and permits resulting from ESA consultations, National Historic Preservation Act consultations, Clean Water Act permits, or additional NEPA analysis specific to that project.

For the purposes of this analysis, however, commonly applied measures (from agency experience with past and current restoration actions) were considered as applied to projects so that a reasonably realistic portrayal of effects in Chapter 3 and 4 might be displayed. The measures listed in the table below display the types of measures considered in this analysis. This list is not limited to these criteria or measures, nor is it implied that all criteria or measures are applicable to every project. As discussed above, every project will have its design and mitigation measures determined through project-specific inter-disciplinary analysis, public scoping, and regulatory agency consultation and permitting.

Table 2 Common Design Criteria and Mitigation Measures considered for effects evaluation

Criteria Considered in Effects Determination (not intended for all projects)	
Protect ecological processes and features	Design projects to restore ecosystem processes with hydrology and hydraulics beneficial for estuary marsh development and vegetation succession.
	Replace natural materials and features if altered during project.
	Monitor project results to ensure restoration objectives are met.

Criteria Considered in Effects Determination (not intended for all projects)	
Protect water and sediment from Hazardous Material Pollution	Sample water and sediment quality during project planning to identify concerns.
	Use only non-contaminated sediments for restoration activities.
	Limit the use of products containing hazardous materials in restoration projects.
	Locate staging areas, storage sites (fuel, chemical, equipment, and materials), and potentially polluting activities, well away from water resources.
	Develop Spill Prevention Control and Countermeasures Plans (SPPCC).
	Use only hydraulic fluids approved for work in aquatic environments when working below mean high water.
	Wash heavy equipment before delivery to project site to remove oils, fluids, grease, etc.
	Inspect and clean heavy equipment regularly.
	Implement pollution and erosion control measures.
	Perform all non-emergency maintenance of equipment off site.
	Dispose of all waste (solid waste, hazardous materials, etc.) off site as regulated by the state.
	Remove all equipment, materials, supplies, and waste from project site when complete.
Protect Water Quality	Design projects to minimize impacts to water quality.
	Schedule activities and manage flows and water levels to provide dry working conditions as much as possible.
	Apply Clean Water Act permit-specific protection measures.
	Apply erosion control and/or stormwater pollution protection plans.
	Apply 'Best Management Practice' erosion and sediment control measures during operations.
	Isolate in-water work areas from the active river channel.
	Sequence dike removal or levee breeching with the tide cycle to minimize erosion.
	Cover disturbed soils if they will be inactive for more than a few days.
	Operate machinery for in-water work from atop levees or within adjacent out of water areas as much as possible.

Criteria Considered in Effects Determination (not intended for all projects)	
Protect Soil from Loss, Compaction, Displacement	Develop and implement soil stabilization plans during and following project activities (e.g. seeding, planting, mulching, etc.).
	Apply Best Management Practices and other erosion control measures.
	Use low ground pressure heavy equipment or mats to prevent compaction.
	De-compact construction roads and staging areas following project completion.
	Minimize the size of disturbed areas.
Protect Native Vegetation	Protect and retain existing native vegetation as much as possible.
	Use native plants and materials in estuary restoration projects.
	Inspect and wash equipment as necessary to avoid transport of invasive species.
	Remove invasive species from the project site.
	Apply only approved herbicides and strictly follow label requirements.
	Remove/obliterate access roads and work staging areas upon project completion.
	Use floodplain seed mix and native plants in post-project rehabilitation plans.
Protect Sensitive sites and species (Cultural, ESA, plants, habitats)	Conduct pre-projects assessments to identify sites, species, and habitats needing protection.
	Consult with regulatory agencies as required by law (ESA, National Historic Preservation Act, etc.) to identify necessary avoidance areas and protection and mitigation measures.
	Avoid sensitive habitats and species and cultural resource areas in project design and during construction.
	Apply project design features, site-specific protection measures, conservation measures, BMPs etc. from consultation and permitting efforts.
	Isolate in-water work areas and conduct fish salvage and relocation when isolating in-water work areas.
	Maintain fish passage around isolated in-water work areas.
	Apply established protocols (legal or scientific) for handling listed species.

Criteria Considered in Effects Determination (not intended for all projects)	
Protect Sensitive sites and species (Cultural, ESA, plants, habitats)	Apply archeological data recovery methods (excavation, documentation, public interpretation) as identified during the consultation process with appropriate parties when avoidance of cultural sites is not possible.
Protect Public Interests, Health, and Safety	Provide opportunity for public review for projects with changes of a scope or scale likely to be of interest or concern.
	Post notifications of pending and ongoing restoration actions and effects related to public safety, convenience, and interest.
	Use local labor and materials whenever possible.
	Stage equipment, and locate construction travel routes as far from public travel lanes as possible.
	Use flaggers and safety signage as necessary to avoid vehicle and other conflicts.
	Apply dust control measures.
	Limit restoration project work hours to normal daytime working hours as much as possible.
	Minimize noise-generating activities at night.
	Use the least noise-generating equipment and methods as much as possible.
	Design restored sites to minimize mosquito breeding areas as much as possible.
	Repair damage to roads and trails after restoration project is complete.

It is likely that restoration projects tiered to this EA would utilize programmatic consultations and permits which allow for more efficient environmental reviews such as BPA's Habitat Improvement Program (HIP) and the Corps' Standard Local Operating Procedures for Endangered Species (SLOPES) Programmatic Biological Opinions for ESA coverage. If programmatic coverage is not utilized, then BMPs from the individual project's consultations, when required, would be implemented as part of the project. Conservation measures and BMPs outlined in the permits and consultations would supplement or replace the BMPs described in Table 2. In addition, when Nationwide Permits (NWPs) or water quality 401 certifications under the Clean Water Act are required, applicable conservation measures and BMPs would also be supplement the BMPs identified above. Additional BMPs or design features resulting from the National Historic Preservation Act consultation for each project and the site-specific NEPA analysis would also be implemented.

2.5 Summary of Environmental Effects

The table below displays a brief summary of the effects of implementing restoration projects in the Columbia estuary as analyzed in this environmental assessment.

Table 3 Summary of Effects of Estuary Restoration Actions

Resource Affected	Summary of Environmental Effects of Estuary Restoration Projects
Fish	Short-term effects from construction related turbidity and temperature increases; accidental spills of fuel, hydraulic fluids, and vehicle wash water; behavioral disruption (e.g. avoidance) from construction activities; and herbicide use. Impacts minimized by application of BMPs and other mitigation measures. Long-term beneficial effects from restored estuarine habitats with increased food web support, enhanced water quality, and restored/improved hydrology.
Hydrology and Hydraulics	Restored natural hydrologic regimes with localized changes in velocity, flow, circulatory patterns, inundation frequency, and depth; and floodplain function which affect rates and patterns of erosion, scour, sediment transport/accretion/deposition, nutrient cycling, and flood-water storage. Long- term beneficial impacts from restored natural hydrologic regimes (e.g. increased inundation) and floodplain function (e.g. water storage and sediment deposition).
Water Quality	Short-term effects from construction-related turbidity and water temperature increases (from vegetation shade loss); and accidental spills of fuel, hydraulic fluids, and vehicle wash water. Long-term beneficial effects from restored estuarine, wetland, and riparian habitats which adsorb pollutants and lower water temperatures; and improved hydrologic connectivity and tidal interchange which increases nutrient flushing thereby reducing nutrient concentrations.
Geomorphology, Soils, and Topography	Short-term temporary increase in construction-related soil erosion, compaction, displacement, and mixing of soil horizons. Long-term restoration of more natural bed-load movement; and sediment transport, accretion and erosion.
Sediment Quality	Short-term contamination potential from equipment fluids and spills; and re-suspension of sediments (some of which may be contaminated) into water column with redistribution within estuary, and possible movement into food chain. Long-term development of wetlands could increase sediment trapping of toxic contaminants.
Air Quality and Climate Change	Short term temporary impacts from construction equipment exhaust on air quality and contributions to greenhouse gasses in the atmosphere. Long-term increase of carbon sequestration from expanded wetland systems. Restoration of tidal and wetland function would increase the estuary's resilience to sea level rise.
Wildlife	Short-term disturbance to wildlife from construction activities. Long-term effects to wildlife species' occupancy of restored areas by habitat conversion from farm/grazing lands to marsh, riparian, or diurnally flooded habitats. Most upland species would be displaced while habitat would be provided for estuarine and wetland- associated species.

Resource Affected	Summary of Environmental Effects of Estuary Restoration Projects
Wetlands, Floodplains, and Vegetation	Short-term loss of vegetation from construction activities. Projects would convert vegetative communities from farm and grazing lands to marsh, riparian, or diurnally flooded wetland communities. Long-term beneficial effects of restored wetlands, increased floodplain connection and function, and expanded native plant communities.
Land Use and Recreation	Estuary restoration projects would change land uses from agriculture to natural wetland or tidal habitats; Recreation opportunities would change from upland-oriented to more wetland or aquatic-oriented recreation types. Some changes in recreation access in some locations may result.
Cultural Resources	Effects to cultural resources would be avoided, minimized, or mitigated after evaluation and consultation with tribes, states, and other consulting parties.
Socioeconomics	Short-term small economic benefits from construction employment and purchases. Long-term effects include economic benefits from improved fish runs and natural scenery enhancements; and potential tax revenue reductions due to landownership changes to non-taxed entities (states, non-profits, tribes), land use changes from revenue generating use (agriculture), and removal of levees and dikes (loss of fee assessments for diking districts).
Visual Resources	Visual resource effects from changes from an engineered human landscape to a more natural landscape.
Noise Hazardous Waste, and Public Health and Safety	Short-term construction-related noise; Risk of hazardous waste from fuel spills, etc., but would be minimized through the application of BMPS and mitigation measures; and potential short-term increased safety risk from construction traffic and activities. Long-term potential public safety risk from increased area of water surface, flowing water, and diurnal or seasonal flooding at specific restoration sites (however, restoration design would ensure no increased flood risk to adjacent properties).
Transportation and Infrastructure	Some removal of local roads atop dikes that have low traffic use, with no-to-low impact to communities. No impact to navigability of Columbia River.

2.6 Comparison of Proposed Action and the No Action Alternative

For most of the resources discussed above, the difference between the Proposed Action and No Action alternatives is the timing of implementation.

The Proposed Action allows projects to be implemented more quickly and within the same time frame, a collectively shorter timeframe, or more strategically sequenced. Under these scenarios, short term adverse impacts from multiple construction activities would be more concentrated in time and space while achieving the long term beneficial effects sooner.

Under the No Action Alternative, projects would likely be spaced over time with no concentration of short term impacts; the realization of long term beneficial effects would be delayed, or achieved more slowly; and may allow more time for effective monitoring and adaptive management from lessons learned to be incorporated into restoration project designs.

Under both alternatives, the short term impacts of construction activities would be reduced by the application of mitigation measures listed in Table 2.

Chapter 3 Affected Environment and Environmental Consequences

This chapter describes the affected environment and the environmental consequences of the Proposed Action and the No Action for the estuary restoration program. The first part of this chapter, describes the environmental effects of the estuary management actions and activities inherent in both alternatives. The next section of this chapter describes the effects of implementing the estuary restoration program actions. The impacts of the estuary restoration program as a whole are identified and analyzed by resource area and the impacts specific to the implementation of the Proposed Action verses the No Action Alternative are summarized at the end of the chapter at Section 3.17. The effects are presented by environmental resource as follows:

- Fish
- Hydrology and Hydraulics
- Water Quality
- Geomorphology, Soils, and Topography
- Sediment Quality
- Air Quality
- Wildlife
- Wetlands, Floodplains, and Vegetation
- Land Use and Recreation
- Cultural Resources
- Socioeconomic
- Visual Resources
- Noise, hazardous waste, and public health and safety
- Transportation and Infrastructure
- Climate Change

The impact levels are characterized as high, moderate, low, or no impact. High impacts are considered to be significant impacts, whereas moderate and low impacts are not. Mitigation measures and BMPs that would help reduce or avoid impacts are identified in Table 2 in Chapter 2.

3.1 Common Effects of Restoration Planning and Construction Activities

The agencies assume individual projects would share some of the effects described herein in proportion to the project's complexity, size, and proximity to habitat features. Projects tiered to this EA would likely not have effects greater than the full range of effects described below. If a proposed project is expected to have effects greater than the range of effects described, an analysis of those effects would be included in a subsequent NEPA document tiered to this EA.

Common project elements include:

- Pre-restoration activity (research, monitoring and evaluation, surveying, including geo-technical investigations, wetland delineations, vegetation removal, invasive vegetation control, staking and flagging of site features using personnel and machinery) and site preparations (construction of access roads, staging and stockpile areas)
- Construction activity (vegetation removal, earthwork, excavation, filling/shaping site, topsoil removal, exposing deeper soil layers (may extend into active channel)
- Site restoration and demobilization (seeding, planting, soil stabilization, and invasive species control)
- Long-term effects (reconnection of floodplain to river, restoration of hydrologic connection, increased biodiversity, management of site, research, monitoring, evaluation etc.)

Preconstruction activities for restoration projects typically include surveying, mapping, placement of stakes and flagging, vegetation clearing, invasive vegetation control, and the establishment of access roads and material staging areas. These activities help establish the geographic boundaries that limit the extent of construction related disturbance and often entail the movement of machines and personnel over the project area.

3.1.1 Resource Inventory and Surveying

Culturally sensitive areas and sensitive fish, wildlife, and plant assessments would be carried out prior to restoration actions to determine the presence of critical resources and identify measures to minimize adverse impacts where sensitive resources are present. Typically, wetland, streams and other sensitive habitats are identified and assessments are conducted to identify ESA listed plants and animals to facilitate the avoidance of sensitive areas and species. Similarly, the agencies conduct cultural resources surveys and consultations to evaluate the presence of any sites on or eligible for inclusion on the National Register of Historic Places and document any findings and mitigation measures. Cultural resource and sensitive area surveys generally involve pedestrian (walking) surveys with limited subsurface testing, resulting in no to low impacts to vegetation and soils. These effects would be temporary and short-term.

When appropriate, fish surveys would identify which fish species are present in waterways on a site, and depending on restoration plans, determine if fish salvage and relocation may be necessary before in-water work is conducted. The agencies would follow guidelines established by NOAA Fisheries, Oregon Department of Fish and Wildlife (ODFW), and WDFW (as pertinent) in implementing fish surveys such as non-lethal methods (snorkel, minnow trapping, etc.) to identify species onsite prior to in-water work. Avoidance areas for ESA-listed plant and animal species, cultural resources and sensitive habitats would be developed and carried through planning and implementation. If impacts cannot be avoided, consultations would be completed or permits obtained prior to initiating construction.

In addition, engineering surveys are necessary for projects involving earthwork, including excavation, filling or placement of dredged materials, levee removal and construction, and channel reconstruction. Survey actions could result in impacts to fish and wildlife and vegetation where test pits are needed to evaluate sediment samples. Fish and wildlife flushed from cover during surveys could become more susceptible to predation or increased stress depending on the timing of the survey. Disturbance from pre-construction activities would have short-term effects to individual plants or animals, as survey activities usually last only a few hours, or at most, a few days. Disturbance effects at the community or population scale would be low and would not result in impacts to ecosystem structure or function.

3.1.2 Site Preparation and Construction

Staging, site preparations, and the construction of access roads typically involve disturbing and removing vegetation and topsoils which support floodplain and riparian function. The effects of constructing access roads and staging/stockpile areas would be short-term and temporary, and these areas would likely only remain in place for the duration of construction. After construction, these roads and areas would be removed and obliterated where possible. Erosion and sediment control measures would be applied to any project involving soil disturbance for the duration of construction to protect water quality and soils. Typical erosion control measures include the use of straw wattles, cofferdams, silt fences, and other established means to prevent erosion. Best management practices would be used for the duration of construction to secure a site against erosion during high flow events, the use and disposal of hazardous products would be limited and all waste materials would be transported off-site to an approved disposal location.

Site preparation may also include the removal of non-native and invasive vegetation to prepare the site for restoration. Once vegetation is removed, some effects occur, depending on the area and extent of vegetation removal. If a large area of vegetation is removed (to construct a setback levee or to reconstruct stream channels, for example), the water table in the immediate area may be temporarily lowered. However, because the goal of estuary restoration projects is to restore ecosystem structure and function in the estuary, projects would be designed to minimize impacts to water resources. Any effects would be temporary and short-term, lasting only the duration of construction or until a more-natural hydrologic regime is restored following construction supporting wetlands, the water table, groundwater resources, and stream and river systems. In dry weather, increased soil exposure could result in dusty conditions, temporarily reducing air and water quality; in wet weather, increased soil exposure from vegetation removal could result in increased erosion and stormwater runoff flowing into nearby streams and rivers. Effects of increased erosion and runoff could result in increased sediment supply in lowland drainage areas, increasing total suspended solids and sedimentation in downstream reaches.

Vegetation removal and increased runoff from construction sites could also increase the frequency and duration of high stream flows. The loss of vegetation could result in high stream energy, which could result in localized scour to streambeds and mobilize sediments into the water column. In addition, vegetation removal adjacent to or over waterways could adversely affect water quality through the loss of cover for fish and wildlife, increased water temperature, and modified water chemistry (i.e. dissolved oxygen and pH).

When a construction footprint extends into a riparian or in-stream area, the effects of those actions are likely to include short-term effects to instream or riparian resources from increased turbidity and localized sedimentation and erosion. The use of heavy equipment for vegetation removal and earthwork may compact soils, reducing permeability and infiltration. Where heavy equipment would be needed to conduct construction activities in wetlands or other aquatic areas, BMPs may be implemented if appropriate to prevent long-term effects to these sensitive resources. The use of mats or floating platforms may be used to prevent soil compaction, loss of vegetation, and increased erosion.

Accidental spills from machinery can introduce fuels, lubricants, hydraulic fluid, coolants, and other contaminants into the project area. Petroleum-based products, such as fuel, oils, and some hydraulic fluids contain polycyclic aromatic hydrocarbons (PAHs), which are acutely toxic to fish and other aquatic organisms at high levels and can result in sub-lethal effects at lower concentrations. To avoid these potential impacts, biodegradable products would be used when heavy equipment is utilized for in-water work. In addition, heavy equipment would be regularly inspected and cleaned before operation to ensure vehicles remain free of oil, grease, mud, or other visible contaminants. Areas where heavy equipment is cleaned would include erosion and pollution control measures to prevent contaminants from entering the project site and adjacent waterways.

Work involving heavy equipment or vehicles in active channels where ESA-listed fish and wildlife are present may result in injury or death to these species. To minimize this risk, heavy equipment would be operated from the bank where possible and restoration activities would be timed to avoid vulnerable life stages, including migration, spawning, and rearing. Where in-water work is unavoidable, work areas would be isolated to reduce effects to fish and wildlife, particularly juvenile salmon and steelhead and other ESA listed species per the project specific ESA permit. Where a work area is isolated from the active channel, adult and juvenile fish salvage would be conducted and passage would be provided per the project specific ESA permit and NOAA Fisheries guidance (NOAA Fisheries 2011a). If an area requires de-watering, temporary water withdrawals would include fish screens installed, operated, and maintained according to criteria provided in NOAA Fisheries guidance(NOAA Fisheries 2011a). It is unlikely that adult fish would be present in a project area during in-water work because the work would be timed to occur when they are least likely to be present. If any adults are present, they would likely be able to avoid the construction area and minimize their exposure to temporary and localized effects associated with construction.

Restoration and construction related effects are discussed in greater detail below, specific to each resource area.

3.1.3 Post Construction Activities and Restoration Benefits

Following construction actions at a project site, all equipment would be removed from the site and the site restored through re-vegetation and soil stabilization. The site would be maintained in a natural condition and monitoring would occur to ensure successful re-vegetation and invasive species would be controlled.

Fish passage and floodplain reconnection actions have long-term beneficial effects at the watershed scale (Roni et al. 2002). All activities implemented as part of the estuary restoration program would be designed to restore ecosystem processes and functions, benefiting fish and wildlife and their habitats. Over the long-term, beneficial effects include improved floodplain connectivity, increased streambank function, improved water quality, and fish passage improvements. The estuary restoration actions are intended to contribute and lead toward ecological recovery of ESA-listed species present in the implementation area, including the establishment or restoration of natural ecosystem processes.

Each estuary restoration project would typically include replacement of natural materials or other geomorphic site features or characteristics that were altered or degraded in the past or during construction. The effects of site restoration and restoration of natural ecosystem processes would reverse the effects of active construction. Exposed soils and bare earth would be protected against erosion by seeding, planting or mulching, where appropriate. As vegetation becomes established and grows, soil surface temperatures would cool and retain moisture within the project area. Roots would stabilize streambanks and filter fine sediments and nutrients from runoff, functioning to reduce erosion and improve water quality. Vegetation establishment supports fish and wildlife by providing in-stream habitat, increasing shade, cover and refugia, and supporting the food web through the influx of leaf and organic material via inputs derived from outside the instream environment.[13] The recovery of ecosystem processes, including soil stability, sediment filtering, nutrient absorption, and vegetation succession would recover over time, though the rates of recovery would vary according to site conditions and the level of degradation or disturbance which occurred from past land use and active construction. These effects of restoration benefit the ecosystem and local project site by improving overall habitat quality and resilience to climatic disturbances.

3.2 Fish

3.2.1 Affected Environment

The Columbia River is the largest river in the Pacific Northwest, and by volume, the fourth largest river in the United States. The river originates in the Rocky Mountains of British Columbia in Canada and empties into the Pacific Ocean near Astoria, Oregon. The physical landscape of the Columbia River watershed has been shaped primarily by glacial events and volcanic activity of the Pleistocene era, including the Missoula Floods 10,000 to 15,000 years ago and uplift of the Cascade Mountain range. The Columbia River estuary was initially shaped by a variety of natural forces and climatic conditions then modified by anthropogenic activity starting in the early part of the 20th century (Williams 2006, Corps 2011a).

The human impact within the estuary includes the construction of dams, dikes and levees, installation of water control structures (tide gates, flood gates, irrigation pumps), dredging and deepening of the river, and disconnection of hydrologic and tidal influence through the alteration of wetlands and floodplains. Dikes, levees, and other structures were built throughout the estuary in the late 19th and early 20th centuries to protect agricultural practices, reduce flooding and erosion, and increase stream flow. In the 1930s, the Corps established flood risk mitigation structures and constructed higher levees to protect multiple land uses from seasonal floods (Mighetto and Ebel 1994). These actions have effectively disconnected the mainstem of the river from the floodplain and associated wetlands, and

---

[13] Allochthonous inputs are those derived from outside of the instream environment (typically a terrestrial environment) and provide energy sources, nutrients, and minerals important in primary production.

converted tidal marsh and swamps to agricultural areas. Consequently, the estuary has experienced a loss of approximately two-thirds of its original wetland habitat, with many areas cut off from natural processes, including tidal exchange and sediment accretion (Johnson 2003).

The FCRPS and other hydroelectric development in the Columbia River basin has fundamentally affected the estuary by changing the flow of water in the Columbia; altering the timing and magnitude of spring flows and water quality in the river. Because all salmon and steelhead in the Columbia River Basin must pass through the estuary during their lifecycles, protection of existing estuary habitat and restoration of degraded habitat to a properly functioning condition is important to the recovery and long-term survival of ESA-listed salmonids. Protection and restoration of the estuary can help offset the impacts these fish experience from migrating past the FCRPS dams.

The Columbia River estuary and its tributaries provide habitat for numerous species of fish. Fish species known to occur in the Columbia River estuary include river lamprey (*Lampetra ayresi*), white sturgeon (*Acipenser transmontanus*), Pacific eulachon (*Thaleichthys pacificus*), suckers (*Catostomus* spp.), sticklebacks (*Gasterosteus* spp.) shiners (*Cyprinidae*), sculpin (*Cottus* spp), Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiosus*), and starry flounder (*Platichthys stellatus*), peamouth (*Mylocheilus caurinus*), and chiselmouth (*Acrocheilus alutaceus*).

In addition, the estuary is important for anadromous fish migrating upstream to spawning areas and for juveniles migrating downstream to the ocean. In particular, the estuary is an important overwintering and foraging area for juvenile salmon. Juvenile salmonids may rear in shallow-water and nearshore areas of the estuary for several months before migrating into the ocean (Simenstad et al. 1982, Bottom et al. 2001, Williams 2006). These shallow water intertidal floodplains offer critical refugia from high flows, seasonal turbidity, and larger predatory species. Emergent vegetation within these inundated floodplains also provides important feeding and rearing grounds for juvenile fish. These shallow-water and nearshore habitats are crucial for juvenile salmon on their way to sea.

The natural process of estuary marsh, swamp, and wetland habitat (juvenile salmonid rearing, overwintering, and foraging habitat) formation and maintenance has been greatly altered by construction and operation of the FCRPS, as discussed in the hydrology and geomorphology sections. Sediment transport processes fundamental to habitat-forming processes in the estuary are now disconnected and no longer influence the creation, maintenance, or distribution of juvenile salmonid rearing, overwintering, and foraging habitat in the estuary.

The estuary has also been extensively altered through the construction of levees, dikes, and other structures for flood control and agricultural purposes. Some of these structures simply block fish access to these habitats, others have been used to entirely de-water them and change their function from tidal and floodplain wetlands to dike/levee-protected farmland or pasture. The impact of these land alterations, habitat exclusions, and tidal flow changes are particularly impactful to salmon and steelhead, which are heavily dependent on estuarine environments during rearing and outmigration. These changes have reduced and changed the sources of base-level food production, blocked habitat availability and connectivity of habitats within the estuary, and limited habitat diversity and complexity (NOAA Fisheries 2011b). Loss of off-channel floodplain habitats prevents access to rearing, feeding, and refuge habitats critical for salmon and steelhead survival.

Numerous special-status fish occur in the affected area. For the purposes of this EA, "special status" refers to species that are federally listed as threatened or endangered, or species of concern[14]. Critical habitat[15], defined as specific geographic locations critical to the existence of a threatened or endangered species and designated by NOAA and USFWS under the ESA, also occurs throughout the affected area. The table below identifies the current threatened, endangered, candidate, and species of concern fish species and whether critical habitat is designated.

Table 4. Special-status fish species and critical habitat potentially present in the estuary[16]

Species	Federal Status	Critical Habitat Status
Chinook salmon (*Oncorhynchus tshawytscha)*		
Snake River spring/summer	Threatened 70 Federal Register (FR) 37160	Designated 58 FR 68543
Snake River fall	Threatened 70 FR 37160	Designated 58 FR 68543
Upper Columbia River spring	Endangered 70 FR 37160	Designated 70 FR 52685
Estuary	Threatened 70 FR 37160	Designated 70 FR 52685
Upper Willamette River	Threatened 70 FR 37160	Designated 70 FR 52685
Steelhead (*O. mykiss*)		
Snake River	Threatened 70 FR 37160	Designated 70 FR 52685
Upper Columbia River	Threatened 74FR 42605	Designated 70 FR 52685
Middle Columbia River	Threatened 57 FR 14517	Designated 70 FR 52685
Estuary	Threatened 62 FR 43937	Designated 70 FR 52685
Upper Willamette River	Threatened 62 FR 43937	Designated 70 FR 52685
Chum Salmon (*O. keta*)		
Columbia River	Threatened 70 FR 37160	Designated 70 FR 52685
Sockeye Salmon (*O. nerka*)		
Snake River	Endangered 70 FR 37160	Designated 58 FR 68543
Coho Salmon (*O. kisutch*)		
Estuary	Threatened 70 FR 37160	Designated 81 FR 9251
Pacific eulachon (*Thaleichthys pacificus*)	Threatened 75 FR 13012	Designated 76 FR 65323
Southern DPS	Threatened 75 FR 13012	Designated 76 FR 65324

[14] A species of concern is an informal term, not defined in the federal Endangered Species Act. The term commonly refers to species that are declining or appear to be in need of concentrated conservation actions.

[15] A term defined in the Endangered Species Act that refers to a specific geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection.

[16] NMFS species available at http://www.nmfs.noaa.gov/pr/species/esa/listed.htm. USFWS species available on the Information, Planning, and Conservation System (IPaC), Version 1.4, available at http://ecos.fws.gov/ipac/.

Species	Federal Status	Critical Habitat Status
Green sturgeon (*Acipenser medirostris*)		
Southern DPS	Threatened 71 FR 17757	Designated 73 FR 52088
Bull Trout (*Salvelinus confluentis*)		
Columbia River DPS	Threatened 63 FR 31647	Designated 75 FR 63898
Coastal Cutthroat Trout (*O. clarki clarki*)	Species of Concern	None
Pacific lamprey (*Lampetra tridentata*)	Species of Concern	None

Juvenile anadromous salmon and steelhead rear in and migrate through the Columbia River estuary between Bonneville Dam and the Pacific Ocean. They range throughout the Columbia basin and inland as far as Idaho. Chum salmon are present in the estuary following emergence as early as mid-January through mid-July, with the peak abundance between mid-April and mid-May as they migrate seaward. Hatchery and wild coho salmon use the estuary as a migratory route to the Pacific Ocean and also for rearing in some cases. Rearing coho salmon may be in the estuary throughout the year, with peak abundance of smolts migrating between April and June. Similar to coho salmon, juvenile Chinook salmon may be found rearing in the estuary any time of the year. Stream-type Chinook salmon, which typically rear in higher elevation tributaries for one year prior to migrating to sea, are most abundant in the estuary between early April and early June. Large numbers of pre-smolt Chinook salmon rear in the estuary, and it is likely that many of these are fall Chinook salmon. The fall Chinook salmon migration through the estuary typically peaks between May and July. However, there is typically a pulse of subyearling Chinook salmon entering the estuary in March from hatchery releases upstream of Bonneville Dam. Sockeye salmon typically rear in freshwater lakes for one to three years prior to migrating to the ocean and primarily use the estuary as a migration corridor. The limited information available indicates that sockeye salmon are most abundant in the estuary in May. Cutthroat trout may use the estuary for seasonal rearing and as a migration corridor, with peak abundance of migratory juveniles between March and May. Steelhead typically rear in freshwater tributary habitats for one to several years prior to seaward migration, although juvenile steelhead may use the estuary for limited rearing. Juvenile steelhead abundance in the estuary peaks between late May and mid-June (Corps. 2009). While bull trout critical habitat is mapped in the main stem of the Columbia River, bull trout are a very rare occurrence in the estuary.

Pacific eulachon spend little time in the estuary, rapidly traversing it to spawning streams in late winter through mid-spring. The larvae spend no time rearing in streams or estuaries, but rather are carried downstream into the ocean in late spring and early summer to spend the majority of their lives in the ocean. The estuary is, however, designated as critical habitat for the Southern DPS of the Pacific eulachon as it serves as the primary migration corridor between the ocean and spawning habitats in tributaries to the Columbia River.

Juvenile pacific lamprey are found in the estuary year round while adults appear to traverse the estuary in their upstream migration from late winter through spring (Weitkamp).

Green sturgeon occupy the estuary in large numbers in the summer and fall and migrate into rivers to spawn in late spring. Juveniles spend up to four years rearing in the estuary before moving into the ocean where they spend most of their lives. Green sturgeon have been impacted by dams, altered flows, and water diversions that impede or inhibit upstream spawning migration of adults and downstream migration of juveniles. The estuary has been designated as critical habitat from the mouth up to river mile 75.

3.2.2 Types of Impacts from Restoration Activities

In the sections below, note that the term "fish" refers to all fish in the estuary, including those listed in Table 4. Likewise, the term "habitat" includes general fish habitat, including federally designated or proposed critical habitat.

Fish and fish habitat can be directly impacted by many of the actions implemented under the estuary restoration program. The degree of potential direct and indirect effects from these actions is dependent on the duration of the action, and the types of protective measures used to minimize adverse effects. All of the actions included in the estuary restoration program [CRE actions 1 (protect and restore riparian areas), 3 (protecting and/or enhancing instream flows), 6 (beneficial use of dredged material), 9 (protect and restore off-channel habitats), 10 (breaching, lowering, relocation, or other modification of dikes and levees), and 15 (invasive species management)] would have impacts on local fish species and fish habitat at a project site.

These effects, discussed in greater detail below, would vary in context and intensity depending on species of fish, site-specific conditions and implementation of the action. These effects include:

- Construction-related turbidity associated with channel excavation, levee breaches, and in-water work
- Injury or mortality during fish salvage and work-area isolation
- Construction-related vegetation removal
- Changes in hydrologic regime and water quantity (e.g. restoration of tidal cycles)
- Changes in water quality
- Increased habitat area and access (including floodplain, side channel, and stream habitat) available for juvenile salmonid rearing and foraging

3.2.3 Effects of Restoration Activities

While the estuary restoration program would have limited, short-term effects on individual fish, overall the action would result in a net benefit to individual fish, fish populations, and fish habitat. Table 5 breaks down the Proposed Action into the CRE actions and summarizes the potential impacts of each action as they relate to fish and fish habitat. The following sections describe these impacts in more detail.

Table 5. Types of impacts to fish and fish habitat resulting from the Proposed Action

CRE	Proposed Action	Turbidity	Discharges	Injury/mortality	Reduced fitness	Veg removal/conversion	Restore/improve hydrology	Increased habitat area, access, diversity	Food web	Water quality	Water quantity	Shade
1	Protect and restore riparian areas	x				x	x	x	x	x	x	x
3	Protecting and/or enhancing instream flows						x	x		x	x	
6	Beneficial use of dredged material	x	x	X				x	x	x		
9	Channel excavation	x	x	x		x	x	x	x	x	x	x
	Streambed/streambank treatments (large wood, pools)	x	x	x		x	x	x	x	x	x	x
	Floodplain re-contouring	x	x			x	x	x	x	x	x	x
10	Remove water-control structures	x		x		x	x	x	x	x	x	
	Breach or relocate levee	x	x	x		x	x	x	x	x	x	
15	Invasive species management				x	x			x	x	x	x

Impacts to fish and fish habitat include short-term impacts related to construction, including turbidity resulting from excavation of channels, breaching of dikes, removal of water-control structures, floodplain re-contouring, or similar actions. Construction-related turbidity may cause a variety of responses from fish, ranging from temporary avoidance of the area to cessation of feeding, but it rarely results in death to fish. To minimize these impacts, all restoration projects would use a suite of BMPs and adhere to regulatory requirements and permit conditions from state and federal agencies such as Oregon Department of Environmental Quality (Oregon DEQ), Washington Department of Ecology (Washington DOE), Corps, NOAA Fisheries, USFWS, ODFW, and WDFW. Where applicable, the construction activities would follow an erosion control or storm water pollution protection plan developed, implemented, and inspected by a trained individual, including methods discussed in Section 3.1. BMPs may include, but would not be limited to, straw wattles, sediment fencing, check dams, coir matting, erosion-control blankets, hydroseeding, and performing work during an in-water work window timed to minimize impacts to fish.

When using heavy equipment, there is a risk that accidental spills of fuel, lubricants, hydraulic fluids, or other contaminants may occur. Additionally, construction water may be discharged during the course of vehicle washing, concrete washout, pumping for work area isolation, and other purposes. This discharge may carry sediments or contaminants to active water bodies, floodplains, wetlands, or riparian areas, exposing fish and fish habitat to toxic substances. However, the actions would employ numerous BMPs to avoid or minimize the potential for construction-related discharges. These BMPs may include, but not be limited to: implementation of a Spill Prevention Control and Countermeasures Plan, adherence to terms and conditions of permits and other environmental authorizations, and locating potentially polluting activities away from active water bodies. Because the work would use BMPs and adhere to permit conditions, construction related water quality impacts to fish would be temporary and low.

Regulatory agencies may require work-area isolation and fish salvage during in-water construction. Methods could include the use of cofferdams, screened pumps, seine nets, or electroshockers. This action may lead to incidental injury or even death of fish in the affected area. However, because the project would adhere to limits set by various regulatory permits, impacts to populations would likely be low.

Fish passage includes a broad range of actions to restore or improve juvenile fish passage where it has been partially or completely eliminated by past activities and habitat degradation. Frequently, construction activities are needed to restore fish passage and use a combination of heavy equipment (excavators, bulldozers, dump trucks, etc.) either in or near a stream channel, as described above for construction-related effects. Impacts resulting from active construction would be temporary and short-term, lasting only the duration of construction. Temporary effects to fish include increased suspended sediments, degrading water quality, and general disruption of natural behaviors, such as feeding, resting and sheltering.

Although rare, there may be instances where the installation of fish screens may be necessary for projects implemented as part of the estuary restoration program because juvenile fish may be entrained. To avoid this impact, all fish screens would be designed according to NOAA Fisheries' fish passage criteria (2011a). It is anticipated that screens would only be installed/upgraded on existing diversions and used to minimize fish strandings in locations not suitable for use. The long-term benefits of installing/upgrading fish screens for water withdrawals would include decreased mortality due to entrainment where water is diverted out of the waterway.

Most of the actions would result in some removal of vegetation, which could reduce or eliminate fish habitat in the short term (Darnell 1976, Spence *et al*. 1996). Cleared areas may lose organic matter and dissolved minerals, such as nitrates and phosphates. The soil may become drier and warmer, resulting in a local increase in water temperatures. Implementation of BMPs (site stabilization and replanting) would reduce the risk of soil erosion and increased sedimentation in streams, thus reducing the likelihood of impacts to fish habitat.

Ocean-type juvenile salmonids would benefit most from the beneficial use of dredged material since they use shallow-water habitats and nearshore environments to a greater extent than stream-type juveniles. However, stream-type juveniles would benefit when they out-migrate early or late as fingerlings and sub-yearlings and spend time in the estuary. Additionally, exporting macro-detritus from these wetland habitats also provides associated prey resources to fish migrating within the mainstem of the river.

Estuary restoration projects have a number of effects which affect the quality of fish habitats such as:

- Increased food web support
- Conversion of vegetation
- Restoration of sedimentation and accretion
- Restored or improved hydrology
- Enhanced water quality
- Reduced fitness through use of herbicides

3.2.3.1 Increased Food Web Support

Improved habitat can produce significant amounts of food resources for fish. The results of numerous studies including several in the Columbia River estuary demonstrate that estuarine marsh and other wetlands are highly productive ecosystems that generate a wealth of insect prey that benefit fish on site and even well beyond the original site as prey is carried in the water to other areas (BPA and Corps, 2013). Studies show tidal freshwater and estuarine habitats provide important forage for juvenile salmon, even those that do not use or reside in the marshes (Diefenderfer et al. 2012). Sampling of stomach contents of juvenile salmon and steelhead at John Day Dam, Bonneville Dam, and the mouth of the Columbia river on their downstream migration revealed that their stomachs were substantially more full after transiting to the estuary (Diefenderfer et al. 2012), indicating they feed more actively in the estuary than at other locations on their migration to the sea. Improvements to estuary habitat would increase the food available to both ocean and stream-type fish, promoting their growth and survival.

3.2.3.2 Conversion of Vegetation

Over the long term, vegetation is likely to convert from heavily managed agricultural condition to a more natural wetland condition. For example, mowed or grazed pastures would convert to ponds, riparian wetlands, shrublands, or riparian forests. Newly planted areas would likely become dominated by native species, rather than agricultural or invasive plants. Long-term stewardship would also promote the conversion to native species-dominated plant communities. This conversion is expected to result in a long-term improvement to fish and fish habitat. Wetland and riparian plant species would also provide fish with better food-web support, refugia, and slower backwaters, in comparison to the current condition. Replacing open fields with forests would provide shade cover, woody debris, and refuge areas, all of which are important habitat features for fish. Additionally, the change in vegetation would increase detrital inputs and the abundance of aquatic insects, not only within the immediate project footprint, but also into the surrounding estuary.

3.2.3.3 Restoration of Sedimentation and Accretion

Restoration projects would result in changes to sedimentation and accretion patterns. For example, levees and dikes may continue to erode after breaching, new flow regimes may modify rates of scour and deposition within occupied fish habitat, or newly flooded areas of exposed soil may contribute sediments to fish-bearing waters. Ultimately, however, restoration actions would restore the historical patterns of sedimentation and accretion, resulting in a net benefit to fish and fish habitat. For example, dike breaching would allow for newly inundated tidal areas to remove sediment through accretion from the water column, resulting in enhanced water quality, organic soil formation, and food web development.

3.2.3.4 Restored or Improved Hydrology

In the long term, the restored natural hydrological regime would benefit most species of fish. Restored hydrology would allow wetland and riparian areas to continue expanding, providing more shade cover and inputs of food sources. Restored natural flow would increase nutrient flushing, improve water quantity and quality (especially temperature and dissolved oxygen levels) in the affected area. Other beneficial effects would include increased availability of high-water refugia, rearing and foraging habitat. Streambank treatments would decrease erosion, provide food-web support, increase habitat diversity, and reduce the risk for bank failure. Floodplain re-contouring would increase diversity in the topography, flow regime, and vegetation of the affected area, and would increase the amount of fish prey. These habitat improvements could, in turn, lead to an increase in species and genetic diversity, abundance, and survival of fish over the long term.

3.2.3.5 Enhanced Water Quality

Water quality concerns within the estuary are discussed below in Section 3.4 (Water Quality). This discussion addresses the water quality improvements that restored wetlands are expected to produce. Reductions in pollutants, increased dissolved oxygen, and lowered water temperatures are all expected water quality improvements from estuary restoration projects that would benefit fish survival.

3.2.3.6 Reduced Fitness through Use of Herbicides

While the effects of improved estuary function are shown to be overwhelmingly beneficial to anadromous fish, there is one action used in this effort that could pose some risk to fish health: herbicide use. The effect of herbicide use on fish species would be mitigated through the use of BMPs identified in ESA consultations and by following the herbicide label requirements. Even with the implantations of these BMPs, it is expected that some herbicide may reach waterways.

Herbicides used to control invasive plant species on restoration sites may enter waters by way of vapor drift, surface runoff, and groundwater. Once in the waterway, herbicides may affect fish and fish habitat through chemical toxicity. The magnitude, extent, and duration of effects depend on numerous factors such as the type of herbicide, the timing of application, buffer zones, residence time, and the lag time between application and exposure to water. As confirmed by modeling and years of herbicide application as directed by the label, the use of herbicides is not expected to result in the mortality of fish. However, there is some uncertainty about the amount of chemicals expected to reach the water. While the amounts are expected to be low, there is always some risk that chemicals would reach fish-bearing waterway, with the potential for sub-lethal effects to fish, including:

- Increase or decrease in growth

- Changes in reproductive behavior or fertility
- Developmental abnormalities, including behavioral deficits or physical deformities
- Reduced ability to tolerate shifts in environmental variables (such as temperature salinity, or increased stress)
- Increased susceptibility to disease or predation
- Changes in behavior

3.2.4 Conclusion for effects to fish from the Restoration Activities

Restoration projects which aim to protect or restore riparian areas and breach or lower dikes and levees on the floodplain provide access to off-channel habitat and increase foraging opportunities and provide shelter and refugia for juvenile salmonids with ocean-type life history strategies (NOAA Fisheries 2008). Restoration projects which remove passage barriers and restore channel morphology, sediment transport, and water quality in tributaries improve the overall habitat quality in spawning and rearing areas for juvenile salmonids with stream-type life history strategies (NOAA Fisheries 2008). As a result, ocean-type juveniles benefit from actions restoring the ecological processes which drive the structural and functional components of the mainstem river and stream-type juveniles benefit from actions restoring the ecological processes in tributary habitats, as well as mainstem river projects. Projects that target portions of both the river and off-channel rearing habitat benefit both ocean- and stream-type juveniles. These benefits can be expressed through improvements in abundance, productivity, and life history diversity of juvenile salmonids in the Columbia River estuary.

One of the simplest and most basic indicators of whether restored habitat benefits salmon and steelhead is how quickly and to what degree fish access reopened habitat. A 2009 assessment of monitoring data from the Columbia River estuary found that at four of five improvement sites in the estuary, juvenile salmon either arrived where they had been absent or greatly increased in number; the only exception was a site where fish presence was depressed because it appeared few fish tended to migrate into the vicinity of the restoration site (Johnson and Diefenderfer 2010). The review noted that researchers found wild and hatchery-reared Chinook salmon at all dike breaches and created habitat. Generally, the more complete the reconnection of the habitat to natural hydrologic influences, the more positive the response from fish (Diefenderfer et al. 2012). In the Grays River, juvenile salmon quickly expanded into newly available habitat following the removal of tide gates from diked pastureland and based on salmon size and the timing of hatchery releases, most salmon sampled in the restored site were the progeny of natural spawners (Roegner 2010). Thus, restoration of tidal wetlands in the estuary improves ecosystem connectivity and reduces fragmentation and may therefore increase survival of a variety of Pacific salmon stocks during their migration (Roegner 2010).

The overall effects to fish from projects envisioned in the EA are intended to be beneficial since fish habitat improvement is the intent of these actions. While there would be short term construction related impacts to fish from decreases in water quality, changes in hydrology, vegetation management, and direct harm from fish salvage and in-water work, there would be long term and lasting benefits.

Many if not all of the projects implemented as part of the estuary restoration program are expected to have the potential to impact listed fish species or habitat and would therefore require informal or formal consultation under the ESA. The ESA consultation process requires that impacts to ESA-listed fish species and habitat be assessed and BMPs and mitigation measures applied to reduce impacts. The BMPs and mitigation measures determined in the consultation process would be required. Therefore, implementation of the estuary restoration program is expected to have a moderate and beneficial impact to ESA-listed fish species.

3.3 Hydrology and Hydraulics

3.3.1 Affected Environment

The hydrologic characteristics of a river are largely determined by the climate, geological features, and water control structures present within a watershed. The Columbia River is the largest river entering the northeastern Pacific Ocean, discharging on average over 250,000 cubic feet per second (cfs), peaking at approximately 350,000 cfs in the wetter winter season and an average low of 100,000 cfs in the drier summer months (Simenstad 1984). The Willamette River is the largest tributary below Bonneville Dam, contributing a mean annual flow of 33,000 cfs (between 13 and 18 percent of the annual Columbia River flow). The Cowlitz River is the second largest tributary to the Columbia River below Bonneville and drains the slopes of Mt. Rainier, Mt. Adams, and Mt. St. Helens. The Cowlitz River contributes a mean annual flow of approximately 9,000 cfs to the Columbia River (between 2 and 5 percent of the annual Columbia River flow). In addition, the Cowlitz River also contributes a major source of sediment to the Columbia River following the eruption of Mt. St. Helens in 1980. The Corps annually dredges 6 to 9 million cubic yards of material from the Columbia River and nine federally authorized side channels below Bonneville Dam to support and maintain the Federal Columbia River Navigation Channel. Other major tributaries include the Sandy, Lewis, Kalama, Coweman, Grays, Youngs, and Lewis and Clark rivers.

The Columbia River basin receives most of its annual precipitation as rain in the lower elevations and snowfall in the mountainous areas between November and May. Historically, the estuary flooded under two distinct seasonal regimes. Winter floods were initiated by winter rains west of the Cascade Mountains, and spring floods were initiated by spring snowmelt east of the Cascades. Across the lower reaches of the river and estuary, annual precipitation varies between 90 and 200 inches at higher elevations, where approximately 80 percent of the annual precipitation falls as rain between the months of November through February. Of the remaining 20 percent, less than 7 percent falls in June, July and August. Approximately 25 percent of the water entering the estuary originates from west of the Cascades due to higher precipitation occurring in the Coastal and Cascade mountain ranges (Tetra Tech 1992). Snowfall contributes to the peak discharge in the interior drainage basins, where it is stored through the winter and early spring in the high elevations of the Rocky Mountains and Cascade Range.

Historically, the Columbia River estuary experienced an annual spring freshet[17] of approximately 600,000 cubic feet per second (cfs), which was 75 to 100 percent higher, on average, than the current freshet under the FCRPS. Historical winter flows (between October and March) also were approximately 35 to 50 percent lower than current flows (ISAB 2000). Completion of the FCRPS reduced the peak seasonal discharges and changed the velocity and

[17] A rush of fresh water flowing into the sea from heavy rain or melted snow

timing of seasonal flows in the river (ISAB 2000). Currently, river flow peaks generally occur between April and June, approximately 14 to 30 days earlier than prior to the FCRPS, and mean flows are approximately 16 percent less than in the latter part of the 19th century (Jay and Kukulka 2003, Corps 2011a). Outflows from the dams located within the Columbia River system are regulated by the Corps between May and June to support navigation, provide storage capacity to ameliorate peak flows, minimize downstream flooding, and generate hydropower. Low river flows generally occur from August through October and are also regulated by the Corps to maintain in-stream flows for fish and wildlife, generate hydropower, and support navigation and recreation.

Hydraulically, the Columbia River estuary can be characterized as a system with large river discharges and strong tidal currents. River discharge is a function of precipitation, temperature, and flow regulation via dam and reservoir operations (Johnson 2003). Following construction and operation of the FCRPS, construction of a multitude of levees and dikes, urbanization and other development along the river, flow is highly regulated, and floodplain connectivity has been substantially reduced, if not eliminated altogether in some locations. Riverine processes interact with oceanic processes (tidal action and waves) in the estuary and produce complex hydrodynamics resulting in deposition of suspended sediments and erosional processes, which in turn create and maintain tidal channels and shallow-water habitats. Sediment deposition can forms islands and other land forms which can develop into different habitat types over time, including tidal marshes and swamps. Similarly, tidal channels created and maintained by erosive processes provide opportunities for fish and wildlife to access marsh and swamp habitats.

The Columbia River estuary is dominated by both riverine (seasonal one direction flow) and estuarine (daily tides with flow in both directions) processes. The daily tidal cycle, as opposed to riverine flows, generally dominates water-level variation between RM 0 and 37 (ERTG 2013b). Upstream of RM 37, riverine processes are largely influenced by hydrologic factors in the channel (bed slope, channel width, bed form[18] and roughness, velocity, and circulation). The bed of the river at Bonneville Dam is 11.27 feet above the mean lower low water at the river's mouth, resulting in an average slope of 0.001 percent for the lower river between RM 146 and the mouth (Tetra Tech 1992). Channel width varies dramatically between the riverine and estuarine segments of the river due to bedrock formations near Bonneville Dam transitioning to an alluvial floodplain further downstream. Channel widths upstream of RM 47 (Puget Island) range between 3,500 and 5,500 feet, whereas channel width in the estuary can reach upwards of 47,000 feet at RM 21 (Rice Island) during low flows.

The Columbia River is a flat, lowland river with relatively high velocities in the navigation channel (upwards of 8 feet per second during high flows) and slower velocities in backwater sloughs and side channels. Because the estuary is influenced by daily tides, the direction of flow can reverse between extreme high tides and low flow conditions.

---

[18] Bedslope refers to the slope/steepness of a riverbed; bedform is the shape of a river bed's surface as it has been shaped by water flow

3.3.2 Types of Effects from Restoration Activities

Given the range of proposed restoration actions discussed in Chapter 2, there is a corresponding range of potential effects to the hydrology (water levels) and hydraulics (water velocity and erosive potential) within the estuary. Estuary restoration projects including CRE actions 3 (protecting and enhancing flows), 6 (beneficial use of dredged material), 9 (modification of dikes and levees), and 10 (off-channel habitat improvement) would have impacts on local hydrology and hydraulics at a project site. The potential effects to local hydrology and hydraulics from implementing these actions as stand-alone measures as well as a part of a suite of other actions would depend on site-specific restoration needs and opportunities, location, proximity to the mainstem of the river, adjacency to other projects, and past land uses. These effects, discussed in greater detail below, would vary in context and intensity depending on site-specific conditions and implementation actions. These effects include:

- Erosion, scour, floodplain accretion, and in-channel deposition
- Increased frequency and duration of inundation
- Localized changes in velocity, flow, and circulatory patterns at
- Increase instream flows and groundwater exchange
- Abatement of peak flows and amelioration of flooding

3.3.3 Effects of Restoration Activities

Protecting and enhancing instream flows (CRE 3) could influence flows in the Columbia River and tributaries. Managing water withdrawals and implementing other water management actions would protect flows entering the estuary and restoring natural flow regimes would aid in water conservation and availability. Maintaining sufficient instream flows is important to sustaining fish and wildlife populations, water quality, and recreational and navigational needs in tributaries entering the estuary. By acquiring and protecting lands, the Action Agencies could protect instream flows to increase the quantity and overall water quality of flows entering the estuary from tributaries, supporting downstream habitat processes. These actions would improve many ecosystem processes which are currently degraded. Currently, insufficient water flow is available during dry summer months when withdrawals are typically highest or where water quality is limited because instream flow is reduced or marginalized from withdrawal or other water management actions.

The beneficial use of dredged material (CRE 6) can involve the notching or scraping down of areas where existing material limits hydrologic connectivity. In other instances, CRE 6 could be implemented to place material along shorelines or in-water to facilitate the development of marsh and wetland habitats. For example, the Corps placed dredged material in an intertidal area adjacent to Miller Sands Island in the Columbia River (RM 23.5) to create wetland and upland habitat in 1975 (Corps 1985). Subsequent monitoring revealed the site developed into a productive wetland with fish and wildlife communities comparative to reference sites within five years following placement. Dredged materials could also be removed or re-shaped within a project site to increase the spatial extent of tidal inundation or increase the frequency and duration with which an area is inundated. If material is removed or re-shaped in an area that is seasonally dry or located behind a levee, the effects to local hydrology and hydraulics would be delayed until the area were wetted such as through levee and dike breaching. The placement or removal of material would be designed to maximize the spatial extent of inundation or increase the complexity of off-channel habitats and tidal networks. Depending on site location, the placement of material in the estuary could directly affect hydrology and hydraulics by altering flow conditions and circulatory patterns. The placement of dredged materials could increase surface water elevations in the project area, but would not measurably influence tidal cycles or the magnitude of flow in the estuary or tributary habitats.

Inundation of the floodplain supports an assortment of natural processes, including sediment transport, nutrient cycling, water storage, primary production and food web dynamics, which in turn support ecological functions influencing water quality, fish and wildlife production, and overall biodiversity. By implementing management actions which protect or restore degraded off-channel habitats, the Action Agencies would alleviate some of the ecological stressors influencing opportunities for salmon and steelhead to feed, rear, and find refuge from the higher-energy environment of estuary. Actions supporting the restoration of off-channel habitats and facilitating access to these areas address structural constraints which currently limit fish and wildlife access to valuable off-channel habitats. In addition, the restoration of degraded off-channel areas facilitates prey production and macrodetrital[19] inputs to the estuary, supporting the broader ecosystem and increasing structural complexity.

The hydrologic impacts of implementing CRE 9 (which aims to protect and restore high-quality off-channel habitats) would include the removal and restoration of structural ecosystem components that influence the frequency, duration, and extent of inundation at a project site. Off-channel habitat actions may include the excavation or re-shaping tidal channels to mimic reference sites or historical conditions. Restoration of tidal channel via excavation would affect site-specific hydrology and hydraulics (increased connectivity and hydraulic exchange), and over the long term, would facilitate increased frequency, duration, and spatial extent of intertidal or flood inundation on the floodplain or stream habitat. The size and shape of channel networks would be dependent upon several factors, including hydrodynamics, substrate and soil type, vegetation composition and density, and other features unique to each project area. In addition, off-channel habitats could include reconnection of wetland habitats, supporting flood storage and water supply.

Reconnecting of channel habitats may also increase the intertidal prism, which is the volume of water exchanged over a given area during each tidal cycle. Channel excavation in tidally-influenced areas allows for a larger volume of water to enter and exit the estuary on the flood and ebb tides, increasing the exchange of water across the intertidal zone. Increasing the tidal prism and restoring connectivity also affects fish and wildlife production, water quality, sediment transport processes, nutrient cycling, primary production and food web dynamics, and water storage to attenuate the impacts of high flow and flood events.

Where stream channels have become destabilized, there is an increased risk of head-cutting and grade destabilization which could lead to channel incision, erosion and deposition of fine sediment in downstream substrates, vertical discontinuity of the waterway and floodplain, and impacts to groundwater and water tables. Headcuts propagate upstream, and restoration measures to stop further propagation and restore structure stability include the use of rock

[19] The term "macrodetrital" refers to organic material derived from dead plants and animals generally large enough to be visible.

and log step structures to stabilize the stream bed and banks. Restoration of stream channels and banks using rock and log structures requires instream construction, resulting in short-term effects to water quality and local hydrology and hydraulics similar to the effects described above for in-water construction activities. Additionally, fish and wildlife passage may be temporarily blocked during construction, but if left untreated, head cutting and channel instability may eventually result in complete fish passage blockage. Stabilizing stream channels and arresting headcuts results in improvements to water quality, restoration of channel form and function, decreased sedimentation, and restoration of hydrology and hydraulics including floodplain and groundwater functions.

Complimenting efforts to restore off-channel habitats, the breaching, lowering, relocation, or other modification of dikes and levees (CRE 10) in the estuary would provide substantial benefit to the ecosystem and restore natural processes. As discussed above, many floodplain habitats have been disconnected from the mainstem of the river and tidal influence by the construction of dikes and levees to minimize flooding and support alternative land uses (agriculture, urban and industrial development, etc.). These actions have drastically reduced the interaction between the river and floodplain, resulting in widespread loss of natural processes supporting diverse habitat types and associated ecological functions. Implementing actions which remove or minimize the restriction of tidal influence and inundation of a project site would have the greatest effect on local hydrology and hydraulics. Furthermore, implementing actions to breach, lower or relocate dikes or levees results in increased accessibility to off-channel habitats which are currently inaccessible to salmon and steelhead.

At locations where levees would be breached or lowered to allow tidal exchange with the floodplain, the project site would be inundated, and hydrologic processes which have been disconnected for decades would be restored almost instantaneously. The effects of restoring hydrology would include a localized increase in the water quantity including an increase in the depth of water and duration of water on the sites. The depth and duration would depend on the extent of the levee removal and the site location within the tidal or floodplain area. Hydraulics would also be altered within the site and would be expected to further the development of a natural tidal channel network and restore sediment accretion within tidal marsh due to the restoration of natural processes. Over time, the restoration of hydrologic connectivity and inundation at a project site would support the restoration of natural processes contributing to habitat establishment and development, fish and wildlife usage, and structural and functional dynamics at the project site. Increasing the wetted area via breaching or lowering a levee or dike would provide additional floodplain capacity and conveyance for flood flows, reducing the local flood profile. Restoring local hydrology improves ecological structure, sustaining a diversity of habitat types which in turn increases the resilience and self-sufficiency of the wider ecosystem.

Actions that reconnect stream corridors, floodplains, estuaries, wetlands, improve aquatic organism passage and restore natural channel and flow conditions result in impacts to sediment transport, patterns of accretion and erosion, energy and stream flow, temperature, and primary production. In the estuary, levee removal and floodplain inundation could influence the tidal prism and have effects downstream and upstream of a project site. For instance, increasing the tidal prism at a project site could alter velocities, flow volumes, or flow duration, resulting in localized erosion and accretion at the project site, as well as at downstream and upstream locations. The legacy of flow control on the landscape has resulted in substantial alterations to the structure and function of habitats behind levees and dikes and the tidal tributaries that connect them. Decreases in daily tidal flows brought about by the construction of the levee systems have decreased the water quantity, duration, and velocity within the adjacent tidal tributaries. This change in hydraulics has caused channel deposition within many of the tidal tributaries that served historical tidal marshes. Levee breaching and lowering along a tidal tributary has the potential to increase the flow velocities, duration, and erosion potential along that waterway. Therefore, large scale levee breaching and floodplain restoration projects likely have a potential to impact offsite resources when located along tidal tributaries that have adjusted to reduced flow. These tidal tributaries are likely to adjust vertically or horizontally to accommodate the restored tidal prism, and the effect would be lessened in locations closer to the mainstem of the Columbia River. In places where erosion currently occurs, increased erosion could influence the stability and safety of structural features on the landscape (levees, docks, and other water control structures etc.). Where structures are degraded from lack of maintenance or otherwise damaged, continued disrepair could result in unplanned failures resulting in adverse effects. For projects that have the potential to alter the hydrology and hydraulics within a stream reach, the agencies would evaluate site-specific hydrologic and hydraulic impacts of a proposed action, and the results of these analyses would be discussed and made available to the public during the tiered NEPA process.

While projects implemented under the estuary restoration program have the potential to impact hydrology and hydraulics both within and outside the restoration area, the effects of are expected to be moderate due to the mitigation measures presented in Table 2. If during the tiered NEPA process, there is the potential for significant impacts the preparation of an Environmental Impact Statement would be warranted.

3.4 Water Quality

3.4.1 Affected Environment

Under the Clean Water Act, the Oregon Department of Environmental Quality and Washington Department of Ecology are required to regularly assess water quality and report to the U.S. Environmental Protection Agency (EPA) on the condition of the State's waters. As required in Clean Water Act Section 303(d), Oregon Department of Environmental Quality and Washington Department of Ecology identify those waters which do not meet water quality standards for beneficial uses.[20] Where data is available, each agency also identifies specific water quality limitations and impairments for the State's waters. The summary report is commonly referred to as the 303(d) list and is used to identify where improvements to water quality are needed to meet state and national standards.

The Columbia River was designated in 2004 as w*ater quality limited* and placed on the Clean Water Act Section 303(d) list for temperature, pH, and a number of chemical contaminants including PCBs, arsenic, dichlorodiphenyl trichloroethane (DDT), and PAHs (Oregon DEQ 2010, Corps 2011a). In Washington, the river also is on the 303(d) list for dissolved gas fecal

---

[20] Beneficial uses include domestic and industrial water supply; irrigation and livestock watering; fishing, boating, and water contact recreation; fish and aquatic life, wildlife, and hunting; aesthetic qualities; and hydropower, commercial navigation, and transportation.

coliforms, sediment bioassay, and a number of chemical contaminates including DDT, Alpha BHC (a pesticide), mercury, dieldrin, chlordane, aldrin, dichlorodiphenyldichloroethylene (DDE, a breakdown product of DDT), (Oregon DEQ 2010, Corps 2011a). The entire Columbia River is subject to an EPA total maximum daily load for dioxin for the beneficial uses of "anadromous fish passage," "drinking water," and "resident fish and aquatic life" (Oregon DEQ 2010, Corps 2011a).[21] Prior studies classified the Columbia River as "marginally healthy" based on levels of dissolved oxygen, toxins, and habitat conditions (Tetra Tech 1996).

Turbidity levels in the Columbia River roughly follow the river's hydrograph, increasing during spring freshets and western subbasin winter floods, subsiding in the low flow season in the summer. At any given river discharge, there are variations in the observed turbidity. For most of the year, turbidity levels are less than 10[22] nephelometric turbidity units (NTUs) (Corps 2011a). During flood events, NTUs greater than 20 are observed (Corps 2011a). Turbidity levels at the mouth of the Columbia River are highly variable and depend on river flow and ocean conditions. Fine, suspended sediments which cause turbidity can remain in the estuary for up to 1 to 4 months, depending on tides, river flows, and travel paths. An estuarine turbidity maximum occurs in both the north and south channels of the estuary. The location of the estuarine turbidity maximum shifts with the tide and river discharge, similar to the movement of the salt wedge[23]. Researchers have found the estuarine turbidity maximum in the south channel at various locations from RM 5 to 20 (Corps 2011a).

Toxic contaminants, nutrient loading, and reduced dissolved oxygen have changed water quality conditions in the estuary and tributaries contributing to the estuary. Increased concentrations of nutrients (phosphorous and nitrogen) and pesticides can limit plant growth and at high levels be toxic to plants and animals, including humans. In September 2014, the Oregon Health Authority issued a public health advisory for toxic blue green algae (*Cyanobacteria* sp.) in the Willamette River following regular water quality testing by the Oregon Department of Environmental Quality. The advisory encouraged people to limit recreational activities and avoid contact with the water. The advisory was lifted in early October, allowing regular recreational use of the river to resume. High levels of nutrients can trigger algae blooms, which lower dissolved oxygen concentrations, degrading water quality for fish and wildlife.

Water-soluble contaminants, trace metals, and chlorinated compounds have been detected in the estuary (Fresh et al. 2005), and DDT, PCBs, dioxins, and metals have been detected at elevated levels in tissue from fish in the estuary (NPCC 2004). Fecal coliform and heavy metals (arsenic, mercury, etc.) can directly affect human health and be acutely toxic to fish and aquatic wildlife. Fecal coliform consume oxygen when breaking down organic materials, reducing

---

[21] A total daily maximum load is a regulatory term in the Clean Water Act of 1972 (33 USC §1251), describing the maximum amount of a pollutant that a body of water can receive while still meeting state and federal water quality standards.

[22] Drinking water is frequently limited to less than 5 NTU; surface water quality standards generally range between 10-50 depending on State and waterbody.

[23] Salt wedge estuaries occur when the mouth of a river flows directly into salt water. The circulation is controlled by the river that pushes back the seawater. This creates a sharp boundary that separates an upper less salty layer from an intruding wedge-shaped salty bottom layer.

dissolved oxygen concentrations and degrading water quality. The bioaccumulation of mercury in fish is widely recognized as an environmental problem, increasing health risks to humans who consume fish from waters with high concentrations of heavy metals. In addition to human health risks, contaminants can be acutely toxic to fish and wildlife, especially juvenile salmonids rearing in the estuary. One study on juvenile salmon estimated disease-induced mortalities between 1.5 and 9 percent from contaminant stressors for juveniles residing in the Columbia River estuary for as little as 30-120 days (Loge et al. 2005).

In 1996, the Lower Columbia Estuary Partnership conducted a comprehensive study of toxics and other ecosystem components of the estuary (Tetra Tech 1996). That study concluded that water quality in the estuary was impaired by dioxins and furans, metals, PCBs, PAHs, and pesticides, all of which degrade water and sediment quality and limit fish and wildlife use. Certain heavy metals (arsenic) are known carcinogens, and samples exceeded state and federal water quality criteria for human health. Sediment contamination was highest near urban and industrial areas, and certain contaminants (DDE, PCBs, PAHs) exceeded levels of concern. Certain contaminants have been banned from use but still persist in the environment (DDT), and pesticides in current use enter the estuary from agricultural runoff and stormwater pollution.

Toxic contaminants enter the estuary directly (point source pollution) or indirectly (non-point source pollution). According to the EPA, the term “point-source” means any discernable, confined and discrete conveyance or discharge of pollution, including pipes, ditches, conduits, animal feeding operations, vessels. Point source pollution is regulated by state and federal agencies and subject to the EPA’s total maximum daily load for a specific waterway. Point source pollution does not include agricultural runoff or return flows from irrigation, urban, or industrial sites. Non-point source pollution is more difficult to manage, as it cannot be linked to a particular source but is rather diffuse across the landscape. Non-point source pollution is caused by rainfall or snowmelt moving over and through the ground, picking up natural and man-made pollutants and depositing them into receiving waters.

In the Columbia River, year-round temperature is a water quality concern for beneficial uses for “salmon and steelhead migration”, and pH[24] in the fall, winter, and spring was listed as a water quality concern for the beneficial uses of “residential fish and aquatic life”. Because most aquatic organisms (fish, primarily) are cold-blooded, changes in water temperature can exert a major influence on the health of an individual or population. As water temperature increases, the rate of chemical reactions increase which in turn influence biological activity. Warm water holds less oxygen than cold water, decreasing dissolved oxygen concentrations necessary to support aquatic species. For instance, fish and other aquatic species experience some degree of stress or may die when dissolved oxygen levels fall below 8 to 10 milligrams per liter (mg/l) (CFWWC 2005). Aquatic environments with low dissolved oxygen concentrations create stressful conditions, and at times lethal conditions, for fish and aquatic organisms. Fish adapted to cold-water systems (cutthroat and bull trout, for example) are sensitive to even minor increases in temperatures, especially when spawning.

[24] pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base.

Summer stream temperature is a primary water quality concern, when many stream reaches designated as critical habitat for salmonids exceed water quality standards for temperature. The condition of many stream and river corridors has been modified from natural conditions through various land use practices and development. Stream temperature can become elevated from urban runoff and discharge, raising water temperatures above the upper tolerance limit for fish and aquatic wildlife. The combination of forestry and agricultural practices in some areas has reduced streamside vegetation, resulting in increased stream temperatures and lack of shade. Roads and pollution from urban areas have contributed to increased sediment loads entering the river system, increasing localized turbidity, introducing contaminants, and depositing fines in waterways. Agriculture, including dairy operations and cattle grazing, contribute phosphorous, nitrogen, and bacteria to water resources.

Measurements of pH reflect the relative acidity and alkalinity, which can be influenced by human activities, the amount of primary production (photosynthesis), and local geologic conditions. Most aquatic organisms can tolerate a range of pH from 6.5 to 8.5; beyond these levels, an area can be too acidic or too alkaline. In areas where excess nutrients and pollution results in increased algal and plant growth, pH levels may increase and change the solubility of nutrients, altering dissolved oxygen concentrations and overall water quality. In addition, high levels of dissolved and suspended sediments and turbidity can be detrimental to fish and aquatic organisms by impairing visibility and smothering local habitats.

3.4.2 Types of Impacts from Restoration Activities

Water quality can be impacted by a multitude of actions, including those actions implemented under the estuary restoration program. Of the proposed restoration actions that could be implemented in the estuary, there is a range of potential direct and indirect effects to water quality dependent on the duration of the action and protective measures used to minimize adverse effects during restoration actions. All of the actions included in the estuary restoration program [CRE actions 1 (protect and restore riparian areas), 3 (protecting and/or enhancing instream flows), 6 (beneficial use of dredged material), 9 (protect and restore off-channel habitats), 10 (breaching, lowering, relocation, or other modification of dikes and levees), and 15 (invasive species management)] would affect water quality at a project site and in some cases downstream waters. The potential effects to water quality from implementing these actions as stand-alone measures and in combination with other actions would depend on site-specific conditions at a project site and opportunities to improve water quality. These effects include:

- Construction-related turbidity and erosion
- Increased composition of native vegetation
- Increased riparian buffer width
- Increased vegetation cover
- Localized decrease in non-point source pollution
- Changes in land use practices minimizing sediment and contaminant inputs
- Increased quantity of tidal marsh habitat
- Increased flows, tidal exchange, and flushing

- Increased channel complexity and alignment
- Decreased composition, distribution, and quantity of invasive species

3.4.3 Effects of Restoration Activities

Restoration-related construction activities in or near streams or rivers could increase localized turbidity, but as discussed above, these actions would be short-term and limited to the duration of construction and subsequent site stabilization. As a result, the adverse effects of construction-related water quality concerns would be short-term and temporary. As discussed above, specific BMPs would be implemented, including those resulting from Clean Water Act and ESA permitting, to minimize adverse effects to water quality during construction.

Riparian buffers function to moderate fluctuations in stream temperature, light penetration, habitat diversity, channel morphology and stability, food web and species richness, and support water quality. Implementing CRE 1 (protect and restore riparian areas) would enhance riparian vegetation, which would benefit long-term water quality in areas where current vegetation is limited and provides little functional value to stream systems. Long term protection of functioning and restored riparian areas would protect and maintain water quality function in adjacent waterways by reducing erosion, incision, and minimizing bank failure, filtering sediments and pollutants out of stormwater runoff, increasing shade and canopy cover, and supporting prey production for fish and wildlife.

Vegetated riparian buffers help maintain lower stream temperatures in the summer by providing stream shade, and reduce temperature fluctuations in the winter. Riparian zones as narrow as 10 feet have been found to provide adequate temperature control for small streams if the vegetation is tall enough to directly shade or cover the waterway (Brazier and Brown 1973). In areas where riparian buffers have been reduced, native vegetation can be planted to increase the width and species composition of buffers to provide shade and cover to stream systems. Planting vegetation in degraded riparian zones also stabilizes streambanks and reduces erosion and bank failure when plant roots provide tensile strength[25] to the streambank and maintain soil structure to prevent erosion. Reconstructing riparian buffers using vegetation reduces channelization and slows surface water flow, allowing sediments to settle out of runoff, reducing erosion and suspended sediments. The relationship between buffer width, bank stability and erosion is dependent on vegetation type, density, species richness, and bank slope. The specific composition of riparian vegetation would depend on site conditions and include native vegetation appropriate for the site.

Where instream flows are managed for irrigation withdrawal or other purposes, the restoration of a natural flow regime (CRE 3) can improve water quality by increasing the volume or timing of flows entering the Columbia River and estuary. Where off-channel habitat is degraded or removed through channelization or has been disconnected from the mainstem river, restoration actions to restore ecosystem function to off-channel habitat (CRE 9) would increase water quality and support ecosystem processes dependent on water quality. Where channel habitats have been simplified through the removal of large wood or the removal of other structural features to facilitate drainage or conveyance, replacing this structure would

[25] Tensile strength is the resistance to breaking under tension

support water quality functions by slowing water velocities, protecting streambanks from bank failure and increased erosion and scour. This would effectively reduce the amount of sediment entering the waterway as suspended sediments and thus improve water quality.

The excavation of new tidal channels would facilitate increased tidal exchange and floodplain connectivity, restoring regular flow regimes and nutrient exchange at a project site. These actions would support water quality where current conditions limit flushing and nutrients are concentrated beyond concentrations safe for fish and wildlife. At project sites where acquisitions results in a change from current land use practices, water quality may improve as a result of reducing non-point source pollution and contamination entering adjacent waterways. In addition, on lands currently used for livestock grazing, the removal of grazing activities from levee protected tidal wetlands or installation of fencing to protect wetlands and waterways can improve water quality by allowing wetland vegetation or the riparian buffer to re-establish. Protecting streams and wetlands from livestock or wildlife damage prevents high nutrient loads from entering waterways, improving overall water quality. In addition, fencing can protect streambanks from failure and incision, which serve as a major source of erosion and suspended sediments in waterways where active grazing is unimpeded.

At some project sites, floodplain topography may be re-contoured, including soil scraping, notching or removal of previously placed dredged materials (CRE 6). These actions would result in a temporary increase in turbidity associated with construction. However, as discussed above for in-water construction related effects, effects to water quality associated with CRE 6 would decrease following construction and water quality would improve as a result of increased water connectivity and circulation, vegetation establishment, and the restoration of natural habitat forming processes associated with the construction and use of dredged materials in the estuary.

Where levees are breached, lowered, or otherwise modified to increase access to floodplains and off-channel habitats (CRE 10), there could be a temporary pulse of sediment into nearby waterways immediately following the initial breach. The turbidity would decrease as the site becomes stabilized through vegetation establishment and after several flushing events when less material is suspended in the water column during tidal exchange. In addition, increasing tidal and floodwater exchange in areas previously used for agriculture or livestock grazing may increase the export of phosphorous, nitrogen, and organic matter from remnant channels into nearby water resources because many levee-protected areas have been widely used for farming or cattle grazing. Water and sediment sampling at project-specific sites would identify if contamination were a concern and subsequent NEPA documents tiered to this EA would discuss project alternatives and BMPs to minimize adverse effects to water quality from these impacts.

Invasive plants are pervasive throughout the Columbia River ecosystem. Often times, invasive plant species out-compete native vegetation and alter the structural composition of plant communities resulting in changes to water quality supporting ecosystem processes. While the widespread removal or control of invasive species is not feasible throughout the implementation area, management actions can be implemented at project sites to reduce the spread and establishment of invasive species (CRE 15). Removing localized populations of invasive species and establishing native vegetation supports natural processes influencing food web dynamics, primary production, and water quality, and in turn supports fish and wildlife populations in the estuary. Increasing the composition, distribution, and density of native vegetation would enhance riparian buffers and improve water quality.

Invasive plants alter the physical structure and biological composition of tidal marshes, mudflats, and streams and rivers. Functionally, invasive species can exclude light, altering photosynthetic processes, as well as create stagnant waterbodies with low oxygen levels and increased temperatures, degrading water quality. Managing or controlling invasive species would restore the composition of native vegetation which in turn supports ecological processes of photosynthesis and primary production. In areas where mechanical control methods are infeasible, chemical control means would be employed, and BMPs identified in ESA consultations would be implemented to minimize adverse effects to water quality.

The impacts from increased turbidity and erosion on water quality are expected to be low to moderate and mitigated through the use of BMPs identified in Table 2.

3.5 Geomorphology, Soils, and Topography

3.5.1 Affected Environment

Geomorphology is the study of the relationship between physical features on a landscape and the processes affecting them. With regards to river systems, fluvial geomorphology is the study of the physical processes affecting river channels and flow gradients. The Columbia River basin and associated tributaries were formed by volcanism, sequences of uplift and erosion, and flooding (including the Missoula floods). Many of the tributaries to the Columbia River are generally flat and were subject to annual inundation before human alterations in the Columbia River Basin. There is evidence of this flooding in the remnant channels and islands which give the floodplain its characteristic terrain and flat profile.

The Columbia River estuary can be characterized as an alluvial channel[26] immediately downstream from Bonneville Dam which changes to a semi-braided and meandering stream channel as the river transitions into the tidal portion of the estuary. Upstream of Bonneville Dam, the river functions as a transport zone, where sediment sourced in the upper watersheds is transported downstream and deposited in the river. The estuary functions as a sediment sink or area of deposition before the river empties into the Pacific Ocean.

The primary factor controlling sediment transport and suspended sediment volumes in the Columbia River is the large peak flows associated with spring freshets in the interior basin and the western sub-basin winter flood events (Corps 2011a). Flow regulation under operation of the FCRPS has reduced the peak 2-year flood discharge from 580,000 to 360,000 cubic feet per second (cfs) (Corps 1999). This reduction of peak flows has reduced the average annual suspended sediment load in the river from the historical level of 12 million cubic yards (mcy) per year to 2 mcy per year (Corps 2011a). The present suspended sediment concentrations measured at Beaver, Oregon (RM 54) have been in the range of less than 10 milligrams per liter (mg/l) at 100,000 cfs; approximately 20 mg/l at 200,000 cfs; from 20 to 50 mg/l at 300,000 cfs; and from 20 to 60 mg/l at 400,000 cfs. These ranges equate to suspended sediment discharges of 2,000 cy per day, 8,000 cy per day, 12,000 to 30,000 cy per day, and 16,000 to 48,000 cy per day, at the different flows respectively (Corps 2011a).

---

[26] An alluvial river channel is one in which the bed and banks are made up of mobile sediment and/or soil.

An estuary's form is altered primarily through the deposition of sediment—either sediment that is reworked from other parts of the estuary or sediment that enters the estuary from upstream sources. Sediment moves among each of the components within the estuary, allowing the estuary as a whole to continuously adjust toward a long-term equilibrium in response to changes in physical or geomorphic processes (Philip Williams & Associates and Farber 2004). Sediment and channel form within the estuary also affects the formation of nearshore ocean habitats north and south of the Columbia River entrance. Sediment provides important minerals and nutrients that support food production in the estuary and plume and also helps create and maintain tidal marsh habitats which are important to carbon cycling[27] in the estuary and provide habitat for juvenile salmonids.

The geo- and fluvial morphology of the river has been radically altered by the human environment. The construction of the FCRPS functionally eliminated the delivery and deposition of fine sediments into the estuary. Currently, the Columbia River is a sediment-starved system, wherein the majority of sand and gravel from upstream sources is trapped behind dams and reservoirs upstream of Bonneville Dam. As a result, sediment transport processes are disconnected and no longer influence the creation, maintenance, or distribution of salmonid habitats in the estuary. The tributary streams below Bonneville Dam now serve as the main source of sediment moving into the mainstem Columbia River and estuary. The transport of sediment is fundamental to habitat-forming processes in the estuary through sediment deposition and erosion (Fresh et al. 2005). Restoration projects would be implemented on the flat, broad river terraces formed along the flanks of the Columbia River, where the floodplain is the accumulation of thick deposits of river alluvium[28] forming broad terraces within the tidally influenced portion of the river and its tributaries.

Unless diked and drained, soils in the estuary have a permanently high water table at or near the surface, which fluctuates with the tides and is subject to tidal overflow and seasonal flooding. Levees and dikes prevent natural sedimentation processes and cause the subsidence of a floodplain because the removal of tidal influences has stopped accretion (soil deposition) from upstream sources, and land use practices result in compaction of the soil structure. Since the 19th century, sediment transport from the interior basin to the estuary has decreased about 60 percent, and total sediment transport has decreased about 70 percent (Jay and Kukulka 2003). The loss of tidal swamp and marsh habitat has decreased the opportunity for juvenile salmon and steelhead to access and use these crucial rearing habitats. Furthermore, the loss of these habitats further degrades the overall ecosystem by effectively eliminating the exchange of water, materials, and organisms between the larger ecosystem (mainstem Columbia River) and adjacent, shallowly vegetated habitats (floodplains and tidally influenced marshes and swamps in tributary systems). While some hydrologic exchange is maintained by tide gates or other water control structures, the loss of natural exchange alters natural habitat-forming and maintaining processes, such as sedimentation and erosion.

---

[27] The carobon cycle is the combined processes, including photosynthesis, decomposition, and respiration, by which carbon as a component of various compounds cycles between its major reservoirs—the atmosphere, oceans, and living organisms.

[28] Deposits of clay, silt, sand, and gravel left by flowing streams in a river valley or delta, typically producing fertile soil.

The Columbia River estuary consists of individual landforms created after the Missoula Floods of the late Holocene Epoch. Examples of such landforms include terraces, dune fields, floodplains, deltas, individual bars, levees, islands, channels, and ponds. The dynamics of these processes result in high topographic variation across the landscape. Three main soil types are found in and adjacent to the Columbia River mainstem: (1) gravelly, silty, sandy, or clay loam, which is characteristically poorly drained hydric[29] soil typically associated with wetlands and floodplains; (2) riverwash, cobbles, or sand which occurs extensively along the shoreline of the Columbia River and in tributary drainages and is comprised largely of sand and gravel deposits; and, (3) muck or mucky peat, which is characteristically associated with tidal areas and marsh or swamp habitats in the area.

3.5.2 Types of Impacts from Restoration Activities

Given the range of proposed restoration actions discussed in Chapter 2, there are a corresponding range of potential effects to local geology, soils, and topography. Estuary restoration projects that include CRE actions 6 (beneficial use of dredged material), 9 (modification of dikes and levees), and 10 (off-channel habitat improvement) would affect local geology, soils, and topography at a project site. These effects, discussed in greater detail below, would vary in context and intensity depending on site-specific conditions and implementation. These effects include:

- Temporary erosion and sedimentation
- Altered channel form, structure, and density
- Localized changes in velocity, flow, and circulatory patterns
- Increased groundwater exchange resulting in changes to soil structure and porosity

3.5.3 Effects of Restoration Activities

Short-term construction related impacts would include a temporary increase in soil erosion, compaction, and mixing of soil horizons. Soil disturbance from construction work would include the construction of staging areas and access roads, earthwork, excavation, vegetation removal, and restoration of the hydrologic regime to areas that have been isolated from the river's natural hydrologic processes.

A major source of sand and gravel in the estuary comes from the Corps' dredging operations to maintain the Federal Columbia River Navigation Channel for the purposes of navigation. The material dredged from the navigation channel is placed in upland, shoreline and in-water placement sites throughout the estuary, and ocean disposal sites. However, this material can also serve as an important ecological source to retain coarse sediments in the estuary, and the beneficial use of dredged material (CRE 6) can be used to create or enhance intertidal swamps and marsh habitat for fish and wildlife. Estuary restoration actions would not only increase the quantity and availability of habitats but would also restore sediment transport processes which are currently highly degraded, if not lost altogether, in the Columbia River estuary.

---

[29] Hydric soil is soil which is permanently or seasonally saturated by water, resulting in anaerobic conditions, as found in wetlands.

Scraping down or removing dredged material from previous placement can restore soil structure, natural landforms, and local topography at project sites. Similarly, the strategic placement of dredged materials can be implemented to create tidal marsh habitat or augment existing wetland or marsh habitats to increase their quantity and spatial distribution.

Projects that restore off channel habitats (CRE 9) and modifications to dikes and levee, such as levee breaching, (CRE 10) have the potential to impact geomorphology and soils and geology through altered hydrology and hydraulics. In addition, restoration related activities such as tidal channel creation and ditch filling have the potential to alter the site geomorphology, soils, and topography through excavation and grading. The potential for increased soil erosion is expected during and immediately after levee breaching, when destabilized soils would be exposed to daily tides. However, soil erosion would decrease rapidly over time as the site becomes stabilized and vegetation establishes on the project site.

Construction of levees typically causes the subsidence of a floodplain because the removal of tidal influences has stopped accretion (soil deposition). When estuary projects are implemented, alluvial processes are restored, leading to sediment accretion and restoration of natural soil development processes. Over time accretion rates balance with erosional forces at levee breach sites to establish a self-sustaining marsh ecosystem. Site-specific projects would likely cause rapid sediment accretion and tidal channel evolution thereby restoring floodplain marsh surface elevations.

After levee breaching, existing vegetation not suited for a tidal marsh typically dies back and tidal marsh vegetation appropriate for the restored tidal regime quickly becomes established. Additional soil erosion may still occur during this transition period, but as native species colonize the site, the soils stabilize, and marsh plain elevations rise through accretion.

Vegetation communities in the estuary are highly dependent on elevation and inundation frequency. As tidal marsh habitat develops and habitat succession occurs, site topography and elevation is anticipated to change in response to sediment accretion and localized patterns of erosion.

Project actions implemented to reconnect stream corridors, floodplains, estuaries, and wetlands would restore natural bedload movement, sediment transport, and natural patterns of accretion and erosion. Functionally, these actions restore the spatial and temporal connectivity of streams, floodplains, and wetlands. At large scales, these actions improve population dynamics and spatial community structure across the Columbia River ecosystem. The legacy of flow control on the landscape has resulted in substantial alterations to the structure and function of habitats behind levees and dikes and the tidal tributaries that connect them. Since the building of many of the levee systems in the estuary, historical tidal marshes were isolated from tidal and riverine processes and have subsided due to an increase in erosion and elimination or decrease in accretion rates. In addition deposition rates within many of the tidal tributaries have increased resulting in shallow tidal channels. Tidal and floodplain restoration projects in the estuary restore natural soil forming process and erosion patterns and have a beneficial effect by establishing resilience in the estuarine system better positioning areas to respond to climate change and sea level rise. While construction effects from projects implemented under the estuary restoration program have the potential to have a moderate, temporary in the near-term impact on geomorphology, soils, and topography due to the amount of material displaced, the long-term impacts would ultimately be beneficial due to the restoration of natural soil forming process, erosion patterns, and floodplain function.

Offsite impacts to geomorphology, soils, and topography for projects tiered to this EA are expected to be low to moderate primarily due to changes to hydraulics within tributaries and would be mitigated through the implementation measures listed in Table 2. These projects would be analyzed in site-specific NEPA analysis as necessary.

3.6 Sediment Quality

River sediments are derived from natural geologic sources such as erosion and river scouring; and anthropogenic sources such as land clearing, logging, agricultural activities, urban runoff, and point source discharges. Sediment quality, like air and water quality, is a measure of the contaminant load within sediments. Sediments with low levels of chemical contamination are considered to be of high quality. Sediments of low quality have high levels of contamination.

Chemical contaminants include a high variety of metal and organic substances from urban, agricultural and industrial sources. These adsorb onto suspended sediment particles in the water column that settle to the bottom of rivers and estuaries. Once there, they can be taken up by a variety of plants and animals such as worms, crustaceans, and insect larvae that inhabit the benthic environment. The levels of toxic effects depend on the specific compounds, but they can affect developmental and reproductive processes, immunity, and neurological systems. This is especially true of compounds that bioaccumulate up the food chain such that higher order predators such as otters, sea lions, and fish-eating birds can have large concentrations of these toxics in their systems.

Sediment quality indicators include the types of contaminants, the silt-clay content, and the toxicity levels. The silt-clay content bears on sediment quality because metals and contaminants bind more readily to fine mineral and organic particles than to sand or gravels. Said another way, the higher the ratio of fine mineral and organic materials in sediment, the higher the potential for contaminant retention. Toxicity is a measure of the survival of test organisms in sediments under laboratory conditions. Toxicity is often correlated with chemical loads in sediments, but not always.

3.6.1 Affected Environment

Historically, there were generally two natural sources of sediment for the Columbia River:

- Upstream of the Cascade Range – The upper Columbia basin provided finer sediments from metamorphic, plutonic, and sedimentary rocks that are transported primarily by suspension in the water column
- Volcanic sources from the Cascades – The Cascade mountain range contributes courser sands and gravels that are transported primarily as bedload. The eruption of Mount St. Helens is a clear example of how these mountains have shaped sediment profiles in the estuary

Today, the primary sources of suspended sediments for the Columbia River estuary come from the Snake and Willamette Rivers. Though dam construction has altered the dynamics of sediment deposition in the estuary, the change has been primarily the pattern and season of transport rather than the amount or type of sediment (Whetten, 1969).

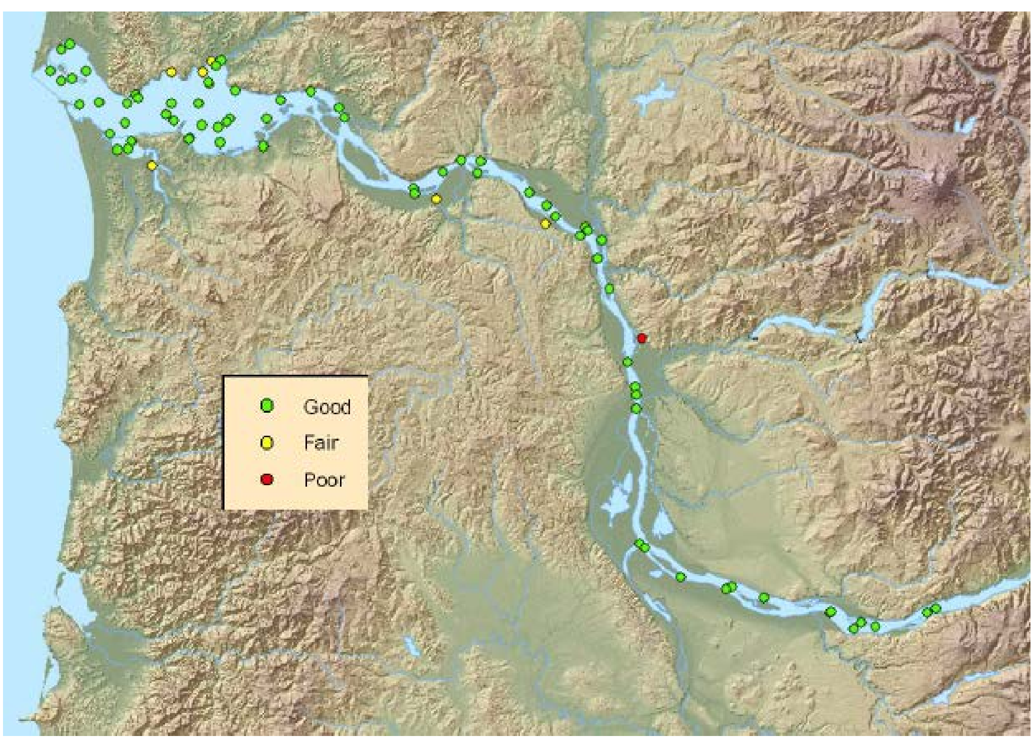
The Columbia River is a sandy river, with most sediment in the mainstem composed of sand and gravels with very little organic content (Hayslip et al 2007). EPA found that 89% of estuary sediments sampled were primarily sand. Fine sediments are found primarily in backwater areas where slow-moving water allows small particles to settle out of the water column.

Organic material in sediments is highly localized and at low levels throughout the estuary. Unlike many rivers where organic material tends to accumulate in slow-moving waters, there is little correlation in the estuary between areas with fine sediment deposition (slow waters) and measures of total organic content (Whetten et al, 1969). This indicates that the primary source of organic materials for sediment comes from localized sources of detritus from aquatic and wetland plants, and litter from riparian vegetation. Historically, log storage areas in the river (timber rafts) provided a significant amount of organic fines, but that practice has been significantly reduced with the decline of timber production since the 1990s (Tetra Tech, 1994). This localization of organic content could explain why estuary sediments, both with and without fine mineral particles, have a low organic content, and for the estuary as a whole, a low toxic chemical adsorption capability.

Numerous studies of water quality, sediment quality, and aquatic species' contamination in the estuary have been conducted over the past few decades and their findings generally agree that there is a chemical contamination problem in the estuary. This contamination, however, is primarily in the water column, not in the sediments.

Known toxic metals and chemicals in suspended and bed sediments in the estuary include trace elements of copper, cadmium, and zinc; dioxins and furans, PCBS; organochlorine pesticides (dieldrin, lindane, chlordane, and DDT); and PAHs. While present, the levels of chemical concentration in most areas (see Figure 2) have been found to be non-problematic (Hayslip et al 2007, Tetra Tech 1994).

Figure 2. Sediment Contamination Condition (from Hayslip et al, 2007)



Radioactive elements were also detected, but they were found infrequently and with concentrations lower than, or similar to, those above Hanford – the largest potential historical direct source (Tetra Tech, 1994).

The highest and most problematic contaminant levels were recorded near urban and industrial areas, with contamination there in excess of levels of concern for DDE, PCBs, dioxins and furans, and PAHs. In these areas, PAH levels have been detected at levels that exceed state or federal sediment quality guidelines or are considered harmful to humans and aquatic life (LCREP 2007).

The Lower Columbia Estuary Partnership contracted with the U.S. Geological Survey and with NOAA Fisheries to collect and analyze water quality, sediment quality, and chemical contamination in salmon in an effort to learn how toxic contaminants are transported and ultimately accumulate in fish in the estuary. The 2007 report concluded that water quality and suspended sediment were of concern in most areas as were chemicals in fish tissue. Sediment in the river bed was not. Their report indicated that contaminants likely move from river water and suspended sediments directly into salmon prey species and from there into juvenile salmon (LCREP 2007).

Bottom sediments appear to pay a comparatively minor role in the transport of toxic contaminants into juvenile salmon in the estuary. This may be because bottom sediments have a low ratio of fine mineral and organic material to sand in most areas, and this limits chemical storage capacity. Tetra Tech conducted toxicity tests and found that overall toxicity in estuary bottom sediments was low and highly localized (near urban, industrial, and agricultural areas), and that toxicity levels appeared to be poorly correlated to the amount of fines in the sediments (Tetra Tech 1994).

Taken together, the estuary data appear to indicate that:

- The water column, suspended sediment, and biota throughout the estuary are carrying a problematic load of toxic chemicals.
- River and estuary bed sediment quality is generally good throughout the estuary.
- The majority of the estuary's sediments are sandy with low percentages of fines and organic content and little capacity to store toxic chemicals.
- The organic component of estuary sediments is generally low with higher levels seen primarily near vegetated sites providing source material from aquatic, wetland, and riparian plants.
- There are localized sites in the estuary where sediment quality is poor because it is either close to contaminant sources, or the sediment at that site contains sufficient concentrations of fines and organic materials to adsorb and retain contaminants from the water column.

3.6.2 Types of Impacts from Restoration Activities

There are five types of impacts that can affect sediment quality:

- Mechanical disturbance of existing sediment
- Changing hydrologic flow patterns that redistribute existing sediments
- Disturbance and re-flooding of soils that create runoff into the estuary contributing sediment and toxins to the estuary
- Increasing the amount of organic material sources in the estuary
- Introduction of pollutants

3.6.2.1 Mechanical disturbance of existing sediments

Dredging and relocation of dredged materials, and dike/levee removal using heavy equipment is the action likely to disturb existing sediments the most. These actions stir up fine sediments, re-suspending them in the water column.

3.6.2.2 Changing hydrologic flow patterns

Disturbance of existing sediments also occur from changes in hydrologic patterns that would likely result from levee, dike or tide gate removal, or otherwise increasing hydrologic connection between wetlands and the mainstem channel. These changed flow patterns redistribute sediments as estuary systems adjust due to the rearrangement of flow-controlling features.

3.6.2.3 Floodplain and tidal reconnection

Wetland restoration includes re-flooding former sediments that have been altered by agricultural or other purposes for many decades. These soils likely have a high organic content, high nutrient load from animal waste, and perhaps high levels of agricultural contaminants. Re-flooding these lands could likely provide a short term pulse of contaminants into the estuary. These actions will create new wetlands, providing increased acreage within the estuary for sediment deposition.

3.6.2.4 Increasing sources of organic material for sediments

The restoration of wetlands, floodplains, and riparian habitats throughout the estuary will ultimately increase the sources and amounts of organic material to estuary sediments.

3.6.2.5 Introduction of pollutants

The operation of heavy equipment creates the possibility of minor spills or leaks of lubricants and hydraulic fluids. The chemical treatment of invasive plants introduces the potential for chemical overspray or spills during application.

3.6.3 Effects of Restoration Activities

Dredging and the relocation of dredged sediments; and dike/levee removal would stir up sediments, re-suspend them in the water column, and redistribute them within the estuary. These sediments would primarily have been buried (in the riverbed, dike, or levee) and may or may not be contaminated. The level of effect is dependent on the level of contamination present in the disturbed sediments, which would vary based on the degree of fine mineral and organic material in the sediments. Re-suspended sediments with high amounts of fine mineral and organic material can be expected to adsorb higher amounts of toxic chemicals and have the most adverse toxic effect to organisms.

If these sediments are of high quality (low toxicity) the effects likely would be a short-term siltation but no long term effect to estuary organisms. There could, however, be a long term benefit as the sediments are redeposited within the estuary. If the redistributed sediments are of high quality, the potential exists for them to contribute to the long term burial of other sediments that are not.

If these disturbed sediments are of low quality (moderate to high toxicity) then re-suspending them makes them more readily available for uptake by aquatic organisms. If toxic sediments had been sequestered and formerly unavailable for uptake in the biotic system, then the action is essentially reintroducing these toxic chemicals back into the system from which they had formerly been separated. These reintroduced toxic chemicals could find their way into the food chain.

This is a short term effect since it is likely that a project's sediment removal and relocating actions would take place in a single season and not create a perpetual source of toxic chemical pollution. It may also be accompanied by a long term effect: the reintroduction of toxic chemicals back into the food chain. Reintroduced toxic chemicals can cycle multiple times through the estuary food chain and be redistributed throughout the entire watershed as higher order animals accumulate it and transport it elsewhere. This recycling and redistribution of toxic chemicals in the watershed and estuary would continue until the toxic contaminant is removed from the system, sequestered within the system, or rendered chemically inert.

Changing hydrologic flow patterns

Removing dikes and levees will change flow patterns which would likely re-suspend and redistribute sediments as estuary systems adjust to the rearranged flow-controlling features. Sediment would likely be scoured away in some locations and ultimately deposited in others. Sediment source locations could be varied and unpredictable and include areas both within the restoration sites and offsite areas where hydrologic patterns are altered, such as in adjacent tributaries. Between the scouring and the deposition, fine sediments would be suspended in the water column, making them readily available for uptake by organisms. These action-induced impacts are short term, occurring over a matter of days or weeks as the moving water gradually rearranges shorelines and bottoms. High seasonal flows following such changes would likely disturb sediments anew as the estuary system continues to adjust to new flow regimes.

Floodplain and tidal reconnection

Restoring wetlands by flooding former agricultural lands would likely introduce a pulse of nutrients and possibly chemical contaminants into the estuary. The nutrient pulse (eutrophication) may foster localized algae blooms that could temporarily degrade water quality and lower oxygen content with adverse effect to benthic[30] organisms and chemical

---

[30] "Benthic" refers to the ecological region at the bottom of a body of water

processes critical in maintaining function of nutrient pathways in high quality sediment. Critical processes that could be affected include phosphorous binding and removal of nitrogen.

These actions, however, would restore wetlands and sediment accretion rates, with new and increased acreage for future sediment development. Increased acreages of wetland sediments, with their high organic content, increases the estuary's binding and storage capacity for nutrients and contaminants.

Increasing sources of organic material for sediments

As discussed above, restoring degraded off-channel wetland habitats provides increased acreage for sediment development with high organic content. The percentage of sediments with high organic content (high capacity for uptake of toxic chemicals) in the estuary is low. Wetland restoration could ultimately increase toxic storage capacity in sediments in the estuary. This increased capacity would not change the level of toxins in the estuary, but they could alter the dynamics of how existing chemicals are transported and stored, reduce their concentrations in the water column, and ultimately sequester them so they are unavailable to be taken up by other organisms.

Toxicity in juvenile fish in the estuary appears to come directly from the water column and suspended sediments. An increase in chemical storage capacity in bed sediments could effectively pull some of this contamination out of the water column, improving fish health. While bed sediment is not divorced from the processes of toxic uptake in organisms and bioaccumulation, it accumulates and deepens and has the capacity to bury (sequester) contaminated sediments below the extent of biological uptake.

Introduction of pollutants

Pollutants could be introduced into the estuary as a result of restoration projects. Leaks from heavy equipment lubricants and hydraulic fluids, and spills or overspray during chemical treatment of invasive plants are the most likely sources. These incidents are anticipated to be uncommon and mitigation measures would be followed to prevent them.

Overall effects on sediment quality are moderate in the long term. Though there may be some short term adverse effects from disturbing and redistributing sediments, the actions proposed would increase organic material into the estuary's sediments over time, increasing their capacity to store nutrients as well as toxic chemicals. While this may lower sediment quality, water quality could improve the water column, thus improving the health of the aquatic biota.

3.7 Air Quality

3.7.1 Affected Environment

Under Sections 108 and 109 of the Clean Air Act, 42 U.S.C. §§ 7401 *et seq.*, the EPA established National Ambient Air Quality Standards to protect the public from air pollution. These standards identify six criteria pollutants which are of particular concern for human health and the environment. Both Washington Department of Ecology and the Oregon Department of Environmental Quality have monitoring networks which measure the levels of these pollutants and attainment, nonattainment, and maintenances areas across each state.[31] These six criteria pollutants are:

- Particulate matter
- Carbon monoxide
- Nitrogen dioxide
- Sulfur dioxide
- Ozone
- Lead

When an area's monitoring results exceed the National Ambient Air Quality Standards a certain number of times, the EPA designates this area as a "nonattainment area". According to both Washington Department of Ecology and the Oregon Department of Environmental Quality, there are no designated "nonattainment areas" within the implementation area. The Portland/Vancouver area is designated as a "maintenance area" for carbon and ozone.

There are four air monitoring stations for that might cover project sites in the estuary. Two are located in the Portland/Vancouver metropolitan area. One is located on Sauvie Island; the other is in Longview. Other than the Sauvie Island site, all stations are focused on urban or industrial sources of air quality issues. The Sauvie Island monitoring site is located in an agricultural setting near the banks of the Columbia River and is monitored year–round for ozone, visibility, wind speed and direction, and temperature. However, it does not monitor the other five pollutants of concern. As such, none of these sites provide background information against which project impacts might be compared.

Greenhouse gases are chemical compounds found in the earth's atmosphere that absorb and trap long-wave thermal radiation emitted by the land and ocean, and radiate it back to earth. The resulting retention and build-up of heat in the atmosphere increases temperatures, which causes warming of the planet through a greenhouse-like effect (EIA 2009). This effect is commonly referred to as "global warming." Global warming has occurred in the past from natural processes, but evidence shows that it has accelerated in the past few centuries, especially since the Industrial Revolution, as a result of increased anthropogenic (caused or produced by humans) emissions of greenhouse gasses. For example, atmospheric concentrations of carbon dioxide, a primary greenhouse gas, have continuously increased from about 280 parts per million in preindustrial times to 379 parts per million in 2005, a 35 percent increase (IPCC 2007). Anthropogenic activities are increasing atmospheric concentrations of greenhouse gases to levels that could increase the earth's temperature up to 7.2 degrees Fahrenheit by the end of the 21st century (EPA 2010b).

---

[31] An attainment area is a geographic area that EPA or the state designates as having met or 'attained' air quality standards, and a nonattainment area is any area designated as having not met air quality standards for any of the criteria pollutants. A maintenance area is an area that formerly exceeded air quality standards for one of the six criteria pollutants (a nonattainment area) but has since met the applicable state promulgated standards and has a maintenance plan to stay within the standards approved by the EPA.

3.7.2 Types of Impacts from Restoration Activities

Air quality can be impacted by a multitude of actions, including those actions implemented under the estuary restoration program. Of the proposed restoration actions that could be implemented in the estuary, there is a range of potential effects to air quality dependent on the duration of the action and BMPs used to minimize these impacts. All of the actions included in the estuary restoration program [CRE actions 1 (protect and restore riparian areas), 3 (protecting and/or enhancing instream flows), 6 (beneficial use of dredged material), 9 (protect and restore off-channel habitats), 10 (breaching, lowering, relocation, or other modification of dikes and levees), and 15 (invasive species management)] would have the potential to effect air quality temporarily at a project site during restoration activities.

3.7.3 Effects of the Restoration Activities

Project impacts to air quality are expected to be low both in concentration and duration. Construction equipment would emit some carbon monoxide, nitrogen oxide, unburned hydrocarbons, and particulates (primarily soot) from tailpipe emissions and cause dust during ground disturbance and travel along unpaved access roads. These could affect air quality locally for short durations. While use of herbicide for invasive species control could cause air quality degradation if applied during high temperatures or inversions, herbicide label requirements restrict application during these conditions, and this is not expected to occur.

Greenhouse gas emissions (which focus on carbon dioxide, methane, and nitrous oxide) associated with the projects would be localized and temporary in the form of construction emissions, off-road vehicles, on-road vehicles (including worker commuting and material delivery), and dust from ground disturbing activities.

Implementation of the estuary restoration program is not expected to generate long term or short-term violations of state air quality standards. Impacts from site specific estuary restoration projects would primarily occur from construction and would be temporary and localized in nature and would not have long-term impacts on air quality. Annual effects to air quality from stewardship, research, monitoring, and evaluation actions would consist primarily of emissions related to travel to and from project sites for maintenance purposes and would also be low.

3.8 Wildlife

3.8.1 Affected Environment

Wildlife habitat types that could be impacted by estuary restoration projects include, but are not limited to:

- Hay/pasture and irrigated or drained agriculture areas
- Lowland mixed hardwood-conifer forest
- Douglas-fir-western hemlock forest
- Hyper-maritime Sitka spruce forest
- Lowland riparian forest
- Coastal sand dune

- Extensive wetlands, including wet prairie, freshwater emergent marsh, tidal salt and brackish marsh, dune wetland, and conifer swamp.
- Harvested/ regenerating lowland forest
- Low, medium, and high intensity developed lands
- Mixed habitats suitable for Columbian white tailed deer

Open grassy wetland areas, bordered by mixed deciduous and coniferous forests, where the estuary restoration projects would typically occur could provide habitat for a number of wildlife species. These include large, grazing mammals such as elk (*Cervus canadensis*), Columbian black-tailed deer (*Odocoileus hemionus columbianus*), Columbian white-tailed deer (Odocoileus virginianus leucurus), and small mammals such the Townsend's mole (*Scapanus townsendii*), Townsend's vole (*Microtus townsendii*), and deer mouse (*Peromyscus maniculatus*).

Habitat in the estuary also provides hunting grounds for predatory mammals such as the long-tailed weasel (*Mustela frenata*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), and coyote (*Canis latrans*); and raptors such as bald eagles (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus),* hawks (*Accipiter* spp.), and owls, including long-eared (*Asio otus*), short-eared (*Asio flammeus*), great horned (*Bubo virginianus*), western screech (*Megascops kennicottii*), and barn owl (*Tyto alba*).

Harbor seals occur in parts of the estuary year round. Two sea lion species, Steller sea lion (*Eumetopias jubatus*) and the California sea lion (*Zalophus californianus*), may periodically hunt for prey in waters surrounding the project areas but likely do not occur year-round.

Ditches and remnant tidal channels on sites could provide habitat for beaver (*Castor Canadensis*), the introduced and invasive nutria (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), mink (*Neovison vison*), and river otter (*Lontra Canadensis*) as well as a range of waterfowl and shorebirds including ducks, geese, gulls, great blue herons (*Ardea herodias*), and spotted sandpipers (*Actitis macularius*). Open water habitat can also support amphibians, such as frogs and salamanders.

Many migratory bird species migrate seasonally from breeding to feeding grounds and utilize the Columbia River estuary. Some locations within the estuary provide key wintering habitat for waterfowl, resting and staging areas for a wide variety of migratory Neotropical species and support some of the highest concentrations of bird numbers in the Pacific flyway (Oregon Wetlands Joint Venture 1994). Neotropical migratory birds are those that use habitats within the U.S. and Canada during spring and summer breeding and nesting season but winter in Central and South America. Many other birds winter along the temperate Pacific coast.

Several special-status wildlife species occur within the Columbia River estuary. For the purposes of this PEA, "special status" refers to species that are ESA-listed as threatened or endangered, or are candidate or species of concern. Critical habitat, defined as specific geographic locations critical to the existence of a threatened or endangered species, also occurs throughout the affected area. Critical habitat is also designated by NOAA and the USFWS under the ESA. The table below provides the current federally threatened, endangered, candidate, and species of concern wildlife species and critical habitat whose range and habitat indicate some likelihood (strays included) of occupying or being encountered in or near restoration sites.

Table 6. Special-status wildlife species and designated critical habitat potentially present in the Columbia River estuary[32]

Wildlife Species	Federal ESA Status / Critical Habitat Designation	Habitat	Range
Amphibians			
Oregon spotted frog (*Rana pretiosa*) (no known populations in implementation area)	Threatened / Proposed	Large marshes near year-round water	Oregon and Washington
Birds			
Marbled murrelet (*Brachyramphus marmoratus*)	Threatened / Designated	coastal ocean foraging, large inland tree nesting	Eastern Pacific Ocean coast north of San Francisco
Northern spotted owl (*Strix occidentalis caurina*)	Threatened/ Designated	Expansive dense forests with large trees	Oregon, Washington, northern California
Streaked horned lark (*Eremophila alpestris strigata*)	Threatened / Designated	Open grasslands; no shrubs or trees; broad range of conditions including estuaries	Puget lowlands, Estuary, Willamette Valley, Southern Oregon
Western snowy plover (*Charadrius nivosus ssp. nivosus*)	Threatened / Designated	Coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes, beaches at creek and river mouths, and salt flats at lagoons and estuaries	Washington to Baja California
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened / Proposed	Dense shrubs and deciduous trees	Canada, U.S., Mexico

[32] NMFS species available at http://www.nmfs.noaa.gov/pr/species/esa/listed.htm. USFWS species available on the Information, Planning, and Conservation System (IPaC), Version 1.4, available at http://ecos.fws.gov/ipac/.

Wildlife Species	Federal ESA Status / Critical Habitat Designation	Habitat	Range
Mammals			
Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	Endangered (proposed for down-listing to Threatened) / None	Riparian areas and densely forested swamps covered with tall shrubs	Estuary population only -Umpqua river basin population is de-listed
Red tree vole (*Arborimus longicaudus*)	Candidate / None	Douglas fir forests - in largest trees	California, Oregon, and Washington
Reptiles			
Leatherback sea turtle (*Dermochelys coriacea*) (strays only)	Endangered / Designated	open ocean and sandy beaches	Pacific subpopulation forages along Oregon coast
Loggerhead sea turtle (*Caretta caretta*) (strays only)	Endangered / None for North Pacific DPS	open ocean and shallow coastal waters	Pacific subpopulation breeds in Japan; migrates near Oregon coast

3.8.2 Types of Impacts from Restoration Activities

Construction activities would likely displace wildlife within the site-specific project areas and cause short-term effects on wildlife from noise and the presence of humans, which may disturb feeding and breeding activities of wildlife within the immediate vicinity. In addition, sedimentation from grading activities or spills of fuel, oil, or other toxic substances from construction machinery could cause injury to wildlife and affect habitat.

Noise effects could occur at any time of the year but would be limited in duration. If sensitive noise receptors, such as ESA listed species, are present within or near the project area then consultation under the ESA would be required and project specific mitigation measures would be put in place to limit the effects to these species and suitable habitat. Other impacts to ESA listed species that would be included in the ESA consultation and result in mitigation measures include, but are not limited to, changes in habitat suitability as a result of restoration actions, attractants of nuisance species and predators, changes in prey and food sources due to vegetation management, exposure to herbicides, and changes in access such as through fencing.

The conversion of pasture areas and restoration of seasonal flooding and or daily tidal cycles to large low lying areas associated with many estuary restoration projects has the potential to permanently displace some terrestrial species. In particular, large mammals, burrowing mammals, and bird species favoring upland grassland habitat type, may find conditions unsuitable after a project's completion with only scattered patches of such habitats remaining. In addition, a change from open grassland to forested shrub/scrub areas has the potential to alter the species composition and displace some species while creating habitat for other species.

3.8.3 Effects of Restoration Activities

Non-nesting birds and larger mammals (such as deer, bear, elk and coyote) would likely leave the area during construction and restoration activities to avoid human presence and noise. Long-term (permanent) effects on wildlife may result from the conversion of diked and drained pasture habitat or freshwater wetlands to tidal marsh habitat. The conversion of pasture grass to emergent vegetation, intertidal channels and mudflats would permanently displace most upland species.

Semi-terrestrial mammals such as beaver, as well as amphibians, waterfowl, shorebirds, and insect-eating birds, would have expanded and much improved wetland and aquatic habitat for breeding and feeding.

Species favoring riparian forest would benefit from the planting of native tree and shrub species in areas bordering the restored tidal wetland. Site-specific estuary enhancements would increase the availability of high-quality wetland and riparian habitat and improve conditions for many species; however, some species including large mammals as mentioned above, may be displaced in areas where hydrology is restored and inundation patterns dramatically altered. While impacts would typically be beneficial for riparian-favoring species there is the potential that some species would be displaced and distributions altered a moderate impact.

Priority habitat for migratory birds in the Columbia River estuary includes freshwater and tidal marsh wetlands. While projects would have some temporary construction effects, the overall effects of projects would increase and enhance wetland area and quality, returning functionality to a large area of levee-protected floodplain and providing high quality habitat for migratory waterfowl and shorebirds. If present during restoration actions, ground and low-lying nesting birds (including their eggs and nestlings), smaller ground-dwelling mammals, and reptiles and amphibians may be harmed or killed incidentally by equipment. For these reasons the short-term effects of projects on wildlife and habitat would be moderate.

Threatened and endangered species listed under the ESA may be impacted through the implementation of the restoration actions. ESA-listed terrestrial wildlife species that are particularly at-risk of being affected by estuary restoration projects include the Columbian white-tailed deer, Streaked horned lark, and the marbled murrelet. These species are at a higher risk because of their occurrence within the implementation area and affinity for sites that also make ideal estuary restoration projects.

Columbia White-tailed Deer prefer riparian areas and fragmented habitats along the Columbia River estuary. Some population strongholds within the estuary are also ideal estuary restoration sites. This species has a high potential to be adversely impacted by large scale levee breaching projects if they occur within core habitat areas.

Streaked horned lark prefer relatively disturbed open areas with sparse vegetation. In addition to airports, dredge spoil sites, and frequently disturbed sites, sparsely vegetated areas along open water often provide suitable habitat for the streaked horned lark. These types of locations are also often ideal estuary restoration locations.

The marbled murrelet nests in older large trees on sufficiently sized branches high in the canopy. The marbled murrelet is somewhat less likely to be found nesting in ideal estuary restoration sites since restoration projects are typically not sited where large trees occur. Tha marbled murrelet could however be impacted by construction noise and nest predators that can be attracted if construction sites near occupied habitats are not kept clean of food attractants.

There is the potential that ESA-listed species could be displaced through the implementation of large scale estuary restoration projects that involve the changes to hydrology over large areas or changes in the vegetation communities within currently occupied habitat.

For estuary restoration projects that could impact ESA-listed species a consultation would be conducted and mitigation measures, conservation measures, or project design features identified to minimize impacts to these species. Due to the potential for projects to impact individual ESA-listed species if they occur in the project area impacts would be moderate.

3.9 Wetlands, Floodplains, and Vegetation

3.9.1 Affected Environment

Wetlands are complex ecosystems that perform a variety of important physical, chemical and biological functions which are essential to the health of the environment, including:

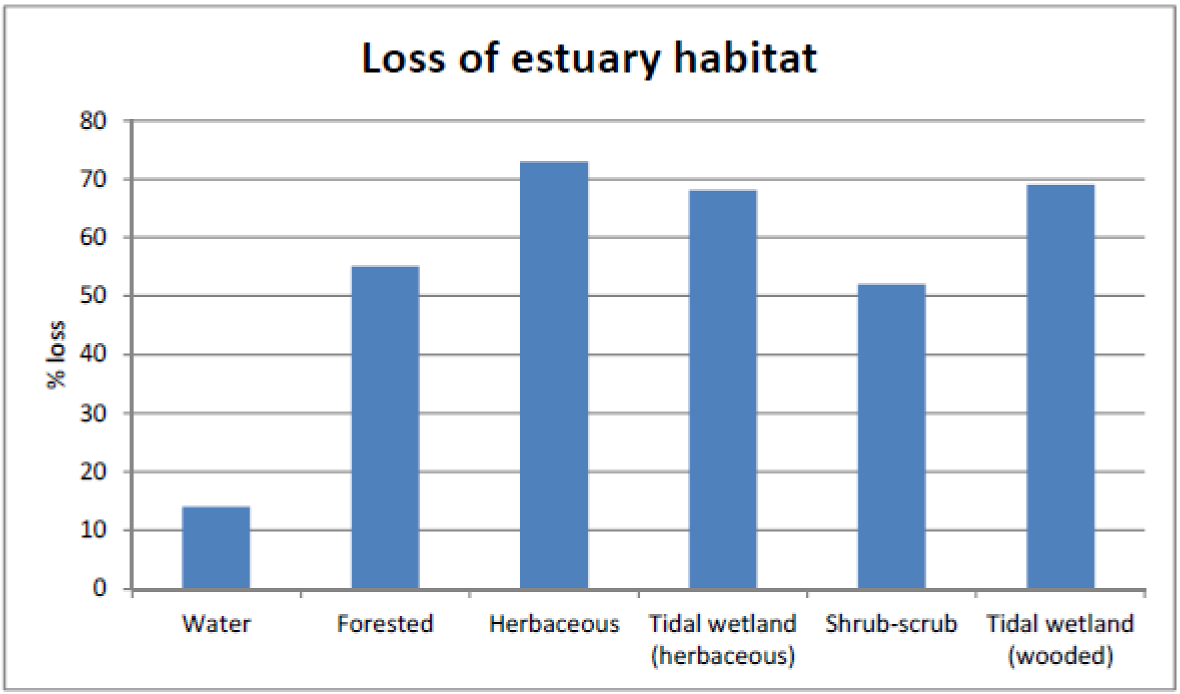
- Wetlands provide temporary storage of storm flows, which reduces erosion and flood peaks, as well as maintenance and recharge of water flows during dry periods.
- Wetlands retain and filter excess nutrients, sediments and contaminants, improving water quality.
- Wetlands provide diverse habitats for fish and wildlife, including breeding grounds, nesting and foraging sites, refuge, and other critical habitat for a variety of fish and wildlife.
- Flood events in the estuary are known to transport macro-detritus and invertebrates out of tidal wetlands into the mainstem river (ERTG 2013b). These estuary-produced food sources are critical to migrating anadromous fish.

The Federal Emergency Management Agency (FEMA) identifies areas with a one percent chance of being flooded in a given year as 100-year floodplains. The entire estuary is within the FEMA-mapped floodplain of the Columbia River and for analysis purposes here, every project site is assumed to be in its floodplain.

3.9.1.1 Wetland losses

Over the past century, the amount of tidal swamp habitat (including tidal sloughs) has decreased by upwards of 78% from historical levels because of dike and levee construction and associated development activities (NPCC 2002). Native riparian plant communities dominated by Oregon ash (*Fraxinus latifolia*) or black cottonwood (*Populus trichocarpa*) forest have declined approximately 86% from historical levels, and forested swamps dominated by Sitka spruce (*Picea sitchensis*) have declined approximately 70% (Graves et al., 1995; Corps 1996). Figure 3 depicts the percentage of historical wetland area lost within the Columbia River estuary by habitat types. As a result of these losses, the flow of nutrients into and out of the wetlands is restricted, altering the food web and decreasing primary production. Dikes, levees, tide gates, and other water control structures also block fish and wildlife access to historical wetlands and seasonal floodplains. Moderating the rates of flow (a result of dam construction and operation) has altered natural flow dynamics in the estuary, resulting in changes to the timing, duration, magnitude, and frequency of seasonal flows. This in turn alters natural processes governing sedimentation, accretion, and erosion throughout the estuary which maintains high quality wetlands and often drives wetland formation throughout the estuary.

Figure 3. Loss of Estuary Habitat (from Marcoe 2013)



3.9.1.2 Historically Altered Wetlands

The construction of dikes and levees, and installment of drainage ditch networks, pump stations, and water control structures has removed tidal influence and seasonal flooding from thousands of acres of wetlands within the estuary. This has led to the conversion of wetland areas to pasture and grass-dominated levee-protected floodplain that have been used for livestock grazing or hay production for the past 70 to 100 years. These lands have typically been seeded with pasture grass on a semi-annual basis and drainage has been maintained creating hydrologic and vegetative conditions that are not representative of historical wetland conditions. While many of the leveed and diked areas still exhibit wetland conditions they have been converted from tidal and riverine wetlands to freshwater depressional wetlands and the wetland hydrology depressed due to the isolation of the wetlands form adjacent waters. These types of converted wetlands often provide significantly reduces ecosystem services and values. Species present in these areas planned for restoration typically includes pasture grasses such as perennial ryegrass (*Lolium perenne*), colonial bentgrass (*Agrostis capillaris*), tall fescue (*Festuca arundinacea*), water and meadow foxtail (*Alopecurus geniculatus* and *A. pratensis*), velvet grass (*Holcus lanatus*), white clover (*Trifolium repens*), or creeping buttercup (*Ranunculus repens*). If not maintained these leveed areas are often dominated by reed canarygrass (*Phalaris arundinaceae*), soft rush (*Juncus effusus*), and birds-foot trefoil (*Lotus corniculatus*).

3.9.1.3 Remnant and Restored Wetland and Riparian Areas

Remnant and restored tidal wetlands (marsh and swamps) and riparian areas occur throughout the estuary and provide important ecosystem services and values such as providing high quality habitat, water quality improvements, and flood reduction. Tidal wetlands areas are subject to tidal inundation and include salt, brackish, and fresh water components. Tidal marshes are typically located between mean lower low water and mean higher high water and are dominated by emergent plants and low herbaceous shrubs. Tidal swamps are dominated by woody shrubs and trees and typically occur at elevations higher than tidal marshes, but sometimes extend below the mean higher high water (Thomas 1983). Riparian areas, shallow water habitats, and tidal flats are also important habitat types also present throughout the estuary.

3.9.1.4 Support for Aquatic Food Web

Marsh and swamp habitats directly support invertebrate species and communities, which in turn provide the basis of the food web and provide an important food source for juvenile salmonids foraging in the estuary. Insects known to be of importance to salmonids include aphids, emergent chironomids, and other dipteran flies (Miller and Simenstad 1997, Simenstad and Cordell 2000). In addition, shallow water and tidal flat habitats are highly productive for benthic invertebrates, particularly *Corophium salmonis*, which is also an important food source for juvenile salmonids (Simenstad et al. 1990). The breakdown of vegetation and other detritus supports invertebrate communities and the remineralization of vegetative production provides nutrients which support phytoplankton production.

3.9.1.5 Special Status Plant Species

There are six plant species that are listed as threatened or endangered under the ESA that are potentially present at proposed restoration sites (see Table 7). Of these, only water howellia (*Howellia aquatilis*) is known to naturally occur in the estuary. Golden paintbrush (*Castilleja levisecta*) and Nelson's checker-mallow (*Sidalcea nelsoniana*) are also known to occur, however, these species were planted at a national wildlife refuge for conservation purposes and are not naturally occurring. The ESA-listed species that have the potential to occur occupy various wetland, grassland, or prairie habitats.

Table 7. Special-status plant species and critical habitat potentially present in the Columbia River estuary[33]

Species	Federal ESA Status / Critical Habitat Designation	Habitat	Range
Bradshaw's lomatium (*Lomatium bradshawii*)	Endangered / None	Seasonally saturated or flooded prairies near creeks and small rivers	Oregon and Washington
Golden paintbrush (*Castilleja levisecta*)	Threatened / None	Upland prairies, flat grasslands with glacial soils, commonly with shrub thickets	Oregon and Washington
Kincaid's lupine (Lupinus sulphureus ssp. kincaidii)	Threatened / Designated	Upland prairie, native grasslands	Willamette Valley
Nelson's checker-mallow (*Sidalcea nelsoniana*)	Threatened / None	Wetlands, remnant grasslands; open areas with little or no shade	Willamette Valley, estuary, Coast Range
Water howellia (Howellia aquatilis)	Threatened / None	Wetlands within Oregon ash and Oregon white oak communities	Puget Sound, eastern Washington, floodplain of the Columbia River
Willamette daisy (Erigeron decumbens var. decumbens)	Endangered / Designated	River bottomlands and alluvial soils	Willamette Valley

Water howellia is known to occur in a mosaic of wetlands, Oregon ash, and Oregon white oak (*Quercus garryana*) communities in the Columbia River floodplain in Clark County, Washington. Its habitats are threatened by urbanization, cattle grazing, timber cutting, road construction and habitat conversion. Wetland succession and encroachment by non-native plants such as

[33] USFWS species available on the Information, Planning, and Conservation System (IPaC), Version 1.4, available at http://ecos.fws.gov/ipac/.

reed canarygrass, and purple loosestrife (*Lythrum salicaria*) have also contributed to the decline of this species (USFWS Species Fact Sheet, Water Howellia, *Howellia auatilis*).

The Washington Department of Natural Resources Natural Heritage Program and Oregon Conservation Strategy have identified state priority plant species within the estuary that may be present in or near estuary restoration project sites. These plant species are presented in the Tables 8 and 9.

Table 8. Special-status plant species and critical habitat potentially present in the Columbia River estuary in Washington

Species	Habitat	Range
western ladies-tresses (*Spiranthes porrifolia*),	Moist and wet habitat such as freshwater swamps and riverbanks	Western U.S. from Washington and Idaho to southern California
tall bugbane (*Actaea elata*)	Moist, shady, dense woods and forests	Pacific Northwest in British Columbia, Washington, and Oregon
Bolandra (Bolandra oregana)	Low elevation sites near streams or on cliffs near waterfalls in moist wooded, rocky places in deep shade	Estuary, Gorge and Snake River Valley

Table 9. Special-status plant species and critical habitat potentially present in the Columbia River estuary in Oregon

Species	Habitat	Range
Bradshaw's lomatium (*Lomatium bradshawii*)	Seasonally saturated or flooded prairies near creeks and small rivers	Oregon and Washington
Golden Paintbrush (*Castilleja levisecta*)	Upland prairies, flat grasslands with glacial soils. Commonly with shrub thickets	Oregon and Washington
Water howellia (Howellia aquatilis)	Wetlands within Oregon ash and Oregon white oak communities	Puget Sound, eastern Washington, floodplain of the Columbia River
Kincaid's Lupine (Lupinus sulphureus ssp. kincaidii)	Upland prairie, native grasslands	Willamette Valley
Nelson's checker-mallow (*Sidalcea nelsoniana*)	Wetlands, remnant grasslands; open areas with little or no shade	Willamette Valley, estuary, Coast Range

Species	Habitat	Range
Willamette daisy (Erigeron decumbens var. decumbens)	River bottomlands; alluvial soils	Willamette Valley
Peacock larkspur (Delphinium pavonaceum)	Willamette River floodplain in native wet prairies; edge of ash and oak woodlands; fence rows and roadsides	Willamette Valley
White rock larkspur (*Delphinium leucophaeum*)	River banks, moist lowland meadows, roadside ditches, moist rocky slopes, edges of oak woodlands	Oregon and Washington
White-topped aster (*Sericocarpus rigidus*)	open, grassy, seasonally moist prairie and savannah habitats	Oregon, Washington, Southern British Columbia

3.9.1.6 Invasive Vegetation

Both aquatic and terrestrial invasive plant species are prevalent in the estuary from decades of accidental and intentional (e.g. ornamental use) introduction.

Noxious weed lists are maintained by the states of Oregon and Washington, and the U.S. Department of Agriculture and each state has their own classification and tracking systems. Dozens of species are listed with varying potential to occur in any one project site.

In the estuary, the following emergent and upland plants are especially problematic when considering restoration of estuary habitats: reed canary grass, scotch broom (*Cytisus scoparius*), Himalayan blackberry (*Rubus armeniacus*), Purple loosestrife, Common reed (*Phragmites australis*), and Japanese knotweed (*Fallopia japonica*). These plants are frequently found dominating sites and often displacing native vegetation entirely. They would likely be targeted for aggressive treatment as part of estuary restoration projects. Other aggressive species including Gorse (*Ulex europaeus*) are less common in the estuary but may be targeted aggressively since they are not yet widespread. Other, less dominant, emergent and upland invasive species may be present and treated in project sites as well.

Invasive aquatic plant species, such as elodea (*Egeria densa*), Eurasian milfoil (*Myriophyllum spicatum*), and Japanese eelgrass (*Zostera japonica*), though prevalent in the estuary, and known to degrade aquatic/wetland habitats, and impede navigation, irrigation, and recreation, are not considered in this EA. They may be mechanically removed or otherwise affected incidentally in the course of implementing estuary restoration actions, but chemical treatment for control of floating-leaved or submerged invasive plants is not considered in this EA. If proposed additional analysis would be conducted to assess the impacts.

3.9.2 Types of Impacts from Restoration Activities

Vegetation and wetlands would be impacted by a multitude of project actions implemented under the estuary restoration program. Of the proposed restoration actions that could be implemented in the estuary, there is a range of potential effects to vegetation and wetlands dependent on the extent of the restoration and construction actions. Estuary restoration actions that would have measurable effects on vegetation and wetlands include CRE actions 1 (protect and restore riparian areas), 6 (beneficial use of dredged material), 9 (protect and restore off-channel habitats), 10 (breaching, lowering, relocation, or other modification of dikes and levees), and 15 (invasive species management).

These effects include:

- Alteration of wetland hydrology
- Conversion of wetland types (such as conversion of depressional freshwater wetlands to tidal wetlands)
- Restoration of wetland forming processes
- Increased wetland area
- Increased habitat complexity
- Increased composition of native vegetation
- Increased riparian buffer width
- Increased vegetation cover
- Increased quantity of tidal marsh habitat
- Increased flows, tidal exchange, and flushing
- Decreased composition, distribution, and quantity of invasive species

3.9.3 Effects of Restoration Activities

Restorations activities are anticipated to restore natural ecological function to floodplains within project sites, and in some cases, in areas immediately nearby. Floodplain function, its flood water conveyance and storage capacity, is therefore expected to increase. These projects will be removing features such as dikes, levees, ditches, impervious surfaces (such as drainage tiles and road surfaces), and other structures that redirected and increased velocity of flood flows. Restoration projects will increase the floodplain's ability to more safely store and move floodwater through the estuary. They could, to some degree reduce floodwater's erosion damage in and near project sites, and increase other natural flood-mitigating functions such as capturing flood-born sediment and filtering out floodwater's impurities and excess nutrients through increased wetland vegetation cover (see below).

Protecting intact and restoring degraded riparian areas (CRE action 1) would enhance riparian vegetation communities and adjacent wetlands within the estuary. As discussed in other sections, enhancement to riparian vegetation would improve water quality and habitat for ESA-listed fish species including prey production and macro-detrital inputs to the ecosystem. By increasing canopy coverage and the diversity of native vegetation in riparian zones, pollutants and fine sediments would be filtered out of overland flow, improving water quality inputs in aquatic environments. In addition, increased canopy cover would increase shade over wetlands and waters, lowering temperatures and further improving water quality. Implementing actions which protect and restore riparian habitats promotes resiliency in the ecosystem and helps to dampen effects from global climate change (see discussion below). Both ocean-type and stream-type juvenile salmonids would benefit from improvements to the riparian habitats as well as increasing the spatial extent and distribution of these areas. For these reasons, large scale protection, restoration, and enhancement of riparian vegetation would have a low to moderate beneficial effect.

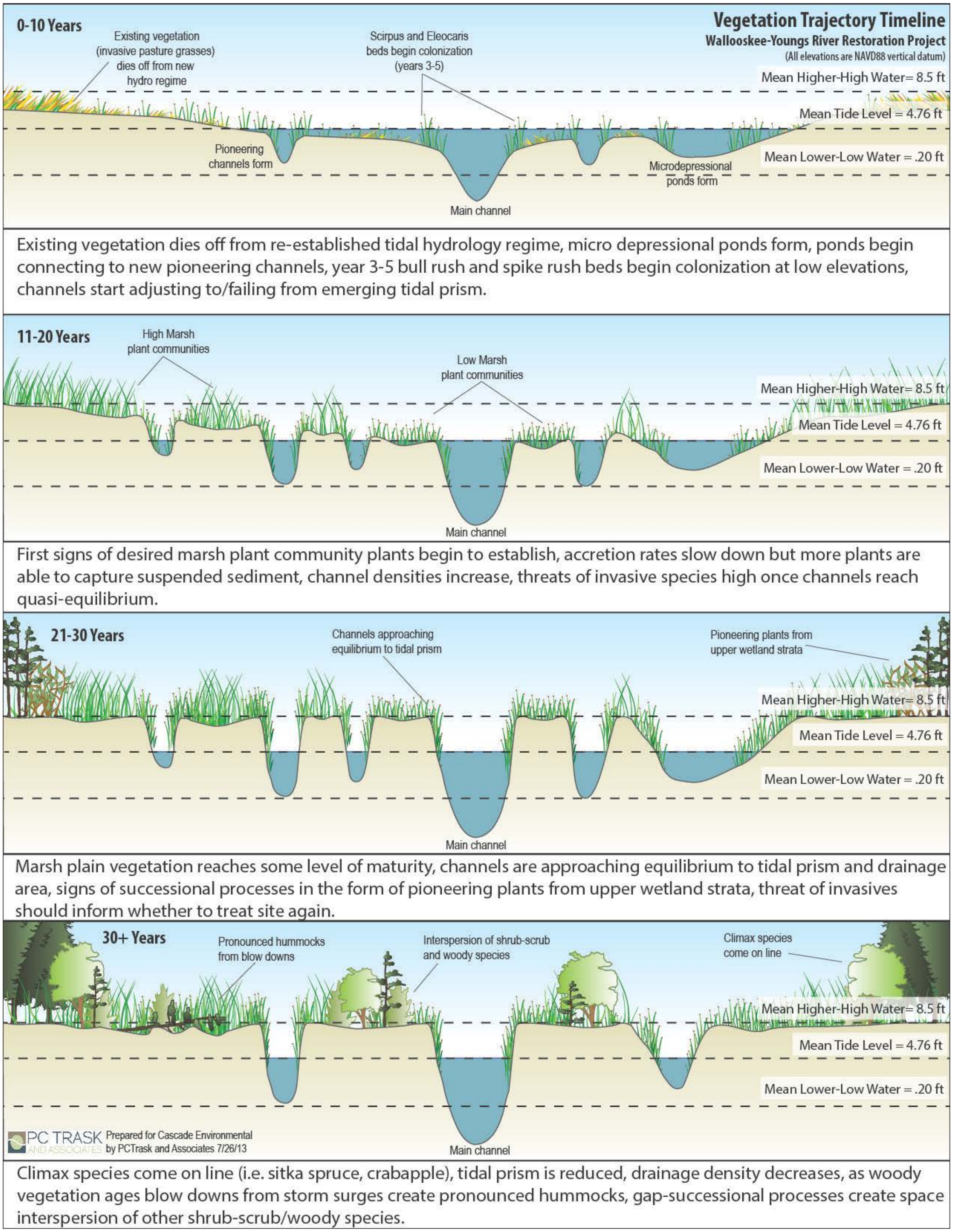
Implementation of projects that include CRE 6 (beneficial use of dredged material) and 9 (protect and restore off-channel habitats) would enhance wetland areas through improvements in wetland hydrology and the restoration of natural flow regimes. These types of management actions could directly impact wetlands through removal and fill within wetland areas associated with tidal channel creation and placement of dredged material. Impacts to wetlands would typically take place in low quality wetlands that have been ditched and drained in the past and would be expected to be offset by restoring of natural wetland forming processes, hydrologic regimes, and creating of large contiguous wetland areas. Implementation of these management actions also typically cause changes in hydrology resulting in the restoration sites becoming wetter, which in turn results in changes to vegetation. In many cases existing vegetation would die back and the areas recolonized by wetland species adapted to the wetter environment. Many estuary restoration sites have been drained for several decades and some have developed forested components with large trees. It is likely that restoration actions in areas that improve wetland hydrology may cause larger trees adapted to dryer conditions to die and be replaced by wetter tree and shrub species. For these reasons, projects that include beneficial use of dredged material and restore and improve off channel habitats would have moderate impacts that include beneficial effects to wetland hydrology and changes to vegetation communities.

Implementation of projects that include CRE 10 (breaching, lowering, relocation, or other modification of dikes and levees), would have short-term impacts to vegetation and wetlands, but are expected to have long term beneficial effects. Restoration would directly impact levee and dike protected wetlands and floodplains through levee and dike modifications, and degraded wetlands would be restored due to the reintroduction of a natural hydrologic regime. Many large scale estuary restoration projects implemented as part of this management action would require vegetation removal and invasive species control throughout much if not all of the restored wetland areas in anticipation of the levee and dike modifications. Furthermore, for restoration actions that include CRE 10 (levee and dike breaching) within tidal wetland areas, the majority of existing vegetation within previously managed areas would likely die back since it would not be suited to the restored hydrologic regime. Modifications in the hydrological regime would create conditions unsuitable for some vegetation communities and alter the wetland types. Overall, the function of the tidal marsh vegetation community would be increased. Figure 4 displays timeframes and processes by which wetlands develop following restoration activities. The effects to existing tidal wetlands that are enhanced or restored through hydrologic improvements associated with levee, dike, and water control structure modifications would be similar to those described above for levee and dike protected areas (e.g., improvements to wetland hydrology and changes in the existing vegetation communities). Vegetation, including trees and shrubs adapted to dryer environments, would likely die back and be replaced by species adapted to wetter environments. In most situations, natural colonization by native herbaceous species would be relied upon to revegetate sites since active planting of these species may not be feasible due to the tidal washing away of seeds. Some projects would include the active planting of tree and shrub species appropriate for restored conditions. In areas where levee removal is conducted to restore floodplain capacity and inundated seasonally during flood events, the effects to wetlands and vegetation described above would be low. In areas where tidal hydrology is restored, impacts to wetlands and vegetation would be moderate and beneficial due to large scale changes in the vegetation community and wetland types as described above.

Implementation of CRE 15 (invasive species management) would directly impact vegetation communities and alter the species composition and structure within riparian and wetland areas. Introduction of invasive species is second only to direct habitat loss in reducing and eliminating native biodiversity. Invasive plants occupy space needed by native plants, and some are aggressive enough to dominate sites, totally replacing native plant species, and thus, the native invertebrates, fungi or other species that may depend on them. This loss of native species can further impact species "higher" on the food chain. Invasive species would be reduced or eliminated from preserved and restored areas through mechanical and chemical control of invasive species. The actions taken to achieve this, however, could impact non-target plant species and vegetative communities. Mechanical methods, whether by machine or by hand, and chemical applications would likely individual, non-target, native plants during invasive species control. The planting of native species and implementation of a hydrological regime unfavorable to most invasive species in the project area during restoration would also contribute to the long-term management of invasive species. Ground disturbance from project activities is usually associated with increasing the risk of spreading invasive plants. In these projects, however, ground disturbed by project activities would most likely be flooded, producing physical conditions that exclude invasive plants and producing conditions that foster tidal marsh vegetation replacing invasive species-dominated sites. A concerted effort to control invasive plant species as a function of restoration projects would likely continue through long-term site stewardship by implementation partners. While invasive species management may result in moderate short term adverse impacts within a restored wetland due to the large scale removal of vegetation, the implementation of this management action is expected to have long term beneficial effects due to the increase in native species appropriate for the site.

Sensitive plant species, including species listed under the ESA, have the potential to be impacted through the implementation of the restoration elements describes above. Impacts to sensitive species would primarily be due to changes in hydrology and construction impacts and would only occur on project sites where sensitive species are present. Due to the historical human caused changes (construction of levees, dikes, and site drainage features) as well as more recent management actions within many of the estuary restoration sites it is unlikely that the areas to be restored would harbor sensitive plant species. If they occur within the restoration sites state-listed sensitive plant species would likely be impacted by the implementation of project elements either directly due to vegetation management and construction or passively due to changes in hydrology. For estuary restoration projects that could impact ESA-listed species, consultation would be conducted with the USFWS and mitigation measures, conservation measures, or project design features identified to minimize impacts to these species. The measures identified during this process would be required. Due to the potential for projects to impact individual ESA listed species when they occur in the project area, the impacts to this resource would be moderate.

Figure 4. Schematic of marsh development and vegetation succession in tidally restored areas (from Wallooskee-Youngs Confluence Restoration Project)



The Clean Water Act requires project sponsors to obtain removal/fill permits for work in wetlands. Many of these projects are expected to be permitted under Nationwide Permit 27 which authorizes removal/fill in wetlands for restoration purposes provided that the project does not have an adverse effect to wetlands or waters. Projects implemented under the estuary restoration program would be unlikely to impact high quality wetlands and wetland functions and values would increase because of the restoration actions. Project that impact wetland functions and values or impact high quality wetlands and require mitigation for wetland impacts are not considered within the scope of this EA and would require site-specific analysis for wetland impacts in a future tiered NEPA document. Restoration actions contemplated in this programmatic EA would create higher quality wetlands with increased habitat diversity, increased water quality function due to increased biomass for nutrient uptake, and increased water quantity functions due to flood storage capacity. Natural processes would be restored and the sites managed to attain typical estuarine conditions. As the restored wetlands continue to evolve, habitat complexity and water quality functions would continue to increase. Wetland functions and values would be greatly improved by the projects through the restoration of tidal process and function. In the long-term, wetland functions and values at restoration sites would increase, and the effects would be beneficial and moderate.

In summary, the effects to wetlands and vegetation from projects envisioned in the EA are intended to be beneficial, by design, since wetland restoration, invasive species control and estuary habitat improvement is the intent of these actions. The scale of these beneficial effects is dependent on the scale of the restoration project, but the goal will normally be to maximize beneficial effects to native vegetation, wetlands, and estuary habitats in the areas treated. While not expected, if a project is proposed that has adverse impacts to wetlands or waters and requires mitigation, then additional analysis would be required in a future tiered NEPA document.

3.10 Land Use and Recreation

3.10.1 Affected Environment

A variety of land uses are found within and adjacent to the Columbia River estuary. The area contains multiple cities and political jurisdictions, including Portland, which is Oregon's largest city, and Vancouver, the fourth largest city in Washington. Smaller cities include but are not limited to Astoria, Cathlamet, Longview, Kalama, Woodland, and Camas. Approximately 1.5 million people live in the vicinity of the estuary, and the population is growing. Five deep-water ports in the area support a shipping industry that transports 30 million tons of goods annually (Lower Columbia Fish Recovery Board 2004), worth $13 billion each year (Columbia River Channel Improvement Re-consultation Project). Timber harvest occurs throughout the basin—six major pulp mills contribute to the region's economy. Until the early 2000s, aluminum plants along the river produced more than 40 percent of the country's aluminum. Agriculture is widespread throughout the floodplain and includes fruit and vegetable crops along with beef and dairy cattle. Commercial and recreational fishing play an important role in local economies, bringing in millions of dollars of revenue each year. Primary outdoor recreational activities include fishing, wildlife observation, hunting, boating, water sports, and hiking (NOAA Fisheries 2011b).

The Natural Resources Conservation Service assigns land classifications, including farmland classifications, based on soil properties and other factors that directly influence the specific use of the land. Farmland classifications identify the location and extent of soils that are best suited to food, feed, fiber, forage, and oilseed crops by specifying soil map units as prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance, as defined in (7 USC § 4201 *et seq.*). Portions of the low-lying areas within the estuary are identified as prime, unique, or farmland of statewide importance by the Natural Resources Conservation Service.

3.10.2 Types of Impacts from Restoration Actions

The majority of the estuary restoration projects would occur within low lying portions of the floodplain along the Columbia River and its tributaries. The projects would have impacts to existing land uses within these areas and could also entail changes in land ownership with willing sellers.

The primary impact to land use would be the conversion of low-lying agricultural and rural residential lands to historical tidal marsh. Impacts would include modifications to dikes and levees, including Corps authorized levees that would return historical hydrologic patterns to restoration areas.

Impacts to recreation are also expected to occur within the project areas due to changes in land ownership and public access.

3.10.3 Effects of Restoration Activities

Potential long-term effects on land use and recreation from project implementation could include, but are not limited to:

- Changes in land ownership
- Conversion of lands from agricultural use to tidal marsh habitat
- Removal of existing infrastructure such as flood protection levees
- Changes in access to or availability of recreational opportunities within the project vicinity

The Farmland Protection Policy Act(7 USC § 4201 *et seq.*), directs federal agencies to identify and quantify adverse impacts of federal programs on farmlands, to ensure those programs do not contribute to the unnecessary and irreversible conversion of agricultural land to non-agricultural uses. Much of the farmland that would be impacted by the proposed restoration actions is located on land that has subsided since being converted from tidal marsh to levee-protected floodplain. Furthermore, many of the levees that surround these lands have deteriorated since construction and require maintenance. When protection of these lands is considered in conjunction with anticipated sea-level rise, it becomes apparent that their ongoing use as farmland may become unsustainable. Restoring degraded farmlands to tidal marsh areas would restore accretion rates and position these areas to better respond to sea-level rise. The proposed action is expected to impact low lying areas currently utilized for agricultural activities and in some cases may impact farmlands identified as prime, unique, or farmlands of statewide importance. While estuary restoration projects would have a low to moderate adverse effect to farmlands, the projects would only occur in areas with willing landowners and federal assistance would be provided when agricultural lease holders are impacted.

Effects to recreation would include construction-related impacts associated with visual and noise disturbance. Long-term impacts may also occur due to changes in ownership, public access, and habitat modifications. Private land often has access restrictions limiting public uses for recreation activities such as boating access, fishing, wildlife viewing, or hunting. Changes in ownership may bring about changes in public access; however, access may continue to be limited to protect fish and wildlife conservation values. Impacts to recreation can also come from these changes in land use. Creating more diverse habitats and more productive wetlands will increase fish and wildlife populations in both numbers and diversity. This will, in turn, increase the amount and quality of recreational experiences such as wildlife viewing, fishing, and hunting. Overall, effects on land uses and recreation are expected to be low to moderate.

When considering individual projects, land use conversions from agriculture (primarily grazing) to natural habitats is anticipated to have impacts on local communities. Changes in recreational opportunities at specific sites are also expected to be of minimal scale and consequence. However, when considering the effects of multiple restoration projects in close proximity to one another there is the potential that the effects could be measurable and therefore have potentially moderate impacts primarily due to the loss of lowland agricultural areas. Provided that restoration projects are only implemented with willing landowners and displaced lessees are relocated the impacts would remain low to moderate.

3.11 Cultural Resources

Cultural resources include things and places related to human occupation or activity related to history, architecture, archeology, engineering, or culture. Historic properties, as defined by 36 C.F.R. 800, the implementing regulations of the National Historic Preservation Act (54 U.S.C. § 300101 *et seq.*), are a subset of cultural resources that includes any district, site, building, structure, or object, important in human history that meets the eligibility criteria for the National Register of Historic Places (National Register).

The National Historic Preservation Act requires that cultural resources be inventoried and evaluated for eligibility for listing in the National Register and that federal agencies evaluate and consider effects of their actions on these resources. Cultural resources are evaluated for eligibility in the National Register using four criteria identified in 36 C.F.R. Part 60.4(a-d). A cultural resource must meet at least one criterion and possess integrity to be eligible for listing in the National Register.

Historic properties include pre-contact resources that predate European contact and settlement. Traditional cultural properties are properties that are eligible for inclusion in the National Register because of their association with the cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community (Parker and King, 1998).

3.11.1 Affected Environment

Cultural resources are common in the estuary including both pre-contact and post-contact cultural resources. The area surrounding the confluence of the Willamette and Columbia rivers had very high pre-contact populations. Many sites have been identified and many other sites have yet to be identified throughout the estuary.

Pre-contact cultural resources present throughout the estuary may include sites associated with all aspects of use and occupation including, but not limited to village sites, burial areas, gathering areas, and fishing stations. Due to the dynamic landforms within the estuary, pre-contact sites can be expected to occur in submerged locations that would not typically be expected in other areas of the Pacific Northwest. Post-contact site types may include farmsteads, irrigation systems, dikes, levees, bridges, roads, commercial fishing, cemeteries, etc. Due to its historic and continued association with both commercial fishing and transportation, numerous sites are located throughout the estuary associated with these activities.

3.11.2 Types of Impacts from Restoration Activities

Each agency would either need to determine effects to historic properties for each of the site-specific projects independently or a lead Federal agency would consult to satisfy the National Historic Preservation Act requirements for multiple agencies. During the design and development of these site-specific projects, measures to avoid, minimize and mitigate effects to properties on or eligible for listing on the National Register of Historic Places would be considered. Each agency would comply with Section 106 of the National Historic Preservation Act andany other applicable cultural resource laws.

The restoration actions envisioned in this EA include dike and levee removal, with associated re-flooding of areas formerly protected from flooding; and tidal channel (re)creation, ditch filling, etc. The resulting conditions would often be re-flooded former wetlands, re-establishment of wetland and riparian upland plant communities, re-established tidal channels, structure removal, and roadbed removal. These actions could impact both buried and above-ground cultural resources.

3.11.3 Effects of Restoration Activities

A variety of cultural resources could be impacted from the due to the restoration actions. Overall effects to cultural resources are expected to be moderate, although most site-specific projects would likely have low effects. In some instances, projects may have a beneficial effect on cultural resources due to the restoration of more natural conditions on some landforms. In other instances, particularly dike removal/breaching, the restoration of more natural conditions could impact the historic character of landforms on a large scale. Minimization, avoidance, and mitigation measures developed through consultation under Section 106 of the National Historic Preservation Act would be used to offset site-specific project effects.

Minimization and avoidance are typically achieved by modifying the project design to lessen the amount or type of construction that is proposed in certain areas. Sometimes protective measures can be incorporated into the project design and implementation that can also minimize or avoid affecting cultural resources. An example would be using archaeological testing to document the presence of fill across the surface of an archaeological site and then only implementing the project within the fill rather than the intact archaeological site. Another example would be using introduced fill to construct a temporary access road across an archaeological site rather than material present within the project area. Other methods of minimizing or avoiding effects can consist of using temporary fencing to restrict project activities from impacting adjacent cultural resources or using cultural resource monitors to observe restoration activities to ensure that cultural resources are not impacted.

Post review discovery plans can be used to communicate when to stop work and steps to take in the event a cultural resource is discovered or impacted during construction. Mitigation can be used to offset the effects of a project on cultural resources. A variety of methods can be identified through consultation that can be used to mitigate effects. Some mitigation methods are implemented on-site while others are implemented off-site. Three relatively common mitigation methods are archaeological data recovery through excavation, documenting historic properties, and public interpretation such as through signage.

In some cases, it may be that an impact to a cultural resource is unavoidable. For example, a dike may be identified for removal or breaching to restore valuable wetlands, and that dike is culturally significant; or a building or other constructed feature would be flooded as a result of dike removal and that constructed feature is cultural significant. In these circumstances, site-specific consultation with the consulting parties, including the State Historic Preservation Office and interested tribes, is critical in developing the appropriate approach to avoid loss of valuable historic information and values.

Effects to cultural resources could be avoided, minimized, or mitigated after thorough evaluation and consultation with tribes, states, and other consulting parties. The effects are therefore considered low.

3.12 Socioeconomics

3.12.1 Affected Environment

Socioeconomic resources include population and housing, employment and income, public services, utilities and infrastructure, government revenue, property values, and land-generated income such as agricultural production and private timber production. Socioeconomic issues include, existing quality of life and other values important to individuals who live or visit the area.

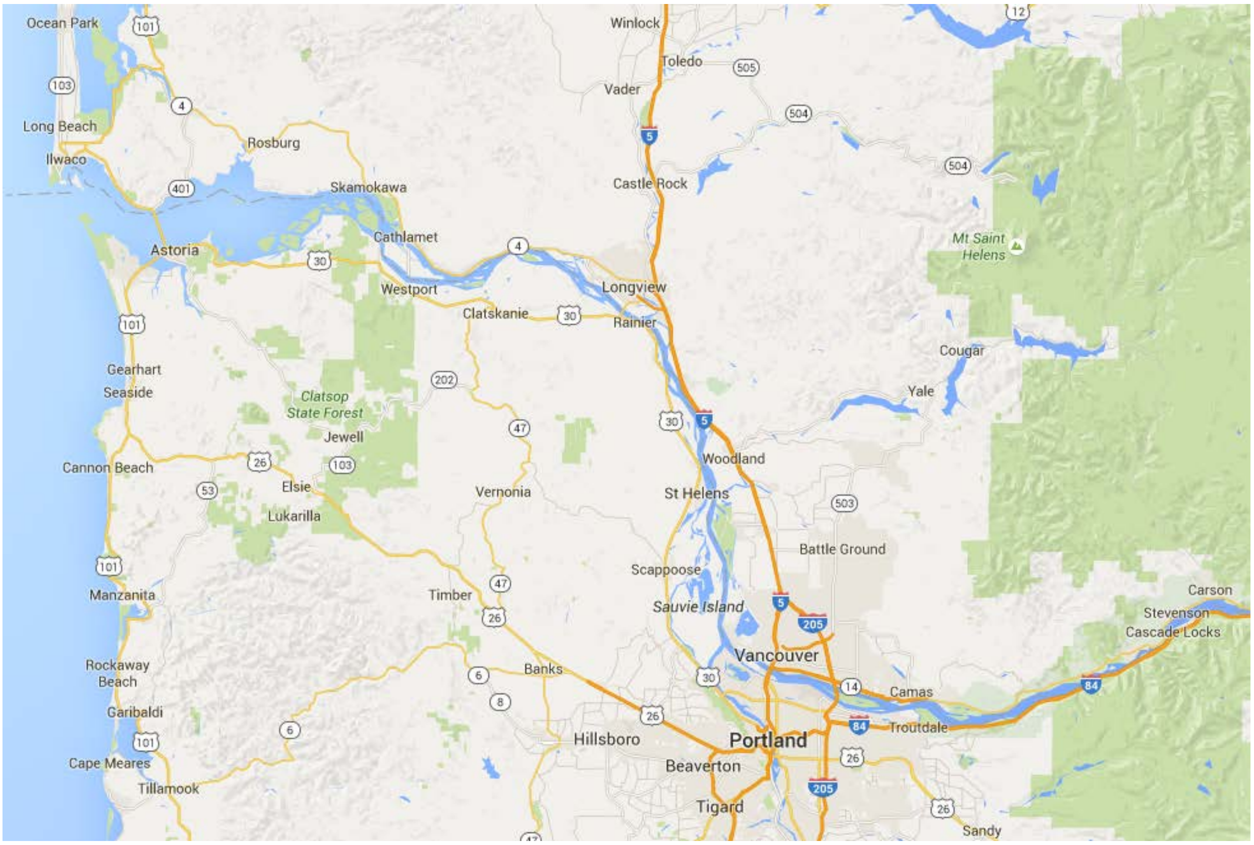
The estuary extends from the mouth of the Columbia River upstream 147 river miles to Bonneville Dam. This extensive stretch of territory includes lands in two states, eight counties, a major metropolitan area and dozens of small cities and towns (Figure 5). The area's economic diversity is enabled by ready availability to international shipping; railway access to the north, south, and east; and major highway access in all directions.

The economic base is centered in the Portland/Vancouver metropolitan area, with Kelso and Longview also serving as a significant localized economic hub. These two hubs are connected by Interstate 5 with most of the communities in between serving primarily as bedroom communities for these major employment centers.

The communities downriver from these economic hubs are small with their economies generally based on agriculture, forestry, fishing, or other natural resource dependent employment. The dominant upland use is commercial timber production, with low-lying areas within and near the estuary primarily devoted to agriculture.

The town of Astoria has tourism as a significant part of its economic base. It has the benefit of being located near the mouth of the Columbia River, the only bridge access across the river downstream of Longview, and at the junction of highways running along the Pacific coast (Hwy 101) and along the Columbia River (Hwy 30).

Figure 5. Communities near the Columbia River Estuary



Agricultural development within the estuary was focused primarily on livestock production and support (hay fields) and is now the dominant non-urban land use in the estuary. Agriculture uses account for 15.4% of the lands within the historical floodplain of the Columbia River. This is 6% more than the next most dominant non-urban land use: deciduous upland forest (9.2%) (Marcoe and Pilson, 2012).

Most of the historical diking and drainage of wetlands within the estuary was designed to create more favorable conditions for dairy farming (Christy, 1993). As a result, this is the land use, along with other agricultural use of drained lands, that would likely be most affected by the actions proposed in this environmental assessment. However, the economic contribution of the type of agriculture most likely to be affected (primarily pasture and hay production) to the area's economy is smaller than others (manufacturing, technology, forest products, transportation and distribution, etc.) in the estuary.

Table 10 displays the population characteristics of the counties and communities within the estuary. Clatsop, Columbia, Cowlitz, Pacific, and Wahkiakum are the counties most likely to see the majority of the restoration actions envisioned in this assessment.

Table 10. Economic Characteristics of estuary counties, cities, and towns (U.S. Census Bureau)

Geographic Area	Population	Minority Population	Number of Households	Average Household Size	Median Household Income	% Below Poverty Level	Four Yr College Degree or Higher
State of Oregon	**4,028,977**	**22.1%**	**1,522,988**	**2.50**	**$50,521**	**16.6%**	**30.1%**
Multnomah County, OR	776,712	19.5%	308,595	2.40	$52,845	18.6%	40.3%
Portland, OR	619,360	23.9%	225,185	2.33	$53,230	18.3%	44.4%
Columbia County, OR	49,459	6.9%	15,746	2.31	$47,337	15.4%	23.6%
Scappoose, OR	6,856	8.8%	2,522	2.66	$62,244	13.3%	20.1%
Clatsop County, OR	37,474	6.9%	18,772	2.61	$54,605	12.0%	17.1%
Astoria, OR	9,521	10.8%	4,233	2.16	$45,104	19.9%	28.5%
State of Washington	**7,171,351**	**19.3%**	**2,645,396**	**2.55**	**$60,294**	**13.2%**	**32.3%**
Skamania County, WA	11,340	7%	4,433	2.51	$50,986	12.6%	21.4%
Camas, WA	21,220	12.6%	6,836	2.98	$84,643	5.8%	42.0%
Clark County, WA	451,008	22.7%	160,492	2.71	$59,551	9.9%	26.5%
Vancouver, WA	169,294	19.1%	65,666	2.49	$50,379	15.7%	25.1%
Cowlitz County, WA	102,133	8.1%	39,765	2.54	$46,571	20.6%	15.6%
Kelso & Longview, WA	48,271	13.9%	19,732	2.41	$36,768	22.8%	14.2%
WahKiakum County, WA	4,067	6.4%	1,716	2.29	$44,500	13.9%	13.9%
Pacific County, WA	20,561	10.1%	9,143	2.23	$39,418	17.8%	16.5%

3.12.2 Types of Impacts from Restoration Activities

Restoration activities would have short term construction related impacts that create long term effects relevant to socioeconomics. The short term impacts would be those related to the direct actions taken to restore estuary habitat such removing or breaching dikes, levees, and dredge spoils; constructing, or removing tide gates, culverts, drainage tile, and other infrastructure; treating invasive plant species and planting native plants. These involve heavy equipment operations and have the potential to creating short term employment opportunities, local short-term traffic, or lifestyle disruptions due to construction activities.

Long term effects include those that result from restored estuary habitats and tidal flows such as land use conversions from grazing and agriculture to seasonally flooded wetlands; and increased populations of anadromous fisheries. These changes have economic implications for individuals, diking districts, communities, and counties.

3.12.3 Effects of Restoration Activities

3.12.3.1 Socioeconomics

Implementation of the estuary restoration program would likely create short-term beneficial economic effects for local businesses (food, fuel, lodging, and materials) associated with construction and restoration actions. Materials necessary to build projects may also be sourced locally (e.g., riprap, soils), and lodging, food, and other services would be required to support construction workers traveling from outside of the immediate area. When practicable, local companies would be utilized for restoration project activities which could provide a shot term increase in jobs. Although beneficial, the positive impact from construction of restoration projects would be small and temporary when compared to the larger local economy. Therefore, the construction related impacts to socioeconomics are considered low due to the minimal amount of goods and services that are expected to be required during these site-specific projects.

The estuary restoration program may also improve fish runs and natural scenery leading to long-term benefits for fishing and tourism within the communities.

Estuary restoration projects would only occur on lands owned by willing land owners or purchased from willing sellers. The majority of the suitable estuary restoration sites would include lands previously utilized for grazing and agriculture. There will be an increase in the acres of land removed from a county’s tax base through land acquisitions (moving lands from private to public ownership), and changes to tax bases by land-use conversion from agriculture to protected wetland. These effects to tax revenue would vary depending on the project and the appraisal process, as well as the final uses and tax status of the land after restoration. These effects are expected to be low since many counties reduce taxes for properties that are used in agricultural production. Nonetheless, there is expected to be a cumulative economic impact on some counties’ tax bases that would impact tax revenue to fund school districts, diking districts, public transportation, infrastructure, and other municipal government projects.

There is expected to be likely no to low impact to population as a result of implementing the estuary restoration program. Some individuals (willing sellers of lands to be restored) might leave the local area, or relocate within it, but this level of change is likely within the amount of routine residential “turnover” any community might experience in a ten to thirty year period.

Similarly, there will be no effect on housing available for local populations. This action would not displace people or eliminate residential suitability from lands unless willing owners sell their property.

Removal of leveed and diked areas from established diking districts may reduce the revenue available to diking districts for routine maintenance and infrastructure improvement. In some cases this loss of revenue may be offset by the reduction in miles of dikes and levees requiring maintenance. The degree of effect is dependent on the level of dependence any one district has on the revenues associated with the dikes that would be removed. The effects of the loss of revenue for an individual diking district due to the removal of a leveed area from the district would likely be low to moderate.

Land use conversions from agriculture (primarily grazing, haying, and hybrid poplar plantations) to natural habitats could have impacts on agricultural productivity and revenue due to changes in land use, a decrease in farming related jobs, and a decrease in agricultural support services.

Effects to the socioeconomics of the region associated with the implementation of the estuary restoration program would be low due to the small scale and dispersed nature of the projects. However, if several estuary restoration projects are concentrated within or near a small rural community, the effects to that community could be moderate due to the removal of lands from agricultural use or changes in land use, employment opportunities, and tax base. Changes in land use, or increases in estuary habitats from implementing the estuary restoration program is not expected to adversely affect property values.

3.12.3.2 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations* (collectively, environmental justice populations), states that each federal agency should identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Executive Order further stipulates that agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination because of their race, color, or national origin.

For the purpose of Executive Order 12898, minority populations include all people of the following origins: African-American, American Indian and Alaska Native, Native Hawaiian or Other Pacific Islander, and Hispanic (of any race). Low-income populations are populations that are at or below the poverty line, as established by the U.S. Department of Health and Human Services.

As the primary goal of the estuary restoration program is habitat restoration it is not anticipated that the projects would have adverse human health or environmental effects or disadvantage low-income or minority populations.

3.13 Visual Resources

3.13.1 Affected Environment

Visual resources consist of natural and human-made features that give a particular environment its aesthetic qualities. At each project, the landscape character would be evaluated to assess whether a project would appear compatible with existing features, or if it would contrast noticeably with the setting and appear out of place.

Views are considered sensitive when they have high scenic quality and are experienced by relatively large numbers of people (i.e., views from publicly accessible areas). Scenic quality is a measure of the overall impression or appeal of an area created by the physical features of the landscape, such as natural features (landforms, vegetation, water, color, adjacent scenery, and scarcity) and human made features (roads, buildings, railroads, other built elements, and agricultural patterns).

The scenic values within and near the estuary are dramatic and varied depending of which stretch of river is being experienced. The following paragraphs are descriptions of the remarkable scenic values of different reaches of the estuary extracted from the "Estuary Water Trail Map and Guide" (Matrazzo):

Overview: "The scenery is sublime, from spectacular waterfalls and sheer basalt cliffs to evergreen-cloaked hills and mazes of mist-shrouded islands. Wildlife refuges harbor hundreds of species of birds and mammals, while immense flocks of migratory birds soar high overhead. History haunts the shorelines with remembrances of abandoned canneries, docks, roaring steamboat towns, Lewis and Clark landing sites, Chinook Indian fishing camps. A day's paddle might veer from tranquil sandy shores to bustling ports of call. A river of legend, the Columbia is extravagant in beauty, dramatic in landscape, and always an intriguing journey."

River Mile 146-122: "just below Bonneville Dam, the last of the Columbia River dams; from here the river is free-flowing to the Pacific. Throughout this reach, the trail passes through the beautiful Columbia River Gorge National Scenic Area, where craggy 3,000-foot basalt cliffs rise dramatically from the river. Multnomah Falls, with its 620-foot drop, is tallest of the bevy of cascading waterfalls -- the second highest concentration in the country, next to Yosemite Valley. Intriguing rock formations like Phoca Rock, Rooster Rock and 850-foot Beacon Rock are remnants of ancient lava flows. The river is wide and open, with frequent rough waters, and strong winds confirm the Gorge's reputation as a sailboarding mecca."

River Mile 122-102: "Flowing past the communities and metropolitan areas of Camas and Vancouver in Washington, and Troutdale and Portland in Oregon, the river is fringed with moorages and marinas, and Portland International Airport. The Columbia's two largest deep-water ports, the Port of Portland and the Port of Vancouver, are typically lined with docked international cargo ships. On clear days, Mt. St. Helens, Mt. Adams, and Mt. Hood are visible jutting above the panorama of Cascade Mountains."

River Mile 102-86: Sauvie Island in Oregon is the largest Columbia River island, 15 miles long and four miles wide, with its own rivers, lakes and sloughs. The southern half is mainly private farmland while the northern 12,000 acres comprise the Sauvie Island Wildlife Area, permanent home or migratory stopover for more than 260 species of wildlife. The northern shore is a popular long, sandy beach with Warrior Rock Lighthouse near its end. Across the river is the Ridgefield National Wildlife Refuge. "Scappoose Bay offers an extensive, intricate maze of wetlands and marsh. The Mainstem of the Columbia is narrow here with many side channels, sloughs, bays, and adjacent lakes".

River Mile 86-68: "A number of islands worth exploring -- Sand Island, Deer Island, Martin Island, Goat Island and Sandy Island -- offer interesting sloughs and side passages. Along this stretch the Columbia is narrow, although the shore broadens on the Washington side near Woodland."

River Mile 68-38:"Wooded hills and mountains in the distance frame the river scene, until downriver where the Washington shoreline rises into steep cliffs. This reach features a variety of open water, island and backwater sloughs, with the mainstem dominated by the shipping channel and large commercial river traffic. "

River Mile 38-18: "From the water, much of this reach looks untouched by civilization. The Lewis & Clark National Wildlife Refuge is a labyrinth 35,000 acres of dozens of islands, wetlands, tidelands and marshes laced with myriad channels and backwater sloughs. Roosevelt elk, small white-tailed deer, and many species of birds inhabit the 5,600 acre Julia Butler Hanson National Wildlife Refuge for Columbian white-tailed deer. One of the few remaining Sitka spruce swamps is preserved at Blind Slough. A stretch of vertical cliffs and 80-foot waterfalls is known as the "lower Gorge." The towns of Cathlamet and Skamokawa recall the once-abundant river communities that dotted the shoreline. Water conditions vary greatly. Near Tenasillahe and Puget islands, the river is narrow and confined, then widens to a broad, open expanse downriver."

River Mile 18-0: "Between Cape Disappointment and Clatsop Spit the mouth is two miles wide. The river's confluence with the Pacific is fraught with large waves, river and tidal current and strong winds that create both challenging and potentially dangerous conditions. Up through the tributaries of this reach are calm backwater streams and small rivers meandering through wetlands, woods and farms. Astoria, one of the first settlements in the West, still has a working waterfront, with docks and wharves along its length. A short stroll from Netul Landing on the Lewis & Clark River is Fort Clatsop, a replica of the fort built by Lewis and Clark. Across the Columbia, Fort Canby and Cape Disappointment commemorate the spot where Lewis and Clark first reached the Pacific."

3.13.2 Types of Impacts from Restoration Activities

Impacts to visual resources from implementation of the estuary restoration program include short-term impacts associated with the construction of restoration projects and long-term impacts associated with the changes in land use (primarily from agricultural to restored areas).

3.13.3 Effects of Restoration Activities

Long-term effects on visual resources from implementation of site-specific projects would likely come from the transformation of specific sites from agricultural uses to undeveloped, natural open space. There would likely be modifications to existing infrastructure such as decommissioned roads, upgraded culverts or bridges, removal of levees and dikes, and removal of buildings. Changes would be more localized and site-specific and likely not visible in surrounding areas. The changes in some locales, however, could be evident in territorial views depending on the scale of the site-specific project, and the viewpoint of the observer.

Removing sections of barriers, such as levees and dikes, would alter the physical landscape of many site-specific projects by removing sections of the existing infrastructure and creating tidal channel networks throughout the site. The character of the site would change from that of an engineered human landscape to one that is characterized and shaped by nature's forces, and consistent with the natural landscapes surrounding it.

While some viewer groups prefer the aesthetics of agricultural land to natural areas, some viewer groups prefer the vegetative, topographic, and hydrologic diversity of natural landscapes, as well as the increased wildlife available for viewing. The project designs would be consistent with the historical, natural aesthetics of the site, and restoring habitat diversity would result in visual conditions more typical of the historical landscape.

For visual resources, the effects would be low, but could be moderate to viewers near restoration sites during and after construction.

3.14 Noise, Hazardous Waste, and Public Health and Safety

3.14.1 Affected Environment

Noise is the intrusion of a new sound inconsistent with and above the background level of the existing soundscape. The existing soundscape of the estuary where most restoration projects might be located can be characterized as rural, where the dominant sounds come from agricultural activity, rural roadway travel, river navigation; and natural sounds such as flowing water, small waves, wind through vegetation, wildlife, and domesticated animals. In some areas, sounds of residential or urban human activity may intrude.

Hazardous waste sites are few in areas where estuary restoration is envisioned. There may be small localized sites on agricultural lands where small spills from agricultural equipment or agricultural chemical use occurred in the past. There are, however, likely no large sites where hazardous chemicals have accumulated over the years such as industrial sites or large ports. No large scale hazardous waste dumps or sites contaminated by chronic leaking would likely be selected for estuary restoration. Such sites might be identified within lands proposed for restoration, but these are anticipated to be a rare exception, and would be planned for cleanup prior to restoration of any tidal flows.

Existing risks to **public health and safety** on sites envisioned for estuary restoration projects are anticipated to be few, and would be those common to agricultural and rural settings along rivers such as those associated with operations of agricultural machinery and equipment, livestock related, collapse of old structures, falling trees, drowning, falls, and electrocution.

3.14.2 Types of Impacts from Restoration Activities

Noise

Noise impacts associated with the implementation of the estuary restoration program include short term (few days to a couple of weeks) noise from construction equipment (bulldozers, graders, backhoes, etc.) during construction activities. This would be followed by intermittent (every few years) short duration (1-2 days) maintenance-related noise generation. Construction equipment could cause noise impacts at site-specific project locations that could be heard from adjacent properties.

Hazardous Waste

Construction equipment contains petroleum products, such as gasoline, diesel fuel, motor oil, and hydraulic fluid, and other hazardous fluids, such as anti-freeze. Equipment leakage may lead to the release of small quantities of these substances into the environment. Releases of hazardous substances to the environment may also occur when contaminated media, such as soil and gravel, are used for construction or backfill materials, or if existing sites of contamination (e.g., underground storage tanks) are encountered during construction. Hazardous material is further discussed in Section 3.6, Sediment Quality.

Public Health and Safety

Restoration activities, including operation of heavy equipment, work in hazardous environments (e.g., next to water) and increased construction traffic, have the potential to impact public health and safety during construction on site-specific projects. These impacts could include, but are not limited to:

- Risk of injury to workers from the use of heavy equipment, working in water, earthwork in general, and exposure to hazardous materials (such as petroleum products and other hazardous fluids), or dust during construction. In particular, work around water involves the risk of drowning and work in saturated soils could lead to unplanned equipment movement where soils lack the strength to support heavy loads.
- Construction trucks and vehicles entering or leaving the project area could increase safety hazards for vehicles and travelers using nearby streets and roads.

Restored flow regimes and seasonal flooding is likely to be an intended result from many restoration projects. This is an impact with potential long-term safety and health implications as discussed below.

3.14.3 Effects of Restoration Activities

3.14.3.1 Noise

Construction and maintenance related noise would be the primary noise generating activity associated with implementation of the estuary restoration program. Individual equipment operating during construction would likely be discernible above ambient noise up to 2,000 feet away from a construction zone in areas of general quiet. On-site (within 50 feet), the noise level generated by construction equipment is generally within the allowable limits set by the Occupational Safety and Health Administration for worker exposure for an eight hour day, however, hearing protection would be utilized for some actions. For off-site observers, construction noise may be a short term nuisance, but would not place people at risk of hearing loss.

Construction-related noise could impact nearby neighbors, businesses, and wildlife during construction. Projects would, therefore, typically limit construction activities to normal daytime working hours. At night, activities generating noise would be limited to only those necessary, such as for dewatering pumps or equipment use when needed to accommodate tidal schedules. Short-term effects due to noise are expected to be low due to the relatively short duration of construction.

Once implemented, the site-specific projects would not make noise, except for that from limited vehicle access to the site to monitor and maintain it. Follow-up maintenance actions would likely be limited to infrequent use of equipment for vegetation maintenance (such as mowing) and monitoring if applicable. The noise from these actions, however, is expected to be similar to that from agricultural operations generated prior to restoration actions, and from those in surrounding areas.

Over the long term people living, working, or recreating near restoration sites would likely experience a decrease in human created noise coming from restoration sites and an increase in natural sounds associated with restored estuary habitats.

3.14.3.2 Hazardous Waste

Once implemented, the site-specific projects would not present the hazardous materials risks associated with the use of construction equipment. Long-term stewardship might require limited access by maintenance vehicles, but those would follow best management practices to avoid causing contamination. There would likely be no long term effect from hazardous waste.

3.14.3.3 Public Health and Safety

The short-term effects from construction/restoration activities would not be expected to overburden the existing health and safety infrastructure near site-specific projects. The potential health and safety risks to workers and the public during construction would not be greater than a standard construction project, and therefore the short-term effects of the project to health and safety would be low. Adequate signage and other routine safeguards for worker and public safety would be applied to minimize these effects.

These projects would restore historical seasonal flood regimes to lands that were leveed and diked off from the river. This type of seasonal flooding is not the life-and-property-endangering flooding that rivers of this size historically produced. Those major floods are now prevented by the series of upstream dams that regulate flows for public safety and other benefits. The types of flooding restored by these projects would allow daily tidal flooding or seasonal flooding of comparatively small contained acreages designed to avoid harm to personal property values and human life. Nonetheless, these projects would increase the surface area of flowing and standing water in places where there was none in recent local history. There could be safety concerns (accidental drowning, stranding, etc.) in some locations where roads or trails bring people in close proximity to new/restored hydraulics.

The restored site could create low-lying or poorly-drained areas which could pond water for sustained periods of time. Under some circumstances, ponded water could provide breeding habitat for mosquitoes, which are a nuisance and a public health threat, since they can serve as vectors for diseases such as West Nile virus. The restoration sites would be subject to regular tidal inundation, and the restoration elements would be designed to ensure adequate drainage within the site, both to prevent fish stranding as tide waters recede and to ensure mosquito breeding habitat is not inadvertently created.

In addition, the restoration sites would be monitored long-term to ensure restoration objectives, including proper site drainage, are met. As a result, the long-term effects on public health and safety from mosquito-borne disease would be low (and commensurate with existing levels).

Due to the reasons described above the effects of the estuary restoration program to noise, hazardous materials, and public health and safety would be low.

3.15 Transportation and Infrastructure

3.15.1 Affected Environment

Ground transportation within the estuary primarily occurs along state and federal highways, and other types of roads and streets for residential, agricultural, and business use. Dikes and levees are frequently topped with roads that provide access for agricultural, recreational, or other uses. These access routes may be affected if dikes or levees are removed or breached. Similarly, estuary restoration work could permanently change land use (e.g. from agricultural land to flooded wetland) and access to site-specific locations may be affected.

Most affected roads are expected to be 'local', 'minor collector' or 'major collector' roads under the Federal Functional Classification[34]. Roads atop dikes are usually local roads, but some serve as minor collectors.

The Columbia River provides a travel corridor for large ships and smaller vessels within the estuary. Smaller boats also utilize many of the tributaries within the estuary and most waters within the estuary are navigable during high tide.

In addition to roads, infrastructure, such as buildings, bridges, power supplies, pipelines, etc. is likely to be present in some form or another on many restoration sites. In most cases these features will be serving a larger area than that proposed for restoration and will require protection or relocation. Where infrastructure elements serve only places that will no longer need that infrastructure following restoration (e.g. bridges or pipelines to buildings that might be removed) the infrastructure element will likely be removed.

3.15.2 Types of Impacts from Restoration Activities

Construction could temporarily increase traffic on roads near the projects sites. Best management practices and site-specific mitigation would minimize effects to transportation, such as using traffic control when necessary and staging equipment and vehicles as far away from roads as possible.

If dikes or levees are breached or removed, the roads that top them would likely be eliminated. Some breaches may be accomplished without the loss of their associated roads if culverts or bridges are used to maintain road connections.

Navigability of tributaries could be altered if flow regimes are significantly changed due to the implementation of estuary restoration projects. Specific impacts to transportation along navigable tributaries associated with restoration could include changes in the flow velocity or duration, alteration of the water course path, or changes in deposition patterns within the tributary that affect the ability of vessels to utilize the water course.

Infrastructure could be placed at risk by restored tidal flows or other restoration actions. In some cases, bridges, roads, or utility lines were erected in areas at a time following initial

[34] 'Local' roads provide access over short distances, primarily to provide access to adjacent land; Collector roads collect traffic from local roads; 'Minor collector' roads to link smaller communities not served by higher classification roads; 'Major collectors' link smaller communities to larger towns and cities.(Federal Highway Administration).

draining and were thus not constructed to withstand such inundation or flows. Protection or relocation of essential infrastructure will be required to avoid effects to these features.

3.15.3 Effects of Restoration Activities

Loss of some local roads would reasonably be expected. For projects under the program, designers would use the Federal Functional Classification to identify the type of service and amount of traffic affected roads might carry to determine what level of mitigation, reroute, or replacement, if any, is needed.

Long-term maintenance of restoration sites would likely require infrequent vehicle trips. In the long term, access might be permanently limited or changed at the site-specific locations due to changes in hydrology, land use, and other project effects. These effects are expected to be moderate.

Navigability within the Columbia River or tributaries within the estuary is not expected to be impacted through the implementation of the estuary restoration program. A thorough discussion of the effects estuary restoration program on water quantity, velocity, erosion, and sedimentation patterns within the Columbia River and the tributaries within the estuary is provided in Section 3.3. In general, implementing estuary restoration and floodplain reconnection projects could increase the amount of water moving through tributaries adjacent to projects on a daily basis due to tidal fluctuations. Over time channel depth within these tributaries may adjust down slightly to accommodate the increased duration or velocity of water flow. Due to the volume of flow within the Columbia River relative to the increased flow from estuary restoration sites, there would likely be no to low effects to navigability. If there is the potential to affect navigability, these effects could be studied in additional site-specific analyses that would be tiered to this EA.

3.16 Climate Change

Climate is governed by incoming solar radiation and the associated greenhouse effects which influence short-term, seasonal, and long-term weather patterns. Greenhouse gases include: water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Anthropogenic activities, such as the burning of fossil fuels and the clearing of forests adds additional greenhouse gases to the atmosphere, intensifying natural greenhouse effects, and ultimately causing changes to global, regional, and local climates.

Executive Order 13514 and subsequent guidance from the Council on Environmental Quality (2011a and 2011b) led to development of Corps policy and planning documents: the *Climate Change Adaptation Policy Statement* and the *Climate Change Adaptation Plan and Report* (Corps 2011b, 2012, and 2013, respectively). The policy states, "mainstreaming climate change adaptation means that it will be considered at every step in the project lifecycle for all [Corps] projects, both existing and planned . . . to reduce vulnerabilities and to enhance the resilience of our water resource infrastructure." In its *2013 Climate Change Adaptation Plan*, the Corps identified four categories of climate change effects which have the potential to impact its national mission and operations (Corps 2013). These four categories include:

- Increasing air temperatures
- Changing precipitation
- Increases in extreme events

- Sea level change and associated tides, waves, and surges

Climate change is widely recognized as a critical issue with potentially wide-ranging effects on water resources, fish and wildlife species and their habitats, and other natural resources. It has also been suggested that the effects of climate change will exacerbate temperatures; the timing and magnitude of stream flow; habitat loss, isolation and degradation; invasive species; and drought. According to the U.S. Global Change Research Program (USGRP), the average regional air temperatures have increased by an average of 1.5°F over the last century (up to 4°F in some areas), with warming trends expected to continue into the next century (2009). Precipitation trends during the next century are less certain than those for temperature, but increased precipitation is likely to occur during October through March and less during summer, with more winter precipitation falling as rain rather than snow (ISAB 2007, USGCRP 2009).

Greenhouse gases are chemical compounds found in the earth's atmosphere that absorb and trap long-wave thermal radiation emitted by the land and ocean and radiate it back to earth. The resulting retention and build-up of heat in the atmosphere increases temperatures, which causes warming of the planet through a greenhouse-like effect (EIA 2009). This effect is commonly referred to as "global warming." Global warming has occurred in the past from natural processes, but evidence shows that it has accelerated in the past few centuries from an increase in anthropogenic emissions of greenhouse gasses. For example, atmospheric concentrations of carbon dioxide, a primary greenhouse gas, have continuously increased from about 280 parts per million in pre-industrial times to 379 parts per million in 2005, a 35 percent increase (IPCC 2007). Anthropogenic activities are increasing atmospheric concentrations of greenhouse gases to levels that could increase the earth's temperature up to 7.2F by the end of the 21st century (EPA 2010).

3.16.1 Affected Environment

Long- and short-term climate fluctuations throughout history have caused natural variations in Columbia River flow. The Pacific Decadal Oscillation alternates between cold and warm phases approximately every 30 years (Fresh et al. 2005). The cold, rainy phase is typical of the Northwest and increases flows, while the warm phase is drier and decreases flows (Fresh et al. 2005).

The El Niño/Southern Oscillation is a shorter, 3- to 7-year phenomenon that similarly has cold and warm phases that may magnify or reduce the effects of the Pacific Decadal Oscillation.

Climatic fluctuations have a profound effect on the amount and timing of water flowing to the estuary (Fresh et al. 2005). Since 1878, climatic changes have reduced Columbia River flows by 9 percent (Jay and Kukulka 2003). The NOAA Fisheries Northwest Fisheries Science Center has observed changes in Pacific Decadal Oscillation and El Niño/Southern Oscillation indicators that suggest that changes in ecosystem structure are unfavorable for salmon and steelhead (Varanasi 2005).

These changes may continue over the next several years. Scientists believe that the release of high levels of carbon dioxide from human activities is contributing to global climate change. The source of these releases includes the use of fossil fuels to run cars, heat homes and offices, and power factories. Over the past century, global climate change has caused sea levels to rise about four to five inches (10 to 13 centimeters), worldwide precipitation to increase by about one percent, and the frequency of extreme rainfall events to increase in much of the United States (EPA 2005).

Over the long term, winter precipitation is expected to increase, and summer precipitation is expected to decrease. Within the Columbia River basin, expected effects of rising temperatures include more precipitation falling as rain rather than snow, diminished snow pack, reductions in late-summer/early-fall flow, altered timing of flows, increased peak flows, and continued rises in water temperatures.

Recent climate change studies indicate that global warming trends will accelerate the melting of polar ice sheets and sub-polar glaciers, both of which will contribute to sea level rise. While there is considerable uncertainty about the short-term estimates of sea level rise, most studies point to a long-term trend that will result in considerable sea level increases by 2100.

The National Research Council has estimated that for the Washington and Oregon coast, sea level is projected to change between falling 1.6 inches to rising 9.0 inches by 2030, falling 1.2 inches to rising 18.9 inches by 2050, and rising between 3.9 and 56.3 inches by 2100 (NRC 2012).

Sea-level rise is uneven, varies from place to place, and depends on regional factors, such as ocean and atmospheric circulation patterns and tectonic plate movements associated with earthquakes. Earthquakes have affected sea levels in and around the estuary, and could dramatically change sea levels in the future. An earthquake of magnitude 8 or greater, which occurs in this area every several hundred to 1,000 years with the most recent in 1700, could cause parts of the coast to subside immediately and the relative sea level to rise suddenly by a meter or more (NRC 2012).

3.16.2 Types of Impacts from Restoration Activities

Climate change can be impacted by a multitude of actions, including those actions implemented under the estuary restoration program. Of the proposed restoration actions that could be implemented in the estuary, there is a range of potential effects to climate change dependent on the duration of construction, BMPs used to minimize these impacts, and long term disposition of the site and its roll in carbon sequestration. All of the actions included in the estuary restoration program [CRE actions 1 (protect and restore riparian areas), 3 (protecting and/or enhancing instream flows), 6 (beneficial use of dredged material), 9 (protect and restore off-channel habitats), 10 (breaching, lowering, relocation, or other modification of dikes and levees), and 15 (invasive species management)] would have the potential to effect climate change at a project site during restoration activities. The effect of climate change, specifically sea level rise, could have on restoration projects is also analyzed.

3.16.3 Effects of the Project to Climate Change

Greenhouse gas emissions from restoration actions are discussed in the air quality section. As discussed, due to the short construction duration, low number of vehicles and equipment, and estimate of emissions well below the EPA's reporting threshold, the impact from greenhouse gas emissions would be low and therefore the potential for the program to accelerate climate change would be low.

The creation of tidal wetlands proposed by the estuary restoration program would help to mitigate increases in greenhouse gases and associated climate change because tidal wetland restoration creates a carbon sink due to absorption of carbon dioxide by the restored plant community. A study of both restored and existing Oregon tidal wetland systems found that tidal wetlands could sequester an order of magnitude more carbon than any other type of wetland community and emit only a negligible amount of methane compared to freshwater wetlands (MacClellan 2011).

The drainage and agricultural use of former tidal wetlands caused a loss of stored soil carbon (MacClellan 2011). Restoring former tidal wetlands would turn sites that are currently exporting carbon into carbon sinks. By increasing stored carbon through the creation of tidal wetlands, the estuary projects would help mitigate for the release of greenhouse gases. For these reasons, effects on climate change from the program are beneficial and low.

Sea-level rise could affect site-specific project areas by inundating plant communities and changing water depths to a level that does not support tidal wetland plant communities. The restoration of a functioning wetland plant community would help buffer the effect of rising sea levels by attenuating wave action and storm surges. Restoring native plant communities and soil forming processes such as sediment accretion would also belter position the restoration sites to respond to sea level rise.

3.17 Summary of Effects for Proposed Action and No Action Alternative

As mentioned throughout this analysis, that actions associated with the Proposed Action and those of the No action will likely be identical. Likewise, the mitigation measures applied to all actions would be the same under both the Proposed Action and the No Action Alternative.

The differences between the alternatives are found in the pace of their implementation, and the likelihood projects being implemented concurrently.

3.17.1 Effects of the Proposed Action

The Proposed Action is anticipated to enable efficient processing of environmental review of estuary improvement actions. With this increased efficiency there could be a more rapid implementation of resource improvement actions and in some cases, efficiently sequencing or concurrent implementation. This can have both beneficial and adverse consequences.

Adverse effects, particularly those short term effects associated with project implementation could be more concentrated in both time and space. Construction related impacts such as sedimentation, noise, traffic, erosion, all discussed under the resource discussions above, could be more impactful to vegetation, fish, wildlife, and people. These effects, however, would be mitigated as discussed in Chapter 2 such that violations of applicable standards would not occur. The adverse short term effects, however, could still be more intense under the Proposed Action than under the No Action Alternative.

Beneficial effects, however, would accrue more quickly. These are generally long term effects to wetlands, vegetation, fish, and water quality… resources in need of restoration as soon as possible. These are the resources currently threatened, endangered, or not meeting required quality standards.

In the case of fish, an increased pace is desired as fish production and habitat improvements upstream are providing conditions for increased fish runs with an expected increased demand for estuary feeding and rearing resources.

3.17.2 Effects of the No Action Alternative

The No Action Alternative will continue estuary improvement actions at the current pace. Projects under this alternative are expected to be implemented more slowly and sequentially than under the Proposed Action, and there is far less likelihood of efficiently sequenced or concurrent actions under the No Action Alternative.

This slower pace, however, can have its benefits. There is expected to be less of the concentrated short-term adverse impacts associated with project implementation, and short-term adverse impacts would likely unfold more sequentially and thus slowly.

However, the long beneficial effects would certainly develop more slowly as well, with long term benefits to estuary habitats fish populations and water quality developing later and more gradually over time. This gradual improvement may not be sufficient to support increasing fish populations that are being enabled by habitat and production improvements elsewhere in the Columbia River basin.

This page left intentionally blank

Chapter 4 Cumulative Impacts Analysis

Cumulative impacts are the impacts on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

4.1 Past, Present and Reasonably Foreseeable Future Actions

The following section provides information on how past, present, and reasonably foreseeable future actions were identified, and discusses possible cumulative effects when considered with the effects of the actions proposed in this EA.

4.1.1 Past and Present Actions

Past actions relevant to the cumulative analysis in this EA are those that have previously taken place and are largely complete, but that have lasting effects on one or more resources that also would be affected by Columbia River estuary restoration projects. The nature and extent of resource management efforts that has resulted from past actions in the vicinity of the project area is largely described earlier in this chapter in the "Affected Environment" sections for each resource.

Present actions are those projects, developments, and other actions that are currently underway because they are either under construction or occurring on an ongoing basis. Present actions generally include on-going land management and use activities such as grazing, farming, and residential, commercial, and industrial development. Effects of present actions have largely been captured in Chapter 3.

Past and present actions contribute to the existing conditions in the Columbia River watershed as described in Chapter 3. These include the past construction and current operation and maintenance of dams and reservoirs along the entire river and its tributaries; regional development for residential, commercial, industrial, agricultural, and recreational use; and the construction of dikes and levees to facilitate the conversion of land use from floodplain habitats into agricultural and grazing pastures for cattle. These actions altered the physical structure of the estuary, the hydraulic processes that historically shaped it, and its biological and chemical components, which have adversely affecting the estuary and the anadromous fish that use it. The introduction of non-native species, overfishing, mining, predation, early hatchery practices, the release of toxic pollutants, and adverse ocean and climate conditions have all added pressure to this system, ultimately contributing to the endangerment of numerous anadromous fish runs. Since the 1970s however, a concerted public and private effort has been underway to restore these fish runs and the habitat upon which they depend without losing the benefits (e.g. flood protection, safe navigation, and power generation) provided by the initial actions and infrastructure. Thousands of mitigation actions (structural and operational) and restorative projects (populations and habitat) have been implemented. Among these is the protection or restoration of more than 7,000 acres of estuary habitat. Anadromous fish runs are now beginning to increase throughout the Columbia basin in response to these restoration actions.

4.1.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions generally include those actions formally proposed or planned, or highly likely to occur based on available information. The reasonably foreseeable future actions considered for this analysis are primarily the continuation of present activities of similar scale and level of effect. These include:

- Operation and maintenance of the FCRPS dams, reservoirs, and hatcheries
- Logging, fishing, mining (sand and gravel), and agricultural practices
- Use and development of the estuary for residential, commercial, and industrial purposes (including operations of port facilities) related to expected population growth throughout the region
- Dredging of the Columbia River navigation channel and side channels
- Restoration of existing natural areas and the acquisition, restoration, and conservation of aquatic, riparian, and upland habitats by federal, state, and local land management agencies
- Implementation of federal and state natural resource protection laws
- Implementation of the FCRPS BiOp and RPA to minimize adverse effects to ESA-listed salmon and steelhead, and protection of critical habitats
- Implementation of water quality improvements to improve overall water quality

Agricultural activities, the operation of the FCRPS, dredging of the Columbia River channel, and human land and resource uses will all likely continue at a scale comparable to the present.

This analysis presumes an increase in coal, natural gas, and crude oil transport through the region, whether by truck, rail, ship, or pipeline. It likewise presumes improvements in major roads and bridges, including widening, realignment, and replacement, though specific locations are unknown. It presumes adequate maintenance activities and necessary upgrades for railways and pipelines and successful implementation of state-of-the-art safety and monitoring measures. This analysis recognizes the likelihood of infrequent and minor spills.

Table 11 summarizes the past, present, and reasonably foreseeable future actions in the Columbia River estuary that could have cumulative effects relevant to this analysis:

Table 11 Past, Present, and Reasonably Foreseeable Future Actions in the Estuary

Affected Resource	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Fish	Initial development of the FCRPS with hatcheries and subsequent modifications to enhance fish passage; dredging for navigation; flood control levees and diking to create farmlands and pasture; commercial and recreational overfishing; upstream fish habitat degradation/loss.	Operation of the FCRPS with hatcheries and modified flow regimes and structures to provide for fish passage; dredging for navigation with beneficial uses of dredge spoils; regulated commercial and recreational fishing; anadromous fish and fish habitat restoration activities basin-wide; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration and increases in upstream fish habitat and fish population restoration projects. Improvements in flow and temperature regimes with FCRPS to aid fish migrations.
Hydrology and Hydraulics	Initial development of the Federal Columbia River Power System (FCRPS) and subsequent modifications to enhance fish passage; dredging for navigation; flood control levees and diking to create farmlands and pasture; logging/log rafting.	Operation of the FCRPS with modified flow regimes and structures to provide for fish passage; dredging for navigation with beneficial uses of dredge spoils; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Water Quality	Industrial activities; agricultural activities; road construction and maintenance; residential and commercial development; logging, milling, log rafting.	Same as past activities with Clean Water Act compliance and BMPs; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.

Affected Resource	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Geomorphology, Soils, Topography	Diking to create farmlands and pasture; agricultural activities; road and railroad construction; commercial and residential development; logging/log rafting.	Agricultural activities; residential development; maintenance of roads, and railroads; dredging for navigation with beneficial uses of dredge material; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Sediment Quality	Industrial activities; agricultural activities; road construction and maintenance residential, commercial and industrial development; dredging for navigation; flood control levees/ diking to create farmlands and pasture; logging, milling, log rafting.	Industrial activities; agricultural activities; road construction and maintenance; residential and commercial development; dredging for navigation with beneficial uses of dredge material; all of the above with Clean Water Act compliance and BMPs; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Air Quality	Agricultural activities, burning of wood/yard debris; residential commercial, and industrial development; road and railway construction and maintenance; transmission construction and operation.	Same as past activities with Clean Air Act compliance; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.

Affected Resource	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Wildlife	Diking to create farmlands and pasture; agricultural activities; road construction and maintenance; residential, commercial and industrial development; logging; initial development of the FCRPS and subsequent modifications to enhance fish passage; hunting and fishing; introduction of invasive species.	Agricultural activities; road construction and maintenance; residential, commercial and industrial development; logging; operation of the FCRPS with modified flow regimes and structures to provide for fish passage; regulated hunting and fishing; fish habitat, stream, and riparian restoration activities basin-wide; estuary restoration activities; expansion of invasive species; invasive species control actions; beneficial uses of dredge spoils; control of Caspian terns and double-crested cormorants; compliance with Endangered Species Act.	Same as present actions with increased acreages of estuary restoration and basin-wide riverine and upland habitat improvements.
Wetland, Floodplains, and Vegetation	Diking and draining to create farmlands and pasture; agricultural activities; flood control levees; road construction/maintenance; residential, commercial and industrial development; initial development of the Federal Columbia River Power System; introduction of invasive species.	Agricultural and timber harvest activities; road construction and maintenance; residential, commercial and industrial development; wetland restoration projects; expansion of invasive species; invasive species control actions; beneficial uses of dredge spoils.	Same as present actions with increased acreages of estuary restoration.

Affected Resource	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Land Use and Recreation	Diking to create farmlands and pasture; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; fishing and hunting.	Agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; fishing and hunting; non-consumptive recreation activities.	Same as present actions with increased acreages of estuary restoration.
Cultural Resources	Initial development of the FCRPS; diking to create farmlands and pasture; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development.	Residential, commercial and industrial development; logging; road construction and maintenance; agricultural activities; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Socio-Economic	Initial development of the FCRPS; diking to create farmlands and pasture; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development.	Agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; fish habitat, stream, and riparian restoration activities basin-wide; operation of FCRPS to enhance fish runs; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Visual Resources	Initial development of the FCRPS; diking to create farmlands and pasture; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development.	Agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; estuary restoration projects.	Same as present actions with increased acreages of estuary restoration. Increased protections of scenery in lower Columbia River (state or federal scenic designations).

Affected Resource	Past Actions	Present Actions	Reasonably Foreseeable Future Actions
Noise, Hazardous Waste, and Public Health and Safety	Initial development of the FCRPS; dredging for navigation; flood control levees/diking to create farmlands and pasture, agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; dredging of river channel.	Maintenance of flood control levees, dikes, and flow structures; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development; dredging of river channel; estuary restoration activities.	Same as present actions with increased acreages of estuary restoration.
Transportation	Initial development of FCRPS; dredging of river channel for navigation; road construction; road development atop dikes and levees; residential, commercial and industrial development.	Dredging of river channel for navigation; road construction and maintenance; residential, commercial and industrial development; minor loss of local roads atop dikes or levees with estuary restoration projects.	Same as present actions with increased acreages of estuary restoration. Likely expansions to existing roads and bridges. Increased removal of dikes and levees in estuary restoration.
Climate Change	Initial development of the FCRPS; diking to create farmlands and pasture; agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development.	Agricultural activities; logging; road construction and maintenance; residential, commercial and industrial development.	Same as present actions with increased acreages of estuary restoration.

4.2 Cumulative Impacts Analysis Considerations

For this analysis, there will be no distinction between the Proposed Action and the No Action Alternative.

Cumulative impacts for both the Proposed Action and the No Action Alternative are considered to be indistinguishable. The Proposed Action and the No Action Alternative would implement the same estuary restoration program,, but the differences in impacts between these alternatives relate primarily to timing and sequencing of the restoration projects within the program. There are no differences in impacts between these alternatives from a cumulative impacts perspective. In this discussion of cumulative effects they will be referred to collectively as the estuary restoration program, which includes restoration actions and land acquisition actions. The Proposed Action and No Action Alternative are referred to separately in all other parts of this document.

4.2.1 Fish

The past and present actions impacting fish include actions that are detrimental as well as those designed to be beneficial. These comparatively recent beneficial actions are occurring throughout the Columbia basin and address both populations (through hatcheries, fish passage and transport, and species distributions) and their habitats (through improvements and restorations, and flow regulations). The detrimental actions include the impacts from human population growth and its associated industrial, commercial, and residential development, as well as direct impacts from fishing and human presence.

Past actions were far more detrimental to fish than present actions. Present actions that adversely impact fish have a lower impact than past actions because of improved design and mitigation measures intended to minimize adverse effect. Present actions also include the relatively recent extensive program of fish population and habitat improvements intended to mitigate for effects of the FCRPS. These present actions are expected to continue into the reasonably foreseeable future.

Through the estuary restoration program, BPA and the Corps intend to provide an on-going region-wide approach for providing improved habitat for salmon and steelhead. This approach includes tidal restoration and land acquisition projects throughout the estuary as well as mitigation at hydroelectric dams and basin-wide restoration within tributary habitats. Preliminary results show that restoration projects in the Columbia River watershed are improving spawning habitat as well as juvenile salmon and steelhead growth and survival, and that further improvements in the condition of the habitat and fish growth and survival will continue to occur as additional actions are implemented (PNNL, 2012). This program of habitat improvements is funded by rate-payers for electricity provided by the FCRPS and is expected to continue funding population and habitat improvements into the reasonably foreseeable future.

Absent additional estuary restoration or protection projects, fish populations are expected to continue to benefit and increase to some degree into the foreseeable future from past actions in the estuary and throughout the Columbia River basin. The cumulative effect of adding an increased scope and scale of estuary restoration would only increase incremental impacts to which fish and wildlife populations benefit into the future.

The cumulative effects of estuary improvements and acquisitions for wetland protection extend basin-wide because an increased capacity of the estuary to support rearing juvenile salmon and steelhead in the future will be critical to support the expected increased numbers of fish from upstream past and ongoing improvements. The estuary is extremely important rearing habitat for juvenile salmon and steelhead prior to their entrance into the Pacific Ocean. The long-term success of basin-wide restoration efforts to recover populations of anadromous fish is likely dependent on commensurate improvements in the estuary.

Fish populations are not expected to return to levels believed to exist prior to pre-European settlement. However, with the cumulative effects of all past, present, and reasonably foreseeable adverse future human activity and the restoration actions underway at the present and into the reasonably foreseeable future, fish and wildlife populations are expected to increase to support ceremonial and subsistence fisheries for American Indian Tribes, as well as for commercial and recreational fishing.

The cumulative impacts of the estuary restoration program on fish when added to past, present and reasonably foreseeable actions are expected to be moderate.

4.2.1.1 Special Status Fish Species

Table 12 displays the types of long-term and cumulative effects to special status fish species from implementing the restoration projects in the estuary. The effects were identified considering the following long-term effects of estuary habitat improvements:

- Conversion of vegetation
- Sedimentation and accretion
- Restored or improved hydrology
- Increased food web support
- Enhanced water quality
- Increased populations of anadromous fish

These effects were considered along with those of past, present, and reasonably foreseeable actions in the estuary. A common conclusion for all of the discussions in this table is that past, present, and reasonably foreseeable actions in the estuary would not negate the effects that increased acres of wetlands and restored tidal processes will have on plant and animal communities over time.

For anadromous salmonids the individual species are included under one heading because their uses of estuary habitat types and food sources overlap and are nearly identical.

Table 12. Cumulative Impacts to Special Status Fish Species

Species	**Summary of Cumulative Impacts from Estuary Improvement Program When Added to, Past, Present and Reasonably Foreseeable Actions**
Anadromous salmonids	Increasing acreages over time of improved rearing and feeding estuary habitats will increase fitness of anadromous fish before moving on to ocean life phase. Increased estuary carrying capacity for juvenile fish will increase effectiveness of upstream hatchery, habitat, and population enhancement efforts. Estuary enhancement efforts are expected to overshadow detrimental effects from other human activities for the factors benefitting these fish in the long run.
Pacific eulachon	Eulachon traverse estuaries quickly when moving between spawning areas and the ocean, making no use of estuaries for feeding or rearing. Increasing amounts of estuary habitat could provide some water quality improvements but in general it is expected the projects would provide minimal benefit. Estuary enhancement efforts may not be as relevant to eulachon populations over time as would be detrimental effects from other human activities for the factors affecting these fish.
Green sturgeon	Increasing acreages over time of improved rearing and feeding estuary habitats will increase fitness of juvenile sturgeon before moving on to ocean life phase, and will improve amount and quality of estuary of habitat for adults staging in estuaries in the months before spawning migrations upstream. Estuary enhancement efforts are expected to overshadow detrimental effects from other human activities in the long run.
Bull trout	For lower Columbia River segment only. Bull trout are a very rare occurrence in the estuary and cumulative effects are expected to be minimal due to the rarity of occurrence of the species in the estuary.
Coastal cutthroat trout	Increasing acreages over time of improved rearing and feeding in estuary habitats will benefit both adult and juvenile cutthroat trout as they spend much of their time in these habitats. Estuary enhancement efforts are expected to overshadow detrimental effects from other human activities for the factors benefitting these fish in the long run.
Pacific lamprey	Increasing acreages over time of improved rearing and feeding estuary habitats will increase fitness of juvenile lamprey before moving on to ocean life phase. No long-term benefit for adults as they do not use the estuary. Estuary enhancement efforts are expected to overshadow detrimental effects from other human activities for the factors benefitting these fish in the long run.

4.2.2 Hydrology and Hydraulics

The degree of impacts to hydrology and hydraulics associated with current levels of the activities listed in Table 11 is expected to continue into the foreseeable future as described in Chapter 3. Of all the actions, operations of the FCRPS and dredging have the most direct and immediate effect on flows and these are expected to continue as they do now, or if modified in the future, would be so in a manner intended to benefit anadromous fish or to avoid or minimize harm.

As population-growth-related development continues within and near the estuary it is expected that local effects to hydrology may occur due to altered drainage patterns. Runoff is likely to become flashier during storm events due to an increase in impervious surface area.

Restoration projects implemented under the estuary restoration program are expected to be relatively localized with limited, if any, off-site changes to hydraulic regimes. The accumulation of these across the estuary over time is expected to create no cumulative change to flow patterns that would create effects not already addressed in Chapter 3. Cumulative restoration actions, however, will increase the estuary's capacity to accommodate increased flood flows, thus the flashier flows that could result from future land development could be offset to a large degree, if not entirely.

Overall, the incremental impact of the estuary restoration program when added to other past, present and reasonably foreseeable actions is expected to be low.

4.2.3 Water Quality

Water quality in the estuary is an issue today, and this issue is expected to continue. The impacts to water quality resulting from the past and present actions listed in Table 11 are expected to continue into the reasonably foreseeable future. This industrial, residential and agricultural activity is expected to increase as the population grows, and will likely remain the primary contributors to water quality concerns (see Chapter 3). This increase, however, is also expected to be offset by reasonably foreseeable actions of increasingly aggressive application of BMPs, the Clean Water Act and effective attention to resolving site-specific water quality issues.

The long-term effects of multiple restoration projects, including land acquisitions for wetland protection, throughout the estuary can be expected to improve water quality. Wetland vegetation restores natural filtering processes that remove sediments, nitrogen, phosphorous, and other nutrients (Thom et al. 2013). Increasing acreages of protected wetlands over time, with their filtering capabilities and contributions of organic materials to sediments can be expected to increase the estuary's capability to draw contaminants out of the water column and transfer them to wetland sediments where they can ultimately be sequestered (discussed further under "Sediment Quality", below). This increased capacity to remove contaminants from the water, along with anticipated increases in water quality improvement efforts at contamination sources is expected to lead to improvements in water quality over time. Thus, the estuary restoration program is expected to have a low cumulative impact on water quality.

4.2.4 Geomorphology, Soils, and Topography

The degree of impacts to soils and topography associated with current levels of the associated actions listed in Table 11 is expected to continue into the foreseeable future as described in Chapters 3 and 4. Agricultural and timber practices and future land development have the most potential for erosion. The site-specific and cumulative effect of this erosion, however, is low (as compared to historical impacts from these activities) since BMPs would be routinely applied.

The cumulative effect of estuary restoration and land acquisitions under the estuary restoration program for wetland protection, however, is an increasing and stable capacity over time for the estuary to productively capture sediment (as displayed in Figure 4). Estuary restoration improves floodplain sediment storage as part of the natural process of building tidal marshes. Studies of estuary restoration sites show very rapid sediment accumulation, which benefits wetland plant communities and channel development (Thom et al. 2013).

The likely interaction, therefore, between the estuary restoration program and possible erosive runoff from future land development and management activities would be of one (restoration actions) offsetting the other (erosion effects of land management).

Implementation over time of numerous estuary restoration projects and land acquisitions would restore the physical processes and resources over many acres protected for that purpose that could cumulatively increase the estuary's capacity for flood water storage and sediment accumulation. This increased capacity can dampen, to some degree, likely adverse hydrologic and geomorphologic effects of the past, present, and reasonably foreseeable future land management and development actions. Therefore, the estuary restoration projects are expected to have a low cumulative impact on geomorphology, soils and topography.

4.2.5 Sediment Quality

Sediment quality in the estuary is not an issue today (see Chapter 3), and is not expected to become an issue in the foreseeable future. Though industrial, residential, and agricultural activities are expected to increase as the population grows, this will likely not translate into a sediment quality issue. This is because of the water quality protective actions discussed above and because sediment quality condition is a function of the sandy nature of the river rather than the level of pollutants. The coarse sediments are not capable of adsorbing pollutants from the water, and reasonably foreseeable actions will not affect the sandy nature of Columbia River sediments.

The long-term effects of multiple restoration projects and land acquisitions for wetland protection throughout the estuary will produce two results relevant to sediment quality:

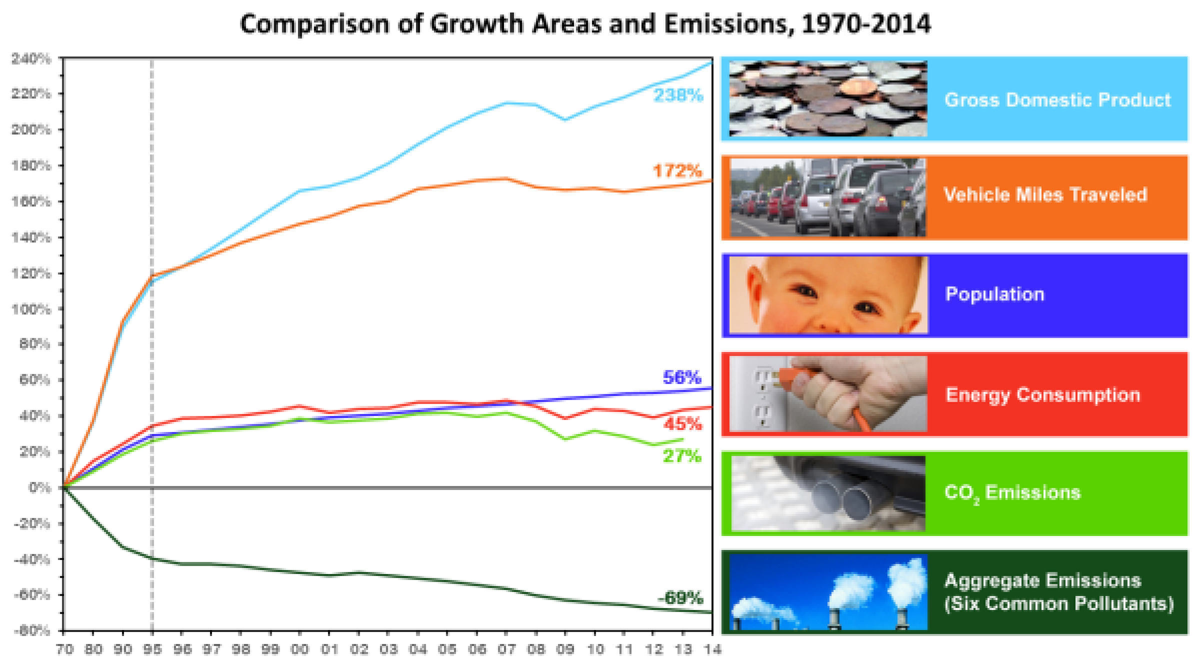
- There will be an increased acreage of protected wetlands with sediments high in organic content capable of storing pollutants
- Some organic content from these wetlands will be transported to other areas of the estuary increasing the organic content of the sediments and thus their pollutant adsorption capacity. However, this increase is anticipated to be slight

The increased acreage of wetlands from the estuary restoration projects over time increases the estuary's capacity to store toxic chemicals, pulling them from the water column and ultimately sequestering them in deepening sediments. Though this uptake of toxic chemicals degrades sediment quality locally, it would improve water quality and improve the health of fish and other organisms. The cumulative impact on sediment quality from the estuary project is expected to be low, when added to other, past, present, and reasonably foreseeable actions.

4.2.6 Air Quality

Agricultural activities, land development, transportation, and infrastructure development (Table 10) are expected to increase in the reasonably foreseeable future as population along the Lower Columbia River grows. Attention to air quality issues is expected to increase as the application of the Clean Air Act continues to progress. Figure 6 shows a clear nation-wide trend of air quality improvement in the face of increasing population and economic development and this trend is anticipated to apply to the estuary into the reasonably foreseeable future. Air quality from past, present, and reasonably foreseeable actions is not anticipated to decline.

Figure 6. Air Pollutant Emissions Trends[35]



An increasingly functional estuary over time (as a result of the estuary restoration program) is expected to play a minor role in air quality improvement: it will not be a source of air pollutants, but it will slightly increase vegetative air-filtering capability. Its more measurable cumulative contribution over time is likely the conversion of agricultural lands to naturally functioning estuaries that sequester carbon. In addition fewer emissions

---

[35] From EPA, available at http://www3.epa.gov/airtrends/aqtrends.html

from farm equipment and agricultural activities would occur. The cumulative effect on air quality from the estuary restoration program is expected to be low, contributing to the cumulative improvement trend displayed in Figure 6.

4.2.7 Wildlife

The past and present actions impacting wildlife include actions that are detrimental as well as those designed to be beneficial. These comparatively recent beneficial actions are occurring in various places throughout the estuary and primarily improve habitat for species associated with wetlands and riparian habitats such as waterfowl, shorebirds, beaver, muskrat, and otter. In most cases, these improvements for wildlife are a by-product of projects primarily designed to benefit anadromous fish species. The detrimental actions include the impacts from human population growth and its associated industrial, commercial, and residential development, as well as direct impacts from fishing, hunting, and human presence.

Past actions were far more detrimental to wildlife than present actions. Present actions that adversely impact wildlife have a lower impact than past actions because of improved design and mitigation measures intended to minimize adverse effect. Present actions also include the relatively recent extensive program of habitat improvements intended to mitigate for effects of the FCRPS. These present actions are expected to continue into the reasonably foreseeable future.

Through the estuary restoration program, BPA and the Corps intend to provide an on-going region-wide approach for providing improved habitat for salmon and steelhead. As mentioned above, these improvements provide (as a byproduct) habitat improvements and increased food sources for wildlife. This approach includes tidal restoration and land acquisition projects throughout the estuary as well as mitigation at hydroelectric dams and basin-wide restoration within tributary habitats. This program of habitat improvements is expected to into the reasonably foreseeable future.

Absent additional estuary restoration or protection projects, wildlife populations are expected to continue to benefit and increase to some degree into the foreseeable future from past actions in the estuary and throughout the Columbia River basin. The cumulative effect of adding an increased scope and scale of estuary restoration would only increase incremental impacts to which wildlife populations benefit into the future.

The cumulative impacts of the estuary restoration program on wildlife when added to past, present and reasonably foreseeable actions are expected to be low.

4.2.7.1 Special Status Wildlife Species

The table below displays the types of long-term and cumulative effects to special status wildlife species from implementing the estuary restoration program. The effects were considered along with those of past, present, and reasonably foreseeable actions in the estuary. A common conclusion for all of the discussions in the table below is that past, present, and reasonably foreseeable actions in the estuary would not negate the effects that increased acres of wetlands and restored tidal processes will have on plant and animal communities over time. Construction related impacts to special status plant species are included in Chapter 3.

For marine mammals (seals, sea lions, otters, orcas, dolphins, etc.), the individual species are included under one heading because they are all protected under the Marine Mammal Protection Act (and some under the Endangered Species Act) and all share but one common reasonably-foreseeable long-term effect from estuary improvements: increases in their food supply from anadromous fish and a strengthened food web.

Table 13 Cumulative Impacts to Special Status Wildlife Species

Species	Summary of Cumulative Impacts from the Estuary Restoration Program When Added to, Past, Present and Reasonably Foreseeable Actions
Oregon spotted frog (Rana pretiosa)	Estuary restorations will provide increasing acres of habitat over time, providing expanded lands for dispersal and occupancy. Removal of livestock, however, may allow development of wetland vegetation beyond stages used by this species. Improved water quality could benefit reproduction. Other ongoing present and future human activities expected to continue pressuring habitat for this species on unprotected lands. Acquisitions into protected ownership over time will likely improve habitat availability over the long term for this species.
Northern spotted owl (Strix occidentalis caurina)	Spotted owls occupy large conifer trees/forests. It is unlikely that habitat will be affected by the estuary restoration program and rather is impacted by the other past, present, and reasonably foreseeable actions. Some suitable habitat may develop in riparian corridors over the long-term providing dispersal habitat. Acquisitions into protected ownership will likely improve possibility of riparian trees/forests reaching mature and old-growth stage.
Marbled murrelet (Brachyramphus marmoratus)	The marbled murrelet nests in older large trees on sufficiently-sized branches high in the canopy. It is unlikely that habitat will be affected by the estuary restoration program and rather is impacted by the other past, present, and reasonably foreseeable actions. Some suitable habitat may develop in riparian corridors over the long-term. Acquisitions into protected ownership will likely improve possibility of riparian trees/forests reaching mature and old-growth stage and protection of existing older stands of trees could provide suitable habitat in a shorter timeframe.

Species	Summary of Cumulative Impacts from the Estuary Restoration Program When Added to, Past, Present and Reasonably Foreseeable Actions
Streaked horned lark (Eremophila alpestris strigata)	Streaked horned larks would lose the open grassland habitats they may have used in managed lands being restored to wetlands. Restored sites may provide foraging or nesting habitat in the early stages of wetland development, but increasing vegetation development may preclude lark use in the long term. They key in the long-term habitat suitability is how that site accumulates sediments and its vegetation develops/evolves. Habitat may be lost from the estuary restoration program. Other ongoing present and future human activities are expected to continue pressuring habitat for this species on unprotected lands. Acquisitions into protected ownership over time may improve habitat availability over the long term for this species provided suitable habitat is maintained.
Western snowy plover (Charadrius nivosus ssp. nivosus)	Estuary improvements are expected to provide little benefit for this species unless project sites are close to the ocean. Restored sites may provide foraging habitat in the early stages of wetland development, but increasing sediment accumulation and vegetation development may preclude plover use in the long term. Other ongoing present and future human activities are expected to continue pressuring habitat for this species on unprotected lands. Acquisitions into protected ownership will likely protect habitat made newly available for nesting and foraging, but long-term availability of this habitat may not be maintained as wetland succession proceeds.
Yellow-billed cuckoo (Coccyzus americanus)	Increases in riparian shrub and forest habitats will provide expanded habitats for cuckoo occupancy and dispersal across the estuary. Dispersal corridors will be expanded and forage areas improved. Other ongoing human development likely to continue pressure on habitat outside of reserves. Acquisitions into protected ownership over time will likely improve habitat availability over the long term for this species.
Columbian white-tail deer (Odocoileus virginianus leucurus)	Increases in riparian shrub and forest habitats will provide expanded habitats for deer dispersal across estuary. Loss of agricultural lands and an increase in flooded wetlands eliminates upland habits for feeding and cover. Dispersal corridors will increase, forage areas will improve, and overall upland area will be reduced. Other ongoing human development is likely to continue putting pressure on habitat outside of protected areas. Acquisitions into protected ownership over time may improve habitat availability over the long term for this species provided suitable habitat is maintained.

Species	Summary of Cumulative Impacts from the Estuary Restoration Program When Added to, Past, Present and Reasonably Foreseeable Actions
Red tree vole (Arborimus longicaudus)	Red tree voles occupy large conifer trees/forests. It is unlikely that habitat will be affected initially by the estuary restoration program. Some suitable habitat may develop in riparian corridors over the long-term. Acquisitions into protected ownership will likely improve possibility of riparian trees/forests reaching mature and old-growth stage.
Marine mammals	Increased populations of anadromous fish will increase food source for marine mammals near mouth of Columbia River, within the Columbia river plume, and to a limited degree up and down the Pacific coastline.
Leatherback sea turtle (Dermochelys coriacea)	Improved estuary habitats strengthen the food web within the estuary, the Columbia River's mainstem, and the plume of the river into the ocean. Sea turtle feeding in area of plume will benefit of improved food web.
Loggerhead sea turtle (Caretta caretta)	Improved estuary habitats strengthen the food web within the estuary, the Columbia River's mainstem, and the plume of the river into the ocean. Sea turtle feeding in area of plume will benefit of improved food web.

Thus, the cumulative impacts of the estuary restoration program on special status wildlife species when added to past, present and reasonably foreseeable actions are expected to be low.

4.2.8 Wetland, Floodplains, and Vegetation

The degree of impacts to wetlands and vegetation associated with current levels of the activities listed in Table 11 is expected to continue into the reasonably foreseeable future as described in Chapter 3. Of all the actions, agricultural activities and industrial, commercial, and residential development likely have the most effects on wetlands and vegetation and these are expected to continue as they do now.

Past actions of levee construction, diking and draining of wetlands, and other forms of development over the last century have reduced estuary wetland habitats by nearly 70 percent from historical levels (Marcoe 2013), cumulatively reducing wetland functions (i.e., water quality, hydrology, and wildlife habitat). Present and reasonably foreseeable restorations of wetlands, (including through the estuary restoration program) are designed to reverse many of these acreage and functional losses, steadily increasing riparian vegetation and wetland habitats and cumulatively benefitting water quality, hydrologic function, wildlife habitat and air quality.

These restoration gains in wetland acreage and function are expected to proceed at a faster pace and at a larger scale that the continued impacts of population-driven development and other human activity. Land acquisitions for restoration and long-term wetland protection are also anticipated in the estuary restoration program, and such acquisitions would increase protections in the long-term.

There will be an increase in functional floodplain capacity as a result of restoration actions over time, as described in Section 3.9, above. Cumulatively, this increased capacity will serve to offset losses of floodplain capacity, to some degree, from human growth and development actions elsewhere in the estuary.

Vegetation would be transitioned from non-native to native vegetation and protected as part of the estuary restoration program. Native vegetation would continue to be lost through other reasonable foreseeable actions such as continued residential and commercial development. The impacts to ESA–listed plant species are expected to low due to the limited presence of these species within the estuary and the protections afforded by the endangered species act.

The cumulative impacts of the estuary restoration program when added to other past, present, and reasonably foreseeable actions is expected to be low for wetlands and vegetation.

4.2.9 Land Use and Recreation

The degree of impacts to land uses and recreation associated with past and present actions listed in Table 11 is expected to continue into the reasonably foreseeable future. Of the actions listed in Table 11, residential, commercial, and industrial development (as related to human population increase) would likely have the most impact on land use and recreation. As more land is committed to urban or suburban infrastructure, less is available for recreation, agricultural, or other open space-related uses. The estuary restoration program also entails changes in land uses as many restoration projects are expected to convert agricultural or grazing lands to flooded or seasonally flooded wetlands. This is a reasonably foreseeable action that will impact land use.

Taken together, both the past, present and reasonably foreseeable population growth-related land use changes and estuary restoration-related land use changes will cumulatively reduce the amount of acres for agriculture and grazing in the estuary. Though both will likely convert pastoral lands, there may be a qualitative difference in the productivity of the lands they convert. Growth-related land use conversions would primarily convert uplands although some wetland or floodplain agricultural sites could also be expected to be converted urban and commercial uses. The estuary restoration program would primarily be converting historic tidal wetlands and floodplains from agricultural use. There is a difference in the level of agricultural productivity between upland agricultural lands and historical tidal wetland and floodplain lands.

Agriculture within historical tidal wetlands is often limited to grazing and haying operations because of wet and unproductive soils. Agriculture in these areas requires extensive drainage and levee networks that need routine maintenance and active pumping to remove water from the site. The historical removal of tidal sediment-depositing processes (soil accretion) and the associated land subsidence following drainage decreased the productivity of these agricultural lands in most areas. Additionally, their now-decreased elevation makes them more susceptible to anticipated sea level rise in the coming decades. While restoration projects within wetland-converted agricultural sites may remove these lands from agricultural use, these lands are often the least productive of the agricultural lands available, and the most likely to become unsustainable in the future because of maintenance costs and sea level rise. Due to the expected development within the region and associated loss of farmland the cumulative impact to agriculture is expected to be low to moderate.

The cumulative impact of these land use conversions on recreation opportunities is expected to be low. Present and reasonably foreseeable growth-related conversions will likely reduce open space recreation opportunities, while restoration-related conversions will maintain open-space but convert the types of recreation opportunities available (Chapter 3). The question of available access, however, remains. Converted lands of both types will likely have been in private ownership with no public recreation access available prior to conversion, and the degree of recreational access after conversion for restoration sites is uncertain as land ownership and management will vary. Land acquisitions for restoration and long-term protection are also anticipated in the estuary restoration program and such acquisitions could potentially maintain recreational access opportunities in the long-term. Cumulatively, more recreation opportunities are expected to be available on restoration sites than were previously available on those sites prior to conversion, though the type of access and recreation might differ.

Thus, the cumulative impacts of the estuary restoration program on land use and recreation is expected to be low to moderate when added to the past, present, and reasonably foreseeable actions.

4.2.10 Cultural Resources

Impacts to cultural resources are directly related to amounts of land disturbed. The degree of land disturbance associated with current and reasonably foreseeable levels of the activities listed in Table 11 is expected to continue into the foreseeable future as described in Chapter 3. Of the actions listed there, residential, commercial, and industrial growth; logging; and road construction and maintenance activities would likely have the most potential to impact cultural resources. Restoration actions under this proposal will also create land disturbance, so cumulatively, this action along with present and likely foreseeable future actions will increase the potential for both disturbance and discovery of cultural resources. Land acquisitions for restoration and long-term wetland protection are also anticipated as part pf the estuary restoration program, and such acquisitions would likely limit disturbance potential in long term over what might occur on private lands, adding more protection for cultural resources. Additionally, laws are in place to protect cultural resources on both private and public lands, so the overall impacts are not expected to be adverse.

It is likely that cultural resources in the estuary have been cumulatively affected by past and present development activities of residential, commercial, and industrial growth; logging; and road construction and maintenance activities. They may continue to be affected by other reasonably foreseeable future actions in the estuary, including ongoing agriculture, recreation, and land development, that have the potential to disturb previously undiscovered cultural resources. The estuary restoration program would likely have a moderate cumulative impact on historic properties because there may be unknown cultural resources that are discovered during construction and implementation of restoration projects. Mitigation measures described in Table 2 would reduce the potential for construction and restoration activities to cumulatively impact known cultural resources in the estuary.

Land acquisitions for restoration and long-term wetland protection are also anticipated in the estuary restoration program, and such acquisitions would likely limit disturbance potential in long term over what might occur on private lands, adding more protection for cultural resources.

Thus, the cumulative impacts of the estuary restoration program on cultural resources when added to past, present and reasonably foreseeable future actions is expected to be moderate.

4.2.11 Socioeconomic

Impacts to socioeconomic conditions (Chapter 3) from the estuary restoration program relates directly to:

- Lands placed in conservation through land acquisitions thereby reducing a county's taxable base
- Opportunities created by re-establishing harvestable populations of fish sufficient to support:
    - Traditional and subsistence fishing opportunities for Native American Tribes
    - Commercial fisheries
    - Recreational fisheries

The degree of land ownership transference and change in use to conservation lands with other present and reasonably foreseeable future actions listed in Table 11 is expected to be low and to continue into the foreseeable future. Private actions do not routinely remove lands from a county's tax base, though they might alter the taxable basis through land use changes.

Harvestable populations of fish were significantly reduced though cumulative past actions (construction of FCRPS, overfishing, basin–wide habitat degradation, construction of levees and dikes). Present and reasonably foreseeable future actions, however, are now increasing those populations through modified operations of the FCRPS, hatcheries, and basin-wide habitat improvements.

The estuary restoration program increases the level of estuary habitat improvements over what is occurring presently. This increase, when considered cumulatively with past, present and reasonably foreseeable future actions will impact socioeconomics in the estuary as discussed further below.

There is expected to be a cumulative economic impact on some counties' tax bases from land ownership transfers from taxable entities to non-taxable that would impact tax revenue to fund school districts, diking districts, public transportation, infrastructure, and other municipal government projects.

From the social aspect, there is a cumulative impact from an increasingly harvestable anadromous fish population. In considering the cumulative impact from the estuary restoration program on the anadromous fish population when added to past, present, and reasonably foreseeable future actions, the impacts of present actions to restore these populations are already seeing positive results in the face of increasing human population growth. The estuary restoration program will only serve to cumulatively increase that positive effect. As a result of this increasingly harvestable fishery, coastal and upstream tribes will benefit from fish runs sufficient to support traditional and subsistence fishing and their cultural traditions. Recreational fishing opportunities are also expected to improve over time creating recreational opportunities and supporting fishing-associated businesses and services.

There would be no cumulative effect on population levels, public facilities, and social services (outside of those associated with the limited changes in tax revenue discussed above). Because the employment and income associated with the site-specific projects would be temporary and limited in duration, the estuary restoration program would likely not contribute to long-term economic benefits (employment, income) or demand for housing in communities near the project area. In addition, because the projects would not disproportionately affect any low-income or minority populations, there would be no cumulative effects on environmental justice populations. The increased number of restoration sites could also benefit schools by providing educational opportunities focused on studying the natural environment, the history, and the recovery of wetland systems.

Thus, when added to the past, present, and reasonably foreseeable future actions in the estuary, the estuary restoration program is expected to have low impacts on socioeconomics.

4.2.12 Visual Resources

Agriculture, logging, road construction, and commercial and residential development have caused most of the past and present impacts to visual resources in the estuary. These are anticipated to continue into the reasonably foreseeable future. These impacts include changes in scenery from BPA and Corps-funded restoration projects through the estuary restoration program.

The estuary restoration program in combination with past, present and reasonably foreseeable future actions would cumulatively impact the visual resources by modifying agricultural lands (including the removal of visible infrastructure, such as levees and farm buildings) to create habitats dominated by tidal marsh and other restored habitats.

The cumulative impact to visual resources resulting from the estuary restoration program is expected to be lo as vegetation matures, producing less developed areas along the estuary that would have visual complexity, variety, and a more natural appearance.

4.2.13 Noise, Hazardous Waste, and Public Health and Safety

4.2.13.1 Noise

Within the estuary, the present predominant sources of noise are vehicular, river, and railroad traffic. These sources of noise would continue to occur. Noise from restoration projects would only occur during construction of restoration activities (short term effects). When combined with existing noise sources, the estuary restoration program is expected to have a low cumulative impact because noise impacts would be temporary.

The cumulative contribution of estuary restoration program in the long-term will be the reduction of noise. Over time there could be a slight change in the soundscape in the estuary as the sounds of agricultural use (livestock sounds, farm equipment, motor vehicles, pumps, etc.) decrease and those of wetlands (wildlife sounds, low waves, flowing water, wind in vegetation, etc.) increase. Noise from river traffic may carry differently in some locales because of levee and dike removal through restoration projects.

Thus, the cumulative impacts from the estuary restoration program on noise would be low.

4.2.13.2 Hazardous Waste

The degree of impacts to hazardous waste throughout the estuary associated with present actions listed in Table 11 is expected to continue into the reasonably foreseeable future. It is possible some new hazardous waste sites will develop as a result of industrial, commercial and urban growth, and as a result of truck, train, or pipeline spill incidents. At the same time, there is a reasonable expectation that known hazardous waste sites will be remediated in the foreseeable future.

Under the estuary restoration program, each site-specific project would identify the existence of hazardous waste sites within the project area and some will likely remove or mitigate the effects of those past sites. Because construction-related hazardous waste would be minimized through mitigation, and spill protections strictly enforced, there is expected to be no addition of hazardous wastes to the estuary than what is already present. There is the potential for toxic pollutants to be pulled from the water column and become sequestered in tidal wetland sediments as they develop in estuary restoration project sites, which is discussed in detail in Sediment Quality (Section 4.25). Therefore, cumulative effects to hazardous waste from the estuary restoration program are expected to be low.

4.2.13.3 Public Health and Safety

Past, present, and reasonably foreseeable actions that could cumulatively affect public health and safety are associated with logging, agriculture, construction, residential and commercial development, and dredging. Similar to the construction of restoration projects, these actions can put workers at risk when they operate heavy machinery or work around dangerous environs (e.g., waterways, forests) and can increase safety risks to the public if exposed to construction traffic or hazardous materials. These risks only exist during construction activities and would be temporary in duration and therefore low.

When considered in combination with other past, present, and reasonably foreseeable restoration projects in the estuary, the site-specific projects of the estuary restoration program would likely reduce mosquito-breeding habitat. This would occur particularly where restoration actions convert shallow ponded areas where mosquitoes are likely to breed to waters subject to tidal flow less suitable for mosquito breeding. There is also expected to be an increase in fish populations which will prey on mosquito larvae, and bird populations that can prey on mosquito adults.

Thus, the cumulative impacts of the estuary restoration program on the public health and safety resource are expected to be low.

4.2.14 Transportation and Infrastructure

The degree of impacts to transportation throughout the estuary associated with present actions listed in Table 11 is expected to continue into the reasonably foreseeable future. Improvements, modifications, and maintenance actions on surface roads and navigation channels are expected to continue into the foreseeable future as they are in the present. The primary drivers that could cumulatively affect surface transportation are associated with logging, agriculture, and industrial, commercial, and residential development. Past, present, and reasonably foreseeable dredging by the Corps is the primary impact for river navigation.

As discussed in Chapter 3, the estuary restoration program's contribution to cumulative, long-term effects on transportation is its potential to remove local roads where they are located atop dikes or levees to be removed as part of the restoration project. These roads, however, were primarily to serve the localized agricultural use of their surrounding lands, which would no longer be agricultural, so their loss will likely have no effect on remaining traffic patterns and flow. The loss of these local roads will have no cumulative effect on accessibility or mobility.

The estuary restoration program is expected to have low cumulative impacts on river navigation as restoration sites are along the banks of the river, not in the navigation channels. There is the possibility that altered flows from restoration actions could alter patterns of sediment deposit within the navigation channel.

The cumulative effects of the estuary restoration program on transportation when added to past, present and reasonably foreseeable actions would be low.

There are no anticipated cumulative effects to infrastructure since in all projects, necessary infrastructure will be protected or relocated.

4.2.15 Climate Change

The past and present vehicular traffic, agriculture, timber harvesting, and commercial and residential facilities in the estuary have all contributed to the accumulation of greenhouse gasses in earth's atmosphere. These greenhouse-gas-emitting actions are anticipated to continue into the foreseeable future as they are at current levels. The contribution of the estuary restoration program to the accumulation of greenhouse gases comes from three sources:

1. The combustion emissions and dust generation from site-specific projects would generate a temporary contribution to greenhouse gases.
2. Estuary restoration projects help to mitigate for increases in greenhouse gases through increased absorption of these gases by the increased vegetation resulting from wetland restoration and subsequent sequestration of the carbon in accreted soils.

The cumulative impacts of the estuary restoration program on greenhouse gas accumulations and its impacts on climate change when considering present and likely foreseeable actions is expected to be low.

Chapter 5 Status of Environmental Compliance

This EA supports a phased decision-making process to implement construction of ecosystem restoration projects under the estuary restoration program. The following discussions demonstrate how the Proposed Action complies with applicable environmental laws and executive orders.

5.1 National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq.

Under NEPA, federal agencies are required to assess the impacts that their actions may have on the environment. NEPA requires preparation of an Environmental Impact Statement for major federal actions significantly affecting the quality of the human environment.

Finding: This EA provides the basis for compliance with NEPA. After the public comment period for this EA, the agencies will respond to comments, and if necessary, supplement the analysis in future tiered NEPA documents. The agencies will either make a Finding of No Significant Impact or if significant impacts are identified, determine if an Environmental Impact Statement is needed.

5.2 Bald and Golden Eagle Protection Act of 1940, 16 U.S.C. § 668 *et seq*.

This Act provides for the protection of bald and golden eagles by prohibiting the taking, possession and commerce of such birds, except under certain specified conditions. The Act covers intentional acts of take or disturbance and acts in "wanton disregard" of the safety of bald or golden eagles. Take is defined as "to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturbance" relates to activities that affect the viability of eagle populations (e.g., from nest or chick abandonment), which would result from otherwise normal, lawful business practices. The USFWS's National Bald Eagle Management Guidelines (USFWS 2007) identify measures to avoid impacts to eagles during the nesting season. These measures differ depending on the type of activity (i.e. road construction, timber operations, off road use, etc.). Specific measures include developing buffers of vegetation or of distance where there is an active eagle nest between January 1 and August 15.

Finding: Bald eagles are common along the Washington and Oregon coast and freshwater rivers and streams at low elevations and they use portions of the project area to forage, perch, roost, and nest. Bald eagles that breed along the estuary are primarily year-round residents and do not migrate. Restoration projects involving motorized equipment, blasting, and other work may produce loud or intermittent noises which could disrupt breeding activity if they occur within 1000-feet of an active or alternate nest time during the breeding season (January 1 through August 15). In the long term, increased fish populations and foraging habitat will be produced which will benefit bald eagle populations.

Impact Avoidance Measures: The agencies would conduct surveys to determine if bald or golden eagles are present (i.e., nesting or roosting) in the project area prior to initiating restoration activities. If nests are observed at a distance of less than 660 feet from restoration activity or less than 1,000 feet when operating heavy motorized equipment, restoration activities would be timed to begin after the breeding season (August 16-December 31).

5.3 Clean Air Act of 1970, 42 U.S.C. § 7401 *et seq*.

The Clean Air Act (CAA), as amended, requires the EPA and delegated states to carry out a wide range of regulatory programs intended to assure attainment of the National Ambient Air Quality Standards. The National Ambient Air Quality Standards are health standards set for criteria pollutants: carbon monoxide; lead; nitrogen dioxide; 8-hour ozone; particulate matter (PM-10) and (PM-2.5); and sulfur dioxide. The EPA sets these standards and Washington Department of Ecology and the Oregon Department of Environmental Quality maintains a list of areas/counties that have exceeded these health standards and are considered "non-attainment" areas.

Finding: Because the agencies' program of restoration projects proposed in the Columbia River estuary would occur in an area that is currently in attainment for meeting the National Ambient Air Quality Standards and because no stationary sources of air emissions would occur, conservation activities associated with the project are exempted for regulation under the CAA.

5.4 Clean Water Act of 1972, 33 U.S.C. § 1251 *et seq*.

The Clean Water Act established the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. It is unlawful under the Clean Water Act to discharge any pollutant into navigable waters, unless a permit is obtained.

Section 401)– A federal permit to conduct an activity that causes discharge into navigable waters is issued only after the state certifies that existing water quality standards would not be violated if the permit were issued. Washington Department of Ecology and the Oregon Department of Environmental Quality would review the project's Section 402 and Section 404 permit applications for compliance with state water quality standards and grant certification if the permits comply with these standards.

Section 402– This section authorizes the EPA, and delegated states to permit the discharge of pollutants under the National Pollutant Discharge Elimination System program for all land disturbances over an acre in size.

Section 404 – Authorization from the Corps is required in accordance with the provisions of Section 404 of the Clean Water Act when dredged or fill material is discharged into waters of the United States, including wetlands. Federal regulations at 33 C.F.R. § 336.1 (a), provide that a Section 404 permit is not issued by the Corps to itself; however, the Corps shall apply all applicable substantive legal requirements, including public notice, opportunity for public hearing, and application of the Section 404 (b) (1) guidelines. BPA would work with the Corps' regulatory process to comply with the Clean Water Act Section 404(b)(1) guidelines established by the EPA. The Corps' Nationwide Permit (NWP) Program provides approval for a standard set of activities in wetlands and waters that have routine and known effects.

Ecosystem restoration projects, such as those included in the estuary restoration program, generally fall under a category of actions that has been pre-approved under the NWP program. To qualify for NWP authorization and to use the applicable states' pre-approved 401 water quality certification, the estuary restoration project must comply with the NWP general conditions, any regional or specific conditions and the applicable states' 401 water quality certification general or specific conditions. A "pre-certified" water quality permit means the 401 certification has been approved for all actions authorized by that particular NWP, provided all applicable national and regional NWP conditions and all applicable 401 certification conditions are adhered to. The permittee is not required to contact the certifying agency for further authorization or approval unless the 401 certification for a particular NWP requires it. Each NWP has an individual 404(b)(1) analysis associated with it that was made available for public comment during the Federal Register notice announcing the renewed NWPs (77 FR 10184).

Finding: Ecosystem restoration projects, such as those included in the estuary restoration program, generally fall under a category of actions that has been pre-approved under the Corps' Nationwide Permit (NWP) Program. The following table displays the NWPs that typically apply to restoration projects.

Table 14. Applicable Nationwide Permits for Oregon and Washington

#	NWP	401 Water Quality Certification		
		Oregon	**Washington**	**EPA (if tribal land)**
7	Outfall Structures & Associated Intake Structures	Partially certified. Denied are discharge outfalls	Certified if conditions are met. If the outfall is new, agency notification is required.	Partially denied if new outfalls affect special aquatic sites.
13	Bank Stabilization	Partially certified	Certified if conditions are met. If an activity is greater than 300 feet in length or is in inland marine waters, agency notification is required.	Denied, individual certification required
27	Aquatic Habitat Restoration, Establishment, & Enhancement Activities	Certified if all Oregon Department of Environmental Quality conditions are met	Certified if conditions are met. An individual 401 review is required if: 1) the project or activity involves fill in tidal waters; or 2) The project or activity affects ½ acre or more of wetlands.	Partially denied, conditions similar to Washington Department of Ecology

#	NWP	401 Water Quality Certification		
		Oregon	**Washington**	**EPA (if tribal land)**
33	Temporary Construction, Access and Dewatering	Certified if all Oregon Department of Environmental Quality general conditions are met	Certified if conditions are met. If an activity will require temporary fills to remain in place longer than six months, agency notification is required. An individual 401 review is required if: 1) temporary fills are placed in more than ½ acre of wetlands and left in place for more than 90 days; or 2) temporary fills are left in place for longer than six months.	Partially denied, conditions similar to Washington Department of Ecology
41	Reshaping Existing Drainage Ditches	Certified if all Oregon Department of Environmental Quality general and specific conditions are met	Certified if conditions are met. An individual 401 review is required if: 1) the project or activity discharges dredged or fill material into a ditch that receives water from or discharges water to a wetland within ½ mile of project site; or 2) the project or activity occurs within a wetland.	Denied, conditions similar to Washington Department of Ecology

In addition to qualifying under the Corps' NWP program, BPA-funded habitat improvement projects in Oregon may also qualify for Section 404 coverage under the Corps' Regional General Permit 6 and the associated Section 401 water quality certification from Oregon Department of Environmental Quality. The estuary restoration program described in this EA would meet the requirements of the Clean Water Act Sections 401, 402 and 404 because the actions qualify for authorization under NWPs and Regional General Permit 6. In addition, projects would be designed to meet the applicable general and regional conditions. In the cases where more than 1 acre of ground may be disturbed by a restoration activity, a National Pollutant Discharge Elimination System permit would be obtained and a Stormwater Pollution Prevention Plan and Sediment and Erosion Control Plan would be prepared.

5.5 Coastal Zone Management Act of 1972, 16 U.S.C. § 1451

The Coastal Zone Management Act is administered by NOAA and provides for the management of the nation's coastal resources, including the Great Lakes. The Coastal Zone Management Act directs federal agencies to address competing land uses and resource impacts occurring in the nation's coastal areas and be consistent with a state's Coastal Management Program, statewide planning goals, comprehensive plans, and various state agency authorities. The goal of the act is to preserve, protect, develop, and where possible, restore or enhance the resources of the nation's coastal zone. The Coastal Zone Management Act provides a federal consistency requirement that allows states with an approved coastal management program to review federal actions affecting coastal uses or resources.

In Oregon, the coastal zone is the area lying between the Washington and California borders on the north and south, bound on the west by the extent of the state's territorial sea jurisdiction (3 nautical miles offshore). The coastal zone extends inland to the crest of the Coast Range, except for certain areas, including in the Columbia River Basin, where it extends upstream to the downstream end of Puget Island. The Oregon Department of Land Conservation and Development reviews federal actions for Coastal Zone Management Act consistency.

In Washington, the coastal zone is defined as the 15 counties which front saltwater: Whatcom, Skagit, Snohomish, King, Pierce, Thurston, Kitsap, San Juan, Island, Clallam, Jefferson, Grays Harbor, Mason, Pacific, and Wahkiakum. The Washington Department of Ecology manages the state's Coastal Zone Management Program and reviews federal actions for Coastal Zone Management Act consistency.

<u>Finding</u>: Estuary restoration projects are consistent with the goals of the Coastal Zone Management Act since the program intends to protect, preserve, restore, and enhance estuarine habitats and coastal zones included in the Act. Where the coastal zone applies to proposed projects, the agencies would coordinate with each state's Coastal Management Program to document how site-specific project actions are consistent with the state's planning goals, comprehensive plans, and state agency authorities.

5.6 Endangered Species Act of 1973, 16 U.S.C. § 1531 *et seq*.

The ESA (16 USC § 1531 *et seq.*) established a national program for the conservation of threatened and endangered species of fish, wildlife, and plants, and the preservation of the ecosystems on which they depend. The ESA is administered by the USFWS for terrestrial species and some freshwater species, and by NOAA Fisheries for anadromous fish and marine species. Requirements of the Act ensure activities authorized, funded, and carried out by federal agencies are not likely to jeopardize the continued existence of any listed species or result in adverse impacts to designated critical habitat of a listed species. Section 7(a) of the ESA requires federal agencies to ensure that the actions they authorize, fund, and carry out do not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. Section 7(c) of the ESA requires that federal agencies to initiate consultation and to prepare biological assessments addressing the potential effects of their actions on listed or proposed endangered species and critical habitats.

Finding: The estuary restoration program generally includes short-term ground disturbing activities and in-water work which have the potential to cause short term increases in sedimentation and localized increases in turbidity.. Noise and disturbance to fish and wildlife from the proposed restoration activities may affect listed endangered or threatened species and require the agencies to consult with NOAA Fisheries and USFWS per Section 7 of the Act. The actions, however, are designed and intended to produce long term increases in habitat for, and populations of, endangered species.

During the site-specific project analysis, the agencies would conduct a review to determine which endangered and threatened species and critical habitat occurring within the implementation area also occur within the project boundary. The agencies would obtain coverage under the ESA prior to funding or implementing the proposed project. Pursuant to Section 7 of the ESA, the Corps would seek covered using the applicable Standard Local Operating Procedures for Endangered Species (SLOPES) Biological Opinion(s).[36] BPA would obtain coverage under the Habitat Improvement Program (HIP) Biological Opinion for BPA-funded fish and wildlife restoration projects.[37] As necessary, the agencies would seek coverage through formal or informal consultation with the Services. If other federal agencies are involved in the project additional programmatic ESA coverage available to those agencies may also be utilized, provided it adequately covers the agencies' obligations under the ESA.

5.7 Farmlands Protection Policy Act, 1994, 7 U.S.C. § 4201 *et seq.*

The Farmland Protection Policy Act directs federal agencies to identify and quantify adverse impacts of federal programs on farmlands. The purpose of this act is to minimize the number of federal programs that contribute to the unnecessary and irreversible conversion of agricultural land to non-agricultural uses.

Finding: As discussed in Section 3.10 of this EA, the estuary restoration program would result in conversion of agricultural land to non-agricultural uses. This conversion, however, is neither unnecessary nor irreversible. The conversion is necessary to restore endangered fish populations and can be reversed to farmland again.

While this conversion in land use would result in a reduction in available farmland, continued use of the majority of the low-lying farmland subject to the estuary restoration program is not sustainable due to historical and ongoing subsidence. The proposed action would restore estuarine process to these lands offsetting historic subsidence and better positioning these lands to respond to climate change and sea level rise. Site-specific analysis would be conducted to ensure the estuary restoration program is not contributing to the unnecessary and irreversible conversion of agricultural lands and impacts disclosed on a site-specific basis.

---

[37] HIP Biological Opinion can be found at: http://efw.bpa.gov/environmental_services/endangeredspecies.aspx

5.8 Federal Noxious Weed Act of 1990, 7 U.S.C. § 2814

This federal act, as amended in 2009, directs federal agencies to manage undesirable plant species on federal lands when management programs for those species are in place on state or private land in the same area. Undesirable plant species are defined as those that are classified as undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to state or federal law. A noxious weed list (7 CFR 360.200) is developed by the Secretary of Agriculture, which lists noxious weeds (as defined by the Plant Protection Act) that are subject to restrictions on interstate movement (7 USC § 7712).

Finding: Restoration activities routinely include aggressive noxious weed control actions, reducing the populations of weeds on restored sites. Though ground disturbing activities, with their attendant risk of weed spread, are likely, they will be accompanied by the use of best management practices and other conservation measures, designed to minimize, if not prevent, such spread.

5.9 Fish and Wildlife Conservation Act of 1980, 16 U.S.C. § 2901 *et seq.*, and Fish and Wildlife Coordination Act of 1958, 16 U.S.C. § 661 *et seq*.

The Fish and Wildlife Conservation Act encourages federal agencies to conserve and promote conservation of game and non-game species and their habitats. The Fish and Wildlife Coordination Act requires federal agencies with projects affecting water resources to consult with USFWS and the state agency responsible for fish and wildlife resources. For the Corps, all coordination under the Fish and Wildlife Coordination Act is in accordance with the *2003 Agreement between the U.S. Fish & Wildlife Service and the U.S. Army Corps of Engineers for Conducting Fish and Wildlife Coordination Act Activities*.

Finding: The proposed action is designed to promote conservation of fish and wildlife species and their habitats. Coordination by the BPA and Corps with the USFWS under Fish and Wildlife Coordination Act would occur on a project-by-project basis and be documented in site-specific NEPA documents tiered to this EA.

5.10 Magnuson-Stevens Fishery Conservation and Management Act of 1976, 16 U.S.C. § 1801 *et seq*.

The Magnuson-Stevens Fishery Conservation and Management Act, which was amended by the Sustainable Fisheries Act of 1996, is designed to actively conserve and manage fishery resources found off the coasts of the United States to support international fishery agreements for the conservation and management of highly migratory species. The Magnuson-Stevens Fishery Conservation and Management Act established procedures designed to identify, conserve and enhance Essential Fish Habitat for fisheries regulated under a federal fisheries management plan. The Magnuson-Stevens Fishery Conservation and Management Act defines Essential Fish Habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Waters include aquatic areas and their associated physical, chemical, and biological properties used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; and "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem (50 C.F.R. § 600.10 (2010)).

Under Section 305(b)(4) of the Magnuson-Stevens Fishery Conservation and Management Act, NOAA Fisheries is required to provide Essential Fish Habitat conservation and enhancement recommendations to federal and state agencies for actions that adversely affect Essential Fish Habitat. Federal agencies must consult with the NOAA Fisheries on all proposed actions authorized, funded or carried out by an agency which may adversely affect Essential Fish Habitat.

Finding: Relevant fish resources pertinent to the implementation area include all 13 species of salmon and steelhead present in the estuary. Most of the habitat historically accessible to salmon and steelhead has been designated as Essential Fish Habitat. The estuary is designated as Essential Fish Habitat for salmon and steelhead, as it provides waters and substrate necessary for spawning, breeding, feeding, and growth to maturity.

Wherever possible, NOAA Fisheries uses existing interagency coordination processes to fulfill Essential Fish Habitat consultations with federal agencies. As discussed in Section 3.2, the estuary restoration program could impact Essential Fish Habitat for spawning, breeding, feeding, and growth to maturity for salmon and steelhead. Conservation measures and best management practices would be implemented to avoid and minimize impacts to fish and their habitats as identified in this EA.

The agencies would continue to coordinate and consult with NOAA Fisheries to ensure appropriate mitigation measures would be used to minimize impacts to Essential Fish Habitat. Any coordination would be documented in future site-specific NEPA documents tiered to this EA.

5.11 Marine Mammal Protection Act of 1972, 16 U.S.C. §§ 1361–1423h

The Marine Mammal Protection Act established a federal responsibility to conserve marine mammals within waters of the United States. With certain specified exceptions, the Marine Mammal Protection Act establishes a moratorium on the taking and importation of marine mammals. All marine mammals are covered under the Marine Mammal Protection Act. Marine mammals expected to occur within the waters within the project area include harbor seals, Steller sea lion, and the California sea lion.

Finding: It is not likely that the estuary restoration program would include working in a haul-out (temporary out of water resting areas) location for any marine mammals since haul-out sites are primarily coastal, not within the estuary. During site-specific analysis, the agencies would determine if there is the potential to harass or injure any marine mammals and work to minimize any mitigate for these effects. An Incidental Harassment Authorization would be pursued based on site-specific analysis, if required and documented in future site-specific NEPA documents tiered to this EA.

5.12 Migratory Bird Treaty Act of 1918, 16 U.S.C. § 703 *et seq*.

The Migratory Bird Treaty Act, as amended, implements various treaties and conventions between the United States and other countries, including Canada, Japan, Mexico, and Russia, for the protection of migratory birds (16 U.S.C. §§ 703-712). Under the Migratory Bird Treaty Act, taking, killing, or possessing migratory birds, or their eggs or nests, is unlawful. The act classifies most species of birds as migratory, except for upland and nonnative birds such as pheasant, chukar, gray partridge, house sparrow, European starling, and rock dove.

Finding: The analysis in this EA indicates that the estuary restoration program would have incidental, potentially moderate impacts on ground and low-lying nesting birds during construction and restoration activities, including migratory birds. To the extent practicable, the agencies would time construction activities to occur outside of the breeding season to minimize impacts to migratory birds. When actions are planned to occur during the breeding season, or where wintering birds would be impacted during construction and restoration actions, the agencies would coordinate the activity with the USFWS to minimize adverse effects.

5.13 National Trails System Act of 1968, 16 U.S.C. § 1241-1251

The National Trails System Act established a National Trails System with the purpose of promoting the preservation of, public access to, travel within, and enjoyment and appreciation of the open-air, outdoor areas and historic resources of the nation. The Act and its subsequent amendments have created a network of national scenic, historic, and recreational trails throughout the United States. The project area contains two national trails: the Lewis and Clark National Historic Trail, and the Oregon National Historic Trail, both administered by the National Park Service.

5.13.1 Lewis and Clark National Historic Trail

This approximately 3,700-mile-long trail was established under the National Trails System Act through an act of Congress in 1978, and is administered by the National Park Service as a component of the National Park System (NPS 2009). The primary purpose of this trail is to commemorate the Lewis and Clark Expedition of 1804-06. Generally tracing the courses of the Missouri and Columbia rivers, the Lewis and Clark National Historic Trail stretches through 11 states from a point near St. Louis, Missouri to where the Columbia River drains into the Pacific Ocean. From about Richland, Washington westward, the trail generally follows the Columbia River to the Pacific Ocean. A Comprehensive Management Plan was prepared for the Lewis and Clark National Historic Trail in 1982, and the National Park Service is currently in the process of developing a new Comprehensive Management Plan. The 1982 Comprehensive Management Plan recommends various trail sites, segments, and routes. In the project area, the Columbia River and its shores, Youngs Bay, and the Lewis and Clark River to Fort Clatsop are considered a water trail, and Washington SR 14, U.S. Highway 101 and various local roads are considered a motor route. The Comprehensive Management Plan also identifies various campsites and portage points of the Lewis and Clark Expedition along the Columbia River in the project area.

5.13.2 Oregon National Historic Trail

This approximately 2,170-mile-long trail was established under the National Trails System Act through an act of Congress in 1978, and is administered by the National Park Service as a component of the National Park System (NPS 2006). The purposes of this trail are to (1) identify, preserve, and interpret the sites, route, and history of the trail, and (2) commemorate the westward movement of emigrants to the Oregon Country. The Oregon National Historic Trail extends approximately from Kansas City, Missouri to the Portland, Oregon vicinity.

A Comprehensive Management Plan was prepared for the Oregon National Historic Trail in 1999, and a long-range interpretative plan was finalized for the trail in 2010. These plans cover other historic trails as well.

Finding: The Action Agencies would work with the National Park Service as required to minimize impacts to these trails where they occur within a site-specific project boundary. Coordination would be documented in future site-specific NEPA documents tiered to this PEA.

5.14 Cultural Resource Laws, Regulations, and Executive Orders

Preserving cultural resources allows Americans to have an understanding and appreciation of their origins and history. A cultural resource is an object, structure, building, site or district that provides irreplaceable evidence of natural or human history of national, state or local significance. Cultural resources include National Historic Landmarks, archeological sites, properties of traditional religious and cultural importance to a Native American Tribe (also known as Traditional Cultural Properties), and other properties listed (or eligible for listing) on the National Register of Historic Places.

Laws and other directives for the management of cultural resources include the following:

- National Historic Preservation Act of 1966 (16 U.S.C. § 470 *et seq.*), as amended, inclusive of Section 106
- Executive Order 13007, Indian Sacred Sites (1996)
- American Indian Religious Freedom Act of 1978 (42 U.S.C. § 1996, 1996a)
- Historic Sites Act of 1935 (16 U.S.C. § 461-467)
- Archaeological Data Preservation Act of 1974 (16 U.S.C. § 469 a-c)
- Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470 aa-mm), as amended
- Native American Graves Protection and Repatriation Act (25 U.S.C. § 3001 *et seq.*)
- Antiquities Act of 1906 (16 U.S.C. §§ 431-433)

Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of their actions on historic properties. This act provides a process (known as the Section 106 process) that enables agencies to assess impacts on historic properties along with participation from interested and affected parties such as tribes, and then avoid, minimize, or mitigate for these impacts. Historic properties may be pre-contact or historic sites, including objects and structures that are included or eligible for inclusion in the National Register. Historic properties also include artifacts or remains within historic sites and properties of traditional and cultural importance to tribes.

If a federal agency plans to undertake a type of activity that could affect historic properties, it must consult with the appropriate State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO) to make an assessment of the property and to assess adverse effects on identified historic properties. The National Historic Preservation Act specifies that Traditional Cultural Properties or TCPs may be determined to be eligible for inclusion on the National Register of Historic Places. In carrying out its responsibilities under Section 106, a federal agency is required to consult with any Indian tribe that attaches religious or cultural significance to any such properties, along with other potential consulting parties.

Finding: The lead federal agency would conduct site-specific analyses and consultation. Site-specific analyses depend on the nature and extent of the site specific project but could include background research to identify known or potential historic properties and/or previous cultural resource investigations that have taken place in the area. Field surveys would be conducted depending on the scale and location of the proposed project and are likely to occur for most project areas where previous surveys have not been conducted. Methods utilized during the field surveys would consist of pedestrian inventory and subsurface testing at a minimum but could include additional background research regarding archaeological, ethnographic, and/or historic resources; remote sensing, and archaeological evaluation among other methods.

Consultation would be initiated with the consulting parties prior to conducting a field survey in order to determine if there was agreement on the proposed methods of identifying historic properties and the Area of Potential Effects. Additional consultation would follow based on the results of the field survey. If historic properties were identified, measures to avoid, minimize, and mitigate the potential effects of the project on historic properties would be applied. If previously unidentified cultural resources were identified during construction or restoration actions, the lead federal agency would follow appropriate federal laws and regulations.

5.15 Rivers and Harbors Act of 1899, 33 U.S.C. § 401

Section 10 of the River and Harbor Act of 1899, as amended, regulates structures in or over any navigable water of the U.S., the excavating from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters. This Act is administered by the Corps and addresses structures or actions which may affect the course, location, condition, or capacity of navigable waterways.

Finding: In-water work would be required for implementation of the estuary restoration program. Under the implementing regulations for Section 10, the Corps issues permits for work in navigable waters of the U.S. BPA would obtain a Section 10 permit prior to implementing restoration actions in a "water of the U.S." as defined in the Rivers and Harbors Act and in a navigable water as defined by the Corps.

Under Section 14 through the Section 408 review process, the Corps would make a determination on a project specific basis on the requested alteration to the in-place performance of the federally authorized project. BPA would follow the Section 408 guidance (EC-1165-2-2-16) and submit the required documentation necessary for the Corps to make a decision.

5.16 Executive Order 11988, Floodplain Management, 24 May 1977

This executive order directs federal agencies to evaluate the potential effects of proposed activities on floodplains, to avoid possible long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Federal agencies are directed to develop alternatives to floodplain activities, where practicable, and identify what impacts (beneficial and/or adverse) result from the action.

Finding: The purpose of the estuary restoration program is to restore floodplain connectivity and function by returning land in floodplains to pre-development conditions where practicable. Development within the floodplain would not occur as a result of implementing the estuary restoration program. Therefore, the estuary restoration program is in compliance with this Executive Order and no further review is necessary.

5.17 Executive Order 11990, Protection of Wetlands, 24 May 1977

The purpose of this executive order is to minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. In planning their actions, federal agencies are directed to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

Finding: The purpose of the estuary restoration program is to restore estuarine wetland functions and values by returning wetlands to pre-development conditions where practicable. While wetlands may be impacted by the estuary restoration program, the return of natural estuarine processes will serve to preserve and enhance the natural and beneficial values of the wetlands.

5.18 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 11 February 1994

This executive order directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Finding: The estuary restoration program would not cause disproportionately high and adverse impacts on minority and low-income populations as discussed in Section 3.12.3.2.

5.19 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000

The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. This order directs federal agencies to formulate and establish "regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes." This consultation is meant to work towards a mutual consensus and is intended to begin at the earliest planning stages, before decisions are made and actions are taken.

Finding: The agencies fully respect Tribal law, and recognize Tribal governments as sovereigns and would consult with Tribal governments to ensure that Tribal rights and concerns are considered prior to taking action, making decisions, or implementing programs that may affect Tribal resources. The agencies recognize that Tribal interests are not limited to cultural resources but may also include fish, wildlife, water resources and wetlands, vegetation, health, socioeconomic impacts, noise, and visual resources. The agencies also recognize that Tribes may have specific rights reserved under treaties, such as fishing, hunting, gathering and grazing rights.

5.20 Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds, 10 January 2001

This executive order identifies federal agency responsibilities to protect migratory birds and their habitats, and directs executive departments and agencies to undertake actions that will further implement the Migratory Bird Treaty Act. The executive order encouraged each agency to immediately begin implementing fifteen identified conservation measures, as appropriate and practicable. These conservation measures include avoiding or minimizing adverse impacts on migratory bird resources, lessening the amount of unintentional take, restoring and enhancing the habitat of migratory birds, and promoting research and information exchange related to the conservation of migratory birds, including coordinated inventorying and monitoring. It also directs federal agencies to develop a Memorandum of Understanding with the USFWS to promote the conservation of migratory bird populations, including their habitats, when their actions have, or are likely to have, a measurable negative effect on migratory bird populations.

Finding: The Department of Defense signed a Memorandum of Understanding with USFWS July 31, 2006. The Memorandum of Understanding states the Department of Defense shall, among other things, "encourage incorporation of comprehensive migratory bird management objectives in the preparation of Department of Defense planning documents (…including NEPA analyses)." Similarly, BPA (through the U.S. Department of Energy) and USFWS have a Memorandum of Understanding to address migratory bird conservation, which addresses how BPA and USFWS can work cooperatively to address migratory bird conservation and includes specific measures to consider implementing during project planning and implementation.

This EA considers measures to minimize impacts to migratory birds. Where feasible these are integrated into the estuary restoration program and alternatives and would be implemented to the extent practicable. Further coordination with USFWS would occur for site-specific projects via the Fish and Wildlife Coordination Act.

5.21 Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, 5 October 2009

This executive order requires that federal agencies shall increase energy efficiency; measure, report and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse and storm-water management; eliminate waste, recycle and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products and services; design, construct, maintain and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which federal facilities are located; and inform federal employees about and involve them in the achievement of these goals.

Finding: BPA is currently developing a Sustainability Action Plan, which addresses managing and reducing greenhouse gas emissions by the agency.

5.22 Hazardous Materials

Several federal laws related to hazardous materials and toxic substances potentially apply to the estuary restoration program, depending upon the exact quantities and types of hazardous materials created or stored at the sites.

5.22.1 Spill Prevention Control and Countermeasures Rule, 40 CFR Part 112

The Spill Prevention Control and Countermeasures Rule (40 CFR Part 112) includes requirements to prevent discharges of oil and oil-related materials from reaching navigable waters and adjoining shorelines. It applies to facilities with total aboveground oil storage capacity (not actual gallons onsite) of greater than 1,320 gallons and facilities with belowground storage capacity of 42,000 gallons. No onsite storage of oil or oil-related materials is proposed as part of the project.

5.22.2 Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq.

The Resource Conservation and Recovery Act, as amended, is designed to provide a program for managing and controlling hazardous waste by imposing requirements on generators and transporters of hazardous waste, and on owners and operators of treatment, storage, and disposal facilities (42 USC 6901 et seq.). Each facility owner or operator is required to have a permit issued by EPA or the state. Typical construction and maintenance activities have generated small amounts of these hazardous wastes—solvents, pesticides, paint products, motor and lubricating oils, and cleaners. Small amounts of hazardous wastes may be generated by the project. These materials would be disposed of according to state law and the Resource Conservation and Recovery Act. Solid wastes would be disposed of at an approved landfill or recycled.

5.22.3 Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 et seq.

The Comprehensive Environmental Response Compensation Liability Act, as amended, provides funding for hazardous materials training in emergency planning, preparedness, mitigation implementation, response, and recovery. Eligible individuals include public officials, emergency service responders, medical personnel, and other tribal response and planning personnel. Any sites which are identified as a Superfund sites or on the EPA's National Priorities List would not be selected as a potential restoration site due to complications with managing environmental hazards and the intent of the program to efficiently implement restoration of habitat for the benefit of fish and wildlife.

5.22.4 Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. § 136(a-y)

The Federal Insecticide, Fungicide, and Rodenticide Act (7 USC 136 [a-y]) registers and regulates pesticides. Pesticides may be used as part of the project and would be used in accordance with all applicable federal and state regulations. Herbicide containers would be disposed of according to Resource Conservation and Recovery Act standards.

Chapter 6 Coordination and Distribution

Public concerns identified in comments would aid in determination of whether or not an Environmental Impact Statement is necessary for the Proposed Action. If it is determined that an Environmental Impact Statement is not required, a Finding of No Significant Impact would be prepared and signed, concluding the NEPA process.

This draft EA is being issued for a 30-day public review period, beginning April 15, 2016 and ending May 16, 2016. The draft EA is available at BPA's website at http://www.bpa.gov/goto/EstuaryRestorationProgram and Corps' website at http://www.nwp.usace.army.mil/Media/Announcements.aspx.

A public notice was sent to all interested parties and stakeholders for the public review period, including but not limited to the following agencies and groups:

Confederated Tribes of the Grand Ronde

Confederated Tribes of Siletz Indians

Confederated Tribes of the Warm Springs

Cowlitz Indian Tribe

Confederated Tribes and Bands of the Yakama Indian Nation

Confederated Tribes of the Umatilla Indian Reservation

Nez Perce Tribe

Shoalwater Bay Tribe

Chinook Indian Nation

Clatsop-Nehalem Confederated Tribes

Pacific, Wahkiakum, Cowlitz, Clark, and Skamania Counties, Washington

Clatsop, Columbia, and Multnomah Counties, Oregon

National Marine Fisheries Service

Natural Resources Conservation Service

Bureau of Land Management

U.S. Army Corps of Engineers

U.S. Senate and House Representatives

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

Oregon Department of Environmental Quality

Oregon Department of Fish and Wildlife

Oregon Department of Parks and Recreation

Oregon Department of State Lands

Oregon Department of Transportation

Oregon Watershed Enhancement Board

State of Oregon, Governor's Office

State of Washington, Governor's Office

Washington Department of Ecology

Washington Department of Fish and Wildlife

Washington Department of Natural Resources

Washington State Parks and Recreation

Columbia Riverkeeper

Lower Columbia River Ports

Lower Columbia River Drainage and Diking Districts

Estuary Partnership

Lower Columbia Fish Enhancement Group

Lower Columbia Fish Recovery Board

Lower Columbia River National Wildlife Refuges

Columbia River Estuary Study Task Force

Columbia Land Trust

Fiends of the Columbia River George

This page left intentionally blank

Chapter 7 References and Literature Cited

Bonneville Power Administration (BPA), US Army Corps of Engineers (Corps). 2013. Benefits of Habitat Improvements in the Estuary and Estuary: Results of Research, Monitoring and Evaluation.

Bottom, D. L., E. A. Simenstad, A. M. Baptista, D. A. Jay, L. Burke, K. K. Jones, E. Casillas, and M. B. Schiewe. 2001 (unpublished). Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia Salmon. National Marine Fisheries Service, Seattle, W A.

Brazier, J.R. and G.W. Brown. 1973. Buffer strips for stream temperature control. Research Paper 15, Forest Research Lab, Oregon State University. Corvallis, OR.

Council on Environmental Quality (CEQ). 2011a. Federal agency climate change adaptation planning: Implementing instructions. 4 March 2011. President's Council on Environmental Quality, Office of the White House, Washington, DC. Available at: http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf

CEQ. 2011b. Federal agency climate change adaptation planning: Support Document. 4 March 2011. President's Council on Environmental Quality, Office of the White House, Washington, DC. Available at: http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_support_document_3_3.pdf

CEQ. 2014. "Effective Use of Programmatic NEPA Reviews," Memorandum for Heads of Federal Departments and Agencies. December 18, 2014.

Columbia River Channel Improvement Reconsultation Project. Web site. Accessed on November 28, 2005. http://www.sei.org/columbia/background.html

Corps. 1985. Long-term monitoring of habitat development at upland and wetland dredged material disposal sites: 1974-1982. Final Report. July 1985. Waterways Experiment Station, Technical Report D-85-5.

Corps. 1996. Estuary Bi-state Water Quality Program, Fish, Wildlife, and Wetlands GIS Habitat Mapping. Prepared for the Oregon Department of Environmental Quality. Portland District, Portland OR.

Corps. 1999. Columbia River Channel Improvement Study, Final Integrated Feasibility Report and Environmental Impact Statement. Portland, OR.

Corps. 2007. Biological Assessment: Effects of the Federal Columbia River Power System and Mainstem Effects of Other Tributary Actions on Anadromous Salmonid Species Listed under the Endangered Species Act. August 2007. Prepared by the U.S. Army Corps of Engineers, Bonneville Power Administration, and the U.S. Department of the Interior Bureau of Reclamation.

Corps. 2009. Seasonal Juvenile Salmond Presence and Migratory Behavior in the Estuary, Final Report. Portland OR. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18246.pdf

Corps. 2009. Estuary Habitat Memorandum of Agreement on Columbia River Estuary Habitat Actions between the State of Washington, the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. September 16, 2009.

Corps. 2011a. Endangered Species Act biological assessment for anadromous salmonids, green sturgeon, Pacific eulachon, marine mammals & marine turtles for Columbia River channel operations and maintenance, mouth of the Columbia River to Bonneville Dam, Oregon and Washington. U.S. Army Corps of Engineers, Portland District, Portland, Oregon. April 2011 Amended August 2011.

Corps. 2011b. USACE Climate Change Adaptation Policy Statement. 3 June 2011. Office of the Assistant Secretary of the Army for Civil Works, Washington, DC. Available at: http://www.corpsclimate.us/docs/USACEAdaptationPolicy3June2011.pdf

Corps. 2012. USACE 2012 Climate Change Adaptation Plan and Report. 23 June, 2012. Available at: https://corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf

Corps. 2013. 2013 Strategic Sustainability Performance Plan. 28 June 2013. Office of the Assistant Secretary of the Army for Civil Works, Washington, DC. Available at: http://www.usace.army.mil/missions/sustainability/strategicsustainabilityperformanceplans.aspx

Christy, John A. and Putera, Judy A. 1993. Estuary Natural Area Inventory. Report to the Nature Conservancy, Washington Field Office, Seattle. Available at: http://library.state.or.us/repository/2008/200812221147561/index.pdf

Darnell, R.M. 1976. Impacts of construction activities in wetlands of the United States. U.S. Environmental Protection Agency, Ecological Research Series, Report No. EPA-600/3-76-045, U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon.

Diefenderfer H.L., G.E. Johnson, R.M. Thom, A.B. Borde, C.M. Woodley, L.A. Weitkamp, K.E. Buenau, and R.K. Kropp. 2012. An Evidence-Based Assessment of the Cumulative Effects of Tidal Freshwater and Estuarine Ecosystem Restoration: Early Life-Stage Habitat Functions for Endangered Salmonids. Draft Report Prepared by Pacific Northwest National Laboratory and NOAA Fisheries for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

Energy Information Administration (EIA). 2009. Energy and the environment, greenhouse gases basics. Accessed February 22, 2016 at: http://tonto.eia.doe.gov/energyexplained/index.cfm?page=environment_about_ghg

Environmental Protection Agency (EPA). 2005. *Global Warming—Climate.* 2005. Accessed on November 9, 2005 at: http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

EPA. 2010. Climate change – science: atmosphere changes. Accessed February 22, 2011 at http://www.epa.gov/climatechange/science/recentac.html

EPA. 2014. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011. Accessed July 2014 at: http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Expert Regional Technical Group (ERTG). ERTG *Scoring Criteria.* December 2010. ERTG 2010-02. Available at: https://www.cbfish.org/FileResource.mvc/DownloadPdfFileResource/abeb5458-b7b9-43a7-9442-0b528567ad3e

ERTG. *History and Development of a Method to Assign Survival Benefit Units*. Revised December 2011. ERTG 2010-03. Available at: https://www.cbfish.org/FileResource.mvc/DownloadPdfFileResource/38f3507b-9b66-4e4c-a1b2-ffea1a2d6694

ERTG. 2013. *Calculating Survival Benefit Units for Subactions Involving Floodplain Lakes*. September 2013. ERTG 2013-01.

ERTG. 2013. *ERTG Analysis of Water Levels for Site Determination in Tidal-Dominated Regions*. October 2013. ERTG 2012-01, Rev. 1.

E&S Environmental Chemistry, Inc. 2000. Youngs Bay Watershed Assessment. Youngs Bay Watershed Council, Astoria, Oregon.

Federal Columbia River Power System (FCRPS). 2013. 2013 Comprehensive Evaluation Section 1. Available at: http://www.salmonrecovery.gov/docs/FCRPS_2013_CE_Section_1.pdf

Federal Highway Administration, (no date). Planning Processes website, accessed at: https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section03.cfm#Toc336872985

Federal Highway Administration. 2006. Roadway Construction Noise Model (RCNM) User's Guide. Final Report, January. FHWA-HEP-05-054, DOT-VNTSC-FHWA-05-01. Available at: http://www.fhwa.dot.gov/environment/noise/construction_noise/rcnm/rcnm.pdf.

Fish Passage Center. 2008. Online database of current and historical fish passage data for the Federal Columbia River Power System. Fish Passage Center, Portland, Oregon. Available at http://www.fpc.org (April 2009).

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. *Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead: An Evaluation of the Effects of Selected Factors on Salmonid Population Viability.* NOAA technical memorandum, Northwest Fisheries Science Center, National Marine Fisheries Service. Seattle, WA. 136 pp.

Good et al, 2005. Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Graves, J.K., J.A. Christy, and P.J. Clinton. 1995. Historic Habitats of the Estuary. Columbia River Estuary Study Task Force, Astoria OR.

Gustafson, R. and nine coauthors. 2008. Summary of scientific conclusions of the review of the status of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. NMFS Northwest Fisheries Science Center. Seattle, WA. 114 p. Available: http://www.nwr.noaa.gov/Other-Marine-Species/upload/Eulachon-Review.pdf. Accessed April 2009.

Independent Scientific Advisory Board (ISAB). 2000. The Columbia River Estuary and the Columbia River Basin Fish and Wildlife Program. A Review of the Impacts of the Columbia River's Hydroelectric System on Estuarine Conditions. Conducted for the Northwest Power Planning Council in conjunction with studies by National Marine Fisheries Service.

ISAB. 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, OR. Jones, Philip. 2005. Lower Coast Fork Willamette River Watershed Assessment. Final Report, June 2005. Prepared for Coast Fork Willamette Watershed Council.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: Working Group I: the physical science basis. Chapter 2: changes in atmospheric constituents and radioactive forcing: atmospheric carbon dioxide. Accessed February 22, 2011 at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2.html

Jay, D.A. and T. Kukulka. 2003. Impacts of Columbia River Discharge on Salmonids Habitat, Park 2: Changes in Shallow-Water Habitat. September 2003. Journal of Geophysical Research 108(C9), 10-16.

Johnson, G.E., R.M. Thom, A.H. Whiting, G.B. Sutherland, T. Berquam, B.D. Ebberts, N.M. Ricci, J.A. Southard, J.D. Wilcox. 2003. *An Ecosystem-based Approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia River Estuary.* Prepared by the Pacific Northwest National Laboratory for the U.S. Army Corps of Engineers, Portland District, under a related services agreement with the U.S. Department of Energy, Contract DE-AC-06-76RLO1830. Final Report PNNL-14412.

Johnson OW, WS Grant, RG Kope, K Neely, FW Waknitz, and RS Waples. 1997. Status Review of Chum Salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFSNWFSC-32, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.

Loge, F.J, M.R. Arkoosh, T.R. Ginn, L.L. Johnson, and T.K. Collier. 2005. ―Impact of Environmental Stressors on the Dynamics of Disease Transmission.‖ *Environmental Science and Technology.* 39:7329-7336.

Lower Coast Fork Willamette River Watershed Assessment. Final Report, June 2005. Prepared for Coast Fork Willamette Watershed Council.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Salmon-Washougal and Lewis Rivers Watershed Planning - WRIAs 27 and 28. Watershed Management Plan September 2004 DRAFT.

Lynch, J.A., E.S. Corbett, and K. Mussalleum. 1985. Best management practices for controlling non-point source pollution on forested watersheds. Journal of Soil and Water Conservation, 40: 164-167.

MacClellan, Megan. 2011. Carbon Content in Oregon Tidal Wetland Soils. Report for the Cooperative Institute for Coastal and Estuarine Environmental Technology. Oregon State University, Marine Resource Program, Corvallis, Oregon. Marshall et al. 1987.

Marcoe, K. 2013. Historical Habitat Change in the Estuary and Estuary. Presentation to the Landscape Planning Workshop.

Marcoe, K. and S.Pilson. 2012. Habitat Change in the Estuary and Estuary, 1870-2011. Available at http://www.estuarypartnership.org/sites/default/files/resource_files/Lower%20Columbia%20Estuary%20Historical%20Landcover%20Change%20final_2013_small.pdf

Matrazzo, Donna.(no date). *Estuary Water Trail Map and Guide*. Prepared for the Estuary partnership. Available at: http://www.donnamatrazzo.com/docs/58.pdf

Mighetto, Lisa and Wesley J. Ebel. 1994. Saving the Salmon: A History of the U.S. Army Corps of Engineers' Efforts to Protect Anadromous Fish on the Columbia and Snake Rivers. Prepared by Historical Research Associates, Inc. for the U.S. Army Corps of Engineers, Portland and Walla Walla Districts. September 6, 1994.

Miller, J. A. and C. A Simenstad. 1997. A comparative assessment ofa natural and created estuarine slough as rearing habitat for juvenile Chinook and coho salmon. Estuaries 20:792-806.

National Oceanic and Atmospheric Administration (NOAA Fisheries). 2000. *Endangered Species Act Section 7 Biological Opinion on the Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin*. NMFS, Portland, Oregon. 10 December 2000.

NOAA Fisheries. 2004. *Revised 2004 Biological Opinion on the Consultation on Remand for Operation of the Columbia River Federal Columbia River Power System and 19 U.S. Bureau of Reclamation Projects in the Columbia Basin.* NMFS, Portland, Oregon. 30 November 2004. (Revised and reissued pursuant to court order, NWF v. NMFS, CIv. No. CV 01-640-RE [D. Oregon].)

NOAA Fisheries. 2008. *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program*. NMFS, Portland, Oregon. 5 May 2008. (Revised and reissued pursuant to court order NWF v. NMFS, Civ. No. CV 01-640-RE [D. Oregon].)

NOAA Fisheries. 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries Service, Northwest Region. November, 2009.

NOAA Fisheries. 2010. *Endangered Species Act Section 7(a)(2) Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1) Permit for Juvenile Fish Transportation Program.* NMFS, Northwest Region. 20 May 2010. F/NWP/2010/02096.

NOAA Fisheries. 2011a. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

NOAA Fisheries. 2011b. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. NMFS Northwest Region. Portland, OR. Prepared for NMFS by the Estuary Estuary Partnership and PC Trask & Associates, Inc. January 2011.

NOAA Fisheries. 2013. ESA Recovery Plan for Estuary Coho Salmon, Estuary Chinook Salmon, Columbia River Chum Salmon, and Estuary Steelhead. NMFS, Northwest Region. June 2013. Available at http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/final_plan_documents/final_lcr_plan_june_2013_-corrected.pdf

NOAA Fisheries. 2014. *Endangered Species Act Section 7(a)(2) Supplemental Biological Opinion for the Consultation on Remand for Operation of the Federal Columbia River Power System*. NMFS, Northwest Region. 17 January 2014. NWR-2013-9562.

Northwest Power and Conservation Council (NPCC). 2002. Estuary and Columbia River Estuary Subbasin Summary. Available at http://cfw.nwcouncil.org/FWProgram/ReviewCycle/fy2003ce/workplan/020517LowerColEstuary.pdf

Northwest Power and Conservation Council (NPCC). 2004. ―Mainstem Estuary and Columbia River Estuary Subbasin Plan.‖ In *Columbia River Basin Fish and Wildlife Program*. Portland, OR.

Northwest Power and Conservation Council (NPCC). 2014. Columbia River Basin Fish and Wildlife Program. January 2015. Document 2014-12. Available at: http://www.nwcouncil.org/fw/program/2014-12/program/

National Research Council (NRC). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Washington, DC: The National Academies Press.

Oregon Department of Environmental Quality (Oregon DEQ). 2008. Portland Harbor. Available at: http://www.deq.state.or.us/lq/cu/nwr/portlandharbor.

Oregon DEQ. 2010. Integrated water quality assessment database. Available at: http://www.deq.state.or.us/wq/assessment/rpt2010/search.asp.

ODFW and NOAA Fisheries, 2011. Upper Willamette River Conservation And Recovery Plan For Chinook Salmon And Steelhead; Prepared by Oregon Department of Fish and Wildlife and the National Marine Fisheries Service Northwest Region. August 5, 2011.

Oregon Wetlands Joint Venture.1994. Joint Venture Implementation Plans: Estuary. Prepared for Pacific Coast Venture, West Linn, Oregon.

Pacific Northwest National Laboratory (PNNL). 2012. Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Estuary.

Philip Williams & Associates, Ltd., and P.M. Farber. 2004. *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay.* The Bay Institute and California Conservancy, Oakland, CA.

Restoration Project Draft Environmental Assessment. NEPA Register Number: DOE/EA-1969. January. Pp. 3-59.

Roegner G.C., E.W. Dawley, M. Russell, A. Whiting and D.J. Teel. 2010. Juvenile Salmonid Use of Reconnected Tidal Freshwater Wetlands in Grays River, Estuary Basin. Transactions of the American Fisheries Society. 139:4, 1211-1232.

Roni, R., T.J. Beechie, R.E. Bilby, F.E. Leonette, M.M. Pollock, and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management 22:1-20.

Salo EO. 1991. Life history of chum salmon (Onchorhynchus keta). In Pacific Salmon Life Histories, C Groot and L Margolis, pp. 231–310. University of British Columbia Press, Vancouver, Canada.

Simenstad, C. A., K. L. Fresh, and E. O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function, pp. 343-364 In Estuarine Comparisons, V.S. Kennedy, ed. Academic Press, New York, NY.

Simenstad, C. A., D. A. Jay, C. D. McIntyre, C. Sherwood, and L. Small. 1984. The dynamics of the Columbia River Estuary ecosystem, Volumes I and II, CREDDP (Columbia River Estuary Data Development Program). Astoria, Oregon, 695 pages.

Simenstad C.A., L.F. Small and C.D. McIntire. 1990. Consumption processes and food web structure in the Columbia River estuary. Progress in Oceanography 25:271-297.

Simenstad, C. A. and J. R. Cordell. 2000. Ecological assessment criteria for restoring anadromous salmonid habitat in Pacific Northwest estuaries. Ecology Engineering 15:283-302.

Simenstad, C.A., Burke, J.L., O'Connor, J.E., Cannon, C., Heatwole, D.W., Ramirez, M.F., Waite, I.R., Counihan, T.D., and Jones, K.L., 2011, Columbia River Estuary Ecosystem Classification – Concept and Application: U.S. Geological Survey Open-File Report 2011-1228, 54 p.

Spence, B.C., G.A. Lomincky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. December. *Accessed January 2003:* http://www.nwr.noaa.gov/1habcon/habweb/ManTech/front.htm

Tetra Tech. 1992. Estuary Bi-State Program – Reconnaissance Survey of the Estuary, Task 3: Review of Hydraulic, Hydrologic, Sediment Transport, and Geomorphic Characteristics of the Estuary. March 1992. Final Report, TC-8526-03.

Tetra Tech. 1996. Estuary Bi-State Program -The Health of the River, 1990-1996. Integrated Technical Report. Prepared for Oregon Department of Environmental Quality and Washington Department of Ecology.

Thom, R.T., N.K. Sather, D. Bottom, and G.C. Roegner. 2013. "Columbia Estuary Ecosystem Restoration Program: 2012 Synthesis Memorandum." Final report submitted to U.S. Army Corps of Engineers, Portland, Oregon.

Thomas, D. W. 1983. Changes in the Columbia River Estuary Habitat Types Over the Past Century. Columbia River Estuary Study Taskforce Columbia River Estuary Data Development Program, Astoria, OR.

Tiffan et al, 2012. Kenneth F. Tiffan, William P. Connor, Brian J. Bellgraph. Snake River Fall Chinook Salmon Life History Investigations Annual Report 2011, April 2011—March 2012. Pacific Northwest National Laboratory, Richland, Washington. Prepared for: U.S.

U.S. Fish and Wildlife Service (USFWS). 2005. *Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary: Final Environmental Impact Statement*. Portland, OR.

USFWS. (no date). Species Fact Sheet Coastal Cutthroat Trout *Oncorhynchus clarki.* Available at: http://www.fws.gov/wafwo/species/Fact%20sheets/CoastalCutthroatTrout.pdf

USFWS. (no date). Fisgheries Resources, Pacific Lamprey. Accessed at: http://www.fws.gov/pacific/Fisheries/sphabcon/Lamprey/index.cfm

USFWS. (no date). Species Fact Sheet, Water Howellia, *Howellia auatilis.* Accessed at http://www.fws.gov/wafwo/species/Fact%20sheets/Waterhowellia_factsheet.pdfU.S. Global Change Research Program (USGCSP). 2009. Our Changing Planet: The U.S. Climate Change Science Program. Available at: http://www.usgcrp.gov/usgcrp/Library/ocp2009/

U.S. Army Corps of Engineers, see Corps

U.S. Census Bureau. (no date). Quick Facts website. Accessed at: http://www.census.gov/quickfacts/table/PST045215/41,53

Varanasi, U. 2005. *Biological Implications of Recent Ocean Conditions*. Memorandum to Regional Administrator

Weitkamp, Laurie. (no date). *West Coast Lampreys Friends or Foes*. Power Point Presentation by Laurie Weit NOAA Fisheries, Northwest Fisheries Science Center Newport, OR. Available at: http://nativefishsociety.org/wp-content/uploads/Weitkamp-lamprey-MCWC-handout.pdf

Williams, R. N., ed. 2006. *Return to the River: Restoring Salmon to the Columbia River.* Burlington, MA: Elsevier Academic Press. Print. 699 pp.

Zydlewski J, JR Johnson, J Hogle, J Brunzell, S Clements, M Karnowski, and C. Shreck. 2008. Seaward migration of coastal cutthroat trout (Oncorhynchus clarki clarki) from four tributaries of the Columbia River. In Movements of Coastal Cutthroat Trout (Oncorhynchus clarki clarki) in the Estuary: Tributary, Mainstem and Estuary Use. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Appendix A – Columbia River Estuary Hydrogeomorphic Reaches.

The implementation area for the estuary restoration program includes the entire area of tidal influence within the Columbia River estuary. The Columbia River estuary is defined as zone of tidal influence in the mainstem Columbia River and all tributaries in Oregon and Washington from the mouth of the Columbia River at River Mile (RM) 0, upstream to Bonneville Dam at RM 146.

The table below shows the ecological zone from west to east and the major sub-basins in both Washington and Oregon which are included in the implementation area.

Table A-1. Ecological Zones and Sub-basins of the Estuary

Ecological Zone	Oregon Subbasins	Washington Subbasins
Coast Range	Youngs Bay, Big Creek, Clatskanie, Scappoose	Chinook, Wallacut, Deep, Grays, Elochoman, Skamkowa, Mill, Abernathy, and Germany Creeks
Cascade	Clackamas, Sandy	Cowlitz (Lower and Upper), Cispus, Tilton, Coweeman, Toutle, Kalama, North Fork and East Fork Lewis River, Salmon Creek, and Washougal
Gorge	Lower Gorge (below Bonneville Dam)	Gibbons, Duncan, Hamilton, Hardy, and Multnomah creeks

The Oregon and Washington subbasins included in the Coast Range and Cascade ecological zones are consistent with the subbasins delineated in the Council's Fish and Wildlife Program (Johnson 2003, NPCC 2014).

The estuary can be viewed as a series of eight hydrogeomorphic reaches between the mouth and Bonneville Dam. Hydrogeomorphology can be defined as the relationship between landforms and water, wherein a landscape is created or modified by its water resources. Figure A-1, below, depicts the estuary and the different hydrogeomorphic reaches.

The hydrogeomorphic reaches making up the implementation area are described as the following:

Reach A: This area includes the estuary entrance (Clatsop Spit and Trestle Bay), Bakers Bay, and Youngs Bay upriver to the Astoria-Megler Bridge at river mile (RM) 14. The entrance of the Columbia River is dominated by subtidal habitat and has the highest salinity and most extensive mixing of estuarine and marine waters in the estuary. This reach features dynamic environmental conditions with dramatically fluctuating salinity, velocity, and turbidity throughout the year. Reach A is also subject to storm surges, fluvial flooding, and extreme coastal disturbances, such as earthquakes and tsunamis, and continually experiences coastal uplift due to coastal tectonics (Simenstad et al. 2011).

Historically, the estuary entrance was a high-energy area with a complex of channels, shallow water, and sand bars. The dynamic nature of the entrance area has changed from construction of jetties and routine dredging of the federal navigation channel, limiting wave action and the marine supply of sediment in the estuary. As a result, tidal marsh habitat has recently started to develop in some areas, although much of the historical tidal marsh and tidal swamp habitat has been lost because of dike construction in the floodplain. Given its closeness to the river mouth, Baker Bay consists primarily of brackish water. Youngs Bay has a broad floodplain and historically was abundant in tidal marsh and swamp habitats. Diking and flood control structures have converted floodplain habitats to pasture and farmland. The remaining fragmented tidal marsh and tidal swamp habitats in Youngs Bay differ structurally and functionally from historical conditions of these habitats.

Reach B: Reach B extends from the Astoria-Meglar Bridge (RM 14) upstream to the western-most tip of Puget Island at RM 38. This area includes what has been referred to as the mixing zone (NPCC 2004), along with Grays Bay and Cathlamet Bay. The mixing zone is a network of mid-channel shoals and flats, such as Desdemona and Taylor Sands. Reach B also has the highest variation in salinity within the estuary because of the interactions between tide cycles and river flows. The maximum turbidity in the estuary, which is created through these interactions, often occurs in the mixing zone of Reach B. There are many islands in Reach B, including Tenasillahe, Horseshoe, Marsh, Karlson, Russian, Svensen, Miller Sands, Rice, and Lois islands. Grays Bay is on the Washington side of the river in Reach B; Cathlamet Bay is on the Oregon side of the river.

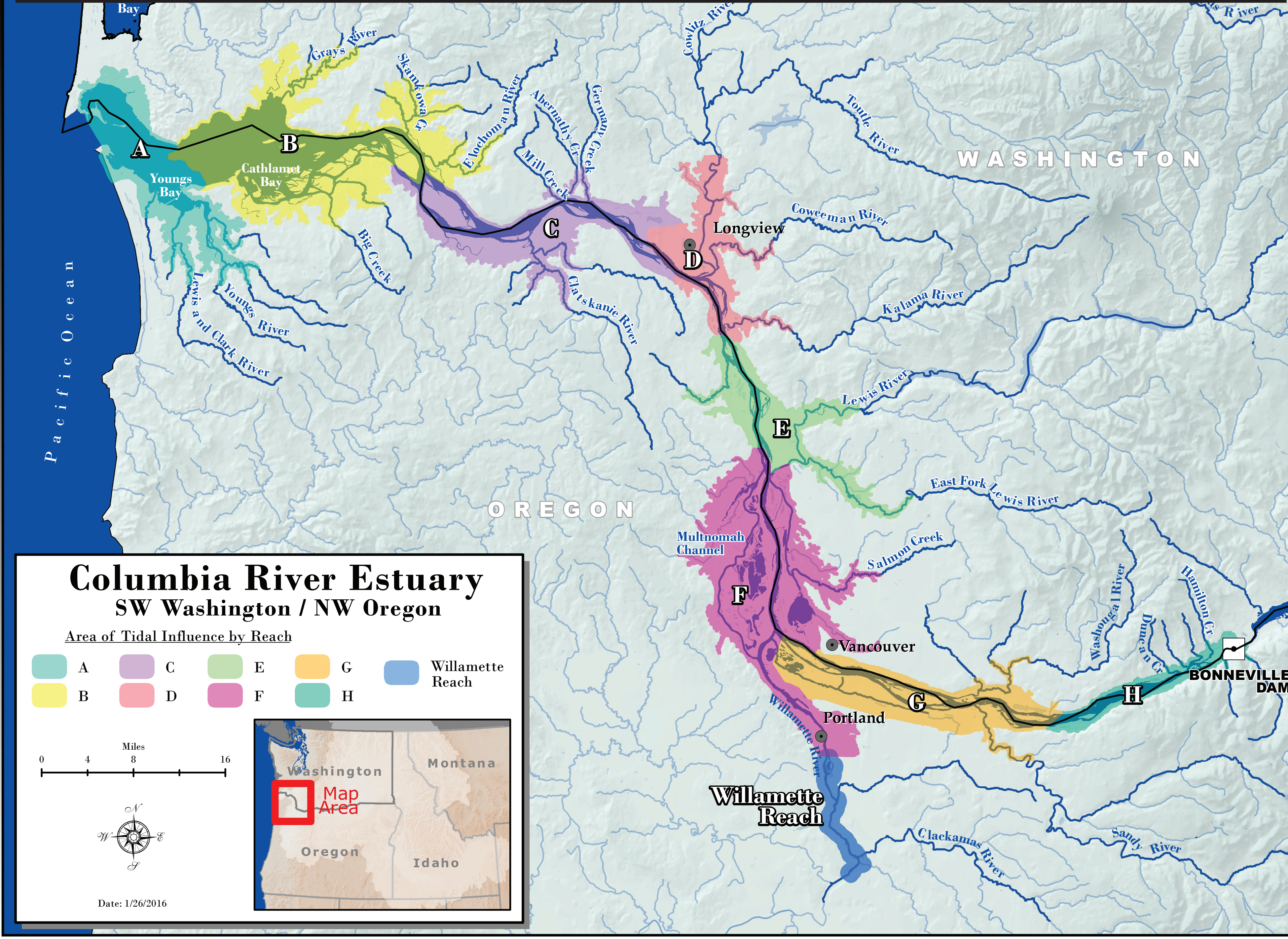
Historically, water circulation in Reach B was caused by interactions between river flow and tidal intrusion. Pile dike fields built next to the main Columbia River navigation channel have decreased circulation in Grays Bay, increasing sediment accretion, which has likely caused flooding problems in the Grays and Deep River valley bottoms. This accretion may have promoted the beneficial development of tidal marsh habitat in the bay. Dike construction, primarily for pasture conversion, has isolated the main channel from its historical floodplain throughout Reach B and eliminated much of the historical tidal swamp habitat further upstream in the related tributaries.

Cathlamet Bay has some of the most intact and productive tidal marsh and swamp habitat remaining in the estuary. A large portion of Cathlamet Bay is protected by the U.S. Fish and Wildlife Service (USFWS) Lewis and Clark National Wildlife Refuge. The western edge of Cathlamet Bay contains part of the brackish oligohaline[38] zone, which is important to juvenile salmon and steelhead during their transition from freshwater to saltwater, a process known as smolting. Portions of Cathlamet Bay have lost substantial acreage of tidal swamp habitat from dike construction. Conversely, tidal marsh habitat has formed along the fringe of dredged material placement sites for the purposes of maintaining the federal navigation channel (Tenasillahe, Miller Sands, Pillar Rock, and Rice Islands).

---

[38] Term to characterize water with salinity of 0.5 to 5.0 (parts per thousand), due to ocean-derived salts.

Figure A -1. Columbia River Estuary and Major Tributaries and Reaches



Reach C: This area includes deep channels and steep shorelines on the Washington side of the river and extends from the westernmost tip of Puget Island (RM 38) to the western edge of Longview (RM 64). Historically, Reach C contained large areas of tidal swamp dominated by Sitka spruce. Dike construction and clearing of vegetation caused a substantial loss of tidal marsh habitat on islands and floodplain along the Oregon portion of Reach C. Islands located in Reach C include Lord Walker, Hump Fisher, Crims, Wallace and Puget islands.

Reach D: This area begins west of Longview (RM 64) and ends north of the city of Kalama at RM 74. Reach D is distinct from the downstream reaches in its geology, vegetation, and climate. It includes inflows from the Cowlitz and Kalama rivers. Extensive diking and filling around Longview and the mouth of the Kalama River have substantially reduced the floodplain. In addition, sediment loading from the 1980 eruption of Mount St. Helens significantly altered hydrology and channel morphology in, and downstream, of the Cowlitz and Kalama rivers. Dredging and the subsequent placement of sediment from Mount St. Helens eruption have fundamentally changed Howard and Cottonwood Islands. Also, Reach D is exposed to high levels of polychlorinated biphenyls (PCBs) from industrial activities in the Longview and Kalama area.

Reach E: Reach E includes the Columbia River south of the city of Kalama (RM 74) to the confluence with the Lewis River, next to the city of St. Helens, Oregon at RM 85. The Lewis River system, including the North Fork and East Fork, flows into the Columbia River in Reach E. Sandy, Goat, Deer, Martin, and Burke islands are included in Reach E. Several of these islands, including Sandy and Goat islands, were created through the placement of dredged materials, and Sandy and Deer Islands are currently used as dredged material placement sites. Extensive diking has occurred on Deer Island and around the city of Woodland, Washington.

Reach F: This area includes the Columbia River south of the confluence with the Lewis River (RM 85) up to and including the midpoint of Hayden Island at RM 102.5. Reach F also extends into the Willamette River, to the downstream tip of Ross Island at RM 15 on the Willamette River. Reach F is rural, but it is immediately downstream of the most urban and industrial areas in the entire Columbia River.

Reach F contains the largest historical floodplain lakes below Bonneville Dam: Sturgeon Lake, at about 3,600 acres, and Vancouver Lake, which is approximately 2,400 acres. The historical floodplain was very wide relative to the narrow and constricted channel through the Columbia River Gorge. Bachelor and Sauvie islands are in Reach F. Sloughs include the 13-mile Lake River system and the more than 20-mile-long Multnomah Channel. Scappoose Bay is relatively un-diked; however, Sauvie Island and Bachelor Island are extensively diked.

In the Willamette River, Reach F also includes Portland Harbor which is 6-mile stretch of the river running through a heavily industrialized portion of downtown Portland. The Environmental Protection Agency (EPA) added this stretch of the Willamette River to the National Priorities List in December 2000 due to the discovery of contaminated sediments[39]. Sediments in the river at this site are contaminated with various toxic compounds, including metals, polycyclic aromatic hydrocarbons (PAHs), PCBs, chlorinated pesticides, and dioxin (Oregon DEQ 2008).

Reach G: This area includes the Columbia River west of Hayden Island (RM 102.5) and extends to east of Reed Island at RM 127. Major tributaries to Reach G include the Washougal and Sandy Rivers. The cities of Portland and Vancouver straddle the Columbia River in this reach. Hayden Island, Government Island, Lady Island, and Reed Island are located in Reach G. Similar to downstream reaches, extensive diking has reduced the floodplain throughout Reach G. Smith and Bybee lakes have a large floodplain lake system, similar to that of Vancouver and Sturgeon lakes in Reach F. Many industrial piers and over-water structures line the Columbia River in this reach.

Reach H: This area includes the Columbia River from east of Reed Island at RM 127 to the Bonneville Dam at RM 145. This reach receives flow from several smaller tributaries, including Gibbons, Duncan, Hamilton, Hardy, and Multnomah creeks. Notable islands in this reach include Ackerman and Skamania islands. Reach H includes the entrance to the Columbia River Gorge, which has steep slopes and was designated as a National Scenic Area in 1986 because of its natural and aesthetic values. Little diking has occurred in this area, primarily because steep slopes on both side of the river naturally constrain the floodplain and limit development.

Lower Willamette Reach: This highly urbanized reach extends upstream from the northern tip of Ross Island (RM 15) to Willamette Falls at RM 26.5. The Lower Willamette reach bisects the city of Portland and flows past the cities of Milwaukie, Lake Oswego, Gladstone, and Oregon City. Notable islands in the Lower Willamette reach include Ross and Hardtack, Elk Rock, Hog, Cedar, and Goat Islands. The primary tributary entering the Lower Willamette reach is the Clackamas River, which is downstream of Willamette Falls. Other smaller tributaries include Johnson, Tryon, Kellogg, Miller, and Stephens Creeks. The shoreline of the Lower Willamette reach has been highly modified for industry, flood control, and other uses. Twelve transportation bridges cross the Willamette River in this reach.

---

[39] In 1980, the Comprehensive Environmental Response, Compensation and Liability Act was enacted and gave the EPA the authority to establish a program and trust fund (the "Superfund") to clean up the nation's uncontrolled hazardous waste sites. As part of the Superfund program, the EPA maintains a prioritized list of identified sites which release or threaten to release hazardous substances, pollutants, or contaminants, known as the National Priorities List. For additional information, please visit the EPA's Superfund website: http://www.epa.gov/superfund/index.htm

This page left intentionally blank

Appendix B – Completed and Planned Estuary Restoration Projects

To date BPA and the Corps have completed estuary restoration projects at specific sites and are currently studying and planning additional projects proposed for implementation. The types of actions typically implemented under the estuary restoration program are described in Section 2.3 and example projects that have been recently implemented or are in the planning stages are described referenced below.

Completed Estuary Restoration Projects

BPA and the Corps have completed a number of estuary restoration projects in recent years and protected or restored over 7,000 acres of habitat within the estuary. A list of properties that have been acquired and projects that have been implemented are included below.

Table B-1. Completed Restoration Actions in the Columbia River Estuary

Year	Project Name	Acres	
2007	Fort Clatsop Restoration	45	80
	Ramsey Lake Restoration	5	
	Scappoose Bottomlands Restoration	30	
2008	Big Creek Restoration	16.1	879
	Mirror Lake Restoration - Phase 1	168	
	Sandy River Delta Riparian Forest Restoration (Area #1)	100	
	Sandy River Delta Riparian Forest Restoration (Areas #5, #6, #7)	155	
	Scappoose Bay 2007-2009	41.3	
	Stephens Creek Restoration	0	
	Walluski River North, Elliot property #1 – Restoration	24.4	
	Willow Grove- Acquisition	304	
	Wolf Bay - Acquisition	70.21	
2009	Columbia Slough Confluence Habitat Enhancement Restoration	3.4	403
	Crazy Johnson Creek - Acquisition	150.87	
	Elochoman Slough West - Acquisition	196.36	
	Gorley Springs, Grays R. - Acquisition & Restoration	40	
	Perkins Creek Restoration and Enhancement Restoration	2.2	
	Vancouver Water Resources Education Center Restoration	10	

Year	Project Name	Acres	
2010	Haven Island Restoration	97	612
	Julia Butler Hansen NWR - Mainland Unit Restoration	320	
	Mirror Lake Restoration - Phase 2	3.3	
	Sandy River Delta Riparian Forest Restoration (Area #8)	47	
	Sandy River Delta Riparian Forest Restoration (Area #9)	145	
2011	Duncan Creek Chum Channel Restoration	0.4	382
	Fort Columbia Restoration	85.1	
	Germany Creek - (BA) Floodplain Restoration	8.61	
	Grays Bay - Mill Road - & Restoration	93.9	
	Sandy River Delta Riparian Forest Restoration (Area #10)	194	
2012	Abernathy Creek Tidal Restoration	4.5	1,436
	Brix Bay-Deep River Confluence - Acquisition	54.96	
	Colewort Creek (Nutel Landing) Restoration	35.4	
	Columbia Stock Ranch - Acquisition	646.25	
	Elochoman Slough East - Acquisition	89.61	
	Gnat Creek Restoration - Phase 1	19	
	Hamilton Creek Chum Channel Restoration	0.5	
	Knappton Cove Acquisition	436	
	Otter Point Restoration	53.2	
	South Tongue Point (Liberty Lane) Restoration	15	
	Wallacut River - Acquisition	81.63	

Year	Project Name	Acres	
2013	Chinook River WDFW - Acquisition	202	1,467
	Dibblee Point Restoration	15.3	
	Gnat Creek Restoration - Phase 2	67.81	
	Grays Bay Kandoll Farm Restoration - Phase 2	255.6	
	Grays River Confluence - Acquisition	123.05	
	Honeyman Creek Restoration	58	
	Horsetail Creek Restoration	138.02	
	Kerry Island - Acquisition	110	
	LA (Louisiana) Swamp Restoration	65.24	
	Sandy River Dam Removal	58.19	
	Sauvie Island, North Unit (Ruby Lake) Restoration - Phase 1	139.8	
	Skamokowa Creek - Dead Slough Restoration	70.5	
	Wallooskee Youngs - Acquisition	163.4	
2014	Brix Bay Acquisition	22	1,182
	Chinook River WDFW - Restoration	354	
	Julia Butler Hansen NWR-Steamboat Slough Restoration	142.9	
	Karlson Island Restoration	319.5	
	Multnomah/Wahkeena Restoration	26.5	
	Sauvie Island, North Unit Restoration - Phase 2	161.3	
	Sharnelle Fee Restoration	50	
	Thousand Acres Restoration	106.5	
2015	Batwater Station Restoration	52.2	1,320
	Brix Bay Acquisition	27.5	
	Buckmire Slough Restoration – Phase 1	87	
	Crooked Creek Acquisition	18.3	
	Elochoman Slough Restoration	562.6	
	LaCenter Wetlands Restoration	473.5	
	Sauvie Island, North Unit Restoration - Phase 3	99.2	
Grand Total		7,760 acres	

In order to provide more detail on typical estuary restoration projects implemented as part of the estuary restoration program select project descriptions are provided below.

Sandy Riparian Delta Riparian Forest Restoration

The 1,500-acre Sandy River delta is located at the confluence of the Sandy and Columbia rivers in Multnomah County, Oregon at RM 120-125. Historically, the delta was a wooded riparian wetland with ponds, sloughs, bottomland and oak woodlands, prairie, and low- and high-elevation floodplains. In 2008, the Corps and BPA initiated a multi-year project to remove the extensive coverage of invasive vegetation and restore native species on approximately 202 acres of Sun Dial Island. Restoration was completed in 2010.

Sandy River Dam Removal

The Sandy River is a major tributary to the estuary, which empties into the Columbia River at RM 120. In 2013, the Corps partnered with the U.S. Forest Service to remove a 1930's-era diversion dam across the main channel of the Sandy River near the confluence with the Little Sandy River. The project reconnected flows to the east channel, restoring physical and biological ecosystem processes in support of local fish and wildlife, including salmon and steelhead. The project connected 190 acres of the historical channel with the estuary.

Julia Butler National Wildlife Refuge – Mainland Unit Restoration

The Corps worked with the USFWS to replace three tide gates and repair a failing culvert at the Julia Butler National Wildlife Refuge at RM 36 in Wahkiakum County, Washington in 2010. The project replaced a derelict top-hinged tide gate with a hydraulically-efficient side-hinged tide gate to provide improved fish passage and water quality. In addition, the Corps installed two new side-hinged tide gates on a blind slough on the Refuge, restoring a muted tidal signal and facilitating fish passage in shallow-water habitat. The project restored 110 acres of slough/wetland habitat and 210 acres of riparian forest habitat.

Julia Butler National Wildlife Refuge – Steamboat Slough

In 2014, the Corps completed restoration of tidal habitat in the project area between Steamboat Slough and the Columbia River, reconnecting Ellison Slough to the tidal influence of the Columbia River. The project restored tidal connectivity and fish access to 68 acres of historical tidal wetlands on the mainstem Columbia River at RM 35 in Wahkiakum County, Washington. The Corps constructed a setback levee and breached the existing levee in two locations to facilitate inundation of tidal marsh habitat and wetlands, fully restoring ecosystem processes.

Fee-Simon Wetland Restoration Project

The Columbia River Estuary Study Taskforce and the Natural Resources Conservation Service, in partnership with the Clatsop Diking Improvement Company No. 9, modified a section of the existing federal levee at five relatively small-scale locations on the Klaskanine River. The project facilitated the reestablishment of tidal connection to 46 acres of historical wetland and floodplain habitat disconnected by the construction of the Federal Flood Control Works levee system in the 1930s. The project site is in Clatsop County, Oregon approximately nine miles southeast of Astoria. It lies on the north bank and floodplain of the Klaskanine River approximately 2,400ft upstream of its confluence with the Youngs River. The Fee-Simon Wetland Restoration Project was completed in 2014 and restored ecological processes including tidal influence and nutrient cycling to a currently disconnected floodplain.

Sauvie Island North Unit – Phase 3

Phase 3 of the Sauvie Island North Unit project was completed in 2015 and restored freshwater wetlands, channels, and backswamps. Removal of undersized culverts and earthen barriers, along with channel enhancements, improved hydrology to existing slough networks, restoring access and estuarine habitat function for juvenile salmonids. Lowering the marsh plain through soil excavations is designed to help control invasive plant species and benefit native species, and expand the diversity of habitat affected by increased flooding frequency and duration throughout the wetlands.

La Center Wetlands

The La Center Wetlands restoration project, located in Clark County, WA, corrected impaired hydrology, riparian and floodplain function and habitat diversity and complexity. by re-connecting the floodplain with the river and encouraging natural hydrologic and geomorphic processes across 453 acres. Project activities included removing two fish passage barriers (existing weir and culvert) that are not functioning correctly, replanting significant acres with native species, installing beaver structures, and improving off-channel habitat.

Karlson Island

The Karlson Island restoration project restored functional hydrology and fish access to 320 acres of tidal marsh habitat. By lowering and removing levees the project increased access to emergent marsh habitat for juvenile salmonids species, improved hydrologic exchanges to more closely resemble natural conditions, improved hydraulics and flow patterns in the existing channels, and enhanced food web connectivity between the marsh floodplain and surrounding riverine system. Installation of large woody debris increased habitat structure and complexity to the slough network, and controlling invasive plant species.

Proposed Estuary Restoration Projects

BPA and the Corps have a number of estuary restoration projects that have been proposed and are currently in the feasibility analysis and planning process. Projects that are in the planning stages are outlined below. This list is not all encompassing and additional projects will be proposed for implementation. Additional information for each project can be found on the BPA NEPA website at https://www.bpa.gov/efw/Analysis/NEPADocuments/Pages/default.aspx or Corps NEPA website at http://www.nwp.usace.army.mil/Media/Announcements.aspx.

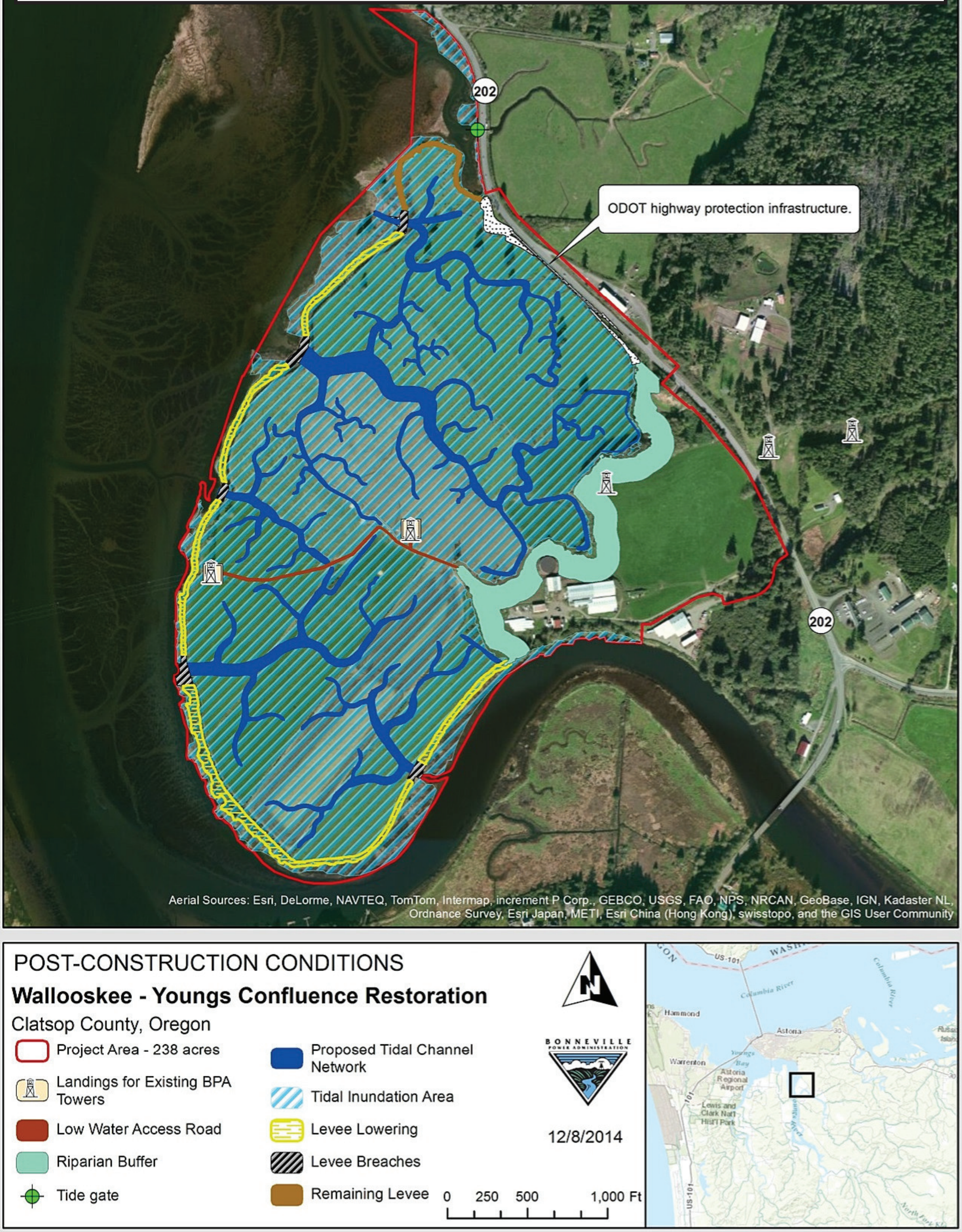
Project descriptions and conceptual design maps are provided below for some proposed projects and in order to provide additional information on the types of actions likely to be implemented under this programmatic EA.

Wallooskee-Youngs Confluence Restoration

In 2015 BPA completed an EA, issued a Finding of No Significant Impact, and decided to fund a restoration project at the confluence of the Wallooskee and Youngs Rivers in Clatsop County, Oregon, five miles southeast of the Columbia River near Astoria (see Figure B-1). The project will restore 193 acres of tidal wetlands by modifying a levee to allow tidal influence to return to the area, creating a network of tidal channels, and reestablishing native vegetation across the site. Implementing the project will also require actions to reinforce a state highway and relocate utilities on or near the project area. Once complete, the Cowlitz Indian Tribe will provide long-term stewardship and management of the site to benefit fish and wildlife.

In 2015 drainage ditches were filled and the drainage tile network disabled. In addition, new tidal channels were excavated within the floodplain and existing BPA transmission towers were reinforced and a low water access road to provide access to the towers was constructed. Levee breaching is planned for 2016 after the state highway protection measures that will reinforce the road and protect it from the new tilde regime.

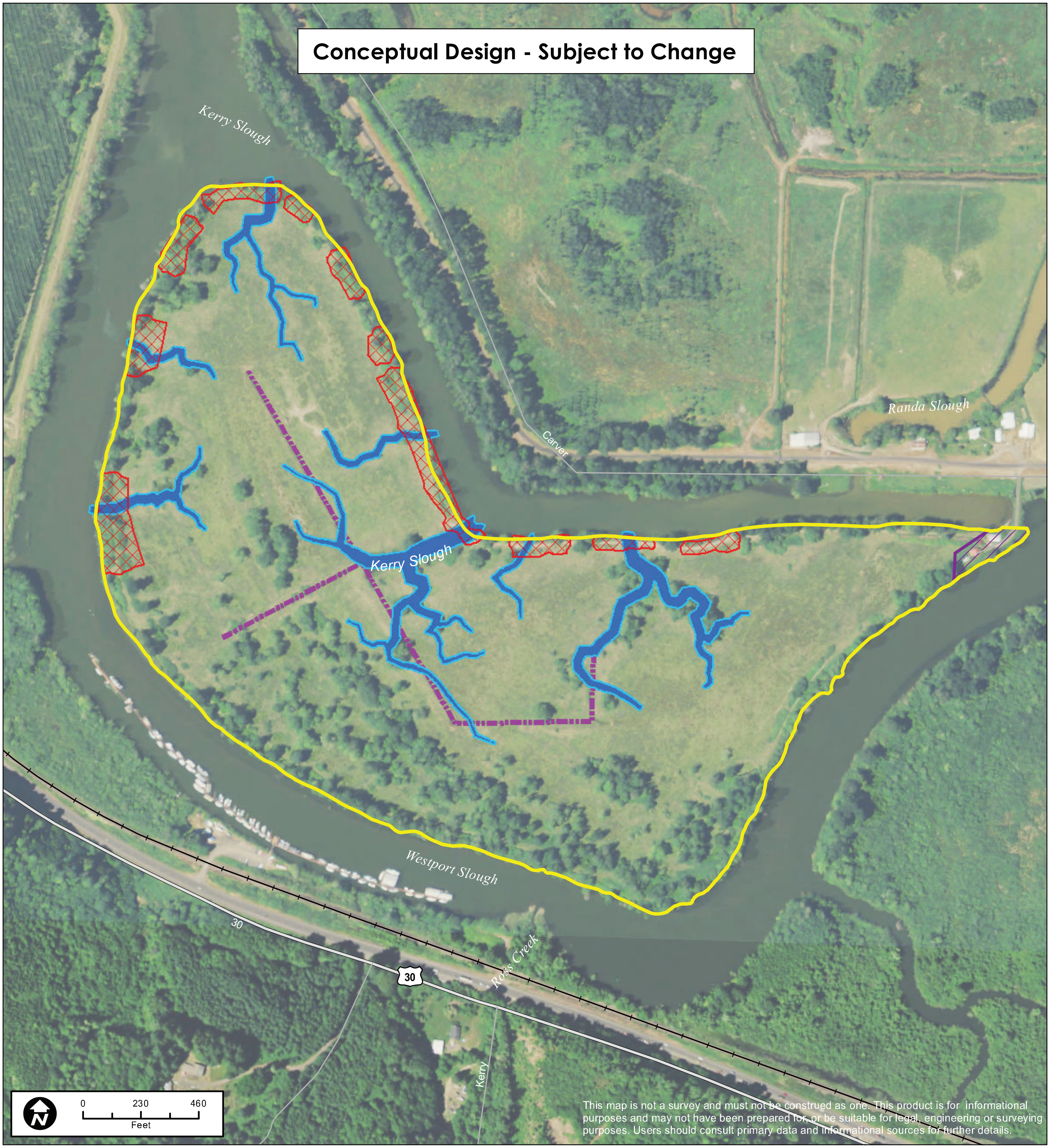
Figure B-1. Wallooskee-Young Confluence Restoration



Kerry Island Estuary Restoration

BPA is proposing to fund the Kerry Island Estuary Restoration, a project proposed by Columbia Land Trust, located along Westport Slough approximately 1 mile east of the town of Westport, Oregon. The proposed action is to restore tidal wetlands and floodplain connectivity by removing a levee surrounding the island and restore the historical channel network through the filling of existing drainage ditches and creation of a tilde channel network (see Figure B-2). BPA is currently evaluating the proposed restoration plan feasibility. Planning is expected to continue into 2016, and construction would be initiated late in 2016. Initial project scoping is expected to begin in late-February 2016. A separate NEPA document specific to the project site would be prepared and tier to this EA.

Figure B-2. Kerry Island Estuary Restoration



2/8/2016

Project Area
Highways
Local Roads
Railroad

Restoration Actions

Channel Excavation
Levee Removal
Structure Removal
Ditch Filling

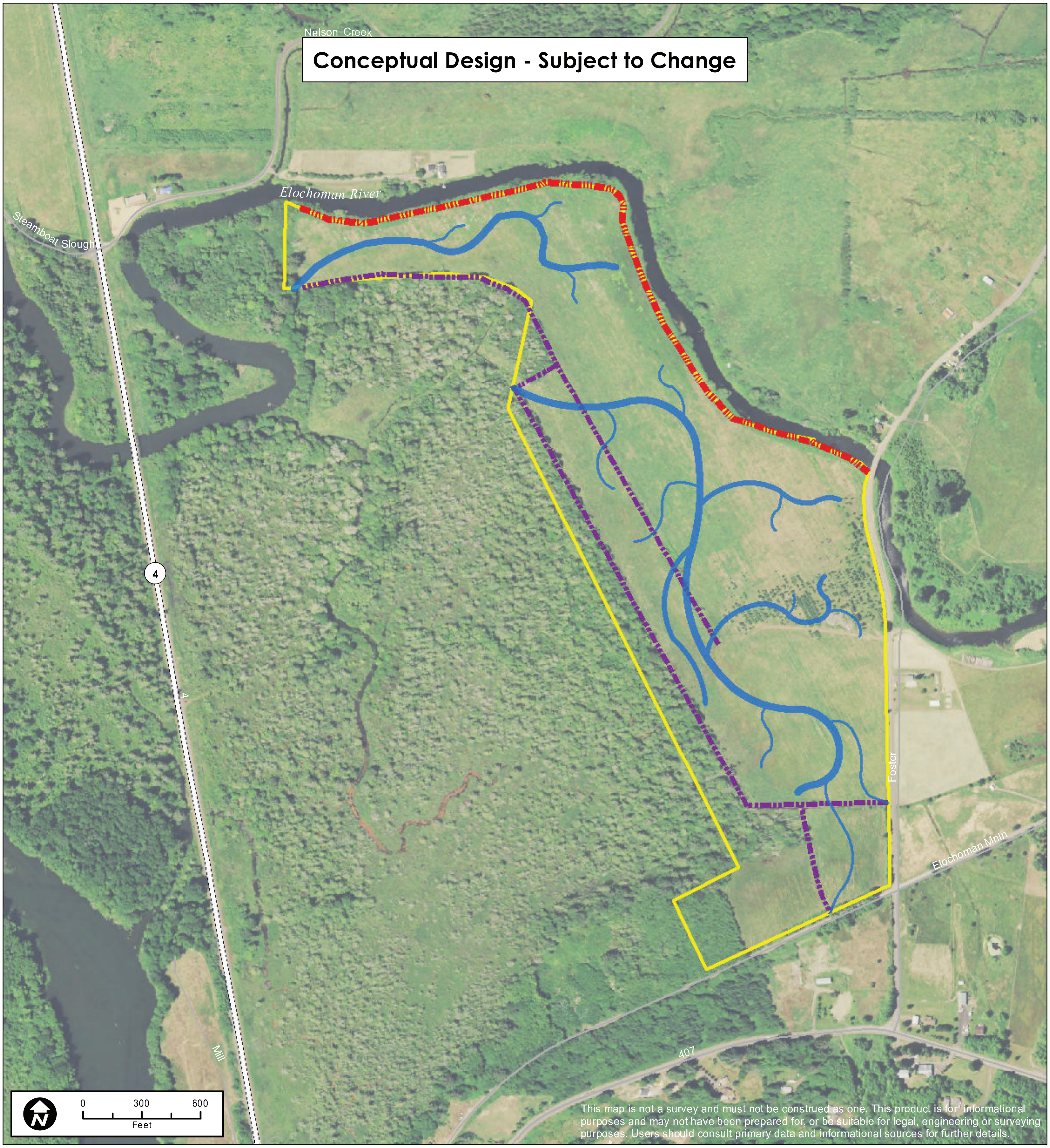
Data Sources: (1) NAIP 2014 Imagery (2) Restoration Actions (Interfluve 60% Design)

Lower Elochoman Estuary Restoration

BPA is proposing to fund the Lower Elochoman Estuary Restoration, a project proposed by Columbia Land Trust, located along the Lower Elochoman River approximately 2 miles north of the town of Cathlamet, Washington. The proposed action is to restore floodplain connectivity by removing a levee along the lower Elochoman River and enhance tidal wetlands through the filling of existing drainage ditches and creation of a tilde channel network (Figure B-3). BPA is currently evaluating the proposed restoration plan feasibility.

Planning is expected to continue into 2016, and construction would be initiated late in 2016. Initial project scoping is expected to begin in late-February 2016. A separate NEPA document specific to the project site would be prepared and tier to this EA.

Figure B-3. Lower Elochoman Restoration



2/8/2016

Project Area
Local Roads
Highways

Restoration Actions
Channel Excavation
Levee Removal
Ditch Filling

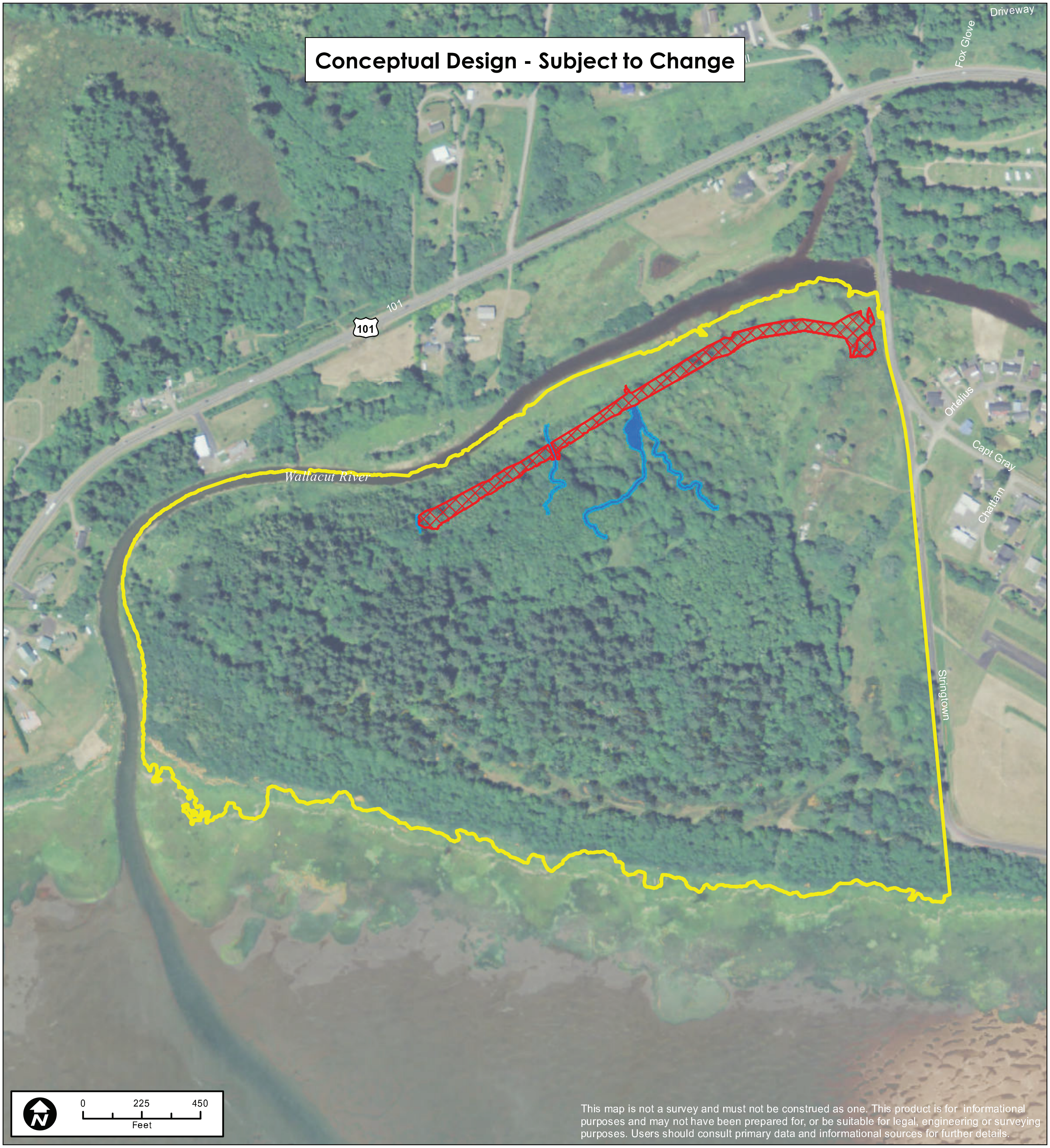
Data Sources: (1) NAIP 2014 Imagery (2) Restoration Actions (Conceptual Draft Plan)

Wallacut River Confluence Estuary Restoration

BPA is proposing to fund the Wallacut River Confluence Estuary Restoration, a project proposed by Columbia Land Trust, located along the Wallacut River at its confluence with the Columbia River approximately 1.5 miles northeast of the town of Ilwaco, Washington. The proposed action is to restore floodplain connectivity by removing a levee along the lower Wallacut River and enhance tidal wetlands through the filling of existing drainage ditches and creation of a tilde channel network (see Figure B-4). BPA is currently evaluating the proposed restoration plan feasibility.

Planning is expected to continue into 2016, and construction would be initiated late in 2016. Initial project scoping is expected to begin in late-February 2016. A separate NEPA document specific to the project site would be prepared and tier to this EA.

Figure B-4. Wallacut River Confluence Estuary Restoration



2/8/2016

Project Area
Local Roads
Highways
Restoration Actions
Channel Excavation
Levee Removal & Ditch Filling

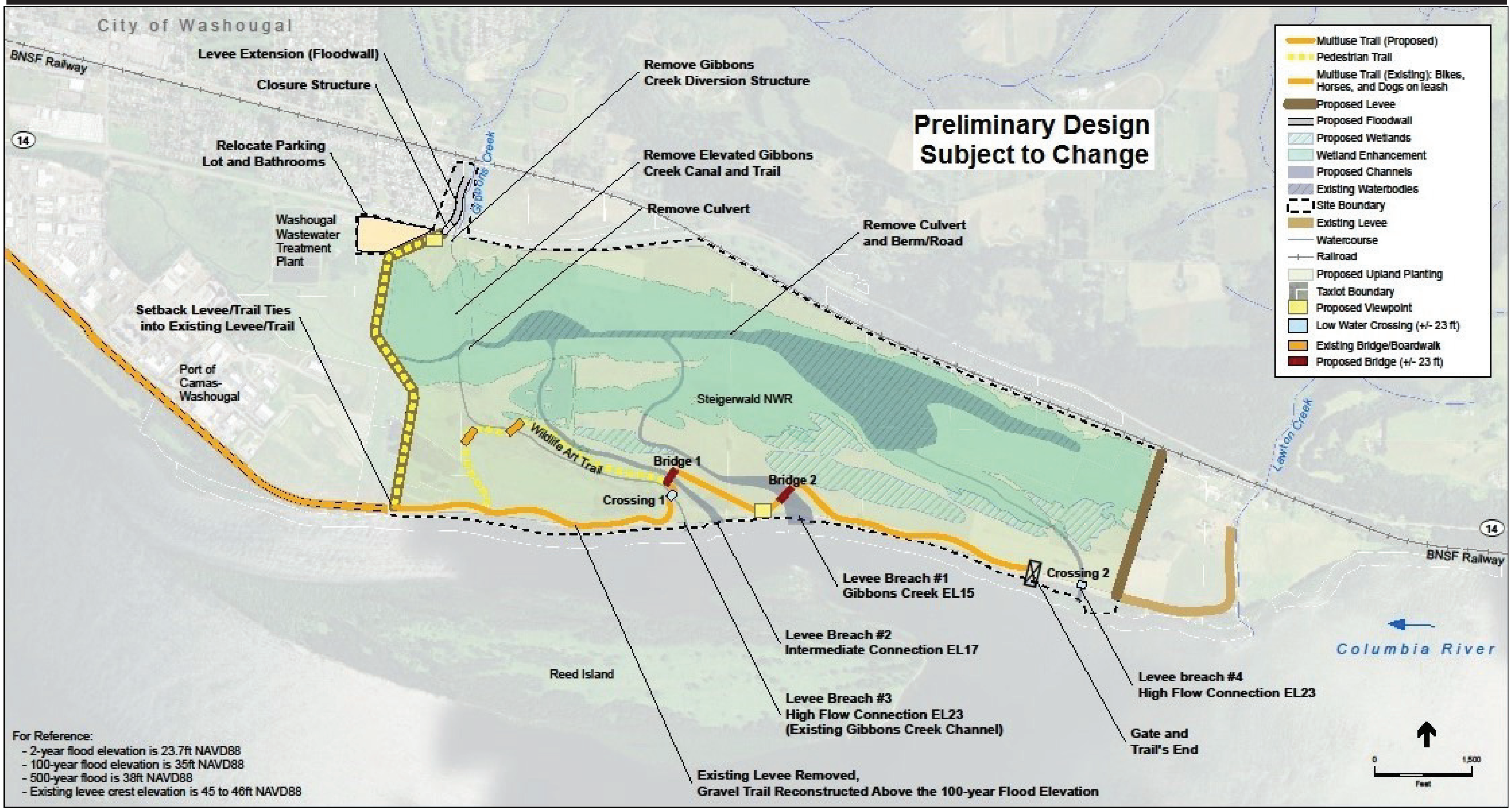
Data Sources: (1) NAIP 2014 Imagery (2) Restoration Actions (Interfluve 90% Design)

Steigerwald Floodplain Restoration

BPA is proposing to fund the Lower Columbia Estuary Partnership's proposal to restore floodplain connectivity to the Columbia River within the Steigerwald Lake National Wildlife Refuge, managed by the USFWS, in Clark County, WA (see Figure B-5). The project would involve reconnecting Gibbons Creek to the Columbia River by breaching a U.S. Army Corps of Engineers' levee; removing a diversion structure, fish ladder, elevated channel, and water control structure; constructing a setback levee; enhancing approximately two miles of wetland channels; and re-establishing the site's riparian forest.

BPA completed scoping for the project in January 2016, and is currently in the process of developing a Draft EA for the project. BPA is currently also working with the Corps on the Section 408 review for modifications to a federally authorized levee. If the project is approved, construction would begin in 2018.

Figure B-5. Steigerwald Floodplain Restoration



Trestle Bay

BPA and the Corps have decided to fund the Trestle Bay restoration project proposed by the Columbia River Estuary Study Taskforce to restore the tidal prism, fish access, and increase duration of tidal inundation in Trestle Bay, on the Oregon shoreline at the mouth of the Columbia River at RM 6 in Clatsop County. Trestle Bay is a 628-acre bay separated from the Columbia River estuary by the South Jetty Root, an 8,800-foot long structure of large rocks rising 25 feet above the surface of the water. Currently, there is a 500-foot gap that was constructed under a previous restoration project (funded by Section 1135 of WRDA 1986), and this gap provides limited fish access into the bay. The project will include constructing multiple openings with a cumulative opening width of no more than 900 linear feet and will extend down to the riverbed, providing unimpeded access for fish (namely salmon and steelhead) into Trestle Bay.

In 2015, the Corps and BPA completed an EA issued a Finding of No Significant Impact for the project. The draft EA, available on the Corps and BPA website, includes project maps and a complete description of the proposed action. Construction is tentatively planned to begin in February 2016.

Dairy Creek – Sturgeon Lake Restoration

Working in partnership with the West Multnomah Soil and Water Conservation District and BPA, the Corps recently evaluated actions under Section 1135 authority (WRDA 1986) to improve flow along Dairy Creek and circulation in 4,100 acres of Sturgeon Lake on Sauvie Island between RM 87-101 on the Columbia River. The proposed action would restore physical, chemical, and biological ecosystem processes by improving connectivity between Sturgeon Lake and the Columbia River by removing impediments along Dairy Creek, reducing sediment accretion in the lake, and enhancing fish access and use of this floodplain lake. The proposed project would also enhance water quality in the lake by increasing tidal flushing and reducing the concentration of nutrients which degrade water quality for the area's fish and wildlife.

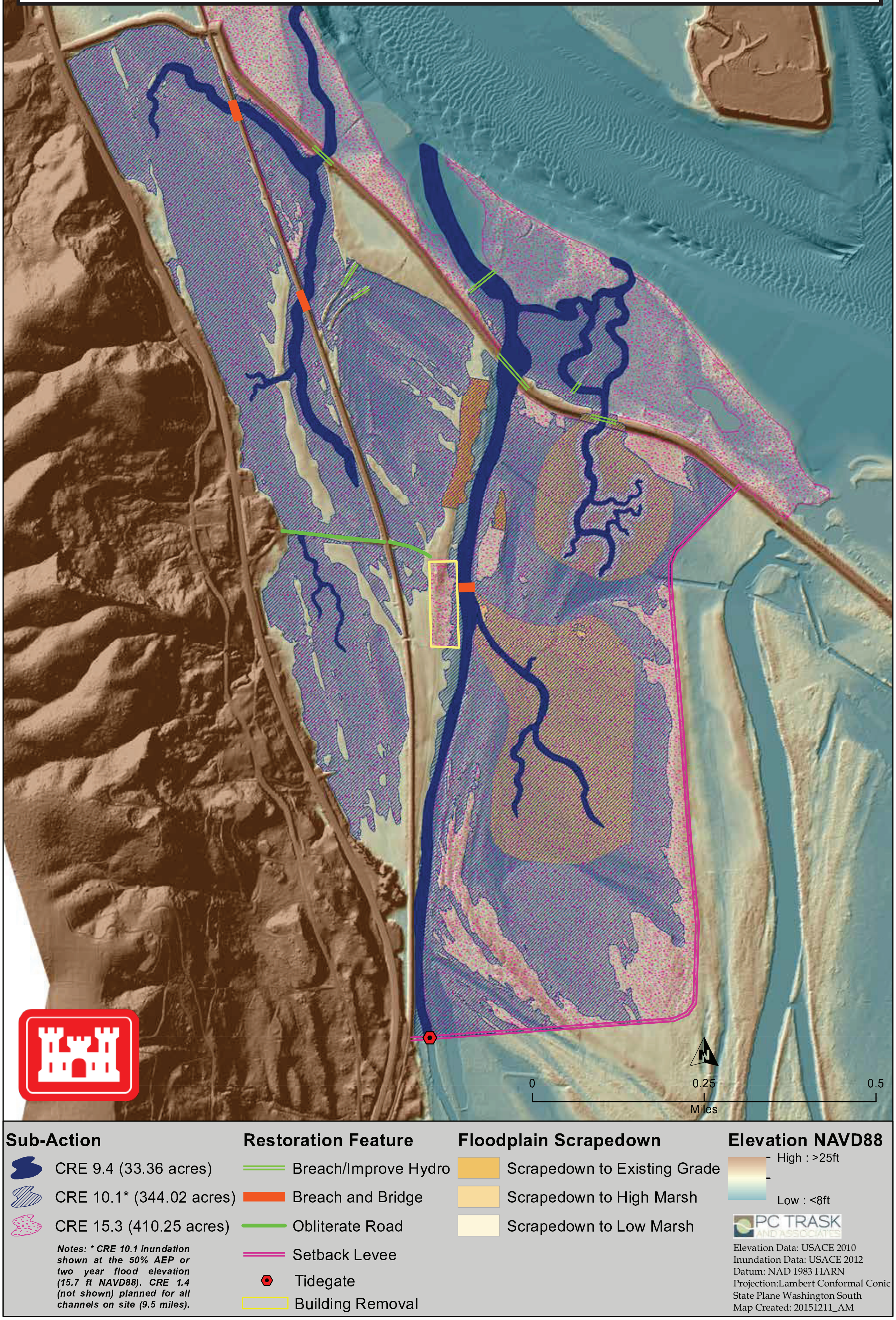
In January 2015, the Corps completed a feasibility study and EA for Dairy Creek and issued a Finding of No Significant Impacts in March 2015 for the preferred restoration action. Construction is expected to be complete in 2017.

Columbia Stock Ranch

In 2011, BPA funded Columbia Land Trust to acquire 646 acres of farmland near Deer Islands at RM 75 on the Columbia River. Columbia Land Trust has proposed breaching and lowering a federal levee to reconnect 360 acres of the isolated floodplain to tidal-estuarine and riverine processes (see Figure B-6). The Corps is currently evaluating the proposed restoration plan and feasibility of construction and requesting BPA cost share funding. Planning is expected to continue into 2016, and construction would be initiated in 2017 for completion in 2017. The current restoration plan includes constructing a setback levee, modifying/breaching the main levee, installing multiple fish-passable culverts under the railroad on the interior of the property, and excavating tidal channels to restore physical and biological processes across the project site.

Due to the proposed project schedule it is expected that the Corps and BPA will pursue the completion of an individual EA for this project.

Figure B-6. Columbia Stock Ranch Estuary Restoration



This page left intentionally blank

Bonneville Power Administration

DOE/BP-4758 • April 2016