WILLAMETTE RIVER FLOODPLAIN RESTORATION STUDY

DRAFT

INTEGRATED FEASIBILITY REPORT/ ENVIRONMENTAL ASSESSMENT

Lower Coast and Middle Fork Willamette River Subbasins

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U.S. Army Corps of Engineers
Portland District

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EXECUTIVE SUMMARY

This feasibility report presents the results of a U.S. Army Corps of Engineers (Corps) feasibility study undertaken to identify and evaluate alternatives for restoring natural floodplain functions in the lower Coast and Middle Forks of the Willamette River. This report provides documentation of the plan formulation process to select a recommended restoration plan, along with environmental, engineering, and cost details of the recommended restoration plan, which will allow final design and construction to proceed following approval of this report.

The study area is the Willamette River Basin of western Oregon. The Willamette River is a major tributary of the Columbia River and is the tenth largest river in the United States, based on average annual flow. This study is being conducted in phases due to the large size and complexity of the Willamette River Basin. **Phase 1** of the study involved the development of a framework level plan for the entire Willamette Basin – the *Willamette Subbasin Plan* (WRI 2004); which documented conditions in the basin and strategies to recover fish and wildlife species as part of the Columbia River Basin Fish and Wildlife Program. **Phase 2**, the subject of this report, is a feasibility study of floodplain restoration opportunities in the lower Coast and Middle Forks of the Willamette River. The Coast and Middle Forks study is an initial study to develop the process for identifying and evaluating restoration alternatives to function in the dynamic floodplain environment. The process developed in this phase will then be used in the analysis of other subbasins within the larger Willamette River Basin.

The Coast Fork and Middle Fork of the Willamette River merge upstream of Eugene, Oregon to form the mainstem Willamette River (see Figure ES-1). The lower Coast and Middle Forks and their floodplains downstream of Cottage Grove and Dexter Dams, respectively are of interest for floodplain restoration because many areas of the floodplain are relatively undeveloped and the construction and operation of Corps' revetments and the upstream dams have had adverse effects on floodplain functions which makes Corps involvement appropriate. The lower Coast and Middle Forks of the Willamette have substantial opportunities for floodplain restoration.

This study has involved a large number of stakeholders including agencies, watershed councils, academic researchers and other organizations. From the outset, this stakeholder group has helped scope and refine the study. The restoration goal and objectives developed with the stakeholders for this study are outlined below. The goal and objectives have guided the plan formulation process and selection of a recommended restoration plan.

Coast and Middle Fork Floodplain Restoration Goal and Objectives	
Restoration Goal	Restore natural floodplain ecosystem function and condition to the Coast and Middle Fork Subbasins.
Restoration Objective 1	Increase channel complexity and diversity
Restoration Objective 2	Restore connectivity of river to floodplain habitats
Restoration Objective 3	Restore native floodplain habitats, including cottonwood gallery forests, riparian and wet prairie habitats

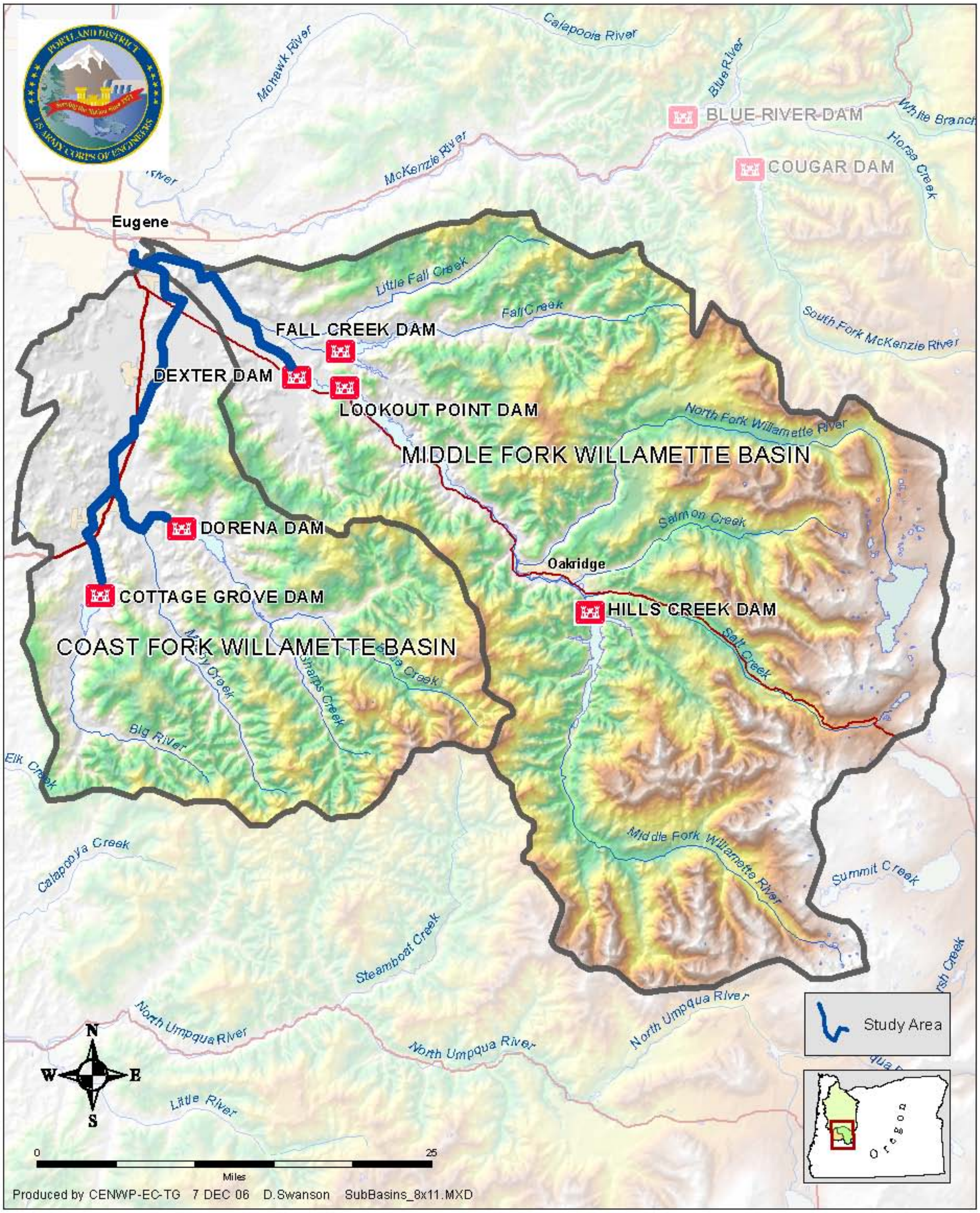

Figure ES-1. Coast Fork and Middle Fork Subbasins

The baseline condition in the study area is degraded for native fish and wildlife and has much reduced floodplain functions. Causes for this degradation include the construction of upstream dams that have modified flows and raised water temperatures, construction of revetments that reduce channel migration and the formation of habitats, development of the floodplain, removal of riparian vegetation, removal of wood from the river channels, blocking access to off-channel habitats, and the widespread presence of non-native species.

Forty-three potential floodplain restoration sites were identified in consultation with the stakeholder group and were initially developed at a conceptual level. Two or more scales of restoration were considered at each site: 1) a minimum level of restoration that included measures such as removal of invasive species, replanting with native riparian and floodplain vegetation, and placement of large wood in the floodplain; and 2) a maximum level of restoration that included the measures from the minimum scale plus other features such as excavation of channels, removal of revetment, floodplain grading, restoration of gravel mined ponds, installation of engineered log jams, culverts or bridges, and other features. The majority of the potential sites were visited to collect data on existing conditions and to confirm if restoration measures were appropriate, and/or to add additional measures.

Preliminary cost estimates were developed for each site and scale of restoration, along with calculation of habitat benefits that could accrue from restoration measures. Habitat benefits were calculated using a multi-species Habitat Evaluation Procedures (HEP) model. The preliminary costs and habitat benefits were used in a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) to identify alternatives that provide high levels of habitat benefit relative to the costs. The CE/ICA was a primary element used to select the recommended restoration plan.

A recommended restoration plan was selected that includes floodplain restoration on five sites (Figure ES-2). All five sites selected for restoration have been subject to gravel mining in the past and include multiple gravel mined ponds. Restoration would include restoration of the gravel mined ponds by grading on-site sediments and topsoil back into the ponds to create wetland and shallow water habitats, excavation of connector channels between ponds and to connect to the rivers via backwater channels, removal of invasive species, plantings with native wetland, riparian and floodplain vegetation, placement of large wood in the ponds and floodplain, installation of engineered log jams in the river adjacent to the sites, removal of debris and revetment materials, and installation of culverts at road-crossings to remain on site.

The effects of the recommended restoration plan would be beneficial in the long-term by restoring native fish and wildlife habitats, increasing floodplain connections and storage on a frequent basis, promoting the natural formation of gravel bars and side channels by the installation of engineered log jams and removal of revetment material and providing fish access into off-channel and floodplain habitats. There would be no rise in the 100-year water surface elevation. During construction there could be temporary adverse effects such as the potential for increased turbidity, release of pollutants, and handling of fish. These effects would be minimized by providing erosion and pollution control best management practices (BMPs) and conducting all fish salvage and removal activities according to state and Federal requirements. A number of conservation measures would be implemented during construction to minimize effects to listed species.

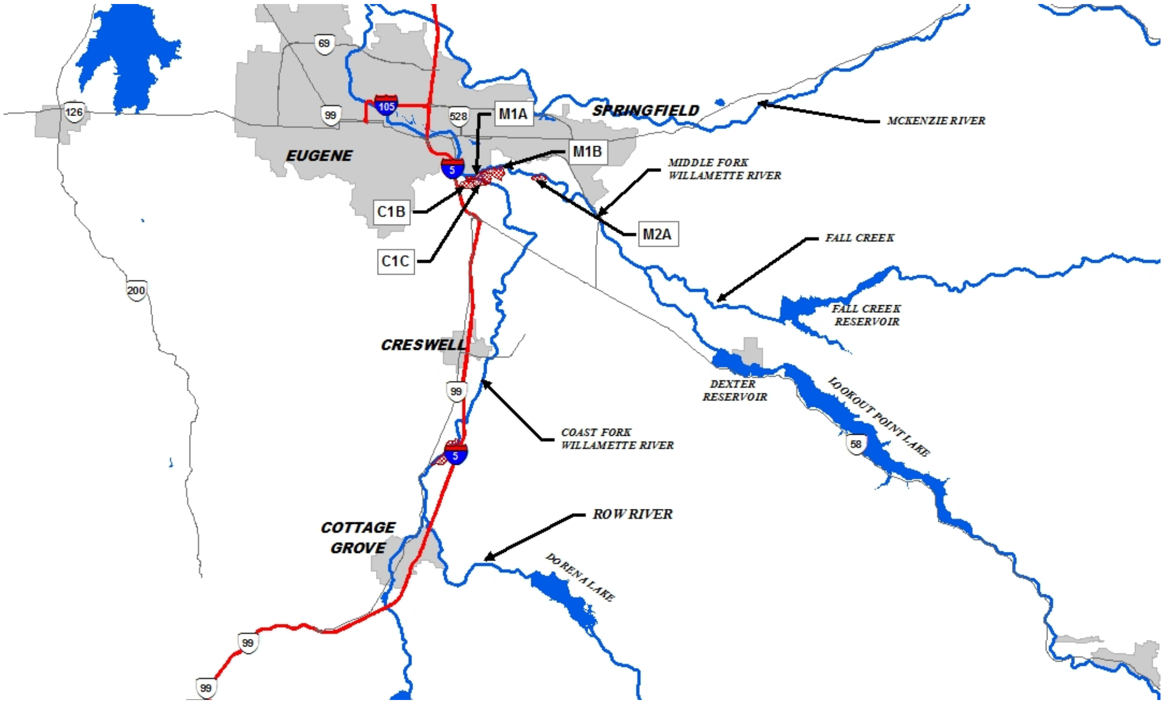

Figure ES-2. Location of Project Sites Included in Recommended Restoration Plan.

Overall, the recommended restoration plan would provide frequent hydrologic connections to nearly 600 acres of floodplain habitats; restore off-channel habitats for fish rearing and refuge; significantly improve the quality of a variety of natural floodplain, wetland, and riparian habitats, reduce invasive species, and reduce fish stranding and mortality that can currently occur following flood events. This plan would also provide significant benefits to listed fish species that occur in the Upper Willamette basin.

The recommended restoration plan is proposed for implementation at a total project cost of $48,882,222 to be cost-shared 65% Federal and 35% non-Federal. The non-Federal sponsor is the Nature Conservancy.

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1. STUDY BACKGROUND

1.1. STUDY OVERVIEW

The purpose of this study is to identify opportunities for restoring natural floodplain functions and improving flood storage along the Willamette River and its tributaries. The study emphasizes the identification of opportunities for the restoration of aquatic and riparian ecosystems, recovery of proposed and listed threatened and endangered species, flood damage reduction, and improvement of water quality. The study area is the Willamette River Basin of western Oregon (Figure 1). The Willamette River is a major tributary of the Columbia River and is the tenth largest river in the United States, based on average annual flow.

This study is being conducted in phases due to the large size and complexity of the Willamette River Basin. **Phase 1** of the study involved the development of a framework level plan for the entire Willamette Basin (WRI 2004); which documented conditions in the basin and strategies to recover fish and wildlife species as part of the Columbia River Basin Fish and Wildlife Program. **Phase 2**, the subject of this report, is a feasibility study of floodplain restoration opportunities in the lower Coast and Middle Forks of the Willamette River. The Coast and Middle Forks study is an initial study to develop the process for identifying and evaluating restoration alternatives to function in the dynamic floodplain environment. The process developed in this phase will then be used in the analysis of other subbasins within the larger Willamette River Basin.

The Coast Fork and Middle Fork subbasins are located in the southern portion of the Willamette River Basin (Figure 2). These particular subbasins were chosen for the Phase 2 study for several reasons. First, several opportunities exist below the dams to restore natural floodplain functions. Second, Corps' dams and bank protection projects, among other activities, have substantially altered hydrologic and hydraulic conditions in these subbasins, and it is appropriate for the Corps to take the lead in restoring more natural floodplain functions to these subbasins. Third, the high percentage of public land ownership in these subbasins, as compared to other major tributaries and the mainstem Willamette, increases the likelihood that a cost-effective, integrated restoration plan can be implemented. Finally, there is a high degree of interest in floodplain restoration among stakeholders and potential sponsors in these subbasins.

1.2. STUDY AUTHORITY

The Section 905(b) report was completed in 1999. This report evaluated floodplain restoration opportunities in the Willamette River basin. Study authority for this feasibility study was provided when the reconnaissance report was approved on 18 June 1999 for proceeding into the feasibility phase of planning. Section 202 of the Water Resources Development Act of 2000 (P.L. 106-541, 11 December 2000) titled "Watershed and River Basin Assessments" was enacted to provide authorization and funding for assessing in particular ecosystem protection and restoration in the Willamette River Basin.

1.3. PLANNING PROCESS

Ecosystem restoration is one of the primary missions of the Corps' Civil Works program. The Corps' main objective in ecosystem restoration planning is to contribute to national ecosystem restoration. Contributions to national ecosystem restoration (NER) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER outputs are based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured both in the regional planning area and for the overall benefit of the Nation.

The Corps planning process follows a six-step process. This process is a structured approach to problem solving which provides a rational framework for sound decision-making. The six-step process is used for all planning studies conducted by the Corps of Engineers. The six steps are:

Step 1 - Identifying Problems and Opportunities
Step 2 - Inventorying and Forecasting Conditions
Step 3 - Formulating Alternative Plans
Step 4 - Evaluating Alternative Plans
Step 5 - Comparing Alternative Plans
Step 6 - Selecting a Plan

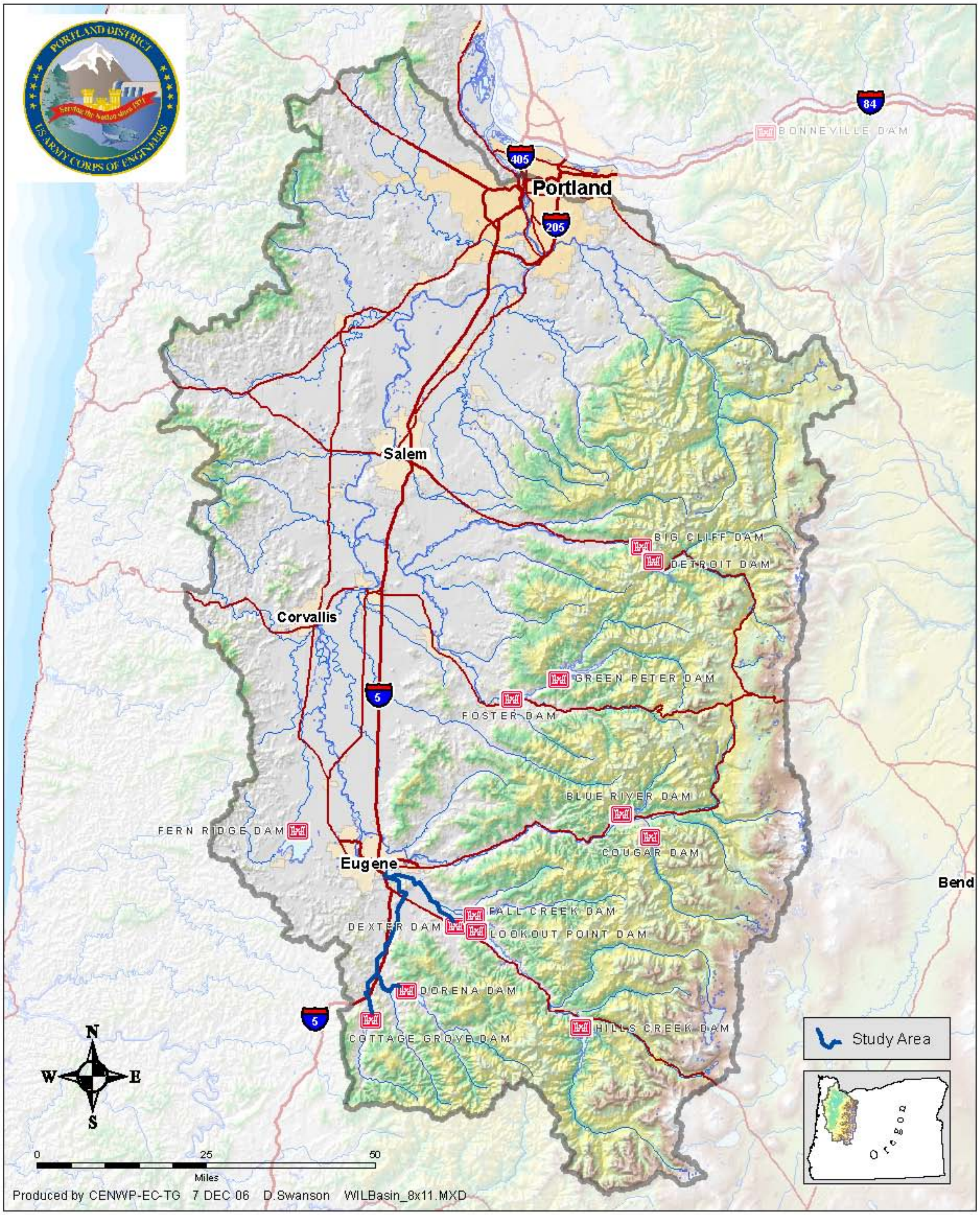

Figure 1. Willamette River Basin

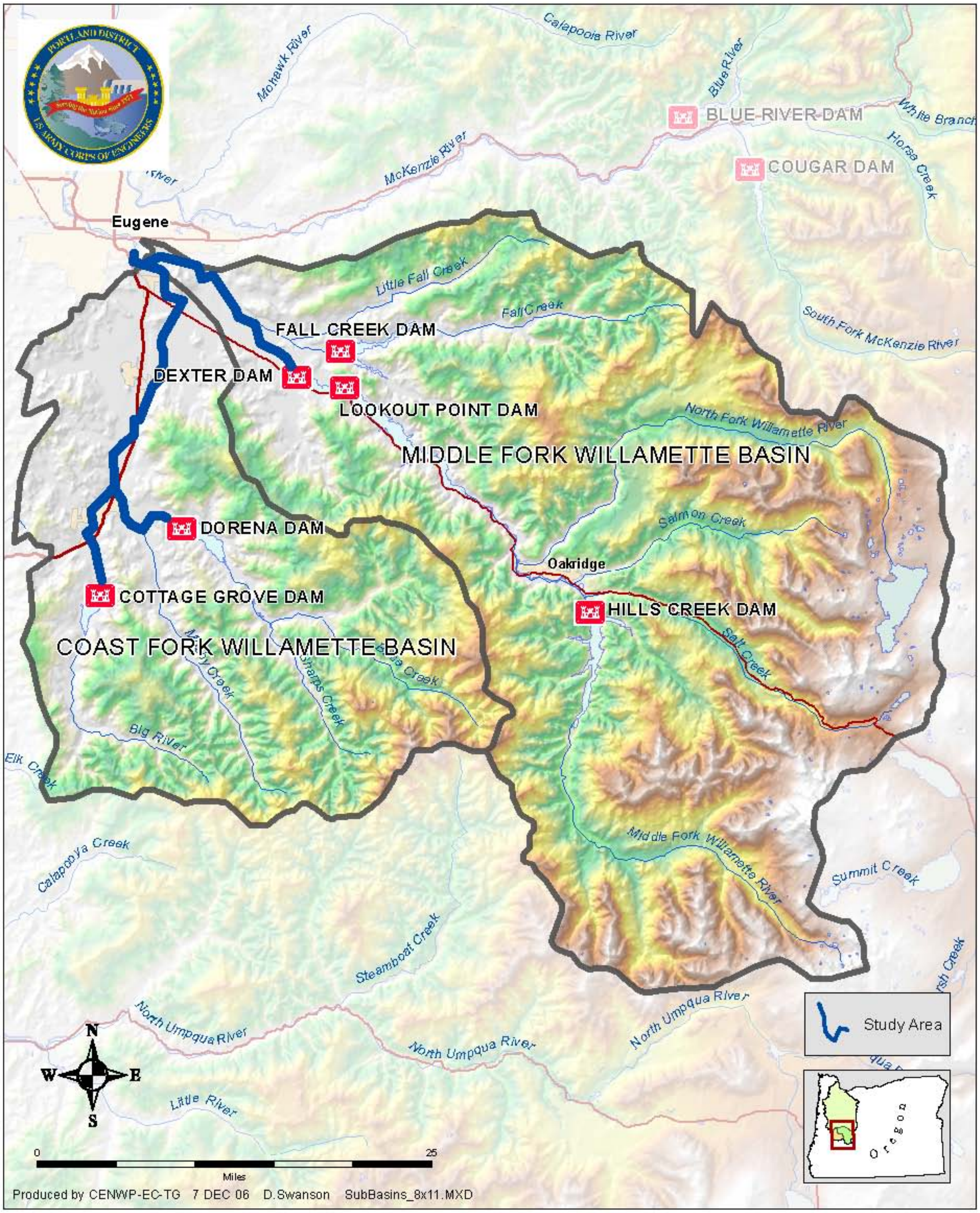

Figure 2. Coast Fork and Middle Fork Subbasins

1.4. RECONNAISSANCE STUDY

The reconnaissance study evaluated the entire Willamette River Basin in a general sense, and was completed in April 1999 and approved by Headquarters in June 1999. The reconnaissance report documented that there was a Federal interest in conducting a feasibility study and confirmed the interest of the State of Oregon in participating in a cost-shared feasibility study.

The reconnaissance report (USACE 1999) identified six major problems in the basin including: 1) loss of natural floodplain function; 2) flooding and flood damages; 3) loss of fish and wildlife habitat; 4) multiple threatened and endangered species; 5) degraded water quality conditions; and 6) lack of an integrated restoration strategy. A number of factors have caused these problems, including agricultural and urban development in the floodplain, channelization and armoring of the river banks, the construction and operation of dams, historic and on-going discharge of pollutants from point and non-point sources, and piecemeal approaches to problems as they arise, rather than a basin-wide perspective. Of particular interest to the Corps are problems 1 through 4.

The reconnaissance report identified several objectives for further study in the feasibility phase to address problems associated with ecosystem degradation:

- Develop a comprehensive framework for river management and floodplain restoration that assists in achieving the goals and objectives of the State of Oregon.
- Develop the floodplain management tools needed to identify cost effective, environmentally sensitive methods for reducing flood damages through restoration of natural storage functions of the floodplain.
- Evaluate fish and wildlife habitat conditions in the Willamette River Basin and identify opportunities to restore aquatic and terrestrial habitats associated with floodplains.
- Evaluate the hydrology of the Willamette Basin and identify opportunities to restore its hydrologic regime to a condition resembling a more natural state.
- Evaluate the effects of past water resource development projects on the fluvial geomorphic functions of the Willamette River and identify opportunities to restore to geomorphic conditions resembling a more natural state.
- Identify opportunities and methods for restoring natural floodplain functions that are consistent and compatible with State goals to protect prime farmlands, maintain the viability of agriculture as a key sector of the economy of the Willamette Valley, and are based on active, willing participation by landowners.
- Enhance the quantity and aesthetic quality of recreation opportunities.

The reconnaissance report recommended conducting two major phases of the study: 1) Phase I, develop a basin-wide framework for integrated river management and floodplain restoration; and 2) Phase II, multiple feasibility studies at a reach and/or subbasin scale. The Phase I study would establish a framework for collaboration with the very large set of stakeholders in the basin, compile existing data and identify data gaps, develop an unsteady flow model of the Willamette Basin with a GIS interface, identify potential restoration measures/projects/areas, establish criteria to evaluate and prioritize sub-reaches and subbasins, and establish a cooperative long-term implementation program. The Phase II studies would identify potential floodplain restoration measures and develop a demonstration project for either a specific site or a subbasin to identify a workable process of evaluating, prioritizing, and implementing restoration opportunities.

The Phase I study was completed in 2004 and the product developed was the Willamette River Subbasin Plan (WRI 2004). The plan was prepared pursuant to the objectives and requirements of a variety of major stakeholders including the Northwest Power and Conservation Council for adoption into the Columbia River Basin Fish and Wildlife Program; the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) to assist in the recovery of threatened and endangered species; the Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality (DEQ) to assist in improving water quality and complying with Total Maximum Daily Loads (TMDLs); federal treaty and trust responsibilities with Native American Tribes; and to facilitate the further detailed study of floodplain restoration opportunities by the Corps during future phases.

The basin-wide priorities from the Willamette River Subbasin Plan (WRI 2004) included: 1) modify dams to allow fish passage and restore more natural hydrologic cycles; 2) fix culverts and diversions to allow fish passage; 3) focus on valley and foothills wildlife; 4) restore lowland riparian areas; 5) restore low-cost, high-benefit areas of the Willamette floodplain; 6) let the river cool itself with natural bar and island features; and 7) ensure that all of the above priorities are taken up at an organized way at the local level. A key strategy to achieve restoration and recovery of the fish and wildlife populations is to restore the natural processes that create and maintain natural habitats.

1.5. FEASIBILITY STUDY SCOPE AND OBJECTIVES

In the fall of 2002, a comprehensive stakeholder group shown in Table 1 was convened to help develop the scope of the feasibility study. Over a series of workshop meetings, the stakeholder group reviewed the set of problems, opportunities and objectives developed in the reconnaissance report and a number of alternatives were considered and discussed. The reconnaissance report had described one potential floodplain restoration site, at Harken’s Lake on the mainstem Willamette, but had not proposed any larger reach(es) of floodplain to conduct further detailed analysis during feasibility. The reaches around the confluence of the McKenzie River, and the mainstem Willamette River between Harrisburg and Corvallis were considered, but dropped because of concerns regarding the lack of support from the major landowners in these reaches. The site-specific project identified in the reconnaissance study (Harken’s Lake) could not be pursued because there was no interested sponsor. The Coast and Middle Forks of the Willamette River were then considered for study because there was substantial support from local sponsors and landowners and significant opportunities for floodplain restoration. A feasibility cost-sharing agreement was signed with the Mid-Willamette Council of Governments on February 20, 2004 for this study to include the lower Coast and Middle Forks of the Willamette River.

The stakeholder group defined two initial phases for the feasibility study: Phase 1 – develop a framework plan for the entire Willamette Basin that will document baseline conditions and evaluate and define strategies for fish and wildlife habitat restoration; and Phase 1A – conduct a detailed evaluation of floodplain ecosystem restoration opportunities in the Coast and Middle Fork Willamette Rivers subbasins. During this feasibility study, the terminology was changed from Phase 1A to Phase 2. This Phase 2 study does not include flood damage reduction as a purpose, although flood damage reduction may still be considered in other feasibility studies undertaken within the basin. The stakeholders also developed a broad set of goals and objectives specific to the Coast and Middle Fork Willamette Rivers. These goals and objectives include study goals and objectives as well as restoration goals and objectives. Table 2 provides a summary of the study and restoration goals and objectives carried forward into Phase 2. Restoration Goal 1 and the subsequent three restoration objectives are the primary focus of this feasibility study. Throughout the remainder of this document the blue highlighted primary restoration goal and objectives will be considered for plan formulation, evaluation of alternatives, and selection of a recommended restoration plan.

Table 1. Stakeholders Involved in Feasibility Study Scoping

Watershed Councils	**Local Governments**
Coast Fork Willamette Watershed Council	Lane County
Middle Fork Willamette Watershed Council	Lane Council of Governments
Federal Agencies	City of Springfield
USDA Forest Service	City of Cottage Grove
National Marine Fisheries Service	City of Creswell
Natural Resources Conservation Service	City of Lowell
Bureau of Land Management	City of Oakridge
U.S. Fish and Wildlife Service	East Lane Soil and Water Conservation District
U.S. Environmental Protection Agency	**Other Interest Groups**
State Agencies	Willamette Restoration Initiative
Oregon Department of Agriculture	Friends of Buford Park & Mt. Pisgah
Oregon Dept. of Environmental Quality	McKenzie River Land Trust
Oregon Dept. of Fish and Wildlife	The Nature Conservancy
Oregon Dept. of Forestry	Oregon State University
Oregon Dept. of Geology & Mineral Industries	Pacific Northwest Ecosystem Research Consortium
Oregon Dept. of Land Conservation and Development	The Trust for Public Land
Oregon Watershed Enhancement Board	Willamette Riverkeepers

Table 2. Goals and Objectives

	Goal / Objective Statement	Issues/Constraints
Study Goals and Objectives for Phase 2 Feasibility Study		
Study Goal 1	Develop tools to evaluate ecological outputs, costs and tradeoffs associated with floodplain restoration measures that can be used in other subbasins in the Willamette Basin	Floodplain functions and interactions are extremely complex and poorly understood, making it difficult to measure actual increases in function or habitat quality/quantity.
Study Objective 1	Develop a clearly defined picture of the baseline biological, ecological, and hydrologic conditions in the Coast and Middle Fork subbasins and select reference sites which illustrate them	Difficulty in finding reference sites in developed floodplain.
Study Goal 2	Provide opportunities for public outreach and promote dialogue of the opportunities, benefits and tradeoffs associated with restoration of floodplain and ecosystem function	Lack of understanding in both biophysical and socio-cultural realms. Concerns about economic damages.
Study Objective 2	Implement direct outreach programs to private landowners and the general public in the project area about the ecological and economic benefits associated with floodplain restoration	Need to identify willing landowners.
Study Objective 3	Understand and communicate the tradeoffs associated with various floodplain restoration measures	Support public involvement conducted by the watershed councils, etc.
Study Objective 4	Link and develop partnerships with the variety of programs that reward agricultural landowners for restoring floodplain or providing easements. Tie those programs to the Willamette Floodplain Restoration project.	To be conducted by stakeholders separate from this project.
Study Objective 5	Use the study of the Coast and Middle Forks as a demonstration project for floodplain restoration.	Define appropriate level of analysis for large-scale floodplain restoration.
Study Objective 6	Monitor and evaluate efforts to restore channel complexity/diversity, natural river hydrograph, connectivity, and floodplain habitat.	Monitoring is cost-shared; consider cost-sharing capability of non-federal sponsor.
Coast and Middle Fork Floodplain Restoration Goals and Objectives		
Restoration Goal 1	Restore natural floodplain ecosystem function and condition to the Coast and Middle Fork Subbasins.	No increase in economic flood or erosion damages.
Restoration Objective 1	Increase channel complexity and diversity	No increase in economic flood or erosion damages; protect private land. Consider impact on recreation.
Restoration Objective 2	Restore connectivity of river to floodplain habitats	Locate willing landowners to acquire lands or easements Maintain critical infrastructure
Restoration Objective 3	Restore native floodplain habitats, including cottonwood gallery forests, riparian and wet prairie habitats	Avoid adversely affecting sensitive fish and wildlife species (i.e. Oregon chub)

1.6. PROJECT PURPOSE AND NEED

The purpose of this floodplain restoration feasibility study is to restore natural floodplain ecosystem functions along the lower Coast and Middle Forks of the Willamette River. These functions include fish and wildlife habitat, groundwater recharge, incidental flood storage, and sediment and erosion processes. This project is needed because of the need to restore large floodplain sites to contribute to the recovery of sensitive fish and wildlife species in the subbasins. Without Federal action, other stakeholders in the subbasins would not have the funds or means to accomplish this same scale of restoration. Because of the substantial changes in natural riverine and floodplain processes due to the construction of multiple dams and revetments in the subbasins, the habitats that sustain fish and wildlife populations are disappearing and becoming degraded or developed. Large-scale restoration of floodplains provides the best opportunity to restore the natural formation of habitats and provide important off-channel rearing and refuge habitats for multiple species. Floodplains will likely become even more important to dissipate high energy and high flows as climate change occurs – it is likely that winter snowpack in the Pacific Northwest will decline, whereas more variable rainfall will lead to higher peak runoff events and lower sustained flows. Floodplains help moderate peak runoff events and allow groundwater recharge that contributes to the maintenance of low flows.

1.7. STUDY AREA

1.7.1. <u>Coast Fork Willamette River Subbasin</u>

The Coast Fork Willamette River subbasin covers an area of about 665 square miles within the Calapooya Mountains (Western Cascades province) and the floor of the Willamette Valley. The river is approximately 40 miles long and joins the Middle Fork Willamette near Eugene to form the mainstem Willamette River. Big River and Saroute Creek in the Calapooya Mountains join to form the Coast Fork Willamette River.

About 96% of the Coast Fork subbasin is in Lane County, with the remainder of its southern extremity in Douglas County. About 64% of land in the subbasin is privately owned with the remainder under federal ownership. Management of federal lands is almost equally divided between the Forest Service and the Bureau of Land Management (BLM). Ninety percent of the subbasin is forested. Commercial forestry is the major land use in the subbasin, but mining and agricultural resources are also significant. The communities of Creswell, Cottage Grove, Goshen, London, and Dorena are located in the subbasin.

The Row River, the largest tributary, drains nearly 60% of the Coast Fork subbasin and joins the Coast Fork Willamette River just below the City of Cottage Grove. Sharps and Mosby Creeks are important tributaries to the Row River, which flows through a complex mixture of sedimentary and volcanic rocks. Mineral bearing layers intrude into bedrock in the headwaters of the Row River, and the area continues to be mined both commercially and recreationally. Mercury has been mined intensively in the Black Butte area in the upper reach of the mainstem Coast Fork Willamette, and in the Bohemia Mining District in the upper Row River drainage. The latter has been the most productive mining district in the Oregon Cascade Range for gold, silver, copper, lead, zinc, and antimony. Bedrock in the western portion of the subbasin, including the majority of the Coast Fork Willamette and Mosby Creek drainages, is composed of marine sandstones and siltstones of the Eugene Formation.

Two dams divide the Coast Fork subbasin, Cottage Grove on the Coast Fork Willamette at RM 29 and Dorena on the Row River. These dams limit upstream fish passage and greatly influence downstream hydrologic regimes, temperature patterns, sediment and bedload transport, and large wood delivery to the lower reaches.

Stream gradients are generally high in the upper Coast Fork subbasin and gentler in the middle to lower reaches. The longitudinal profile of the Coast Fork Willamette reflects the difference in parent material between the more resistant volcanic materials underlying the Row River, and the more erodible marine silt and sandstones of the Coast Fork Willamette and Mosby Creek drainages. Lower Mosby Creek and the Row and Coast Fork Willamette Rivers downstream of the dams flow through narrow valleys filled with erodible alluvial sediments. Downstream of the confluence of these three major tributaries, in the upper Willamette Valley, the gradient is less than 0.2%. The valley widens considerably downstream of this confluence. Sand and gravel are mined in the lower subbasin, and much of the area is used for agriculture. Although the Row River downstream of Dorena Dam has an average slope of about 0.2%, it quickly increases from 0.5% to more than 2% within 30 miles upstream of the dam. The Coast Fork Willamette upstream of Cottage Grove Dam continues at a slope of approximately 0.3% until rapidly steepening 10 miles upstream of the dam. Slopes in the upper Row River drainage are steep and the streams flow through narrow, deeply incised valleys.

The upper subbasin drains the lower elevations of the western Cascade Range and the Calapooya Mountains. Headwater elevations in the Coast Fork are lower than in the Middle Fork and the Coast Fork hydrograph does not exhibit a spring snowmelt runoff. As a result of the subbasins' low elevations, summer stream flows are not supplemented by large amounts of snowmelt or numerous spring-fed sources.

This study is focused on the floodplain of the Coast Fork Willamette River below Cottage Grove dam to the confluence with the Middle Fork Willamette River. This lower floodplain area is the primary area of interest for restoring natural floodplain processes and habitats. The lower mile of the Row River is also considered in this study.

1.7.2. Middle Fork Willamette River Subbasin

The Middle Fork Willamette River subbasin covers an area of approximately 1,360 square miles (865,920 acres) on the western slope of the Cascade Mountains and the floor of the Willamette Valley. The river is 84 miles long and joins the Coast Fork Willamette River near Eugene to form the mainstem Willamette River. The Middle Fork Willamette River originates in two connecting lakes formed by lava flows; Opal and Timpanogas Lakes in the Willamette National Forest.

About 94% of the Middle Fork subbasin is in Lane County, with the remainder of its southern extremity in Douglas County. Approximately 12% of the land area of the subbasin is below Dexter Dam (108,026 acres). Dexter Dam is located 18 river miles upstream from the confluence with the Coast Fork. The majority of the land below Dexter is privately owned, although there are a few large publicly owned sites, including Elijah Bristow State Park and Howard Buford Regional Recreation Area. About 75% of the land in the upper subbasin (above Dexter Dam) is publicly owned, most of which is managed by the U.S. Forest Service (Forest Service).

The headwaters of the subbasin are characterized by two major physiographic provinces; the High Cascades and the Western Cascades provinces (Franklin and Dyrness 1988). In the High Cascades the geology includes recent deep lava deposits that contribute spring-fed flows to the system, particularly in some tributaries above Hills Creek Reservoir. These spring-fed sources are not of sufficient volume to significantly influence flow patterns or water temperature regimes in the mainstem river reaches below the dams; however, the headwater elevations are high enough to form a seasonal snowpack, which contributes to summer stream flows and maintains low water temperatures. The western foothills and lower peaks of the Western Cascades province has much older volcanic material including deeply weathered rocks, steep and highly dissected hill slopes, and significant erosion. Stream runoff patterns are dominated by a rain-on-snow hydrology in the mid to upper elevations and rain-dominated flow patterns in the lower subbasin, which lead to rapid delivery of water into the stream network. The lower subbasin below Jasper is in the Willamette Valley Province, characterized by broad alluvial flats and low basalt hills. The very low gradient profile of the valley promotes significant meandering of the rivers.

Soils in the Middle Fork subbasin tend to be unstable and finely textured with high clay content. Mass wasting from steep slopes, and less severe but more pervasive surface erosion, contributes substantial sediment and turbidity to downstream areas. Shoreline erosion from winter wave action results in high turbidity in Hills Creek Reservoir and in downstream waters.

The Lookout Point and Dexter projects divide the Middle Fork subbasin, limiting upstream fish passage and greatly influencing downstream hydrologic regimes, temperature patterns, sediment and bedload transport, and large wood delivery to the lower reaches. The North Fork of the Middle Fork Willamette River and Salt and Salmon Creeks are major tributaries in the upper subbasin that historically supported anadromous fish populations. The upper Middle Fork Willamette River flows through a narrow, steep forested canyon. Hills Creek Dam further divides the upper subbasin. The river's gradient decreases from 2.6% upstream of Hills Creek Reservoir to approximately 0.5% between Hills Creek Dam and Lookout Point Reservoir.

Below Dexter Dam, the Middle Fork Willamette River flows into the wide, alluvial Willamette Valley. Fall, Little Fall, and Lost Creeks are major tributaries in the lower subbasin. Below Dexter, the river is very low gradient (less than 0.2%) and flows through a relatively wide valley with an extensive floodplain.

As the leading land use in the subbasin, commercial forestry has contributed to degradation of fish habitat by modifying hydrology and increasing sediment inputs and water temperatures. Mature and old-growth forest currently occupy about 36% of the Hills Creek Reservoir drainage, which has been estimated to be a loss of 55% from historic conditions (NPCC 2004a). The lower subbasin is dominated by agricultural and urban land uses that constrain the river's ability to meander and have resulted in the removal of much of the riparian gallery forest.

The communities of Oakridge, Westfir, Lowell, Dexter, Fall Creek, Jasper and portions of south Springfield and Pleasant Hill all lie within the Middle Fork subbasin. The North Fork of the Middle Fork Willamette River is a designated National Wild and Scenic River.

This study is primarily focused on the floodplain below Dexter dam to the confluence with the Coast Fork Willamette River. This lower floodplain area is the primary area of interest for this study for restoring natural floodplain processes and habitats. The upper subbasin has a narrower valley and floodplain. Some opportunities may exist for floodplain restoration above Lookout Point Reservoir, but are not considered further in this report.

1.7.3. River Reaches

To more effectively describe the conditions in the lower rivers and their floodplains based on geomorphic and land use conditions of the Coast Fork and Middle Fork Willamette Rivers, each river has been broken into the reaches outlined below and shown in Figure 5.

Throughout this report, river mile locations on each Fork are referenced in the text. River Mile (RM) locations for the Coast Fork start at RM 0 (corresponding to the confluence with the Middle Fork) and extend upstream. When referencing RM locations for the Middle Fork, the confluence of the Coast Fork and Middle Fork is referred to as RM 187 and increases moving upstream along the Middle Fork, which continues the river mileage of the mainstem Willamette where RM 0 is the confluence with the Columbia River.

1.7.3.1 Coast Fork Willamette River

1. *Reach C1 – Middle Fork/Coast Fork confluence to Highway 58 crossing (RM 0 to 6.4).* This reach is 6.4 miles in length and flows between Buford Park and I-5/Hwy 58 for its entire length. There are two tributaries that enter this reach, Wild Hog and Papenfus Creeks, and several remnant sloughs or cut-off meanders of the river. Land uses in the floodplain include agriculture, rural residential, suburban residential, and park/open space. Howard Buford Recreation Area (Lane County) occupies the majority of the right bank in this reach. There are numerous roads and residential structures in the left bank floodplain, with several dense developments. There are several gravel ponds located near the confluence. There are five crossings of the Coast Fork in this reach, the private access road to the gravel pits, Seavey Loop Road, two transmission lines, and Hwy 58. This reach is predominantly a single-thread channel with rock bank protection in many locations, except at the confluence where gravel bars and islands are present.

2. *Reach C2 – Highway 58 crossing to I-5 crossing (RM 6.4 to 15.6).* This reach is 9.2 miles in length and the Coast Fork flows through a wide and more rural floodplain. There are numerous revetments along this reach that reduce the tendency to meander. The left bank floodplain is developed in a large portion of this reach with residential and other development in the City of Creswell. There are three tributaries that enter this reach, Camas Swale, Bear, and Hill Creeks and several remnant sloughs or cut-off meanders of the river. Land uses in the floodplain include agriculture, golf course, rural residential, suburban residential, industrial, and park/open space. There are numerous roads and residential structures in the floodplain, with several dense developments. There are only two crossings in this reach, Cloverdale Road and I-5. There are numerous houses immediately adjacent to the river upstream of Cloverdale Road, but very few structures within 1000 feet of the river downstream of Cloverdale Road. The portion of the reach between where the tributaries enter still has a fairly substantial riparian forest and multiple sloughs and off-channel areas.

3. *Reach C3 – I-5 crossing to Row River confluence (RM 15.6 to 21).* This reach is approximately 5.4 miles in length and is constrained to a fairly narrow floodplain between I-5 and Highway 99. There are numerous gravel ponds in this reach. There are three tributaries that enter this reach, Gettings and Hill Creeks, and the Row River, and several remnant sloughs or cut-off meanders of the river. Land uses in the floodplain include agriculture, rural residential, suburban residential, and industrial. There is only one crossing in this reach, Saginaw Road. Figure 3 shows an existing oxbow in this reach.

Figure 3. Remnant Oxbow along Coast Fork near Camas Swale.

4. *Reach C4 – Row River confluence to Cottage Grove Dam (RM 21 to 29.6).* This reach is approximately 8.6 miles in length and flows from Cottage Grove Dam to the downstream end of Cottage Grove. This reach is fairly confined along most of its length, first in the City of Cottage Grove and then in the narrower floodplain below the dam. There are thirteen tributaries that enter this reach, Piper, Langdon, Snyder, Lane, Cooley, Finney, Martin, Silk, and Bennett Creeks, and four unnamed creeks. Land uses in the floodplain include agriculture, urban residential, commercial, industrial, rural residential, a golf course and developed athletic facilities, and park/open space. There is high density development through the City of Cottage Grove. In general, there is limited undeveloped floodplain in this reach.

5. *Reach R1 – Row River Confluence to Row River Road (RM 0 to 2.8).* This reach is approximately 2.8 miles in length and is constrained by I-5 and the Cottage Grove Airport, although the confluence area is fairly unconstrained and undeveloped and much of the confluence area and the left bank upstream is owned by the City of Cottage Grove. There are two crossings in this reach, I-5 and Row River Road at the upstream end. Land uses in the floodplain include a golf course, airport, residential and commercial development, and City owned parkland and open space.

1.7.3.2 Middle Fork Willamette River

1. *Reach M1 – Middle Fork/Coast Fork confluence to Springfield Millrace (RM 187 to 191).* This reach is approximately 4 miles in length and generally flows along the southern edge of the City of Springfield. The Middle Fork is constrained by some revetments and natural basalt hill slopes, but there is otherwise a large area of floodplain in this reach. The river flows adjacent to Howard Buford Recreation Area (Mt.

Pisgah) on the south. Several gravel pit ponds are present directly adjacent to the river on the south side and gravel mining within the channel has occurred in the past in this reach. The Springfield Millrace is a diversion from the river that flows approximately 4 miles northwest and re-enters the mainstem Willamette River downstream of the confluence. The Springfield Utility Board operates a well field in the floodplain, partially fed by infiltration from Gorrie Creek, a secondary diversion off of the Millrace. Land uses in the floodplain include agriculture, rural residential, sand/gravel mining, and park/open space. There are very few structures located within 1000 feet of the Middle Fork in this reach, except on the right bank at the Middle Fork/Coast Fork confluence and some houses adjacent to the Millrace. A significant portion of the floodplain in this reach is publicly owned, as well as one major private landowner (The Nature Conservancy recently acquired Wildish Land Company's property). Islands and bars are present in the river in several locations.

2. *Reach M2 – Springfield Millrace to Hills Creek confluence (RM 191 to 195.2).* This reach is approximately 4.2 miles in length and generally flows from Jasper to Springfield. There are multiple Corps revetments in this reach, although there is limited development in the floodplain. The revetments generally protect agricultural lands. The Springfield-Creswell Highway and Southern Pacific Railroad line are located very close to the Middle Fork and constrain the river's right bank for approximately 1.5 miles of this reach. The tributaries that enter this reach include Pudding and Wallace Creeks and Hill Creek. Land uses in the floodplain include agricultural, rural residential, gravel mining, and forested/undeveloped. There is a major electrical transmission line crossing in this reach as well as the Springfield-Creswell Highway bridge. Several old meander scars and oxbows are present in this reach. Figure 4 shows a representative section of this reach near Clearwater Park.

Figure 4. Middle Fork Willamette River at Clearwater Park.

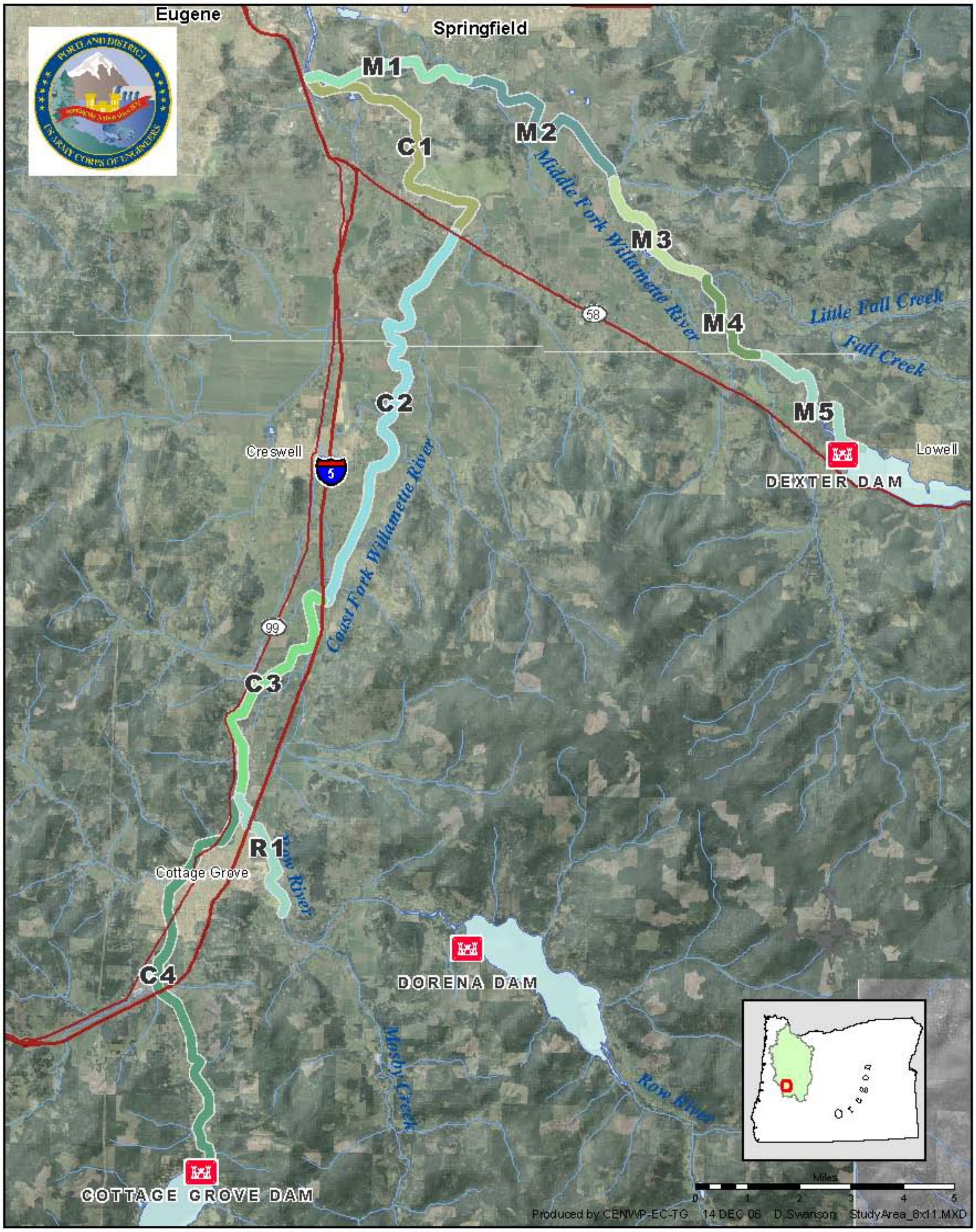

Figure 5. Coast Fork and Middle Fork with Study Reaches Delineated.

3. *Reach M3 – Hills Creek confluence to Fall Creek confluence (RM 195.2 to 198.3).* This reach is approximately 3.1 miles in length and flows primarily adjacent to Jasper, OR. The Middle Fork is less constrained by roads in this reach, although the Jasper-Lowell Road goes through the right bank floodplain, along with residential streets in the left bank floodplain. The primary tributaries that enter this reach are Rattlesnake and Fall Creek. Little Fall Creek is a major tributary to Fall Creek. Land uses in the floodplain include agriculture, rural residential, industrial, and park/open space. Development is more dense in this reach than in Reaches M1 or M2; associated with Jasper and Pleasant Hill and there is limited opportunity for floodplain restoration on the left bank, except for the area immediately adjacent to the railroad crossing. There are numerous structures located within 1000 feet of the Middle Fork in this reach. There is only one major crossing in this reach, the Southern Pacific Railroad line. This reach has numerous islands and bars and is braided in multiple locations.

4. *Reach M4 – Fall Creek confluence to Lost Creek confluence (RM 198.3 to 200.6).* This reach is approximately 2.3 miles in length and flows through a highly braided section likely influenced by alluvial deposits from both Fall and Lost Creeks. There is limited development in the floodplain in this reach and a moderate riparian zone. Land uses in the floodplain include agriculture, rural residential, and park/open space. There is a power line crossing in this reach. This reach has numerous islands and bars and old meander scars and oxbows.

5. *Reach M5 – Lost Creek confluence to Dexter Dam (RM 200.6 to 203.8).* This reach is approximately 3.2 miles in length and is located primarily within Elijah Bristow State Park. The river meanders and braids through this reach fairly extensively. The river is constrained in some locations by roadways, but otherwise is not constrained. There are several remnant or high flow side channels that could be reconnected to the river in this reach.

1.8. REPORT CONTENTS

This report contains a summary of the feasibility study from plan formulation through selection of a recommended plan, feasibility designs and cost estimating, and an analysis of the effects of the recommended plan. This document is an integrated feasibility report with an Environmental Assessment (EA) to comply with the National Environmental Policy Act (NEPA). A Biological Assessment (BA) has been prepared for consultation under the Endangered Species Act (ESA) and is provided in Appendix D. The feasibility report has been prepared to an appropriate detail of analysis required to develop the project schedule and baseline cost estimate and to facilitate a decision on whether to move forward with PED. PED will include additional reach-scale analyses required to finalize the design and prepare plans and specifications. These additional analyses are proposed in Appendix F.

The EA has been integrated into this feasibility report to assess the effects from the proposed restoration plan. The types of individual restoration measures proposed in this project have been implemented widely throughout the Pacific Northwest and much is known relative to their effects, which are beneficial, although some adverse effects are expected during construction. It is the intent for all restoration actions implemented as part of this plan to be conducted using appropriate mitigation measures and best management practices (BMPs) to avoid and minimize any adverse effects during construction. The long-term effects of this proposed plan are beneficial and intended to specifically benefit sensitive fish and wildlife species and contribute to the restoration of natural riverine and floodplain processes.

Chapter 1 includes the general description of the study authorization, process, and study area. Chapter 2 describes other Federal, state and local programs and projects operating within the study area. Chapter 3 describes the existing and likely future conditions within the study area. Chapter 4 describes the problems and restoration opportunities in the study area. Chapter 5 describes the plan formulation process. Chapter 6 describes the recommended restoration plan. Chapter 7 describes the effects of the recommended restoration plan on the environment. Chapter 8 describes public and agency involvement efforts conducted, to date. Chapter 9 describes the status of environmental compliance. Chapter 10 describes the proposed monitoring plan. Chapter 11 provides the conclusions and recommendations from the study.

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2. EXISTING PROJECTS AND RELATED STUDIES/ PROGRAMS

There have been multiple water resources infrastructure projects developed in the Middle and Coast Forks subbasins, and there continues to be additional development of plans and implementation of restoration and enhancement measures in many parts of the Willamette Basin. Major federal, state, and local initiatives and programs are summarized below, with an emphasis on those pertaining to the Coast Fork and Middle Fork subbasins.

2.1. CORPS OF ENGINEERS

2.1.1. Willamette Projects

The major tributaries of the Willamette River, including the Coast and Middle Forks, are regulated by the Corps of Engineers' multiple purpose dams. There are five large storage reservoirs and one re-regulating reservoir (Dexter) in the Coast Fork and Middle Fork subbasins (Table 3). These projects are part of a system of 13 multiple-purpose dams and reservoirs in the overall Willamette Basin constructed by the Corps. The annual weather patterns and runoff characteristics of the Willamette Basin make the multiple purpose operation of the reservoir system possible. The well-defined limits of the flood season allow the reservoirs to be drawn down in the fall and winter to catch flood flows. The reservoirs are then filled in the spring and held full as long as possible in the summer so that water stored in, or released from the reservoirs can serve a variety of beneficial uses. Each reservoir is operated on the basis of a water control plan (rule curve) which establishes the elevation at which the pool is to be maintained during various seasons and seasonal transitions.

The original authorized plan for the Willamette projects is described in House Document 544, 75th Congress, 3rd session, March 16, 1938. The plan for open-river navigation improvement above Willamette Falls stipulated a minimum flow of 5,000 cubic feet per second (cfs) between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively. House Document 544 also recognized that these navigation flows would increase flows during the low-water period and would "benefit sanitary conditions along the main stream" by diluting wastes and would increase "the dissolved oxygen content of the stream with a resultant beneficial effect on fish life."

Table 3. Corps Projects in the Coast Fork and Middle Fork Subbasins

Project	River	Date Completed	Flood Storage Capacity (acre-ft.)	Total Storage (acre-ft.)	Drainage Area (sq. miles)
Coast Fork Subbasin					
Dorena	Row River	Oct 1949	70,500	71,900	265
Cottage Grove	Coast Fork Willamette	Sep 1942	30,060	31,790	104
Middle Fork Subbasin					
Hills Creek	Middle Fork Willamette	Aug 1961	200,000	350,600	389
Lookout Point	Middle Fork Willamette	Nov 1953	337,300	443,000	991
Dexter*	Middle Fork Willamette	Dec 1954	7,200	29,900	996
Fall Creek	Fall Creek	Oct 1965	115,000	117,500	184
**Dexter is a re-regulating project below Lookout Point Dam.*					

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

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

2.1.1.1 Middle Fork Subbasin Projects

In the Middle Fork subbasin, the Hills Creek project, completed in 1961, is located at river mile (RM) 234.8 on the Middle Fork Willamette River. It is operated in conjunction with Lookout Point to meet summer instream flow needs on the mainstem Willamette River. The Hills Creek embankment dam is 338 feet high, impounds 350,600 acre-feet of water at full pool, and controls runoff from a 390 square-mile drainage area. An authorized minimum release flow of 100 cfs is maintained below the dam from February through November. However, because this is less than the minimum discharge (300 cfs) required for efficient operation of the power generation units, no power is generated if flow drops below 300 cfs.

Lookout Point is located at RM 208.3 on the Middle Fork Willamette River. Dexter Dam is located about 3 miles downstream and re-regulates the releases from Lookout Point to provide more consistent flows downstream and additional power generation. The Lookout Point embankment dam is 258-feet high and impounds 443,000 acre-feet of water at full pool, while the Dexter embankment dam is 107-feet high and impounds 29,900 acre-feet of water (Figure 6).

Figure 6. Dexter Reservoir

Lookout Point has a large storage capacity and is the first of the 13 Willamette reservoirs to be drafted in the spring and early summer for meeting flow requirements on the mainstem Willamette River. An authorized minimum flow of 1,200 cfs is maintained below Lookout Point/Dexter from February through June, and 1,000 cfs from July through November.

The Fall Creek project, completed in 1965, is located at RM 7.2 on Fall Creek, a tributary of the Middle Fork Willamette River. It controls runoff from a 184-square mile drainage area. The 193-foot- high embankment dam impounds 117,500 acre-feet of storage at full pool. There are no hydropower facilities at the project. The lake has significant recreational use in summer. An authorized minimum flow of 30 cfs is maintained below the dam from February through November. However, a negotiated discretionary minimum flow of 150 cfs between April and

June and then limiting maximum flows below the dam to 1,000 cfs from September through October is done as part of the state's water management objectives. Fish collection facilities are provided and Chinook salmon collected at Fall Creek are transported to state hatcheries. Steelhead migrating upstream are collected and transported past the dam. Fingerlings migrate downstream through a collection system and bypass conduit at the dam.

2.1.1.2 Coast Fork Subbasin Projects

In the Coast Fork Willamette River subbasin, the Dorena project, completed in 1949, is located at RM 6.5 on the Row River. It controls runoff from a 265-square mile drainage area. The dam is 145-feet high and impounds 71,900 acre-feet of storage at full pool. There are no hydropower facilities at the project. An authorized minimum flow of 190 cfs is maintained below the dam from February through June, and 100 cfs from July through November.

Figure 7. Cottage Grove Reservoir

The Cottage Grove project, completed in 1942, is located at RM 29 on the Coast Fork Willamette River and also includes revetments at 9 locations downstream. It controls runoff from a 104-square mile drainage area. There are no hydropower facilities at the project. The dam is 95-feet high and impounds 31,790 acre-feet of water at full pool (Figure 7). An authorized minimum flow of 75 cfs is maintained below the dam from February through June, and 50 cfs from July through November.

2.1.2. Willamette River Bank Protection Program

The Willamette River Bank Protection program protects public and private lands in the Willamette Valley from erosion damage. The program was authorized by the Flood Control Acts of 1936, 1938, and 1950 and covers bank protection and channel clearing works along the Willamette River from New Era (approximately RM 30; upstream of Willamette Falls) and upstream to each Corps' dam. Project components include bank revetments, pile and timber bulkheads, drift barriers, minor channel improvements, and continued maintenance for flood protection and the prevention of bank erosion and to maintain an efficient discharge channel below the flood control reservoirs operated by the Corps. This program was an integral part of the overall Willamette River flood control project.

In 1947, the Corps specified that approximately 6 miles of levees with a mean height of 6 feet would be required to provide adequate channel capacity for controlled flood discharges released from the dams in the Middle Fork subbasin. As of 1989, approximately 50% of the lower 8 miles of the river had been protected by levees or revetments (USACE 2000a).

The Corps also specified that construction of 11-foot high levees along the Coast Fork Willamette from Cottage Grove (RM 23) to the confluence with the Middle Fork would prevent flood damage, but determined that the cost of construction outweighed the benefits at that time (USACE 2000a). A need for approximately 4.3 miles of levee along the Row River also was noted. As of 1989, approximately 5 miles of levees and revetments had been constructed on the Coast Fork downstream of RM 12, and 1 mile of levees and revetments had been constructed on the lower Row River (USACE 2000a).

2.1.3. Middle Fork Willamette River Fishery Restoration Project

A reconnaissance study was completed in 1997 that evaluated the potential to modify the Hills Creek and Lookout Point/Dexter projects to restore native runs of spring Chinook salmon and winter steelhead upstream of the dams (USACE 1997). The study evaluated alternatives for adult and juvenile passage and identified four alternatives for re-establishing fish runs above Lookout Point Reservoir. The alternatives were combinations of measures providing both juvenile and adult passage past the Lookout Point/Dexter projects. Two of the alternatives also provided temperature control of water releases from Hills Creek Dam to facilitate upstream migration. While federal interest in further study was demonstrated, a feasibility level study will not proceed until a local sponsor is able to cost-share a study.

2.1.4. Willamette Project Operations Biological Opinion

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

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

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

1. Creation and coordination of a multi-agency action team for ecosystem restoration to oversee flow management activities and other interim measures to avoid jeopardy to the listed species.
2. Operational modifications to modify flows to provide more natural seasonal fluctuations and access to riverine/floodplain habitats and provide suitable flows for outmigrating juveniles in the spring and summer and also to provide adequate rearing habitat and temperatures for fish during the summer/fall months. Additional monitoring activities such as the installation of new gages and instream flow studies will help to inform and revise minimum flow targets in future years.
3. Evaluate and update water contracts and require fish screening at all diversions receiving federally provided water.

4. Provide fish passage at the dams through a variety of methods including outplanting, trap and haul, fish collection, downstream passage through dams, and other methods to be identified through the development of a Willamette Fish Operations Plan. Upgrade facilities to comply with the Plan.
5. Improve water quality downstream of the dams by operational activities and facility upgrades/construction at dams to provide more normative water temperatures and reduced total dissolved gas (TDG) in the tributaries and mainstem Willamette.
6. Evaluation and modification of hatchery operations through Hatchery and Genetic Management Plans and other measures such as upgrades to facilities and mass-marking of hatchery releases.
7. Implement habitat mitigation and restoration measures throughout the basin (at both off-site and on-site locations). Collect and make large woody debris available and restore habitat at existing Corps revetments. Funding to be provided through existing funding programs such as the:
    - Columbia Basin Fish and Wildlife Program,
    - Continuing Authorities Programs,
    - General Investigation Studies (applicable GI studies include the Willamette Floodplain Restoration Study, Eugene-Springfield Metro Area Watershed Feasibility Study, and Lower Willamette Ecosystem Restoration Feasibility Study),
    - Planning Assistance to the States
    - Upper Willamette Watershed Ecosystem Restoration Authority (Section 3138, WRDA 2007),
    - Ecosystem Restoration and Fish Passage Authority (Section 4073, WRDA 2007),
    - Sustainable Rivers Partnership with the Nature Conservancy.
8. Conduct ESA compliance and coordination activities with NMFS and USFWS.
9. Develop and implement a comprehensive research, monitoring and evaluation plan.
10. Identify fish protection maintenance needs.

2.1.5. Willamette Flow Management Project

The Nature Conservancy, in partnership with the Corps and other stakeholders, has begun a study to evaluate the potential benefits of modifying the operation of several dams in the Willamette basin. The study will focus on the Coast Fork, Middle Fork, McKenzie, and North and South Fork Santiam Rivers below the Corps' dams and the mainstem Willamette River down to Salem. The purpose of this study will be to understand how modified flows could benefit species and ecosystems within the context of existing flood control, recreation, and irrigation needs. Key elements of the study include: 1) Compile existing information and literature describing current data and knowledge on the flow requirements of the river-floodplain system and native species and communities. 2) Develop ecological models to link flow conditions to ecological processes and biotic response. 3) Hold a workshop with key scientific experts to develop initial flow recommendations based on ecological objectives, and to identify critical information gaps. Initial quantitative flow recommendations will include recommended ranges for low flow, high flow and flood pulses, duration and frequency of each, and the rate of change from one condition to another. 4) Develop a monitoring program to evaluate the ecological effects of implementing the recommended flow regimes. Utilize model simulations or economic analysis to evaluate the effects of flow changes on reservoir operations and ability to meet the multi-use purposes of the dams. Utilize existing hydrologic models to evaluate effects on downstream hydrographs and water surface elevations. 5) Apply adaptive management principles to refine flow targets and dam modifications.

2.2. State of Oregon

2.2.1. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead

In August 2011, ODFW, with participation from the Governor's Natural Resource Office (GNRO) and NMFS adopted their final recovery plan for Chinook salmon and steelhead in the Upper Willamette River watershed. While the NMFS is responsible for preparing recovery plans for listed species, the State of Oregon wishes to be a strong partner in the delisting and recovery of salmonids for future generations and has thus, led the preparation of this plan. The plan identifies delisting goals, recovery goals, current status, viability gaps, and limiting factors, and then outlines a management strategy to fill the viability gaps, reach the delisting goals and progress towards the broader recovery goals. Fourteen management strategies were identified, of which eleven are relevant to habitat conditions: 1) protect and conserve natural ecological processes that support the viability of wild salmon and steelhead populations and their life history strategies throughout their life cycle; 2) restore floodplain connectivity and function and maintain unimpaired floodplain connectivity and function; 3) restore riparian condition and LWD recruitment and maintain unimpaired conditions; 4) restore passage and connectivity to habitats blocked or impaired by artificial barriers and maintain unimpaired passage and connectivity; 5) restore and maintain hydrologic regimes that support the ecological needs of wild salmon and steelhead populations; 6) restore channel structure and complexity and maintain unimpaired structure and complexity; 7) restore impaired food web dynamics and function and maintain unimpaired dynamics and function; 8) restore degraded water quality and maintain unimpaired water quality; 9) restore degraded upland processes to minimize unnatural rates of erosion and runoff and maintain natural upland processes; 10) reduce the impact of non-native plants and animals on wild salmon and steelhead populations and prevent the introduction of new non-native plants and animals; and 11) reduce predation on wild salmon and steelhead that has been exacerbated by anthropogenic changes to the ecosystem.

2.2.2. Oregon Plan for Salmon and Watersheds

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

2.2.3. Willamette Partnership

In September 1998, Governor John Kitzhaber established the Willamette Restoration Initiative (now the Willamette Partnership). The Partnership was established to develop and implement a long-range conservation plan for the Willamette River and its watershed. Completed in 2001, this conservation plan, called the Willamette Restoration Strategy, is the Willamette chapter of the Oregon Plan. The Willamette Restoration Strategy identifies 27 critical actions needed to preserve and improve watershed health in the areas of water quality, water supply, habitat and hydrology, and institutions. Two of the actions call for more detailed identification of fish and wildlife conservation priorities and more integrated environmental planning. The development of the *Willamette Subbasin Plan*, below, represents substantial progress for the Partnership in both of these areas.

2.2.4. Willamette Subbasin Plan

The Northwest Power Act directs the NPCC to develop a program to protect, mitigate, and enhance fish and wildlife of the Columbia Basin and to make annual funding recommendations to the BPA for projects to implement the program. The purpose of subbasin planning is to document subbasin conditions and evaluate and define strategies that will drive the implementation of the Fish and Wildlife Program at the subbasin level. The NMFS and USFWS also use the plans in their recovery planning efforts for threatened and endangered species. The NPCC designated the Willamette Partnership as the lead entity for developing the *Willamette Subbasin Plan*, which was completed in May 2004 (Phase 1 of this study). The plan includes a compendium of current knowledge about basin conditions (particularly fish and wildlife and their habitats), an inventory of existing plans and programs, and strategies and actions to implement the plan. This plan is the basis for developing more detailed studies and restoration designs in the basin.

2.2.5. Total Maximum Daily Loads

The Oregon Department of Environmental Quality (ODEQ) is required to establish Total Maximum Daily Loads (TMDLs) for stream segments in the state that do not meet water quality standards and are listed under Section 303(d) of the Clean Water Act. The *Final Willamette Basin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)* was completed and approved in 2006 for all Willamette Basin streams and developed waste load allocations for individual facilities (point sources) and for nonpoint sources. Some stream segments in the Middle Fork subbasin do not meet standards for temperature and dissolved oxygen, and some segments in the Coast Fork subbasin do not meet standards for temperature, bacteria, dissolved oxygen, and mercury. More information on TMDLs and specific recommendations for the Middle Fork and Coast Fork are found in Section 3.2.4.

2.2.6. Conservation Reserve Enhancement Program

The Oregon Conservation Reserve Enhancement Program (CREP) is a cooperative program between the U.S. Department of Agriculture and the State of Oregon that provides financial incentives for riparian restoration along agricultural lands. The program was created in 1998 with a purpose to establish riparian vegetation on agricultural lands, protect water quality and restore fish and wildlife habitat. CREP allows agricultural landowners to enroll eligible near-stream lands into a 10- to 15-year contract and receive annual conservation payments for the contract period, cost reimbursement, and other financial incentives. The program was recently amended to provide more riparian restoration options for pasture and rangeland statewide. This program could be used as an incentive to landowners that may be interested in participating in this study, although the short-time period for contracts may not provide adequate guarantees of habitat restoration or protection in perpetuity.

2.2.7. Native Fish Conservation Policy

In November 2002, the Oregon Fish and Wildlife Commission adopted the Native Fish Conservation Policy (NFCP). The policy is focused on the conservation and recovery of naturally produced native fish.

There are three major goals of the policy: 1)prevent the serious depletion of native fish; 2) maintain and restore naturally produced fish in order to provide substantial ecological, economic, and cultural benefits to the citizens of Oregon; and 3) foster and sustain opportunities for fisheries consistent with the conservation of naturally produced fish and responsible use of hatcheries. This policy will allow the management of hatcheries, habitat, fish harvest, predators, competitors, and water quality across the state with the goal of recovery naturally produced native fish.

2.2.8. Willamette River Legacy Program

On March 5, 2004, Governor Ted Kulongoski announced that his, "...top environmental priority over the next three years is to clean up the crown jewel of Oregon's river system – the Willamette River…from the headwaters east of Eugene all the way to the Columbia." Governor Kulongoski identified three priority areas of focus for the *Willamette River Legacy Program*. The plan lists a number of high priority actions for each of the following themes.

1. Repair – clean up the industrial pollutants and toxins that have contaminated the river.
2. Restore – return the river to its natural state, restoring its abundant wildlife and pristine riverbanks. Recommended high priority actions that are particularly relevant to this study include protection/restoration of floodplain functions and restoration of riparian habitats.
3. Recreate – address the role that the Willamette River plays in Oregon's quality of life so Oregonians can enjoy the many activities the river offers, and to do so responsibly so that it will be here for future generations.

2.2.9. Oregon Parks and Recreation Department Master Plan

The Oregon Parks and Recreation Department (OPRD) completed a final *Master Plan* for management of their parks on the Middle Fork Willamette River and Dexter and Fall Creek Lakes (OPRD 2006). The planning process includes 15 properties that OPRD owns or leases, reaching from Jasper State Recreation Site on the lower Middle Fork to Fisherman's Point campground at the upper end of Fall Creek Reservoir. Input was gathered from an Advisory Committee and a wide variety of stakeholders to develop long-term plans for further development to accommodate recreation needs and opportunities. Plans for further actions at the sites below Dexter Dam acknowledge the presence of several high quality habitats and will provide additional protections for these habitats. The Master Plan also references the potential for floodplain restoration activities in conjunction with the Corps of Engineers and other partners.

2.3. LOCAL INITIATIVES AND PROGRAMS

2.3.1. Oregon Habitat Joint Venture

The Oregon Habitat Joint Venture is a coalition of groups and agencies involved in cooperative efforts to protect and restore important habitats for birds and other native fish and wildlife. As the Oregon arm of two larger, regional joint ventures – the Pacific Coast Joint Venture and the Intermountain West Joint Venture – this partnership serves as a vehicle for implementation statewide of national and international conservation initiatives targeting habitat for birds.

The primary purpose of the *Pacific Coast Joint Venture Implementation Plan, Willamette Valley* (Roth *et al*., 2004) is to provide a common framework for action by the joint venture partners. It also may serve other purposes by highlighting habitat conservation needs and opportunities at an ecoregion scale, and to provide a strategic framework for site-specific habitat protection and restoration projects. One of the target areas in the plan is the Willamette Forks Confluence area. The confluence holds tremendous potential for restoring a diverse array of wetlands.

Camas Swale is a broad band of hydric soil and floodplain area that is currently farmed. There is potential to restore wet prairie habitat throughout the area and upland prairie and oak savanna on the fringes of the swale. The Natural Resources Conservation Service has purchased one permanent easement in this area and the City of Creswell owns a small parcel. Recommended actions in the confluence area include:

- Protect and restore an additional 1,000 acres of floodplain habitat around the confluence area through conservation easements and fee title acquisition from willing landowners.
- Restore / enhance oak savanna and woodland habitats at Howard Buford Recreational Area and Camas Swale.
- Acquire and protect intact floodplain forest along the Middle Fork Willamette River.
- Protect and restore wetlands in the Camas Swale area through conservation easements and fee title acquisition from willing landowners.
- Create a riparian and floodplain corridor along the Coast Fork Willamette River from the confluence upstream to Creswell.

These recommended actions are very similar to and compatible with the objectives of this restoration study and will be considered further in the study for potential high priority floodplain restoration areas. It may also be possible to leverage Joint Venture funds with Corps funding.

2.3.2. Willamette River Basin Planning Atlas

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

Future scenario Plan Trend 2050 depicts a future in which the currently published policies of civil jurisdictions and land management agencies, and the currently dominant practices in private agriculture and forestry would be extrapolated to the year 2050. Development 2050 is a future scenario in which legal and administrative land use regulations would be relaxed relative to Plan Trend, and market forces would have greater influence. The Conservation 2050 scenario projects a future in which the conservation and restoration of ecological function would play a larger role in land and water allocation decisions. There were significant differences in environmental qualities among the scenarios with most indicators of natural resource condition showing substantial improvement in Conservation 2050 and little change or future decline in Plan Trend 2050 and Development 2050. Key features of the Conservation 2050 scenario include protection and restoration of riparian areas, conifer forests, grasslands, and oak savannah habitats.

2.3.3. Region 2050, Southern Willamette Valley

Region 2050 is a voluntary, collaborative regional planning effort to improve and sustain the quality of life in the southern Willamette Valley over the next 50 years (LCOG 2001). Region 2050 began in the summer of 1999 with the adoption of formal resolutions by the Lane County Board of Commissioners and the City Councils of Coburg, Cottage Grove, Creswell, Eugene, Junction City, Lowell, Oakridge, Springfield, Veneta, and Westfir. The resolutions endorsed the concept of developing a Regional Growth Management Strategy and defined the forum for the dialogue among the partners. Other collaborators include the Lane Transit District, local utilities, the Oregon Department of Land Conservation and Development, other state agencies, the Governor's office, and the League of Women Voters.

The outcome of this effort is the *Southern Willamette Valley Regional Growth Management Strategy*. The strategy includes an evaluation and goals for population growth, economic development, transportation infrastructure upgrades, and protection of the environment. Major recommendations relevant to this study include the likelihood of transportation upgrades (I-5 widening and Highway 58 improvements) that may constrain some reaches of the Coast or Middle Forks and the intent to protect and restore floodplain and riparian areas to minimize future problems and restore high quality habitats.

2.3.4. Lane County Parks

Lane County Parks is updating its *Parks and Open Space Master Plan.* The new master plan will replace the outdated 1980 master plan and will document the condition of the existing 61 county parks, analyze needs and issues, and set forth goals, policies and recommendations. Howard Buford Recreational Area is a key Lane County Park and includes floodplain areas that may provide key locations to restore floodplain functions through this study.

2.3.5. Coast Fork Willamette Watershed Council

The Coast Fork Willamette Watershed Council serves to improve water quality and watershed conditions in the Coast Fork Willamette subbasin through education, coordination, consultation and cooperation of diverse interests. The Council serves local communities by acting as a forum for natural resource issues which results in both broad-based science education and voluntary landowner participation in watershed restoration. In June 2005, an assessment of the Lower Coast Fork subbasin was completed. The assessment identifies impairments to water quality, hydrology, sedimentation, and riparian, wetland, and in-stream habitats. These impairments are caused by stream channel modifications due in part to land use practices intended for flood control, development, and agriculture. Priority action items for the Watershed Council as identified in the assessment include: riparian zone protection and restoration, floodplain reconnection, reintroduction of flooding along some segments, fish passage, and wetland restoration. The Council completed a 2-year Action Plan and a 5-year Strategic Vision in 2007 from the assessment and other data sources.

2.3.6. Middle Fork Willamette Watershed Council

The Middle Fork Willamette Watershed Council is a volunteer-based partnership of diverse stakeholders to work together as a community to restore and sustain the ecological integrity and economic viability of the watershed, and promote local control by providing effective voluntary solutions to watershed issues.

The Council completed the Lower Middle Fork Willamette River Watershed Assessment in August 2002 and used the results of the assessment to develop a 5-year Action Plan for habitat restoration/protection, water quality, and education. Parameters assessed in the watershed assessment included hydrology, riparian condition, aquatic habitat condition, wetlands, water quality, and sediment. Many of the recommendations made in the action plan directly relate to this study. Such actions include protection and restoration of riparian areas, restoring floodplain connections and functions such as bar and side channel formation, removal/modification of revetments, and exploring opportunities to modify flows from the dams. The Council prioritized actions for the protection and restoration of floodplain and riparian forest areas, and is working with the Corps and other partners to identify and implement a comprehensive floodplain restoration strategy in the lower Middle Fork subbasin.

2.3.7. Friends of Buford Park and Mt. Pisgah

The mission of the Friends of Buford Park and Mt. Pisgah (FBP) is to preserve the ecological integrity of the 2,363-acre Howard Buford Recreation Area (the largest Lane County park) and its adjacent natural areas. Activities include:

- Restoring diverse native plant communities and the wildlife they support.
- Conducting public education and encouraging volunteer activities.
- Fostering public involvement in park planning, maintenance and enhancement.
- Raising funds for acquisition, development and operation of the park.

The dominant feature of the park is Mt. Pisgah, which rises 1,000 feet above the valley. The lands around the mountain are of incredible natural diversity. In particular the wetland, prairie and oak savanna habitats are some of the most valuable left in existence in the Willamette Valley. Hundreds of plant species, dozens of birds and mammals, numerous reptiles and amphibians, and countless insects and fungi make the park their home. A trail system of over 16 miles allows access to the recreation area's natural beauty.

FBP completed the South meadow project (see Figure 8 below) to restore more frequent flows to a side channel of the Coast Fork Willamette River within Lane County's Howard Buford Recreation Area, at the foot of Mt. Pisgah. In 2003, FBP and Lane County Parks Division collaborated to remove obstructions at the inlet, outlet and along the course of two side channels of the Coast Fork and removing dirt to restore more frequent flows through the site. This project is a good example of a side channel reconnection and floodplain/riparian revegetation project along the Coast Fork Willamette River.

Figure 8. South Meadow Project

3. CHARACTERIZATION OF BASELINE CONDITIONS

3.1. HISTORICAL CONDITIONS

3.1.1. Pre-Settlement

This assessment of conditions prior to Euro-American settlement is based on available reconstructions of historic conditions (Hulse, *et al*. 2002; Holland 1994) and currently accepted hydrologic and biologic principles. It is intended to give a sense of what conditions were like historically in the lower Coast and Middle Forks study area.

3.1.1.1 Landscape and Vegetation

The pre-settlement landscape of the Willamette Valley was a highly complex mosaic of deciduous and coniferous forest, shrubland, prairies, and wetlands (Hulse, *et al*. 2002; Holland 1994). Plant communities included Douglas fir forest, multiple oak savannah communities, mixed deciduous/coniferous forest, cottonwood riparian, alder/willow shrubland, chaparral, and wetlands and other aquatic features. The map of pre-settlement vegetation (circa 1851) in the *Willamette River Basin Planning Atlas* (Hulse, *et al*. 2002) shows that the Coast and Middle Forks floodplains were a diverse mix of closed forest riparian (cottonwood gallery), emergent wetlands, woodland, savannah, and prairie.

The vegetation of the Willamette Valley was managed prior to European settlement by the native peoples. Kalapuyan people that occupied the Willamette Valley during the early 19th century are reported to have set regular fires in the study area (Hulse, *et al*. 2002). These fires are believed to have maintained the prairie and oak savannah communities by preventing tree species from encroaching and dominating the landscape.

Both wet and dry meadows and prairies were extensive in the valley outside of the riparian gallery forest with species including: tufted hairgrass, slough grass, Roemer's fescue, June grass, slender wheatgrass, California oat grass and meadow barley (Christy *et al* 1998 cited in CFWWC 2005). Riparian forests containing cottonwood, Oregon ash, big leaf maple, dogwood and willows lined the river banks. Oak savanna with a scattering of ponderosa pine and Douglas fir covered higher ground that did not flood in the winter. Further up the hill slopes were hardwood trees like big leaf maple, Oregon white oak and golden chinquapin. On the surrounding hills were forests of Douglass fir, grand fir, ponderosa pine, incense cedar, western hemlock and western red cedar (CFWWC 2005).

Wetlands likely were abundant in the Coast Fork and Middle Fork Willamette River subbasins. For example, based on the location and amount of hydric soils in the Coast Fork subbasin, wetlands have been estimated to have covered approximately 36% of the subbasin (CFWWC 2005). The Middle Fork subbasin floodplain has a significant distribution of alluvial soils demonstrating significant meandering of the river (SCS 1981). Many historic wetlands were likely created and maintained by beaver activity as well as the frequent migration of the rivers.

3.1.1.2 Fish and Wildlife

Information concerning wildlife species in the Middle Fork and Coast Fork subbasins prior to Euro-American settlement is limited to anecdotal information from Indian tribes and early settler accounts. However, accounts indicate that, in general, during aboriginal times, deer, elk, bear, and other land mammals were extremely abundant. Elk were tied closely to the prairies for grazing, deer utilized both prairie and forest areas, while brown bear, wolf, and coyote all foraged extensively in the grasslands

(Holland 1994). Seasonal flocks of waterfowl used this habitat for forage and resting grounds, California condor scavenged the carcasses of large herbivores, while a diverse passerine, raptor and (seasonal) shorebird community were present in the area (Holland 1994).

Historically the Middle Fork Willamette River subbasin supported viable populations of spring Chinook salmon, bull trout, Oregon chub, and cutthroat trout. The upper Middle Fork may have supported the largest spring Chinook stock in the upper Willamette basin (WRI 2004). Native fish species in the Coast Fork subbasin included spring Chinook, Oregon chub, and cutthroat trout. It is not believed that the spring Chinook population in the Coast Fork was very large (ODFW 1992). Steelhead are not thought to have been present in the Coast or Middle Fork subbasins historically, although there were likely significant resident rainbow trout populations.

The area also supported a moderate diversity of reptile and amphibian species. Historical reports cite that the western pond turtle was found to be very common in all the sloughs of the Willamette River and its tributaries and the sluggish streams and ponds of the lowlands (Holland 1994).

3.1.1.3 Flooding

The rivers of the Coast Fork and Middle Fork Willamette subbasins had low summertime flows and intermittent high flows, which often overtopped the banks, in the fall, winter, and spring. Flooding therefore was a natural and frequent occurrence in the Willamette Valley and encompassed an extremely large area. The width of the valley floor is an indication of the formerly flood-prone area.

Large downed trees and piles of wood contributed to the formation and movement of the river channels. The wood obstructed and diverted channel courses and contributed to the dynamics of the river (Sedell and Froggatt 1984). In general, the braided and complex channel created a connectedness between the river's channel and its floodplain that was once complex and extensive and supported critical biological and ecological linkages (Benner and Sedell 1997).

3.1.2. Post-Settlement

A significant number of changes have occurred in the basin, since Euro-American settlement began in the subbasins. Historians believe that the first Euro-Americans to enter the upper Willamette Valley region were fur trappers working for the Northwest Company of Montreal, Canada. Fur trading between Europeans and Northwest Native Americans starting in the late 1700's and early 1800's led to the gradual exploration and settlement of the area by Europeans. By the 1840s, logging and agriculture began to replace fur trading as the primary activities in the region. As a result, major alterations to local aquatic and plan communities occurred over much of the area, as the land was subjected to greater amounts of burning, logging, and clearing.

3.1.2.1 Landscape and Vegetation

Logging of the dense forested hills began soon after settlers arrived to the area in the 1830s and 1840s. The transportation of logs involved log driving in rivers and the creation of splash dams in smaller tributaries (CFWWC 2005). Removal of LWD in the river channels to allow for log driving and navigation contributed to the simplification of the channel systems.

Much of the river valleys were developed for agricultural use and most of the major cities were settled along the rivers. The level, fertile alluvial lands on floodplain islands were more accessible for farming once secondary and seasonal channels were eliminated (Benner and Sedell 1997). In order to drain flooded fields, homesteaders would ditch and straighten small streams that meandered across their homesteads.

The *Willamette River Basin Planning Atlas* (Hulse *et al.*, 2002), documents substantial changes in the basin since Euro-American settlement. By 1990, 42% of the Willamette Valley had been converted from natural vegetation to agricultural use and 11% to structures. The acreage of older conifer forests (>80 years) was reduced by two-thirds. Although the number of people living in the basin is expected to nearly double over the next 50 years, more landscape change, and thus more environmental effects, occurred from 1850 to 1990 than is likely to happen under any future scenario to 2050.

3.1.2.2 Fish and Wildlife

Salmon harvest and canning operations on the Columbia River from Euro-American settlers began in the 1860s and peaked in 1883 with nearly 43 million pounds of salmon harvested (Montgomery 2003). Harvest declined from then on, well before the construction of major dams began on the Columbia River. Salmon populations throughout the basin were heavily affected, with few fish to be found. Chinook were the primary species exploited because of their large size (Montgomery 2003).

The U.S. Bureau of Fisheries (McIntosh, *et al* 1989) surveyed the Willamette Basin for fish habitat in the 1930s and 1940s, shortly prior to the construction of the first major dams. The Middle Fork was surveyed in 1937-38 and the Coast Fork was surveyed in 1938. Notes from the survey indicate that fish populations had been larger, according to old-time residents, prior to various human actions such as construction of agricultural and mill diversions and small dams. No salmon had been seen in the Coast Fork for 20-30 years (which coincides with the dramatic downturn of harvest on the lower Columbia River). Trout were abundant in both subbasins, along with other species such as whitefish and cottids. The Middle Fork was still a major spring Chinook river, although the majority of the spawning habitat was upstream of Lookout Point. The Coast Fork was becoming highly polluted from mill and mining wastes and sewage effluent. The Middle Fork had good water quality with temperatures less than 60° F, even in the lower reaches. Pools were very common in both subbasins (up to 20/mile) and the substrate was primarily small to large gravels/cobbles.

The construction of the major dams in the subbasins further changed the water quality, habitats and fish and wildlife populations in the basin. It has been estimated that the construction of the Dexter and Fall Creek dams blocked approximately 80% of the habitat historically accessible to spring Chinook in the Middle Fork subbasin (ODFW 1992). The Willamette Hatchery on the Middle Fork was constructed as mitigation for the construction of the dams, and the hatchery stock represents more than 50% of the returning adults. The dams have changed the water temperature regimes in the Coast and Middle Forks by discharging cold water from the stratified reservoirs during the summer months and then warm water as the reservoirs are drawn down in the fall during the salmon spawning period.

3.1.2.3 Flooding

Annual flooding was a constant struggle for early settlers. The flood-prone area extended throughout the Coast Fork Willamette valley north to the Coburg Hills and south to areas of Cottage Grove (CFWWC 2005). Floods could occur at least two out of every three years. When official records of the Coast Fork began in 1897, local records show that 40 out of the first 49 years the Coast Fork reached flood stage (Register Guard, December 15, 1946 cited in CFWWC 2005).

Dams on the Coast Fork and Middle Fork Willamette River were constructed beginning in the 1940s for the primary purpose of flood control (MFWWC 2002). There have been several environmental consequences as a result, including blocking fish passage and alteration of flow patterns. As a result of the dam operations, flows are higher in the summer, unusually high during the reservoir draw down period in the fall, and winter and spring peak flows are 70 - 80% of what they were under natural conditions (CFWWC 2005 and MFWWC 2002).

Channelization of the rivers through levee building and stabilization of banks with riprap was a common practice to reduce flood and erosion damages (CFWWC 2005). Once the floodplains were protected, development of the floodplains through the construction of buildings and homes further significantly altered the floodplain condition.

Due to the development of the floodplains since Euro-American settlement in the 1800s, the Willamette River, including the Coast Fork and Middle Fork has experienced extensive channel loss. For example, an analysis of the Willamette River between Eugene and Albany shows an average loss of approximately 45 to 50% of the original channel length. Over time, the rivers have been altered from multiple channels to a simplified and often single-thread channel system (Benner and Sedell 1997).

3.2. CURRENT AND FUTURE WITHOUT PROJECT CONDITIONS

3.2.1. Hydrology

3.2.1.1 Coast Fork Willamette River Subbasin

The Coast Fork Willamette River drains an area of approximately 665 square miles. Flow rates in the Coast Fork reflect the seasonality of rainfall, with the majority of runoff occurring during the winter and spring and low flows occurring during July and August. However, headwater elevations in the Coast Fork are not in the high Cascades and are fairly low elevation, thus, the Coast Fork hydrograph does not exhibit a spring snowmelt runoff. Within the study area the hydrograph has been altered from natural conditions. With dam regulation, the average monthly flows from February to April are 10-20% of what they were under natural conditions, and flows from July to October are typically 200-400% higher (CFWWC 2005). Peak flows have also been reduced substantially.

Flows in the lower Coast Fork Willamette River have been controlled by Dorena and Cottage Grove dams since 1949 and 1943, respectively. Flood risk management is the primary purpose of the entire Willamette system and Dorena and Cottage Grove dams are operated in concert with the other 11 dams in the system. The reservoirs are drawn down to the minimum flood control pool between September and December and the primary flood control season is December through January. Floods are less likely to occur from February through May and thus conservation storage for multiple uses occurs during this time period.

The dams have substantially decreased the magnitude and frequency of extreme high flow events in the Coast Fork Willamette and Row Rivers. Additionally, the dams have decreased the magnitude of lower return period channel forming flood events (USACE 2000). Flood frequency analysis conducted by the USACE-Portland District for the USGS Gage at Goshen (USGS 14157500) has shown that the 2-year return period flood event is 15,800 cfs for the regulated condition, as compared to 26,700 cfs for the unregulated condition (OSU 2007); see Table 4 for flows for various frequencies of occurrence under existing conditions. The bankfull flow and regulation goal at Goshen is 12,000 cfs, so flows are typically maintained to this level unless runoff is above the 2-year return event.

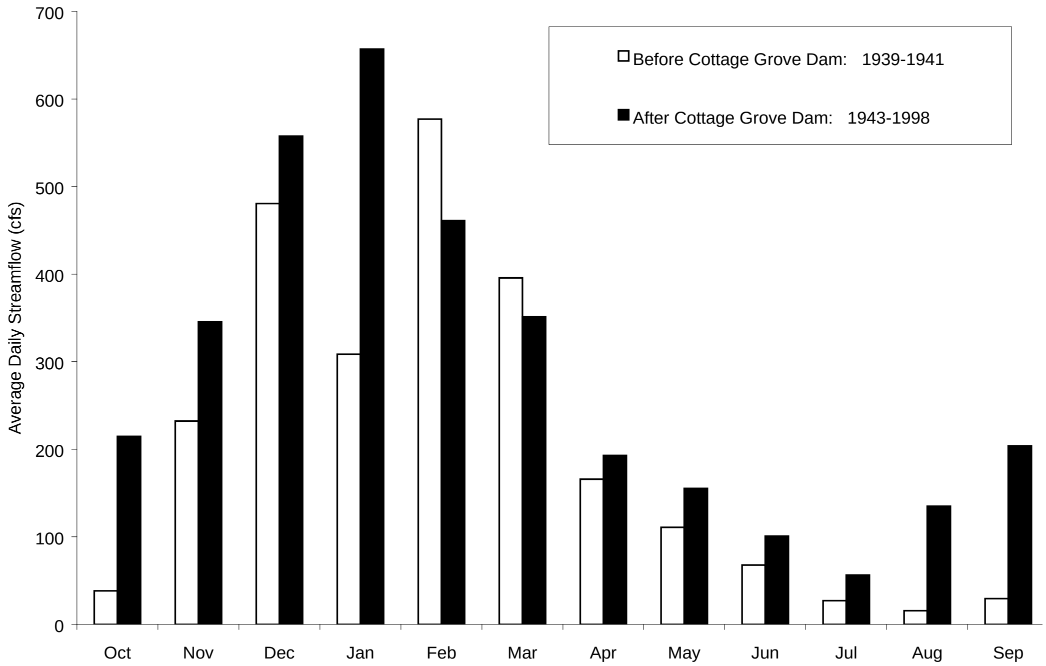
Table 4. Coast Fork Willamette River Flow Rates for Range of Exceedance Values and Return Periods.

Flow Duration and Flood Frequency Ordinate	Flow Rate by Location (cfs)		
	Coast Fork below Cottage Grove USGS Gage 14153500	Row River near Cottage Grove USGS Gage 14155500	Coast Fork near Goshen USGS Gage 14157500
95% Exceedance [a]	46	107	274
90% Exceedance [a]	57	177	386
75% Exceedance [a]	78	221	632
50% Exceedance [a]	180	600	1,350
25% Exceedance [a]	425	1,300	2,920
10% Exceedance [a]	883	2,660	5,890
5% Exceedance [a]	1,330	3,900	7,686
1.5-year Return Period [b]	2,500 [c]	4,000 [c]	11,000 [c]
2-year Return Period [b]	2,500 [c]	4,000 [c]	15,800
5-year Return Period [b]	2,500 [c]	5,500 [c]	20,000 [c]
10-year Return Period [b]	2,900	7,700	25,500
20-year Return Period [b]	3,600 [c]	10,500 [c]	31,500 [c]
100-year Return Period [b]	8,400	19,300	48,000

Notes:

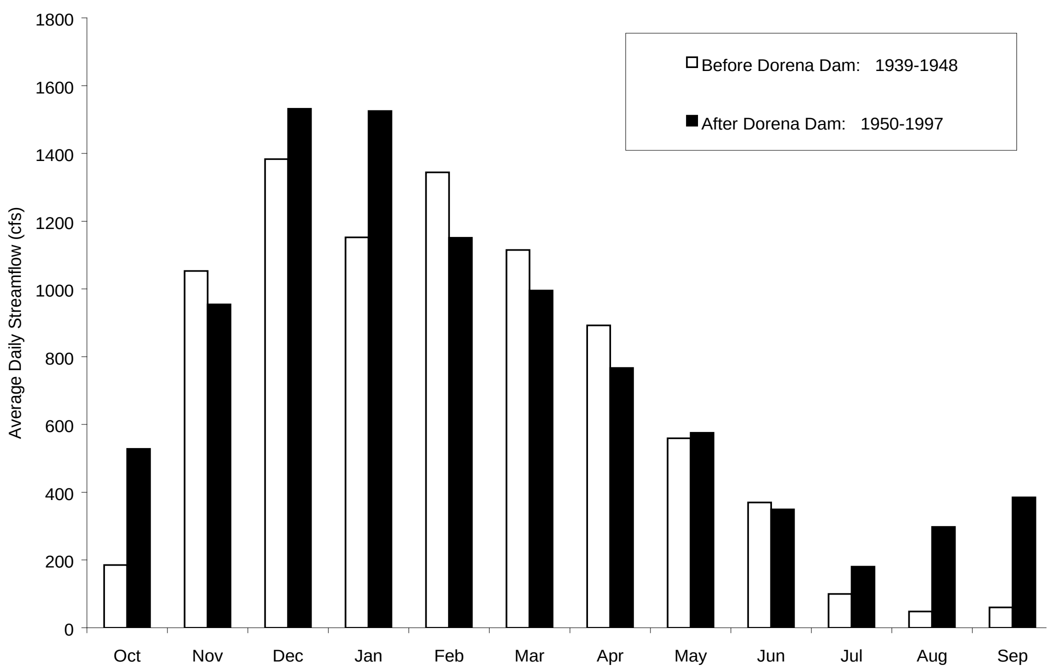
a. Flow Exceedance Values from Winter/Spring Season Flow Duration Curve
b. Flood Frequency Values are for the Regulated Condition
c. Value Interpolated from USACE-Portland District Flood Frequency Curve

Figures 9 to 11 illustrate the pre- and post-dam changes in average monthly flows below Cottage Grove and Dorena dams, as well as on the Coast Fork Willamette River below the dams. In the Coast Fork subbasin, flows are naturally lowest in the late summer and early fall. The average daily flow of the Coast Fork Willamette near Goshen in August was 95 cfs prior to dam construction, which increased to 481 cfs after dam construction. Post-dam summer flows are greater than what occurred historically because multiple-use storage is available to redistribute winter volumes for irrigation, navigation, power generation, recreation, instream flows for aquatic life, wildlife, and municipal and industrial water supply (USACE 2000a).



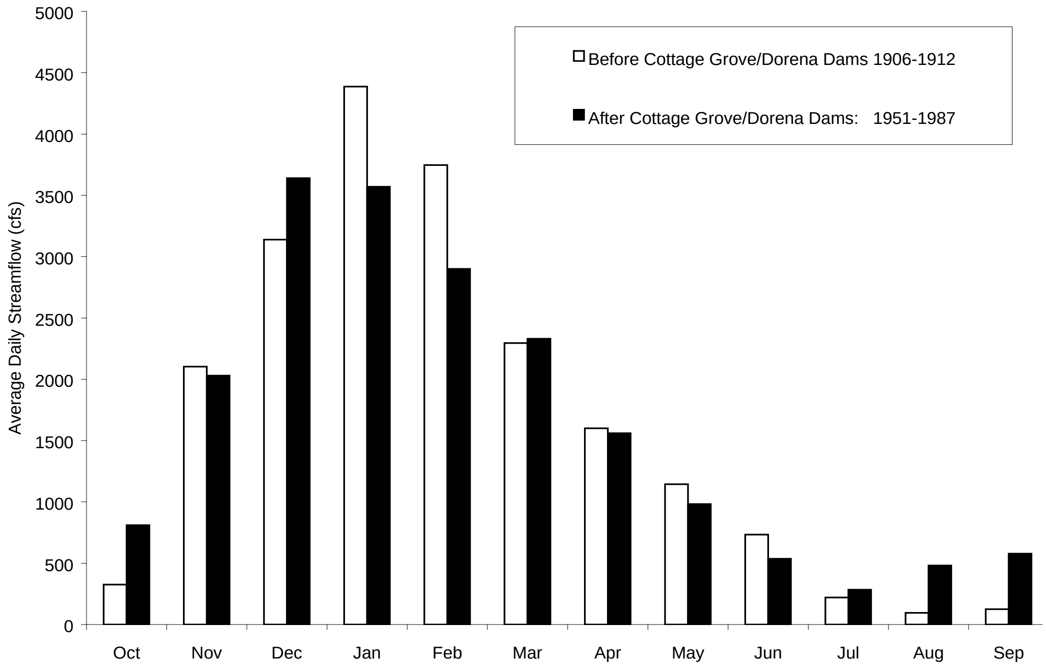
Data from USGS gage 14153500 (USACE 2000a).

Figure 9. Average Monthly Flows, Coast Fork Willamette below Cottage Grove Dam



Data from USGS gage 14155500 (USACE 2000a).

Figure 10. Average Monthly Flows, Row River near Cottage Grove below Dorena Dam



Data from USGS gage 14157500 (USACE 2000a).

Figure 11. Average Monthly Flows, Coast Fork Willamette near Goshen

A hydraulic model was developed for the project using Version 4.1 of the Hydrologic Engineering Center's River Analysis System (HEC-RAS) (USACE-HEC 2010) to develop a combined model of the lower Coast Fork and Middle Fork Willamette River systems. HEC-RAS is a one-dimensional hydraulic model software that models hydraulic parameters such as velocity and water depth. It can be used to model either steady-state or unsteady state flow conditions. For this study, the model was used exclusively in a steady state mode. The model is described in more detail in Appendix E.

The model was run for a range of design flow rates to support the preliminary design of the restoration sites and to establish without project hydraulic conditions throughout the study area. The following flow rates were the primary flow rates used to support the hydraulic design:

- **90% Exceedance Flow** – the 90% exceedance flow rate for the winter/spring period (defined as November 1 through June 1, inclusive) was used as a design flow in support of frequent backwater connections to the floodplain.
- **2-year return period flood flows** – this flow rate was used in general to identify estimated top elevations for in-channel engineered log jam features (i.e. river-type ELJs). This flow rate was also used as the design flow in support of flow through side channel features.
- **100-year return period flood flows** – this flow rate was used to estimate conservatively high values for general contraction scour for in-channel engineered log jam features.

Figure 12 shows the water surface profile of the lower Coast Fork.

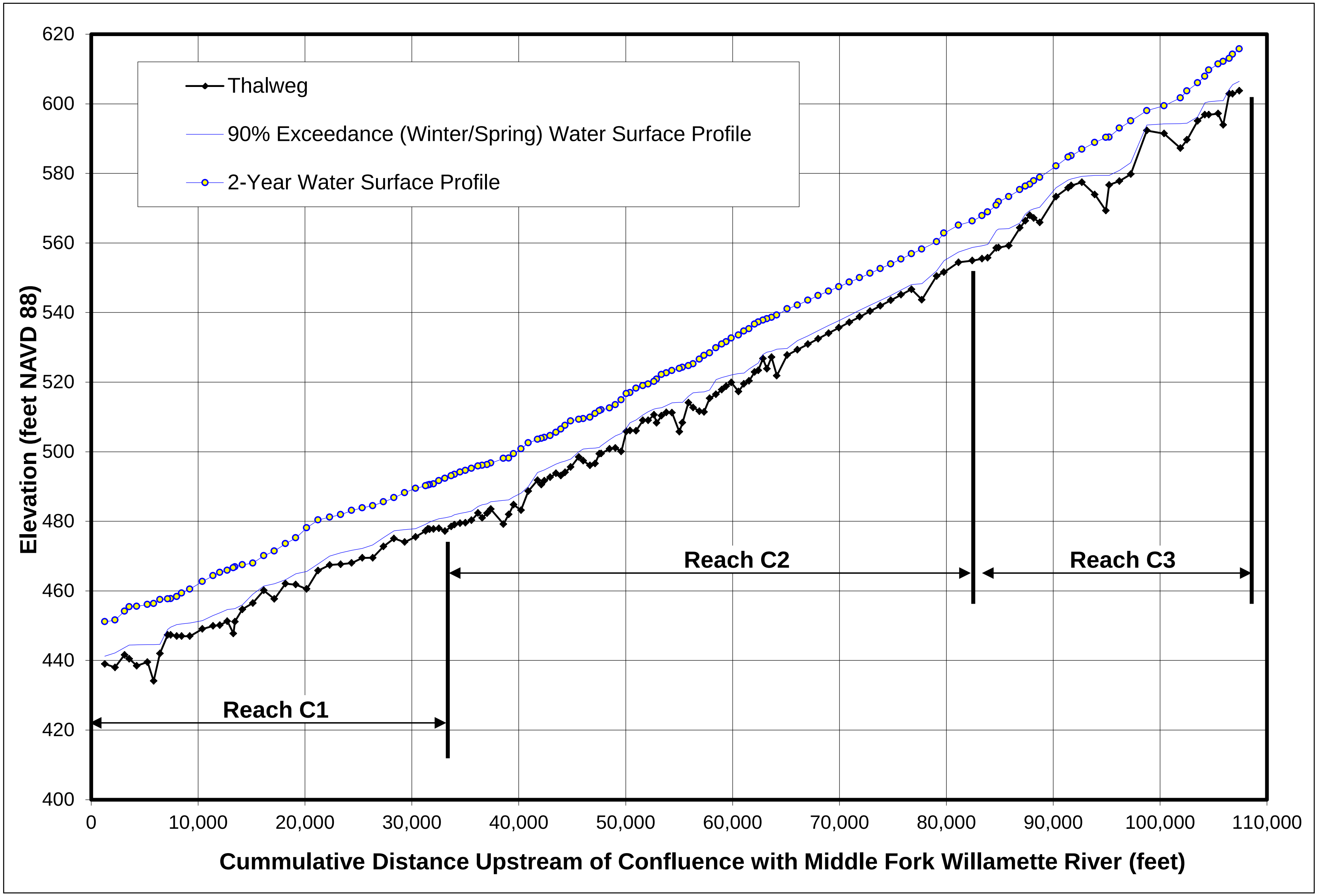


Figure 12. Without Project Conditions Water Surface Profiles for the Coast Fork Willamette River.

3.2.1.2 Middle Fork Willamette River Subbasin

The Middle Fork Willamette River drains an area of approximately 1,360 square miles. The hydrograph in the Middle Fork subbasin also reflects the seasonality of rainfall, with the majority of runoff occurring during the winter and low flows occurring during July and August. Typically a smaller, secondary peak occurs in May and June because headwater elevations are high enough to develop a seasonal snowpack and meltwater runoff. The majority of the study area is below 1500 feet and therefore, rainstorms are the dominant cause of runoff in the lower subbasin. A portion of the Lower Middle Fork Willamette River and the majority of the Little Fall Creek and Lost Creek Watersheds are above 1500 feet and are subject to rain-on-snow events. These events occur when warm rainstorms rapidly melt accumulated snow creating high runoff events (MFWWC 2002).

Flows in the Middle Fork have been controlled by the Lookout Point-Dexter, Hills Creek, and Fall Creek projects since 1954, 1961, and 1965, respectively. These dams are operated similarly in concert with the other Willamette system dams for flood risk management. Flood control operations at the dams have substantially decreased the magnitude and frequency of extreme high flow events in the lower Middle Fork Willamette River. Additionally, the dams have decreased the magnitude of channel forming flood events (USACE 2000). Flood frequency analysis conducted by the USACE-Portland District for the USGS Gage near Jasper (USGS 14152000) has shown that the 2-year return period flood event is 20,000 cfs for the regulated condition, as compared to 39,900 cfs for the unregulated condition (OSU 2007); see Table 5 for flows for various frequencies of occurrence under existing conditions. The bankfull flow and regulation goal at Jasper is 20,000 cfs.

Table 5. Middle Fork Willamette River Flow Rates for Range of Exceedance Values and Return Periods.

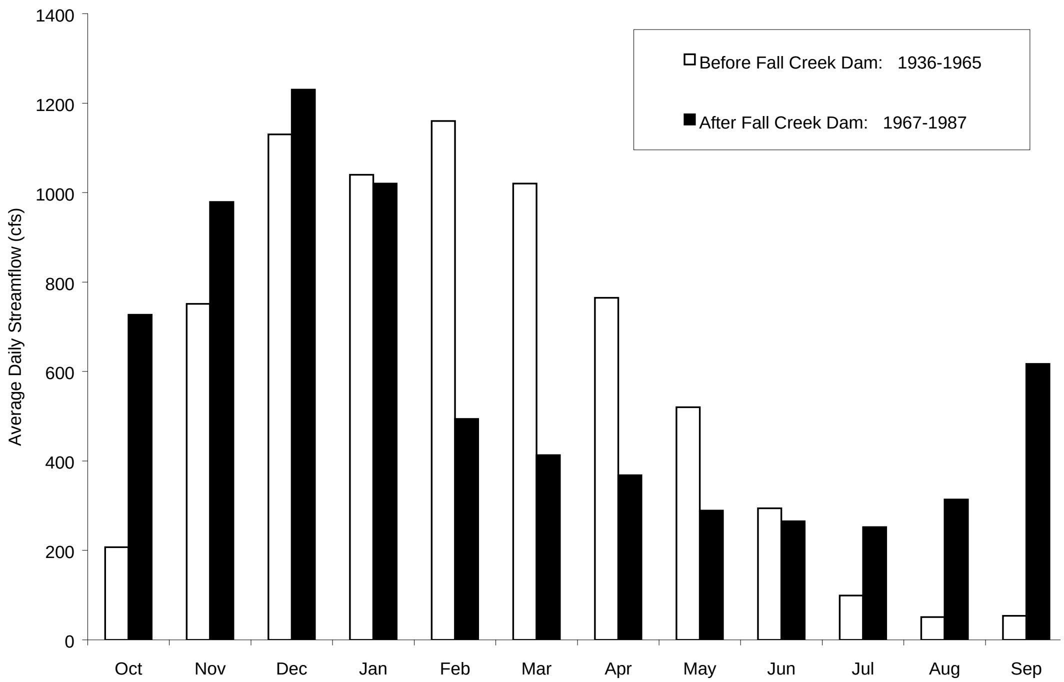
Flow Duration and Flood Frequency Ordinate	Flow Rate by Location (cfs)	
	Dexter Dam Outflows	Middle Fork near Jasper USGS Gage 14152000
95% Exceedance [a]	1,070	1,380
90% Exceedance [a]	1,150	1,530
75% Exceedance [a]	1,250	1,970
50% Exceedance [a]	2,550	3,670
25% Exceedance [a]	4,350	6,140
10% Exceedance [a]	7,930	10,300
5% Exceedance [a]	9,824	13,300
1.5-year Return Period [b]	12,000 [c]	20,000 [c]
2-year Return Period [b]	12,000 [c]	20,000
5-year Return Period [b]	12,000 [c]	20,000 [c]
10-year Return Period [b]	12,000	20,000
20-year Return Period [b]	12,000 [c]	20,000 [c]
100-year Return Period [b]	20,300	35,500

Notes:

a. Flow Exceedance Values from Winter/Spring Season Flow Exceedance Curve
b. Flood Frequency Values are for the Regulated Condition

c. Value Interpolated from USACE-Portland District Flood Frequency Curve

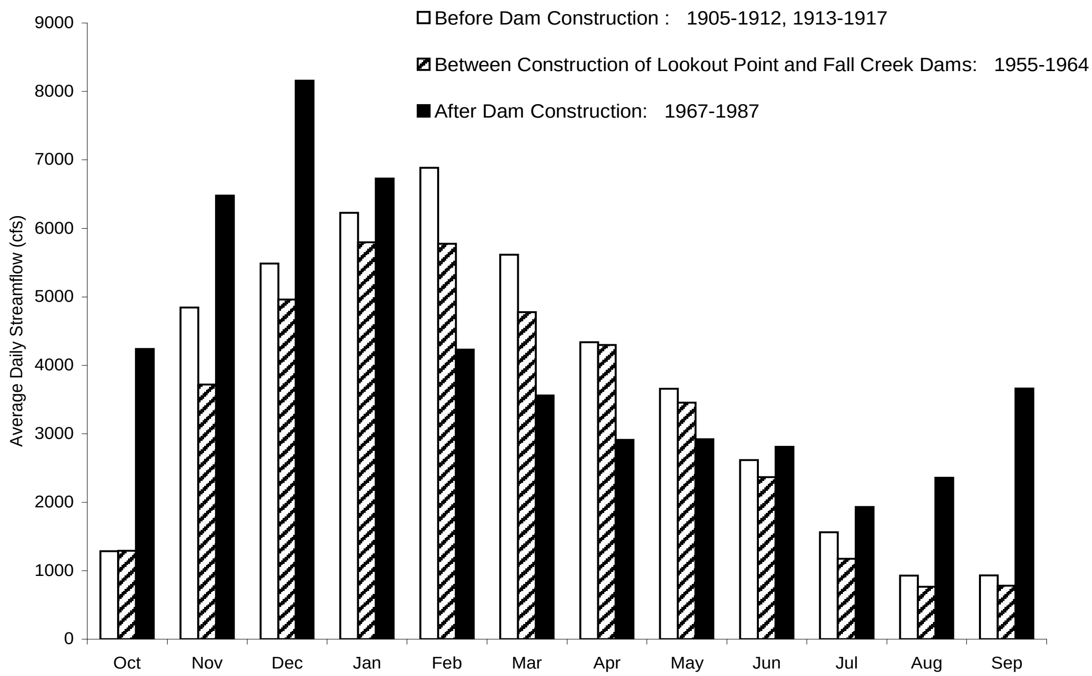
In general, dam construction resulted in higher summer and fall flows, and lower spring flows. Figures 13 and 14 illustrate the pre- and post-dam changes in average monthly flows below Fall Creek dam, as well as on the Middle Fork at Jasper after construction of all the Corps' dams in the subbasin. In the Middle Fork subbasin, flows are naturally lowest in the early fall.[1] The average daily flow at Dexter in September prior to dam construction was 846 cfs. Since construction, the average daily flow in September has increased to 2,760 cfs. Figure 15 shows the water surface profile in the lower Middle Fork.



Data from USGS gage 14151000 (USACE 2000a).

Figure 13. Average Monthly Flows, Fall Creek below Winberry Creek (below Fall Creek Dam)

[1] Data from U.S. Geological Survey (USGS) gage 14148000 (USACE 2000a). Note for Figures 9 to 13: average monthly flows were estimated for USGS gages before and after dam construction by using data reported in Moffatt and others (1990) or by using USGS daily streamflow data. Data for the year of dam construction were not included.



Data from USGS gage 14152000 (USACE 2000a).

Figure 14. Average Monthly Flows, Middle Fork Willamette at Jasper (below Fall Creek Dam)

The Corps is cooperating with The Nature Conservancy (TNC) and other entities to implement the Sustainable Rivers Program (SRP) on the McKenzie and Middle Fork Willamette Rivers. The goal of the SRP is to restore pre-dam riverine functions with the specific objectives to: 1) allow more winter flows to reach bankfull; 2) provide spring and fall flows that mimic natural hydrograph from rain events; and 3) provide lower and steadier summer and early fall flows that mimic more natural conditions (Scullion and Tackley 2011). The SRP flows have been on-going since 2008 and initial monitoring indicates the higher winter flows are allowing reconnections of existing side-channels, movement of large wood, and recruitment of gravel. The hydrograph under the SRP is shown in Figure 16. It is likely that these types of flows will be implemented for both the Middle Fork and the Coast Fork in the future. Flows will still be controlled to the bankfull maximum, as feasible, but pulsed flows that coincide with rain events will occur as feasible.

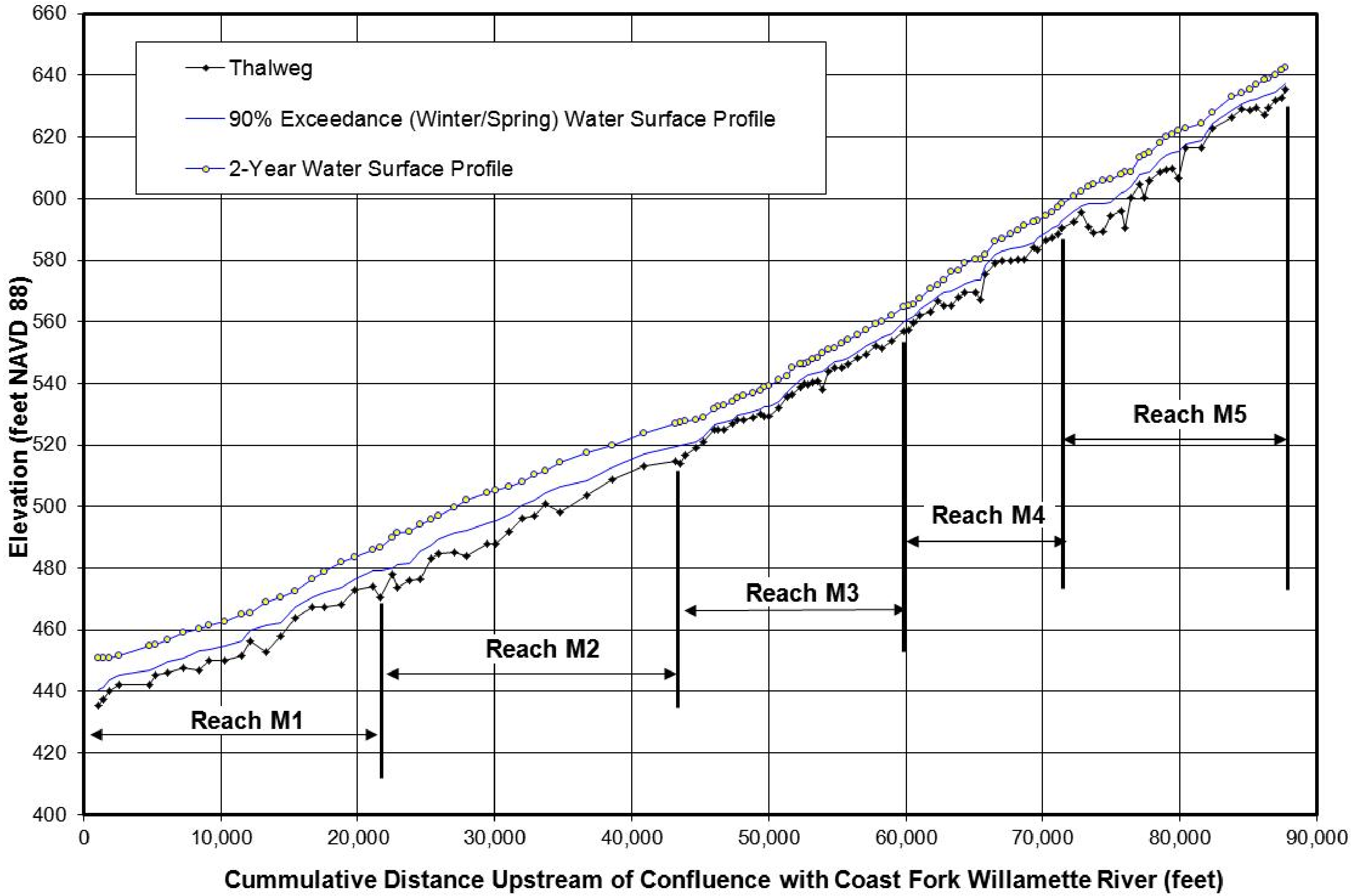


Figure 15. Without Project Conditions Water Surface Profiles for the Middle Fork Willamette River.

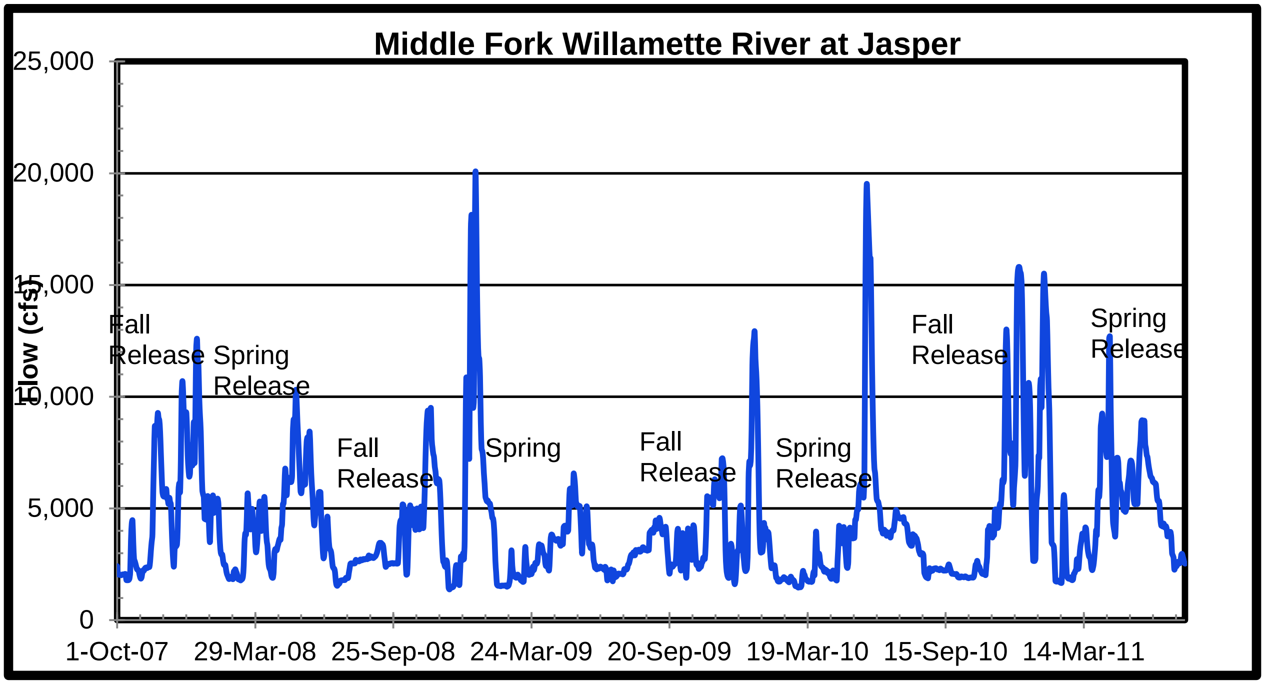


Figure 16. SRP Flow Releases since 2007.

The dominant land uses in the study area are forestry and agriculture/rural residential. These land uses combined with an associated road density have the potential to affect peak flows. Table 6 displays the results of an assessment conducted by the Middle Fork Willamette River Watershed Council to determine the potential land use impacts on peak flow runoff.

Table 6. Potential Land Use Impacts on Peak Flow Runoff.

Watershed	Risk from Forest Land	Risk from Ag/RR land		Risk from Forest Roads	Risk From Ag/RR Roads	Risk from Urban Roads
		Poor Condition	Good Condition			
Lower Middle Fork	Low	Mod	Low	Low	Low	High
Little Fall Creek	Low	Mod	Low	Low	Mod	NA
Lost Creek	Low	Mod	Low	Low	Mod	NA

In addition to the dams, many existing revetments constructed by the Corps affect the geomorphology of their respective streams. These revetments were intended to function in perpetuity and will remain in place, functioning as designed to control erosion, unless specifically requested by the landowner or operator to be removed or modified (CFWWC 2005). Figure 17 shows the Corps' revetments along the Coast and Middle Forks that constrain natural geomorphic processes. There are additionally a number of other revetments along both rivers installed by other public and private entities. The result of the altered hydrology and geomorphology in the study area due to dams and revetments has been the loss of habitat quantity and complexity in the rivers due to a simplification of the channel network. It is highly unlikely that any of the major dams in the subbasins will be removed due to the large flood-prone population downstream in Eugene and Springfield. Dam operations will be modified to some extent to comply with the recent Biological Opinions (NMFS 2008a; USFWS 2008), but continued simplification or reductions of habitat is expected because the dams are required to reduce flood flows and are also likely to dampen channel forming flows.

Some change in the operation of the Coast and Middle Forks dams is expected in the future. Since the 1999 listing of salmon and steelhead as threatened under the ESA, the Corps has made significant adjustments in the operation of the Willamette Projects to better meet the needs of aquatic species. In particular, the initiation of mainstem Willamette River springtime (April-June) flow augmentation targets have resulted in significant changes in the timing and volume of storage in the reservoirs and downstream releases. The Corps is continuing to work with state and Federal fish management agencies to adjust the operational regime of all of the dams within the Willamette Project. In addition to working with the Nature Conservancy of Oregon under the SRP, the Corps is implementing flows and water quality improvements under the requirements of the recent Biological Opinions (NMFS 2008a; USFWS 2008). Additionally, the Cities of Cottage Grove and Creswell are developing plans to withdraw surface water from the Row River and the Coast Fork, respectively, to accommodate future growth and provide cleaner water to their customers. It is likely that water withdrawals for municipal and industrial use will increase over time as the population increases, although agricultural usage may decline somewhat. However, even with increased demand for municipal and industrial water supply, minimum flows will still be required in the rivers from both the State of Oregon and per the recent Biological Opinions (NMFS 2008a; USFWS 2008). This project will not affect water supply or instream flows, except for the potential for incidental benefits to minimum flows as a result of groundwater discharge into the river that may result from additional floodplain connections and groundwater recharge.

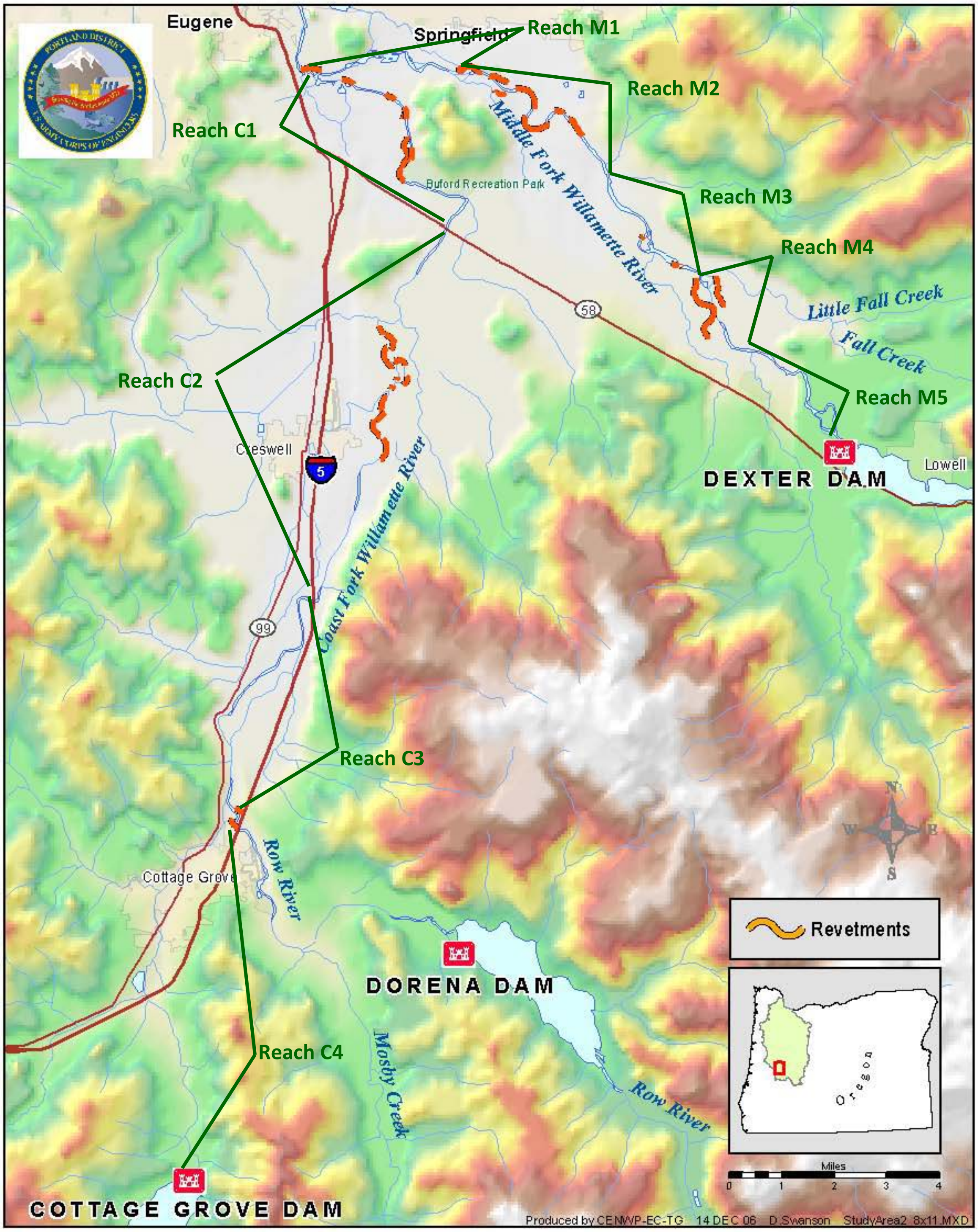


Figure 17. Corps' Revetments along the Coast and Middle Forks Willamette River.

NOTE: Revetments occur primarily in reaches C1, C2, M2 and M4 where channel avulsion and braiding were most predominant.

3.2.2. Geomorphology

Dykaar (2005) conducted an assessment of the status and trends of river-floodplain habitats downstream from Corps' dams in the Coast Fork and Middle Fork subbasins. This section summarizes the results of Dykaar's study. Representative reaches were chosen to assess the status and trends of habitats since the 1930s using geomorphic indicators as visible on historical aerial photography.

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

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

3.2.2.1 Geomorphic Indicators of Habitat Function

Five geomorphic features were used by Dykaar (2005) in the analysis of the Coast and Middle Fork study reaches: main channel, islands, barforms (gravel), avulsions, and large woody debris jams.

- **Main channel**. The main channel of a river can change over time due to channel migration. The rate of channel migration is related to the erosion and deposition of bars, floodplain deposits and wood. Avulsions (a rapid shift in channel position) create secondary channels with associated shallow-water habitats and oxbow lakes.
- **Islands**. Islands naturally form from bars and may coalesce with the bank and floodplain yielding numerous habitat types such as high and low flow secondary channels, backwaters, lakes and smaller ponds, and floodplain woodland.
- **Barforms**. Gravel supplies the material to construct almost all alluvial river-floodplain habitat types. The amount of bare gravel visible in any given year is a precursor to future habitat creation (bar/island/floodplain).
- **Avulsions**. An avulsion is a rapid change in channel alignment (an event) that can create additional channel length, side channels, and habitat diversity.
- **Large woody debris jams**. Large wood, particularly root wads, increase habitat diversity and can be a catalyst for gravel bar development.

The Coast and Middle Fork Willamette Rivers are medium energy, gravel-bedded streams, and their natural fluvial processes are broadly similar. Within-channel bars appear to be the dominant floodplain landform and habitat for primary succession of important riparian species (i.e. cottonwoods). The interlinked development of bar(s) and erosion of near banks, the filling of channels, and establishment and growth of pioneering trees results in islands that eventually coalesce with older floodplain or other islands. Floodplain appears constructed from coalesced bars and islands, meander lobe cut-offs (Middle Fork only) and filling of channels. Off-channel aquatic features result from incomplete channel filling.

The differences between Coast and Middle Fork habitat formation appear to be due to the relative importance of certain fluvial processes and landforms. Notable differences between the streams are discussed below.

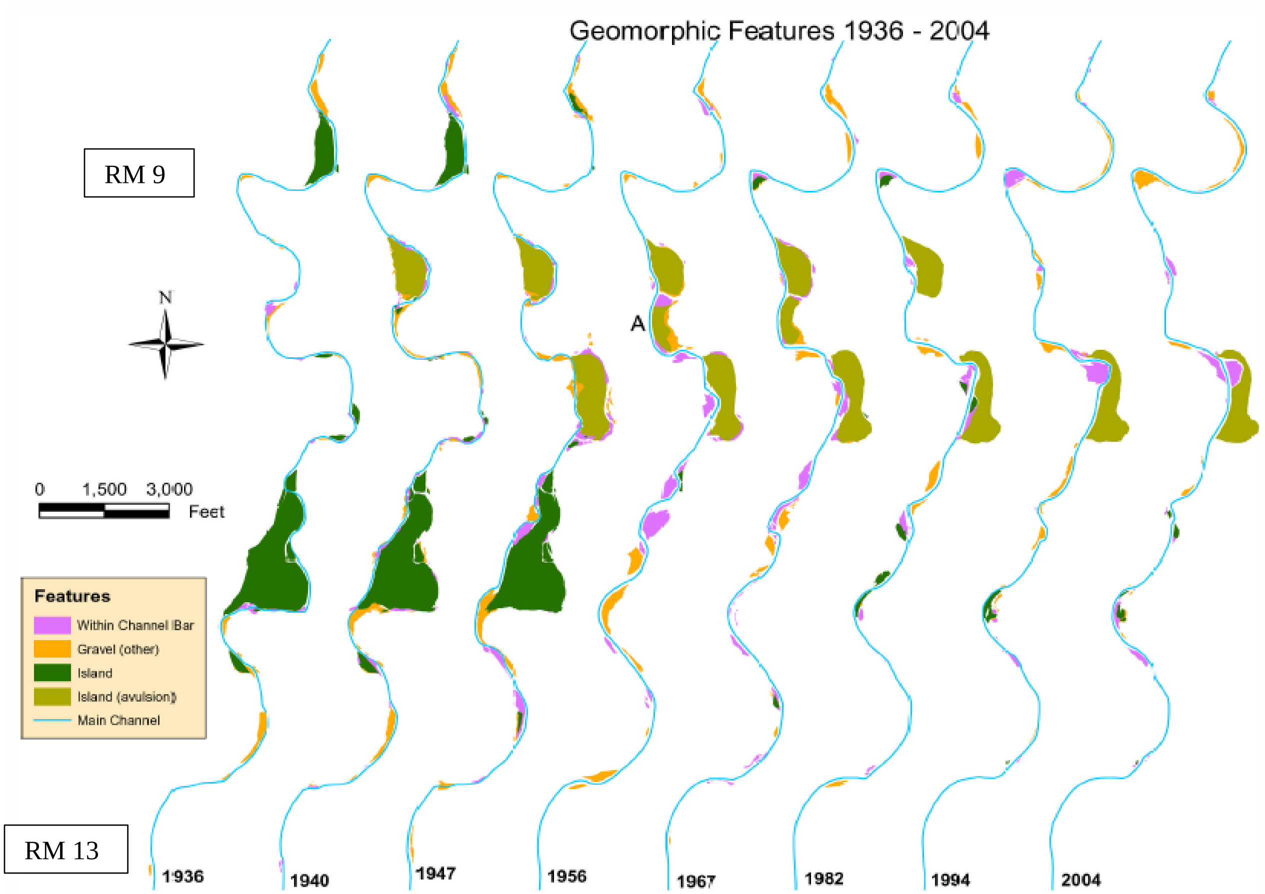
Coast Fork

1. Pre-dam Coast Fork fluvial processes created relatively long avulsions through mature floodplain.
2. Avulsions yielded new straighter and higher gradient channels whose subsequent self-adjustment to a lower gradient produced bars first, then islands and floodplain.
3. Abandonment of the old channel following avulsion produced side channels and ox-bows and linear patches of woodland as channels filled.
4. Coast Fork floodplain woodland was patchy in aerial photo reviews, with large open areas, whereas the Middle Fork floodplain forest had mostly a closed canopy. Euro-American settlement had been occurring in the Willamette Valley for nearly 100 years prior to the earliest photography available and it is unclear if the observed lack of tree canopy is natural. Whether natural or not, a lack of trees in the floodplain likely increased the ability of the river to avulse by reducing the resistance of the floodplain to erosion. Riprap has been placed on banks in multiple locations, likely to prevent these large-scale avulsions.

Middle Fork

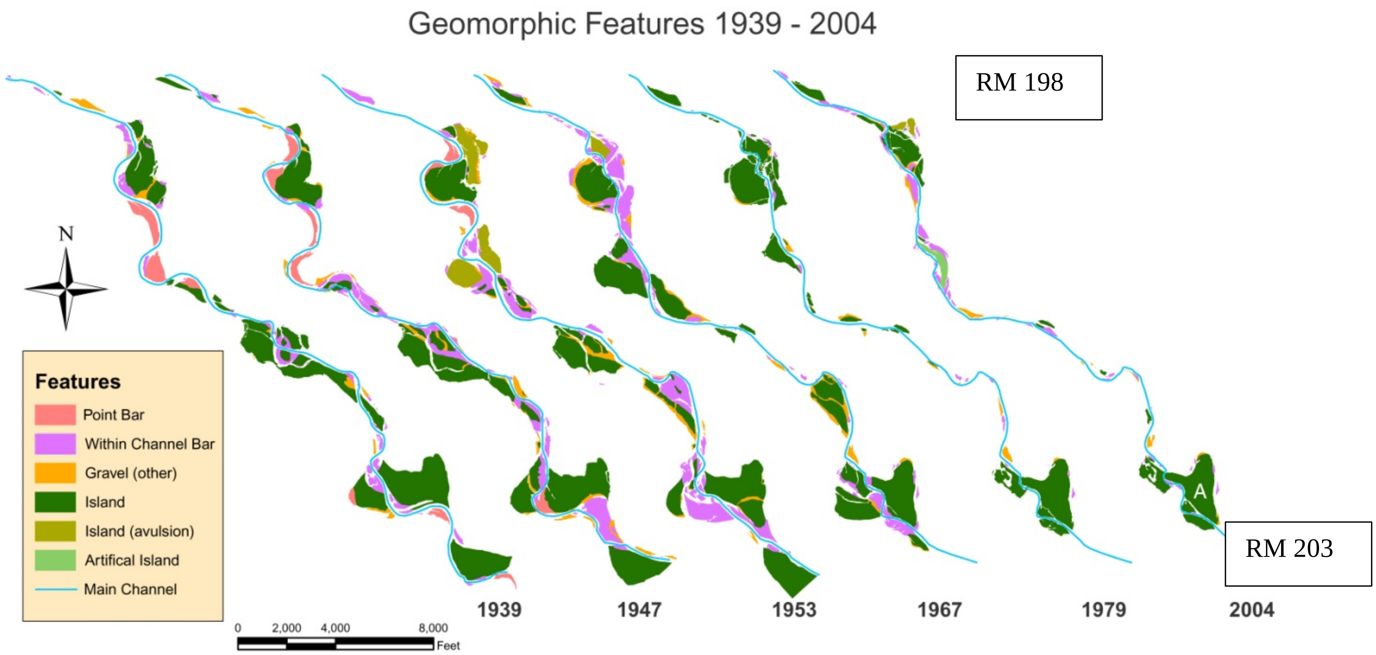
1. Pre-dam Middle Fork fluvial processes created many large meander loops.
2. Meander loop construction created conditions for subsequent cut-off avulsions through the meander lobe. The new straighter and higher gradient channel would rapidly generate barforms, lengthening its path. The cut-off lobe would merge with mature floodplain adding a patch of woodland and aquatic features.
3. The pre-dam river built broad sheets of within-channel gravel composed of overlapping barforms.

Following dam and revetment construction on both the Coast and Middle Forks, channel migration and changes in channel and floodplain morphology declined. (Figures 18 and 19).



Pre-dam periods are 1936, 1940, 1947. Source: Dykaar 2005.

Figure 18. Comparison of Geomorphic Features within Reach C2, Coast Fork Willamette River (RMs 8-13)



Pre-dam periods are 1939, 1947, 1953. Source: Dykaar 2005.

Figure 19. Comparison of Geomorphic Features in reaches M4 and M5, Middle Fork Willamette River (RMs 198-203)

Important changes from the pre-dam to post-dam conditions are discussed below and in Table 7.

- Main channels of the Coast Fork and Middle Fork were found to be shorter in the post-dam years, about 6% and 10% shorter, respectively.
- Avulsions on both rivers were greatly reduced in post-dam years. In the pre-dam era on the Coast Fork, avulsion rate was 344 feet/year while post-dam rate was 22 feet/year, a reduction of 94%. Pre-dam avulsions on the Coast Fork appeared to be the primary channel migration mechanism. On the Middle Fork, in the pre-dam era, three avulsions were identified, cutting about 4,011 feet of total new channel. This amounts to an average rate of about 670 feet of new channel cut per year. The immediate post-dam rate (1953 to 1965) was 71 feet/year (a 62% reduction) while the post-dam rate from 1965 to 2004 was zero.
- The amount of exposed gravel in the Coast Fork was down 20% from a pre-dam average. On the Middle Fork, exposed gravel was down 70% from a pre-dam average. Most areas of formerly exposed gravel have become vegetated islands or vegetated bank features. Formation of meander loops with associated point bars has stopped on the Middle Fork in the post-dam era.
- Total island area on the Coast Fork was down 74% from a pre-dam average by 2004. On the Middle Fork, total island area was down 57% from a pre-dam average; the overall rate of island loss exceeds formation rate as island area appears to be continuing to decline at a rate of about 2.53 acres per year. Rates of island formation (gravel deposition and colonization/growth of trees) were down dramatically in the post-dam era. The most recent average rate of island formation measured from 1979 to 2004 is only about 10% of the pre-dam level from 1947 to 1953.

Table 7. Summary of the Percent Change in Geomorphic Indicators

River	Percent Change from a Pre-dam Average						
	Main Channel Length	Avulsion Rate		Total Gravel Area	Total Island Area	Rate of Island Formation	Large Wood Jams
		1st Order	2nd Order				
Coast Fork	-6%	-94%	-100%	-20%	-74%	NA	NA
Middle Fork	-10%	-100%	-95%	-70%	-57%	-91%	-100%

Note: Values used to calculate a percent change are from the most recent time period available for each category and river. NA = not applicable. Source: Dykaar 2005

In summary, Dykaar's investigation (2005) found that the rate of formation of new riverine and floodplain habitats has been reduced significantly in the post-dam time period for both the Coast and Middle Fork study reaches. The natural ecosystem was highly dynamic with many habitat types forming simultaneously over extended areas of the floodplain and time periods. It is also important to note that while the construction and operation of the dams in the Coast and Middle Forks dramatically changed the hydraulic and sediment regimes, a second key activity of the installation of bank protection/revetments also contributed to the reduction of channel migration. Other activities such as the removal of floodplain vegetation, building of structures in the floodplain, gravel mining and removal of wood have also reduced the rate of channel migration and habitat formation. Human activities have significantly reduced the fluvial processes that cause habitat formation, which has diminished the capacity of both rivers to support native species.

3.2.2.2 Geomorphology by Reaches

The high priority reaches C1, C3, M1 and M2 are described in more detail in this section based on a review of historic aerial photos and site visits.

Reach C1 – RM 0 to RM 6.4

Reach C1 is the downstream most reach on the Coast Fork and extends from the Middle Fork confluence, upstream for over 6 miles. It has the shallowest gradient of all the reaches studied at 0.0013 (~ 7 feet/mile). This area has historically been quite active geomorphically, with the presence of multiple channels. It appears to have been a depositional area which is likely why it has historically been an area heavily mined for gravel. The left bank of the Coast Fork in this reach is an area that has several gravel pits that have been protected via bank protection on the Coast Fork as well as some gravel pits that have been captured (likely in 1996) and incorporated into the floodplain and side channel features of the Coast Fork.

Reach C3 — RM 15.6 to RM 21

The slope of the Coast Fork in Reach C3 is moderately low gradient at 0.0019 (~ 10 feet/mile). Through this reach the Coast Fork channel planform changes considerably. From approximately RM 17.9 to RM 18.6, the river is a straight and single channel with a total absence of channel features such as bars, islands and side channels. The river appears to have been channelized in this reach. Below RM 17.9 the channel splits into two main side channels around a mid-channel island. The mid-channel island is laced with numerous small chutes. The two primary side channels rejoin at RM 17.3 to form a single channel with smaller islands and bars. Review of aerial photos spanning the period from 1974 to the present indicate that this has been the form of the channel over the past 40 years. The gravel mining activity on the left bank appears to have been prior to 1974, whereas the mining on the right bank appears to have been ongoing from prior to 1974 into the 1990s. There is some riprap along the toe of both banks as well as high ground that appears to have been fill material placed for roadways or other access features during the gravel mining period.

Reach M1 RM 187 to RM 191

Reach M1 is the downstream-most reach on the Middle Fork and extends 4 miles upstream from the confluence with the Coast Fork. It has an average gradient of 0.0018 (~9 feet/mile), which is slightly steeper than the adjacent Coast Fork with a gradient of 0.0013 (~7 feet/mile). As previously described, the confluence area of the Middle and Coast Forks of the Willamette River is a depositional area with multiple channel braids. Much of the floodplain area has been gravel mined in the reach. A review of historic aerials indicates that extensive gravel mining occurred first in the river channel and then a berm was constructed to isolate the primary gravel mining from the river in the 1970s.

Reach M2 RM 191 to RM 194

The average slope of Reach M2 at 0.0020 (~10 ft/mi) is only slightly steeper than that of the downstream Reach M1 at 0.0018 (~ 9 ft/mi). Similar to the other priority reaches, this reach has been mined for gravel. Review of historical aerials show multiple channel braids and a large expanse of open gravel bed prior to the 1960s. The remnant of one of these channels is evident on the back side (south) of the existing left bank gravel pits. Over the decades and under the influence of the water and sediment regime after dam construction, the channel has evolved into a single thread with limited bars and islands. Observations of this reach after high flows in January 2012 indicate that localized erosion and deposition of gravel is still occurring at flows at or above bankfull. Significant deposition occurred at the boat ramp at Clearwater Park on the right bank, and the left bank had localized erosion.

3.2.2.3 Future without Project Conditions

It is likely that the river channels would continue to become more predominantly single thread channels in the future without project condition. This is due to a reduced supply of sediment from the upstream watershed due to dams, vegetation growing on existing bars and islands that reduces that ability of the river to erode the bars, a reduction in peak flows that tends to confine the flows within the bankfull channel and reduce channel migration and avulsion, and bank armoring that further prevents channel migration. Several former gravel pits have been captured over the past decades and more could naturally be captured during flood flows in the future. While this would tend to reconnect former floodplain areas it is difficult to predict when or how this would occur. The benefits that could be realized to the ecosystem by the capture of these off-channel habitats could sporadically occur, but would be much less than what could occur under the proposed with project condition.

Without Federal action, it would be very difficult for stakeholders in the subbasins to undertake large-scale floodplain restoration that would affect the rivers on a geomorphic scale. While localized habitats would continue to be restored (especially riparian revegetation), likely in multiple locations, the stakeholders in the subbasins do not have the funds or means to provide this scale of restoration. The future-without project geomorphic condition will likely continue to worsen, by continuing the trend towards single-thread channels with limited off-channel and in-channel diversity, even with actions taken by the Corps specific to compliance with ESA requirements and the recent Biological Opinions (NMFS 2008a; USFWS 2008).

3.2.3. Water Quality Conditions

The Oregon Department of Environmental Quality (ODEQ) maintains ambient water quality monitoring sites throughout Oregon to provide representative statewide geographical coverage. Trends in water quality are measured using the Oregon Water Quality Index (ODEQ 2008). The Index analyzes a defined set of water quality parameters including temperature, dissolved oxygen, biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorous, and fecal coliform. The Index produces a score describing general water quality. Index scores are grouped into the following categories: less than 60 (very poor), 60-79 (poor), 80-84 (fair), 85-89 (good), and 90-100 (excellent).

In addition, in September 2006, EPA approved the ODEQ Total Maximum Daily Load (TMDL), for the Willamette Basin. The TMDL focuses on the three most common 303(d)-listed pollutants in the basin: bacteria, mercury, and temperature. A TMDL can be thought of as a tool for implementing water quality criteria and is based on the relationship between pollution sources and in-stream water quality conditions. The Coast Fork and Middle Fork Willamette rivers and some of their tributaries do not meet water quality standards for some parameters (Figure 20).

3.2.3.1 Coast Fork Willamette River

The ODEQ ambient water quality monitoring site on the Coast Fork Willamette River is located at Mt. Pisgah Park (RM 3.0). This site scored 87 points on the Oregon Water Quality Index (ODEQ 2008) and is ranked in the ‘good’ category.

Within the study area, the mainstem of the Coast Fork is listed on the 303(d) list for iron and Camas Swale Creek is listed for dissolved oxygen (DEQ 2010). Dorena Lake is newly listed for aquatic weeds or algae. Three health advisories issued were by Oregon Harmful Algae Bloom Surveillance (HABS) program based on cell counts or toxicity levels.

There are five individual National Pollutant Discharge Elimination System (NPDES) permitted point sources in the subbasin. Two discharge directly into the Coast Fork Willamette River downstream of Cottage Grove Reservoir. In addition, there are 38 general NPDES permits in the subbasin, consisting of 21 stormwater permits. Stormwater sources are not considered to have reasonable potential to contribute to exceeding temperature criteria (ODEQ 2006).

3.2.3.2 Middle Fork Willamette River

The DEQ ambient water quality monitoring site on the Middle Fork Willamette River is located at Jasper Bridge (RM 195.0). This site scored 93 points on the Oregon Water Quality Index and showed an increasing trend in the score over the past 10 years (ODEQ 2008). This site is ranked in the ‘excellent’ category.

The ODEQ (2006) states that the dissolved oxygen 303(d) listings were not addressed in the Willamette Basin TMDL. In the study area, Anthony Creek and Lost Creek are listed for dissolved oxygen on the 303(d) list (DEQ 2010). The listings occurred in 2002 and there was not sufficient time to collect data for the TMDL analysis.

The Dexter Reservoir, Hills Creek Lake, and Lookout Point Lake, have all been newly listed on the 303(d) list for aquatic weeds or algae (ODEQ 2010). Health advisories for each of these lakes were issued by Oregon Harmful Algae Bloom Surveillance (HABS) program based on cell counts or toxicity levels.

In the Middle Fork subbasin, point source discharges also play only a minor role in stream heating. There are six individual NPDES permitted sources in the subbasin. Three sources discharge directly into the mainstem Middle Fork Willamette River. The remaining three discharge year-round and are classified as minor discharges; two are domestic discharges into the North Fork of the Middle Fork and the mainstem Middle Fork, and the third is an individual discharge into the Mill Race in Springfield (lumber company). In addition to these individual NPDES permits, there are 14 general NPDES permits in the subbasin that include 12 storm water permits (ODEQ 2006).

Water quality conditions in the subbasins are expected to slightly improve in the future without-project condition, with the implementation of the TMDLs and other regulations and programs. To implement the temperature TMDL, ODEQ will look to permit holders, local governments, land managers, and others to develop and implement TMDL Implementation Plans, which will describe the strategies and timelines needed to meet the temperature load allocations set in the TMDL (ODEQ 2006). The Corps may implement temperature control facilities on the Middle Fork dams to allow selective withdrawal to more effectively mimic pre-dam water temperatures. However, this would tend to increase summer and fall temperatures, thus potentially working against the TMDL requirements. Additionally, climate change may reduce winter snowpack in the Cascades, thus reducing summer/fall flows, which could exacerbate temperature problems (ODFW 2011, Climate Impacts Group 2006).

To implement the mercury TMDL, ODEQ will look to permit holders, local governments, land managers, and others to begin reducing the amount of mercury released into the environment. Permitted point sources will likely need to reduce mercury emissions. To help minimize the movement of mercury into waterways, soil erosion from urban, agricultural and forested landscapes will be controlled through a variety of mercury reduction plans (ODEQ 2006).

Until a TMDL for dissolved oxygen is developed, riparian protection and restoration measures developed to address temperature concerns also will benefit dissolved oxygen levels because dissolved oxygen concentrations are directly related to water temperature.

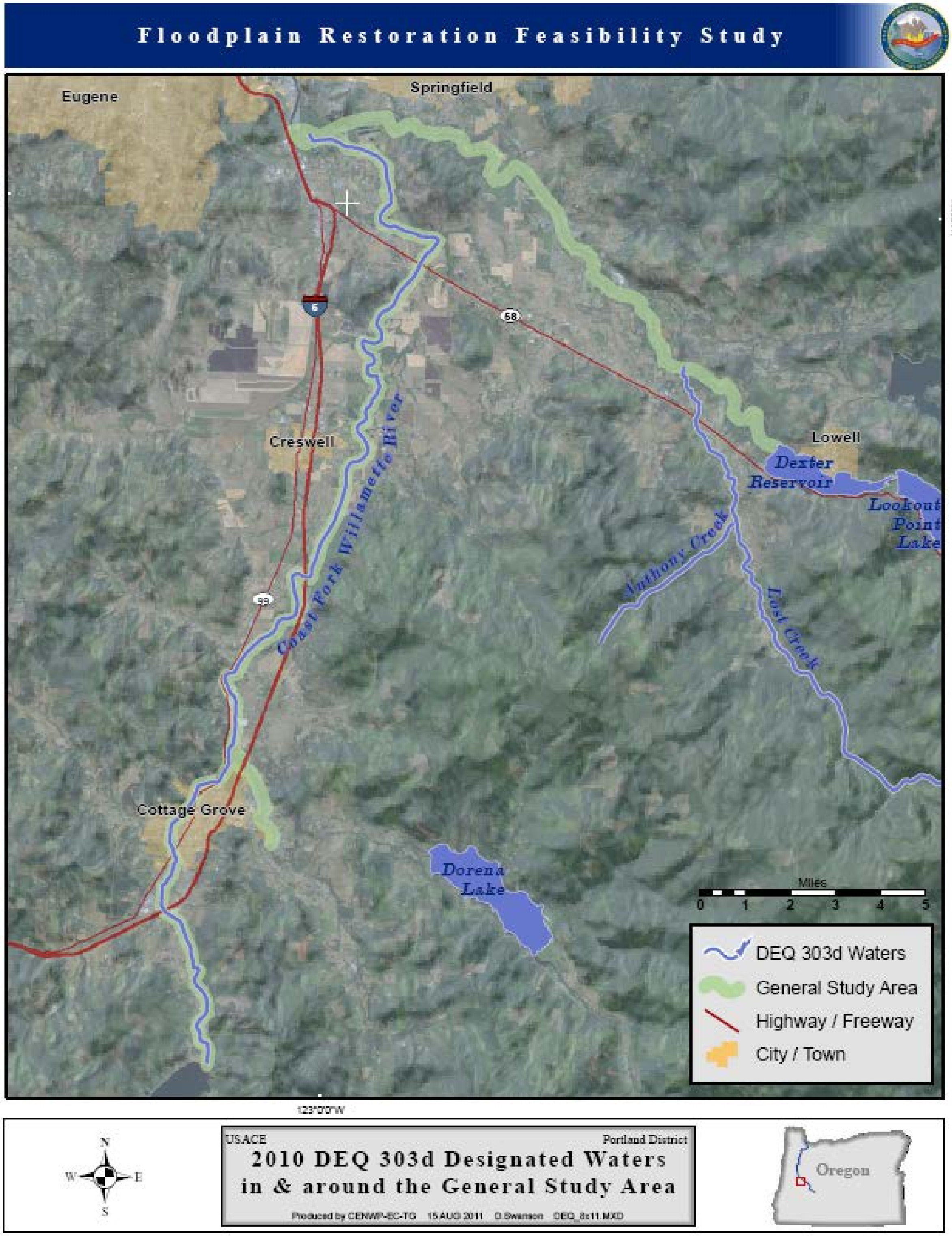


Figure 20. Oregon DEQ Designated 303(d) Waterbodies in the Study Area.

3.2.4. Fish and Aquatic Habitat

3.2.4.1 Fish

A number of native and non-native fish species are present in the Coast and Middle Fork subbasins, including spring Chinook salmon, rainbow trout, cutthroat trout, bull trout, mountain whitefish, large-scale sucker, sculpins, longnose dace, leopard dace, Northern pike minnow, Oregon chub, peamouth chub, redside shiner, speckled dace, three-spine stickleback, sand roller, Pacific lamprey, Western brook lamprey, river lamprey, common carp, largemouth bass, and smallmouth bass (Hulse *et al* 2002).

Federally listed endangered, threatened, and species of concern in the Coast and Middle Fork subbasins are focal fish species for this feasibility study (Table 8). Cutthroat trout also was selected as a focal species in the Willamette Subbasin Plan (NPCC 2004a), and will be considered a focal species in this study because of their broad distribution and value as an indicator of habitat conditions.

Table 8. Focal Fish Species in the Middle and Coast Fork Subbasins

Species	Federal Status
Spring Chinook Salmon Upper Willamette River ESU *(Oncorhynchus tshawytscha)*	Threatened
Bull Trout (*Salvelinus confluentus)*	Threatened
Oregon Chub (*Oregonichthys crameri)*	Threatened
Malheur mottled sculpin (*Cottus bairdi ssp.)*	Species of Concern
Pacific lamprey (*Lampetra tridentate)*	Species of Concern
Coastal cutthroat trout (*Oncorhynchus clarkii spp.)*	Species of Concern

Altered natural watershed processes, modified riparian and aquatic habitat, and limited access to historical spawning and rearing areas in the Coast Fork and Middle Fork subbasins have affected the productivity, capacity, and diversity of resident cutthroat trout, bull trout, and spring Chinook populations. In addition, Oregon chub have lost habitat as backwater and off-channel areas have disappeared as a result of changes in seasonal flows associated with the construction of Corps' dams in the subbasins (NPCC 2004a).

3.2.4.1.1 Coast Fork Willamette River

Focal species present in the Coast Fork subbasin include spring Chinook, Oregon chub, Malheur mottled sculpin, Pacific lamprey, and cutthroat trout.

Spring Chinook: Native spring Chinook salmon existed, but were never likely abundant, in the Coast Fork subbasin (USACE 2000a). The Dorena and Cottage Grove dams currently block upstream access to spawning areas, although significant suitable spawning habitats were historically present in the lower river (McIntosh, *et al.* 1989). Low flows and warm water discharge from the two dams are believed to reduce the productivity of Chinook salmon below the dams (USACE 2000a).

Oregon Chub: Oregon chub were found historically in the Coast Fork Willamette River (NPCC 2004a). Three records exist for chub presence near Cottage Grove (1950), Saginaw (1967), and Dorena (1958) in the Coast Fork subbasin. Currently, there is one natural and one introduced population near Creswell and in the upper Layng Creek drainage, respectively. The presence of nonnative predatory fish and bullfrog, and the loss of off-channel habitats limit chub recovery. No critical habitat has been designated in the Coast Fork subbasin.

Malheur Mottled Sculpin: Sculpins are most abundant in clear, rapidly flowing freshwater streams, and are usually found in association with trout, dace, and other fish requiring clean water and low temperatures. Sculpins are bottom-dwellers, and seldom swim more than a few centimeters above the substrate. They are most commonly found resting beneath flat rocks. They are carnivorous, and prey primarily on insect larvae, crustaceans, and fishes (NANFA 1982). The Malheur mottled sculpin is mostly found in smaller tributaries and disconnected streams in Malheur, Snake and Columbia Basins.

Pacific Lamprey: Pacific lamprey are thought to have historically occurred wherever salmon and steelhead populations occurred. Their distribution has been reduced due to impassable dams and other barriers. Lamprey spawn in gravel bedded streams between March and July. Lamprey hatch in approximately 19 days and the ammocoetes drift downstream to areas of low velocity and fine sediments. They may reside for several years before metamorphosing into juveniles that move downstream and migrate to the ocean. Adults are parasitic on salmonids and other fish in the marine environment. After 1 to 3 years they return to freshwater to spawn. (USFWS 2010c)

Cutthroat Trout: Cutthroat trout have the widest distribution of any trout in the Willamette Basin and are the only trout native to west side tributaries draining the Coast Range (NPCC 2004a). The primary life history form of cutthroat trout above Willamette Falls, including the Middle Fork and Coast Fork subbasins, is the resident form with a migratory life history (NPCC 2004a). Compared to historical conditions, there have been dramatic changes to the distribution of cutthroat trout in the Willamette Basin, and the ability of the habitat to support abundant populations. Dams, road crossing culverts, and other fish passage barriers have limited the distribution of cutthroat and their access to spawning and rearing habitat. Historically, lowland streams were characterized by abundant side channels, large wood jams, and other complex and diverse habitats, and provided the most productive fish habitat.

3.2.4.1.2 Middle Fork Willamette River

The focal fish species currently or recently present in the Middle Fork subbasin include spring Chinook salmon, bull trout, Oregon chub, Malheur mottled sculpin, Pacific lamprey, and cutthroat trout. Table 8 shows the life stage timing for ESA-listed fish species in the Middle Fork subbasin, which is similar to the Coast Fork timing.

Spring Chinook: The Middle Fork subbasin was a major natural production area for spring Chinook salmon in the Willamette Basin. In 1947, the spring Chinook run into the Middle Fork Willamette was estimated to comprise 21% of the spawning population above Willamette Falls (USACE 2000a). Dexter and Fall Creek dams blocked approximately 80% of habitat historically accessible to spring Chinook salmon in the Middle Fork subbasin (ODFW 1990; USACE 2000a). Table 9 highlights the historical and current distribution of spring Chinook in the Coast Fork and Middle Fork subbasins.

Historically, spring Chinook salmon in the Middle Fork subbasin spawned in Fall Creek, Salmon Creek, the North Fork of the Middle Willamette River, Salt Creek, and the mainstem Middle Fork Willamette River (Parkhurst *et al*., 1950; NPCC 2004a). Mattson (1948) estimated that 98% of the 1947 run in the Middle Fork system spawned upstream of the Lookout Point Dam site. Construction of these dams restricted the population to only 20% of its historically accessible area, below Dexter/Lookout Point, which was not generally considered to have suitable spawning habitat (McIntosh *et al*., 1995). In 1998, 10 redds were observed in the reach between the town of Jasper and Dexter Dam, which was not used for spawning before the dams were built (Lindsay *et al*., 1999).

According to the Willamette Subbasin Plan (NPCC 2004a), hatchery Chinook were first released in the Middle Fork subbasin in 1919. The Willamette Hatchery, built as mitigation for lost production above

Corps' dams, is located on the Middle Fork near the town of Oakridge. Stock for the Willamette Hatchery comes from collection facilities at Dexter and Foster Dams on the South Santiam River (USACE 1997).

ODFW (1995) concluded that the native spring-run population was extinct, although some natural production by hatchery-origin adults occurs. Of the 260 carcasses from the Middle Fork Willamette (including Fall Creek), 11 (4%) were estimated to be naturally produced (Schroder *et al*., 2003).

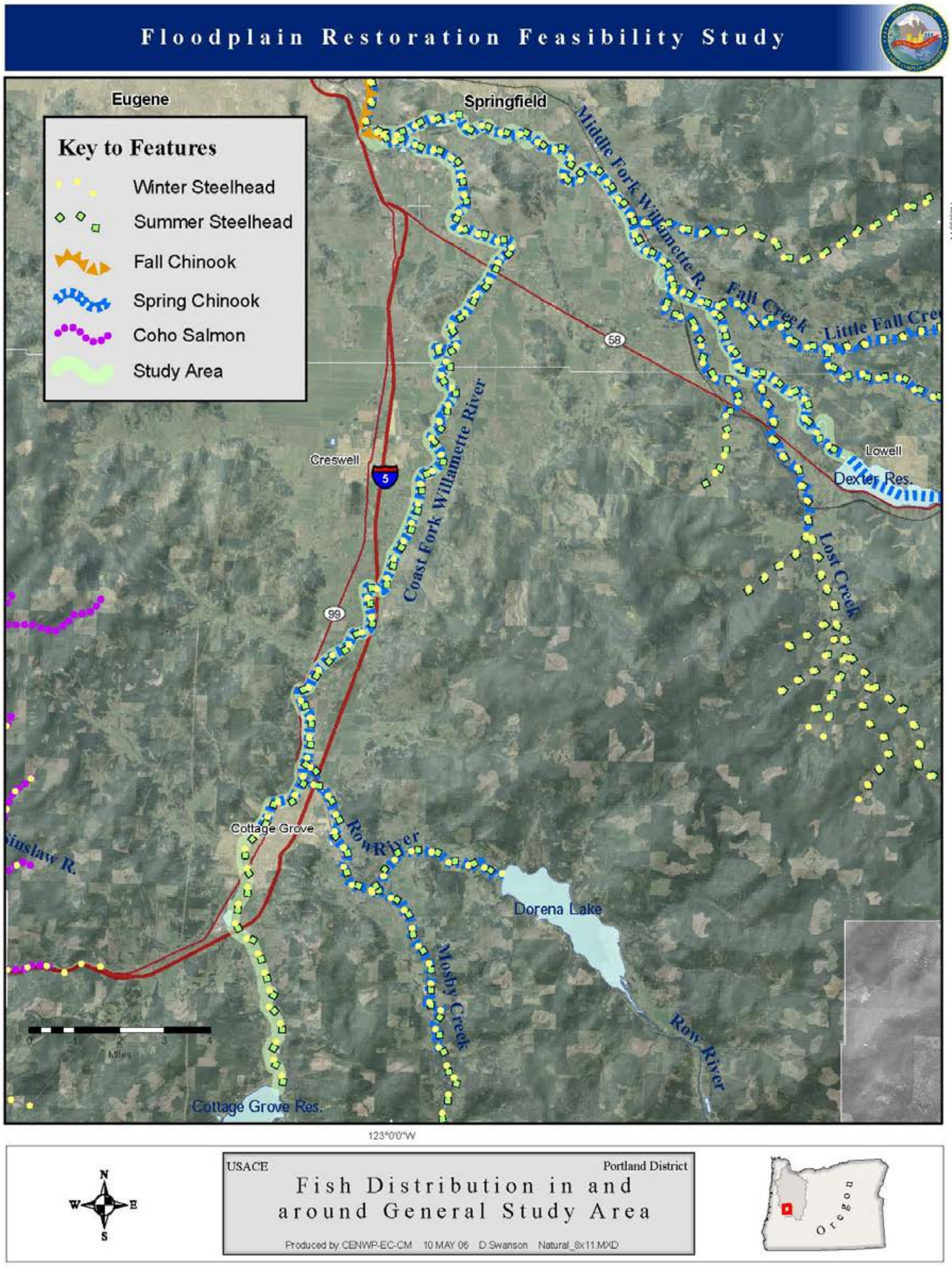


Figure 21. Salmonid Distribution in the Study Area.

Table 9. Life Stage Timing for ESA-listed Fish Species, Middle Fork Subbasin

Species	Life Stage/Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring Chinook	Upstream Migration					///	■	■	///	///			
	Spawning									■	///		
	Incubation	///	///										
	Juvenile Rearing	///	///	///	///	///	///	///	///	///	///	///	///
	Smolt Outmigration			■	///	///						■	///
Bull Trout	Upstream Migration						■	■	■	///	///		
	Spawning									■	■	///	
	Incubation	///	///	///	///	///				///	///	///	///
	Rearing	///	///	///	///	///	///	///	///	///	///	///	///
Oregon Chub	Spawning				///	///	///	///	///	///			
	Incubation				Chub incubation is for approximately one week after spawning.								
	Rearing	///	///	///	///	///	///	///	///	///	///	///	///
		■	Darker shade indicates peak times.										

Source: Adapted from USACE 2000a (compiled from ODFW 1990; Taylor and Reasoner 1998; Unthank 1999; Scheerer 1999).

Table 10. Pre-dam and Current Distribution of Spring Chinook

Location	1947 Distribution [a]	Current Distribution	
		Natural	Hatchery Releases
Coast Fork Subbasin			
Mainstem	Few [1]	None	
Row River	Few [1]	None	
Middle Fork Subbasin			
Mainstem	Present	Few [2]	Present [5]
Fall Creek	Present	Few [3]	Present [5]
Little Fall Creek	Unknown	Few [4]	
North Fork	Present	None	

Notes:
a. Locations shown are specifically mentioned in literature. Other locations also may have been production areas. Relative productivity is indicated where this information was provided.
[1] Probably never abundant (Willis et al., 1960).
[2] Successful spawning below Dexter Dam is minimal due to release of water above 12.8°C during egg incubation (Connolly et al., 1992a); spawning occurs upstream of reservoir by transported adults.
[3] Little spawning occurs because of sedimentation and alteration of water flow and temperature below Fall Creek Dam (Connolly et al., 1992a); spawning occurs upstream of reservoir by transported adults.
[4] Spawning may occur intermittently during high flow years and may be hatchery strays (Connolly et al., 1992a).
[5] Majority of escapement does not enter the collection facilities at Dexter / Fall Creek dams and may contribute to natural production downstream (Connolly et al., 1992a).
Source: USACE 2000a (compiled from Mattson 1948 and Connolly et al., 1992a, b).

Bull Trout: Little information exists on the historical distribution and abundance of bull trout in the Middle Fork subbasin (NPCC 2004a). Buchanan *et al*. (1997) reported that historical distribution of bull trout included the mainstem Middle Fork Willamette from its confluence with the Willamette River upstream to its headwaters, including Salmon and Salt Creeks below Hills Creek Reservoir, as well as the Middle Fork Willamette above Hills Creek Reservoir, including Swift and Staley Creeks. It is likely that historical overwintering and foraging would have extended bull trout distribution into many other tributaries in the subbasin, including the North Fork of the Middle Fork Willamette River. The recent known distribution of bull trout occurs only in the upper Middle Fork subbasin from Chuckle Springs to Hills Creek Reservoir.

No bull trout were identified during extensive surveys in the Middle Fork subbasin in the early 1990s (NPCC 2004a). Buchanan *et al*. (1997) listed bull trout as probably extinct. A plan to rehabilitate bull trout in the upper Middle Fork subbasin was approved by the Willamette Basin Bull Trout Working Group in 1997. Beginning in 1997, bull trout fry from Anderson Creek in the McKenzie River subbasin were reintroduced into four cold-water springs and four creeks above Hills Creek Reservoir by the Forest Service and ODFW (NPCC 2004a). Monitoring has shown good growth and survival of juvenile bull trout in the release sites (ODFW 2001). Adult bull trout are once again present in the Middle Fork Willamette. In 2005, ODFW and USFS began spawning gravel augmentation near fry release sites to create spawning habitat in critical habitat areas. An increased monitoring program for juvenile production and spawning in 2005 resulted in 20 spawning redds identified in the Middle Fork Willamette River from FS Road 2143 Bridge to Tumblebug Creek. Bull trout were not observed on redds but further monitoring may document a naturally producing population of bull trout in the upper Middle Fork subbasin.

Oregon Chub: Oregon chub were found historically in the Middle Fork Willamette River at least up to Oakridge (NPCC 2004a; USFWS 1998). Currently, there are 8 populations in the Middle Fork subbasin with 500 or more individuals and over 16 sites of known occurrence (USFWS 2010). Within the study area, Elijah Bristow State Park has three populations. Nonnative fish and amphibians and loss of off-channel habitats continue to inhibit Oregon chub recovery.

Malheur Mottled Sculpin: Sculpins are most abundant in clear, rapidly flowing freshwater streams, and are usually found in association with trout, dace, and other fish requiring clean water and low temperatures. Sculpins are bottom-dwellers, and seldom swim more than a few centimeters above the substrate. They are most commonly found resting beneath flat rocks. They are carnivorous, and prey primarily on insect larvae, crustaceans, and fishes (NANFA 1982). The Malheur mottled sculpin is mostly found in smaller tributaries and disconnected streams in Malheur, Snake and Columbia Basins.

Pacific Lamprey: Pacific lamprey are thought to have historically occurred wherever salmon and steelhead populations occurred. Their distribution has been reduced due to impassable dams and other barriers. Lamprey spawn in gravel bedded streams between March and July. Lamprey hatch in approximately 19 days and the ammocoetes drift downstream to areas of low velocity and fine sediments. They may reside for several years before metamorphosing into juveniles that move downstream and migrate to the ocean. Adults are parasitic on salmonids and other fish in the marine environment. After 1 to 3 years they return to freshwater to spawn. (USFWS 2010c)

Cutthroat Trout: Cutthroat trout are present throughout the Middle Fork subbasin and similar to the Coast Fork, as compared to historical conditions, there have been dramatic changes to their distribution and the ability of the habitat to support abundant populations. Dams, road crossing culverts, and other fish passage barriers have limited the distribution of cutthroat and their access to spawning and rearing habitat. Historically, lowland streams were characterized by abundant side channels, large wood jams, and other complex and diverse habitats, and provided the most productive fish habitat.

3.2.4.2 Aquatic Habitat

The Corps' dams divide the Coast Fork and Middle Fork subbasins into upper and lower portions, thereby reducing the transport and delivery of large wood and substrate to downstream reaches (NPCC 2004a). Changes in the abundance and distribution of gravels and large wood (particularly in large jams) have reduced suitable spawning areas and limited areas for adult cutthroat trout and juvenile rearing habitat for spring Chinook salmon. Relative to the lower Coast Fork and Middle Fork subbasins, the forested upper subbasins above the dams have aquatic habitat that is closer to the historical baseline, with the highest proportion of functioning riparian areas, the largest amounts of large wood in the river and tributary channels, and the highest quality spawning areas (NPCC 2004a). However, the upper subbasins are generally inaccessible to anadromous fish.

In addition, the dams have changed flow regimes and water temperature patterns. The change in flow regimes has altered the availability and quality of Oregon chub habitat in backwater sloughs, floodplain ponds, and other slow-moving side-channel habitat. Compared to historical conditions, water temperatures below the dams are generally cooler in the summer and warmer in the fall and winter, which affects the upstream distribution of spring Chinook salmon adults, alters the timing of spawning, and affects the period of egg incubation (NPCC 2004a).

Proposed minimum instream flows under the Willamette Biological Opinion (NMFS 2008a) (Table 11) can be compared with flows recommended for upstream passage (Table 12), spawning (Table 13), incubation (Table 14), and rearing (Table 15) of salmonids, (USACE 1982; 2000a). The flows identified in Tables 12 to 15 are based on a number of biological and site-specific factors and reflect the minimum flow recommendations as reported by Hutchison *et al*. (1966).

Table 11. Required and BiOp Target Minimum Instream Flows, Middle Fork and Coast Fork Subbasins

Stream/Location	Period	Flow (cfs)	% Flow Equaled or Exceeded	Purpose
Middle Fork Willamette River (Oregon Water Resources Department Required Flows)				
Coast Fork confluence to 1 mile upstream	Year-round	640		Support aquatic life
North Fork confluence to 1 mile upstream	Year-round	285		Support aquatic life
Middle Fork Willamette River Target BiOp Flows				
Below Dexter Dam	Sept 1 – Oct 15	1200	99.9	Chinook spawning
Below Dexter Dam	Oct 16 – Jan 31	1200	99.9	Chinook
Below Dexter Dam	Feb 1 - June	1200	99.9	Rearing
Below Dexter Dam	Jul 1 – Aug 31	1200	99.9	Rearing
Coast Fork Willamette River (Oregon Water Resources Department Required Flows)				
Middle Fork confluence to 1 mile upstream	Year-round	40		Support aquatic life
Row River confluence to 1 mile upstream of MF/CF confluence	Year-round	15		Support aquatic life
Cottage Grove Dam to Row River	Nov 16 – Mar 31	125		Anadromous/resident fish life
Row River to mouth	Nov 16 – Mar 31	200		Anadromous/resident fish life
Row River (Oregon Water Resources Department Required Flows)				
Coast Fork confluence to 1 mile upstream	Year-round	40		Support aquatic life
Dorena Dam to mouth	Nov 16 – Apr 30	175		Anadromous/resident fish life

Table 12 Recommended Flows for Upstream Passage, Middle Fork and Coast Fork Subbasins

Location	Flow (cfs)	Time Period	Species	Regulation Point
Middle Fork below Dexter	900	Apr 15-Jun 30	Spring Chinook	Dexter Dam
	700	Mar 1-Apr 15	Steelhead	
Fall Creek [1] below Fall Creek Dam	170	Apr 15-Jun 30	Spring Chinook	Fall Creek Dam
	75	Mar 1-Apr 15	Steelhead	
Coast Fork mouth to Row River	200	Oct 15-Dec 1	Fall Chinook	Just below Row River
	175	Jan 1-May 15	Steelhead	
Row River below Dorena Dam	175	Oct 15-Dec 1	Fall Chinook	Dorena Dam
	150	Jan 1-May 15	Steelhead	

[1] Experience at Fall Creek in 1977-1978 showed that 150 cfs is sufficient to provide adult transport, and that this flow should not be interrupted frequently with lower flows. Considerable straying of marked fish was noted to have occurred when a week flow schedule of three days at 150 cfs and four days at 50 cfs was followed.
Source: USACE 1982, 2000a.

Table 13. Minimum Recommended Spawning Flows, Middle Fork and Coast Fork Subbasins

Location	Flow (cfs)	Time Period	Species	Regulation Point
Middle Fork below Dexter	1200	Sep 10-Oct 10	Spring Chinook	Dexter Dam
		Mar 1-Jun 1	Steelhead	
Fall Creek below Fall Creek Dam	150	Sep 10-Oct 10	Spring Chinook	Fall Creek Dam
		Mar 1-Jun 1	Steelhead	
Row River below Dorena Dam	200	Oct 15-Dec 10	Fall Chinook	Dorena Dam
		Mar 1-Jun 1	Steelhead	
Coast Fork mouth to Row River	250	Oct 15-Dec 10	Fall Chinook	Below Row River
		Mar 1-Jun 1	Steelhead	

Source: USACE 1982, 2000a

Table 14. Minimum Recommended Incubation Flows, Middle Fork and Coast Fork Subbasins

Location	Flow (cfs)	Time Period	Species	Regulation Point
Middle Fork Willamette River below Dexter	1 foot lower than flow level at spawning	Oct 1-Mar 15	Spring Chinook	Jasper
		Apr 1-Jun 15	Steelhead	
Fall Creek below Fall Creek Dam	150 cfs	Oct 1-Mar 15	Spring Chinook	Fall Creek Dam
	75 cfs	Apr 1-Jul 1	Steelhead	
Row River below Dorena Dam	150 cfs	Nov 15-Apr 1	Fall Chinook	Dorena Dam
		Apr 1-Jun 15	Steelhead	
Coast Fork Willamette mouth to Row River	250 cfs	Nov 15-Apr 1	Fall Chinook	Goshen
		Apr 1-Jun 15	Steelhead	

Source: USACE 1982, 2000a

Table 15. Minimum Flows Recommended for Salmonid Rearing, Middle Fork and Coast Fork Subbasins

Location	Flow (cfs)	Time Period	Regulation Point
Middle Fork Willamette River below Dexter Dam	1600	Jun 1-Oct 30	Dexter Dam
	800	Nov 1-Jun 1	
Middle Fork Willamette River from Hills Creek Dam to Lookout Point Reservoir	285	year-round	Hills Creek Dam
Fall Creek below Fall Creek Reservoir	150	Jun 1-Oct 30	Fall Creek Dam
	50	Nov 1-May 30	
Row River below Dorena Dam	300	Jun 15-Oct 30	Dorena Dam
	100	Nov 1-Jun 15	
Coast Fork Willamette mouth to Row River	350	Jun 15-Oct 30	Goshen
	200	Nov 1-Jun 15	
Source: USACE 1982, 2000a			

3.2.4.2.1 Coast Fork Willamette River

In the Coast Fork subbasin, the release of warm water from Cottage Grove and Dorena reservoirs appreciably reduces the value of the lower Coast Fork and Row River for salmonid production (USACE 2000a). Temperatures in excess of 26ºC have been measured downstream of the dams (Thompson *et al*. 1966). Warm water species are much more abundant than salmonids, indicating an unfavorable temperature regime for native species (USACE 2000a).

Historical removal of large wood from the Coast Fork and tributary streams reduced the overall transport of wood, and along with removal of riparian vegetation for various land uses, interacted to reduce the quantity and distribution of instream large wood. In the Coast Fork subbasin, approximately 97% of the upper Row River drainage has been harvested, and 76% of the upper Coast Fork Willamette drainage has been harvested at least once, which has contributed to riparian areas having primarily younger-aged conifers and hardwoods (NPCC 2004a). Also, many of the tributaries in the upper Coast Fork subbasin do not provide adequate shading or large wood recruitment. Limited wood in the river limits the formation of pools, thus reducing hiding areas for adult fish and restricting the quality and quantity of juvenile rearing habitat (NPCC 2004a).

The lower Coast Fork subbasin contains extensive agricultural, urban, and residential development that has limited the extent and composition of riparian vegetation. Further loss of riparian vegetation and function was caused by the construction of levees and revetments along the banks of the lower Coast Fork Willamette River to protect agricultural development from flooding and erosion. The construction of Interstate 5 also reduced riparian vegetation along significant portions of the lower 25 miles of the Coast Fork Willamette River (NPCC 2004a).

Backwater habitats, including pool margins, side channels, and alcoves, have been reduced from historical levels in the Coast Fork subbasin (NPCC 2004a). Dykaar's investigation (2005) found that river-floodplain habitats have been substantially reduced. Declining rates were found for most geomorphic indicators (main channel migration, island development, gravel supply, and large wood) following dam construction. The main channels of the Coast Fork were found to be 6% shorter in the post-dam years. The amount of exposed gravel was down 20% and total island area was down 74% from a pre-dam average for the Coast Fork.

In the lower Coast Fork subbasin, the productivity, capacity, and diversity of cutthroat trout and spring Chinook salmon populations are limited by the following factors (NPCC 2004a):

- **Habitat Connectivity**. Cottage Grove and Dorena dams are complete barriers to adult and juvenile fish movement to historic spawning and rearing areas. Modification of the river's flow regime from dam regulation, channel and bank confinement, and reduced instream large wood have interacted to reduce backwater habitats important for juvenile rearing and winter refuge.
- **Habitat Modification**. Limited spawning areas and reduced levels of gravels/small cobbles are available in the lower rivers for spawning. Revetments along the lower Coast Fork Willamette and Row rivers have reduced habitat complexity. The lower subbasin has reduced floodplain forest extent and connectivity.
- **Large Wood**. Limited wood in the lower river and tributaries has modified gravel deposition patterns, reduced the frequency and depth of pools, and minimized hiding cover.
- **Water Quality**. The mainstem Coast Fork (mouth to RM 31) is listed as impaired for fish passage because of high mercury levels. There are water quality criteria exceedances of summer maximum temperatures below Cottage Grove and Dorena dams and in Camas Swale Creek. There is reduced canopy shade on many tributary streams, which leads to increased water temperatures. Changes in high and low water temperature regimes have affected adult spawning success and egg incubation and have limited the capacity of river and tributary streams to support juvenile fish.
- **Fish Passage Barriers**. Corps' dams and fish passage barriers at road crossings on tributary streams prevent access into historical spring Chinook spawning areas, block the interchange between the upper and lower subbasin cutthroat trout populations, and limit juvenile access into rearing and refuge habitat.
- **Additional Factors**. Other factors that are limiting cutthroat trout and spring Chinook populations include competition with hatchery and introduced fish; lower numbers of salmon carcasses, which reduces nutrient inputs and thus food availability; and harassment of adult migrating and holding pre-spawning fish by recreational activities such as boating and fishing. All of these factors interact with modified habitats and other impacts to the aquatic system to limit fish populations.

The productivity, capacity, and diversity of Oregon chub populations in the lower (and upper) Coast Fork subbasin are limited by the following factors (NPCC 2004a):

- The frequency and magnitude of high flows is not sufficient to create and maintain channel complexity and provide nutrient, organic matter, and sediment inputs from floodplain areas. Loss of connectivity to floodplain and wetland habitats has affected availability of suitable habitat. Dams and other structures have changed river hydrology and reduced the amount of side channel habitat.
- The lower subbasin has reduced floodplain forest extent and connectivity.
- The presence of non-native predators (i.e., bluegill, smallmouth bass, and bullfrog) in this system inhibits Oregon chub recolonization of formerly occupied habitat.
- Camas Swale Creek near Creswell, which once contained numerous Oregon chub, has been so highly degraded as a result of industrial influences that few Oregon chub exist in the creek.

3.2.4.2.2 Middle Fork Willamette River

Rapid flow fluctuations are likely to adversely affect listed fish below Fall Creek Dam. Stranding of adults was noted to be significant below Fall Creek when releases were dropped within a day from 150 cfs down to 50 cfs (USACE 1982, 2000a). The Willamette BiOp (NMFS 2008a) requires that down-ramping rates be minimized when flows are less than 700 cfs below Fall Creek Dam or below 3000 cfs at Dexter Dam.

As a result of dam operations, water temperatures are cooler than historically occurred in spring and summer and warmer in fall and winter. Figure 22 shows the effects that construction of the Lookout Point/Dexter projects has had on the water temperature regime below Dexter Dam. Temperatures of the inflows to Hills Creek Dam are significantly different than the released water temperatures (much cooler in spring/summer and much warmer in fall/winter).

Lookout Point and Dexter reservoirs influence downstream water temperatures most of the year. Outflow temperatures are generally warmer than historic during the fall, winter, and spring months and colder during the summer months. Inflow temperatures peak in July at about 16.7°C while outflow temperatures peak at about 15°C two months later in September. Returns to the Dexter adult collection facility indicate that a thermal influence on migration does not occur below the dam; the peak of adult spring Chinook returns occurs in mid-May as expected and the number of adults returning annually has generally remained strong (USACE 1997). However, the release of warmer water in the fall has likely adversely affected spring Chinook offspring downstream of Dexter through accelerated embryo development and consequent premature emergence during the winter (USACE 2000a) when there is less invertebrate prey availability. The temperature regime downstream of Fall Creek Dam follows a similar pattern, although with a more pronounced release of cooler water in the spring. The Willamette BiOp (NMFS 2008a) requires the Corps to identify and implement measures to release flows with water temperatures that are more normative, but at this time, there is no requirement to install structural features at the Middle Fork subbasin dams to specifically modify temperatures.

Historical removal of large wood from the Middle Fork Willamette River and tributary streams reduced the overall transport of wood, and along with changes in riparian vegetation interacted to reduce the quantity and distribution of instream large wood. In the Middle Fork subbasin, approximately 74% of the riparian forests along the lower Middle Fork have reduced functions, including delivery of large wood (NPCC 2004a).

The lower Middle Fork subbasin contains extensive agricultural, urban, and residential development that has limited the extent and composition of riparian vegetation. Further loss of riparian vegetation was caused by the construction of levees and revetments along the banks of the lower Middle Fork Willamette River to protect agricultural development from flooding and erosion (NPCC 2004a).

Backwater habitats, including pool margins, side channels, and alcoves, have been reduced from historical levels in the Middle Fork subbasin (NPCC 2004a). Dykaar’s investigation (2005) found that river-floodplain habitats have been substantially degraded for the lower Middle Fork. Declining rates were found for most geomorphic indicators (main channel migration, island development, gravel supply, and large wood) following dam construction. The amount of exposed gravel was down 70% from a pre-dam average for the Middle Fork and total island area was down 57%.

Key limiting factors in the Middle Fork subbasin for focal species (cutthroat and spring Chinook) as described above, and in the Willamette Subbasin Plan (NPCC 2004a) include the following:

- **Habitat Connectivity**. Corps’ dams block access to an estimated 80% of historical habitat. Modification of the river’s high flow regime as a result of dam regulation, channel and bank confinement, and reduced large wood in the channels have interacted to reduce backwater habitats important for juvenile rearing and winter refuge.
- **Habitat Modification**. The frequency of flows is not of sufficient magnitude to create and maintain channel complexity and provide nutrients, organic matter, and sediment inputs from floodplain areas. Limited spawning areas and reduced levels of gravels/small cobbles have reduced the areas available for spawning. Revetments along the lower Middle Fork Willamette have reduced habitat complexity.

The lower subbasin has reduced floodplain forest extent and connectivity. Riparian vegetation within 100 feet of the small tributaries of the lower subbasin is generally in poor condition.

- **Large Wood**. Changes in the delivery and transport of large wood in the river and tributaries has modified gravel deposition patterns, reduced the frequency and depth of pools, and minimized hiding cover for adult and juvenile fish.
- **Water Quality**. Compared to historical conditions, cooler summer mainstem temperatures and warmer fall temperatures below the dams disrupt normal migration and spawning behaviors. Changes in high and low water temperature regimes have affected adult salmonid spawning success and egg incubation and have limited the capacity of river and tributary streams to support juvenile fish.
- **Fish Passage Barriers**. Corps' dams and fish passage barriers at road crossings on tributary streams prevent access to historical spring Chinook and cutthroat trout spawning areas, block the interchange between the upper and lower subbasin cutthroat trout populations, and limit juvenile access into rearing and refuge habitat.
- **Additional Factors**. Other, more moderate factors that are limiting cutthroat trout and spring Chinook populations include competition with hatchery and introduced fish; low numbers of salmon carcasses, which reduce nutrient inputs and thus food availability; and harassment of adult migrating and holding pre-spawning fish by recreational activities such as boating and fishing. All of these factors interact with modified habitats and other impacts to the aquatic system to limit fish populations.

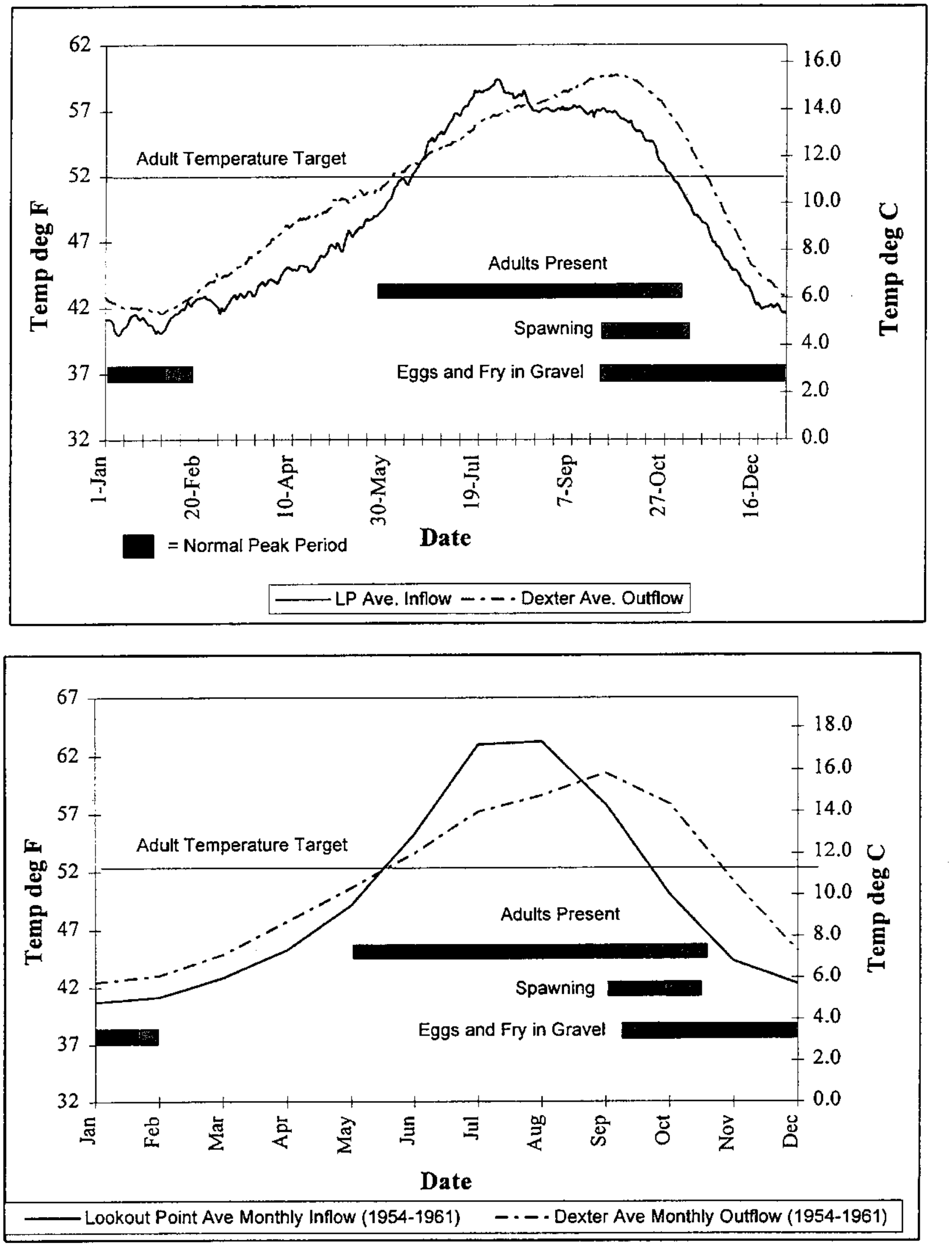


Figure 22. Daily (top) and Monthly (bottom) Average Water Temperatures, Middle Fork Willamette above Lookout Point and below Dexter Dam

The productivity, capacity, and diversity of Oregon chub populations in the lower Middle Fork subbasin are limited by the following factors:

- The frequency and magnitude of high flows is not sufficient to create and maintain channel complexity and provide nutrient, organic matter, and sediment inputs from floodplain areas. Loss of connectivity to floodplain and wetland habitats has affected availability of suitable habitat. Dams and other structures have changed river hydrology and reduced the amount of side channel habitat.
- The presence of non-native predators/competitors, such as bluegill and smallmouth bass, inhibits Oregon chub recolonization of formerly occupied habitat.
- Reduced water quality from upslope commercial timber operations.

In the future without-project condition, it is likely that habitat restoration and enhancement actions by a variety of agencies and groups will occur. The Willamette Subbasin Plan includes a number of recommendations to improve habitats; however, the rate at which these restoration actions may occur will be dependent upon state, local, and private funding, none of which are certain. The Corps will be required to take a number of restoration actions associated with compliance with the 2008 Biological Opinions (NOAA 2008; USFWS 208) as described in Section 2.1.4, although no specific restoration projects have yet been identified or implemented. Key Corps actions in the near-term are associated with temperature modifications and fish passage at the dams. Watershed councils will play a key role in establishing restoration priorities in the Coast Fork and Middle Fork subbasins. The Oregon Watershed Enhancement Board will continue to provide funding and technical assistance for watershed and stream restoration projects, although overall state funding is limited and primarily focused on habitat protection and riparian revegetation efforts. The Oregon CREP will provide incentives to landowners for shorter term riparian and wetland restoration, mainly through the use of vegetated filter strips and riparian buffers; this program does not provide funding for more costly engineering or large-scale restoration.

However, additional factors will continue to degrade habitats, such as continued growth and development, likely continued armoring of river and tributary channels to protect residences and infrastructure, and climate change. Even though the Corps will take actions to improve habitats as required for compliance with the 2008 Biological Opinions (NOAA 2008; USFWS 2008), these actions will primarily be focused on spawning and rearing habitats that can directly compensate for adverse effects from dam operations (i.e. to provide surrogate habitats downstream of the dams while fish passage actions at the dams are being implemented). Without this separate ecosystem restoration study, more comprehensive actions to restore floodplains are not likely to occur. On balance, it is likely that the future without-project condition will slightly improve in localized areas, but not likely to the level required to recover fish and wildlife species. The *Willamette River Basin Planning Atlas* (Hulse, *et al*. 2002) scenarios predict that aquatic habitat quality and quantity will stay about the same, or improve somewhat (20-60%) depending on whether a development oriented or conservation oriented future scenario occurs.

Thus, the key assumptions that are made in this study regarding the likely future condition of habitat conditions is that trees and shrubs in the riparian zone and floodplain will continue to mature and get larger, but non-native invasive species such as blackberries, Japanese knotweed, and reed canary grass will also continue to expand their range, density and size. Large wood recruitment into the river will continue to be limited as compared to natural conditions as a result of land clearing and development, and the inability of native trees to recruit into areas dominated by non-native species. In areas where localized restoration occurs, these areas will contribute large wood to the rivers within the 50 year period of analysis, but this is expected to be much less than would occur with more extensive floodplain and riparian restoration. Temperatures in the rivers will likely remain similar to existing conditions or actually be increased somewhat during the summer/fall as a result of actions taken by the Corps at the dams to release water from varying levels in the reservoirs to mimic natural stream flows and temperature regimes. Climate change effects such as reduced snowpack may also increase water temperatures.

3.2.5. Terrestrial Species and Habitat

3.2.5.1 Terrestrial Species

The Willamette Basin has a rich variety of terrestrial animal and plant species. It is estimated that there are approximately 18 species of native amphibians, 15 reptile species, 154 bird species, and 69 mammal species currently present in the basin (Hulse *et al*. 2002). A number of species have significantly declined and are the focus of conservation concerns. Factors contributing to these declines are frequently complex and poorly known, but include habitat loss, introduced species, contaminants, and human disturbance (Hulse *et al*. 2002).

Not all terrestrial species residing in the Willamette Basin are native. There are about 17 species that have been introduced (Hulse *et al*. 2000). Non-native species include wild turkey, ring-necked pheasant, California quail, European starling, house sparrow, eastern gray squirrel, nutria, and bullfrog (Hulse *et al*. 2000; NPCC 2004b).

Federal ESA-listed species, candidate species, and species of concern were used to compile a listing of terrestrial animals and plants that could serve as a focus for restoration opportunities in the Coast and Middle Fork subbasins. Table 16 shows the special-status wildlife species listed for the subbasins and Table 17 shows special-status plant species. Only those species likely to occur in the floodplain areas of the Coast and Middle Forks are described in more detail below.

3.6.2.1.1 Threatened and Endangered Species

Marbled Murrelet: The marbled murrelet is federally listed as threatened. Marbled murrelets are small seabirds of the family Alcidae that occur along the north Pacific coast from the Aleutian Islands and southern Alaska south to central California. Murrelets feed on small fish and invertebrates usually within 2 miles of shore in open but somewhat sheltered marine waters, such as bays or sounds where water depth is less than 330 feet (Carter 1984). The nesting period begins around the end of March and continues through mid-September (Hamer and Nelson 1995). Nest sites are restricted to stands of mature and old-growth forest (Carter 1984). Because of the scarcity of such stands, it is common for murrelets to fly inland many miles to nest; over 40 miles in some studies (Cooper et al. 2006, 2007). Marbled murrelets only fly to and from their nest sites during crepuscular hours, spending their diurnal hours foraging. The loss of old growth forests is the main cause for the decline of this species. In addition, it is believed that forest fragmentation forces nests closer to forest edges making them vulnerable to predation by jays, crows, ravens, and great horned owls. Other threats to this species include fishing nets and oil spills.

Northern Spotted Owl: The northern spotted owl is a federal and state threatened species. Spotted owls are generally associated with old-growth forests and require multilayered canopies. Some upland coniferous forests in the Coast and Middle Fork subbasins may be suitable nesting habitat for the spotted owl. Other habitats may provide foraging or dispersal habitat for the species. Several spotted owls have been located near Fall Creek Lake. Additional spotted owl activity centers are likely found at or near the Hills Creek project on Willamette National Forest lands (USACE 2000a).

Bald Eagle: The bald eagle is a state threatened species but was delisted from the federal ESA on July 9, 2007. Bald eagles breed and reside year-round throughout the Willamette Basin, and are mostly associated with forested rivers and lakes; during some months eagles can occur extensively in open areas with livestock (NPCC 2004b). They nest mainly in large Douglas fir or cottonwood trees. During summer, Oregon eagles feed mainly on fish (live or dead), then augment this in other seasons with waterfowl and sheep (carrion). The increased nesting success and population increase for bald eagles in recent years can be attributed largely to the reduction of some persistent contaminants (DDT) and to increased protection of nest and roosting sites from harvesting and human visitation (Isaacs and Anthony 2001). The wintering population is stable or increasing, and is not necessarily composed of the same individuals present in summer.

Eagle Rock is a 200-acre sensitive area managed for the protection of bald eagles near the Lookout Point Reservoir. The eagles frequently forage in Dexter Lake especially in the winter months and in the nest initiation season. They also have been observed flying over Lowell Butte to forage in Fall Creek Lake and fishing in the river below Dexter Dam. Bald eagles have been observed at Fall Creek but no nest sites have been identified. Bald eagle territories also are found on Forest Service land at Hills Creek, on BLM land at Dorena, and on private land at Cottage Grove (USACE 2000a).

Table 16. Special-status Wildlife Species, Middle Fork and Coast Fork Subbasins

Species Name	Federal Status	State Status
Marbled murrelet (*Brachyramphus marmoratus)*	T	T
Northern spotted owl (*Strix occidentalis caurina)*	T	T
Fender's blue butterfly (*Icaricia icarioides fenderi)*	E	
North American wolverine (*Gulo gulo luscus*)	C	T
Red tree vole (*Arborimus longicaudus*)	C	
Streaked horned lark (*Eremophila alpestris strigata*)	C	C
Oregon spotted frog (*Rana pretiosa*)	C	
Pallid bat (*Antrozous pallidus pacificus*)	SoC	
White-footed vole (*Arborimus albipes*)	SoC	
Townsend's western big-eared bat (*Corynorynus townsendii townsendii*)	SoC	
Silver-haired bat (*Lasionycteris noctivagans*)	SoC	
Long-eared myotis bat (*Myotis evotis*)	SoC	
Fringed myotis bat (*Myotis thysanodes*)	SoC	
Long-legged myotis bat (*Myotis volans*)	SoC	
Yuma myotis bat (*Myotis yumanensis*)	SoC	
Camas pocket gopher (*Thomomys bulbivorus*)	SoC	
Northern goshawk (*Accipiter gentilis*)	SoC	
Western burrowing owl (*Athene cunicularia hypugaea)*	SoC	
Black tern (*Chlidonias niger*)	SoC	
Olive-sided flycatcher (*Contopus cooperi*)	SoC	
Harlequin duck (*Histrionicus histrionicus*)	SoC	
Yellow-breasted chat (*Icteria virens*)	SoC	
Acorn woodpecker (*Melanerpes formicivorus*)	SoC	
Lewis' woodpecker (*Melanerpes lewis*)	SoC	
Mountain quail (*Oreortyx pictus*)	SoC	
Band-tailed pigeon (*Patagioenas fasciata*)	SoC	
Oregon vesper sparrow (*Pooecetes gramineus affinis*)	SoC	
Purple martin (*Progne subis*)	SoC	
Northern Pacific pond turtle (*Actinemys marmorata marmorata*)	SoC	
Coastal tailed frog (*Ascaphus truei)*	SoC	
Oregon slender salamander (*Batrachoseps wrighti*)	SoC	
Northern red-legged frog (*Rana aurora aurora*)	SoC	
Foothill yellow-legged frog (*Rana boylii*)	SoC	

Species Name	Federal Status	State Status
Cascades frog (*Rana cascadae*)	SoC	
Southern torrent (seep) salamander (*Rhyacotriton variegatus*)	SoC	
Tombstone Prairie farulan caddisfly (*Farula reaperi)*	SoC	
Tombstone Prairie oligophlebodes caddisfly (*Olgophlebodes mostbento)*	SoC	
One-spot rhyacophilan caddisfly (*Rhyacophila unipunctata)*	SoC	
American peregrine falcon (*Falco peregrinus anatum*)	DM	
Bald eagle (*Haliaeetus leucocephalus)*	DM	
E = Endangered T = Threatened C = Federal Candidate SoC = Federal Species of Concern. *DM = Delisted taxon, recovered, being monitored first 5 years.* *SC = State 'critical' - listing as T or E appropriate if immediate conservation actions not taken.* *SV = State 'vulnerable' – species not in imminent danger of being listed.* *SU = State 'undetermined' are those species for which status is unclear.*		

American Peregrine Falcon: The American peregrine falcon was removed from federal ESA listing in 1999. Peregrine falcons have been observed near several Corps' Willamette projects. There are 22 known aeries on the Willamette National Forest. Peregrine falcons are likely to forage along the Coast and Middle Forks and prey may include riparian species and waterfowl (USACE 2000a).

Table 17. Special-status Plant Species, Middle Fork and Coast Fork Subbasins

Species	Federal Status	State Status
Willamette daisy *(Erigeron decumbens* var. *decumbens)*	E	E
Bradshaw's desert parsley*(Lomatium bradshawii)*	E	E
Kincaid's lupine *(Lupinus sulphureus* var. *kincaidii)*	T	T
Crenulate grape fern (*Botrychium crenulatum)*	SoC	C
Cliff paintbrush (*Castilleja rupicola)*	SoC	
Cold-water corydalis (*Corydalis aquae-gelidae*)	SoC	C
Willamette valley larkspur (*Delphinium oreganum*)	SoC	C
Peacock larkspur (*Delphinium pavonaceum*)	SoC	E
Wayside aster (*Eucephalus vialis)*	SoC	
Shaggy horkelia (*Horkelia congesta* ssp. *congesta*)	SoC	C
Thin leaved peavine (*Lathyrus holochlorus*)	SoC	
Whitetop aster (*Sericocarpus rigidus)*	SoC	
Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*)	SoC	
E = Endangered T = Threatened SoC = Federal Species of Concern C = State Candidate		

Fender's Blue Butterfly: Fender's blue butterfly occurs in native grassland habitats within the Willamette Valley. The historic range of this insect is not well known, due to the limited information collected prior to 1931. Fender's blue butterfly populations are present at 31 remnant prairie sites in Polk, Yamhill, Benton, and Lane counties. The butterfly's host plant is primarily Kincaid's lupine but will also use spurred lupine and sickle keeled lupine if Kincaid's is not present. Adult butterflies lay their eggs on perennial Lupinus species (Ballmer and Pratt 1988). After larvae hatch, they feed on their host plant for a short time, reaching their second instar in the early summer (USFWS 2000a). Diapause begins following development into the first instar and may last for one or more seasons, depending on environmental and individual conditions. Through this stage, larvae remain in the leaf litter near the base of the host plant through fall and winter, at a minimum, and typically become active in March or April of the following year. When diapause ends, larvae continue to feed and grow through an additional four instars. At this point, larvae enter their pupal stage and adults emerge in April and May. A complete life cycle can occur in one year.

Willamette Daisy: Willamette daisy is state and federally listed as endangered. This perennial herb is endemic to the Willamette Valley and historically was likely widespread in native prairie habitat. It is currently known only from a few small remnants, including sites in Lane County. Willamette Valley prairie is considered to be among the rarest habitats in western Oregon and is threatened by fragmentation, agriculture and urban growth (USFWS March 2002b).

Bradshaw's Desert Parsley: Bradshaw's desert parsley is state and federally listed as endangered. This perennial herb occurs on seasonally saturated or flooded prairies, adjacent to creeks and small rivers in the southern Willamette Valley. Endemic to and once widespread in the wet, open areas of the Willamette Valley, Bradshaw's desert parsley is now limited to a few sites in Lane, Marion, and Benton counties. In Lane County, the greatest concentrations of remaining sites where plants occur are in and adjacent to the Eugene metropolitan area. Most of this plant's habitat has been destroyed by land development for agriculture, industry, and housing. In addition, water diversions and flood control structures have changed historic flooding patterns, which may be critical to seedling establishment (USFWS September 2003).

Kincaid's Lupine: Kincaid's lupine is state and federally listed as threatened. This perennial species is typically found in native upland prairie. The plant's distribution implies a close association with native upland prairie sites that are characterized by heavier soils and mesic to slightly xeric soil moisture levels. There are known populations of this plant in Lane County. Willamette Valley prairie is considered to be among the rarest habitats in western Oregon and is threatened by fragmentation, agriculture and urban growth (USFWS July 2003).

3.6.2.1.2 Candidate Species

North American Wolverine: The North American wolverine is a carnivorous mammal that typically occurs in open forests at higher elevations and in alpine areas. They feed on small mammals and carrion. They den in caves or hollow logs. Prior to 1973, wolverines were considered furbearers in Oregon. They were always rare in Oregon, although sightings, tracks and road kill document their continued presence at low densities. (Csuti, *et al*. 2001)

Streaked Horned Lark: The streaked horned lark is a federal candidate species and a state critical species. This bird is a grassland species and the large loss of native grasslands in the Willamette Valley is the most likely reason for its decline. They were formerly very common breeders in western Oregon, but are now severely depleted in population numbers. These birds need sparsely vegetated open fields and will inhabit disturbed areas such as overgrazed pastures; they dig a nest cavity in dry ground with sparse vegetation. Urban development and agriculture are likely reasons for this species' decline. Potentially suitable breeding habitat exists below Fall Creek, below Dorena at Schwarz Park, and at Row Point on Dorena Lake (USACE 2000a).

Oregon Spotted Frog: The Oregon spotted frog is a federal candidate species and a state critical species. This species has been lost from at least 78% of its former range and currently is known to occur in Lane County (USFWS March 2002a). Most populations are small and isolated. It is found near perennial bodies of water that include zones of shallow water and abundant emergent or floating aquatic plants, which it uses for basking and escape cover. Many factors are believed to have caused the frog's decline, including loss of marsh habitats, predators such as bullfrogs, changes in hydrology and water quality, development, and livestock overgrazing, which continue to result in habitat loss, alteration, and/or fragmentation (USFWS March 2002a). The ORNHIC database contains only two documented records from the upper McKenzie watershed (NPCC 2004b). This species has not been documented on Corps' project lands (USACE 2000a).

3.6.2.1.3 Species of Concern

Pallid Bat: The pallid bat occurs in southwestern Oregon (including western Lane County) and most of eastern Oregon and is known to inhabit portions of the Coast Range near Tillamook State Forest. It occurs in open forested areas (ponderosa pine, oak) and desert areas. It uses cliffs, caves, mines or abandoned buildings for roosts. This bat is known to eat crickets, beetles, grasshoppers and some moths as well as small vertebrates such as lizards and mice. (Csuti, *et al*. 2001)

White-footed Vole: The white footed vole occurs in western Oregon south of the Columbia River, more commonly in the Coast Range but it has been found in the Cascades of southern Lane County. It most often occurs in riparian zones within larger areas of coniferous forest. It feeds on leaves and roots of a variety of plants and is presumed to be a burrowing rodent. It is uncommon in Oregon. (Csuti, *et al*. 2001)

Red Tree Vole: Red tree vole is a federal species of concern. This small, highly specialized rodent resides mainly in the mountainous portions of the Willamette Basin (NPCC 2004b). The preferred habitat is moist, old growth coniferous forest, especially Douglas-fir. To a lesser degree, it uses mid-aged closed-canopy forests that have significant stands of large-diameter trees (>21 inches). Red tree voles also are associated with high percent canopy cover, high stump density, and shorter snags and logs. The species is at risk because of the loss of formerly widespread old-growth coniferous forests, as well as habitat fragmentation.

Townsend's Western Big-Eared Bat: Townsend's big-eared bat is a federal species of concern and a state critical species. Like many bats, its main requirement is for cool roosting and hibernation sites; such as the bark and cavities of large trees (NPCC 2004b). This need also is met by caves, large rock outcrops, and some abandoned buildings or mine tunnels. They forage primarily over water, riparian areas, wetlands, and small canopy gaps in forests. Disturbance and habitat destruction are reasons for their decline. Solitary Townsend's big-eared bats have been observed in an old quarry along Fall Creek Road at Fall Creek Lake, and a single bat was observed in the right abutment of Dorena Dam (USACE 2000a). This individual was removed and the opening secured to preclude further entrance. Small groups of this species have been observed day roosting and hibernating in caves near Lookout Point Lake on lands owned by the Weyerhaeuser Company (USACE 2000a).

Silver-haired Bat: Silver-haired bats occur throughout most of North America, except along the Gulf of Mexico. They prefer forested areas, particularly old-growth forests. They forage around ponds and streams and roost under loose bark. They prey on moths and other soft-bodied insects. They need drinking water and are typically found near waterbodies. (Csuti *et al*. 2001)

Long-eared Myotis Bat: Long-eared myotis is a federal species of concern and inhabits coniferous forest and arid grasslands in a wide elevation range. This forest-dwelling bat uses buildings, bark and rock crevices for day roosts, caves and mine entrances for night roosts, and buildings for small maternity colonies. This species is at risk due to disturbance and habitat loss (relies on snags, decadent trees, and coarse woody debris). This species has been documented at the Fall Creek and Cottage Grove projects (USACE 2000a).

Fringed Myotis: Fringed myotis is a federal species of concern and a state vulnerable species. This bat uses a variety of habitats including forests, woodlands, and grasslands. This colonial species is known to roost in tightly-packed clusters in caves, mines, snags, rock crevices, bridges, buildings, and under bark. They are considered at risk due to general rarity and susceptibility to human disturbance. During surveys in 1997, fringed myotis were captured night-roosting at the Fall Creek project (USACE 2000a).

Long-legged Myotis: Long-legged myotis is a federal species of concern and prefers mature conifer forests but also can be found in agricultural, riparian, and oak woodland habitats. It uses rock crevices, buildings, fissures in bark or the ground for day roosts, and emerges early in the evening to feed. In winter, it hibernates in caves and mines. This species is at risk because of human disturbance and the bat's dependence on snags, decaying trees, old/abandoned buildings, bridges, and caves for roosting and hibernacula since most of these components are declining in terms of presence and availability. Surveys conducted in 1997 identified long-legged myotis at the Fall Creek and Hills Creek projects (USACE 2000a).

Yuma Myotis Bat: The Yuma myotis range extends across western North America, from central Mexico to British Columbia, Montana, and New Mexico. The wintering range is unknown. In Oregon, the Yuma myotis is found in older Douglas fir forests, Sitka spruce forest, and in open oak or Ponderosa pine woodland, and is known to roost in caves, abandoned buildings, and other structures. Food consists of mostly moths and a variety of other small insects, including dipterans, primarily caddis flies, crane flies, and midges, and even some ground beetles. (Csuti *et al*. 2001)

Camas Pocket Gopher: The Camas pocket gopher is endemic to the Willamette Valley and adjacent Columbia River habitats. It lives in grassy areas where burrows can be dug and various herbaceous species can be eaten. It occurs in both prairies and agricultural lands. (Csuti *et al*. 2001). There are no recorded sightings of the Camas pocket gopher in the Eugene/Springfield area.

Northern Goshawk: The northern goshawk is federal species of concern and a state critical species. This bird is found in a variety of mature forests, and nests in areas with dense overhead foliage or high canopy cover created by tall trees (typically old-growth). They occur in the Willamette Valley during migration and winter, where they sometimes migrate over or stop in non-forested habitats. Reasons for decline include loss of large habitat patches and the need for mature/old-growth forest. Northern goshawks have been documented at Mt. Pisgah.

Western Burrowing Owl: The Western burrowing owl is a grassland specialist distributed throughout Western North America, primarily in open areas with short vegetation and bare ground in desert, grassland, and shrub-steppe environments. Burrowing owls are dependent on the presence of fossorial mammals (primarily prairie dogs and ground squirrels), whose burrows are used for nesting and roosting (Klute *et al* 2003). Burrowing owls are protected by the Migratory Bird Treaty Act in the United States and Mexico. It is a rare winter visitor in the Rogue and Willamette valleys, along the coast, and occasionally in eastern Oregon.

Black Tern: Black terns are holoarctic breeders from Alaska/Canada south to California and across Siberia and Scandinavia south to the Mediterranean. They nest in marshes along lakes or rivers and forage in wetlands, pastures, agricultural lands and shallow water. Diet includes insects or all kinds as well as aquatic invertebrates and small fish. In Oregon, they are known to nest in Malheur National Wildlife Refuge and other desert marshes as well as some Cascade lakes. A few pairs have nested at Fern Ridge Reservoir in Lane County (Csuti, et al. 2001).

Olive-Sided Flycatcher: The olive-sided flycatcher is a federal species of concern and a state vulnerable species. This species has been documented in all counties in the Willamette Valley. These birds nest along the edges of lakes and rivers and in open-forest sites. In the valley, they are typically found in a large habitat patch with older trees on the edges, a clearing in the middle, and one or more tall snags on which to perch. Potential causes for decline include fire suppression, urban development, and deforestation (USACE 2000a).

Harlequin Duck: The harlequin duck is federal species of concern. This medium-sized diving duck is a rare summer resident in the northern and central Cascade Mountains, breeding along swiftly flowing, rough, turbulent mountain streams, typically nesting under shrubs, debris, or rocks along these streams. It also may nest in rock crevices among boulders or in tree cavities. Harlequin ducks feed primarily on crustaceans, mollusks, aquatic insects, and fish. Breeding has not been documented on Corps' project lands (USACE 2000a). The riparian area of Fall Creek in the Willamette National Forest provides nesting habitat for this species.

Yellow-Breasted Chat: The yellow-breasted chat is federal species of concern and a state critical species. This bird breeds in second growth, shrubby old pastures, thickets, bushy areas, and low wet areas near water sources. Threats to this species include habitat loss due to conversion to agricultural and urban land uses, and cowbird parasitism. Yellow-breasted chats have been documented at the Fall Creek and Hills Creek projects.

Acorn Woodpecker: The acorn woodpecker is a federal species of concern. This non-migratory, cavity-nesting species seldom occurs above 1,000 feet in elevation (NPCC 2004b). A main requirement seems to be a relatively open area, such as lawn or heavily grazed pasture, beneath a high canopy that contains some oaks. Granary trees (required for storing acorns) are generally of large diameter. Possibly the greatest threats are the gradual loss (due to fire suppression) of oak stands having at least a few larger-diameter trees, and increased traffic on roads between suitable oak stands thus endangering dispersing birds.

Lewis' Woodpecker: The Lewis' woodpecker is a federal species of concern and a state critical species. They are sometimes associated with post-burn areas. These birds are declining throughout their range, probably due to oak/Ponderosa pine and cottonwood habitat loss; they need open areas for foraging and large trees for nesting. Lewis's woodpeckers have been documented at Mt. Pisgah and at Waldo Lake in the Willamette National Forest.

Mountain Quail: The mountain quail is a federal species of concern. This secretive bird typically inhabits dense brushy slopes and foothills of conifer forest. They breed in higher elevations during spring and summer and retreat to lowlands during winter to avoid the snow. They are abundant west of the Cascades and are legally hunted. They are the only native quail in Oregon. Recent improvements in riparian condition may be improving their population. (USFWS 2010b)

Band-tailed Pigeon: The band-tailed pigeon breeds from British Columbia to Baja California and east to Colorado and New Mexico. They prefer coniferous or mixed coniferous-deciduous forests and also use oak woodlands. They nest in the tops of trees usually near water. They feed on nuts and berries and some insects and seeds. They are a game species in Oregon and occur in forested areas of Lane County. (Csuti *et al*. 2001).

Oregon Vesper Sparrow: The Oregon vesper sparrow is a federal species of concern and a state critical species. This sparrow was formerly common in the Willamette Valley and bred in upland prairie-savanna; as this habitat diminished, it adapted to nesting in lightly grazed pastures and young conifer plantations with extensive weeds and grasses (NPCC 2004b). Vesper sparrows have been documented at Mt. Pisgah and the Fall Creek project.

Purple Martin: The purple martin is a federal species of concern and a state critical species. Formerly common in the Willamette Valley, it is now uncommon to rare and localized (NPCC 2004b). Martins historically nested in cavities of old-growth trees located near water bodies or other open areas. With widespread reduction of this habitat, the species adapted to nesting in artificial structures (bird houses, hollow pilings in rivers). The greatest threats are continued loss of old growth snags of the proper proportions in suitable landscapes, and lack of maintenance of artificial nesting structures. Also, the artificial nest sites are sometimes usurped by exotic species (European starling, house sparrow). Like other swallows, martins are wide ranging aerial foragers and are vulnerable to collisions with vehicles and reductions in insect prey. Purple martins have been documented at the Cottage Grove and Dorena projects and in the Creswell area (USACE 2000a).

Northern Pacific Pond Turtle: The Northern Pacific pond turtle is a federal species of concern and a state critical species. These turtles occur in a wide variety of both permanent and ephemeral wetlands, including lakes, ponds, streams, rivers, and altered habitats including reservoirs, stock ponds, and sewage treatment plants (USACE 2000a). The most important habitat component appears to be the presence of aquatic vegetation and/or physical structure such as overhanging ledges, crevices, and large floating logs for basking in the sunshine. The nesting period begins around June 1 in the Willamette Valley and lasts approximately 6 weeks. Reasons for decline include nest destruction from farm and development practices; aquatic and upland (nesting) habitat destruction; and human actions. Dams, drainage, channelization, and other hydrologic alterations are other possible reasons, generally resulting in simplified ecosystems.

Pond turtles are found at numerous locations in the Willamette Valley, primarily on private lands, although the Willamette Greenway and Row River have important sites for pond turtles (Adamus 2003). Fall Creek Lake supports a small and presumably dwindling population of northwestern pond turtles. Northwestern pond turtles also have been documented at the Dexter, Lookout Point, and Dorena projects. Historical sightings exist at the Cottage Grove project.

Coastal Tailed Frog: The coastal tailed frog is a moderately small slender-bodied frog with rough skin. They are present year-round in and near streams. They are mostly nocturnal, but often seen on creek banks in daylight. Adults are usually active from April to October, depending on the locality. To escape predators, they will tuck in their limbs and let the water carry them downstream. Adults are relatively long-lived, with speculation that they can live up to 15 - 20 years. Their range includes the Cascade Mountains of Oregon.

Oregon Slender Salamander: The Oregon slender salamander occurs in the North and central Cascades of Oregon, typically in old-growth forests or younger forests with high concentrations of downed logs. They also occur in moist talus. (Corkran & Thoms 1996)

Northern Red-Legged Frog: The Northern red-legged frog is a federal species of concern and a state vulnerable species. This frog inhabits moist forests, wetlands, and riparian habitats, and slow-moving streams (USACE 2000a). Red-legged frogs are highly terrestrial and forage in forests near water. They breed and lay eggs in relatively slow-moving water in ponds, along rivers, in reservoirs, lakes, springs, and marshes in January or February. Possible reasons for decline include displacement by bullfrogs and pesticide/herbicide runoff. This frog species has been documented at the Fall Creek and Lookout Point projects (USACE 2000a).

Foothill Yellow-Legged Frog: The foothill yellow-legged frog is a federal species of concern and a state vulnerable species. This frog is found in and around permanent open, low-gradient streams with rocky, gravelly, or sandy substrates (USACE 2000a). It breeds from mid-March to June in low-velocity tributary streams. In 1997 and 1998, Borisenko and Hayes (1999) surveyed multiple historic known sites for yellow-legged frogs, including two tributaries upstream of Fall Creek, and two tributaries upstream of Dorena. Foothill yellow-legged frogs were not found at any of these locations, which may be due to inundation of the historic habitats.

Cascades Frog: Cascades frogs occur throughout the Cascades Range in Oregon and Washington. They typically occur above 3,000 feet in elevation in mountain lakes and meadows and moist forest. (Corkran & Thoms 1996)

Southern Torrent (Seep) Salamander: The Southern torrent salamander occurs in the Oregon Coast Range, Klamath Mountains, Willamette Valley and Southern Cascades. They live in very cold streams, springs, seeps, and waterfall splash zones. They are aquatic and live in gravel and debris within and adjacent to streams. (Corkran & Thoms 1996)

Tombstone Prairie Farulan Caddisfly: Tombstone prairie farulan caddisfly larvae are found in small (one quarter to one full meter in width) cold spring-fed streams shaded by old growth. Currently know from three collection localities in Oregon; Tombstone Prairie, Linn County, Ennis Creek, Lane County, and Jackson Creek, Douglas County. It is likely to occur throughout the Oregon Cascades at elevations above 4000 feet (NatureServe 2011).

Tombstone Prairie Oligophlebodes Caddisfly: The Tombstone prairie oligophlebodes caddisfly have been collected in two locations in Oregon. Adults were collected in riparian vegetation zones. Larvae of the genus occur in cold mountain streams (large and small) from sea level to alpine communities throughout western North America. Streams are perennial, cool or cold, free of fine sediment and filamentous algae, with moderate to strong current and are well-oxygenated (NatureServe 2011).

One-spot Rhyacophilan Caddisfly: A caddisfly currently known from two sites in the Oregon Cascades; Hemlock Butte Pass, Lane County, and Barlow Pass, Hood River County. The species may exist throughout higher elevations of the Cascades (NatureServe 2011).

Crenulate Grape Fern: A moonwort that primarily occurs within and at the margins of seeps, springs, fens, wet meadows, dry meadows, and other wetlands at elevations from 3,935 to 8,200 feet. They tend to occur in historically disturbed habitats, where some mineral soil has been exposed within the last 10-30 years. They are seldom found in abundance in mature old growth forests without recent disturbance.

Cliff Paintbrush: Cliff paintbrush is a short, herbaceous perennial that occurs in rock crevices; on rocky ridges and slopes, talus, and scree at high elevations in the subalpine to primarily alpine vegetation zones. The plant is likely a facultative parasite, and likely on different host species. Cliff paintbrush is believed to be pollinated by hummingbirds and bees. Reproduction is solely by seeds, which are likely dispersed by wind, birds, and small mammals (Cliff Paintbrush Recovery Team 2009).

Cold-water Corydalis: Cold-water corydalis is a federal species of concern. It occurs along perennial streams and springs with a gravel bed. In Oregon, it most frequently occurs in headwater or 1st and 2nd order streams with moderately dense high canopy cover. It typically occurs within a few feet of the stream edge and occurs along streams with temperatures below 14˚C. (BLM 1998)

Willamette Valley Larkspur: Willamette Valley larkspur is a perennial forb in the buttercup family that occurs in native prairies. It is endemic to the Willamette Valley.

Peacock Larkspur: Peacock larkspur is a perennial forb in the buttercup family. It is endemic to the Willamette Valley and occurs in well-drained native prairies. Existing populations primarily occur along roadsides with limited disturbance. (Benton County 2010)

Wayside Aster: Wayside aster is a federal species of concern and is state listed as threatened. This perennial plant blooms from July to early August and can be found in open woodlands of Lane County.

This rare plant was thought to be extinct until it was re-discovered near Eugene in 1980 (Eastman 1990). Wayside aster occurs near Cottage Grove reservoir.

Shaggy Horkelia: Shaggy horkelia is a federal species of concern and a state candidate species. This plant is a small, low-growing herbaceous perennial in the rose family and occurs in wet prairies and oak savannahs. There is a population of shaggy horkelia at Dorena Lake (USACE 2000a).

Thin Leaved Peavine: Thin-leaved peavine is a prairie-woodland species that occurs in the Willamette Valley in Oregon and in remnant prairie habitat in Washington. (WA DNR 2010)

White topped Aster: White-topped aster is a federal species of concern and is state listed as threatened. This small perennial is limited to the open grassy prairies of the Willamette Valley and is threatened by loss of habitat because of urban and agricultural development. Most of the existing populations are centered in the Eugene area in Lane County.

Hitchcock's Blue-eyed Grass: Hitchcock's blue-eyed grass occurs in wet prairie habitats in the Willamette Valley.

3.2.5.2 Terrestrial Habitats

According to the Willamette Subbasin Plan (NPCC 2004a, b), the loss of habitat has been and continues to be among the most important factors that limit terrestrial animal and plant populations in the Willamette Basin. In particular, the loss of vital habitats has been accompanied by the decline of many wildlife, plant, and butterfly species that use these habitat types. Other factors that likely limit terrestrial species populations include roads and other barriers, vegetation change, diminished supply of dead wood, water regime change, pollution, water temperature change, soil degradation, harassment, and invasive species, pathogens, and parasites. Together, these limiting factors degrade terrestrial habitat and often tend to fragment and simplify the internal structure of habitats making them less able to support viable plant and animal populations (NPCC 2004b).

Six vital natural habitats are found in the Coast and Middle Fork subbasins including: upland prairie-savanna, oak woodlands, wetland prairie and seasonal marsh, ponds and their riparian zones, stream riparian zones, and old growth conifer forest. These habitats are dramatically reduced from their historic distribution due to conversions to other land uses and historically supported exceptional wildlife or plant diversity, and/or had consistent use by a relatively large number of plant and wildlife species of concern (NPCC 2004b). Acreage estimates of historical (circa 1850s) and current (circa 1990s) land cover types in the Middle Fork and Coast Fork subbasins are shown in Table 18. Because old-growth conifer forests did not historically occur in the floodplain of the Coast and Middle Fork subbasins, this habitat type will not be discussed in detail in this report.

Upland Prairie-Savanna: This habitat type includes communities where native grasses and forbs are dominant, with little or no woody vegetation (NPCC 2004b).When shrubs and/or trees also are present, but comprise less than 30% canopy cover, the habitat is termed 'savanna.' Upland native prairie is among the rarest of North American ecosystems. Upland prairie/savanna has been identified as a priority for protection and restoration in ecological assessments for the Willamette Basin. Much of the recent attention directed at this habitat has been due to its hosting three federally listed species: golden paintbrush, Kincaid's lupine, and Fender's blue butterfly. In addition, this habitat hosts species of concern such as the streaked horned lark and Oregon vesper sparrow.

Historically, prairies, savanna, and oak woodlands formed a successional mosaic throughout lower-elevation portions of the Willamette Basin. Many such areas were maintained by fire, often set intentionally by indigenous tribes. Upland prairies were among the first habitats to be plowed by early settlers of the valley because they were so easy to clear. As shown in Table 17, the west side grasslands land cover type had the overall largest acreage losses in the lower Middle Fork and Coast Fork subbasins.

Oak Woodlands: Oak woodlands include stands of Oregon white oak (*Quercus garryana*), with either closed canopies (oak forest) or with open canopy but with tree densities generally greater than about 100 trees per acre (NPCC 2004b). Likely as a result of fire suppression, oak woodlands have increasingly become denser forests with Douglas-fir as a common co-dominant. Oak woodland has been identified as a priority for protection and restoration in ecological assessments for the Willamette Basin. Compared with other habitat types, oak woodlands in good condition provide the best habitat for 37 wildlife species, and are used regularly by at least an additional 100 wildlife species (NPCC 2004b). Species of concern that are associated with this habitat include Kincaid's lupine and Fender's blue butterfly, and Oregon vesper sparrow (occur along oak woodland edges), and Lewis' and acorn woodpeckers. Oaks are a critical feature of acorn woodpecker habitat. Unfortunately, in oak woodlands that are regulated by the Oregon Forest Practices Act, harvested oaks must be replaced with conifers (150/acre) unless prior exemption is requested (NPCC 2004b).

Table 18. Estimated Historical and Current Land Cover Types

Location	Land Cover Type	Historical Acres	Current Acres	Acre Change
Lower Middle Fork Subbasin	Agriculture	0	14,288	+14,288
	Herbaceous wetlands	59	0	-59
	Montane mixed conifer forest	6,305	16,552	+10,247
	Open water – lakes, rivers, streams	1,991	6,066	+4,075
	Ponderosa pine/interior white oak forest & woodlands	0	26	+26
	Urban or residential	0	5,248	+5,348
	Westside grasslands	19,032	142	**-18,890**
	Westside lowland conifer-hardwood forest	368,764	378,662	+9,898
	Westside oak/dry Douglas-fir forest & woodlands	14,234	546	**-13,688**
	Westside riparian wetlands	12,075	958	**-11,117**
Lower Coast Fork Subbasin	Agriculture	0	37,220	+37,220
	Herbaceous wetlands	66	0	-66
	Montane mixed conifer forest	24	2899	+2,875
	Open water – lakes, rivers, streams	1,057	2,868	+1,811
	Ponderosa pine/interior white oak forest & woodlands	0	376	+376
	Urban or residential	0	5,008	+5,008
	Westside grasslands	51,268	438	**-50,830**
	Westside lowland conifer-hardwood forest	202,832	241,870	+39,038
	Westside oak/dry Douglas-fir forest & woodlands	35,670	4,515	**-31,155**
	Westside riparian wetlands	8,374	4,208	**-4,166**

Data source: NPCC (2004b)

Wetland Prairie: Wetland prairie and seasonal marsh habitat includes areas that are outside of the annual floodplain of rivers, are inundated or saturated for only part of the year by lentic (non-flowing) water, are dominated by vegetation characteristically associated with wetlands, and contain hydric soils (NPCC 2004b). Wetland prairie and seasonal marsh habitats have been identified as a priority for protection and restoration in ecological assessments for Willamette Basin (NPCC 2004b). Species of concern that are associated with this habitat include fringed myotis, Bradshaw's lomatium, Willamette daisy, bald eagle, peregrine falcon, purple martin, streaked horned lark, western pond turtle, and red-legged frog.

Along with upland prairies and oak woodlands, wetland prairies were a prominent feature of the lower elevations of the basin until the late 1800s. As was true of the upland prairies, the dominance of herbaceous vegetation was maintained largely by frequent fires set by indigenous tribes. Loss of wetland prairie in the Willamette Valley since pre-settlement times has been estimated at 99%, and loss of other herbaceous wetlands is estimated at 57% (NPCC 2004b). As shown in Table 17, the west side riparian wetlands land cover type has had large acreage losses in the lower Coast and Middle Fork subbasins.

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

Ponds and most other lentic waters have not been accorded a priority for protection and restoration in ecological assessments for the Willamette Basin. This may be due to their relative abundance, lack of evidence of major decline from historical extent, apparent absence of any endemic species, and lack of ecological survey effort. Nevertheless, ponds and their riparian areas provide a remarkable contribution to regional biodiversity. Species of concern that are associated with this habitat include fringed myotis, bald eagle, peregrine falcon, purple martin, red-legged frog, Oregon spotted frog, and western pond turtle (NPCC 2004b).

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

Riparian Areas of Rivers and Streams: This habitat type includes all lotic (flowing water) areas and their adjoining riparian areas, as well as natural and artificial channels (rivers, streams, and ditches; NPCC 2004b). The importance of perennial streams, rivers, and riparian areas for aquatic animals (notably salmon and trout) are widely recognized by laws, policies, and science for the Willamette Basin (NPCC 2004b). Less often noted is the importance of this habitat type for wildlife. Species of concern that are strongly associated with this habitat include bald eagle, harlequin duck, foothill yellow-legged frog, and western pond turtle.

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

In the future without-project condition, there is likely to be some restoration of terrestrial habitats, primarily on public lands. Additionally, forest areas will likely age and become higher quality in many areas. The Corps, state and local parks and federal landowners are conducting some restoration actions, particularly to restore pond turtle habitats and prairies and for USFWS to recover listed species. However, with continuing population growth and development, it is likely that some existing habitats on private lands will be converted to residential or other land uses and wildlife habitats on agricultural lands will also be reduced. The *Willamette River Basin Planning Atlas* (Hulse, *et al*. 2002) scenarios identify a potential benefit to wildlife species and terrestrial habitats if conservation actions are undertaken. Particularly, coniferous forest habitats and amphibian/reptile habitats will likely improve. If the development scenario occurs, then terrestrial habitats will likely remain similar to the existing condition, or slightly worsen.

3.2.6. Socio-Economic Conditions

The Willamette River basin has been important to the region since initial settlement, fostering the socioeconomic development of the region. The basin is the most populated area in Oregon and its water resources have been developed to provide and support many economic uses including:

- Flood risk management
- River-related recreation
- Water supply for irrigation and municipal and industrial use
- Hydropower
- Navigation

Demand for these economic services is a function of population and economic activity in the Basin. This section provides a summary of population trends in the Middle and Coast Forks followed by a discussion of the two primary elements that could be affected by this project, flood risk management and river-related recreation. As this study is not proposing to modify dam operations, water supply, hydropower and navigation will not be discussed further, except navigation in the recreational context.

3.2.6.1 Coast Fork Willamette River Subbasin Population

Incorporated cities in the Coast Fork Willamette River subbasin are Creswell and Cottage Grove. Unincorporated communities include Goshen, Pleasant Hill, Saginaw, Dorena, London, and Culp Creek. Population data for incorporated cities is shown in Table 19.

Table 19. Population Data for Incorporated Cities, Coast Fork Subbasin

City	2010 Population Estimate	April 1, 2000 Census Population	Population Change 2000-2009	Percent Change 2000-2010
Creswell	5,031	3,579	1,452	41%
Cottage Grove	9,686	8,445	1,241	15%
Source: Cai 2006; US Census 2012: http://2010.census.gov/2010census/popmap/ipmtext.php?fl=41				

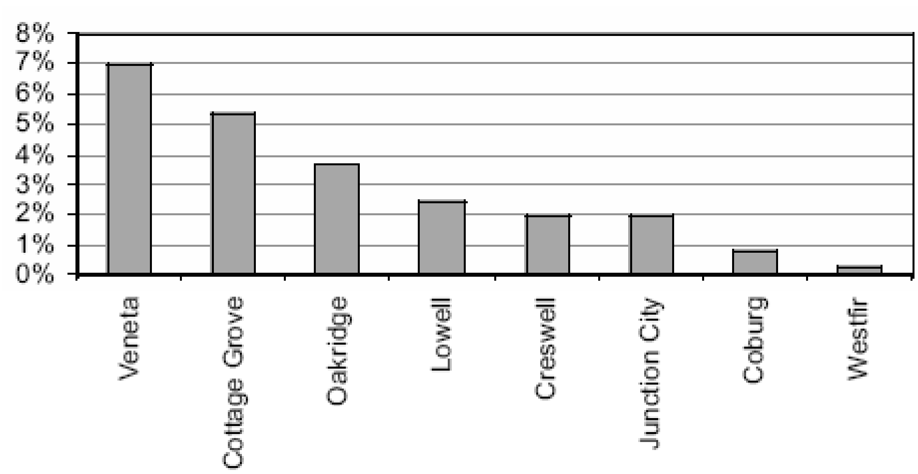
The City of Creswell is located approximately 10 miles south of Eugene-Springfield along Highway 99 and Interstate 5. Creswell is situated in a relatively flat river valley with a backdrop of forested foothills to the east and west. Hills Creek flows through town north toward the Coast Fork of the Willamette River and Camas Swale Creek lies to the north of town. Creswell has grown from a farming community into a small city with close ties to the Eugene-Springfield area. Creswell currently has a diverse economic base and higher-end commercial and residential development activity. Foster Farms and Creswell Forest Products account for about one third of Creswell's employment (LCOG 2000d). Other employers include Bald Knob Land & Timber Company, a veneer mill; RENS Manufacturing, a metal detector manufacturer; Northwest Fir Products, a producer of specialty timber products; and numerous retail and cottage industries. Over half of Creswell workers currently commute to jobs in the Eugene-Springfield area (LCOG 2000d).

The City of Cottage Grove is located about 17 miles south of Eugene. The city is bisected by Interstate 5, with its downtown situated west of the interstate. Cottage Grove is situated just above the confluence of the Coast Fork and Row Rivers. Cottage Grove is the largest city along Interstate 5 between Eugene and

Roseburg; it is the largest city in the Coast Fork subbasin and serves as the area's major trade center. About 69% of workers in Cottage Grove commute to the Eugene-Springfield area along Highway 99 and Interstate 5. The largest employment sectors in Cottage Grove are retail trade and services. Education is the next largest sector followed by other professional services and timber-related industries. Examples of small local manufacturing companies in Cottage Grove include panelized housing, model-building kits, and handmade hardwood crafts (LCOG 2000e).

According to the Lane Council of Governments (LCOG) Region 2050 study (LCOG April 2001), there are about 16,174 undeveloped acres within urban growth boundaries (UGBs) in the southern Willamette Valley region; about 26% of the total UGB land area (includes Eugene and Springfield). Of these, about 10,613 acres (66%) are designated residential in comprehensive plans, 21% are designated industrial, 5% commercial, and 8% for other uses including parks and open space. However, much less land than this is available for development because some undeveloped land is not buildable due to physical constraints such as floodways, steep slopes, and unstable soils.

The population of the southern Willamette Valley region is projected to nearly double in the next 50 years, from 297,811 to 515,000 in the year 2050. For the most part, these new residents will reside in cities. The UGBs of Eugene and Springfield contain the largest share of the region's undeveloped residential land, about 48% and 30%, respectively, followed to a lesser extent by Veneta, Cottage Grove, and Oakridge (Figure 20). New residents also will live on rural residential lands; there are as many as 3,000 undeveloped residential parcels in the region outside UGBs, based on a tax lot analysis and current zoning (LCOG April 2001).



Note: Not all undeveloped land is suitable for residential or commercial development. Source: LCOG April 2001.

Figure 23. Regional Share of Undeveloped Residential Land in Non-metro UGBs, 2000

As the population grows, the increased pressure to develop floodplain lands will likely place more infrastructure at risk from flooding. Increased development of tributary watersheds would increase peak flows and volume of runoff to the floodplain areas of the Coast Fork and Middle Fork Willamette, as well as to the floodplain on the mainstem Willamette River. Flood damages would likely increase. Climate change scenarios with increased rainfall predictions could also cause flood damages to increase.

Urban growth also will likely result in significant potential for increased point and non-point water quality impacts. The effect of continued use and development of watershed management plans (local, state, federal) in offsetting these impacts is uncertain.

Population pressures will increase demand for water for drinking, irrigated agriculture, recreation uses, and other demands affecting flow quantity and therefore quality, particularly during low-flow (summer) periods. At the same time, it is likely that community concern to protect and restore indigenous wildlife habitat, and to be able to enjoy high-quality native landscapes from an aesthetic and recreational viewpoint, would increase.

According to the Willamette Basin Planning Atlas (Hulse *et al*., 2002), changes in the basin have been substantial since Euro-American settlement. By 1990, 42% of the Willamette Valley had been converted from natural vegetation to agricultural use and 11% to structures. The acreage of older coniferous forests (>80 years) was reduced by two-thirds. As a result of these and other landscape changes, indicators of natural resource condition were generally 30% to 90% higher prior to Euro-American settlement than today. Although the number of people living in the basin is expected to nearly double over the next 50 years, more landscape change, and thus more environmental effects, occurred from 1850 to 1990 than stakeholders considered plausible from 1990 to 2050, regardless of the future scenario.

3.2.6.2 Middle Fork Willamette River Subbasin Population

Incorporated cities in the Middle Fork Willamette River subbasin include portions of south Springfield and Pleasant Hill, Lowell, Westfir, and Oakridge. Unincorporated communities include Jasper, Fall Creek, Trent and Dexter. Population data for incorporated cities in the subbasin are shown in Table 20.

Table 20. Population Data for Incorporated Cities, Middle Fork Subbasin

City	2010 Population Estimate	April 1, 2000 Census Population	Population Change 2000-2010	Percent Change 2000-2010
Lowell	1,045	880	165	19%
Westfir	253	280	-27	-10%
Oakridge	3,205	3,172	67	2%
Source: Cai 2006; US Census 2012				

The City of Lowell is approximately 20 miles southeast of Eugene and borders the north shore of Dexter Lake. According to the Lane Council of Governments (LCOG 2000a), the majority of workers living in Lowell commute to the Eugene-Springfield area. The major route to the city is on Interstate 5 by way of Highway 58, passing Dexter and Pleasant Hill. Highway 58, a major freight route, continues past Lowell, southeast through Oakridge, and later intersects with Highway 97 in eastern Oregon. Employment in Lowell is provided by the Forest Service, two manufacturers, the high school, and several small retailers. Employment oriented around forestry and forest products has declined in recent years, and small, independently owned businesses have grown. Specialty agriculture also has growth potential for the local economy. Lowell enjoys ready access to water-oriented recreational such as boating, fishing, swimming, and kayaking (LCOG 2000a).

The City of Westfir is located in the forested hills along the western slopes of the Cascade Mountains and is a small residential community. The town centers on the North Fork of the Middle Fork Willamette River, which flows through town before converging with the Middle Fork Willamette. Surrounded by the Willamette National Forest, the area has historically supported the wood products industry and now supports expanding recreational activities. Highway 58 links Westfir to the Eugene-Springfield area about 40 miles to the northwest, and to the City of Oakridge about 5 miles to the southeast. Travel to Oakridge or to Eugene-Springfield is necessary for access to goods, services, and jobs. Most Westfir residents are employed in manufacturing, agriculture/forestry/fisheries, retail, or construction trades. The largest employers in the area are the Oakridge/Westfir School system and the Forest Service (LCOG 2000b).

The City of Oakridge is located about 45 miles east of Eugene-Springfield and is bordered along the south by the Middle Fork Willamette River. Hills Creek Reservoir lies just south of Oakridge and Salt Creek Falls, the second highest waterfall in Oregon, is 16 miles east on Highway 58. State Highway 58 links Oakridge to points east including the Willamette Pass ski area and State Highway 97, and points west including Interstate 5 and the Eugene-Springfield area. The Aufderheide National Scenic Byway links the Oakridge area with the McKenzie River corridor and the Three Sisters Wilderness Area (LCOG 2000c).

The city's position as a gateway to Willamette Pass continues to define its economic and community development. Thousands of people pass through Oakridge each year to enjoy Willamette Pass recreational opportunities. The city also serves as the basic services center for residents of Oakridge, Westfir, and the surrounding rural area. Oakridge continues to be well-positioned to host secondary wood products industries and recreational vehicles manufacturing, as well as to attract tourists and serve as a hub for recreation. The main industries include manufacturing, retail, agriculture, forestry, fisheries, and construction. The largest manufacturers are Armstrong Wood Products, Oakridge Sand and Gravel, Davidson Construction, and Diamond Traffic Products. The largest local employer is School District 76 (LCOG 2000c).

3.2.6.3 Floods and Flood Damages

As previously described, annual flooding was common in the Middle Fork and Coast Fork subbasins before the construction of the dams. Flood risk management is the primary purpose of the Corps' Willamette projects. The five Corps dams upstream of the study area play an important role in controlling local flooding and also controlling flood stages downstream along the Willamette River. In the future without-project condition, flood risk management will remain the primary purpose of the Corps' Willamette projects. Dam operations are being evaluated for changes that can be made to comply with existing and future requirements under the recent Biological Opinions (NMFS 2008a; USFWS 2008).

3.2.6.3.1 Coast Fork Willamette River

Two Corps projects in the Coast Fork Basin provide storage for flood risk management (Cottage Grove on the Coast Fork and Dorena on the Row River). Cottage Grove has provided over $1 billion (unadjusted) in estimated flood risk management benefits since it began operating in 1942. Dorena has provided over $3 billion (unadjusted) in estimated flood risk management benefits since it began operating in 1949. (USACE 2005 unpublished data).

On the Coast Fork Willamette River, gage data is available from two gage stations, one located at Goshen, which is active today; and the other located at Saginaw. Historical peak flows were highest in 1907 and 1910 when flows measured above 57,000 cfs. Mean annual peak flows at Goshen were 20,810 cfs, pre-dam construction and 13,110 cfs, post-dam construction in 1951. Flooding occurs when flows exceed bankfull flows of approximately 12,000 cfs.

3.2.6.3.2 Middle Fork Willamette River

Three Corps projects (Dexter/Lookout Point and Hills Creek on the Middle Fork and Fall Creek on Fall Creek) in the Middle Fork Basin provide storage for flood risk management. The Dexter/Lookout Point project has provided over $4.8 billion (unadjusted) in estimated flood risk management benefits since it began operating in 1954. The Hills Creek project has provided over $3 billion (unadjusted) in estimated flood risk management benefits since it began operating in 1961. The Falls Creek project has provided over $2.3 billion (unadjusted) in estimated flood risk management benefits since it began operating in 1965. (USACE 2000b)

Two gauging stations provide discharge data for the lower Middle Fork Willamette River; Jasper and Dexter. Natural flows before dam operations went online in 1954 show the highest peak flows exceeding 90,000 cfs occurring in 1908 and 1910. Peak flows greater than 40,000 cfs were common during this period (MFWWC 2002), which is twice the bankfull discharge of 20,000 cfs maintained today.

3.2.6.3.3. Willamette River Forks Typical Flood Control Operations

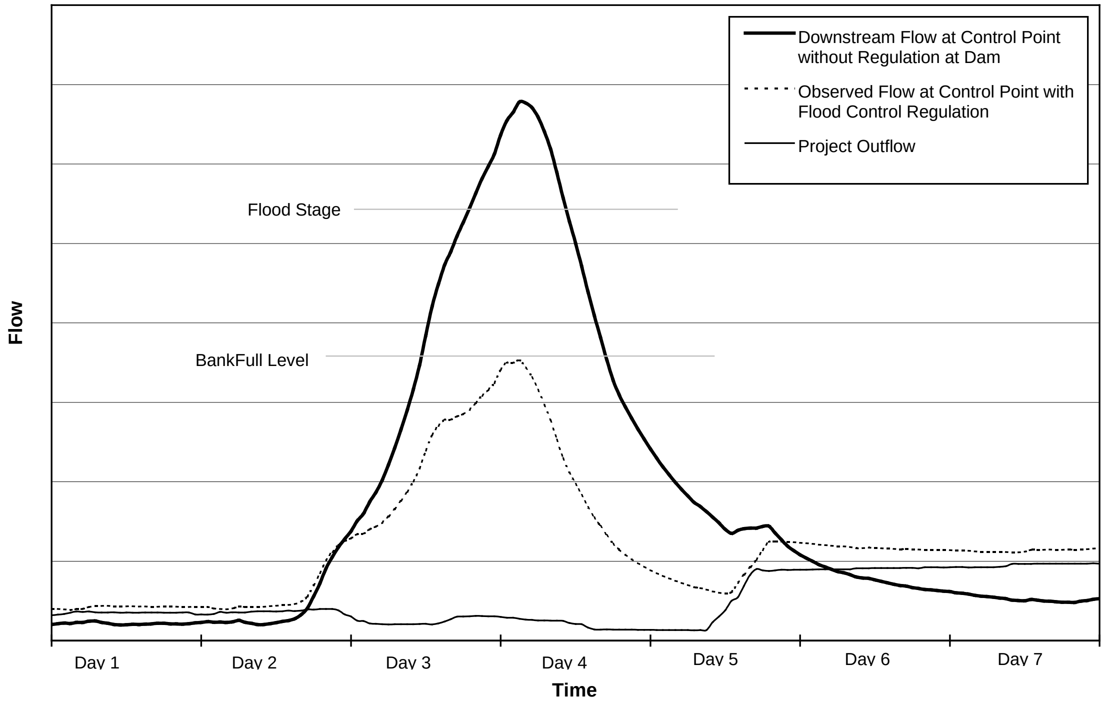
The reservoirs are drawn down to minimum flood control pool beginning in September according to established operating criteria. Releases are made under the normal operating criteria and by considering negotiated discretionary minimum releases made for state water management objectives. For example, there is salmon spawning activity downstream from Dexter (Lookout Point) from mid-September to mid-October; state water management objectives include attempting to keep flow levels constant and within specific flow ranges to prevent salmon redds from being dewatered.

The major flood control season in the Willamette Basin occurs primarily from early December to the end of January. During the flood control season, each reservoir is maintained at a minimum flood-control level to store water during flood events for subsequent controlled release. A normal operation during a flood event usually requires quick reductions in project releases, sometimes in a matter of hours, in order to prevent overbank or flooding conditions at control points located immediately downstream of each project and on the mainstem Willamette River (bank-full discharge). A representative flood control operation is depicted in Figure 24.

Bank-full discharge is an important operational guideline for the Willamette projects. In general, when flow forecasts predict that the flow at a control point will exceed the bank-full discharge, reservoir operations are modified in an attempt to keep flow below the bank-full discharge. The bank-full discharge on the Middle Fork of the Willamette River at the Jasper control point is 20,000 cfs. The bank-full discharge on the Coast Fork Willamette River at the Goshen control point is 12,000 cfs. However, specific bank-full discharges are only general operation guidelines because the Willamette projects are operated as a system. During system-wide flood operations, the bank-full discharge at an upstream control point may be exceeded or the flow may be kept lower to address other downstream concerns and reduce overall basin-wide flood damages.

Given the rain-driven nature of the Willamette Basin and how quickly river levels can rise, timing of flow reductions is of crucial importance in reducing the peak flow and flood damages. The large size of the basin may influence which projects have their releases controlled during a flood event, depending on storm track and subbasin-specific conditions, and project-specific features may constrain how each project is operated. Continuous monitoring of hydrometeorological conditions in and near the basin is accomplished with a real-time data collection system. The real-time data are used to prepare flood forecasts and schedule project releases, generally for the next 72 hours.

Inflows are generally passed through each project until flood forecasts predict that a reduction in outflows is necessary to prevent project releases from combining with uncontrolled local flow to exceed flood regulation goals at the downstream control points. The effect of these reductions from one or multiple projects at a control point is a function of travel time and the rate of rise of flood waters. After flows have receded and the danger of flooding has passed, release of stored flood water is coordinated among the projects to prevent overbank flow conditions downriver, and to return the reservoir to the minimum flood control pool in anticipation of the next flood event.



Source: USACE 2000a

Figure 24. Typical Flood Control Operating Strategy for the Willamette Projects

Figure 25 shows the FEMA floodplain and floodway for the study area along the Coast and Middle Forks. More detailed maps of the FEMA floodplains are shown in Appendix E for Reaches C1, C3, M1 and M2. The majority of the areas being considered for restoration are located within the 100-year floodplain. There are still significant areas within the floodplain, in spite of the dams. In the 1996 floods, the southern Willamette Valley was not hit as hard as the northern Willamette Valley. The only location within the study area of significant flood damages was in Cottage Grove at the confluence of the Row River with the Coast Fork. Bank erosion occurred in several locations. Controlled outflows from the dams on the Coast and Middle Forks generally prevented flooding of structures and infrastructure, but many of the undeveloped floodplain areas considered in this study were flooded.

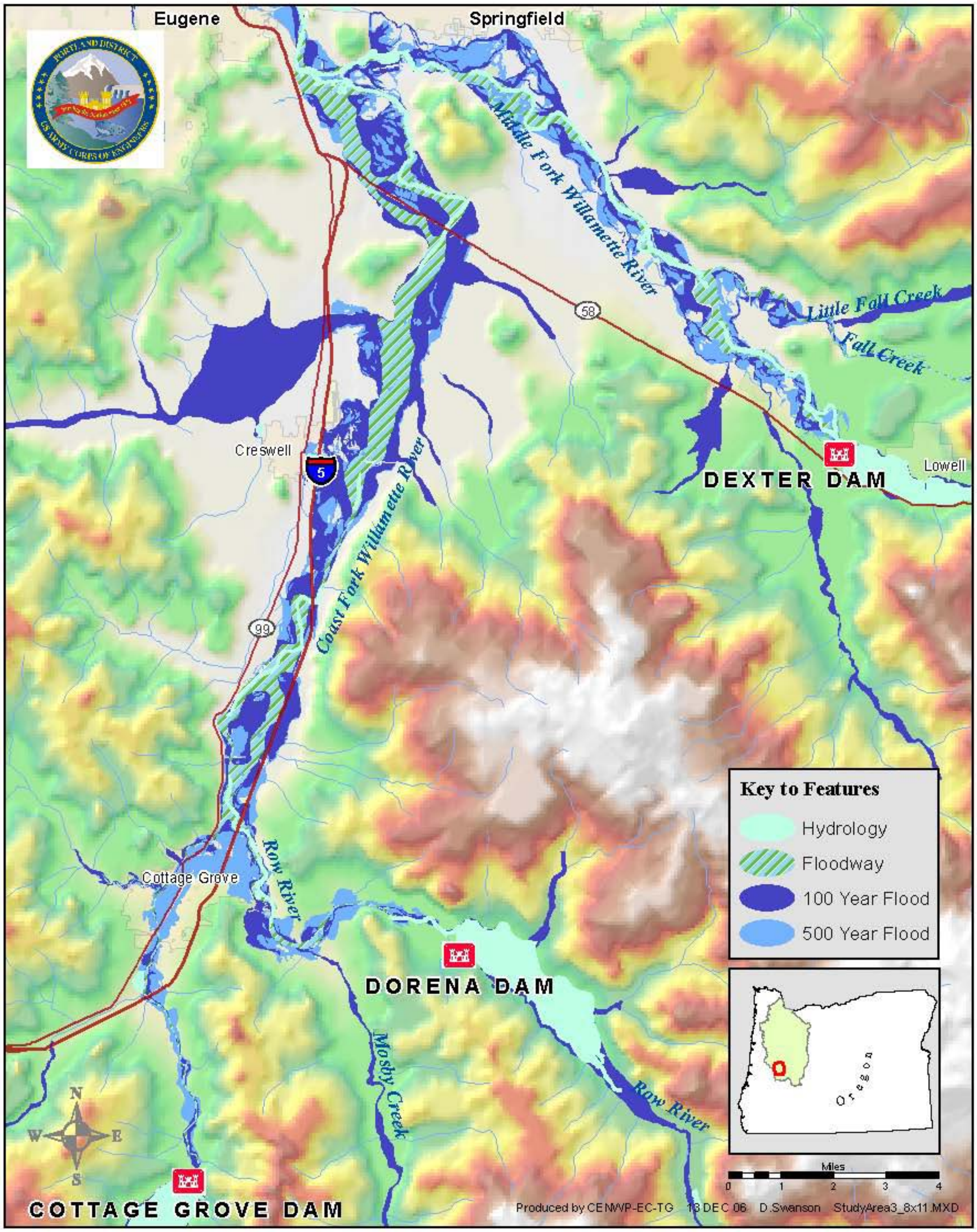


Figure 25. FEMA Floodplain and Floodway along the Lower Coast and Middle Forks.

3.2.6.4 River-Related Recreation

A wide variety of river corridor recreational opportunities are available in the Middle Fork and Coast Fork subbasins. The primary providers of recreational facilities are the Corps, Lane County Parks, Oregon Parks and Recreation Department (OPRD), and the Forest Service's Willamette National Forest (Middle Fork subbasin) and the Umpqua National Forest (Coast Fork subbasin). Recreational sites in the Middle Fork and Coast Fork Willamette subbasins are expected to see increasing visitation pressures in the future as the population in the area grows. Table 21 presents the major river related recreation sites in the study area and identifies the managing entity, recreation features, and approximate location of each.

3.2.6.4.1 Coast Fork Recreational Visitation

Cottage Grove Lake: Cottage Grove Lake is popular for water-skiing, fishing, lakeside camping, and day use associated with waterborne recreation. Approximately 559,000 recreation visits were made to Cottage Grove recreation areas in 1996.

Dorena Lake: Dorena Lake offers a variety of recreation activities, and is a popular boating lake with a higher percentage of sailboats and sailboards and a smaller percentage of water skiers than Cottage Grove Lake. Approximately 433,000 recreation visits were made to Dorena recreation areas in 1996.

3.2.6.4.2 Middle Fork Recreational Visitation

Fall Creek Lake: Fall Creek Lake has a moderate level of recreational facilities. Approximately 249,000 recreation visits were made to Fall Creek recreation areas in 1996. The lake is heavily used for water-based recreation, especially boating, fishing, swimming, and water-skiing.

Dexter Lake: Dexter Lake is popular for day-use recreation activities and boating. Approximately 347,000 recreation visits were made to Dexter recreation areas in 1996.

Lookout Point Lake: Lookout Point supports a relatively low amount of recreational use. Recreational use is constrained by a lack of facilities, difficult access, and high degree of reservoir fluctuation. Approximately 127,000 recreation visits were made to Lookout Point recreation areas in 1996.

Hills Creek Lake: Recreational use at Hills Creek is constrained by a lack of facilities, difficult access, and high degree of reservoir fluctuation. Visitors are attracted mainly for fishing and camping. Approximately 71,000 recreation visits were made to Hills Creek recreation areas in 1996. The lake is surrounded by the Willamette National Forest and all parks are operated by the Middle Fork Ranger District.

The reservoirs and the rivers provide opportunities for recreational boating including water-skiing (reservoirs only), fishing, kayaking, and canoeing. Potential modifications to the reservoirs are not included in this study and thus boating on the reservoirs will not be affected by any potential restoration activities. Boating on the rivers could be affected by the placement of in-stream structures, but as the plans are formulated, the designs will take consideration of the potential effects on boating in order to minimize any conflicts.

Table 21. River-Oriented Recreation in the Study Area

Recreation Site	Managing Agency	Recreation Features	Approximate Location*
Coast Fork Willamette River			
Buford Recreation Area	Lane County	Restrooms, Picnicking, Hiking, Water	RM 2 to 6
Seavey Landing	OPRD	Boat Access, Camping	RM 4.5 to 5
Camas Swale Landing	OPRD	Boat Access	RM 9 to 9.5
Bristow Landing	OPRD	Boat Access	RM 10 to 11
Cinderella Park	Lane County	Undeveloped	RM 12
Cloverdale Access	OPRD	Vehicle Access, Restrooms	RM 12.75
Cougar Mountain Access	OPRD	Vehicle Access, Restrooms, Picnicking, Hiking	RM 15- 15.5
Coast Fork Access	OPRD	Boat Access	RM 16.5
Lynx Hollow Access	OPRD	Vehicle Access, Restrooms, Boat Ramp, Hiking	RM 16.75 to 17.25
Giddings Creek Landing	OPRD	Boat Access	RM 17.3
North Regional Park	City of Cottage Grove	River Access, Biking, Hiking	RM 21
Riverside Park	USACE	Picnicking, River Access	RM 29
Lakeside Park	USACE	Day Use, Restrooms, Boat Ramp, Picnicking, Water	Cottage Grove Lake (East Bank)
Shortridge Park	USACE	Day Use, Restrooms, Picnicking, Water	Cottage Grove Lake (West Bank)
Pine Meadows Campground	USACE	Restrooms, Showers, Camping, Picnicking, Water, Swim Area	Cottage Grove Lake (West Bank)
Primitive Campground	USACE	Restrooms, Camping, Water	Cottage Grove Lake (West Bank)
Wilson Creek Park	USACE	Day Use, Restrooms, Boat Ramp, Picnicking, Water	Cottage Grove Lake (West Bank)
Row River			
Schwarz Park	USACE	River Access, Camping, Water Restrooms, Showers, Picnicking, Children's Play Area	Just downstream from Dorena Lake
LaSells Stewart Park	Lane County	Access	Row River
Currin Covered Bridge	Lane County	Nationally designated historic landmark	Row River
Vaughan Park	Lane County	River Access	Lower Dorena Lake
Bake-Stewart Park	USACE	Day Use, Picnicking	Dorena Lake
Harms Park	USACE	Picnicking, Boat Launch, Camping	Dorena Lake
Baker Bay Park	Lane County	Day Use, Picnicking, Boat Ramp, Parking, Hiking Access to Row River Trail	Dorena Lake
Dorena Bridge Park	Lane County	Nationally designated historic landmark	Just upstream of Dorena Lake

Recreation Site	Managing Agency	Recreation Features	Approximate Location*
Middle Fork Willamette River			
Dorris Ranch Living History Farm	Willamalane Park District	Restrooms, Picnicking, Hiking, Water	RM 187 to 188
Clearwater Boat Ramp	Willamalane Park District	Restrooms, Boat Ramp, Picnicking, Hiking,	RM 191
Pisgah Landing	OPRD	Boat Access	RM 192.8
Log Jam Landing	OPRD	Boat Access, Camping	RM 194
Log Jam Access	OPRD	Car Access, Restrooms, Hiking	RM 194.75
Jasper Bridge Ramp	Lane County	Boat Ramp	RM 195
Jasper Bridge Access	OPRD	Car Access, Hiking	RM 195.2
Jasper State Recreation Site	OPRD	Restrooms, Picnicking, Hiking, Water	RM 195.6 to 196.2
WRG Parcel - Middle Fork Access	OPRD	Boat Access	RM 196.8
Green Island Landing	OPRD	Boat Access	RM 199
Pengra Access	OPRD	Restroom, Parking, Boat Launch, Picnicking,	
Elijah Bristow State Park	OPRD	Car Access, Restrooms, Picnicking, Hiking, Water, Bicycling, Horse Trail	RM 200.5 to 203.5
Dexter State Recreation Area	OPRD	Picnicking, Swimming, Boating, Camping, Fishing, Horse Trail, Disc Golf Course	Dexter Lake
Lowell State Recreation Site	OPRD	Picnicking, Swimming, Boating, Boat Slips, Marina, Boat Ramp, Walking Trail, Fishing	Dexter Lake
North Shore Boat Ramp	USACE	Boat Ramp	Near Lookout Point Dam
Meridian Park	USACE	Day Use, Boat Ramp, Courtesy Dock	Lookout Point Lake
Ivan Oakes Park	USACE	Currently closed for renovation	Lookout Point Lake
Signal Point	USACE	Day Use Boat Ramp, Courtesy Dock, Picnicking	Lookout Point Lake
Hampton Campground	U.S. Forest Service	Camping, boating, swimming, fishing, water skiing	Upper end of Lookout Point Lake
Black Canyon Campground	U.S. Forest Service	Camping, picnicking, swimming, fishing, hiking, boating	Upper end of Lookout Point Lake
Cline-Clark Picnic Ground	U.S. Forest Service	Picnicking, Fishing	Hills Creek Lake
C.T. Beach Picnic Ground	U.S. Forest Service	Picnicking, Fishing, Hiking, Boating, Bicycling	Hills Creek Lake
Bingham Boat Ramp	U.S. Forest Service	Boat Ramp	Hills Creek Lake
Sand Prairie Campground	U.S. Forest Service	Camping, RV Camps, Utilities,	Hills Creek Lake

Recreation Site	Managing Agency	Recreation Features	Approximate Location*
Packard Creek Campground	U.S. Forest Service	Camping, RV Camps, Utilities, Swimming Beach, Boating, Picnicking, Fishing, Hiking, Bicycling,	Hills Creek Lake
Fall Creek			
Fall Creek Park (Unity)	Lane County	Picnicking, Barbecue, Horseshoe Pits, Riverfront Access	Approximately 1 mile downstream of Fall Creek Dam
Fall Creek State Recreation Area - Winberry Creek	OPRD	Day-use boating, Boat Ramp, Restrooms, Waterskiing, Fishing, Swimming, Picnicking	Fall Creek Lake
Fall Creek State Recreation Area - Northshore Park	OPRD	Day-use boating, Waterskiing, Fishing, Swimming, Picnicking	Fall Creek Lake
Fall Creek State Recreation Area -Cascara Campground	OPRD	Swimming, Boat Ramp, Camping, Restrooms, Water	Fall Creek Lake
Fall Creek State Recreation Area - Fisherman's Point Campground	OPRD	Swimming, Boating, Camping, Group Camp	Fall Creek Lake
Free Meadow	OPRD	Picnicking, Restrooms, Parking, Boat Launch	Fall Creek Lake
Lakeside I and II	OPRD	Picnicking, Restrooms, Parking, Boat Launch	Fall Creek Lake
Drinkwater Park	USACE	Day Use, Picnicking	Fall Creek Lake
Tufti Park	USACE	Day Use, Picnicking	Fall Creek Lake
Nelson Creek park	USACE	Day Use, Picnicking	Fall Creek Lake
SKY Camp	Private	Outdoor Youth and Recreation Facility	Fall Creek Lake

Notes:
**River Mile (RM) locations for the Coast Fork start at RM0 (corresponding to the confluence with the Middle Fork) and extend upstream. When referencing RM locations for the Middle Fork, the confluence of the Coast Fork and Middle Fork is referred to as RM 187 and increase moving upstream along the Middle Fork.*
Sources:
Willamette River Recreation Guide, 1988. Published by Oregon State Marine Board and Oregon Department of Recreation.
Water Resources in Oregon, 2000. USACE, Portland District.
Lane County Parks and Open Space Draft Master Plan Update, 2006. Lane County Parks.
USACE Willamette Valley Projects Website, 2006; url: http://www.nwp.usace.army.mil/op/v/home.asp.
Oregon Parks and recreation Department, State Parks. Explore the Willamette Valley Website, 2006. URL: http://www.oregonstateparks.org/searchpark.php?region=willamette_valley.

3.2.6.4.3 Potential Economic Impact of Recreation

Based upon the above visitation estimates, the above Middle Fork Corps Projects combine to provide an estimated total of 794,000 annual visits. The Coast Fork Corps projects combine to provide an estimated 992,000 annual visits. Combining both basins results in total estimated annual visitation of 1,786,000 visitor days.

Corps Economic Guidance Memorandum EGM-12-03 provides the range of unit day values to be applied for valuation of recreation visits in Fiscal Year 2012. These values range from a minimum of $3.72 per user day for low quality general recreation to a maximum of $11.17 for the highest quality general recreation activities. Based upon these ranges, recreational visitation in the parks listed above could have National Economic Development (NED) annual economic value of between $6,644,000 and $19,950,000.

The recreational visitation also provides significant Regional Economic Development (RED) benefits to the study area through local direct spending by recreationists at hotels, restaurants, sporting goods stores, and guide services. Indirect contributions to local and regional economies include room, meal, and other taxes.

3.2.6.4.4 Regional Trails

Eugene to Pacific Crest Trail: The Eugene-to-Pacific Crest Trail is a 108-mile-long, multi-purpose recreation trail connecting the City of Eugene with the Pacific Crest National Scenic Trail in the Cascade Mountains. While portions of the trail are complete, there are still several key sections that are missing. The trail starts in Alton Baker Park in Eugene, follows along portions of the Middle Fork Willamette River, and ends southeast of Waldo Lake. The trail links a myriad of federal, state, and private lands, and the communities of Eugene, Springfield, Jasper, Dexter, Lowell, and Oakridge. Established as part of a statewide comprehensive trails plan in the 1970s, the trail became a reality through a series of public and private cooperative efforts.

Row River Trail, Cottage Grove: The Row River Trail is 15.6 miles long and connects the City of Cottage Grove to Dorena Lake, Culp Creek and the Umpqua National Forest. The trail traverses a variety of landscapes that include urban lands; pasture and farm land; timber lands; Dorena Lake shoreline; and the Row River. Management of the Row River Trail is a coordinated effort between the Bureau of Land Management, the City of Cottage Grove, and other federal and state agencies, nonprofit organizations and businesses in Cottage Grove. The trail attracts an estimated 100,000 visitors annually and the majority of these visits are from Cottage Grove and the surrounding rural communities in Lane County. The trail is a keystone project that has helped with the economic recovery of Cottage Grove, Culp Creek, Oakridge, and surrounding rural communities.

3.2.7. Cultural Resources

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment. The historic preservation review process mandated by Section 106 is outlined in regulations issued by ACHP. Revised regulations, "Protection of Historic Properties" (36 CFR Part 800), became effective January 11, 2001 and August 5, 2004.

As noted at the time of Euro-American contact, the Upper Willamette Valley was populated by Native American peoples who spoke languages belonging to the Kalapuyan language family. At least 13 distinct “bands” or “tribes” were present that roughly correspond with the major tributary subbasins of the Willamette River. The Winefelly band occupied the lower Coast and Middle Forks area including the confluence area (Minor and Toepel 1981; Minor et al. 1980; and Zenk 1990 cited in Heritage Research Associates 2012).

The Kalapuyan bands used a variety of fish, wildlife, and vegetable resources in riverine, lowland and upland habitats. Because Willamette Falls restricted anadromous fish access to the Upper Willamette River basin to Chinook and steelhead, the Kalapuyan bands were not as reliant on salmon as other Northwestern native populations. Kalapuyan settlement and subsistence patterns were closely tied to two primary seasonal patterns (wet winters and dry summers) each year. The rainy seasons were spent at permanent winter villages that consisted of multifamily winter dwellings composed of bark or plank houses, which were often excavated into the ground. Villages also commonly included a dome-shaped sweathouse. Winter subsistence activities included hunting, fishing and use of stored vegetable resources.

Dry seasons were spent in temporary camps near concentrations of specific resources such as camas shoots and bulbs. Camas bulbs were collected in large quantities which were roasted in large subterranean rock ovens and then formed into large cakes and dried for storage for winter use or trade. Other vegetable resources such as Wapato were collected in late fall. Hunting and fishing occurred year-round. The practice of burning prairies improved the habitat for camas and other vegetable resources and also provided forage for game animals (Heritage Research Associates 2012).

Archaeological research has been conducted at several sites in the Upper Willamette Valley during the past decades. Artifacts such as large fluted and stemmed projectile points, as well as other stone tools have been found in multiple locations by both amateur and professional archaeologists, but have not been dated. The oldest known sites along the Long Tom River have been radiocarbon dated to between 9660 and 9130 years before present (BP) (Heritage Research Associates 2012). Other Early Archaic Period materials such as roasted camas bulbs and charcoal have been dated to 7750-6525 BP. Middle Archaic Period (6000-2000 BP) artifacts include broad-necked projectile points, milling stone technology and features such as camas ovens, pit houses, and burial sites. The Late Archaic Period (2000-200 BP) is evidenced by the introduction of small, narrow-necked projectile points, which are believed to reflect a change from atlatl and dart technology to bow and arrow use. By about 5000 BP, there was an increase in plant processing using rock ovens. The intensification of processing and storage of food resources has been interpreted as a possible catalyst that led to a significant increase in population, greater social complexity, and increased sedentism (O'Neill et al 2004 cited in Heritage Research Associates 2012).

A review of records at the Oregon State Historic Preservation Office (SHPO) indicates that one prehistoric archaeological site may be located within the study area near the confluence of the Coast and Middle Forks. The site was reported by a local landowner but the presence of archaeological materials was not confirmed in the field by a professional archaeologist. Furthermore, two recent inspections of the location by professional archaeologists did not result in the discovery of artifacts. Although the purported site area is located within the broader study area, the location is not expected to be impacted by the proposed restoration work.

Historic settlement in the study area, as indicated by numerous donation land claims, began in the 1840s. In 1847, Richard Robinson became the Coast Fork subbasin's southernmost settler when he staked his claim just north of present day Cottage Grove (CFWWC 2005). Further settlement in the Coast Fork valley was spurred by emigration along the nearby Oregon Trail and Applegate Trail. For much of the late 1800s and early 1900s, the subbasin's floodplain area was used for a variety of agricultural purposes including fruit and nut orchards, hay production, hops, alfalfa, vegetable crops, as well as livestock grazing. Gold was discovered in the Bohemia Mountains above Cottage Grove in 1858 resulting in a significant increase in settlement in Cottage Grove (Cottage Grove Historical Society 2012). In 1872, the Southern Pacific Railroad line connecting Southern Oregon to Portland was completed.

Historic settlement in the Middle Fork valley followed a similar course as numerous donation land claims (DLCs) were filed for agricultural use of floodplain and prairie areas. Early settlers included Elijah Bristow, for whom the State Park located upstream of Jasper is named. Logging has been a major industry for the area from the earliest historic settlement period up to the present day.

3.2.8. Hazardous Materials

Heavy metals can be toxic to humans who ingest contaminated fish, resident fish and aquatic life. Bioaccumulation is the process of chemicals becoming progressively concentrated from small organisms to larger fish and mammals as they move through the food chain. The bioaccumulation of mercury and PCBs in fish is a recognized environmental problem throughout much of the United States.

Mercury occurs naturally in the environment and can also be released into the air through industrial pollution. Mercury falls from the air and can accumulate in streams and oceans and is turned into methylmercury in the water. Fish absorb the methylmercury as they feed in these waters (EPA 2004).

Polychlorinated biphenyls (PCBs) are colorless and odorless chemicals that were once widely used in electrical equipment such as transformers and capacitors before their production was banned in 1976. Of the 1.2 billion pounds of PCBs produced in the U.S. before 1976, about half has entered the environment through discharges to the air, land, and water. In addition, products that contain PCBs are still often being disposed of improperly. Most PCBs that have entered the environment end up in rivers, lakes, and ultimately the ocean where they enter the food chain (OHA 2011).

3.2.8.1 Coast Fork Willamette River

The Oregon Public Health Division (OPHD 2011) has issued fish consumption advisories for mercury and PCBs in the Coast Fork Willamette Basin. These advisories warn consumers of fish of the health risks associated with eating fish caught from these waters. The Coast Fork Willamette River from RM 0 – 31.3 have high mercury and PCB levels. Dorena and Cottage Grove Reservoir have high and very high mercury levels, respectively (OPHD 2011). These consumption advisories represent an impairment of the beneficial use of fishing in the Willamette Basin and demonstrate that mercury and PCBs are bioaccumulating in fish tissue to levels that adversely affect public health. The ODEQ has listed the Coast Fork Willamette River on the 303(d) list from RM 0 – 31.3, which includes Cottage Grove Reservoir for mercury in the past and has since developed a TMDL for mercury in 2006 (ODEQ 2006).

3.2.8.2 Middle Fork Willamette River

No major issues have been identified with toxics in the Middle Fork Willamette River. A review of the ODEQ water quality data show that standards for toxics have been met in this watershed (ODEQ 2010).

3.2.9. Air Quality

The Environmental Protection Agency (EPA) has established health-based National Ambient Air Quality Standards (NAAQS) for six air pollutants (criteria pollutants): particulate matter (PM10 and PM2.5), ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2) and lead (Pb). Three of the six pollutants are monitored in Lane County: particulate matter, ozone and carbon monoxide. Air Quality in the study area is managed by the Lane Regional Air Protection Agency (LRAPA).

Historically, LRAPA had designated the Eugene-Springfield Urban Growth Area as a non-attainment area for PM10 (particulate matter less than or equal to 10 microns). Currently, Eugene meets the PM10 and PM2.5 standards and is in the process of regaining attainment status. Lane County entirely is in attainment with the federal ozone standards. The Eugene/Springfield area was designated a "non-attainment" area for CO in the late 1970s, but was later redesignated as an attainment area in 1994 (LARPA 2009).

Currently, no activities are conducted on the project sites in the restoration plan and thus no pollutants are being generated locally.

3.2.10. Noise

Lane County noise ordinances (Code 6.5) prohibit noise that exceeds: (a) 50 dBA at any time between 10:00 p.m. and 7:00 a.m. of the following day, or (b) 60 dBA at any time between 7:00 a.m. and 10:00 p.m. of the same day, or (2) Is plainly audible at any time between 10:00 p.m. and 7:00 a.m. of the following day: (a) Within a noise sensitive unit which is not the source of the sound, or (b) On a public right-of-way at a distance of 50 feet or more from the source of the sound.

Generally, the use of construction equipment is allowed between the hours of 7 a.m. and 7 p.m. at normal operating levels. The project sites in the restoration plan are primarily zoned for sand, gravel and rock materials, thus allowing excavation and removal of materials. Some rural residences are located in proximity to Sites C3A and C3B.

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4. Problems and Opportunities

4.1. Introduction

As discussed in the previous chapters, a number of ecosystem degradation problems and floodplain restoration opportunities are present in both the Coast and Middle Forks of the Willamette River. This chapter presents a summary of the problems that have been identified and both general and specific opportunities that are available to restore natural processes and habitats. Some of the recommendations made in the Willamette River Planning Atlas (Hulse *et al*. 2002) that are quite pertinent to the Willamette River Floodplain Restoration Study are provided below.

Restore natural processes and dynamics: Restoring natural processes and dynamics is generally more ecologically and economically effective and sustainable, over the long term, than attempting to create localized desirable habitat features by engineering solutions.

Restore riparian vegetation: Establish riparian vegetation along lowland streams and rivers in agricultural and urban settings. Riparian areas are important habitat for many species of terrestrial wildlife and play a disproportionately large role in stream habitat quality. Thus, riparian vegetation can be a cost-effective means to enhance both aquatic and terrestrial wildlife, in all types of environmental settings: forested, agricultural, urban, and rural residential.

Forested riparian areas provide a wider range and magnitude of benefits than non-forested riparian areas. For several riparian functions (stream shading, woody debris input, nutrient trapping), vegetation nearest the stream has the greatest influence. As a result, reforesting gaps in the longitudinal extent of the riparian zones is likely to be more beneficial than widening existing zones of riparian vegetation. Also, a longer connected riparian zone provides better migration corridors for wildlife species than fragmented riparian patches.

Restore rivers and their floodplains: Natural flow regimes, periodic flooding, complex channels, and fairly wide riparian zone widths will be needed to create and maintain the habitat features and dynamics that make riparian areas especially productive and biologically diverse. In regulated rivers, Corps' reservoirs should be managed to achieve more natural flow regimes (both high and low flows). Erosion and deposition should be encouraged in active channels. Increases in area of off-channel habitats and gravel bars, as well as increases in overall river habitat complexity, would not only have direct habitat benefits, but also could contribute to cooling water temperatures during summer. Also, urban and residential development in 100-year floodplains should be minimized and opportunities identified to reverse past development of buildings and other structures within floodplains (e.g., after flood damage occurs).

Restore habitats for terrestrial wildlife: Because different species have different habitat requirements, a greater number of species (diversity) are likely to occur with a greater diversity of habitat types. About 80% of bottomland forest, 97% of natural grassland, and nearly 100% of oak-savanna habitats that occurred historically in the basin have been lost. These habitats once supported unique sets of species that do not thrive in the remaining habitats. Thus, restoration of these specific habitat types would be particularly beneficial to biodiversity in the basin. In addition to the amount of habitat available for a species, the distribution of habitat on the landscape can be a major factor in determining wildlife abundance and viability. It is preferable to place high quality habitat within reach of other good sites, and likewise to cluster poor quality habitats. Also, avoid barriers to movement that separate good habitats.

4.2. PROBLEMS AND OPPORTUNITIES

Table 22 identifies the major problems in the basin, as derived from the limiting factors analysis, that have caused a loss of habitats, the goals and objectives that relate to each of these problems, and then specific types of opportunities that could address those problems, with potential locations to conduct restoration activities. The goals and objectives developed in the reconnaissance study (Table 2) included both study goals as well as restoration goals, but have been refined in this study to focus only on restoration goals and opportunities that can be brought forward for implementation.

4.3. NATIONAL PLANNING OBJECTIVES

Ecosystem Restoration is one of the primary missions of the USACE Civil Works program. Guidance document ER 1165-2-501 states:

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

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

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

Floodplain restoration is consistent with the USACE ecosystem restoration mission as well as the ecosystem restoration federal objective.

Table 22. Specific Restoration Problems and Opportunities

Ecosystem Problems	Goals/Objectives from Table 2.	Opportunities	Key Locations
Loss of Natural Floodplain Processes	**Restoration Goal 1: Restore natural floodplain ecosystem function and conditions to the Coast and Middle Fork Subbasins.**		
Lack of Floodplain Connections and Storage	Restoration Objective 2. Restore connectivity of the river to floodplain habitats.	- Remove or setback levees and revetments - Remove fill or structures in floodplain - Reconnect side-channels and oxbows - Restore floodplain wetlands and storage areas - Reconfigure/restore gravel ponds for storage and habitat	- Remove or setback levees at MF at RMs 190, 192, 194, 198, 202; CF at RMs 6-10, 18,19, confluence with Row River. - Gravel ponds at MF/CF confluence, CF at RMs 18, 19, Row River confluence.
Lack of Natural Sediment Erosion/Deposition	Restoration Objective 1. Increase channel complexity and diversity. Restoration Objective 2. Restore connectivity of the river to floodplain habitats.	- Remove or setback levees and revetments - Mimic high velocity flows to promote natural scouring - Transport gravel from above the dams - Add in-stream structures (wood, etc.) to promote localized scour and deposition	- Remove or setback levees at MF at RMs 190, 192, 194, 198, 202; CF at RMs 6-10, 18,19, confluence with Row River. - Potential to place gravel on bends immediately downstream of dams for future recruitment. - Instream wood at MF/CF confluence; in MF at RMs 189, 191, 192, 193, 197, 203; CF at RMs 6-10, 17-19.
Loss of Habitat Quantity and Quality	**Restoration Goal 1. Restore natural floodplain ecosystem function and condition to the Coast and Middle Fork Subbasins.**		
Channelization / Loss of Channel Complexity	Restoration Objective 1. Increase channel complexity and diversity.	- Reconnect side-channels and oxbows - Add in-stream structures (wood, etc.) - Restore riparian zone	- Instream wood at MF/CF confluence; in MF at RMs 189, 191, 192, 193, 197, 203; CF at RMs 6-10, 17-19. - Riparian restoration at MF/CF confluence; MF RMs 192-193, Elijah Bristow; CF RMs 3, 9-11, 17-19, 24-25, 28-dam.

Ecosystem Problems	Goals/Objectives from Table 2.	Opportunities	Key Locations
Lack of Large Woody Debris & Sediment	Restoration Objective 1. Increase channel complexity and diversity. Objective 3. Restore native floodplain habitats, including cottonwood gallery forests, riparian and wet prairie habitats.	- Replace or retrofit rock revetments with LW structures and bioengineering - Place wood in the rivers - Restore riparian areas to provide source for recruitment of wood in rivers - Transport wood and sediment from above the dams	- Instream wood at MF/CF confluence; in MF at RMs 189, 191, 192, 193, 197, 203; CF at RMs 6-10, 17-19. - Riparian restoration at MF/CF confluence; MF RMs 192-193, Elijah Bristow; CF RMs 3, 9-11, 17-19, 24-25, 28-dam.
Invasive Exotic Plant & Animal Species (Aquatic & Terrestrial)	Objective 3. Restore **native** floodplain habitats, including cottonwood gallery forests, riparian and wet prairie habitats.	- Remove non-native plants and replant with native species - Restore natural cold-water habitats - Restore seasonality of off-channel habitats to discourage non-native species	- Riparian zone throughout study area - Floodplains throughout study area.
Fish Passage Barriers	Objective 2. Restore connectivity of river to floodplain habitats.	- Remove fish blocking culverts - Allow overbank flows to promote groundwater recharge to increase low flows in summer	- No culverts on main rivers - Promote groundwater recharge via setback levees at MF at RMs 190, 192, 194, 198, 202; CF at RMs 6-10, 18,19, confluence with Row River.
Loss of Floodplain and Riparian Vegetation Communities	Objective 3. Restore native floodplain habitat, including cottonwood gallery forests, riparian and wet prairie habitats.	- Restore riparian zone with native species - Remove revetments - Reconnect off-channel habitats - Remove non-native plants and replant with native species - Fencing and alternative water supplies for livestock	- Riparian zone throughout study area - Floodplain throughout study area.

4.4. SUBBASIN RESTORATION OBJECTIVES

This study is a major component of broader actions being contemplated by the State of Oregon and other stakeholders in the watershed. The Willamette Subbasin Plan (WRI 2004) and the Upper Willamette Chinook and Steelhead Recovery Plan (ODFW 2007) provide watershed-scale restoration considerations that emphasize a holistic, multidisciplinary approach to evaluating and restoring ecosystem function and structure. The concepts of ecosystem function and structure are closely intertwined and include abiotic and biotic elements and processes. This philosophy emphasizes the need for improving or re-establishing both the structural components and the functions of the riverine ecosystem to restore the conditions necessary to create and maintain habitat benefiting a range of species in dynamic environments.

As shown in Tables 2 and 22, a number of goals, objectives and constraints were identified by the stakeholders in the subbasins. These goals and objectives have been focused on the following primary goal and objectives suitable for federal involvement that directly address the key problems in the basin and were used in the formulation of alternative plans.

Goal 1:

Restore natural floodplain ecosystem function and condition to the Coast and Middle Fork subbasins.

Objectives:

1. Increase channel complexity and diversity
2. Restore connectivity of river to floodplain habitats
3. Restore native floodplain habitats including riparian and wetland habitats

Table 23 shows which problem each objective addresses.

Table 23. Restoration Objectives and the Problems they Address.

	Problems in the Subbasins					
Objective	**Lack of Floodplain Connections**	**Lack of Natural Sediment Processes**	**Loss of Complexity**	**Lack of Large Wood**	**Invasive Species**	**Lack of Floodplain and Riparian Communities**
1. Increase channel complexity and diversity		X	X	X		
2. Restore connectivity of river to floodplain	X	X	X	X		
3. Restore native floodplain habitats			X	X	X	X

4.5. Constraints and Assumptions

Constraints were developed to encompass the physical and policy/programmatic planning constraints. The following bulleted list defines the range of constraints on aquatic ecosystem restoration in the study area.

- Proposed restoration actions must not increase flood elevations or flood damages.
- Proposed restoration actions must not degrade water quality conditions.
- The recommended plan must have willing landowner participation; condemnation will not be utilized.
- Dam Operations
    - The design of restoration measures must account for the current and future changes to dam operations on both the Coast and Middle Forks.
    - This study will not recommend changes to dam operations.
- Costs
    - The local sponsor has requested that the overall total project cost of the recommended restoration plan be limited to$40-50 million, to limit their cost share to approximately $15-20 million.
- Construction
    - Construction will need to occur during the designated in-water work windows for each subbasin
- The formulation of alternatives must avoid adverse impacts to significant cultural resources; and if avoidance is not feasible, then adverse impacts to cultural resources must be minimized. Unavoidable adverse impacts to cultural resources must be mitigated.
- The formulation of alternatives should avoid areas that are either known or suspected to be contaminated and/or contain hazardous, toxic, and radiological waste.
- The project must adhere to Corps Environmental Operating Principles and is environmentally, economically and socially sustainable to the greatest extent practicable.

5. PLAN FORMULATION

5.1. A CONCEPTUAL FRAMEWORK FOR FORMULATING FLOODPLAIN RESTORATION ALTERNATIVES

As described in Section 1.3, the federal planning process has six distinct steps that are iterative in nature and lead to the formulation, evaluation, and selection of a recommended restoration plan. To supplement this planning process, a plan formulation framework was developed to help guide the study participants through the steps of the process. The plan formulation framework used in this study is shown in Figure 26. The flowchart is color-coded; with bright blue showing the current phase (Phase 2). The plan formulation steps are shown in yellow, and would be the same for any future phases/subbasins, although a different level of effort might be warranted based on methodologies developed in this phase. The orange boxes denote specific reports or other products developed in this phase and the previous phase. The light blue boxes show technical studies; the pink boxes show constraints or issues that will affect the evaluation and selection of a plan. Public involvement is shown in green.

In Step1, Identify Problems and Opportunities, the Corps conducted the Reconnaissance Study as described in Chapter 1, and developed goals and objectives for the feasibility phase of the study in conjunction with stakeholders and the public. In Step 2, Inventory and Forecast Conditions, the Corps prepared the Base Conditions Report that has become the discussion of the existing and future without project conditions included as Chapters 2 and 3 in this report. Further iterative refinement of the Problems and Opportunities was described in Chapter 4 to help lead to Step 3. This chapter will now summarize Step 3, Formulation of Alternative Plans, Step 4, Evaluation of Alternative Plans, Step 5, Comparison of Alternative Plans, and Step 6, Selecting a Plan.

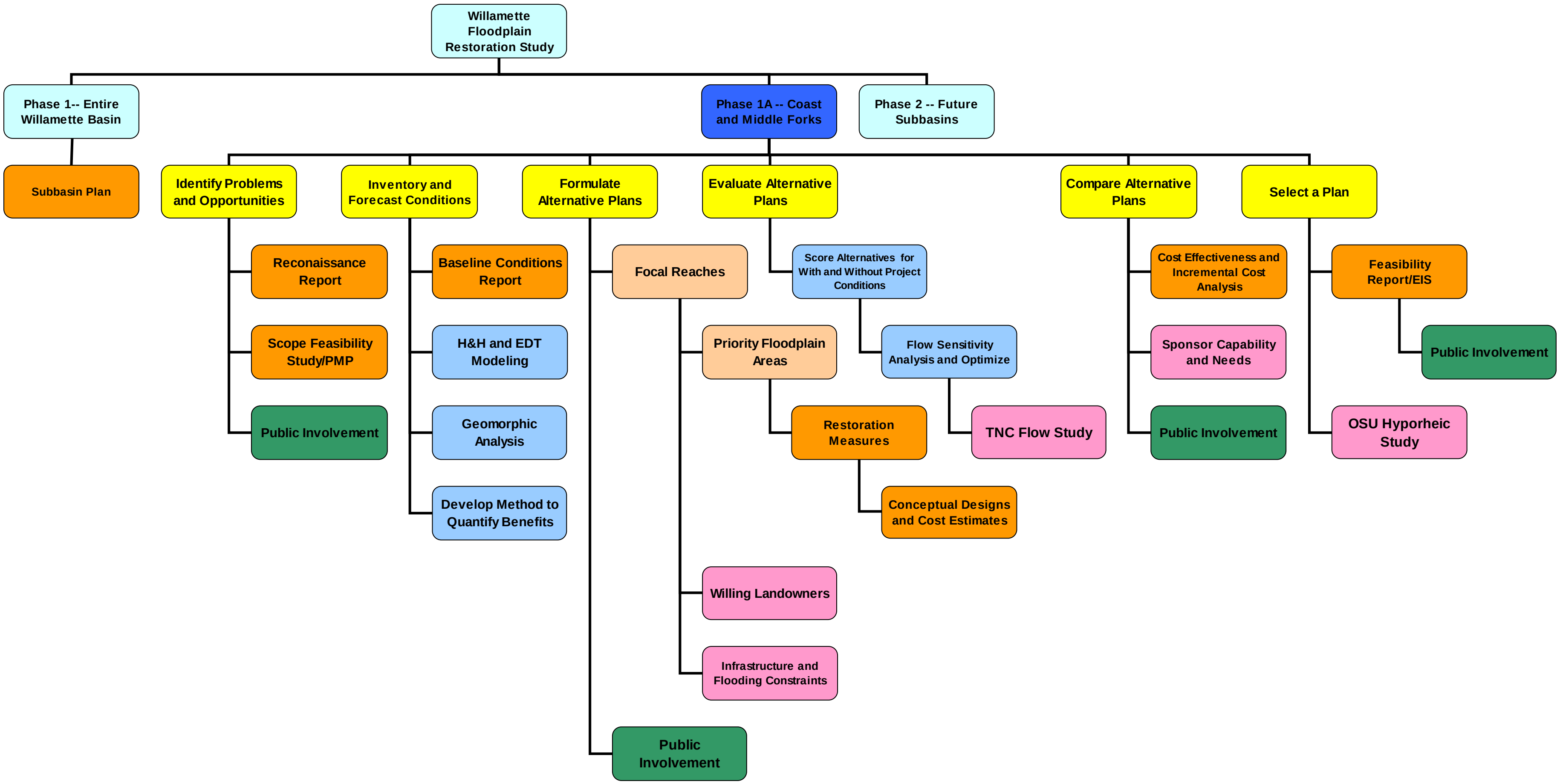


Figure 26. Plan Formulation Framework

5.2. PRIORITY REACHES

Several reaches in the Coast and Middle Forks are of particular interest in this study because of the high potential to reconnect floodplain areas; presence of Corps' revetments that could be considered for modification, public land ownership, low number of structures or other infrastructure present in the floodplain; and the potential to create large connected blocks of habitat. These reaches were designated as priority reaches to narrow down the large watershed area to a more manageable size and are described in more detail below (see map of reaches in Figure 27). The reaches not selected as priority reaches typically have more intensive development in the floodplain and no large floodplain areas that could be restored.

5.2.1. C1 and M1, Coast Fork/ Middle Fork Confluence

The confluence area includes the lower reach of both the Coast and Middle Forks and has high potential for successful restoration because there are extensive publicly owned lands, few structures present in the floodplain (except at the development on right bank immediately downstream of confluence), several gravel ponds that could be restored, existing western pond turtle population, and a moderate amount of existing braiding and gravel bars. The confluence is a natural braided deltaic zone and is located just upstream of the urbanized areas of Eugene and Springfield. There is room to allow natural processes on a moderate scale without disrupting land uses significantly. A key need for further analysis is to identify the most cost effective and beneficial way to restore gravel pits within the context of natural floodplain function without unduly capturing the main river flow, but still providing high quality habitat that is connected to the rivers.

5.2.2. C2, Coast Fork RMs 6-10, Camas Swale Area.

A portion of reach C2 is of high priority interest; the Camas Swale area that extends from approximately RMs 6 to 10 on the Coast Fork and includes several tributary confluences, including Camas Swale, Hill and Bear Creeks. There is a high potential for successful restoration because this was an area of extensive historic channel meandering and floodplain connections, there are several remnant oxbows and other floodplain features, there are multiple Corps' revetments that could be considered for modification, there are some areas of high quality riparian/floodplain vegetation that could be expanded, and there are few structures in close proximity to the river.

5.2.3. C3 and R1, Coast Fork RMs 17-21, Row River Confluence

Reach C3 as well as reach R1 include the Row River confluence area. The area extends from the Row River confluence north on the Coast Fork for 2-3 miles. There is a high potential for successful restoration in this reach because there are significant areas of publicly owned land including North Regional Park, there are multiple gravel ponds that could be restored, several remnant side-channels and oxbows, and fairly wide stretches where there are limited structures in the floodplain. A key constraint is that roads constrain this reach in several locations.

5.2.4. M2, Middle Fork RMs 191-194, Below Jasper

This reach extends from just below Jasper to the gravel ponds immediately northeast of Mt. Pisgah. There is a high potential for successful restoration in this reach because there are virtually no structures in the floodplain, this was an area of historic meandering and gravel bar deposition/erosion, there is a significant amount of riparian/floodplain vegetation that could be expanded, and there are some key revetments that could be removed/modified to spur natural processes where landowners are willing.

5.2.5. M4, Middle Fork RMs 197-200, Fall Creek Confluence Area

This reach includes the Fall Creek confluence and the Middle Fork to the north for a couple of miles. There is a high potential for successful restoration in this reach because the Fall Creek confluence area is a natural deltaic zone with a high potential for braiding and meandering, there are several remnant side-channels and oxbows, there are several areas of riparian/floodplain vegetation that could be expanded, and there are few structures in the floodplain. A limiting factor for salmonids in this reach is the high temperatures during fall as a result of reservoir drawdowns. However, an increase in floodplain hyporheic flow and groundwater recharge could benefit water temperatures and hence, salmonid habitats.

5.2.6. M5, Middle Fork RMs 200-204, Elijah Bristow State Park

This reach has a high potential for restoration of natural processes that can be implemented fairly easily because almost the entire reach is publicly owned. There is substantial existing historic braiding in this reach, but it has been dampened considerably by the operation of Dexter/Lookout Point Dams. This historic meandering and the high quality riparian vegetation could be enhanced significantly by removing some existing bank protection and moving some park features further away from the river to allow meandering without endangering infrastructure. This park also provides excellent opportunities for public education about restoration and enhancement of recreational features (particularly trails). A limiting factor for salmonids in this reach is the high temperatures during fall as a result of reservoir drawdowns. However, an increase in floodplain hyporheic flow and groundwater recharge could benefit water temperatures and hence, salmonid habitats.

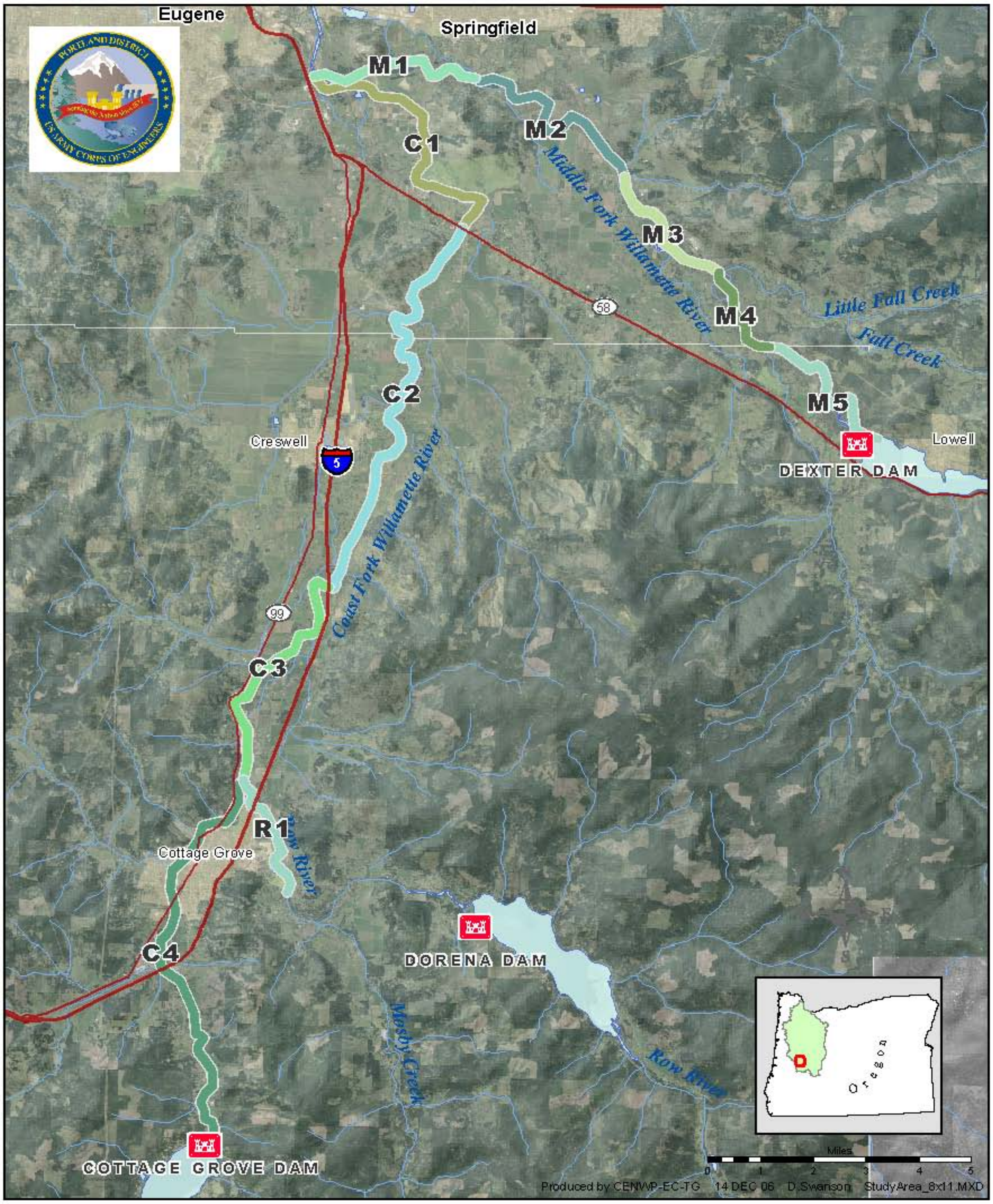


Figure 27. Coast Fork and Middle Fork Study Reaches.

5.3. POTENTIAL RESTORATION MEASURES

Based on the problems and opportunities identified in Chapter 4 and the priority reaches identified in this chapter, there are a number of potential restoration measures that could be undertaken that would each address one or more of the key problems in the watersheds (Table 24). These measures have been formulated initially based entirely on their potential floodplain habitat restoration benefits.

Table 24. Potential Restoration Measures

Potential Restoration Measures	Key Problems Addressed
Remove or Modify Revetments and Levees to Reconnect River to Floodplain and Off-Channel Features	Restores Natural Processes Restores Channel Complexity Increases Floodplain Storage Increases Sediment/Wood Recruitment Increases Hyporheic Flows/Groundwater Recharge
Remove Structures or Fill From Floodplain	Increases Floodplain Storage Increases Habitat Quantity/Quality Provides Riparian/Floodplain Vegetation Restoration Site
Riparian/Floodplain Vegetation Restoration	Increases Wood Recruitment Provides Shading/Cover Reduces Water Temperatures Provides Wildlife Habitat/Corridors
Remove Non-Native Vegetation	Increases Habitat Quantity/Quality Increases Wood Recruitment Provides Shading/Cover Improves Wildlife Habitat/Corridors
Construct Off-Channel/Floodplain Features	Increases Floodplain Storage Increases Habitat Quantity/Quality Increases Hyporheic Flow/Groundwater Recharge Spurs Natural Processes
Placement of Wood In-Channel and Floodplain	Spurs Natural Processes Increases Habitat Quality Provides Cover for Fish and Wildlife
Placement/Scouring of Gravel Bars	Spurs Natural Processes Increases Habitat Quality

5.3.1. Remove or Modify Revetments or Levees

This restoration measure could remove existing rock or concrete revetments on the banks of the rivers to allow the rivers to naturally migrate and create new habitats. This measure could require an existing project to be deauthorized or the O&M agreement to be changed significantly and would only be implemented on sites where the landowners protected by a revetment or levee were willing to allow natural floodplain processes to occur. In areas where benefits provided by the revetment or levee are still required, revetments or levees could potentially be modified to allow controlled flow through a notch or culvert into a side channel or other off-channel habitat. It might also be possible to set back a levee or revetment to allow continued protection of critical structures while allowing floodplain reconnection on a portion of a site.

5.3.2. Remove Structures or Fill from Floodplain

This restoration measure would remove specific structures or fill (such as old roads and abandoned gravel piles) from the floodplain to allow the river to flood and/or migrate without causing any economic damages to the floodplain. This measure would most appropriately be done in conjunction with revetment removal or modification. It could also be implemented in areas where there is active channel migration heading towards existing structures but it would be more economical to move the structure rather than install bank protection.

5.3.3. Riparian/Floodplain Revegetation

This restoration measure would include plantings of native riparian, wetland and upland species in floodplain areas and riparian zones. This could involve complete revegetation in areas where there is little to no existing native vegetation, or underplantings in areas with native tree canopy. This measure would most typically be done in conjunction with the removal of non-native vegetation, since most riparian areas along the rivers have a significant understory of invasive species currently (i.e. Himalayan blackberry).

5.3.4. Remove Non-Native Vegetation

This restoration would involve the active removal of non-native vegetation from the riparian zone and floodplain. Non-native species present include Himalayan blackberry, Japanese knotweed, reed canary grass, yellow flag iris, holly, English ivy, teasel, and other invasive species. A number of invasive aquatic species are also present including Eurasian milfoil and Brazilian milfoil. This measure would most typically be done in conjunction with riparian/floodplain revegetation and/or gravel pit restoration. Removal could be done by mechanical means (plowing, disking, and mowing), hand removal (cutting), and/or spot applications of pesticides where the risk of contamination of waterways is limited. In aquatic areas, removal may be difficult, it may be better to smooth banks out with placement of fill and change the hydrologic connections to eliminate suitable habitat for these species.

5.3.5. Construct Off-Channel Features

This restoration measure would include the engineering and construction to reconnect existing remnant side-channels, backwaters, and oxbows that are currently disconnected (or partially disconnected) from the river, excavate new side channels in geomorphically appropriate areas, restore gravel mined ponds/pits by reshaping and partial fill, reconnect gravel mined ponds as backwaters, and enhance existing off-channel features by the removal of constrictions such as undersized culverts or fill. Because a key concern is to maintain connections to these features this measure would most typically be done in conjunction with the placement of large wood or jams (engineered log jams or ELJs) to promote scour at the openings. This measure would also be done in conjunction with riparian/floodplain revegetation. The construction of channels in some locations could require the installation of a culvert or pedestrian bridge to allow continued access for vehicles or pedestrians to other portions of a site (relocation).

5.3.6. Placement of Wood In-Channel or Floodplain

This restoration measure would include the placement of clumps of LWD or ELJs along the banks, floodplain or within the main channel and side-channels of the rivers. The purpose of this measure is to provide natural scouring and deposition of sediments to create pools, side-channels, bars, and other features, provide complex cover for aquatic species, provide perching habitat for birds, and provide basking habitat and cover for amphibians and reptiles. This measure could be conducted entirely as a stand-alone measure or in conjunction with any other restoration measure.

5.4. Development of Conceptual Alternatives

Within each of the priority reaches identified above, one or more restoration measures may be appropriate to provide significant floodplain reconnection and restoration. A workshop with the key stakeholders was held in May 2008 to help identify potential restoration alternatives based on aerial photography and the experience and knowledge of participants. This workshop resulted in a number of sites identified for potential restoration and a variety of restoration measures that could be implemented at each site. These restoration sites were consolidated into 43 distinct project sites and were then visited by Corps and Tetra Tech staff in the fall of 2008 at a reconnaissance scale to further identify appropriate restoration measures and to determine if any sites should be eliminated or added as a result of on-the-ground observations. The stakeholders were also interested in considering “passive” restoration approaches such as removal of non-native species and plantings, as well as considering “engineered” restoration approaches such as excavation of channels and restoration of gravel-mined ponds.

Table 25 below lists the conceptual alternatives developed following the field reconnaissance. Sites are identified by their reach and the alternative option. At nearly every site, a passive (Minimum) and engineered (Maximum) alternative were developed to allow further evaluation of the range of measures that could be undertaken. The passive alternatives include only measures such as removal of invasive plant species (i.e. Himalayan blackberry), riparian revegetation, and placement of wood in the floodplain. The engineered alternatives include both the passive measures and engineered measures that were selected based on the field reconnaissance that identified the most appropriate types of measures that would work on each site. The nomenclature of Minimum and Maximum are not intended to imply that the Minimum plan is the least restoration that could be done or that the Maximum plan is every possible measure that could be accomplished. Rather, the Minimum plans include the passive measures that would restore natural vegetation communities and contribute to the eventual recruitment of large wood to the system, but would not actively reconnect floodplain areas. The Minimum plans would allow for continued large events to flood the sites and perhaps the eventual “natural” capture of gravel pits or old side channels during floods, but would not provide for immediate or more frequent connections. The Maximum plans would include the passive measures from the Minimum plans but also provide for winter/spring connections to off-channel and floodplain habitats such as side-channels and ponds.

Appendix A includes the conceptual plans for each of the initial array of alternatives. These conceptual plans were developed based on their potential floodplain benefits. Other considerations such as landowner willingness, effects on structures, etc. are considered after the initial evaluation.

Table 25. Initial Array of Conceptual Alternatives

Alternative	Restoration Measures Included	Location
C1A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	State land on left bank and island at confluence of CF and MF; public lands only.
C1A Maximum	Measures from minimum plus reconnect gravel pits, gravel pit restoration, restore side channel and install 2 ELJs	Same as for minimum.
C1B Minimum	Remove invasives, riparian revegetation, place wood in floodplain	Lane County gravel pits on left bank at confluence of CF and MF; public lands only
C1B Maximum	Measures from minimum plus reconnect and restore and reshape ponds.	Same as for minimum
C1C Minimum	Remove invasives, riparian revegetation	Wildish ponds on left bank of Coast Fork at RM 1.2
C1C Maximum	Measures from minimum plus reconnect to Coast Fork and reshape gravel pits.	Same as for minimum
C1D Minimum	Remove revetment, setback protection to road, remove invasives, riparian revegetation.	Lane County land at Buford Park right bank downstream of Seavey Loop Road Bridge at RM 3.
C1D Maximum	Measures from minimum plus reconnect existing sloughs for backwater and install ELJs	Same as for minimum
C1E	Bioengineer existing revetment along left bank below Seavey Loop Road Bridge	Left bank downstream of Seavey Loop Road Bridge at RM 2-3.
C1F Minimum	Remove invasive species and revegetate riparian zone and floodplain	Berkshire/Oxley Slough from RM 4.3 to RM 1.3.
C1F Maximum	Measures from minimum plus install culvert inlet at Coast Fork, excavate to reconnect entire length of slough and reconnect at outlet through either Wildish pond or Lane County ponds.	Same as for minimum
C1G Minimum	Install 8 ELJs in Reach C1	RM 0 to 6.4 on Coast Fork
C1G Maximum	Install 12 ELJs in Reach C1	Same as for minimum
C2A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right bank at RM 8.5 to 9.5 on Coast Fork, private lands
C2A Maximum	Measures from minimum plus remove revetment, reconnect two side channels, install 4 ELJs	Same as for minimum
C2B Minimum	Remove invasives, riparian revegetation, place LWD in floodplain portion of site	Left bank RM 8.2 to 9 on Coast Fork, Lane County land
C2B Maximum	Measures from minimum plus place 2 ELJs	Same as for minimum
C2C Minimum	Remove invasives, riparian revegetation, place wood in backwater	Right bank at RM 10.2 on Coast Fork, primarily State Parks land
C2C Maximum	Measures from minimum plus reconnect side channels, bioengineer revetment and install 5 ELJs	Same as for minimum
C2D Minimum	Remove invasives, riparian revegetation, place buried revetment on east side of site	Right bank at RM 11
C2D Maximum	Measures from minimum plus install 3ELJs, remove 3 structures, remove revetment	Same as for minimum
C2E Minimum	Remove invasives, riparian revegetation	Along left bank slough at RM 11
C2E Maximum	Measures from minimum plus install 2 ELJs and bioengineer revetment on downstream left bank	Same as for minimum

Alternative	Restoration Measures Included	Location
C3A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Lynx Hollow State Park at RM 17; public lands only
C3A Maximum	Measures from minimum plus connect ponds to river, gravel pit restoration, place 3 ELJs	Same as for minimum
C3B Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right bank and islands at RM 17.5
C3B Maximum	Measures from minimum plus reconnect ponds as backwater, gravel pit restoration, install 5 ELJs	Same as for minimum
C3C Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right bank at RM 19
C3C Maximum	Measures from minimum plus reconnect ponds as backwater, gravel pit restoration, install 5 ELJs	Same as for minimum
C3D Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right and left bank immediately upstream of I-5 at RM 16.
C3D Maximum	Measures from minimum plus install 2 ELJs	Same as for minimum
R1A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Row River confluence right and left banks; public lands
R1A Maximum	Measures from minimum plus reconnect oxbow on right bank and install 3 ELJs	Same as for minimum
R1B Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank immediately upstream of I-5 at RM 1; public lands
R1B Maximum	Measures from minimum plus restore side channel and install 2 ELJs	Same as for minimum
R1C Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at South Regional Park at RM 2.5; public lands
R1C Maximum	Measures from minimum plus reconnect gravel ponds as backwaters, gravel pit restoration, install 5 ELJs	Same as for minimum
M1A Minimum	Remove invasives, riparian revegetation, connect to Middle Fork	Wildish downstream-most gravel ponds and forested peninsula between MF and CF at RM 188.
M1A Maximum	Measures from minimum plus reconnect to Coast Fork and reshape banks to restore gravel pits	Same as for minimum
M1B Minimum	Remove invasives and revegetate	Wildish large gravel ponds left bank at RM 189
M1B Moderate	Measures from minimum plus remove concrete and rock revetment, reshape banks of north pond and reconnect to Middle Fork	Same as for minimum
M1B Maximum	Measures from moderate plus reshape banks of south pond and reconnect to Middle Fork	Same as for minimum
M1C Minimum	Install 12 ELJs	Reach M1 from RM 187 to 190.8
M1C Maximum	Install 20 ELJs	Same as for minimum
M1D Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	City property at right bank RM 190.3 (GP property)
M1D Maximum	Measures from minimum plus remove wood chips, restore side channel and chutes, connect pond as backwater, install 5 ELJs	Same as for minimum
M2A Minimum	Remove invasives, riparian revegetation	Left bank gravel pits at RM 191.
M2A Maximum	Measures from minimum plus reconnect ponds, reshape banks, install 5 ELJs, install LWD clumps in ponds	Same as for minimum
M2B Minimum	Remove invasives, riparian revegetation,	Right bank at RM 192

Alternative	Restoration Measures Included	Location
	place LWD in floodplain	
M2B Maximum	Measures from minimum plus restore side channel, install 5 ELJs	Same as for minimum
M2C Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at RM 192.4
M2C Maximum	Measures from minimum plus restore side channels, backwater connection to Pudding Sl., install 6 ELJs	Same as for minimum
M2D Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right bank at RM 193
M2D Maximum	Measures from minimum plus restore side channels, install 4 ELJs	Same as for minimum
M2E Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at RM 194
M2E Maximum	Measures from minimum plus restore side channel and install ELJs	Same as for minimum
M2F	Restore long side channel, install one vehicle bridge, install 2 ELJs, 100-ft buffer for removal of invasives and riparian revegetation	Right bank at RM 193.5
M2G Minimum	Install 8 ELJs	Reach M2 from RM 190.8 to 195
M2G Maximum	Install 13 ELJs	Same as for minimum
M3A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at RR bridge, RM 197.3
M3A Maximum	Measures from minimum plus install 5 ELJs, reconnect side channel around island	Same as for minimum
M4A Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Confluence of Fall Creek, right bank and islands at RM 198.5
M4A Maximum	Measures from minimum plus remove revetment on right bank, install 3 ELJs	Same as for minimum
M4B Minimum	Remove invasives, riparian revegetation, reconnect oxbow through notch in revetment	Right bank at RM 199
M4B Maximum	Measures from minimum except remove revetment and add 1 ELJ	Same as for minimum
M4C Minimum	Remove invasives, riparian revegetation, remove revetment at upper end	Left bank at RM 199, old meander
M4C Maximum	Measures from minimum plus reconnect side channel, install 4 ELJs, place LWD in side channel	Same as for minimum
M4D Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at RM 200, old meander
M4D Maximum	Measures from minimum plus reconnect side channel and pond, install 2 ELJs	Same as for minimum
M4E Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Right bank at RM 200.5
M4E Maximum	Measures from minimum plus restore side channels and install 4 ELJs	Same as for minimum
M4F	Restore side channel to connect to Fall Creek at bridge, 100-ft buffer for removal of invasives, riparian revegetation, install 2 vehicle bridges	Right bank at RM 200.5
M4G Minimum	Install 8 ELJs	Reach M4 from RM 198.3 to RM 200.5
M4G Maximum	Install 12 ELJs	Same as for minimum
M5A Minimum	Remove invasives, riparian revegetation, restore side channel, install 2 ELJs	Left bank at RM 201.8, Elijah Bristow
M5A Maximum	Measures from minimum plus restore add’l	Same as for minimum

Alternative	Restoration Measures Included	Location
	side channel, install 2 more ELJs, place wood in channels	
M5B Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank at RM 201, Elijah Bristow
M5B Maximum	Measures from minimum plus reconnect long slough, install 1 ELJ, place LWD in slough	Same as for minimum
M5C Minimum	Remove invasives, riparian revegetation, place LWD in floodplain	Left bank and islands at RM 202-203, Elijah Bristow
M5C Maximum	Measures from minimum plus install 3 ELJs	Same as for minimum
M5D Minimum	Place 2,500 CY of gravel on left and right bank	RM 204, below dam
M5D Maximum	Measures from minimum plus install 2 ELJs, reconnect backwater on left bank	Same as for minimum
M5E Minimum	Install 8 ELJs	Reach M5 RM 201-204
M5E Maximum	Install 12 ELJs plus excavate two connections for old meander on left bank at RM202.5	Same as for minimum

5.5. EVALUATION OF ALTERNATIVES

In order to evaluate potential restoration alternatives for this study, it was necessary to develop a method to measure the benefits expected from the restoration projects identified above. Further, the Corps of Engineers requires that a cost-effectiveness and incremental cost analysis (CE/ICA) be conducted on all restoration plans to help inform the decision on what level of environmental outputs is “worth it.” An evaluation method that quantifies habitat benefits is necessary to conduct the CE/ICA. Existing methods, commonly used, that quantify habitat benefits include the Habitat Evaluation Procedures (HEP) developed by the USFWS (1980), the Hydrogeomorphic Method (HGM) for assessing wetland functional values, and Ecosystem Diagnosis and Treatment (EDT). HGM has been regionally adapted in many states, including Oregon (Brinson 1993). The Oregon Wetland and Riparian Assessment (OWRA) project was the regional adaptation of HGM to classify wetland and riparian sites in Oregon, based on their hydrogeomorphic features, and to assess their level of functioning in comparison to reference sites and standards (Adamus and Field 2001, Adamus 2001a, 2001b). EDT was developed by fishery managers and tribes in the Pacific Northwest to estimate fish species productivity and abundance in a watershed (or portion of a watershed) based on the quantity and quality of the habitat (Lichatowich, *et al* 1995; Lestelle, *et al*. 2004). The EDT model and data are in the public domain; both are maintained by Jones & Stokes Associates (formerly Mobrand Biometrics, Inc.).

Initial planning for a comprehensive ecological response model was discussed in several previous reports for this study including the *Willamette River Basin Floodplain Restoration Feasibility Study Ecological Response Model Recommendations* (Primozich *et al*. 2004); *An Approach for Synthesis of Willamette Floodplain Aquatic and Terrestrial Attributes* (McConnaha *et al*. 2005); and the *Analysis of the Potential Benefits of Floodplain Habitats in the Middle Fork Willamette River Using Geomorphic Splice Analysis* (McConnaha *et al*. 2006). These previous reports defined functions that floodplains provide and included the use of expert panels to recommend the types of indicators that could be used to represent those functions. It was recommended that indicators of geomorphic functions, terrestrial and aquatic habitats be used in the model to provide a comprehensive evaluation of the potential benefits that could be gained by restoring floodplain habitats. Indicators are fish and wildlife species, plant communities, or functions. Indicator attributes are the actual physical or biological features or processes that can be measured either in the field or via GIS analysis. Attributes can include channel length, floodplain habitat types, temperature, pieces of large woody debris, etc.

The approach recommended by those previous reports was considered to be too time-consuming and costly to apply to both the Coast and Middle Forks watershed (the development of an entirely new EDT model for cutthroat trout would have been necessary for the Coast Fork). However, the EDT model that had been developed for the Middle Fork Willamette River during the subbasin plan was updated with detailed geomorphic data and survey data to identify the reaches where restoration is most needed and would be most effective. The results of the EDT analysis indicated that restoration measures would be most beneficial in the reaches below the Fall Creek confluence because temperature is a significant limiting factor for spring Chinook in the subbasin. This information was used in the prioritization of reaches M1 and M2 in this study and in the formulation of restoration measures.

The approach that is used in this report has been to classify riverine and floodplain environments into major habitat types and address the response of each habitat type through Habitat Suitability Indices (HSIs) following the Habitat Evaluation Procedures (HEP) methodology, for species closely associated with each habitat type (Figure 28). The results from each of the component suitability indices can be examined independently and/or combined into a single overall index of floodplain function we have termed the Floodplain Habitat Index. Each of the component HSIs are described in detail in Appendix B.

The HEP model used in the study is currently being reviewed by the Ecosystem Center of Expertise. Recommendations from that review will be incorporated into the model and this document prior to publication of the draft for public review.

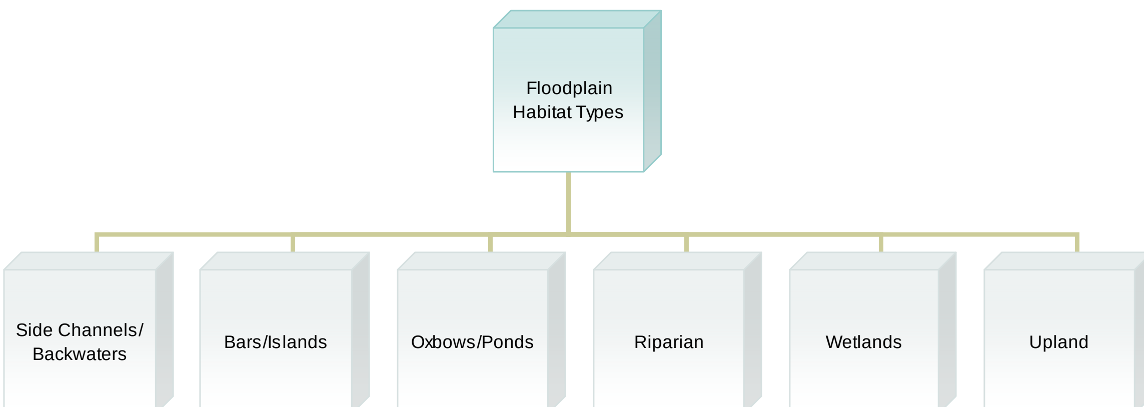


Figure 28. Floodplain Habitat Types

The Habitat Evaluation Procedure (HEP) is a procedure developed by the U.S. Fish and Wildlife Service (1980a and 1980b) to facilitate the identification of impacts from various types of actions on fish and wildlife habitat. The basic premise of HEP is that habitat quantity and quality can be numerically described. HEP can provide a comparison of habitat quality between different sites or between different time periods at one site (for example, pre-construction versus post-construction). A key assumption in HEP is that an individual species "prefers" (or survives/reproduces better) in habitats with certain physical characteristics that can be measured. For example, if yellow warblers typically nest in deciduous shrubs, then sites with greater deciduous shrub cover are more suitable for yellow warblers than sites which have little or no deciduous shrub cover.

A Habitat Suitability Index (HSI) is the typical format used in HEP which is a mathematical relationship between a physical, chemical, or biological habitat attribute and its suitability for a single species or assemblage of species. The Suitability Index is a unitless number between 0 and 1 that describes the requirements of a species for certain attributes such as cover, distance to foraging, water temperature, etc. A set of one or more Suitability Indices that represent key habitat requisites for the species during one or more life history stages are combined into an overall HSI by adding or multiplying the individual indices. The attributes are measured in the field or via GIS analysis and their corresponding index values are inserted into the model to produce a score that describes existing habitat suitability. The overall HSI value is also an index score between 0 and 1. This index value can be multiplied by the area of the site to yield Habitat Units (HUs), or it can be used as an index score for a habitat quality comparison only.

HSIs for several species were utilized to capture the range of benefits, across the multiple floodplain habitat types that could be provided by the proposed floodplain restoration project. The HEP model includes the following species or guilds: (1) Western pond turtle; (2) Oregon chub; (3) beaver; (4) wood duck; (5) yellow warbler (highly riparian associated); (6) native amphibians (red-legged frog, Pacific tree frog, rough-skinned newt); (7) native salmonids (Chinook, steelhead, cutthroat); and (8) American kestrel (grasslands/ag lands). The Western pond turtle and Oregon chub are both species of concern in the study area and utilize backwaters and ponds. The beaver is a mammal species dependent on native riparian species for food (cottonwood, willow and alder). The wood duck is a cavity nesting waterfowl species that utilizes riparian areas for nesting. The yellow warbler is highly associated with riparian habitat for nesting. The red-legged frog, Pacific tree frog, and rough-skinned newt are native amphibians that represent both aquatic and terrestrial amphibians utilizing riparian and wetland habitats. Chinook salmon, steelhead and cutthroat trout utilize off-channel aquatic habitats for rearing and refuge. American kestrel are raptors that utilize open grasslands and agricultural lands for foraging, as well as riparian and woodlands for nesting and perching.

Other species were considered for the HEP model, such as using the non-native bullfrog HSI as a negative component in the model (benefits to bullfrogs would be subtracted from the other HSI scores so that projects that result in negative effects to bullfrogs would score more highly). However, it was determined by the project team that this negative score was making it difficult to differentiate between alternatives (the negative score tended to cause all scores to be reduced by a similar amount that made it more difficult to identify beneficial restoration actions). Thus, the bullfrog was instead used as a constraint in the formulation of the alternatives to design conceptual projects that would specifically reduce bullfrog habitat (i.e. perennial ponds with depths greater than 6 feet). Oregon chub also requires perennial ponds or sloughs, but generally uses waters less than 6 feet in depth, so the focus to reduce bullfrog habitat is to design features that reduce the depth of perennial ponds or slough channels, or provide more seasonal habitats.

An HSI will result for each individual species or guild. To combine the individual species' HSIs into one HSI suitable to use in a cost-effectiveness and incremental cost analysis, the following equation was developed:

$$\mathbf{HSI_{Combined} = (HSI_{\mathit{turtle}} + HSI_{\mathit{chub}} + HSI_{\mathit{beaver}} + HSI_{\mathit{wood\ duck}} + HSI_{\mathit{yellow\ warbler}} + HSI_{\mathit{native\ amphibians}} + HSI_{\mathit{salmon}} + HSI_{\mathit{kestrel}}) / 8}$$

Other equations for the combinations of the individual HSI scores can be used. For example, the chub and salmon HSIs could be multiplied by two to give those species more effect on the ranking. The method of combining the individual HSI scores into the combined score will change the potential ranking of individual alternatives. The project team determined that all native species should be weighted equally because there is an interest in providing benefits to a wide variety of fish and wildlife species that utilize floodplain habitats.

The scores that result from applying the HEP to the proposed restoration alternatives are shown in Table 26. The combined HSI score for each alternative was multiplied by project acres to yield Habitat Units. Project acres were calculated based on the concept designs and included the entire project footprint at each site as removal of invasive species and riparian/floodplain revegetation is proposed to occur on the entire site for each alternative. The existing condition quality was evaluated via field reconnaissance of the sites. Then, likely scores for the future without project condition (no action) were developed, along with future with project conditions for each alternative. The existing condition scores were considered to be representative of the quality of habitat for the base year when the first projects are constructed (2015) and the next ten years (Years 1-10), then vegetation growth/maturity and other likely impacts were considered to develop scores for Years 11-25, and then finally for Years 26-50 for the future without project condition. Because riparian vegetation such as willows and alders are fast growing species, it is presumed that functions provided by these species will be fully provided starting at Year 11. Additional maturity of tree species for the long-term recruitment of large wood will occur over the 26-50 year range. The overall HSI score shown is the sum of the annual scores during each of the three increments (Years 0-10, Years 11-25, and Years 26-50) divided by the 50 year period of analysis[2]. The net increase in HUs shown are the average annual HUs (AAHUs). Because of the multiple species included in the HEP model, in a few cases, alternatives formulated primarily to benefit one species (i.e. salmon) could potentially show reduced scores for other species that could make a zero score or even a negative score possible. But, for the most part, the alternatives were formulated to benefit all of the species included in the model.

Table 26. Habitat Scores for Restoration Alternatives

Alternative	Future Without Project HSI	Project Acres	Future Without Project AAHUs	Future With Project HSI	Future With Project AAHUs	Net Increase in AAHUs
C1A MINIMUM	0.54	52	28.22	0.67	34.63	6.41
C1A MAXIMUM	0.54	52	28.22	0.78	40.51	12.28
C1B MINIMUM	0.52	86	44.68	0.63	54.59	9.91
C1B MAXIMUM	0.52	86	44.68	0.84	72.45	27.77
C1C MINIMUM	0.47	114	53.62	0.66	74.8	21.18
C1C MAXIMUM	0.47	114	53.62	0.82	93.71	40.09
C1D MINIMUM	0.52	99	51.44	0.57	56.85	5.4
C1D MAXIMUM	0.52	99	51.44	0.69	68.73	17.29
C1E	0.4	12	4.75	0.6	7.26	2.5
C1G MINIMUM	0.47	50	23.31	0.57	28.30	4.99
C1G MAXIMUM	0.47	50	23.31	0.59	29.39	6.08
C2A MINIMUM	0.47	296	140.34	0.59	173.51	33.16
C2A MAXIMUM	0.47	296	140.34	0.75	222.55	82.2
C2C MINIMUM	0.63	79	49.86	0.72	57.13	7.27
C2C MAXIMUM	0.63	79	49.86	0.79	62.63	12.76
C2D MINIMUM	0.61	147	89.6	0.75	110	20.4
C2D MAXIMUM	0.61	147	89.6	0.8	117.08	27.47
C2E MINIMUM	0.57	76	43.14	0.69	52.29	9.15
C2E MAXIMUM	0.57	76	43.14	0.75	57.04	13.9
C3A MINIMUM	0.53	70	37	0.62	43.54	6.54
C3A MAXIMUM	0.53	70	37	0.79	54.95	17.95
C3B MINIMUM	0.5	199	99.56	0.62	124.04	24.48
C3B MAXIMUM	0.5	199	99.56	0.81	161.46	61.9
C3C MINIMUM	0.54	83	45.22	0.67	55.83	10.61
C3C MAXIMUM	0.54	83	45.22	0.79	65.65	20.43
C3D MINIMUM	0.57	51	29.25	0.67	34.26	5.01

[2] For example, the following equation was used to calculate the score at each site:
[(HSI score Years 1-10)*10+(HSI score Years 11-25)*15+(HSI score Years 26-50)*25]/50 = AAHUs

Alternative	Future Without Project HSI	Project Acres	Future Without Project AAHUs	Future With Project HSI	Future With Project AAHUs	Net Increase in AAHUs
C3D MAXIMUM	0.57	51	29.25	0.78	39.98	10.74
R1A MINIMUM	0.69	97	66.94	0.79	76.52	9.58
R1A MAXIMUM	0.69	97	66.94	0.8	77.55	10.61
R1B MINIMUM	0.56	15	8.45	0.7	10.57	2.12
R1B MAXIMUM	0.56	15	8.45	0.79	11.82	3.38
M1A MINIMUM	0.46	147	68.23	0.64	94.61	26.38
M1A MAXIMUM	0.46	147	68.23	0.82	120.68	52.45
M1B MINIMUM	0.45	170	77.18	0.58	97.93	20.75
M1B MODERATE	0.45	170	77.18	0.71	121.08	43.9
M1B MAXIMUM	0.45	170	77.18	0.74	126.09	48.9
M1C MINIMUM	0.48	36	17.31	0.53	19.18	1.87
M1C MAXIMUM	0.48	36	17.31	0.57	20.42	3.11
M1D MINIMUM	0.57	69	39.6	0.67	45.9	6.29
M1D MAXIMUM	0.57	69	39.6	0.78	53.78	14.18
M2A MINIMUM	0.47	68	32.28	0.69	46.75	14.48
M2A MAXIMUM	0.47	68	32.28	0.76	51.84	19.56
M2B MINIMUM	0.48	42	20.15	0.55	23.22	3.07
M2B MAXIMUM	0.48	42	20.15	0.79	33.07	12.92
M2C MINIMUM	0.61	259	158.52	0.65	168.34	9.82
M2C MAXIMUM	0.61	259	185.52	0.8	206.12	47.59
M2D MINIMUM	0.48	60	28.58	0.56	33.74	5.16
M2D MAXIMUM	0.48	60	28.58	0.74	44.68	16.09
M2E MINIMUM	0.48	86	40.97	0.56	47.86	6.9
M2E MAXIMUM	0.48	86	40.97	0.74	64.01	23.04
M2F	0.57	6	3.4	0.77	4.62	1.21
M2G MINIMUM	0.48	50	23.78	0.53	26.4	2.63
M2G MAXIMUM	0.48	50	23.78	0.6	30.2	6.43
M3A MINIMUM	0.53	30	15.85	0.66	19.66	3.81
M3A MAXIMUM	0.53	30	15.85	0.72	21.57	5.72
M4A MINIMUM	0.47	73	34.52	0.57	41.3	6.78
M4A MAXIMUM	0.47	73	34.52	0.67	48.85	14.34
M4B MINIMUM	0.54	9	4.86	0.64	5.79	0.92
M4B MAXIMUM	0.54	9	4.86	0.74	6.64	1.78
M4C MINIMUM	0.62	110	67.72	0.71	77.56	9.84
M4C MAXIMUM	0.62	110	67.72	0.75	83	15.28
M4D MINIMUM	0.57	64	36.65	0.69	44.04	7.4
M4D MAXIMUM	0.57	64	36.65	0.71	45.46	8.81
M4E MINIMUM	0.4	64	25.41	0.5	31.78	6.36
M4E MAXIMUM	0.4	64	25.41	0.66	41.98	16.56
M4F	0.51	31	15.89	0.61	18.96	3.07
M4G MINIMUM	0.51	24	12.35	0.57	13.67	1.32
M4G MAXIMUM	0.51	24	12.35	0.6	14.49	2.14
M5B MINIMUM	0.63	117	74.04	0.74	86.51	12.47
M5B MAXIMUM	0.63	117	74.04	0.77	89.62	15.58
M5D MINIMUM	0.56	5	2.78	0.56	2.78	0
M5D MAXIMUM	0.56	5	2.78	0.6	2.98	0.2

Alternative	Future Without Project HSI	Project Acres	Future Without Project AAHUs	Future With Project HSI	Future With Project AAHUs	Net Increase in AAHUs
M5E MINIMUM	0.53	36	19.13	0.57	20.58	1.45
M5E MAXIMUM	0.53	36	19.13	0.65	23.44	4.31

5.6. COST-EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

In order to evaluate the restoration alternatives for selection of a recommended plan, the Corps of Engineers is required to conduct a cost-effectiveness and incremental cost analysis (CE/ICA)(described in Section 5.6.1, below) that compares the cost of an alternative to its habitat benefit. This requires that preliminary costs be developed for each of the restoration alternatives. Table 27 shows the costs developed for the restoration alternatives, including total costs (present value) and average annual costs over the lifetime of the project (50 years), along with the net increase in average annual habitat units (AAHUs) for each alternative.

The preliminary cost estimates were developed using a spreadsheet format and based on data from other recent projects, recent quotes for materials, and RS Means. Price levels are for 2011. The key cost tables are provided in Appendix C. A unit cost table was developed that includes key bid items for each measure identified in Section 5.3. Each of these bid items includes materials, labor, contractor overhead and profit. Other standard cost items such as mobilization/demobilization, permitting, dewatering, traffic control, etc. were included at a standard percentage of the construction cost. A 25% contingency was applied to all alternatives. Design and construction management are included at 20% and 15%, respectively. Standard real estate costs were applied at $20,000/acre for private lands and $5,000/acre for publicly owned lands. The bid items are then included for each alternative site and scale as appropriate based on the work proposed. Quantities were calculated for each item using the conceptual plans developed in GIS for each site and are shown in Appendix C. Additionally, operation and maintenance costs were also estimated based on the type of restoration measures included at each site based on the engineer's experience with similar projects. The O&M costs are discounted at the FY13 discount rate of 3.75% to yield the estimated net present value. The O&M costs were included in the total project cost for the cost effectiveness and incremental cost analyses. The cost estimate for each alternative is then divided by 50 to yield an average annual cost that can be used with the average annual habitat units. These preliminary costs provide a comparable conceptual level cost for each alternative so that they can be compared against each other, in combination with the habitat output scores to identify which plans provide more benefit for the cost.

It is typical that when the recommended restoration plan is selected and additional feasibility level designs and analysis are conducted in more detail that the cost estimates may change. However, this does not affect the results of the CE/ICA because all of the plans were initially compared using the same unit costs.

The total implementation cost per acre for restoration ranges from $26,000 to $180,000 per acre for the alternatives proposed. O&M costs (Net Present Value) are generally about $550 per acre per year. The bulk of the potential O&M costs, however, are related to vegetation maintenance during the first 5 years to ensure that invasive species do not spread back and become dominant species and to ensure survival and growth of the native species planted. Thus, the actual outlay by the non-federal sponsor is anticipated to be about $2500/acre each year for the first five years. This is considered a conservative estimate, to ensure that it included in the evaluation of the alternatives and to determine the non-federal sponsor's capability to undertake the projects.

An initial run was done of the CE/ICA to get a sense of the top 15 ranked project sites and alternatives. Following this initial evaluation, the project sponsors set up meetings or conducted other outreach to both public and private landowners to determine the level of interest in continuing forward with each project site. Project C1F was determined to not be implementable due to the high number of landowners along the alignment of the project and lack of interest. Project C2A was also determined to not be implementable due to the existing agricultural land uses and multiple land owners interested in maintaining that land use. Project Sites C3B and M2B do not have willing landowners. Lane County indicated that they would only be interested in restoration on one of their properties – C1B. At the other Lane County sites – C2B and C1D – the County has requested they be removed from further consideration for this study. Oregon State Parks and the Middle Fork Willamette Watershed Council also determined that they would proceed to implement projects M5A and M5C on their own and this did not want these two project sites to be included in the final array of alternatives. The City of Cottage Grove also indicated that since work was already occurring on the R1C site, that they would prefer to move ahead and implement that project on their own. Thus, it was determined that Sites C1F, C2A, C2B, C1D, C3B, M2B, M5A, M5C, and R1C should be removed from the final array of restoration alternatives. The CE/ICA was then run again after deleting these projects from the list. Table 27 shows the input data for the CE/ICA runs once the previously mentioned sites were deleted.

Table 27. Restoration Alternatives with Identifier Codes, Costs and Outputs.

Alternative	*Scale*	*Scale Name*	*NPV Cost + O&M*	*Avg. Ann. Cost + O&M (rounded)*	*AAHU*
M1A	1	Min	$7,819,500	$348,550	26.4
M1A	2	Max	$9,309,180	$414,950	52.5
M1B	1	Min	$7,554,611	$336,740	20.7
M1B	2	Mod	$8,818,079	$393,060	43.9
M1B	3	Max	$9,238,056	$411,780	48.9
M1C	1	Min	$4,585,957	$204,420	1.9
M1C	2	Max	$5,990,593	$267,030	3.1
M1D	1	Min	$1,975,104	$88,040	6.3
M1D	2	Max	$3,291,840	$146,730	14.2
M2A	1	Min	$2,978,326	$132,760	14.5
M2A	2	Max	$4,098,476	$182,690	19.6
M2B	1	Min	$2,978,326	$132,760	3.1
M2B	2	Max	$4,098,476	$182,690	12.9
M2C	1	Min	$13,042,941	$581,380	9.8
M2C	2	Max	$14,692,814	$654,920	47.6
M2D	1	Min	$4,143,717	$184,700	5.2
M2D	2	Max	$4,918,123	$219,220	16.1
M2E	1	Min	$5,939,328	$264,740	6.9
M2E	2	Max	$6,816,106	$303,820	23.0
M2F	1	Max	$4,411,760	$196,650	1.2
M2G	1	Min	$1,316,736	$58,690	2.6
M2G	2	Max	$2,139,696	$95,380	6.4
M3A	1	Min	$2,096,242	$93,440	3.8
M3A	2	Max	$2,984,118	$133,010	5.7
M4A	1	Min	$5,041,522	$224,720	6.8
M4A	2	Max	$5,782,879	$257,770	14.3
M4B	1	Min	$554,350	$24,710	0.9
M4B	2	Max	$1,775,248	$79,130	1.8

Alternative	*Scale*	*Scale Name*	*NPV Cost + O&M*	*Avg. Ann. Cost + O&M (rounded)*	*AAHU*
M4C	1	Min	$6,630,558	$295,550	9.8
M4C	2	Max	$7,604,424	$338,960	15.3
M4D	1	Min	$4,444,349	$198,100	7.4
M4D	2	Max	$4,892,641	$218,090	8.8
M4E	1	Min	$4,419,965	$197,020	6.4
M4E	2	Max	$5,463,814	$243,550	16.6
M4F	1	Max	$3,579,572	$159,560	3.1
M4G	1	Min	$1,316,736	$58,690	1.3
M4G	2	Max	$1,975,104	$88,040	2.1
M5B	1	Min	$6,642,240	$296,070	12.5
M5B	2	Max	$6,826,553	$304,290	15.6
M5D	1	Min	$183,360	$8,170	0.0
M5D	2	Max	$422,717	$18,840	0.2
M5E	1	Min	$1,316,736	$58,690	1.5
M5E	2	Max	$1,817,640	$81,020	4.3
C1A	1	Min	$2,778,709	$123,860	6.4
C1A	2	Max	$3,311,370	$147,600	12.3
C1B	1	Min	$3,947,272	$175,950	9.9
C1B	2	Max	$4,129,769	$184,080	27.8
C1C	1	Min	$6,441,518	$287,130	21.2
C1C	2	Max	$8,251,399	$367,800	40.1
C1D	1	Min	$4,238,576	$188,930	5.4
C1D	2	Max	$4,531,103	$201,970	17.3
C1E	1	Max	$8,006,124	$356,870	2.5
C1G	1	Min	$1,316,736	$58,690	5.0
C1G	2	Max	$1,975,104	$88,040	6.1
C2A	1	Min	$20,044,359	$893,460	33.2
C2A	2	Max	$22,853,041	$1,018,660	82.2
C2C	1	Min	$3,052,278	$136,050	7.3
C2C	2	Max	$6,587,491	$293,630	12.8
C2D	1	Min	$8,135,855	$362,650	20.4
C2D	2	Max	$17,111,882	$762,750	27.5
C2E	1	Min	$4,013,252	$178,890	9.1
C2E	2	Max	$5,298,481	$236,180	13.9
C3A	1	Min	$3,997,696	$178,190	6.5
C3A	2	Max	$4,737,344	$211,160	18.0
C3C	1	Min	$6,090,536	$271,480	10.6
C3C	2	Max	$7,992,349	$356,250	20.4
C3D	1	Min	$3,314,145	$147,730	5.0
C3D	2	Max	$3,807,921	$169,740	10.7
R1A	1	Min	$5,362,272	$239,020	9.6
R1A	2	Max	$6,167,260	$274,900	10.6
R1B	1	Min	$810,929	$36,150	2.1
R1B	2	Max	$1,239,259	$55,240	3.4

5.6.1. Cost-Effectiveness and Incremental Cost Analysis

The CE/ICA is conducted to evaluate the relative effectiveness and efficiency of alternative restoration measures at addressing environmental objectives of the project. The analyses provide a framework for comparing the differences in output across alternative measures and the associated changes in cost. The analysis was conducted in the following steps:

- Tabulate average annual cost and average annual environmental outputs of each restoration alternative
- Identify any measures whose implementation is dependent upon implementation of others
- Identify any measures that are not combinable with others
- Identify all potential combination of measures
- Calculate cost and output estimates for each alternative
- Identify any measures that provide the same output at greater cost than other combinations
- Identify any measures that provide less output at the same or greater cost as other combinations
- Evaluate changes in incremental costs for remaining combinations
- Identify most efficient set of remaining combinations ("best-buys")
- Display changes in incremental cost for best-buy combinations

5.6.2. Relationships

The analyses involve deriving all possible combinations of the alternatives and then comparing the cost and output levels associated with each combination. Any relationships of dependency or non-combinability need to be determined prior to combining measures. It was identified that the minimum and maximum alternatives at each site were not combinable because the maximum alternatives at each site included all features of the minimum plan. Each site was fully combinable with any other site. The analyses use the FY13 Federal discount rate of 3.75% and a period of analysis of 50 years for discounting and amortization of costs.

5.6.3. Cost-Effectiveness Analysis

Once all combinations were derived and their cost and output estimates calculated, cost-effectiveness analysis was performed in the following two steps:

- Identify any measures that provide the same output at greater cost than other combinations and screen from further analysis
- Identify any measures that provide less output at the same or greater cost as other combinations and screen from further analysis

This two-step screening was performed on the array of possible combinations for each of the subbasins. This cost-effectiveness screening resulted in identification of the array of combinations that are referred to as the "Cost-Effective Set". If considering only the cost and output estimates, there is no rational reason to implement a non-cost effective combination.

Because of the large number of alternatives, the Coast Fork and Middle Fork alternatives were first run separately. Tables 28 and 29 show the results for the initial Coast Fork and Middle Fork runs, respectively. Table 30 presents the best buy plan outputs from the combined Coast Fork and Middle Fork CE/ICA. Figures 29, 30, 31 and 32 graphically present the results from the Coast Fork run, Middle Fork run, then the combined Coast Fork and Middle Fork, in a graph and box plot format, respectively.

Because there are 37 sites in the final array of measures (beyond the capability of the IWR-Plan software that can only evaluate up to 26 alternatives at a time) and the large number of possible combinations (over 14 billion) that bogged the analysis down, the CE/ICA analysis was conducted first separately for the Coast Fork and Middle Fork. The results from each of the runs in each subbasin were evaluated to select an incremental cost threshold in order to combine the top ranked sites across each run; all sites with an incremental cost less than or equal to $15,000 were combined into the final CE/ICA to select the final incrementally justified restoration plan. This allows a comparison across each subbasin at an equivalent incremental cost level. All scales at each site that remained were evaluated in the final CE/ICA because the primary reason for eliminating sites was to bring the number of sites down below 26 for final evaluation. The inclusion of scales at the remaining sites does not affect the ultimate outcome of the best buy plans.

5.6.4. Incremental Cost Analysis

Following the identification of cost-effective combinations, an incremental cost analysis was conducted on the cost-effective set for each of the two subbasins. This incremental cost analysis compares the rate of increase in cost and the rate of increase in output between the cost effective plans providing the least output to all other cost effective plans producing more output. The larger plan that provides the greatest increase in output for the least increase in cost is identified as the "best buy." This best buy is then compared to all larger cost effective plans in a reiteration of the same analytical process to identify the "next best buy." This process is repeated until no larger plans remain. The result is an array of "best-buy" plans that are the most efficient production schedule for the desired environmental outputs.

5.6.5. Interest During Construction

Following the combined Coast and Middle Fork run, interest during construction (IDC) was included for the best buy plans to ensure that scheduling and phasing would not change the results of the analysis. To calculate IDC, the following assumptions were made: 1) assume 4 month work window to construction each site; 2) assume no more than two sites constructed in a year; 3) assume 2015 is the first year that construction begins; 4) assume mid-life full expenditure pattern (half of expenditure accrues IDC over whole construction period); and 5) assume when two sites are constructed in one year that two separate crews are working. Table 31 shows the IDC calculation results.

Table 28. Coast Fork CE/ICA Results.

Names	Code	Scale	Names	Code	Scale
C1A Min	A	1	C2E Min	J	1
C1A Max	A	2	C2E Max	J	2
C1B Min	B	1	C3A Min	A	1
C1B Max	B	2	C3A Max	A	2
C1C Min	C	1	C3B Min	B	1
C1C Max	C	2	C3B Max	B	2
C1D Min	D	1	C3C Min	C	1
C1D Max	D	2	C3C Max	C	2
C1E Max	E	1	C3D Min	D	1
C1G Min	F	1	C3D Max	D	2
C1G Max	F	2	R1A Min	E	1
C2A Min	G	1	R1A Max	E	2
C2A Max	G	2	R1B Min	F	1
C2C Min	H	1	R1B Max	F	2
C2C Max	H	2			
C2D Min	I	1			
C2D Max	I	2			

Codes for two initial Coast Fork CE/ICA runs. Below, all sites from each run with an incremental cost per output less than or equal to $15,000 are retained for the combined CE/ICA. Sites retained are C1B, C1C, C1D, C1G, C2A, and C3A. The codes are renumbered for the combined Coast and Middle Fork run.

Best Buy Plans, CF Run 1					
Name	**AACost**	**AAOutput**	**Inc Cost**	**Inc Out**	**IC/Output**
No Action Plan	0	0	0	0	0
B2	184080	27.8	$184,080	27.8	$6,622
B2C2	551880	67.9	$367,800	40.1	$9,172
B2C2D2	753850	85.2	$201,970	17.3	$11,675
B2C2D2F1	812540	90.2	$58,690	5	$11,738
A2B2C2D2F1	960140	102.5	$147,600	12.3	$12,000
A2B2C2D2F1G2	1978800	184.7	$1,018,660	82.2	$12,392
A2B2C2D2F1G2J2	2214980	198.6	$236,180	13.9	$16,991
A2B2C2D2F1G2I1J2	2577630	219	$362,650	20.4	$17,777
A2B2C2D2F1G2H1I1J2	2713680	226.3	$136,050	7.3	$18,637
A2B2C2D2F2G2H1I1J2	2743030	227.4	$29,350	1.1	$26,682
A2B2C2D2F2G2H2I1J2	2900610	232.9	$157,580	5.5	$28,651
A2B2C2D2F2G2H2I2J2	3300710	240	$400,100	7.1	$56,352
A2B2C2D2E1F2G2H2I2J2	3657580	242.5	$356,870	2.5	$142,748

Best Buy Plans, CF Run 2					
Name	**AACost**	**AAOutput**	**Inc Cost**	**Inc Out**	**IC/Output**
No Action Plan	0	0	0	0	0
A2	211160	18	$211,160	18	$11,731
A2D2	380900	28.7	$169,740	10.7	$15,864
A2D2F2	436140	32.1	$55,240	3.4	$16,247
A2C2D2F2	792390	52.5	$356,250	20.4	$17,463
A2C2D2E1F2	1031410	62.1	$239,020	9.6	$24,898
A2C2D2E2F2	1067290	63.1	$35,880	1	$35,880

Table 29. Middle Fork CE/ICA Results.

Names	Code	Scale	Names	Code	Scale
M1A Min	A	1	M3A Min	A	1
M1A Max	A	2	M3A Max	A	2
M1B Min	B	1	M4A Min	B	1
M1B Mod	B	2	M4A Max	B	2
M1B Max	B	3	M4B Min	C	1
M1C Min	C	1	M4B Max	C	2
M1C Max	C	2	M4C Min	D	1
M1D Min	D	1	M4C Max	D	2
M1D Max	D	2	M4D Min	E	1
M2A Min	E	1	M4D Max	E	2
M2A Max	E	2	M4E Min	F	1
M2B Min	F	1	M4E Max	F	2
M2B Max	F	2	M4F Max	G	1
M2C Min	G	1	M4G Min	H	1
M2C Max	G	2	M4G Max	H	2
M2D Min	H	1	M5B Min	I	1
M2D Max	H	2	M5B Max	I	2
M2E Min	I	1	M5D Min	J	1
M2E Max	I	2	M5D Max	J	2
M2F Max	J	1	M5E Min	K	1
M2G Min	K	1	M5E Max	K	2
M2G Max	K	2			

Codes for three initial Middle Fork CE/ICA runs. Below, all sites from each run with an incremental cost per output less than or equal to $15,000 are retained for the combined CE/ICA. Sites retained are M1A, M1B, M1D, M2A, M2B, M2C, M2D, M2E, M2G, and M4E. The codes are renumbered for the combined Coast and Middle Fork run.

Best Buy Plans, MF Run 1					
Name	**AACost**	**AAOutput**	**Inc Cost**	**Inc Out**	**IC/IO**
No Action Plan	0	0	0	0	0
A2	414950	52.5	$414,950	52.5	$7,904
A2**B3**	826730	101.4	$411,780	48.9	$8,421
A2B3**E1**	959490	115.9	$132,760	14.5	$9,156
A2B3**E2**	1009420	121	$49,930	5.1	$9,790
A2B3**D2**E2	1156150	135.2	$146,730	14.2	$10,333
A2B3D2E2**I2**	1459970	158.2	$303,820	23	$13,210
A2B3D2E2**H2**I2	1679190	174.3	$219,220	16.1	$13,616
A2B3D2E2**G2**H2I2	2334110	221.9	$654,920	47.6	$13,759
A2B3D2E2**F2**G2H2I2	2516800	234.8	$182,690	12.9	$14,162
A2B3D2E2F2G2H2I2**K2**	2612180	241.2	$95,380	6.4	$14,903
A2B3**C2**D2E2F2G2H2I2K2	2879210	244.3	$267,030	3.1	$86,139
A2B3C2D2E2F2G2H2I2**J1**K2	3075860	245.5	$196,650	1.2	$163,875

Best Buy Plans, MF Run 2					
Name	**AACost**	**AAOutput**	**Inc Cost**	**Inc Out**	**IC/Output**
No Action Plan	0	0	0	0	0
F2	243550	16.6	$243,550	16.6	$14,672
B2F2	501320	30.9	$257,770	14.3	$18,026
B2F2K2	582340	35.2	$81,020	4.3	$18,842
B2F2I2K2	886630	50.8	$304,290	15.6	$19,506
B2D2F2I2K2	1225590	66.1	$338,960	15.3	$22,154
A2B2D2F2I2K2	1358600	71.8	$133,010	5.7	$23,335
A2B2D2E2F2I2K2	1576690	80.6	$218,090	8.8	$24,783
A2B2C1D2E2F2I2K2	1601400	81.5	$24,710	0.9	$27,456
A2B2C1D2E2F2H2I2K2	1689440	83.6	$88,040	2.1	$41,924
A2B2C1D2E2F2G1H2I2K2	1849000	86.7	$159,560	3.1	$51,471
A2B2C2D2E2F2G1H2I2K2	1903420	87.6	$54,420	0.9	$60,467
A2B2C2D2E2F2G1H2I2J2K2	1922260	87.8	$18,840	0.2	$94,200

Table 30. Combined Coast and Middle Fork CE/ICA Results.

Names	Code	Scale
M1A min	A	1
M1A max	A	2
M1B min	B	1
M1B mod	B	2
M1B max	B	3
M2A min	C	1
M2A max	C	2
M1D min	D	1
M1D max	D	2
M2C min	E	1
M2C max	E	2
M2E min	F	1
M2E max	F	2
M2G min	G	1
M2G max	G	2
M2D min	H	1
M2D max	H	2
M2B min	I	1
M2B max	I	2
M4E min	J	1
M4E max	J	2

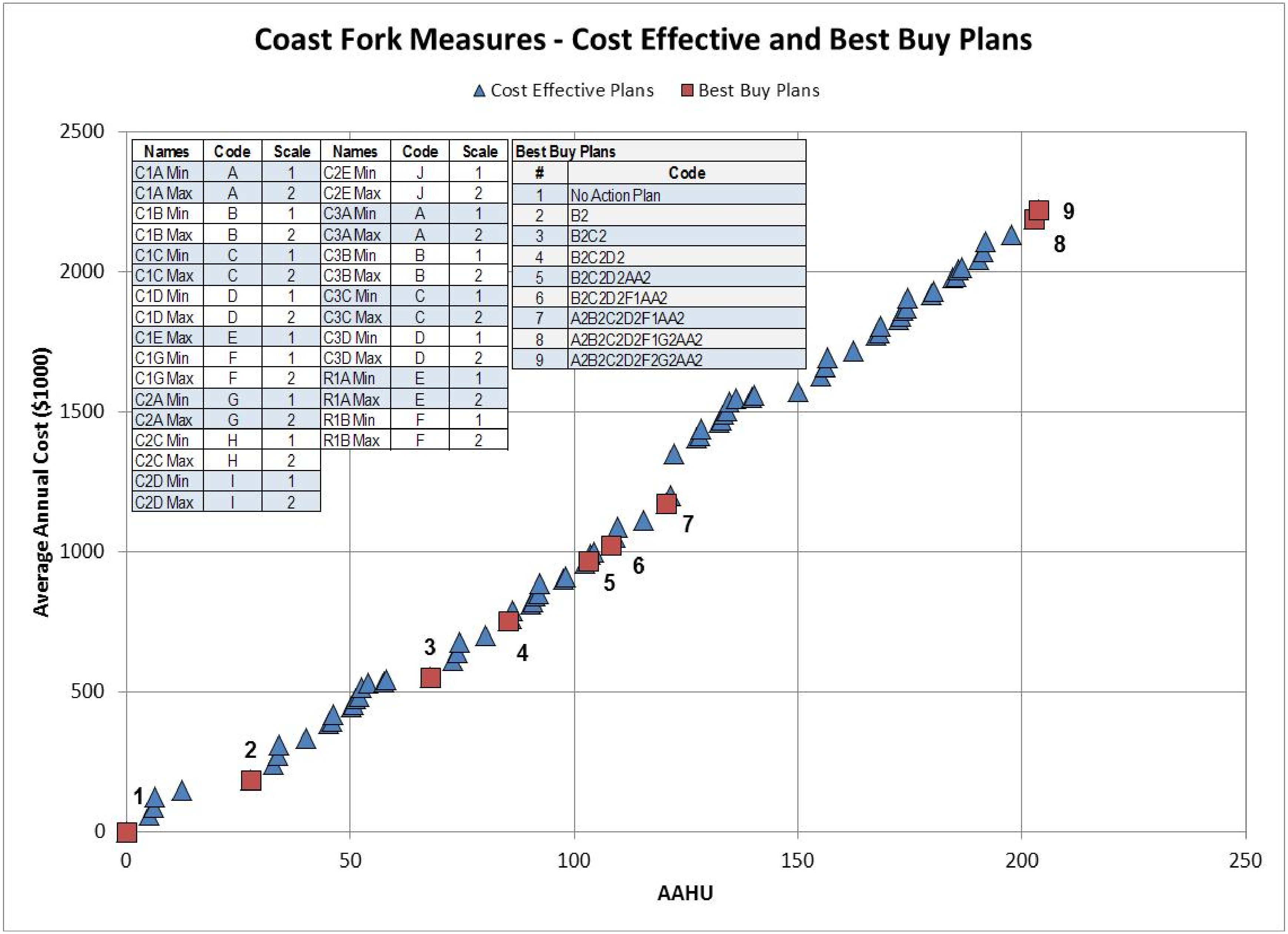
C1B min	K	1
C1B max	K	2
C1C min	L	1
C1C max	L	2
C3A min	M	1
C3A max	M	2
C1D min	N	1
C1D max	N	2
C1G min	O	1
C1G max	O	2
C2A min	P	1
C2A max	P	2
C1A min	Q	1
C1A max	Q	2

Codes for combined Coast and Middle Fork CE/ICA run. All sites from each previous run with an incremental cost per output less than or equal to $15,000 are retained for the combined CE/ICA.

Best Buy Plans					
Name	**AACost**	**AAOutput**	**Inc Cost**	**Inc Out**	**IC/Output**
No Action Plan	0	0	0	0	0
K2	184090	27.8	$184,090	27.8	$6,622
A2K2	599040	80.3	$414,950	52.5	$7,904
A2**B3**K2	1010820	129.2	$411,780	48.9	$8,421
A2B3**C1**K2	1143580	143.7	$132,760	14.5	$9,156
A2B3C1K2**L2**	1511380	183.8	$367,800	40.1	$9,172
A2B3**C2**K2L2	1561310	188.9	$49,930	5.1	$9,790
A2B3C2**D2**K2L2	1708050	203.1	$146,740	14.2	$10,334
A2B3C2D2K2L2**N2**	1910030	220.4	$201,980	17.3	$11,675
A2B3C2D2K2L2**M2**N2	2121200	238.4	$211,170	18	$11,732
A2B3C2D2K2L2M2N2**O1**	2179900	243.4	$58,700	5	$11,740
A2B3C2D2K2L2M2N2O1**Q2**	2327510	255.7	$147,610	12.3	$12,001
A2B3C2D2K2L2M2N2O1**P2**Q2	3346170	337.9	$1,018,660	82.2	$12,392
A2B3C2D2**F2**K2L2M2N2O1P2Q2	3650000	360.9	$303,830	23	$13,210
A2B3C2D2F2**H2**K2L2M2N2O1P2Q2	3869230	377	$219,230	16.1	$13,617
A2B3C2D2**E2**F2H2K2L2M2N2O1P2Q2	4524160	424.6	$654,930	47.6	$13,759
A2B3C2D2E2F2H2**I2**K2L2M2N2O1P2Q2	4706850	437.5	$182,690	12.9	$14,162
A2B3C2D2E2F2H2I2**J2**K2L2M2N2O1P2Q2	4950400	454.1	$243,550	16.6	$14,672
A2B3C2D2E2F2**G2**H2I2J2K2L2M2N2O1P2Q2	5045780	460.5	$95,380	6.4	$14,903
A2B3C2D2E2F2G2H2I2J2K2L2M2N2**O2**P2Q2	5075120	461.6	$29,340	1.1	$26,673

Table 31. Interest During Construction Calculation for Best Buy Plans.

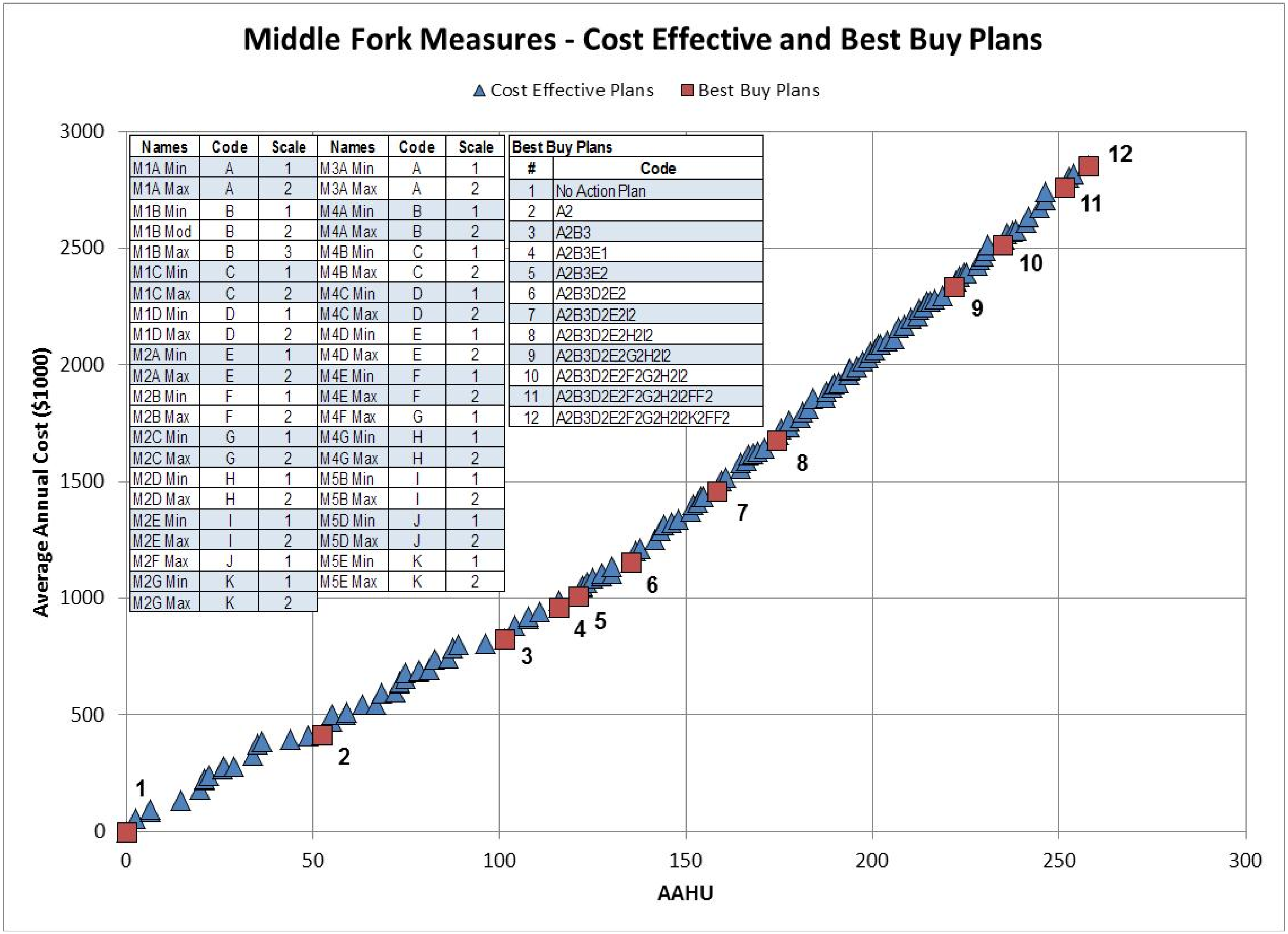
IDC Summary Table				
Best Buy Plan	**IDC ($)**	**Annual IDC**	**Final Alt Cost (Annualized)**	**Final NPV**
2	$25,496	$1,136	$185,226	$4,155,462
3	$82,966	$3,698	$602,738	$13,522,125
4	$139,997	$6,240	$1,017,060	$22,817,232
5	$158,384	$7,060	$1,150,640	$25,814,022
6	$209,324	$9,330	$1,520,710	$34,116,368
7	$216,239	$9,639	$1,570,949	$35,243,438
8	$236,563	$10,545	$1,718,595	$38,555,799
9	$264,536	$11,792	$1,921,822	$43,115,091
10	$293,783	$13,095	$2,134,295	$47,881,830
11	$301,913	$13,458	$2,193,358	$49,206,865
12	$322,357	$14,369	$2,341,879	$52,538,864
13	$463,440	$20,657	$3,366,827	$75,533,068
14	$505,520	$22,533	$3,672,533	$82,391,420
15	$535,883	$23,887	$3,893,117	$87,340,097
16	$626,590	$27,930	$4,552,090	$102,123,827
17	$651,892	$29,058	$4,735,908	$106,247,686
18	$685,624	$30,561	$4,980,961	$111,745,339
19	$698,834	$31,150	$5,076,930	$113,898,351
20	$702,897	$31,331	$5,106,451	$114,560,642



Names	Code	Scale	Names	Code	Scale
C1A Min	A	1	C2E Min	J	1
C1A Max	A	2	C2E Max	J	2
C1B Min	B	1	C3A Min	A	1
C1B Max	B	2	C3A Max	A	2
C1C Min	C	1	C3B Min	B	1
C1C Max	C	2	C3B Max	B	2
C1D Min	D	1	C3C Min	C	1
C1D Max	D	2	C3C Max	C	2
C1E Max	E	1	C3D Min	D	1
C1G Min	F	1	C3D Max	D	2
C1G Max	F	2	R1A Min	E	1
C2A Min	G	1	R1A Max	E	2
C2A Max	G	2	R1B Min	F	1
C2C Min	H	1	R1B Max	F	2
C2C Max	H	2			
C2D Min	I	1			
C2D Max	I	2			

Best Buy Plans	
#	Code
1	No Action Plan
2	B2
3	B2C2
4	B2C2D2
5	B2C2D2AA2
6	B2C2D2F1AA2
7	A2B2C2D2F1AA2
8	A2B2C2D2F1G2AA2
9	A2B2C2D2F2G2AA2

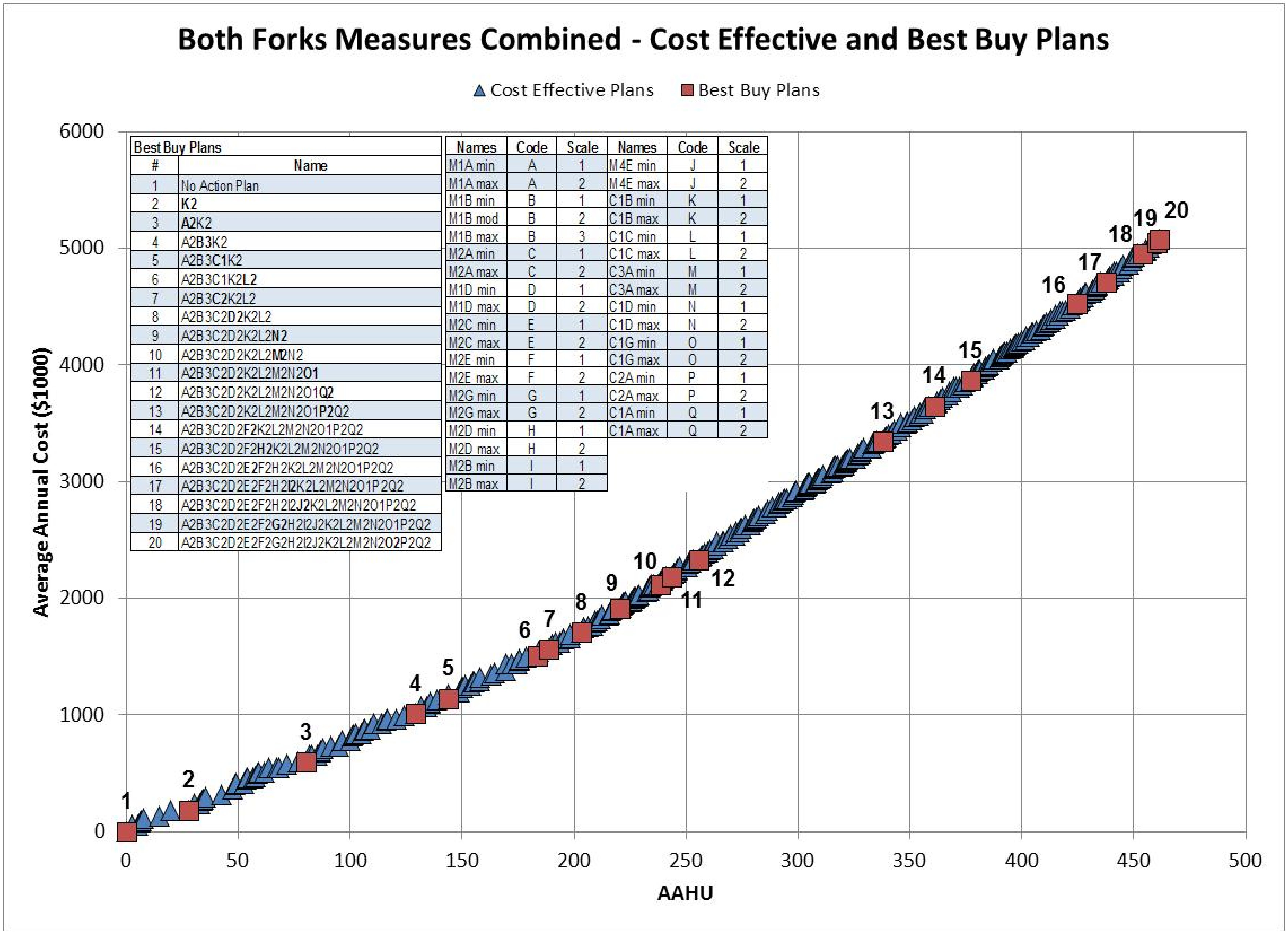
Figure 29. Cost Effective and Best Buy Plans Graph for Coast Fork Cost Effectiveness and Incremental Analysis.



Names	Code	Scale	Names	Code	Scale
M1A Min	A	1	M3A Min	A	1
M1A Max	A	2	M3A Max	A	2
M1B Min	B	1	M4A Min	B	1
M1B Mod	B	2	M4A Max	B	2
M1B Max	B	3	M4B Min	C	1
M1C Min	C	1	M4B Max	C	2
M1C Max	C	2	M4C Min	D	1
M1D Min	D	1	M4C Max	D	2
M1D Max	D	2	M4D Min	E	1
M2A Min	E	1	M4D Max	E	2
M2A Max	E	2	M4E Min	F	1
M2B Min	F	1	M4E Max	F	2
M2B Max	F	2	M4F Max	G	1
M2C Min	G	1	M4G Min	H	1
M2C Max	G	2	M4G Max	H	2
M2D Min	H	1	M5B Min	I	1
M2D Max	H	2	M5B Max	I	2
M2E Min	I	1	M5D Min	J	1
M2E Max	I	2	M5D Max	J	2
M2F Max	J	1	M5E Min	K	1
M2G Min	K	1	M5E Max	K	2
M2G Max	K	2			

Best Buy Plans	
#	Code
1	No Action Plan
2	A2
3	A2B3
4	A2B3E1
5	A2B3E2
6	A2B3D2E2
7	A2B3D2E2I2
8	A2B3D2E2H2I2
9	A2B3D2E2G2H2I2
10	A2B3D2E2F2G2H2I2
11	A2B3D2E2F2G2H2I2FF2
12	A2B3D2E2F2G2H2I2K2FF2

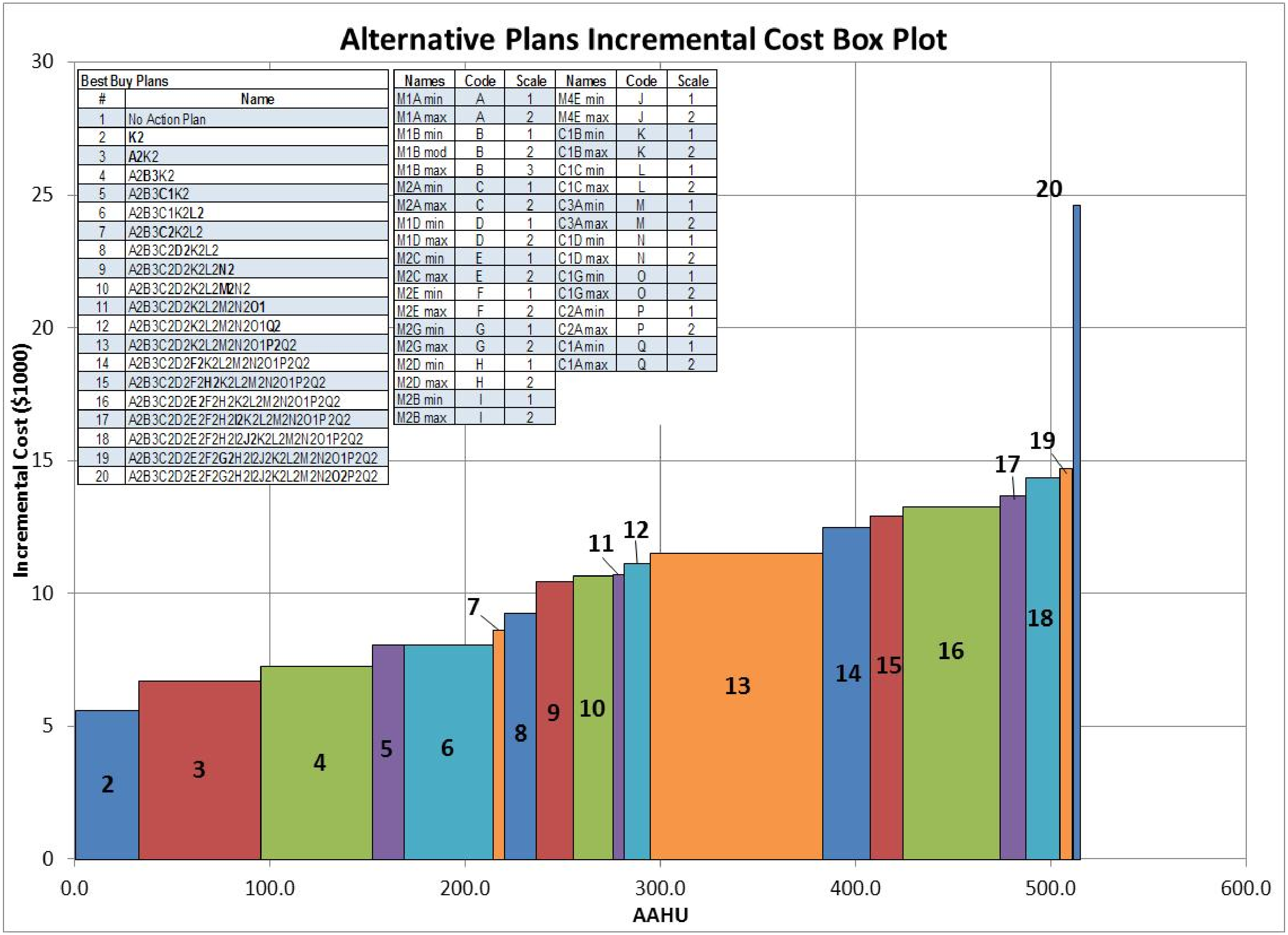
Figure 30. Cost Effective and Best Buy Plans for Middle Fork Cost Effectiveness Analysis.



Best Buy Plans	
#	Name
1	No Action Plan
2	K2
3	A2K2
4	A2B3K2
5	A2B3C1K2
6	A2B3C1K2L2
7	A2B3C2K2L2
8	A2B3C2D2K2L2
9	A2B3C2D2K2L2N2
10	A2B3C2D2K2L2M2N2
11	A2B3C2D2K2L2M2N2O1
12	A2B3C2D2K2L2M2N2O1Q2
13	A2B3C2D2K2L2M2N2O1P2Q2
14	A2B3C2D2F2K2L2M2N2O1P2Q2
15	A2B3C2D2F2H2K2L2M2N2O1P2Q2
16	A2B3C2D2E2F2H2K2L2M2N2O1P2Q2
17	A2B3C2D2E2F2H2I2K2L2M2N2O1P2Q2
18	A2B3C2D2E2F2H2I2J2K2L2M2N2O1P2Q2
19	A2B3C2D2E2F2G2H2I2J2K2L2M2N2O1P2Q2
20	A2B3C2D2E2F2G2H2I2J2K2L2M2N2O2P2Q2

Names	Code	Scale	Names	Code	Scale
M1A min	A	1	M4E min	J	1
M1A max	A	2	M4E max	J	2
M1B min	B	1	C1B min	K	1
M1B mod	B	2	C1B max	K	2
M1B max	B	3	C1C min	L	1
M2A min	C	1	C1C max	L	2
M2A max	C	2	C3A min	M	1
M1D min	D	1	C3A max	M	2
M1D max	D	2	C1D min	N	1
M2C min	E	1	C1D max	N	2
M2C max	E	2	C1G min	O	1
M2E min	F	1	C1G max	O	2
M2E max	F	2	C2A min	P	1
M2G min	G	1	C2A max	P	2
M2G max	G	2	C1A min	Q	1
M2D min	H	1	C1A max	Q	2
M2D max	H	2			
M2B min	I	1			
M2B max	I	2			

Figure 31. Combined Coast and Middle Fork Cost Effectiveness Analysis Graph.



Best Buy Plans	
#	Name
1	No Action Plan
2	K2
3	A2K2
4	A2B3K2
5	A2B3C1K2
6	A2B3C1K2L2
7	A2B3C2K2L2
8	A2B3C2D2K2L2
9	A2B3C2D2K2L2N2
10	A2B3C2D2K2L2M2N2
11	A2B3C2D2K2L2M2N2O1
12	A2B3C2D2K2L2M2N2O1Q2
13	A2B3C2D2K2L2M2N2O1P2Q2
14	A2B3C2D2F2K2L2M2N2O1P2Q2
15	A2B3C2D2F2H2K2L2M2N2O1P2Q2
16	A2B3C2D2E2F2H2K2L2M2N2O1P2Q2
17	A2B3C2D2E2F2H2I2K2L2M2N2O1P2Q2
18	A2B3C2D2E2F2H2I2J2K2L2M2N2O1P2Q2
19	A2B3C2D2E2F2G2H2I2J2K2L2M2N2O1P2Q2
20	A2B3C2D2E2F2G2H2I2J2K2L2M2N2O2P2Q2

Names	Code	Scale	Names	Code	Scale
M1A min	A	1	M4E min	J	1
M1A max	A	2	M4E max	J	2
M1B min	B	1	C1B min	K	1
M1B mod	B	2	C1B max	K	2
M1B max	B	3	C1C min	L	1
M2A min	C	1	C1C max	L	2
M2A max	C	2	C3A min	M	1
M1D min	D	1	C3A max	M	2
M1D max	D	2	C1D min	N	1
M2C min	E	1	C1D max	N	2
M2C max	E	2	C1G min	O	1
M2E min	F	1	C1G max	O	2
M2E max	F	2	C2A min	P	1
M2G min	G	1	C2A max	P	2
M2G max	G	2	C1A min	Q	1
M2D min	H	1	C1A max	Q	2
M2D max	H	2			
M2B min	I	1			
M2B max	I	2			

Figure 32. Combined Coast and Middle Fork Incremental Analysis Box Plot.

5.6.6. Guide to Interpreting Results

The data points on the graph in Figure 32 are sequential per the plan number shown in the corresponding code table. For example, in Figure 32, the third best buy point is Plan 4; the corresponding combination includes C1B Maximum, M1A Maximum, and M1B Maximum.

The most obvious break point in Figure 32 is after Plan 19; this is where the incremental cost per unit jumps from $14,903 to $26,673. However, the total project cost to implement Plan 19 would be more than $115 million, which is well beyond the non-federal sponsor's capability for cost sharing. Thus, plans with less overall output and less overall costs are desirable. Any of the best buy plans could be worth investment and the selection of the recommended plan should be based on an evaluation of what benefits are worth what cost? There is no precise selection criterion that identifies the optimal restoration plan. Instead the project team must consider the results of the CE/ICA, comparing the successive levels of output and their cost and determining which levels are worth their added cost. Flatter sloped portions of the incremental cost curves indicate more increase in output and lower increase in cost than more steeply sloped potions of the curves. As the slope gets steeper and higher, increased scrutiny of, and justification for such a recommendation is in order.

Moving from the lowest cost plans on the left side of the graph in Figure 32, the first obvious break point in is after Plan 3. However, Plans 4, 6, 13, and 16 all provide substantial benefits at only a slightly higher incremental cost. The National Ecosystem Restoration (NER) plan was not determined, but rather plan selection was guided by the amount that the local sponsor could cost-share. The local sponsor has a limitation on their ability to cost share beyond a construction cost of about $50 million (does not include O&M). Thus, the consideration of which plan to select was highly based on selecting a plan that costs less than $50 million. At each best buy plan, the project team determines whether the level of output provided by implementing the plan is worth the incremental cost per output; then the next decision becomes is the additional output provided by the next-larger plan worth its extra cost. The analysis has arrayed the best buy plans such that each successive best buy plan on the graph provides additional output at a higher cost per unit than the previous best buy plan.

After discussions with the project sponsors and stakeholders, Plan 7 that includes 5 projects was selected as a reasonable plan based on the total cost and number of projects distributed in both the Coast and Middle Forks. While there is a relatively smaller increase in benefit when moving from Plan 6 to Plan 7, it would provide maximum connectivity at Site M2A when moving from M2A MIN to M2A MAX that the project team and local sponsor consider highly beneficial. The project team has additionally conducted outreach with all of the affected landowners to ensure that these projects could be implemented. The project alternatives had been developed with consideration to potential floodplain and habitat benefit as the primary consideration, and not whether the site was "available." This was done because the objectives of this study are to restore floodplain functions to these watersheds. Developing project alternatives only based on what is currently "available" does not tend to adequately provide for the restoration of natural processes, and tends to provide only small areas of fragmented habitat that is less beneficial on a watershed scale.

Table 32, below, shows the project sites included in the tentatively recommended plan, Plan 7. Selection of this plan was made with the non-Federal sponsor based on their ability to cost-share the total project cost and because these projects provided substantial restoration benefits in the highest priority reaches (C1, M1, and M2) and on the largest undeveloped sites that would reconnect substantial areas of off-channel and floodplain aquatic habitats. More expensive plans could not be cost-shared by the non-

Federal sponsor. All of the sites in the tentatively recommended plan have been subjected to some level of mineral extraction (gravel mining) in the past and while they are currently significantly degraded, they also provide the best opportunities for substantial restoration of floodplain habitats. Average preliminary costs per acre for the recommended restoration plan are approximately $60,000 per acre (including net present value of O&M in preliminary costs). Average annual cost per habitat unit is approximately $8,000 (including net present value of O&M). While plans up to Plan 10 or 11 could potentially be considered within the non-Federal sponsor's cost-sharing capability, it is likely that costs will increase during the more detailed feasibility level design, so the project team decided to select Plan 7 as the next several plans only have small increases in benefit for the increase in incremental cost.

Table 32. Alternatives Included in Plan 7.

ICA Code	Project ID	Landownership	Acres	Cumulative AAHUs
K2	C1B	Lane County/ OR State Parks	86	27.77
A2	M1A	TNC	147	80.22
B3	M1B	TNC	170	129.12
L2	C1C	TNC	114	169.21
C2	M2A	TNC	68	188.77

5.7. RECOMMENDED RESTORATION PLAN

The sites included in Plan 7 are selected as the recommended plan and will be moved forward for feasibility level designs. The recommended restoration plan will result in a plan with a total increase of 189 habitat units and restoration of 574 acres of floodplain[3]. The primary measures proposed at each site are identified below. More details on the effects of the recommended plan are provided in Sections 6 and 7.

Site C1B. This site is currently owned by Lane County. The restoration plan at this site will be to restore and connect the gravel mined ponds to the Coast Fork. Pond banks will be regraded to smooth out and flatten the slopes, additional fill material piled on site will be regraded into the ponds to provide more shallow water, invasive species such as blackberries will be removed/controlled, native riparian and wetland species will be planted throughout the site, large wood will be placed in the floodplain and ponds, channels will be excavated to connect the ponds to each other and then to the Coast Fork and one ELJ will be installed on an island/bar in the channel to promote split channel flows.

Site M1A. This site is owned by the Nature Conservancy. The restoration plan at this site will be to restore and connect the gravel mined ponds to the Middle Fork. Pond banks will be regraded to smooth out and flatten the slopes, debris will be removed from the site, additional fill material piled on site will be regraded into the ponds to provide more shallow water, invasive species such as blackberries will be removed/controlled, native riparian and wetland species will be planted throughout the site, large wood will be placed in the floodplain and ponds, and channels will be excavated to connect the ponds to each other and then to the Middle Fork.

Site M1B. This site is owned by the Nature Conservancy. The restoration plan at this site will be to restore and connect the large gravel mined ponds to the Middle Fork. Pond banks will be regraded to smooth out and flatten the slopes, debris will be removed from the site, additional fill material piled on site will be regraded into the ponds to provide more shallow water, invasive species such as blackberries will be removed/controlled, native riparian and wetland species will be planted throughout the site, large wood will be placed in the floodplain and ponds, and overflow channels will be excavated to connect the ponds to each other and to both the Coast (high flows only) and Middle Fork.

Site C1C. This site is owned by the Nature Conservancy. The restoration plan at this site will be to restore and connect the gravel mined ponds to the Coast Fork. Pond banks will be regraded to smooth out and flatten the slopes, debris will be removed from the site, additional fill material piled on site will be regraded into the ponds to provide more shallow water, invasive species such as blackberries will be removed/controlled, native riparian and wetland species will be planted throughout the site, large wood will be placed in the floodplain and ponds, channels will be excavated to connect the ponds at both the upstream and downstream ends to the Coast Fork, and two ELJS will be installed to promote channel migration onto the site.

Site M2A. This site is owned by the Nature Conservancy. The restoration plan at this site will be to restore and connect the gravel mined ponds to the Middle Fork and create a more defined outlet for Pudding Creek. Pond banks will be regraded as appropriate without disturbing existing high quality

[3] Area of recommended restoration plan was revised during 35% design to eliminate small areas of private parcels, thus total acreage slightly decreased from 585 to 574 acres.

habitats, invasive species such as blackberries will be removed/controlled, native riparian and wetland species will be planted as necessary (much of the site is already vegetated), large wood will be placed in the floodplain and ponds, and channels will be excavated to connect the ponds to each other and provide a better outlet for Pudding Creek.

5.8. SIGNIFICANCE OF THE RECOMMENDED PLAN

The recommended plan will provide 574 acres of restored and reconnected floodplain in the Coast and Middle Forks subbasins. This will provide essential rearing and refuge habitats for multiple listed fish and wildlife species and species of concern that occur in the subbasins and contribute towards their recovery. Of primary focus are the species included in the HEP analysis; salmonid species including the listed Upper Willamette Chinook and steelhead, cutthroat trout, Oregon chub, Western pond turtle, riparian dependent wildlife such as beaver and wood duck, Neotropical migratory song birds such as yellow warbler, native amphibians, and raptors. Specifically, the types of improvements that this project will make to their habitats include provision of fish access to off-channel habitats, improvements in quality to the off-channel habitats including provision of more suitable off-channel water depths that vary naturally with the seasons (deeper depths in winter, shallower water in summer), improvements in cover and shading, increases in large wood and small woody debris, removal of invasive species and revegetation with native species, and interspersion of habitat types. This project will also contribute to the restoration of natural riverine processes including channel migration and the recruitment of large woody debris over time as the riparian vegetation grows and matures. At the confluence of the Coast and Middle Forks this project will stimulate the formation of natural habitats along nearly 3 miles of river (1 mile on the Coast Fork and 2 miles on the Middle Fork), such as pools, riffles, alcoves and side channels.

The large stakeholder group that has been participating in this study (Table 1) has supported the goals and objectives of the study throughout the feasibility phase. Key agencies, including NOAA, USFWS, EPA, BPA, ODFW, and others are looking to this project to provide a significant amount of floodplain habitat and process restoration. This project, as proposed, would provide one of the largest floodplain restoration projects in the State of Oregon and contribute significantly towards the recovery of sensitive species.

5.8.1. Institutional Significance

Institutional recognition is based on the significance of resources acknowledged in laws, adopted plans and policy statements by agencies both public and private. The formal recognition of the Willamette River by multiple agencies illustrates the significance of the resources. The plans and programs listed in Section 2 demonstrate the significance of the resources to multiple agencies. Of particular importance is the *Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead* (ODFW 2011) that lays out strategies for the recovery of listed Upper Willamette River Chinook salmon and steelhead trout. Reconnection of floodplain habitats is one of the primary methods to assist in recovery.

This project will restore and reconnect off-channel and floodplain habitats for several species listed under the ESA, including Upper Willamette River Chinook salmon (threatened), bull trout (threatened), Oregon chub (threatened), and Oregon spotted frog (candidate). The project will improve habitat designated as critical habitat for these species and contribute towards their recovery. In addition, this project will restore suitable floodplain and riparian habitats for species of concern identified by the USFWS, including Western pond turtle, Northern red legged frog, and Pacific lamprey. This project will also contribute towards meeting key objectives of the Willamette Subbasin Plan (NPCC 2004) developed as part of Phase 1 of this study, but involving multiple federal, state, regional, and local agencies to set priorities for fish and wildlife conservation throughout the basin. Key aquatic habitat strategies that this project will address include: 1) increase interaction of rivers and floodplains; 2) increase supply and recruitment of large wood by improving riparian composition and extent and providing for flows to capture wood; and 3) control the most damaging terrestrial and aquatic invasive species (NPCC 2004).

5.8.2. Public Significance

Public recognition means that some segment of the public either individually or as a group recognizes the importance of an environmental resource. The Willamette River valley hosts 70% of the state of Oregon's population and has strong citizen involvement in the uses and activities of the river. The Willamette River is one of ten rivers included in the Sustainable Rivers Project between the USACE and the Nature Conservancy.

Collaboration with the public through the watershed councils and other public outreach organizations, such as The Friends of Buford Park, has been conducted throughout the feasibility study. This project is supported by those organizations and their members. This feasibility study provided technical documentation to the Nature Conservancy on the potentially significant restoration need and value at the confluence of the Coast and Middle Forks and was a key driver for their fundraising and purchase of the confluence property supported by their large public membership.

5.8.3. Technical Significance

Technical recognition is determined through review of relevant published and non-published literature and documents. Numerous scientific analyses and long-term studies through Oregon State University and the University of Oregon have documented the significance of the resources in the Willamette River basin, of which the *Willamette Basin Planning Atlas* demonstrates the resources that have been lost, while laying out scenarios to guide future development while restoring natural resources.

The recommended plan will restore connectivity between both the Coast and Middle Forks and their floodplain habitats which is a key component of natural floodplain processes that have been significantly altered by the presence and operation of upstream dams, revetments, land use and infrastructure. The recommended plan will restore a large contiguous block of floodplain habitat in a critical river confluence area that was historically highly dynamic with numerous side channels, overflow channels, and a diversity of plant communities. This plan will allow this dynamism to be restored as possible within the context of existing dams and flows, and will restore the diversity of habitats and plant communities appropriate for the site and allow natural formation of habitats to continue over the long-term.

5.9. PLANNING GUIDANCE CRITERIA

Per ER 1105-2-100, recommended plans should be evaluated for completeness, effectiveness, efficiency, and acceptability. The recommended plan can be implemented as a stand-alone restoration project and is not dependent on actions by other agencies or stakeholders. It will function in perpetuity and allow the natural formation of riverine, riparian, and floodplain habitats. The recommended plan includes restoration measures that have been successfully implemented in multiple locations throughout the Pacific Northwest for salmon restoration and have been demonstrated to be effective. Restoration and connections of gravel mined ponds has been conducted in several locations such as along the mainstem Willamette River (Eugene Delta Ponds, Harrisburg, etc.) and on the Washougal and Lewis Rivers in Washington. When gravel mined ponds are less than 25 feet in depth (as all are sites in this recommended plan), it is feasible to regrade and reshape the shorelines to provide shallow water habitat, fringing wetlands, and riparian areas and also reduce the potential for river "capture." That is the intent for this project and has been shown to be effective elsewhere.

5.9.1. Acceptability

An ecosystem restoration plan should be acceptable to State and Federal resource agencies, local governments and stakeholders in the area. There should be evidence of broad based public consensus and support for the plan. A recommended plan must be acceptable to the non-Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan. The recommended plan meets all of the project objectives, including: 1) restores channel complexity and diversity; 2) restores the connectivity of the river to floodplain and off-channel habitats; 3) restores and enhances the floodplain habitats (including riparian and wetland habitats); 4) reduces invasive non-native species, primarily plant species such as reed canary grass and blackberries; 5) contribute to a reduction in water temperatures to meet native species needs by providing more effective connections to the river, shading, and groundwater recharge; and 6) contribute to a reduction in bacteria and nutrient loading by providing improved riparian buffers and provide more frequent connections to floodplain habitats that provide nutrient and sediment deposition opportunities during storm events. The recommended plan meets these objectives, while simultaneously does not cause adverse effects to existing wetland habitats and is constructible. The numerous stakeholders listed in Table 1 have expressed support for the recommended plan.

5.9.2. Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, O&M, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain restoration features and an adaptive management plan has been proposed it must be accounted for in the plan. The recommended plan will realize the predicted habitat outputs by providing the complete mix of measures that ensures that hydrologic, fish passage, wildlife, and vegetation objectives are met. O&M will be required, but is primarily focused on the first 5 years after implementation and conducting invasive species removal/control efforts and replanting as appropriate. This is to ensure that invasive non-native species are controlled for the long-term and do not reoccupy the majority of the floodplain as they currently do. Experience by many entities in the basin has indicated that maintenance efforts for up to 5 years is appropriate to ensure such invasive species are adequately controlled. Once the native vegetation can become established and start to provide shading of the understory, invasive species become reduced in vigor and spread. Temporary controls such as mowing and spot application of herbicide to the invasives are necessary, however, for native species to become fully established. Also, it is typical in most revegetation efforts that some replanting is necessary as not all planted stock survives. Once a plant has survived 1-2 years, it can typically then persist and grow suitably over time. It is not intended that the ELJs or other large wood will be replaced or maintained as it is being installed to provide up to 25 years of cover and habitat formation until the riparian zone can begin to mature and start naturally recruiting large and small wood to the river system. Channel openings will be monitored, but are expected to be sustainable because they are primarily backwater connections. Geomorphic conditions are described further in Section 7.

5.9.3. Efficiency

An ecosystem restoration plan must represent a cost effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution. The recommended plan will provide substantial benefits at a reasonable cost. These benefits cannot be realized more effectively by the local sponsor or other stakeholders because they do not have the funds to construct the primary elements of the project that restore floodplain connections and promote in-channel diversity, namely the grading and channel features and ELJs. Also, while small-scale riparian revegetation has been occurring by many entities, providing nearly 600 acres of revegetation on the highly disturbed sites in the recommended plan is well beyond local entities financial capabilities.

5.9.4. Effectiveness

An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities. As identified above under acceptability, the recommended plan will contribute substantially towards the six primary objectives of the study. The types of restoration measures proposed have been used in many locations and shown to be effective, including providing access to off-channel habitats, installation of ELJs, and riparian restoration.

5.10. Other Evaluation Accounts

The plans formulated and evaluated for this project were all developed to provide ecosystem restoration benefits. There is no evaluation for a National Economic Development (NED) or Regional Economic Development (RED) plan as benefits are not monetized. Additionally, the plans evaluated in this study, while they may provide other benefits, these are primarily incidental, such as flood storage, recreation, community cohesion or other social effects. Thus, no explicit evaluation of the other evaluation accounts was conducted.

6. RECOMMENDED RESTORATION PLAN

6.1. DESIGN FEATURES

The overall project includes the development of several design features that are included in the five proposed restoration sites. Each restoration site includes a unique combination of design features and quantities. The design elements are detailed below, and the draft 35% design drawings are provided in Appendix F.

6.1.1. Clearing

Clearing includes the removal of large rocks, boulders and debris from land for access and in advance of vegetative restoration. This item does not include removal of invasive vegetation (see 6.1.2: Removal of invasive vegetation).

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

6.1.2. Removal of Invasive Vegetation

While it is unlikely that all invasive species can be permanently removed, the removal of these species will be to the level that planted native vegetation can more readily compete to establish a dominant community in subsequent growing seasons (see 6.1.13: Vegetative plantings).

Hand labor and small equipment will be used to cut and/or pull to remove invasive vegetation. Spot application of herbicide is appropriate after cutting to kill or reduce the vigor of the invasive plant stems, while also minimizing any potential for spills or over-application. The removed vegetation will be disposed of off-site, such as at a compost facility, or chipped and composted on-site. It is expected that this would occur prior to planting, and then maintenance to continue to cut and/or apply herbicide to the invasive species would be conducted for three years following construction.

6.1.3. Excavation

Excavation is the removal of earth for the development of side channels and pond connections and/or to regrade bank slopes or disturbed floodplain areas to provide a better planting surface (see 6.1.4: Construction of side channels and pond re-connections). Excavation limits are determined by the design details at each restoration site. Two sites – M1A and M1B – include excavation and regrading or reuse of previously-placed piles of fill or debris in the floodplain (these piles include windrows of top soil removed prior to gravel mining operations as well as piles of cobbles and other material excavated during the gravel mining operations).

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

6.1.4. Construction of Side Channels and Pond Connections

Side channel construction involves the placement of one or more of the following: channel bed material, bank stabilization measures, streambank vegetation restoration, and riparian vegetation restoration. Bed material is typically a well graded mix of fine material and gravel and cobbles either imported from off-site sources or from suitable material on-site. Channel invert grades are designed to provide a backwater connection during the typical winter/spring flows (November to June) at the channel outlets, so grade control measures are unnecessary. Bank stabilization is accomplished using vegetation, large woody debris and root wads, and fabric as necessary. Bank and riparian restoration will include the planting of local, native vegetation species.

Connecting previously mined gravel ponds to the Coast or Middle Forks is a relatively new restoration design concept. Some stakeholders are concerned about the potential for the ponds to "capture" the river if the ponds are very deep (i.e. 50 feet and greater). Gravel mined ponds further upstream on the Middle Fork did capture the river in the 1996 flood event, but now provide a highly braided channel system and a few deep pools to the river. None of the ponds proposed in this project are deeper than 25 feet, and are typically 6-15 feet in depth.

Pond connections include the elements of side channel construction, but are typically shorter because they will be designed to achieve a backwater connection or connections between ponds using existing topographic features (following overflow channels or other existing channels), and may not typically include riparian restoration features if an existing overflow channel is simply widened and/or deepened. No frequent flow-through channels are included; some high-flow connection channels will be excavated to allow connections above a 2-year event. These channels will include roughness features to slow velocities and minimize the potential for river capture. All of the proposed pond connections will connect ponds that are within the 100-year floodplain to their respective rivers. These sites were all inundated during the 1996 flood event, but did not experience avulsions. Some sites already have partial connections below the 2-year flow, including C1C and M2A. These existing connections will be enhanced for frequent accessibility by fish.

Construction of the side channel and pond connection habitat elements will be staged to follow clearing and excavation. Bed material will be placed with excavators, front end loaders, and dump trucks. Large woody debris, root wads, and native rock materials will be placed by using a combination of machines and hand labor. Streambank and riparian vegetative plantings will be accomplished using hand labor during the fall after other construction activities are complete.

6.1.5. Concrete and Debris Removal

In its existing state, Site M1B includes a berm that is protected on its river-side by a privately installed revetment of miscellaneous debris and rock. This berm was created to separate a large gravel mined pond from the river during the mining operations. The M1B design includes partial removal of this private (non-Corps) revetment and replacement with wood and rock, as appropriate. Debris present on M1A and M1B would be removed as appropriate.

The existing concrete and debris will be removed using excavators, dump trucks, small equipment and hand labor. The debris will be disposed of or recycled off-site.

6.1.6. Engineered Log Jam Construction

Engineered log jams (ELJs) are large wood structures designed to withstand 100-year flows and provide fairly long-term (i.e. 25 years or more) stable elements of habitat in otherwise more uniform channels. Their presence will trap and store additional wood that drifts down the rivers. The construction of engineered log jams requires excavation to install key pieces and driving of wooden piles to support the structures. Chains may be used to temporarily anchor the wood to the piles until sufficient sediment or additional wood has racked up on the ELJs to stabilize the structure. Cables will not be used. Ballast of river cobbles/gravel or large rock may also be used as necessary.

Large wood would be installed during low flows (within in-water work windows) using excavators, cranes, helicopters, and hand labor, as appropriate. The work sites would be isolated as much as feasible using coffer dams and/or silt curtains and dewatered if feasible to facilitate construction. Access to islands would be provided by temporary bridges or dewatering of side channels via coffer dams and pumping.

6.1.7. Placement of Large Wood in Floodplains and Ponds

Much of the riparian area, floodplain and the formerly gravel mined ponds in the project area are lacking in large woody debris. Large wood will be placed in vegetated floodplain areas to provide habitat diversity and cover for amphibians, reptiles, and other wildlife species. This wood will not be anchored, but will be installed in well vegetated areas, particularly floodplain forested areas where it is unlikely that the wood could be floated back into the river during a flood event. It is expected that this material will move somewhat around the floodplain over time, but will not cause a navigation hazard. Wood placed in restored ponds will be anchored with large rock or keyed into banks. This wood will provide cover for fish species as well as perching or basking habitat for wildlife.

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

6.1.8. Riprap Installation

Riprap may be used, only as necessary, to protect culvert footings, as part of a bioengineered bank with installed wood and vegetation to protect the toe of the existing berm at site M1B and the flow-through notches from hydraulic scour and potential avulsions. It will only be used as necessary, particularly on the M1B site where erosive forces could be high and where there could be the potential for the large gravel pits to “capture” the river. All connection channels to gravel mined ponds are designed to either function as backwater connections with low velocities, or to connect above the 2-year flow event when water spreads out on many floodplain areas and velocities are reduced in the roughened floodplain. Riprap will only be used following the guidelines in the NMFS SLOPES IV Roads, Culverts, and Bridges Biological Opinion (NMFS 2008b). Riprap will be placed using a hydraulic excavator.

6.1.9. Culvert Installation

In a few locations, new side channels and pond connections cross existing roads or trails that will be preserved. In these cases, the channels will be passed under the road in three-sided culverts that, in addition to providing hydraulic capacity, provide a natural bottom and room for the channel to meander slightly. The culvert size will be determined with hydraulic design calculations and will meet the State of Oregon's requirements for fish passage.

Culvert construction will be staged after the construction of the affected side channels or pond connections. Culvert installation will be conducted with mechanized equipment, and when necessary will include the pouring of concrete footings below the soil surface.

6.1.10. Reshaping Pond Banks

The ponds that currently exist in the floodplain of the project sites are mostly remnants of historical gravel mining activities, and thus have typically steep banks. The steep banks provide little habitat for fish, insects, aquatic and riparian plants, and primary production. Regrading and reshaping the pond banks to a much gentler slope will create shallow water habitat, wetland areas, and a much larger and more extensive riparian zone. It will also allow reptiles and other species better access to and from the ponds.

Pond bank reshaping consists of excavating the upper portion of the bank back to a 5:1 (H:V) slope or gentler and then pushing that bank material and other regraded material into the ponds to create shallow water and wetland habitats. High ground above the pond will be graded to a design slope by excavation using a front end loader or an excavator. The excavated material will be deposited below the water line inside the pond banks to create the shallow water habitat. The disturbed areas will be restored with bank and riparian vegetative plantings using a combination of machines and hand labor.

6.1.11. Constructing Footpath Bridges

Footpath trails intersect new side channels at two sites, so in order to maintain the existing pedestrian access, pedestrian bridges will be installed. The design includes the installation of prefabricated pedestrian bridges to cross these channels. The bridge material and design parameters will vary from location to location, but will be either wooden or aluminum/steel prefabricated bridge with concrete abutments on the banks. The trails will be graded to match the bridge approaches. Hydraulic modeling will be performed to set the bridge low chord elevation and determine appropriate bridge spans to meet fish passage requirements.

The bridges will be constructed using machines and hand labor.

6.1.12. Gravel Road Obliteration

Site C1C features the removal of a small, little-used gravel road that parallels the Coast Fork Willamette River bank. In order to maximize the efficacy of a restored riparian corridor, the road will be excavated down to remove compacted rock and the soil will be ripped to facilitate planting of native vegetation in its place. A nearby road will be preserved to allow access to this area of the site.

The gravel road will be obliterated by excavating the surface material and subgrade using front end loaders and dump trucks. The material will be disposed of off-site. The road bed will be replaced with topsoil using dump trucks and front end loaders, and will be revegetated per section 7.1.13.

6.1.13. Vegetative Plantings

Native vegetation species will be planted at all sites. The primary plant community that will be planted will be the riparian community, dominated by black cottonwood, red alder, Oregon ash, incense cedar, Douglas fir, and a variety of shrub species. At sites with extensive tree cover, currently, the invasive understory will be removed as described in section 6.1.2. and then replanted with appropriate riparian underplantings of shrub and conifer species. At sites with gravel pits, the shallow water and wetland zones will be planted with emergent wetland vegetation.

Currently, the cost estimates reflect paid contract labor for all plantings. Costs could be reduced by the use of volunteer labor.

6.2. COST ESTIMATE

A detailed cost estimate was developed for the recommended restoration plan. The fully funded cost estimate for the project is $45,035,000, including design, construction, engineering during construction, construction management, acquisition of all real estate, escalation of the project for a 4-year phased construction starting in 2015, and monitoring. The details are presented in Appendix C, Cost Estimates. Table 33 provides a summary of the main cost elements by account. The cost estimate was developed using the Corps Micro Computer Aided Cost Estimating Software (MCACES), Version 2 (M2).

Table 33. Cost Summary Table.

Construction Item	Cost ($1,000)
Lands and Damages	426
Elements	
Fish & Wildlife Facilities	24,291
Roads, Railroads and Bridges	2,576
Channels and Canals	1,258
Levees and Floodwalls	8,073
Recreation Facilities	95
Subtotal	**36,293**
Preconstruction Engineering and Design (PED)	3,813
Construction Management (S&A)	4,503
Fully Funded Cost	**45,035**

The feasibility study has already been cost-shared at a 50:50 split. Adding the cost of the feasibility study to the fully funded cost estimate for a total project cost of $48,882,222 would require an estimated federal cost share of $31,773,000 and an estimated local sponsor cost share of $17,109,000 ($426,000 of the non-Federal sponsor cost share would be credit for LERRDs). Table 34 shows the cost-sharing breakdown for the project.

Table 34. Cost Apportionment Table.

Item	Federal	Sponsor	Total
ECOSYSTEM RESTORATION (in $1000s)			
Feasibility Study (already spent; not included in total)	1,923.5	1,923.5	3,847
Design & Construction	29,849.5	14,759.5	44,609
LERRDs*	0	426	426
Total Cost-Shared Implementation Costs	**31,773**	**17,109**	**48,882**
*Percentage of Total Cost-Shared Amount – Ecosystem Restoration (Per Section 210 of WRDA 1996, the non-federal cost for ecosystem restoration projects is 35 percent of all construction costs, including LERRD, and 100 percent of OMRR&R**.*	*65%*	*35%*	*100%*
*Net Present Value of OMRR&R** *		*$2,924,520*	

*LERRDs = lands, easements, rights-of-way, relocation, and disposal sites
**OMRR&R = operation, maintenance, repair, replacement, and rehabilitation

6.3. Real Estate

The preliminary value of the real estate required for the project from the gross appraisal is $426,000. This includes a preliminary valuation of lands already owned by the non-Federal sponsor (The Nature Conservancy), acquisition of lands not owned by the non-Federal sponsor, and with a contingency and escalation factor applied. More details are provided in the Draft Real Estate Plan in Appendix G.

6.4. Construction Issues

For the most part, the construction elements proposed for the recommended plan are straight forward including grading, excavation of channels, removal of invasive species, and plantings of native species. Also, the majority of the work can be constructed “isolated” from the rivers (i.e. work in the gravel ponds that are not connected to the river) until the final connections are made and are thus not subject to the in-water work window restrictions. The only more complicated construction element anticipated for this project is construction of the Engineered Log Jams at island or bar locations that do not have direct access for vehicles. In these cases, access could be provided by a temporary bridge, dewatering of side channels via a coffer dam and pumping to allow vehicles to drive across, or by using a helicopter to deliver wood and other materials, or a combination of these techniques. If a temporary bridge is determined to be the best method, it will likely be necessary to construct a temporary work pad and some type of bridge abutment on the adjacent bank. All of the ELJ work would need to be done during the designated in-water work windows (or with an approved extension by ODFW). Disturbed bar or island areas would require seeding and planting work following the completion of grading and other work by heavy equipment..

6.5. Elements for Detailed Design

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

- Value engineering study
- Supplemental bathymetric and topographic surveying
- Detailed reach-scale hydraulic analysis for:
    - Engineered Log Jam design (size, placement, scour depths)
    - Sizing of side channels and pond connections (refine widths and depths)
    - Sizing of culverts and pedestrian bridges to meet fish passage requirements
- Refinement of cut-fill line for pond bank reshaping
- Riprap revetment sizing
- Detailed planting plans
- Surveying of fish assemblages in ponds proposed for connections

6.6. Non-Federal Sponsor Support

The non-Federal sponsor during the feasibility study has been the Mid-Willamette Council of Governments, with their partner the Nature Conservancy. A number of entities have provided grants and other funding to these partners throughout the feasibility study and there is significant interest by many stakeholders in the implementation of this study. However, the Mid-Willamette Council of Governments will not be the sponsor for implementation because they will not be able to provide the lands or operation and maintenance required for implementation. The Nature Conservancy will be the non-Federal sponsor for implementation and owns four of the five sites included in the recommended plan. They would be able to provide all LERRDs for the project as well as to provide continued operation and maintenance for the project. It is likely that Lane County and other stakeholders would partner with The Nature Conservancy in side agreements due to the varying land ownerships.

6.7. Schedule

The following preliminary schedule has been prepared for the project (Figure 33). A more detailed schedule is provided in Appendix C.

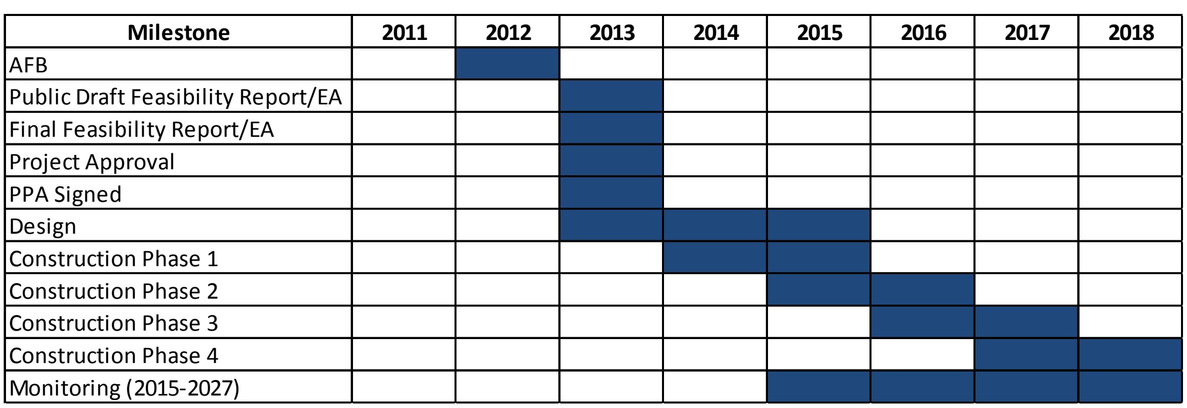


Figure 33. Preliminary Schedule

6.8. RISK AND UNCERTAINTY

A detailed Cost and Schedule Risk Analysis was conducted for this project and is provided in Appendix C. A summary of those key risks as well as additional design/technical and construction risks and potential mitigation of those risks associated with this project are shown below in Table 35. Additional discussion on hydrologic/hydraulic and geomorphic trajectory and risks is described in Section 7.

Table 35. Risk and Mitigation Table.

Potential Risks	Mitigation for the Risks
Potential that proposed fish and wildlife benefits will not be realized.	All restoration measures proposed in the recommended plan have been implemented in multiple sites in the Pacific Northwest. In particular, at the Eugene Delta Ponds project located within a few miles of the confluence, reconnection of a gravel-mined floodplain to the mainstem Willamette River saw immediate use by salmonid species. During design, incorporate information from Delta Ponds monitoring into design and develop detailed monitoring and adaptive management plan to document primary success metrics.
Potential to raise flood water surface elevations	Modeling conducted for feasibility indicates no rise. Conduct detailed reach-scale modeling during design at each site and balance any potential rise with excavation to ensure no-rise.
Potential erosion or avulsion risk to adjacent landowners	Conduct detailed reach-scaled modeling during design at each site and design the placement location and orientation of features to minimize risk.
Project competing nationally for funding may delay implementation and thus raise costs	District will coordinate frequently with Division and HQ staff on status and needed funding. This project is a high priority for the District.
Plan for separate contracts for each site; potential cost implications.	Recommended plan has 5 separate restoration sites that will be phased over 3 years. Separate contracts make sense so that delay at one site will not affect any other site. Some economies of scale could be realized at sites at confluence and will be investigated during PED on the best approach.
Restricted in-water work windows could delay construction or completion of construction.	Consider qualifications of contractors during bidding/selection process to ensure they are capable and experienced with in-water work to expedite construction.
Potential changed climatic conditions that lead to changed hydrologic conditions.	Include range of native plant species that can withstand drought and flood conditions so communities can adapt to changed hydrologic and climatic conditions. Restoration of the floodplain, in and of itself, will help mediate potential increased flood flows by providing

Potential Risks	Mitigation for the Risks
	increased area for flows and storage.
Potential for adverse effects on species or water quality conditions during construction.	Develop erosion control and fish/wildlife protection plans to be implemented during construction.
Potential that restoration measure(s) could not work as designed.	All restoration measures proposed in the recommended plan have been designed and implemented in multiple sites in the Pacific Northwest. This risk is low and will be further mitigation by detailed modeling and engineering during the design phase to ensure features such as ELJs are designed to withstand appropriate flows and velocities.

Because habitat restoration is a relatively new science, there are always uncertainties associated with how long features will persist over time or if the desired benefits will be achieved. The recommended plan includes both passive and engineered measures to bracket this uncertainty. Large wood and ELJs installed with the project will decay and break down over time (generally within 25 years). However, by including a significant component of riparian and floodplain plantings, it is intended that large wood will be recruited naturally into the river and floodplain over time as the trees mature and die on natural cycles or are eroded or washed into the river during flood events. Similarly, connection channels from the river to off-channel habitats may experience periodic sediment deposition or erosion conditions that could change the frequency or location of connections. However, the design of primarily backwater channels is intended to reduce the risk of deposition by creating them in locations of low energy and velocity where sediment transport of coarse material is limited. Additionally, by installing ELJs, it is intended to promote natural channel formation processes that will reform new channel connections, thus maintaining a dynamic equilibrium of habitats, rather than relying on the measures to remain static in perpetuity.

6.9. AREAS OF CONTROVERSY

There are no known areas of controversy with this study. During the design phase more detailed bathymetric surveying and hydraulic analysis will be conducted for each site to ensure that connections to ponds in the floodplain do not increase the risk for river “capture.”

6.10. IMPLEMENTATION REQUIREMENTS

6.10.1. Federal

Cost-sharing for ecosystem restoration is 65% Federal and 35% non-Federal. The Federal Government will provide 65 percent of the first costs of the Recommended Plan; the Federal portion of this project is estimated at $29,849,500 (additional funds required, not including feasibility study already cost-shared). The Corps is responsible for project management and coordination with Federal and State agencies. The Portland District will submit the Feasibility Report for approval, design, prepare plans and specifications, complete all NEPA requirements, execute a Project Partnership Agreement (PPA) with the sponsor, advertise and award construction contract(s), and perform construction contract supervision and administration.

6.10.2. Non Federal

The Nature Conservancy is the non-Federal sponsor for this project, and is responsible for 35 percent of the project costs, estimated to be $14,759,500 (additional funds required, not including feasibility study already cost-shared or real estate value of $426,000). The non-Federal sponsor would like to conduct work-in-kind as a significant element of their cost-sharing responsibilities. Operation and maintenance of those projects is also a non-Federal responsibility. This section describes the primary non-Federal Sponsor responsibilities in conjunction with the Federal Government to implement the Recommended Plan.

A model Project Partnership Agreement (PPA) has been reviewed by the non-Federal Sponsor and its legal representative. The non-Federal Sponsor is aware of its responsibilities. The PPA will be modified to include work-in-kind for the non-Federal sponsor following Corps guidance and process. This deviated PPA will be reviewed and approved through the Corps' chain of command as required and executed prior to implementation. A letter of intent to serve as the project sponsor is provided in Appendix G.

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

- Provide all lands, easements, rights-of-way, relocations, and excavated or dredged material disposal areas (LERRDs).
- Provide, during construction, any additional costs as necessary to make the total non-Federal contributions equal to 35 percent of the total project costs. The Nature Conservancy will provide work-in-kind during final design and construction as well as providing the post-construction monitoring. The value of the LERRDs needed for the project will be deducted from the non-Federal sponsor's cost-sharing requirement. Work-in-kind tasks and estimated costs are provided below. The sponsor anticipates contributing the balance of funds from grant funding.
    - Design of Sites M2A and C1C – $414,000
    - Environmental Compliance (permitting) - $50,000
    - Construction Management - $150,000
    - Removal of Invasives and Plantings All Sites - $11,550,000
    - LERRDs - $426,000
    - Monitoring All Sites - $397,000
    - Cash - $1,772,500
- Operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the completed project at no cost to the Federal Government, in accordance with the applicable Federal and State laws and any specific directions prescribed by the Federal Government for so long as the project is authorized. The annualized operation and maintenance costs are estimated at $130,000.
- Hold and save the Federal Government harmless from damages due to the construction and operation and maintenance of the project, except where such damages are due to the fault or negligence of the Federal Government or its contractors.
- Grant the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon land which the non-Federal Sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purposes of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.
- Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly

reflect total project costs for a minimum of three years after completion of the project construction for which such books, records, documents, and other evidence are required.

- Perform, or cause to be performed, any investigations for hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for construction, operation, and maintenance of the project; except that the non-Federal Sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude without prior specific written direction by the Federal Government.
- Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines are necessary for construction, operation, and maintenance of the project.
- Agree that, as between the Federal Government and the non-Federal Sponsor, the non-Federal Sponsor shall be the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.
- Prevent obstructions of, or encroachments on, the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the aquatic ecosystem restoration, hinder its operation and maintenance, or interfere with the proper function such as any new development on project lands or the addition of facilities that would degrade the benefits of the project.
- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, maintenance, repair, replacement, and rehabilitation of the project, including those required for relocations, the borrowing of material, or disposal of dredged or excavated material, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.
- Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled “Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army”; and all applicable Federal labor standards requirements, including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq*.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq*.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c).
- Provide the non-Federal share of that portion of the costs of data recovery activities associated with historic preservation that are in excess of the 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the Project Partnership Agreement.
- Not use Federal funds to meet the non-Federal Sponsor’s share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

Table 36. Cost-Sharing Summary Table.

			Federal Funding Requirements			
	Federal	**Non-Federal**	**FY13**	**FY14**	**FY15+**	**Totals**
Feasibility[1]	$1,923,611	$1,923,611	$100,000	$0	$0	$3,847,222
PED	$3,349,000	$414,000	$400,000	$1,500,000	$1,449,000	$3,763,000
Env. Compliance	$0	$50,000	$0	$0	$0	$50,000
Construction	$22,544,833	$13,748,167	$0	$0	$22,544,833	$36,293,000
Construction Mgmt	$3,956,000	$150,000	$0	$0	$3,956,000	$4,106,000
Monitoring	$0	$397,000	$0	$0	$0	$397,000
LERRD	$0	$426,000	$0	$0	$0	$426,000
Totals	$31,773,444	$17,108,778	$500,000	$1,500,000	$27,949,833	$48,882,222

1 – Feasibility has been cost-shared 50:50 between the Federal government and non-Federal sponsor. Only remaining funding required is $100,000 in FY13.

7. EFFECTS OF THE RECOMMENDED PLAN

Sections 1500.1(c) and 1508.9(a) (1) of the National Environmental Policy Act of 1969 (as amended) require federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment". This section identifies the expected environmental effects of implementing the recommended plan, which are primarily beneficial, although there will be short-term adverse effects during construction.

7.1. HYDROLOGY

A primary purpose of this restoration plan is to restore more natural and frequent hydrologic connections between the rivers and their floodplains in the Coast and Middle Fork subbasins. The key features included at most sites that influence hydrology and hydraulics are connections to restored gravel pits and side channels via either backwater or high flow connections and the removal of some areas of bank armoring, fill and debris on the sites. The proposed restoration plan will not change the overall hydrologic regime in either the Coast or Middle Forks subbasins because this project does not include changes in dam operations. However, by allowing regular connections and inundation of the floodplain on the project sites, the plan would incrementally restore a more natural flooding regime to approximately 574 acres; approximately 200 acres in the Coast Fork and 374 acres in the Middle Fork. This restoration plan does not rely on changes being made to the operations of the upstream dams, but can operate within the potential changes that are being currently implemented and/or envisioned for the future. These projects are intended to promote natural habitat formation to occur within the variable hydrologic regime. The balanced approach of including both passive and engineered features on each site allows for initial connections to the floodplain with the long-term revegetation and wood structures to promote natural formation of habitats and does not rely on the provision and maintenance of static features in the floodplain.

The potential effects of the recommended plan were evaluated with a hydraulic analysis. One of the primary objectives of the with-project hydraulic analysis was to determine the potential for the implemented projects to increase the 1% (100-year) water surface elevation. Evaluation of with project conditions for the 100-year flood event is necessary to illustrate that there will be a "no-rise" effect due to the implementation of the restoration projects. All five restoration sites are located within a Federal Emergency Management Agency (FEMA) regulated floodway, meaning a detailed hydraulic study must be completed prior to construction to confirm that implementation of the projects will not increase flood heights for the 100-year return period flood event. Figures 15 through 18 in Appendix E show the footprints of the five restoration sites overlaid on the FEMA floodplain.

However, given the current limitations of the "Updated Middle-Coast Fork Willamette River HEC-RAS Model" as a bankfull condition hydraulic model, the traditional no-rise evaluation could not be conducted with the "Updated Middle-Coast Fork Willamette River HEC-RAS Model". The HEC-2 model that was developed for the Lane County Flood Insurance Study (FEMA 1999) is a flood model that is appropriate for modeling flood events in excess of bankfull conditions; however, the cross section spacing and the resolution of the model is too coarse to be used to model the with-project conditions for the proposed restoration sites.

At the feasibility level, the "Updated Middle-Coast Fork Willamette River HEC-RAS Model" was used to evaluate the with-project conditions for a bankfull flow rate, which was assumed to be approximated by the 2-year return period flood event. Modeling of this flood event was used to show that implementation of the five restoration projects will not increase flood heights for the bankfull condition, or would at most increase them by a nominally small magnitude. In the design phase, site specific hydraulic modeling will be conducted, in which case, the "Updated Middle-Coast Fork Willamette River HEC-RAS Model" would be revised to include more detail and flexibility in modeling not only the bankfull flows but also 100-year return period flows. See Appendix E for more discussion of future recommended actions for the hydraulic analysis.

7.1.1. With Project Hydraulic Connection to Restoration Features

With the implementation of the recommended plan, floodplain features at each restoration site will be hydraulically connected to the main stem river much more frequently than under the without project conditions. Refer to the design drawings in Appendix F for references to the site specific restoration features and their associated design elevations included in the discussion below.

Site C1B.

Pond 1 would be hydraulically connected to the Coast Fork starting at approximately the 90% exceedance flow rate for the winter/spring period (386 cfs). All of the other gravel mined ponds at the site would be hydraulically connected to the Coast Fork starting at approximately the 75% exceedance flow rate for the winter/spring period (632 cfs).

Site C1C.

The proposed high flow channel at the upstream end of the site would allow for a hydraulic connection between the Middle Fork and the large gravel mined pond starting at approximately the 25% exceedance flow rate for the winter/spring period (2,920 cfs). The proposed backwater channel further downstream would allow connection between the Middle Fork and the gravel mined pond starting at approximately the 95% exceedance flow rate for the winter/spring period (274 cfs).

Site M1A.

The proposed high flow connection channel between the Coast Fork and the smaller of the two gravel mined ponds would be hydraulically connected to the river starting at approximately the 5% exceedance flow rate for the winter/spring period (7,686 cfs). Starting at approximately the 2-year flood event (15,800 cfs), the entire channel and the smaller of the two gravel mined ponds would then be connected to the Coast Fork. The larger of the two gravel minded ponds would be hydraulically connected to the Middle Fork starting at approximately the 75% exceedance flow rate for the winter/spring period (1,530 cfs).

Site M1B.

The two notches that are proposed to be cut in the existing berm would allow for a hydraulic connection between the Middle Fork and the gravel mined ponds starting at approximately the 90% exceedance flow rate for the winter/spring period (1,530 cfs). At this flow rate, the water surface elevation at the upstream end of the site will be sufficient to allow for a hydraulic connection between the river and all of the ponds on the site.

Site M2A.

The proposed high flow channel (Channel Connection 1) at the upstream of the site would allow for hydraulic connection between the Middle Fork and the eastern-most gravel mined pond starting at approximately the 2-year flood event (20,000 cfs), The proposed backwater channel (Channel Connection 3) at the downstream end of the site would allow for hydraulic connection between the Middle Fork and the western-most gravel mined pond starting at approximately the 25% exceedance flow rate for the winter/spring period (6,140 cfs). At the 2-year flood event (20,000 cfs), all ponds on the site would be connected to the Middle Fork.

7.1.2. No-Rise Analysis and Results

The no-rise analysis for the with-project analysis was conducted for the 2-year return period flood event. The objective was to illustrate that implementation of the seven restoration projects would not increase flood heights for this bankfull flood event, or would at most increase them by no more than a nominal magnitude of 0.3 feet. Based on the results of this 2-year with project analysis, it is reasonable to assume that during the design phase when the 100-year flood is analyzed with a reach-scale hydraulic model more suitable to analyzing out of bank flow conditions, the modeling would show a no-rise situation for the with-project condition. A hydraulic model more suitable to analyzing out of bank flow conditions would account for the hydraulic conveyance afforded by the extensive floodplains and relic floodplain channels adjacent to the Coast and Middle Fork Willamette River when flows are out of bank. The current watershed-scale "Updated Middle-Coast Fork Willamette River HEC-RAS Model" does not have this capability.

At each of the five recommended restoration sites, the cross section geometry of the "Updated Middle-Coast Fork Willamette River HEC-RAS Model" was modified to represent the implementation of the restoration features. Specific restoration features, such as main-channel engineered log jams (ELJ's) and main channel levee/berm modifications, were easily represented in the one-dimensional hydraulic model and were therefore included in the with-project conditions analysis. The main-channel ELJ's were represented in the model as individual blocked obstructions in the closest model cross section to each ELJ site.

Other restoration features, such as floodplain side channels, gravel pit bank-modifications and connector channels between gravel pits were more difficult to represent in the one-dimensional hydraulic model as it is currently configured. As was described in Appendix E, the ineffective flow area option in HEC-RAS was used throughout the "Updated Middle-Coast Fork Willamette River HEC-RAS Model to limit effective conveyance to within the banks of the main channel and to exclude the floodplain and features in the floodplain such as side channels and gravel pits. The floodplain side channels, gravel pit bank-modifications and connector channels between gravel pits that were proposed at the restoration sites were therefore included in the with-project hydraulic model by editing the ineffective flow areas at the project sites. Where a restoration feature such as a flow through side channel was proposed, the ineffective flow areas that were originally defined in the HEC-RAS model were revised to allow for a width of effective flow in the floodplain, commensurate with the expected active flow width attributed to the side channel.

Finally, implementation features such as backwater channels would have no effect on main-channel water surface elevations due to the fact that they would not be effective flow conveyance features. Therefore, they were not included in the with-project hydraulic analysis.

Figures 35 through 37 present the comparison of with project and without project water surface elevations for the 2-year flood event. To provide a point of reference, these figures also include the without project water surface profiles for the 90% winter/spring exceedance flow.

Tables 22 and 23 in Appendix E present the comparison of with project and without project hydraulic modeling for the 2-year flood event for the Coast Fork Willamette River in a detailed tabular format.

The hydraulic modeling of the with-project conditions shows both small increases and decreases in water surface elevation relative to the without project condition. Decreases in water surface elevation are generally attributed to the increased conveyance provided by flow through side channel features; the most significant example of which is the 0.6 foot reduction in water surface elevation in the vicinity of Restoration Site C1C. Increases in water surface elevation are generally attributed to loss of main channel conveyance from placement of ELJ features; the most significant example of which is the 0.2 foot increase in water surface elevation in the vicinity of Restoration Site M2A. At most of the restoration sites, the net decrease or increase in the water surface elevations is the result of the combined effect of those restoration features that decrease main channel conveyance and those restoration features that increase off channel or floodplain conveyance.

It is noted that this analysis is based on the bankfull flow conditions that are approximated by the 2-year return period flood event. Those minor increases in water surface elevation would not be expected when the reach-scale hydraulic analysis of the 100-year flood event is conducted during the design phase with a hydraulic model that is capable of accurately modeling large out-of-bank flood events. When the entire floodplain is inundated, localized minor increases are easily dwarfed by the overall flood event.

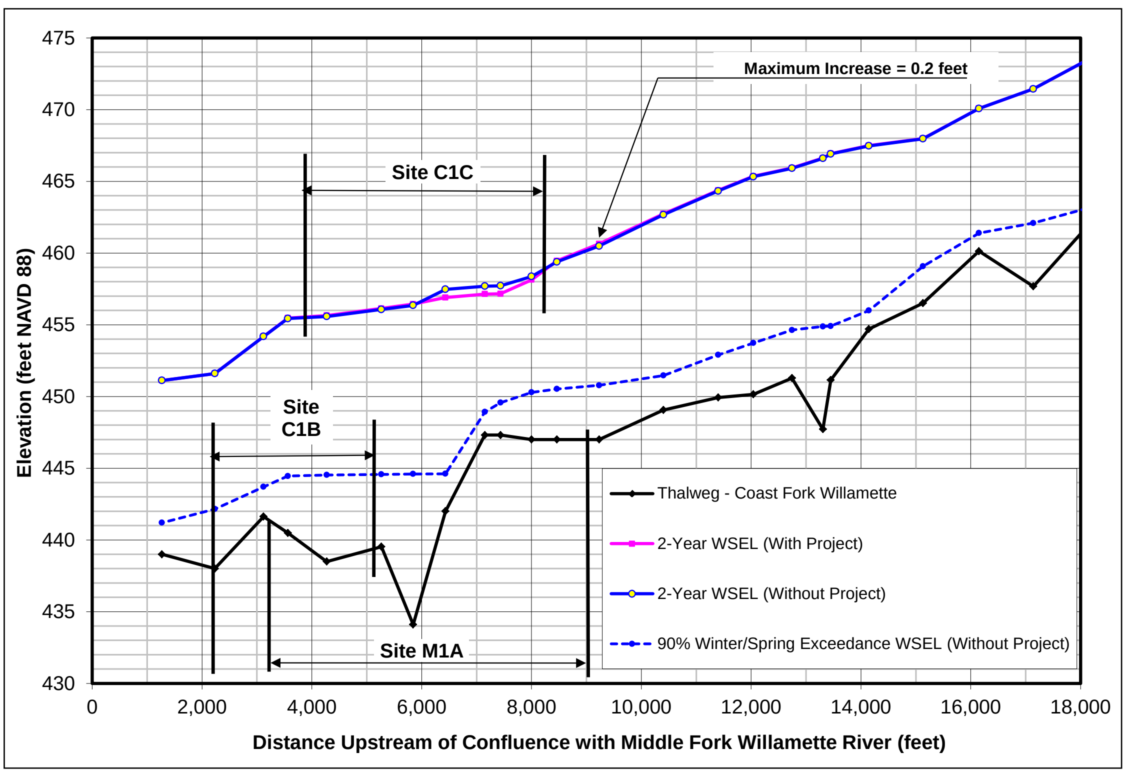


Figure 34. Coast Fork Willamette River without Project versus With Project Water Surface Profiles for 2-Year Return Period Flood for Sites C1B, C1C and M1A.

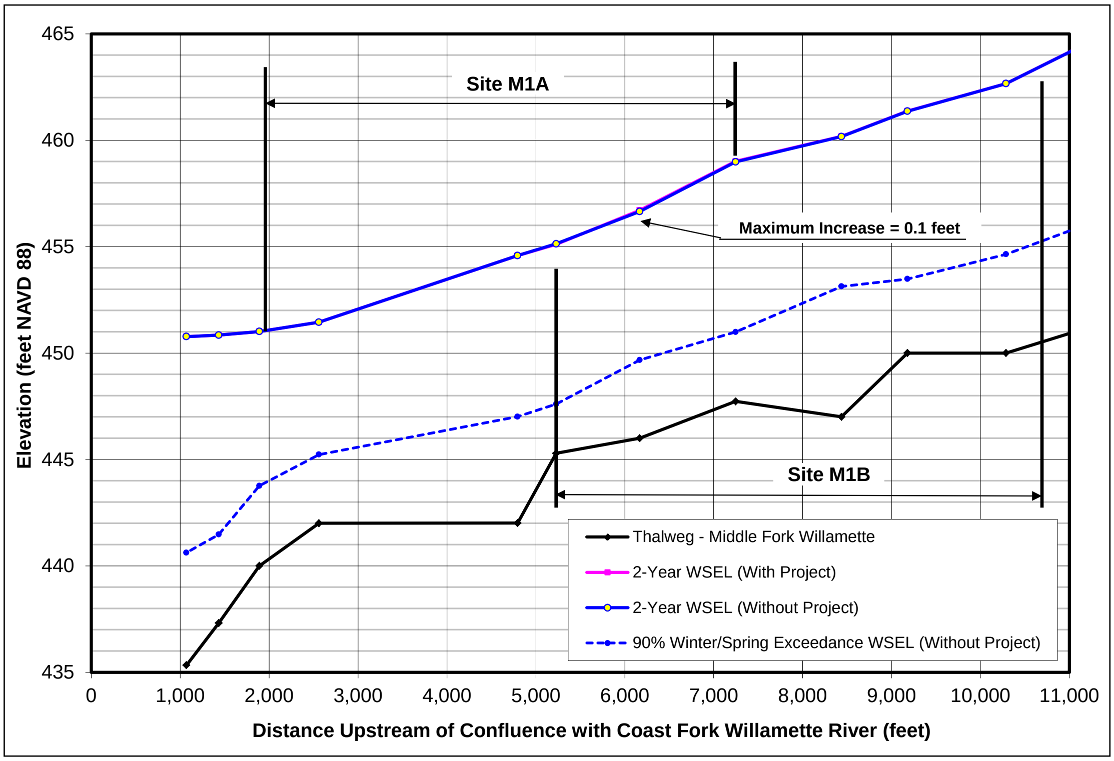


Figure 35. Middle Fork Willamette River without Project versus With Project Water Surface Profiles for 2-Year Return Period Flood for Sites M1A and M1B.

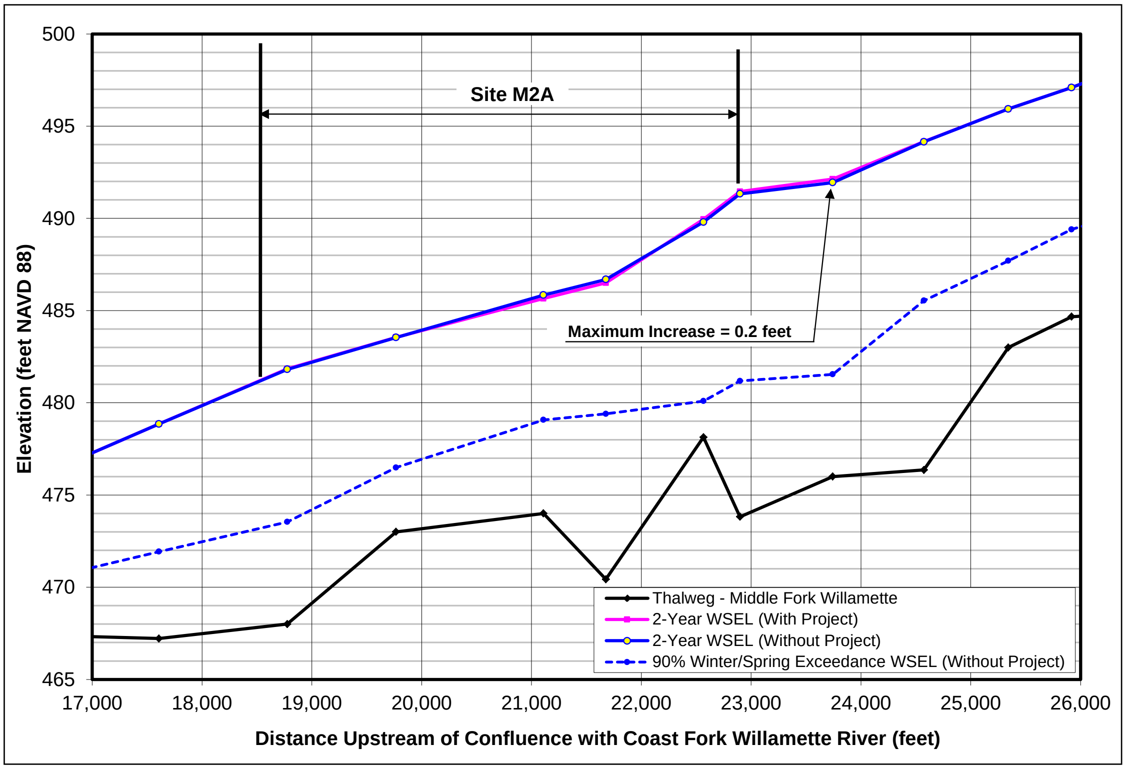


Figure 36. Middle Fork Willamette River without Project versus With Project Water Surface Profiles for 2-Year Return Period Flood for Site M2A.

Additional hydraulic analyses of the recommended plan will be conducted for each site and final designs will be refined, if necessary, to ensure no-rise of water surface elevations as a result of any site or the combined effects of all sites.

7.2. GEOMORPHOLOGY

A primary purpose of this restoration plan is to incrementally restore natural geomorphic processes that form fish and wildlife habitats in the Coast and Middle Fork subbasins. The key features included on all sites that influence geomorphic processes include removal of fill and debris in the floodplains and in some locations, portions of private revetment on the banks to allow some channel migration into the sites, placement of ELJs and wood in the floodplain to promote scour of pools and side-channel openings as well as promoting split channel flows in key locations adjacent to these sites where existing bars and islands can be enhanced and further formed over time, revegetation of the riparian and floodplain habitats that will promote large wood recruitment to the river over time, and channel connections to restored gravel pits and side channels via backwater or high-flow connections. In general, at the sites in the recommended restoration plan, there are no structures or existing land uses or infrastructure that requires protection and the landowners would like to promote natural geomorphic floodplain processes. Particularly at the confluence of the Coast and Middle Forks, the Nature Conservancy has purchased over 1200 acres between the forks with the purpose of protecting and restoring the natural deltaic processes.

Each of the project reaches and the potential effects on geomorphology are described below.

Reach C1 – RM 0 to RM 6.4

Two of the restoration sites included in the recommended plan, C1B and C1C are located in this reach. The sites are contiguous on the left (south) bank of the Coast Fork in an area that has several gravel pits that have been protected via bank protection on the Coast Fork as well as some gravel pits that have already been captured and incorporated into the floodplain and side channel features of the Coast Fork.

A major portion of the restoration effort in Reach C1 is centered on the gravel mined areas. At C1B, the downstream site, five ponds would be connected via a culvert inlet to Pond 1. The other four ponds will be connected by a series of channels between them. There is no direct upstream connection proposed to the Coast Fork; however flows sufficient to overtop the existing bank would flow through a culvert outlet at the downstream end of the site that will connect a sixth gravel pond with the mainstem. Based on a review of the LiDAR topography for the site, the ground elevations surrounding the ponds are on the order of elevation 448 to 450 feet. This compares to the proposed downstream culvert invert of approximately 443 feet. The adjacent river thalweg is at an elevation of approximately 440 feet. Considering the limited topographic differences, there is little chance the gravel pits could capture the main channel.

At C1C, the main restoration features is connection of a large gravel pit to the Coast Fork by a 1,400 foot long channel at the upstream end and a 400 foot long, outlet channel with a culvert at the downstream end. The proposed controlling invert of the downstream connection culvert is 443 feet compared to the adjacent thalweg of approximately 440 feet. The inlet channel connects to the Coast Fork at an elevation of approximately 450 feet at a location where the adjacent channel thalweg is approximately 446 feet. The ponds at this site were recently surveyed for the Nature Conservancy (Tetra Tech 2012). Results show the bottom of the large pond being at an elevation between 440 and 445 feet which is approximately at or up to 6 feet below the adjacent channel thalweg. Considering the downstream culvert control, the length of the connecting channel and the relatively shallow nature of the gravel pit, the likelihood of the proposed restoration effort at Site C1C resulting in capture of the Coast Fork is also small.

Two additional small gravel pits are proposed to be connected by backwater notches to the Coast Fork on the west end of site C1C. These ponds have minimum elevation of about 439 feet compared to the adjacent thalweg of the Coast Fork at elevation 440 feet. The plan also proposes lowering of a roadway berm separating the river from these ponds to an elevation of approximately 453 feet to 449 feet. Considering the limited differences in topography as well as the small footprint of these two ponds, the proposed actions pose no threat to capture of the Coast Fork. During high flows in January 2012, these ponds were connected to the Coast Fork via flows that overtopped the roadway.

The portion of site C1C located upstream of the Wildish bridge and adjacent to the Coast Fork is an abandoned gravel pit that was connected to the Coast Fork in the 1960s. Over time it has evolved into the floodplain and side channel system that currently exists. This is the area that the 1,400 foot channel will be cut across to connect the large pond as a flow-through system. In addition, two ELJs will be installed at side channel inlets to promote scour, create habitat and increase the channel dynamics. This site is currently a good example of how shallow gravel pits may evolve in the Coast Fork and Middle Fork of the Willamette River. Over the five decades that the area has been evolving, the main channel has stayed in the same location, including a bridge crossing at the downstream end of the former pits. This suggests that there is the potential to provide even more main channel connection with the gravel pits to develop complex floodplain and side channel systems similar to what has evolved at the upper end of site C1C. In the next level of design, it is recommended that further investigation be performed to refine the restoration efforts. This analysis should look at the localized hydraulic and sediment transport impacts of the connections, and also consider the system-wide impact. For example, it might make more sense to sequentially connect the ponds over a few years in order to avoid any cumulative impact on sediment transport in the reach that might create an overall sediment deficit that might cause adverse channel impacts such as downcutting and coarsening of the bed material. Similarly, the impacts on infrastructure such as bridges, bank protection and utility crossings would need to be investigated to refine the design.

Reach M1 RM 187 to RM 191

Two of the sites in the recommended plan are located in this reach. Site M1A is located on the left bank of the Middle Fork from RM 187.4 to RM 188.4 and extends across the floodplain to the right bank of the Coast Fork. It occupies the finger of floodplain that separates the Middle and Coast Forks. Site M1B overlaps with M1A and extends along the left bank of the Middle Fork from RM 188.0 to RM 189.2. M1B does not extend all the way across the floodplain to the right bank of the Coast Fork. Both sites involve similar actions including reshaping of the gravel pit banks and reconnection of several gravel pits to the main channel. Site M1A includes placement of ELJs at the reconnection channels, whereas Site M1B does not.

The recent bathymetry data (Tetra Tech 2012) at M1A indicates a minimum pond elevation for the large pond at the center of the site of about 439 feet with the majority of the main pond between elevations 440 to 445 feet or higher. The adjacent Middle Fork thalweg elevation at the connection point is approximately 446 feet. The small pond adjacent to the Coast Fork has a minimum elevation of about 440 with the adjacent thalweg of the Coast Fork at an elevation of 446 feet. Considering the small elevation difference between the main channels and the pond bottoms (similar in scale to in-channel pool depths), the likelihood of stream capture is small. In the design phase, a more detailed reach-scale hydraulic analysis of the connection between the Middle Fork and the Coast Fork should be performed to confirm the likely range of head differentials between the two systems in order to refine the connector channel elevations to minimize any adverse effects on the rivers.

The Middle Fork thalweg ranges from elevation 445 to 449 along the M1B site while the bottom of the largest pond is predominantly at an elevation of between 440 and 445 with the deepest locations at about 440. For the downstream third of the pond, the bottom of the pond is at or slightly below the river thalweg. For the middle third, the thalweg and pond bottom are at about the same elevation. It is only the upper third of the pond where the pond bottom is significantly lower, 5 feet or more, than the adjacent river thalweg. In the design phase, refinements to the downstream connection channel to allow the river channel to readily migrate into the lower third of the pond should be investigated because the pond and river are at the same elevation. This would include a detailed reach-scale hydraulic and sediment transport analysis to determine potential impacts on the mainstem as well as the evolution of the pond.

In addition to the connection to the river, the proposed plan at Site M1B calls for removal of the existing riverward revetment at the two notches (15-foot bottom width) and as part of the regrading that brings the top of bank to OHW. This limited removal of revetment as developed in the current design is not likely to cause the channel to migrate into the ponds for many decades, if ever, based on the performance of the current revetment that has been in place for many years. During the design phase, the extent of removal of the revetment in the lower and middle third of the pond, where the potential for stream capture appears small should be refined. Complete removal of the revetment could be performed separately over several decades by the owner to allow the river to slowly fully migrate into the new area that is opened up without adverse effects on the river.

Reach M2 RM 191 to RM 194

One site in the recommended plan, M2A is located at RM191 within reach M2 on the left bank of the Middle Fork. The bathymetry of the gravel pits at this location was recently surveyed for the Nature Conservancy (Tetra Tech 2012). At the time of survey in January 2012, the two downstream ponds were connected to the Middle Fork during a flood event. Additionally, Pudding Creek flows through the downstream-most pond due to its culvert being blocked and damaged and when river levels are high; this is an existing backwater connection (i.e. Chinook and Oregon chub have been captured in the ponds). The two downstream ponds have minimum bottom elevations of 465 feet or higher. The upstream pond is shallower, with much of its bottom at an elevation of 470 feet or higher. The Middle Fork thalweg adjacent to the downstream pond ranges from about 468 feet to 473 feet. At the upstream pond, the elevation of the thalweg ranges from about 473 feet to 477 feet. Based on this information, the ponds are up to 7 feet deep. This represents a fairly small difference in elevation (similar to typical pool depths in the river) and it does not appear that capture of the river is likely with the limited size of the proposed connections. In developing a long term plan for this site, the possibility of increasing the frequency (elevation) slightly of the connections once the ponds have filled partially with sediment should be investigated in the next level of design. There appears to be little risk of damage to adjacent infrastructure if the ponds were to capture a significant portion of the mainstem flow, although one concern could be the potential to dewater the Springfield Millrace inlet across the river. A reach-scale hydraulic and sediment transport analysis will be conducted to refine the design to ensure no adverse effects across the river.

This restoration plan does not rely on changes being made to the operations of the upstream dams, but can operate within the potential changes that are being currently implemented and/or envisioned for the future as well as likely hydrologic changes due to climate change. The primary purpose of these projects is to allow natural habitat formation to occur within a variable hydrologic regime. The balanced approach of including both passive and engineered features on each site allows for initial connections to the floodplain with the long-term revegetation and wood structures to promote natural formation of habitats and does not rely on the provision and maintenance of static features in the floodplain. While the gravel pit restoration will be designed to reduce overall depths of the existing gravel pits to minimize risks to the river systems from pit capture, over time it is expected that the gravel pits will slowly fill with organic material derived from the floodplain and fine sediments transported by the rivers and that the rivers will form a variety of channel, pond, and oxbow habitats through the sites.

At all sites, restoration efforts involve connecting the gravel pits to the rivers (either the Coast Fork or the Middle Fork). In general, the gravel pits are relatively shallow with the deepest portions of the pits being at a similar elevation to the adjacent mainstem thalweg up to about 5 to 7 feet below the thalweg. For the current designs with limited size of the connections to the mainstem, there is very little risk of capture of a significant portion of the mainstem channel as a result of the gravel pond connections. At the majority of the sites, there does not appear to be the potential for damage to adjacent infrastructure if the pits did capture a major portion of the flow as the site footprints include the floodplain area that could be affected. A very conservative approach to connecting the pits to the main channel has been followed in this proposed design with relatively small openings and channels. In addition, the openings are armored with cobbles and boulders to prevent downcutting and widening.

In the design phase, more detailed hydraulic and sediment transport investigations will be undertaken to refine the depths and widths of connections at each site. The primary question to answer for increased connection frequency would be whether this would result in negative impacts to the overall sediment balance that could induce unwanted changes in the overall river morphology including downcutting and coarsening of substrate. Another option that should be investigated in the next level of design is allowing the river to migrate freely through some of the narrow berms that are separating the pits from the mainstem. Again, this would need to be investigated with a reach-scale hydraulic and sediment analysis. Either of these two approaches to increased mainstem connectivity could be pursued in a long term, adaptive manner.

The incorporation of the pulsed flows (Sustainable Rivers Program) in the dam releases may accelerate filling of the pits. It was observed that after recent high flows on both the Middle Fork and Coast Fork in January 2012 that large gravels and small cobbles had been mobilized and new bars and increased deposition areas were observed. The disadvantage of the higher level of mobilized bed material is a somewhat increased potential for gravels to deposit in the connection channel inlets and reduce their frequency of connection over time. This potential exists without the pulsed flows but is a somewhat higher risk if gravels are mobilized more frequently and to a greater extent. If the inlets do become plugged over time, they can either be maintained or the connections could be allowed to revert to a backwater connection, only open at the downstream end. The proposed design assumes that some periodic maintenance may be required to remove sediment at the inlet channels.

Because of the conservative approach taken to reconnecting the ponds with relatively small sized inlets and outlets and protection of the hydraulic controls that are elevated above the channel thalweg, very little bed load is likely to be delivered to the gravel pits. The primary sediment to enter the reconnection channels will be suspended load. Because of this and the fact that much of the suspended sediment load is trapped in upstream reservoirs, the rate of pit infilling is expected to be slow. The wash load (silts and clays) in the suspended load will not be totally trapped in the pits as some will remain in suspension, particularly the clays. Sand load entering would be expected to be trapped, but it is unknown as to the quantity of sand that is present in the Middle and Coast Forks. In the next phase of design, this issue will be investigated to develop estimates of the sand to be trapped in the pits based on estimates of the volume of water passing thought the pits and the typical suspended sand load concentration in the Middle and Coast Forks.

There are no existing Corps revetments on any of the sites, with the exception of Site M1A, where the Evans revetment is located immediately adjacent to the private bridge crossing of the Coast Fork that provides access to Site M1A. The restoration plan will not remove or modify this revetment. The Nature Conservancy may, at some point in the future, request that this revetment be deauthorized or modified, but will work separately with the Corps in that case.

Geological conditions would not be affected by the recommended plan. Soils and sediments may be removed or regraded/relocated during construction, however the impacts would not be significant. It is likely that each of the restoration activities would cause some amount of upland or stream bank erosion during construction as a result of ground disturbance from vegetation clearing and the use of heavy equipment. These impacts are expected to be minimal and temporary. Measures will be implemented to control erosion both during and after construction. These measures will be described in a Stormwater Pollution Prevention Plan (SWPPP) and will be in compliance with the Oregon Department of Environmental Quality Construction Stormwater General Permit (NPDES permit). Once construction is complete, the restored areas would provide habitat improvements, and would restore natural soil and sediment transport and deposition processes.

Permanent alteration of soils may come from removal during the construction of the projects. Final designs will balance the amount of cut and fill at the project site through the reuse of excavated materials on site. Debris or other unsuitable materials will be removed from the project site and disposed of at a proper disposal facility.

7.3. WATER QUALITY

While water quality improvements are not a project purpose, there may be some incidental water quality improvements that occur as a long-term result of the restoration plan. The increased floodplain connections and inundation may result in increased groundwater recharge and subsequent discharge that could provide cooler water to the rivers during low flows. At this time, this benefit is not considered to be measurable. Additionally, as a result of flow-through or backwater connections to the restored gravel pits, water quality conditions in the pits would be improved. It is likely that temperatures would become more similar to river temperature conditions and the increased flushing of the pits could provide improved dissolved oxygen conditions. However, these effects are expected to be relatively minor.

The overall temperature regimes in the rivers that are highly affected by dam operations will not be significantly changed as a result of the recommended restoration plan. However, it is likely that the Corps will modify its operations of the dams and also install structural features on the dams to help return outflow temperatures to a more natural regime. This restoration plan would be further enhanced by modifications to Corps outflow temperatures, but is not dependent on those actions occurring.

There could be temporary impacts to water quality, mainly turbidity, during construction of the project. These impacts will be minimized by isolating construction activities from adjacent receiving waters by primarily working on the sites prior to making connections to the rivers and implementation of construction stormwater best management practices (BMPs) to the maximum extent practicable. These BMPs will likely include surface stabilization (i.e. mulches), silt fence and other sediment barriers, and by maintaining booms, silt curtains, and absorbent pads on site and implementing source-control program to prevent the generation or release of potential pollutants. Water quality monitoring will take place to meet permit requirements. If the standards are exceeded then construction will be halted until additional BMPs can be installed to ensure standards are met.

Construction equipment may release small amounts of pollutants into the water, including oils and grease or other contaminants, as a result of spills and leakages or the existence of contaminants on machinery that is used within the water column. Contained staging areas and the pollution prevention plans will be used to identify methods and procedures to control contaminants from entering the water through leaks or spills. Machinery and materials used for restoration would be clean from approved sources. During the design phase, detailed erosion and pollution control plans will be developed for each site.

7.4. FISH AND AQUATIC HABITAT

A primary purpose of this restoration plan is to restore and enhance fish and aquatic habitats including floodplains, off-channel, and wetland habitats. Approximately 854 acres of floodplain and in-channel habitats will be restored on both the Coast and Middle Forks. All of the sites included in the restoration plan have had former gravel mining activities occur on sites, so there are gravel pits/ponds that will be restored and enhanced via grading of the shorelines and placement of fill to provide shallow water habitats. Many of these gravel pits/ponds will be reconnected to the rivers via backwater or flow-through channels or high flow connections. Additionally, riparian and wetland habitats will be restored via the removal of non-native invasive species and plantings of native vegetation. In-channel habitats will be restored and enhanced via the installation of large wood and ELJs to promote scour of pools, deposition of gravels in bars or riffles, and formation and maintenance of side-channels. It is intended that the restoration plan will promote the natural formation of a variety of habitats over time rather than relying on the engineering and construction of static habitat features. It is desirable for the river channels to migrate on these sites and promote bar, island, and side channel formation. The revegetation of riparian and floodplain habitats with native tree species will contribute to the long-term recruitment of large wood into the rivers to further promote and maintain channel processes.

Specifically in regards to the focal fish species in this study; Chinook, steelhead, cutthroat and Oregon chub, this plan will restore habitats that are limiting for all of these species such as off-channel ponds, oxbows, channels, pools, shallow water, overhanging vegetation, and cover. As recommended in the EDT analysis conducted for the Middle Fork, restoration is focused in Reaches M1 and M2 where water temperatures are not limiting for the use of salmonids. Focusing on the confluence of the Coast and Middle Forks provides a very large area of contiguous complex habitat for fish species. Particularly on the lower Middle Fork, this restoration plan will work in synergy with the nearly continuous public ownership present on the right bank of the Middle Fork to provide nearly two miles of high quality fish habitat.

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

All work below the ordinary high water line will take place only during the in water work windows, designated by the Oregon Department of Fish and Wildlife (ODFW), to minimize possible harm to fish species. Fish salvage and removal will occur as necessary, such as within the gravel pits/ponds or isolated portions of the rivers to install ELJs.

Overall, adverse impacts to fish during construction are expected to be minor and temporary. Although fish may be temporarily excluded from habitats, the areas of exclusion would be minimal and passage up- and down-stream would not be compromised. Overall, there should be long-term benefits to fish and aquatic habitats from the restoration plan.

7.5. TERRESTRIAL SPECIES AND HABITAT

A primary purpose of this restoration plan is to restore floodplain habitats and processes that will benefit a variety of fish and wildlife species. Approximately 574 acres of floodplain and riparian habitats will be restored on both the Coast and Middle Forks. All of the sites included in the restoration plan have had former gravel mining activities occur on sites and significant disturbance has occurred leaving many of the sites dominated by invasive species. These floodplain, riparian and wetland habitats will be restored via the removal of non-native invasive species and plantings of native vegetation. It is intended that the restoration plan will promote the natural formation of a variety of habitats over time rather than relying on the engineering and construction of static habitat features. It is desirable for the river channels to migrate on these sites and promote bar, island, and side channel formation. The revegetation of riparian and floodplain habitats with native tree species will contribute to the long-term recruitment of large wood into the rivers to further promote and maintain channel processes.

Specifically in regards to the focal wildlife species in this study including native amphibians, pond turtles, raptors and migratory bird species, this plan will restore habitats that are limiting for all of these species such as floodplain forest, wetlands, riparian habitats, cover and large wood. Focusing on the confluence of the Coast and Middle Forks will provide a very large area of complex habitat for wildlife species. Particularly on the lower Middle Fork, this restoration plan will work in synergy with the nearly continuous public ownership present on the right bank of the Middle Fork to provide nearly two miles of high quality wildlife habitat as well as being located immediately adjacent to Mt. Pisgah.

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

Vegetation clearing may reduce the availability of foraging, resting, or nesting habitat. Any clearing conducted for the purposed of access would be carefully planned, leaving important trees or communities intact, whenever possible. In cases where large areas of vegetation are cleared, that vegetation would be non-native, and it is not expected to support a diverse or abundant assemblage of wildlife. Construction activities may require wildlife exclusion or protection during the establishment period.

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

Under the recommended plan, all mature trees will be protected to the extent possible. Any trees that would be taken down due to construction would be used to create an in-stream or terrestrial habitat structure. Sensitive habitats and species that must be protected, including trees, would be clearly marked. Additional native riparian trees and shrubs will be planted in floodplain, riparian, and wetland habitats. Invasive species will be removed from the project area. Only site specific chemical application would be allowed to cut stems of invasive species and no widespread spraying would be conducted. Staging areas would be located in areas of non-native vegetation or where little or no native vegetation would have to be cleared.

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

7.6. WETLANDS

There are wetlands present on all of the sites, primarily associated with the existing gravel mined ponds (fringing wetlands around the ponds) and in floodplain overflow channels. The proposed project is not intended to eliminate any of these wetlands, but will enhance and enlarge these wetlands by providing additional shallow water habitats associated with the ponds and channels. During construction, some wetlands will be disturbed by equipment, removal and fill of material, removal of invasive species, placement of large wood, and native plantings. During the design phase, wetland delineations will be conducted and more detailed information on the total volumes of wetland removal and fill we be identified. The removal and fill actions may change the water depths inundating the wetlands, and thus the plant communities may change, but the project will create/restore more area of wetland than currently exists.

7.7. THREATENED AND ENDANGERED SPECIES

A biological assessment (BA) has been completed for the recommended plan and is included as Appendix D. The recommended plan may adversely affect Chinook salmon, Oregon chub, and bull trout as a result of the temporary effects from construction; but would have no effects on the other listed species, because they are unlikely to occur in the project area. In general, the proposed restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, especially the listed fish species and will help contribute to the recovery of these species. The NMFS and USFWS are charged with recovery of these species and this plan is not intended to be the primary element of that recovery, but will contribute.

The proposed project will restore a more natural hydrologic connection between the Coast and Middle Forks of the Willamette River and their floodplains and is expected to provide long-term benefits to the species. The project will provide a substantially increased area of freshwater off-channel and floodplain rearing and refuge habitat. The project will allow greater dispersal of Oregon chub populations to off-channel habitats and also likely minimize the populations of non-native fish species in the ponds by providing more frequent connections and water exchange. The pond restoration actions will create more shallow water and wetland habitats that Oregon chub utilize.

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

A summary of the preliminary determination of findings is provided in Table 36 below.

Table 37. Threatened and Endangered Species Impacts Summary

Common Name	Scientific Name	ESA Status	Preliminary Determination of Effect
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	No effect
Northern spotted owl	*Strix occidentalis caurina*	Threatened	No effect
Upper Willamette River Chinook salmon	*Oncorhynchus tshawytscha*	Threatened	May affect, likely to adversely affect
Oregon chub	*Oregonichthys crameri*	Threatened	May affect, not likely to adversely affect
Bull trout	*Salvelinus confluentus*	Threatened	May affect, not likely to adversely affect
Fender’s blue butterfly	*Icaricia icarioides fender*	Endangered	No effect
Willamette daisy	*Erigeron decumbens var. decumbens*	Endangered	No effect
Bradshaw’s desert parsley	*Lomatium bradshawii*	Endangered	No effect
Kincaid’s lupine	*Lupinus sulphureus spp. Kincaidii*	Threatened	No effect
Bald eagle	*Haliaeetus leucocephalus*	Protected	N/A

7.8. Socio-Economic Conditions

No significant effects on socio-economic conditions are expected as a result of the recommended restoration plan. The project will occur on lands that are either currently in recreation or open space designations or were historically, but not currently, used for sand and gravel extraction.

During construction, there may be a small number of local construction jobs that would be created or maintained associated with the various construction contracts, which may have direct and indirect effects on the local economy, but these effects are expected to be minor in the scale of overall construction employment in Lane County.

There also may be minor traffic effects to adjacent residences that may affect local businesses when trucks are importing or removing material. Impacts to traffic will be minimized to the maximum extent practicable by traffic control signage and flagging or other methods as necessary. It is not expected that significant adverse economic effects will occur to any businesses or commerce during construction.

7.9. Recreation

The recommended restoration plan does not include any recreational elements. Site C1B is currently owned by Lane County and passive recreation is allowed. The project will include providing culverts under existing major trails and/or roadways to allow continued access, thus no effects on recreation are expected. The other sites are privately owned and are not currently used by the public. It is expected that the Nature Conservancy may allow public access in the future on their property, but this project will not preclude future passive recreational uses.

Overall, indirect/future passive recreational opportunities may be created by the recommended restoration plan including wildlife and bird watching and hunting and fishing as a result of increased habitat and fish and wildlife populations.

7.10. Cultural Resources

Many locations included in the recommended restoration plan have been subjected to previous sand and gravel extraction activities and are likely disturbed to varying degrees. Cultural resources that are or may have been present in these locations were likely also disturbed by these activities. However, given the lack of previous archaeological assessments within the project area, the presence, nature and/or condition of cultural resources in both previously disturbed and undisturbed contexts have remained undetermined. Given these uncertainties, the potential for encountering significant cultural artifacts during the proposed construction and restoration work could not be ruled out. Therefore, a cultural resource assessment investigation was conducted within the proposed project area in November 2012 by Heritage Research Associates (2012). Information and findings from that investigation are summarized below.

A review of the records on file at the SHPO indicates that one prehistoric site (35LA95) was reported in the 1970s by a local landowner above the floodplain in the vicinity of parcel M2A. This site has been described as a thin scatter of materials, but its existence has not been confirmed by a professional archaeologist. The site area was visited during the Heritage Research Associates' 2012 cultural resources field inspections, but no artifacts were found. An earlier archaeological survey conducted in nearby locations identified no artifacts in the purported site area (Musil 2012). The closest, previously recorded archaeological sites (35LA1465; 35LA1470; 35LA1471; and 35LA179) are located north of the Middle Fork Willamette River, each outside and far removed from the proposed project area boundaries.

Historic settlement in this part of the Willamette Valley began in the late-1840s, as indicated by records of several DLCs being made in the project area. However, no DLCs were located within the individual project area parcels. From the late 1800s to the early-mid 1900s, the project area was primarily used for grazing and agriculture. The historic town of Seavey was reportedly located near parcel M2A and included stores, cabins, and a dance hall. However, very little evidence of the town's structures has been found. Three farmsteads were once located within the project area parcels, but all dwellings and structures were removed at an undetermined date. The only remnants of the original farmsteads include two old-growth Douglas fir trees standing near the former Compton house. Extensive gravel mining occurred in these areas from the 1950s through the 1980s.

A pedestrian survey conducted throughout the project area in November 2012 by Heritage Research Associates identified no prehistoric or historic artifacts. Most of the original landforms were found to have been heavily disturbed by gravel mining operations and many locations are now covered by piles of reconfigured topsoil or aggregate. In addition, dense vegetation (primarily blackberry brush) obscures the ground in many locations and greatly reduces surface visibility. A raised concrete foundation remnant, one metal storage tank, assorted pieces of farm equipment and a rectangular depression were observed near the historic Compton and Hilger farmsteads, but none of the items were determined to be historically significant. Areas that were found to have not been impacted by aggregate mining and/or were located within the floodplain showed signs of frequent inundation, scouring and/or sediment deposition. Such locations would not retain obvious evidence of past occupations.

Based on the negative results of the SHPO records searches and pedestrian ground inspections, it appears that further investigations of the project area and cultural items identified at the Compton and Hilger farmsteads would not yield any new information significant to the understanding of the area's prehistory and history. Furthermore, it has been determined that the cultural items identified at the farmsteads do not meet the significance criteria that would make them eligible for inclusion on the National Register of Historic places. The Corps is recommending that the proposed restoration work will have no effect on historic properties and is seeking concurrence with these determinations and recommendations through continued consultation with SHPO and the appropriate Tribes.

In accordance with Oregon State Law (ORS 97.740 to 97.760, 358.905 to 358.955, and 390.235) if any artifacts are uncovered during construction or restoration work, work in the vicinity of the discoveries must be suspended immediately. SHPO and the appropriate tribes must be notified immediately and a qualified archaeologist shall be called in to evaluate the find(s) and recommend appropriate action in consultation with SHPO and the Tribes.

7.11. HAZARDOUS MATERIALS

An environmental database records search was conducted in July 2011 by EDR, Inc. to evaluate the potential for the presence of hazardous materials and other contaminants in the study area. Additionally, the Nature Conservancy contracted with Hahn and Associates to conduct a Level 1 Environmental Assessment of the Wildish properties at the confluence of the Coast and Middle Forks prior to acquisition to evaluate the potential for the presence of hazardous materials and other contaminants (Hahn and Assoc. 2010). The results of these two evaluations of the likelihood of encountering hazardous materials during construction are summarized in this section. All of the proposed restoration sites are located within the 100-year floodplain and floodway. Thus, it is possible that hazardous materials or contaminants in floodwaters could have contaminated any one of these sites. However, there is no specific contamination that has been identified at any of the sites. Additional details are provided in Appendix F.

7.11.1. Coast Fork Willamette River

Site C1B. This site is owned by Lane County and has been used for gravel extraction in past decades. The site is undeveloped, but the public is allowed access on foot from Franklin Boulevard. Visual observation of the site indicated that small quantities of trash are present, primarily adjacent to the road, but no hazardous materials, drums, or sheens/odors were observed. Two high voltage transmission lines are adjacent to this site, but not actually present on the site. The 2001 database search (EDR 2011) revealed eleven potential pollutant sources within one mile of the site. Virtually all of these potential pollutant sources are located along I-5 or Franklin Boulevard to the west of the site and generally separated by a railroad grade from the site. Four of the sites are Resource Conservation and Recovery Act (RCRA) conditionally exempt small quantity generators of hazardous materials such as small manufacturing and gas stations. Four of the sites have had leaking underground fuel storage tanks. A biofuel station within one mile was a former Brownfields site (former gas station) that was cleaned up and turned into a biofueling station that uses non-toxic fuels. A BPA substation within one mile has had several releases of various pollutants including oil, lead, ethanol, PCBs, and other materials. BPA has been working with the State of Oregon and other agencies to clean up and resolve all issues. The site will continue to store herbicides and fuels on the site for maintenance use. Lane Community College has some notices of non-compliance for handling of used oil, as well as documented releases of volatiles and disposal of paint waste into storm drains. They are registered to store and use pesticides and fuels and laboratory materials on site. Overall, it is unlikely that any of these potential pollutant sources have released hazardous materials that could have reached Site C1B. Therefore, the likelihood of encountering hazardous materials or contaminants on the site is low.

Site C1C. This site is owned by the Nature Conservancy and was recently purchased from Wildish. The site was used for gravel extraction in past decades and is generally undeveloped. One high voltage transmission line crosses this site (BPA). Visual observation of the site did not reveal the presence of any hazardous materials, drums, or sheens/odors. The Level 1 Environmental Assessment (Hahn and Assoc. 2010) indicated there were no potential pollutant sources to this site. The potential pollutant sources indicated for Site C1B are also within one mile of Site C1C, but similarly to Site C1B, it is unlikely that any of those potential pollutant sources have released hazardous materials that could have reached Site C1C. Therefore, the likelihood of encountering hazardous materials or other contaminants on the site is low.

7.11.2. Middle Fork Willamette River

Site M1A. This site is owned by the Nature Conservancy and was recently purchased from Wildish. The site was used for gravel extraction in past decades and is generally undeveloped. One high voltage transmission line crosses this site (BPA). Visual observation of the site did not reveal the presence of any hazardous materials, drums, or sheens/odors. The Level 1 Environmental Assessment (Hahn and Assoc. 2010) indicated there was only one potential pollutant source to this site, which is the current hazelnut orchard on the western portion of the site, where pesticides and herbicides may have been used in the past. The 2011 database search (EDR 2011) revealed two potential pollutant sources within one mile of the site, but both sites are former leaking underground fuel storage tanks that have been decommissioned or cleaned up. The Springfield Utility Board drinking water well field is located between the potential pollutant sources and Site M1A and no reports of contaminants have occurred in that area; thus, it is unlikely that any discharges of hazardous materials or pollutants from the two potential sources could have reached Site M1A. Therefore, the likelihood of encountering hazardous materials or other contaminants on the site is low.

Site M1B. This site is owned by the Nature Conservancy and was recently purchased from Wildish. The site was used for gravel extraction in past decades and is generally undeveloped. One high voltage transmission line crosses this site (BPA). Visual observation of the site did not reveal the presence of any hazardous materials, drums, or sheens/odors. The Level 1 Environmental Assessment (Hahn and Assoc. 2010) indicated there was only one potential pollutant source to this site, from the former agricultural use of the site prior to Wildish' s purchase and then an on-going agricultural lease, where pesticides and herbicides may have been used. The 2011 database search (EDR 2011) revealed the same two potential pollutant sources as identified for Site M1A, which are both located across the river, with the Springfield Utility Board well field in between. It is unlikely that any discharges of hazardous materials or pollutants from the two potential sources could have reached Site M1B. Therefore, the likelihood of encountering hazardous materials or other contaminants on the site is low.

Site M2A. This site is owned by the Nature Conservancy and was recently purchased from Wildish. The site was used for gravel extraction in past decades and is generally undeveloped. One high voltage transmission line is adjacent to this site (BPA; upstream). Visual observation of the site did not reveal the presence of any hazardous materials, drums, or sheens/odors. The Level 1 Environmental Assessment (Hahn and Assoc. 2010) indicated there were no potential pollutant sources to this site. The 2011 database search (EDR 2011) revealed three potential pollutant sources within one mile. These three potential sources are all across the river from the project site. One source is a manufacturing company that is a RCRA conditionally exempt small quantity generator that uses spent solvents and other materials. There is no record of spills or other releases. The Clearwater Landfill is located within one mile but there are no records of spills or other releases. Wentworth Buick has a leaking underground fuel storage tank, but it is unlikely that any hazardous materials or other contaminants would have reached Site M2A because Jasper Slough, that discharges into the Springfield Millrace is located between the potential source and the river and if any fuels discharged to ground or surface waters they would have likely been carried down the Millrace. An NPDES permitted stormwater outfall is located in Clearwater Park across the river from Site M2A, but it is not likely that any pollutants from the outfall have contaminated Site M2A. Therefore, the likelihood of encountering hazardous materials or contaminants on the site is low.

7.12. AIR QUALITY

The recommended restoration plan should have no long-term effects on air quality, other than the potential to reduce airborne dust as a result of revegetation sites that are currently disturbed due to sand and gravel extraction activities. The project will not construct any new sources of air pollution.

During construction, airborne contaminants, including dust and other particulate matter may be released into the air during clearing of project areas and use of heavy equipment that stirs up exposed soils. Measures would be taken to reduce dust in cleared areas, including the application of water to exposed soils or placement of mulches or other materials to reduce dust.

Construction vehicles may temporarily increase air emissions in the immediate project vicinity, through the release of carbon monoxide and other pollutants from fuel combustion. Air quality emissions should not exceed EPA's *de minimis* threshold levels (100 tons/year for carbon monoxide and 50 tons/year for ozone) for non-attainment areas, however, the project is located in a maintenance area and there have been no standards set for greenhouse gas emissions (CO_2 in the case of this project) in the state of Oregon. Other emissions under consideration for non-road construction equipment are reactive organic gases (ROGs) (which are ozone precursors), nitrogen oxides (NOx), particulate matter (PM), and sulfur oxides (SOx).

For every gallon of diesel fuel burned, 22 pounds of CO_2 are produced, and every gallon of gasoline produces 19.4 pounds of CO_2 (USEPA 2008). The CO_2 emissions created by this project are likely to be insignificant compared to the emissions generated in Lane County annually. Nevertheless, diesel fuel consumption by heavy machinery required for construction, material delivery and haul-off, and gasoline consumption for travel to the sites are a part of world-wide cumulative contributions to change in climate by way of increases in greenhouse gas emission. However, the plantings at the site should aid in the absorption of CO_2 over time.

Overall, no significant adverse impacts are expected for air quality.

7.13. NOISE

Construction vehicles and equipment may temporarily increase noise in the immediate project vicinity. Construction will be restricted to normal working hours to minimize this disturbance (i.e. 7 a.m. to 7 p.m.), which is within the restricted limits outlined in the Lane County noise ordinance. Some example sources and magnitude of noise arising from construction is summarized in Table 37 (from the FHWA Construction Noise Handbook).

Based on the preliminary project designs, construction may call for the use of excavators, bull dozers, front loaders, a wheel-mounted crane, and a pile driver. Based on the type and duration of construction activities proposed, temporarily elevated levels of noise are not expected to be an issue for the study area. The land uses adjacent to the construction zones are largely composed of rural residential land uses. No sensitive receptors have been identified adjacent to the project sites.

Table 38. Example Equipment Noise Levels

Equipment Description[1]	Impact Device?	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)
Chain Saw	No	85
Compactor (ground)	No	80
Compressor (air)	No	80
Concrete Pump Truck	No	82
Concrete Saw	No	90
Crane	No	85
Dozer	No	85
Dump Truck	No	84
Excavator	No	85
Flat Bed Truck	No	84
Front End Loader	No	80
Grader	No	85

Impact Pile Driver	Yes	95
Pickup Truck	No	55
Tractor	No	84

1 – List of equipment truncated for example purposes. Full list available at source below.

Source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

7.14. Climate Change

There will be no measurable effects on climate either during construction of the projects or as a result of long term operation of the selected plan. According to the United States Global Change Research Program, the Northwest region's average temperature is projected to rise 3 to 10°F in this century, with higher emissions scenarios resulting in warming in the upper end of this range. Increases in winter precipitation and decreases in summer precipitation are projected by many climate models, though these projections are less certain than those for temperature. The construction associated with this project is not anticipated to have a significant impact on regional climate change.

As climate change occurs, ecosystem benefits would still accrue, but changes in conditions such as hydrology are expected. It is expected that climate change will cause reduced snowpack and may also lead to a more variable rainfall regime (higher peak rainfall events and more frequent drought conditions). The restoration of floodplain habitats will help ameliorate effects to the ecosystem and human environment by providing incrementally more flood storage and allowing sediment erosion and deposition. Additionally, more frequent connections to the floodplain will promote groundwater recharge that can help sustain low flows. Lower flows and more frequent droughts may alter the suitability of the current plant community. A drier, warmer summer may shift habitat conditions to favor more drought tolerant plant species. After construction, vegetation survival at the site should be monitored. Depending on monitoring results, the operation and maintenance activities (solely the responsibility of the non-federal sponsor) would include replanting as necessary with a species list informed by the as-built hydrology at the site. A monitoring plan and an operation and maintenance plan will be developed during the design phase.

7.15. Environmental Justice

Executive Order (EO) 12898 states "To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands".

EC 12898 requires the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The federal government has this goal for all communities and persons across this nation. It would be achieved when everyone enjoys the same degree of protection from environmental and health hazards, equal access to the decision-making process, and the opportunity to have a healthy environment in which to live, learn, and work.

The demographics of the project area include a 2009 population estimate for Lane County of 351,109, of which 222,386 are 25 years and older. The median household income is $42,852, with 16.2% of individuals below the poverty level. Of the total population 89.7% has a high school education and 27.3% have a bachelor's degree or higher. The majority of the population is white (89.5%) with Hispanic or Latino and Asian races at 3.2% and 2.8%, respectively. The majority of the population lives within the city centers, with Eugene being the largest with a population of 153,272. This demographic analysis did not identify an ethnic minority, low-income, or subsistence population in the project area

The project would only temporarily affect noise, traffic, and air quality during construction, and should enhance aesthetics once construction is complete. The project will not affect human health as it will not involve the siting of a facility or creation of a scenario in which pollutants or contaminants would be discharged. This project will not have a disproportionately negative effect on an ethnic minority, low-income, or subsistence populations and may provide benefits via the contributions to recovery of fishable salmon populations. Therefore the proposed action is in compliance with this executive order.

7.16. Secondary (Indirect) Impacts

Secondary indirect impacts of the project include the possible promotion of additional restoration projects in the Willamette Basin based on the project's success. Additional fishing and hunting opportunities may be provided due to an increase in the fish and wildlife population as a result of restoration actions. Future recreation and environmental education enhancements may be implemented within the project area as an indirect result of successful habitat restoration.

7.17. Cumulative Impacts

Significant cumulative impacts to the Coast and Middle Forks of the Willamette River have occurred since Euro-American settlement began in the early 1800s. Key actions have included agricultural and urban development, timber harvesting, construction of dams and revetments/levees, water withdrawals and removal of wood from the rivers. These effects have altered the hydrology and geomorphology of the rivers disconnecting the rivers from their floodplains. As a result riparian and off-channel habitats have been greatly reduced resulting in effects to species populations and increased flooding. This proposed project will incrementally reverse some of the cumulative adverse effects that have occurred in the project area by restoring a more natural hydrologic connection to the river and enhancing wetland and floodplain habitats.

The project will restore floodplain and therefore fish and wildlife habitat in an area that has experienced very significant negative cumulative impacts over the past 150 years. This project will restore more natural hydrologic and geomorphologic conditions on the Coast and Middle Fork Willamette Rivers, providing greater floodplain functions and restore large areas of off-channel riparian and wetland habitats. These habitats will additionally be enhanced through removing invasive species, revegetation with native species, and increasing habitat structure in-stream and on the floodplain and will increase the value of fish and wildlife habitat. In addition, in combination with the other restoration actions that are occurring in the broader Upper Willamette River watershed, this project will have a positive cumulative effect on the watershed.

7.18. Relationship Between Short-Term Uses and Long-Term Productivity

The temporary use of construction equipment and materials during construction will generally be minor in the scale of energy use, air quality and noise effects, compared to the long-term restoration of floodplain processes and habitats. Also, the project sites are currently generally fallow, but subject to some recreational uses. By restoring these habitats, the sites will become more useful for conservation and recreational uses, but restrict their use for further gravel mining and development. In the long-term this will reduce the use of energy and further air quality and noise effects within the floodplain. The proposed restoration plan is unlikely to adversely affect the regional economy and may provide minor beneficial effects on the economy by avoiding flood damages and providing suitable recreation and quality of life factors, including aesthetics to nearby residents.

7.19. Unavoidable Adverse Impacts

The only unavoidable adverse impacts would be temporary and short-term associated with construction, such as fish salvage and handling, minor increases in turbidity, and noise associated with pile driving and the use of construction equipment. These short-term effects will be minimized to the maximum extent practicable by the implementation of construction BMPs and other conservation measures. These impacts are not considered significant.

7.20. Mitigation Measures

Construction BMPs will be implemented to minimize any adverse effects to the maximum extent practicable, including implementation of erosion and pollution control measures (i.e. silt curtains, silt fencing, mulching), only working in waters during allowable in-water work windows, work area isolation (such as using coffer dams and silt curtains), fish salvage and removal per an approved fish salvage plan and under a valid Scientific Collection Permit approved by NMFS and ODFW, noise reduction measures for pile driving such as using coffer dams and driving piles out of waters, and other appropriate measures to be developed during the design phase.

7.21. Environmental Operating Principles

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

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

will incrementally address some of the consequences that past Corps programs have caused to floodplain connections and quantity/quality of habitat downstream of Corps dams.

3. *Create mutually supporting economic and environmentally sustainable solutions.* – This project will reconnect floodplain habitats to the rivers in areas with limited development or infrastructure to purposefully restore natural systems and functions. The project will not have adverse effects on residents or infrastructure and may incrementally increase flood storage and reduce velocities in the main channels providing some reduced risk of damages to adjacent infrastructure and development.
4. *Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.* – This project provides restoration of natural systems and is intended to avoid adverse effects on human health and welfare and may incrementally reduce risks to human health and welfare by promoting flood storage and diversification of channel velocities.
5. *Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs*. – This project has been designed in the context of on-going watershed processes including hydrology and sediment transport. It is designed to function over the long-term with potential changes in the operation of dam outflows and promote restoration of these processes. It has also been designed in consideration of climate change effects and may incrementally help to buffer those effects by providing additional flood storage during lower events and promoting groundwater recharge that can supplement low flows.
6. *Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.* – The Corps and the local sponsor have worked extensively with stakeholders and the public during this feasibility study to solicit the input of academic researchers and others in the subbasins on problems and needs and the potential effectiveness of proposed restoration measures. The tools developed for this study will be used by stakeholders in the basin as well as monitoring results for the post-construction condition.
7. *Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.* – The Corps and the local sponsor have worked extensively with stakeholders and the public during this feasibility study to solicit their input and feedback on proposed restoration measures and alternatives.

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8. SUMMARY OF PUBLIC INVOLVEMENT

8.1. STAKEHOLDER & AGENCY INVOLVEMENT

A wide variety of stakeholders were involved in both the development of the Subbasin Plan in **Phase 1** and in scoping this feasibility study – now identified as **Phase 2** (Table 38). These stakeholders have also been consulted at key points in the feasibility phase.

Table 39. Stakeholders Involved in Feasibility Study

Watershed Councils	**Local Governments**
Coast Fork Willamette Watershed Council	Lane County
Middle Fork Willamette Watershed Council	Lane Council of Governments
Federal Agencies	City of Springfield
USDA Forest Service	City of Cottage Grove
National Marine Fisheries Service	City of Creswell
Natural Resources Conservation Service	City of Lowell
Bureau of Land Management	City of Oakridge
U.S. Fish and Wildlife Service	East Lane Soil and Water Conservation District
U.S. Environmental Protection Agency	**Other Interest Groups**
State Agencies	Willamette Restoration Initiative
Oregon Department of Agriculture	Friends of Buford Park & Mt. Pisgah
Oregon Dept. of Environmental Quality	McKenzie River Land Trust
Oregon Dept. of Fish and Wildlife	The Nature Conservancy
Oregon Dept. of Forestry	Oregon State University
Oregon Dept. of Geology & Mineral Industries	Pacific Northwest Ecosystem Research Consortium
Oregon Dept. of Land Conservation and Development	The Trust for Public Land
Oregon Watershed Enhancement Board	Willamette Riverkeepers

A series of stakeholder meetings has occurred from 2008-2011 to discuss restoration measures and alternatives. Key feedback has been provided on the importance of the confluence area and other key off-channel areas, and recommendations for backwater versus flow-through connections and other features. Once the top ranked projects were identified in the first run of the CE/ICA, meetings with landowners occurred to identify interest and willingness to participate. This resulted in the removal of some sites where landowners were not willing. Additionally, Oregon State Parks and the City of Cottage Grove indicated that they were already proceeding with some sites that were then also removed from the list as they would be implemented sooner than this study would be completed.

Public involvement has also occurred at several points during the feasibility study. To date, a series of public meetings were held in June 2006 in the Coast and Middle Fork watersheds. A variety of landowners, stakeholders, and others attended and discussed the general study purpose and overview, study area, defined floodplain restoration and potential ideas, and asked for feedback on issues. Primary concerns of the public in the study area are the existing flooding and erosion damages, some as a result of culverts and other constrictions as well as unintended consequences of bank protection. Many landowners are supportive of restoration but are also concerned that the local jurisdictions continue to allow development in the floodplain and riparian zones.

Additional public meetings were held in October and November 2008. At these meetings large maps were presented with the potential restoration alternatives identified to solicit comments and concerns from the attendees. A number of stakeholder expressed interest in habitat and floodplain restoration, especially State Parks. Private landowners are concerned about flooding effects or bank erosion. The City of Springfield indicated that some of their drainage problems could be helped by floodplain and/or side channel restoration.

This draft report will be reviewed by the stakeholders and the public in 2013 and any additional feedback received will be addressed in the final report. A more detailed summary of the stakeholder and public involvement conducted, to date, is provided in Appendix H.

9. Environmental Compliance Requirements

9.1.1. National Environmental Policy Act

This integrated Draft Detailed Project Report and Environmental Assessment (EA), prepared January 2013, is intended to achieve NEPA compliance for the proposed restoration plan. This EA describes existing environmental conditions within the study area, the proposed action and alternatives, potential environmental impacts of the proposed restoration plan, and measures to avoid and minimize environmental impacts.

9.1.2. Endangered Species Act

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

In accordance with Section 7(a)(2) of the Endangered Species act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must identify and evaluate any threatened and endangered species, and their critical habitat, that may be affected by an action proposed by that agency. A Biological Assessment has been prepared and is included in Appendix D. A determination of "may affect, likely to adversely affect" was made for Upper Willamette Chinook, and a determination of "may affect, not likely to adversely affect" was made for Oregon chub and bull trout. Multiple conservation measures have been proposed to address expected temporary adverse effects during construction.

9.1.3. Clean Water Act

Section 404 of the Clean Water Act authorized a permit program for the disposal of dredged or fill material into waters of the United States, and defined conditions which must be met by federal projects before they may make such discharges. The Corps retains primary responsibility for this permit program. The USACE does not issue itself a permit under the program it administers, but rather demonstrates compliance with the substantive requirements of the Act through preparation of a 404(b)(1) evaluation.

A 404(b)(1) evaluation will be prepared to document findings regarding this proposed restoration plan pursuant to Section 404 of the Act.

Section 401 of the Clean Water Act requires federal agencies to comply with EPA, state, or tribal water quality standards. EPA has delegated implementation of Section 401 to the Oregon Department of Environmental Quality (DEQ). This work will require 401 certification from the Oregon DEQ for compliance with Section 401 of the Clean Water Act for work below the Ordinary High Water (OHW) line. The Corps will abide by the conditions of the water quality certification to ensure compliance with Oregon water quality standards. During the design phase, further coordination with ODEQ will be conducted to document the proposed work area isolation and dewatering plans at each individual site and to develop construction water quality monitoring plans.

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

9.1.4. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through Corps funding of a Planning Aid Letter or Coordination Act Report which provides the basis for recommendations for avoiding or minimizing such impacts. Coordination with USFWS has been ongoing throughout the study process and letter with recommendations will be provided.

9.1.5. National Historic Preservation Act

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

9.1.6. Magnuson-Stevens Fishery Conservation and Management Act

The evaluation of project impacts to essential fish habitat (EFH) is being conducted as part of the Section 7 consultations with NMFS described in Section 9.1.2 above. Conservation measures will be included as part of the proposed action in order to adequately avoid, minimize, or otherwise offset potential adverse effects to EFH.

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

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

Although bald eagles are generally known to occur in the study area, no take of either bald or golden eagles is likely during project construction. No nests are known to be present. Therefore, no adverse effects to eagles are anticipated. BGEPA management guidelines (USFWS 2007) will be followed if any bald eagle nests are identified during the design or construction phases. Generally, the proposed restoration activities can be classified as Category A activities. Buffers of 660 feet should be maintained around nests if the construction work is visible from the nest. Buffers of 330 feet should be maintained around nests if the construction work is not visible from the nest.

9.1.8. Wild and Scenic Rivers Act (16 U.S.C. 1271-1287)

No portions of the Coast or Middle Forks of the Willamette River have been designated as a Wild and Scenic River so this Act is not applicable to the proposed work.

9.1.9. Executive Order 12898, Environmental Justice

Executive Order 12898 directs every federal agency to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The federal government has this goal for all communities and persons across this nation. It would be achieved when everyone enjoys the same degree of protection from environmental and health hazards, equal access to the decision-making process, and the opportunity to have a healthy environment in which to live, learn, and work.

The demographics of the project area include a 2009 population estimate for Lane County of 351,109, of which 222,386 are 25 years and older. The median household income is $42,852, with 16.2% of individuals below the poverty level. Of the total population 89.7% has a high school education and 27.3% have a bachelor's degree or higher. The majority of the population is white (89.5%) with Hispanic or Latino and Asian races at 3.2% and 2.8%, respectively. The majority of the population lives within the city centers, with Eugene being the largest with a population of 153,272. This demographic analysis did not identify an ethnic minority, low-income, or subsistence population in the project area

The project would only temporarily affect noise, traffic, and air quality during construction, and should enhance aesthetics after construction is complete. The project does not involve the siting of a facility that would discharge pollutants or contaminants, so no human health effects would occur. This project will not have a disproportionately negative effect on an ethnic minority, low-income, or subsistence populations and may provide benefits via the contributions to recovery of fishable salmon populations. Therefore the proposed action is in compliance with this order.

9.1.10. Executive Order 11990, Protection of Wetlands, May 24, 1977

The goal of the project is to restore and preserve the functions and values of wetlands in order to restore the functions of the floodplain. The project is in compliance with this executive order because it will not induce adverse effects to wetlands and will restore, enlarge, and enhance wetlands.

9.1.11. Executive Order 11988, Floodplain Management, 24 May 1977

Executive Order 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of the floodplain, and to avoid direct and indirect support of floodplain development where there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains."

The proposed action would not create a change that would affect occupancy or modification of the floodplain and will actually ensure that the project sites are not developed in the future. The project will restore natural functions of approximately 574 acres of floodplain, restoring and preserving the natural and beneficial values of the floodplain such as flood storage and attenuation, sediment deposition, habitats for fish and wildlife and groundwater recharge.

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10. MONITORING AND ADAPTIVE MANAGEMENT PLAN

This monitoring and adaptive management plan has been developed to assess the success of the recommended restoration plan in meeting project objectives and a process to identify if any adaptive management actions are warranted. The proposed monitoring plan will measure the following key elements: vegetation, hydrology and hydraulics, river and floodplain morphology, wildlife, physical habitat, and fish and the methods are described in this section. Photo-monitoring will also be conducted to document site changes over time including vegetation establishment and physical habitat features.

Project Objectives:

1. Restore lost historic channel complexity and diversity
2. Restore connectivity of river to floodplain habitats
3. Restore and protect native floodplain habitats including riparian and wetland habitats

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

Restore lost historic channel complexity and diversity

Target(s):

1. Increase pool habitat in adjacent reach of mainstem rivers by 25% by 2020.
2. Increase LWD abundance in adjacent reach of mainstem rivers by 50% by 2020.
3. Increase diversity of habitat unit types in adjacent reach of mainstem rivers by 25% by 2025.

Monitoring Protocol:

1. Habitat Unit Assessment. Use U.S. Forest Service, Timber-Fish-Wildlife, or similar appropriate protocol to quantify habitat unit types and areas in adjacent reach of mainstem river to each site pre and post-construction (except Site M1B where no in-channel work is proposed). As these protocols are designed for wadable streams, will need to use boat access to supplement wadable parts of reaches. Primary focus is on mapping pools, riffles, and LWD abundance and location. Conduct a baseline survey in summer prior to construction at each site to develop baseline map/areas for comparison to all post-construction periods. Conduct post-construction assessment in Years 1, 5 and 10 after construction.
2. Geomorphic Comparison. At Years 5 and 10 after construction, evaluate river and floodplain morphology using aerial photos from base year and evaluation year as well as LiDAR to document morphologic changes (planform, habitat types, etc.) and compare and correlate any changes to potential effects from restoration actions.

Adaptive Management Trigger(s):

1. If any of the targets are not achieved by the year specified, then additional LWD should be installed in the river channel. The Corps and non-Federal sponsor to identify preferred location and number of pieces of wood to install to promote in-channel habitats.

Restore connectivity of river to floodplain habitats

Target(s):

1. Sustain floodplain connection frequencies per design at each site through 2025 at a minimum.
2. Ensure fish passability through channels during designated connection season per design (6 inch depth minimum, 2 fps velocities) through 2025 at a minimum.
3. Document fish presence/absence to verify accessibility to all connected areas.

Monitoring Protocol:

1. Install recording crest gage and recording velocity gage at primary connection channel on each site (downstream backwater connection channel) to record water surface elevation and flow velocity in Years 1, 5 and 10 following construction. Record hourly and download at monthly intervals during designated connection season (i.e. October through June).
2. Conduct channel cross-section and profile surveys at all connector channels on each site (estimate 2 cross-sections, approximately 100 meters apart on each channel) in Years 1, 5, and 10 following construction. Document changes and identify frequency of connection based on elevation and recording crest gage data. Identify causal factors for changes observed.
3. Conduct fish surveys in a minimum of 3 locations at each site (i.e. 2 ponds and one channel) via methods such as fyke nets, seining, and/or electroshocking. Sampling will occur every two weeks during the connection period (i.e. October through June) and include at least one night-time sampling per month. All fish species collected will be identified and measured for length.
4. Install recording temperature gages in all locations where fish are surveyed to document water quality conditions and potential suitability of habitat for native fish use. Maintain year-round for first ten years following construction.

<u>Adaptive Management Trigger(s):</u>

1. If channel connection frequency and fish passage requirements are not met more than 20% during design flows, then the Corps and non-Federal sponsor will review the data and causal factors to identify preferred management actions. Possible management actions could include installation of large wood to promote scour (i.e. if sediment deposition has occurred) or reduce channel velocities (via increased roughness); additional excavation if frequency targets are not met but no substantial channel deposition has occurred; reorientation of channel location (i.e. if sediment deposition or erosion is caused by orientation and localized scour/deposition conditions); or additional revegetation (to increase roughness or provide sediment trapping capacity).
2. If fish surveys document that salmonids are not present in specific locations, identify potential causal factors in relation to channel connection frequencies and fish passage requirements. If any channel physical factor appears to be creating a barrier, then the Corps and the non-Federal sponsor will evaluate management actions such as those described for the channels above. Also evaluate temperature data to determine suitability of habitat for native and non-native species and correlate to fish presence/absence.

<u>Restore and protect native floodplain habitats including riparian and wetland habitats</u>

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

1. Achieve 80% cover of native vegetation species per design at each site within 5 years post-construction and sustain through 2025 at a minimum.
2. Reduce non-native vegetation species to less than 25% cover per design at each site within 5 years post-construction and sustain through 2025 at a minimum.

3. Document changes in habitat suitability for wildlife species included in habitat model. Compare and correlate presence/absence of native amphibians and native songbirds to habitat suitability parameters.

Monitoring Protocol:

- Establish minimum of five permanent vegetation plots on each site to be representative of the plant communities and restored areas within the project site. Permanent plots shall be 33 foot diameter circular plots (centerpoint of each plot will be documented via GPS coordinates to reoccupy in each of sampling). Percent cover will be visually assessed and documented for each strata (herbs, shrubs, trees, woody vines) and each species with more than 5% cover. Sampling will occur in Years 1, 3, 5, and 10 following construction. Percent survival of planted stock should be a minimum of 80% during Years 1 and 3 otherwise supplemental plantings will be required to replace plants that have died. Percent cover of native species will be measured in the permanent plots and should reach 30% in year 1, 50% in year 3, and >80% in years 5 and 10 (total percent cover in all strata).
- Map non-native vegetation species throughout restored areas on each site in Years 1, 3, 5, and 10 after construction and document percent cover in all locations with more than 100 square feet of presence. Document average percent cover by species across the site and estimate total area of infestation.
- Conduct habitat evaluation using multi-species HEP model in Years 5 and 10 following construction at each site. Document changes from baseline.
- Conduct amphibian and songbird surveys in Years 5 and 10 following construction at each site. Amphibian surveys to be conducted during breeding season following red-legged frog protocol and document all species observed. Conduct bird nesting surveys in summer at each site in Years 5 and 10 following construction. Document amphibian and bird survey data to habitat model parameters (i.e. quantify water temperatures, shrub height and density and other parameters where species observed).

Adaptive Management Trigger(s):

1. If native plant survival or percent cover does not meet targets in any year of monitoring then the non-Federal sponsor will undertake supplemental plantings to achieve the targets. The Corps and non-Federal sponsor will evaluate at the end of 10 years the overall quality of habitat in each restored plant community to identify if
2. If average non-native invasive species cover exceeds 25% cover in any of the monitoring years then the non-Federal sponsor will undertake invasive species removal actions such as pulling, mowing, and spot application of herbicide.
3. Corps and non-Federal sponsor to evaluate habitat suitability indices and presence/absence of native amphibians and birds and modify models as appropriate based on quantitative data of presence relative to specific model parameters.

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11. RECOMMENDATIONS

In conclusion, I recommend the approval of the recommended restoration plan described in this feasibility report that includes floodplain restoration at five sites in the lower Coast and Middle Forks of the Willamette River. The total project cost is estimated at $48,882,222 and will restore 574 acres of floodplain and off-channel habitats that are essential habitats for multiple listed fish and wildlife species, as well as incrementally restoring natural watershed processes of floodplain hydrologic connections, sediment transport, and channel migration.

This plan is being recommended with such modifications thereof as in the discretion of the Commander, HQUSACE may be advisable.

The Nature Conservancy is the non-Federal sponsor and will provide 35% of the total project costs. Prior to implementation, the non-Federal sponsor shall agree to perform the following items:

- Provide all lands, easements, rights-of-way, relocations, and excavated or dredged material disposal areas (LERRDs).
- Provide, during construction, any additional costs as necessary to make the total non-Federal contributions equal to 35 percent of the total project costs. The Nature Conservancy will provide work-in-kind during final design and construction as well as providing the post-construction monitoring. The value of the LERRDs needed for the project will be deducted from the non-Federal sponsor's cost-sharing requirement. Work-in-kind tasks and estimated costs are provided below. The non-Federal sponsor anticipates contributing the balance of funds from grant funding.
    - Design of Sites M2A and C1C – $414,000
    - Environmental Compliance (permitting) - $50,000
    - Construction Management - $150,000
    - Removal of Invasives and Plantings All Sites - $11,550,000
    - LERRDs - $426,000
    - Monitoring All Sites - $397,000
    - Cash - $1,772,500
- Operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the completed project at no cost to the Federal Government, in accordance with the applicable Federal and State laws and any specific directions prescribed by the Federal Government for so long as the project is authorized. The annualized operation and maintenance costs are estimated at $130,000.
- Hold and save the Federal Government harmless from damages due to the construction and operation and maintenance of the project, except where such damages are due to the fault or negligence of the Federal Government or its contractors.
- Grant the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon land which the non-Federal Sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purposes of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.
- Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs for a minimum of three years after completion of the project construction for which such books, records, documents, and other evidence are required.
- Perform, or cause to be performed, any investigations for hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-

of-way necessary for construction, operation, and maintenance of the project; except that the non-Federal Sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude without prior specific written direction by the Federal Government.

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

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APPENDICES

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