Draft Ecosystem Restoration Report and Environmental Assessment

Willapa River Estuarine Restoration Project
Pacific County, Washington

October 2002

A Cooperative Project involving:

US Army Corps of Engineers®
Seattle District

Washington Department of FISH AND WILDLIFE

U.S. FISH & WILDLIFE SERVICE

DUCKS UNLIMITED

United States Department of Agriculture
NRCS Natural Resources Conservation Service

Washington State Department of Transportation

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Responsible Agencies: The agencies responsible for this work are the US Army Corps of Engineers, Seattle District (Corps) and the Washington Department of Fish and Wildlife (WDFW). Cooperating agencies include the US Department of Agriculture Natural Resources Conservation Service (NRCS), the Washington State Department of Transportation (WSDOT), the US Fish and Wildlife Service (USFWS), and Ducks Unlimited, Inc. (DU).

Summary: During the late 1960s and early 1970s, the Corps disposed of dredged material in diked intertidal mudflat and wetland habitat adjacent to the Federal Willapa River Navigation Channel. As a result, several hundred acres of productive estuarine habitat were lost. This reduction in the area and diversity of estuarine habitats has impacted Willapa Bay's capacity to support the variety of fish, bird, and shellfish species that were historically abundant.

The Corps and WDFW are therefore proposing to restore estuarine habitat in an area along the lower Willapa River which is currently diked. This document examines existing environmental conditions in the Willapa Basin, proposes and evaluates alternatives for restoring important habitat functions on lands owned by WDFW, and recommends a preferred restoration alternative. In accordance with National Environmental Policy Act (NEPA), this document also evaluates the potential environmental impacts of the proposed restoration alternative.

THE OFFICIAL COMMENT PERIOD ON THIS ENVIRONMENTAL ASSESSMENT ENDS ON JANUARY 20, 2003.

This document is also available online at: http://www.nws.usace.army.mil/ers/envirdocs.html

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1 Introduction

Over the past century, forest practices, dredging and filling associated with navigation improvements, and diking for agricultural and residential development have degraded fish and wildlife habitat in the Willapa River Basin. The Corps of Engineers, Seattle District (Corps) and Washington Department of Fish and Wildlife (WDFW) are proposing to restore estuarine habitat in an area along the lower Willapa River which is currently diked. This document examines existing environmental conditions in the Willapa Basin, proposes and evaluates alternatives for restoring important habitat functions on lands owned by WDFW, and recommends a preferred restoration alternative. In accordance with National Environmental Policy Act (NEPA), this document also evaluates the potential environmental impacts of the proposed action.

1.1 Study Area

Willapa Bay is a large estuary in the southwest portion of Washington State. It is located between the mouth of the Columbia River and Grays Harbor. The study area for this proposal is located on the left bank of the Willapa River, the largest tributary to Willapa Bay, approximately one mile downstream of the City of South Bend in Pacific County, Washington (T14N R09W Sections 17, 18, 19, and 20). Please see Figure 1 in Appendix A for a location and vicinity map.

The study area is property for which the Natural Resources Conservation Service (NRCS) obtained Warranty Easement Deeds from five landowners through the Wetland Reserve Program. Following the establishment of the wetland easements, all landowners sold their fee title to WDFW. Approximately 400 acres of diked lands and approximately 35 acres of adjoining undiked tidelands have been acquired by WDFW and NRCS (see Figure 2).

1.2 Study Authority

Section 1135 of the Water Resources Development Act of 1986 (Public Law 99-662, as amended) allows the Corps of Engineers to modify the structure or operation of a Corps project to restore fish and wildlife habitat, or to construct restoration projects in locations where an existing Corps project has contributed to the degradation of the quality of the environment. The purpose of the proposed restoration project is to replace some of the estuarine habitat lost when dredged material was placed in intertidal wetlands as part of the Corps' Willapa River and Harbor Project.

The Section 1135 program requires the participation of a non-Federal sponsor, which can include public agencies or large national non-profit organizations. All planning studies, design work, and construction costs are shared between the Corps (75%) and the non-Federal sponsor (25%). The Washington Department of Fish and Wildlife (WDFW) is the non-Federal sponsor for the Willapa River 1135 project evaluated in this document.

Cooperating agencies include the US Department of Agriculture Natural Resources Conservation Service (NRCS), the Washington State Department of Transportation (WSDOT), and the US Fish and Wildlife Service (USFWS). These agencies, along with the Corps, WDFW, and Ducks Unlimited Inc., have participated in an interagency committee which developed the objectives for the proposed restoration work, provided needed data and field studies, and contributed technical expertise during plan formulation.

1.3 Associated Studies and Reports

Much of the information contained in the following sections of this document was obtained from the following studies and reports:

- The *Tide Marsh Restoration and US Highway 101 Improvement Hydrologic and Hydraulic Analysis* prepared by Herrera Environmental Consultants in association with Philip Williams & Associates, Ltd. and Battelle Marine Sciences Laboratory (February 2002) and the *Potters Slough Additional Hydrodynamic Modeling* prepared by Philip Williams & Associates, Ltd. (October 2001) provided much of the basis for the project's design and incremental cost analysis
- The *Wetland Reserve Program Restoration Plan* prepared by NRCS (September 2001 Draft) provided much information about the project's history, including property acquisitions, development/evolution of the interagency committee, and project objectives. The Plan also provided a useful overview of the project area.
- The *Interagency Committee's Recommendations for Design of Tidal Channels Highway Crossings Memorandum* compiled by WSDOT (December 2001) documented the committee's recommendations on the size, location, and design of the conveyance structures beneath US 101. These recommendations are presented in the alternatives analysis discussion.
- Topographic data provided by Ducks Unlimited Inc. were used to develop the grading plan prepared by Tetra Tech Inc. (November 2001). The grading plan provided an estimate of earthwork quantities, proposed locations/elevations for new tidal channels, and identified existing drainage ditches to be filled.
- Information in the juvenile salmon use evaluation and vegetation analysis sections of the *Tide Marsh Restoration and US Highway 101 Improvement Hydrologic and Hydraulic Analysis* report was used in writing the existing conditions and environmental consequences of the selected plan sections of this document.
- Historic navigation project documents were used in writing the existing conditions and environmental consequences of the selected plan sections of this document.
- A NEPA environmental assessment written by USFWS (1997) for the control of *Spartina* on the Willapa National Wildlife Refuge was used in writing the existing conditions sections, as well as in evaluating the effects of proposed *Spartina* control measures.
- The *Analysis of Potential Downstream Contamination Resulting from Dike Removal for Restoration* report prepared by Batelle Pacific Northwest Division (Diefenderfer

and Ward 2002) was used to evaluate the effects of the project on water quality in the Willapa River.

- A wetland delineation of the US 101 corridor by the WSDOT (Null 2002) was used to describe existing conditions on project site and evaluate the effects of the project on wetlands.

2 Objectives

The objective of this study is to propose and evaluate alternatives for restoring important habitat functions lost when dredged material was placed in intertidal wetlands as part of the Corps of Engineers Willapa River and Harbor Project.

2.1 Critical Resources

Willapa Bay is one of the more productive estuaries on the west coast, and the Willapa River and its adjoining habitats provide a significant contribution to this productivity. In the vicinity of the WDFW property, commercially and recreationally important species including oysters, salmon and trout, Dungeness crabs, and waterfowl are harvested by local residents and tourists. These species are dependent on specific habitat types that were historically prevalent, but have been heavily altered by development.

Estuarine habitats are critical habitats for many of these economically important species. The two primary ecological roles of Northwest estuaries are feeding and refuge (Thom 1987). The feeding role involves the production, trapping, export and cycling of energy within an estuary (Thom 1987). Vegetation biomass produced in estuaries provides the primary fuel source for the detritus-based food webs upon which many species, including juvenile salmonids, depend. As plant material decays, it supplies food for micro-organisms. Detritus, a mixture of dead plant material and living microbes, is a major food source for small invertebrates. These invertebrates are food for small fish, including juvenile salmonids and forage fish such as herring, surf smelt, anchovies, and sand lance. The target habitats for this restoration effort—salt marshes and tidal sloughs—are crucial to the feeding function because of their role in detritus production and export (Seliskar and Gallagher 1983, Simenstad 1983). Estuaries also provide refuge, offering protection from predation, and areas for resting, spawning, rearing, larval retention (Thom 1987).

Estuarine habitats are especially important for Pacific salmon and anadromous trout species. Estuaries provide juvenile salmonids with abundant prey during critical growth periods. The highest juvenile growth rates for Chinook and chum salmon have been recorded in estuaries (Simenstad et al. 1982). It is thought that one reason for the declines in some salmon runs over the past century is limited estuarine food resources during the out migration period (Simenstad et al. 1982). Productive foraging habitat allows juveniles to gain a significant amount of weight during their migration to the ocean, which is thought to improve their chances for survival once at sea (Simenstad et al. 1982, Aitkin 1998). Tidal sloughs also provide juveniles with refuge from high stream flows and predators. In addition, estuarine

habitats provide both spawning adults and out migrating juveniles transition or staging sites for the physiological shift from fresh to salt water.

2.2 Problems and Opportunities

Between the 1930s and early 1970s, material dredged from the inner Willapa River Channel below Raymond was disposed on adjacent diked wetlands. During this time, approximately 675 acres of productive intertidal and shallow subtidal habitat was affected by pipeline dredge disposal (Corps 1972). Diking and filling along the lower Willapa River resulted in destruction of vast acreage of native tidal marsh plant communities and extensive dendritic tidal slough systems. By one estimate, 99% of upper intertidal wetlands in the vicinity of South Bend were diked (Shotwell 1977, as cited by Hedgpeth and Obrebski 1981). These changes have reduced the capacity of the project area to support species that were historically abundant.

NRCS has acquired conservation easements on the project site. WDFW followed that action by acquiring the underlying fee title to the site. The acquisition of diked lands by WDFW and NRCS provides an important opportunity to restore key hydrologic processes in the Willapa River estuary at a significant scale. Re-establishing functional connections between the river and its floodplain provides a mechanism to increase both primary and secondary productivity at and downstream of the property. Since restoring tidal hydrology to the WDFW property would re-create habitat types that support the base of the food chain (e.g., dissolved organic and particulate carbon, vegetation detritus, and benthic/epibenthic invertebrates), project benefits would be realized throughout the entire trophic structure. Re-establishing hydrologic connectivity would also facilitate nutrient exchange between productive intertidal marshes and Willapa Bay. By restoring these natural energy flow processes, the project area would be better able support critical life stages of a variety of species, particularly salmonids.

2.3 Project Purpose and Need

During the late 1960s and early 1970s, the Corps disposed of dredged material in diked intertidal mudflat and wetland habitat adjacent to the Willapa River Navigation Channel. As a result, several hundred acres of productive estuarine habitat were lost. This reduction in the area and diversity of estuarine habitats has impacted Willapa Bay's capacity to support the variety of fish, bird, and crustacean species that were historically abundant. The purpose of this proposed Willapa River 1135 habitat restoration project is to partially offset the loss of intertidal estuarine habitat caused by past Corps disposal practices.

2.4 Project Planning Criteria

The project planning criteria have been developed by the interagency project team to measure the potential success of the plans considered. A successful plan will meet as many of the criteria as is reasonable, to the extent that is most justified. The extent to which any of the criteria will be met is subject to the determination of the incremental analysis.

2.4.1 General Criteria

The inter-agency project team has established the following project objectives:

- Restore tidal inundation and processes to an estuarine area that has been diked for the past 90 years.
- Restore native tidal marsh and associated plant communities.
- Restore off-channel rearing and refuge habitat for Chinook, chum, and coho salmon, as well as cutthroat trout and other native fish species.
- Provide habitat for migratory birds that utilize the estuary.

2.4.2 Technical Criteria

The following technical criteria will be used to evaluate the proposed restoration alternatives. These criteria are primarily hydrologic since the restoration of natural tidal hydrology is the means by which the project goals will be achieved.

- Create wetting of all, or nearly all, of the WDFW property under the mean higher high water (MHHW) tide elevation.
- Provide adequate circulation of tidal waters to all parts of the marsh on both ebb and flood tides.
- Promote drainage of tidal waters off of the restored marsh plane to minimize the potential for fish stranding and adverse water quality impacts.
- Improve the quality of salmon habitat in the project vicinity through re-establishment of subtidal and intertidal channels, and increasing the total length of such channels.
- Limit flow velocities through hydraulic openings in the US 101 roadway that passes through the project area.
- Minimize the risk of flooding of the US 101 roadway through the project area.
- Allow for restoration of long-term sediment deposition and transport processes.

2.4.3 Social Criteria

The inter-agency project team established the following social criteria:

- Provide public access for educational opportunities and wildlife-oriented recreation.
- Provide a safe highway pull-off with interpretive materials.

3 Historic Conditions

Prior to 1850, the Willapa River was a flat, meandering river with an estuary containing over 4,200 acres of marsh lands (Shotwell 1977, as cited by Hedgpeth and Obrebski 1981). The lower Willapa River had a broad floodplain with a complex of mudflat, tidal marsh, and slough habitats along the river's margins. The main channels were largely unvegetated mudflats and sand flats. Patches of eelgrass (*Zostera marina*) may have been present in the more saline areas. Extensive marsh communities, vegetated by low marsh species such as saltgrass (*Distichlis spicata*), seaside arrowgrass (*Triglochin maritimum*), Lyngby's sedge (*Carex lyngbyei*), and pickleweed (*Salicornia virginica*), as well as high marsh species like tufted hairgrass (*Deschampsia cespitosa*), Baltic rush (*Juncus balticus*), Pacific silverweed (*Potentilla pacifica*), and red fescue (*Festuca rubra*), would have been present because of the range of substrate types and current energies common in the lower river reaches.

The historic Willapa River estuary was a detrital-based system which provided significant habitat and food for both terrestrial and marine organisms. Tidal action transported decomposed plant matter, or detritus, from the river's fringing marshes to adjacent sloughs, tide flats, and Willapa Bay. The export of dissolved organic carbon, particulate organic carbon, and dissolved nutrients in the detritus drove primary and secondary productivity in the estuary. The salt marsh, slough and tide flat habitats were prime salmon rearing areas because they converted carbon inputs from upland and freshwater sources into forms usable to salmon (e.g., the crustacean populations on which juvenile salmon feed). Juvenile chum (*Oncorhynchus keta*) and Chinook (*O. tshawytscha*) salmon frequently foraged in sand flat and marsh areas. Large populations of other fish species (sculpins and sole), shorebirds (dunlin, sandpiper and yellowlegs), waterfowl (pintail, widgeon, mallard), and shellfish (oysters, clams, crab) were also supported by this highly productive system.

3.1 Willapa River and Harbor Navigation Project

Willapa Bay, a biologically productive deep water harbor surrounded by Pacific coastal forests, began to develop into an important commercial center for shipping timber, fish, and oysters during the latter portion of the 19th century. Congress first ordered the Corps of Engineers to investigate navigation improvements to the Willapa River in 1884, and authorized the first Federal navigation improvements under the Rivers and Harbors Act of 1892. By 1916, subsequent River and Harbor Acts had given the Corps the authority to dredge a deeper and longer navigation channel up the Willapa River, to close dikes along the river, and to clear snags and other debris along the bay's tributary streams. By 1954, a channel across the bar at the mouth of Willapa Bay and small boat basins at various locations in the bay had also been authorized. Ultimately, the navigation project would include over 26 miles of deep-draft navigation channel from the entrance to Willapa Bay through the forks of the Willapa River at Raymond.

During the 1970s, there was a reduction in lumber exports from Port of Willapa Harbor facilities and a recognition that dredged material disposal activities were detrimental to biological productivity in Willapa Bay (Corps 1975). The Corps determined that annual

maintenance dredging was not economically justified, and the Willapa River Channel was classified as inactive in 1977.

Between the 1930s and 1977, when maintenance dredging of the Willapa River Channel ceased, material dredged from the inner Willapa River Channel below Raymond was disposed on adjacent diked wetlands. During this time, approximately 675 acres of productive intertidal and shallow subtidal habitat was affected by pipeline dredge disposal (Corps 1972). Most of the Corps' disposal sites were in the vicinity of South Bend and Raymond, which are just upstream of the project area.

Dredging of the navigation channel, construction of levees, and deposition of dredged material into adjacent marshlands interrupted the flow of the river and diminished nutrient export from the marshes to adjoining habitats such as mudflats. Intertidal sloughs that were once refuge and feeding areas for fish, shorebirds, and waterfowl were lost. By one estimate, 99% of upper intertidal wetlands in the vicinity of South Bend were diked (Shotwell 1977, as cited by Hedgpeth and Obrebski 1981). Not only was significant acreage eliminated, but the continuity of estuary's interspersed habitats became fragmented.

3.2 US 101

US 101 bisects the WDFW property, and in its current configuration would block the movement of tidal waters to the inland side of the roadway and drainage of upland runoff to the river. The WDFW property consists of approximately 284 acres located on the river (northwestern) side of the highway, and about 114 acres on the inland (southeastern) side of the highway. The existing drainage structures through the highway are undersized. They would need to be replaced with much larger water conveyance structure(s) to permit tidal flushing of the inland 114 acres at velocities passable by fish.

As a part of this project, WSDOT is planning to raise the portion of US 101 on the project site in order to prevent the highway from flooding once the dike is removed. In addition, NRCS is planning to fund WSDOT to construct a bridge to allow for conveyance of tidal flows through the road embankment. WSDOT is currently proceeding with design and permit effort for the roadway work, and has budgeted for the construction. NRCS has also budgeted the funds for the bridge construction.

4 Existing Conditions

4.1 Physical Characteristics

4.1.1 Geology

The Willapa Basin is characterized by low hills with steep topography and large lowland floodplains. Floodplains of the lower Willapa River have low, even topography. These characteristics have resulted in extensive diking and agricultural development of floodplain

areas along the lower river reaches. In the low elevation portions of the floodplains, winding sloughs form the only noticeable topographic relief. These sloughs, ranging in width from less that 1 foot to 100 feet, often have no freshwater source and are filled and emptied only by the tide. The sloughs generally have one steep, eroding bank and a shallow accreting bank, and are continually changing in form as the channel is realigned.

Lowland areas which immediately flank the northern, eastern, and southern parts of Willapa Bay are formed on Pleistocene marine terraces composed of sand, silt, and clay. Soils of the Ocosta Association are common in the lower floodplains of the major rivers flowing into Willapa Bay. According to the Pacific County Soil Survey, soils of the WDFW property are comprised primarily of Ocosta silty clay loam, which form in clayey alluvium near coastal bays. This poorly drained soil has a silty clay loam surface layer with the percentage of clay increasing with soil depth. This Ocosta soil is very deep, and has a high water table for most of the winter and spring months.

4.1.2 Hydrology, Hydraulics, Geomorphology

The hydrology, hydraulics, geomorphology, and flooding of the project area are dominated by tidal conditions. The project site consists of diked pasture lands used for cattle grazing, remnant tidal sloughs, and drainage/borrow ditches. Currently the project area is protected from daily tidal inundation by a levee that runs along the left bank of the Willapa River. However, during times in the rainy season, standing water is present on the much of the site. A tide gate located on the southeast property boundary discharges into Potter Slough.

US 101 bisects the site into two areas. There is no significant hydraulic connection through the road fill. The area between US 101 and the levee is drained to the river by a large remaining slough and tide gate. The area between US 101 and the hillside to the west is drained to the southeast by a large ditch and tidegate to Potter Slough.

The mean semi-diurnal tide is 9.4 feet (PWA 2001). When the tide and/or waves exceed 12 feet in elevation, most of the length of US 101 through the project site will be flooded if the existing levee is breached or removed as planned. The 100-year flood elevation for the site is +14.52 feet (NAVD88 datum), and WSDOT is planning to raise US 101 to +15.5 feet through the project site.

Potter Slough flows through a relatively undisturbed marsh to the southeast of the WDFW property. This site is used as the reference condition for predictions about the form and pattern of the tidal channel network and marsh that will form once tidal action is restored to the project area. Philip Williams & Associates, Ltd. (PWA), in association with Herrera Environmental Consultants and WSDOT, performed the hydrologic, hydraulic, and geomorphic investigations for this project.

Channels in the Potter Slough reference marsh typically have straight-sided clay banks. In contrast, remnant channels in the pasture land are characterized by lower-banked, wider, and shallower channel forms.

4.1.3 Water Quality

Willapa Bay is commonly described as one of the least spoiled and most productive estuaries remaining in the contiguous 48 states. However, portions of the lower Willapa River have been placed on the Washington 303(d) list for high summer temperatures and low dissolved oxygen.

The Washington State Department of Health, Office of Food Safety and Shellfish Programs (DOH) certifies and monitors commercial shellfish harvest areas. DOH classifies areas as "approved," "conditionally approved," "restricted," or "prohibited" based upon a combination of water quality and pollution source information. The water quality standard DOH uses is based upon the presence of fecal coliform bacteria. DOH uses a two-part standard based on a minimum of 30 samples from each monitoring station in a shellfish area (Diefenderfer and Ward 2002). Part one of the standard states that the geometric mean of the sample set cannot exceed 14 fecal coliforms (fc) per 100 mL. Part two of the standard states that the estimated 90^{th} percentile of the sample set cannot exceed 43 fc/100 mL. A minimum of six samples per year are collected from each station in Willapa Bay.

The portion of Willapa Bay near the mouth of the Willapa River carries both "approved" and "prohibited" classifications. The DOH sanitary line separating the "approved" and "prohibited" areas is approximately 2.9 miles downstream from the mouth of Potter Slough (Diefenderfer and Ward 2002). The "prohibited" classification is based on a combination of poor water quality and the existence of active point and non-point pollution sources. Point sources impacting the area are the sewage treatment plant outfalls in the Willapa River near Raymond and South Bend. Non-point sources are watershed-wide and include farm animal wastes, storm water, septic systems, and wildlife (Diefenderfer and Ward 2002).

The WDOH sampled 6 stations on the project site and 2 stations in the Willapa River adjacent to the project site for total coliform bacteria in January and May 2002 (Diefenderfer and Ward 2002). Coliform levels in the January samples ranged from 2 – 170 fecal coliforms (fc)/100 mL, with both river samples containing 49 fc/100 mL. Coliform levels in the May samples ranged from 11 – 240 fecal coliforms (fc)/100 mL, with both river samples containing 1.7 fc/100 mL. Two re-suspended sediment samples collected during the May sampling trip contained 49 and 920 fc/100 mL.

4.1.4 Air Quality

There are no major industrial sources of air pollution around Willapa Bay. The predominant onshore winds and winter storms assure an almost constant replenishment of clean, fresh air from the Pacific Ocean. Temperature inversions that might trap smoke or other pollutants are rare.

4.1.5 Hazardous and Toxic Wastes

Past chemical applications on the WDFW property were typical of livestock and residential uses. Herbicides were applied on the pasture soils, and may have also been applied for right-

of-way maintenance along the highway, on the dike, and on the 1998 clear-cut above the project site. Insecticides may have been applied along road ditches prior to the 1970s.

As part of a site investigation funded by NRCS and Ducks Unlimited, Batelle sampled and tested 22 sediment and water stations, 12 soil herbicide stations, and 15 soils and lead shot stations for a variety of contaminants (Diefenderfer and Ward 2002). The sampling stations represent all parts of the project site, including observed potential hotspots. Chemical analyses for the following parameters of concern were conducted: total petroleum hydrocarbons, organ chlorine pesticides, chlorinated herbicides, total sulfides, total organic carbon, nutrients (nitrate, nitrite, ammonia, orthophosphate, total phosphate, total Kjeldahl nitrogen), fecal coliform bacteria, and lead shot.

Diesel-range and residual-range hydrocarbons were not detected or were detected below the method reporting limit in all sediment and samples. Pesticides were not detected or were detected below the method reporting limit in all samples but one soil sample, where 4,4'-DDT and methoxychlor were detected. This station is located inland of one of the proposed cross dikes. Herbicides were detected in only one soil sample, taken at a station located on the dike above the tide gate in the southeastern portion of the property, as well as one sediment sample. No shotgun pellets were present in any of the 15 samples collected in areas of waterfowl hunting.

As part of WDFW demolition work on the property, contractors pulled creosote-coated wood pilings out of the ground at a former cattle feed lot site. A subsequent visual investigation of this area found no creosote at the surface, but was unable to rule out the presence of creosote below ground.

Corps staff has prepared a preliminary assessment screening for the project site. A site visit was performed as part of the preliminary assessment screening on September 20, 2002. The only contamination found is creosote remaining from pile removal at the former feed lot. Also, WDFW indicated that there are two small spot spills of oil and hydraulic fluid from equipment used to remove the Graves barn in January 2001, but no such contamination was found during the site visit.

4.2 Natural Resources

4.2.1 Vegetation

The existing vegetation on the WDFW property is primarily introduced and native pasture grasses (*Agrostis* spp.) with intermixed rushes (*Juncus effusus, J. balticus, Scirpus microcarpus*), and sedges (*Carex obnupta*). Stands of cattail (*Typha* spp.) and horsetail (*Equisetum* spp.) are present in the borrow ditch along US 101, and cattail is present in low-lying areas landward of the highway. Blackberry (*Rubus* spp.) covers much of the dike and also lines some portions of the borrow ditches and many of the channels crossing the site. Willow (*Salix* spp.) is present in scattered clumps as well.

Wetlands. A January 2002 wetland determination by NRCS designated 337 acres of the WDFW property as prior converted cropland and 60 acres, primarily remnant tidal sloughs now serving as drainage ditches, as wetland. Only 6 acres of the site, located in the south east corner landward of US 101, were designated as non-wetland.

WSDOT identified six wetland areas along the US 101 corridor in a March 2002 wetland delineation (Null 2002). Each wetland was classified according to the USFWS system (Cowardin et al., 1979), rated by category according to the Washington State Department of Ecology rating system (Ecology 19983), and rated by classes according to the Pacific County Critical Areas Ordinance, which is very similar to Ecology's system. A summary of estimated wetland acreages and their corresponding classifications can be found in Table 1. below. Several principal functions of these wetlands were identified by WSDOT, including: habitat for wetland-associated birds, habitat for amphibians, organic matter production and export, and flood flow alteration.

Table 1. Delineated Wetlands on the Project Site

	Estimated Acreage	Cowardin Class	Ecology Rating	Pacific Co. Rating
Wetland A	100+ acres	Palustrine Aquatic Bed/ Emergent/Scrub-Shrub	Category II	Class II
Wetland B	~ 1 acre	Palustrine Emergent	Category III	Class III
Wetland C	0.5 – 1 acre	Palustrine Emergent	Category III	Class III
Wetland D	20+ acres	Palustrine Emergent/Scrub-Shrub	Category III	Class III
Wetland E	100+ acres	Palustrine Emergent/Scrub-Shrub/Forested	Category II	Class II
Wetland F	200+ acres	Palustrine Emergent/Scrub-Shrub	Category II	Class II

Source: March 2002 WSDOT wetland delineation (Null 2002).

Approximately 40 acres of high salt marsh (Estuarine Emergent, Category I wetlands) are present on the river side of the dike along the downstream portion of the site. This area is labeled "undiked tidal wetland" on Figures 2 and 10 in Appendix A.

Exotic Species. *Spartina alterniflora* is a perennial, deep-rooted salt marsh species native to the Atlantic and Gulf coasts of North America. It was introduced to the West Coast during the 1890s as a result of its use as packing material for oyster shipments from the East Coast (Frenkel and Kunze 1984). *Spartina* is spreading rapidly over the tidelands of Willapa Bay, and it is degrading habitats that support a diverse community of estuarine organisms, including aquatic migratory birds, anadromous fish, and the invertebrate and plant communities which support them.

Widespread colonization by *Spartina* induces major modifications of physical, hydrological, chemical, and biological estuarine functions. *Spartina* displaces eelgrass (*Zostera spp.*) on mudflats and native vegetation in salt marshes. Benthic invertebrate species composition in the intertidal zone changes substantially as *Spartina* occupies the tidelands (Zipperer 1996, Norman and Patton 1995 as cited by USFWS 1997). As *Spartina* becomes dominant,

mudflats are raised and channels are deepened. This in turn eliminates the gently sloping bare intertidal zone that lies between the salt marsh and the tidal channels (Aberle 1993).

The *Spartina* invasion in Willapa Bay is the largest in Washington. There is a 5 acre *Spartina* meadow directly outside of the dike at the downstream end of the WDFW property, and a larger meadow on the opposite side of the river. The meadow adjacent to the project site was sprayed with herbicides by a WDFW crew, as part of an on-going Washington State *Spartina* control program, during the summer of 2002. Some patches in the meadow on the other bank of the Willapa River were also sprayed in summer 2002. Follow-up treatments are expected to occur during the summer of 2003.

Potter Slough Reference Site. A natural tide marsh and slough complex is located southeast of the restoration site (see Figure 2). This marsh has not been diked, and is in excellent biological condition, so it has been used as a reference area during this study.

A WSDOT survey crew and an estuarine ecologist from the Battelle Marine Sciences Laboratory surveyed the Potter Slough reference area at multiple discrete locations to delineate the upper and lower elevation limits of dominant salt marsh plant species (Herrera Environmental Consultants 2002). Native salt marsh vegetation in the reference marsh was distributed along an elevation gradient from approximately +4 feet to +10 feet (NAVD 88 datum). Some general zonation patterns were evident, with *Carex lyngbyei* dominating at the lower end of this range (+4 to +8 feet) and *Distichlis spicata* at the upper end (+7 to +10 feet). *Distichlis* was mixed with *Deschampsia caespitosa*, at the upper elevations. *Carex* was most often encountered at the edge of marsh channels adjacent to Potter Slough, an area that likely receives relatively large salinity variations from local runoff to the slough. Unvegetated mudflat occurred between +4 feet and +6 feet. *Spartina alterniflora* was located along the river edge at the lower elevation ranges (approximately +6 feet).

4.2.2 Wildlife

A query of the WDFW Priority Habitats and Species database indicates that the project site is designated as wood duck habitat, and a waterfowl concentration area. Marsh hawks (*Circus cyaneus*), osprey (*Pandion haliaetus*), and great blue herons (*Ardea herodias*) are commonly seen hunting on the WDFW property. The pasture grass is thick with vole burrows, and deer trails are often observed. Coyote (*Canis latrans*) scat and elk (*Cervus elaphus*) droppings have also been found on the property.

The Willapa River estuary provides habitat for wintering and migrating shorebirds, which feed on mudflats and roost in marshes and pastures along the river. Dominant species are the Western sandpiper (*Calidris mauri*) and short-billed dowitcher (*Limnodromus griseus*) in the spring, and dunlin (*Calidris alpina*) during the winter (Cullinan 2001).

The Pacific Coast Joint Venture Strategic Plan, Washington State Component (USFWS 1992) identified many habitats within the Willapa Bay area as key to the long-term health and viability of waterfowl and waterfowl habitat. The mudflats in the Willapa Bay contain submerged aquatic vegetation, such as beds of eelgrass (*Zostera* spp.), that provide forage for

many species, including black brant (*Branta bernicla*) and American widgeon (*Anas americana*). Hundreds of thousands of waterfowl use Willapa Bay habitats, including, pintail (*Anas acuta*), mallard (*Anas platyrhynchos*), scaup (*Aythya spp.*), scoters (*Melanitta spp.*), and canvasback (*Aythya valisineria*).

Waterfowl utilize Washington's coastal bays primarily during migration. American wigeon account for 80% of puddle ducks migrating through Gray Harbor and Willapa Bay. Wigeon are the most abundant dabbling duck in the bay, with fall counts peaking at 30,000 birds. Northern pintail are the second most abundant dabbling duck during the fall with about 15,000 using the area at that time. Mallard are common during all times of the year. Large numbers of green-winged teal (*Anas crecca*), common goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), and red-breasted merganser (*Mergus serrator*) will use the area during migration and wintering periods. A fair number of canvasback, northern shoveler (*Anas clypeata*), ruddy duck (*Oxyura jamaicensis*), ring-necked duck (*Aythya collaris*) and gadwall (*Anas strepera*) use the area during migration and wintering periods. A fair number of wood duck (*Aix sponsa*) use the area as breeding habitat and during migration periods.

About 90,000 scoters are counted annually during midwinter surveys by the USFWS, with over half occurring in western Washington. Canada geese are the most numerous along Willapa Bay with a resident population of 900 – 1000 birds. Another significant movement of geese through the region is by black brant. Willapa Bay is one of the most important wintering and spring staging areas for brant on the West Coast. Approximately 12,000 birds use the are as spring staging habitat while 2,500 birds are present during the winter months.

Green winged teal prefer to forage on mudflats where they find seeds and small invertebrates. Wigeon feed more on vegetative parts of aquatic plants, compared to other dabbling ducks, and commonly feed on submerged aquatic vegetation such as eelgrass. Gadwall, pintail, and canvasback also use estuaries and feed on submerged aquatic vegetation. Northern shoveler can be found in shallow water along the shores of estuaries, especially where freshwater inflows enter the estuary. Their diet is heavily dominated by animal material. Scaup forage primarily on animal material including small fish, mollusks, and snails. Buffleheads commonly feed on fish, amphipods, isopods, shrimp, and mollusks in estuarine environments during the winter.

Currently the project area is grazed wet pasture habitat, and consists of palustrine emergent/scrub shrub wetlands along with drainage ditches and borrow areas which retain freshwater. During the rainy season, standing water is probably present on the majority of the site. A variety of waterfowl will use this type of habitat including American wigeon, pintail, mallard, green winged teal, and Canada geese.

4.2.3 Fisheries

The restoration of estuarine habitats is essential for the conservation and recovery of depressed Pacific salmon populations (Simenstad and Cordell 2000). All juvenile salmon move through estuaries during their out migration to the sea, and may be found in both

shallow sublittoral or neritic habitats throughout the year depending on species, stock, and life history stage. Shallow estuarine habitats are structurally complex (e.g., they have submerged aquatic vegetation and large woody debris), highly productive, and dynamic. As such, they are critical areas for juvenile salmonids because they provide food, refuge from predators, and a transition zone to physiologically adapt to salt water existence (Simenstad and Cordell 2000). Juvenile chum (*Oncorhynchus keta*) and Chinook salmon (*O. tshawytscha*) are considered the most estuarine-dependent salmon species, feeding and rearing in these habitats for extended periods before migrating to pelagic marine habitats. The bulk of juvenile chum and ocean-type Chinook salmon out migration occurs in the spring (March through May), and juveniles may spend days to months in estuarine habitats depending on rearing conditions. Chum salmon fry migrate seaward almost immediately after hatching, and enter the estuary at a relatively small size (30-55 mm), while Chinook fry may migrate seaward either soon after yolk resorption (30-45 mm), as fry 60 to 150 days post-hatching, or as fingerlings. Both species prefer relatively fine-grained substrate and low stream gradients, and are oriented to shallow water habitats located close to shore.

Although no study has thoroughly documented patterns and rates of juvenile salmon migration through the Willapa Estuary, out migration periods likely parallel those observed during an extensive study conducted in Grays Harbor, Washington during March – October, 1980 (Prinslow et al. 1981). In that study, juvenile chum salmon migrated first, probably beginning in January, reached greatest abundance in March and April, and departed the estuary in early May. Juvenile coho (age 1) and fall Chinook (age 0+) both entered the estuary in mid-April. Coho out migration reached a maximum abundance in May and terminated in June. Chinook out migration did not reach a maximum until June, with a portion of the population (type III fish) appearing to remain within the estuary through October, while the remainder (type II fish) migrated out of the estuary. Steelhead out migrants entered the estuary in May and had completed their migration through the estuary by July. Several age 1+ cutthroat trout (150 – 200 mm fork length) were also collected in the estuary over the course of the study.

In spring of 2000, fish surveys were conducted on the portion of the property inland of US 101 (Dave Kloempken, WDFW, pers. comm.). The presence/absence of fish was determined by electroshocking. Seven drainage locations were surveyed and electroshocked, where there was sufficient water. No fish were found on any of the surveys.

4.3 Threatened and Endangered Species

The types of habitat degradation described in previous sections have led to population declines of many fish and wildlife species. Some of these species have been listed as threatened pursuant to the Federal Endangered Species Act. Based upon correspondence with the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), four listed species potentially occur in the project vicinity: bald eagle (*Haliaeetus leucocephalus*), marbled murrelet (*Brachyramphus marmoratus*), Northern spotted owl (*Strix occidentalis*), and Steller sea lion (*Eumetopias jubatus*).

No salmonid populations in Willapa drainages are currently protected by the Act. When this study was initiated, coastal cutthroat trout (*Oncorhynchus clarki clarki*) had been proposed for listing by USFWS. Subsequently, USFWS has determined that coastal cutthroat trout are not warranted for listing under the Act

Below are brief descriptions of the life histories and occurrence of these protected species in the project area. Projected impacts of the proposed projects on threatened and endangered species are addressed briefly in Section 8.3, while a more in-depth review is being prepared in a separate Biological Evaluation, which will be submitted to USFWS and NMFS.

4.3.1 Bald Eagle

The Washington State bald eagle population was listed as threatened under the Endangered Species Act in February 1978. Since DDT was banned in 1972, bald eagle populations have rebounded. The bald eagle was proposed for de-listing in July 1999.

USFWS has indicated that wintering bald eagles may occur in the vicinity of the project. The bald eagle wintering season extends from October 31 through March 31. Food is recognized as the essential habitat requirement affecting winter numbers and distribution of bald eagles (Steenhof 1978). Other wintering habitat considerations are communal night roosts and perches. Generally large, tall, and decadent stands of trees on slopes with northerly exposures are used for roosting; eagles tend to roost in older trees with broken crowns and open branching. Bald eagles select perches on the basis of exposure, and proximity to food sources. Trees are preferred over other types of perches, which may include pilings, fence posts, power line poles, the ground, rock outcrops, and logs (Steenhof 1978).

A query of the WDFW Priority Habitats and Species database indicates that there is a bald eagle nest about 1.5 mile from the project area.

4.3.2 Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) was listed as a threatened species under the Endangered Species Act in October 1992. Primary causes of population decline include the loss of nesting habitat, and direct mortality from gillnet fisheries and oil spills.

Marbled murrelets forage in the near-shore marine environment and nest in inland old-growth coniferous forests. USFWS has indicated that foraging marbled murrelets may occur in waters adjacent to the proposed project. Murrelets often aggregate near localized food sources, resulting in a clumped distribution. Prey species include herring, sand lance, anchovy, osmerids, seaperch, sardines, rockfish, capelin, smelt, as well as euphasiids, mysids, and gammarid amphipods. Marbled murrelets also aggregate, loaf, preen, and exhibit wing-stretching behaviors on the water.

Although marine habitat is critical to marbled murrelet survival, USFWS's primary concern with respect to declining marbled murrelet populations is loss of terrestrial nesting habitat.

Critical habitat was designated for the marbled murrelet in May 1996. The critical habitat designation included only terrestrial nesting habitat. A query of the WDFW Priority Habitats and Species database indicates that there have been marbled murrelet sightings in potential nesting habitat approximately 3 miles and approximately 6 miles south-southeast of the project site. In the marine environment, USFWS is primarily concerned with direct mortality from gillnets and spills of oil and other pollutants.

Regional patterns of marbled murrelet activity in marine waters tend to be seasonal, and are tied to exposure to winter storm activity (Speich and Wahl 1995). Murrelets are often found in specific areas (e.g., Hood Canal, Rosario Strait/San Juans), as foraging distribution is closely linked to tidal patterns. However, occurrences are highly variable as they move from one area to another often in short periods of time. The southern portion of Washington state does not seem to be as important to murrelets during the breeding season (April 1 – September 15) as does the northern part of the outer coast (Varoujean and Williams 1995). However, based on data from Grays Harbor, it is thought that the southern coast may play an important role as a wintering area (Varoujean and Williams 1995).

4.3.3 Northern Spotted Owl

The northern spotted owl (*Strix occidentalis caurina*) was federally listed as a threatened species throughout its range in June 1990. The primary reason for this listing was the reduction and fragmentation of habitat that was projected to continue under the forest practices utilized at the time of listing.

The northern spotted owl nests in tree cavities, on debris platforms, and in the old nests of other large birds. In Washington, nesting occurs between March 1 and July 31, and fledging occurs between August 1 and September 30. Dispersal of juvenile owls begins in the early fall. Usually juveniles move from their natal area to a breeding site, and occasionally adults move from one breeding site to another.

Spotted owls prey on a broad array of species, such as insects, birds, and small mammals; however, primary prey items are wood rats (*Neotoma fuscipes* and *N. cinerea*) and flying squirrels. Although spotted owls are nocturnal, during the day they forage opportunistically and may move short distances to change roosting position in response to changes in ambient temperature or exposure to direct sunlight.

In Washington, the northern spotted owl occurs on the Olympic Peninsula, in the western lowlands, and in the Cascades, generally below elevations of 4200 feet. A query of the WDFW Priority Habitats and Species database indicates that there are nesting areas approximately 3.7 miles south-southeast of the project site and 8 miles southeast of the project site.

4.3.4 Steller Sea Lion

The Steller sea lion was listed as a threatened species under the Endangered Species Act in November 1990. In 1997, the North Pacific's population of Steller sea lions was separated

into two distinct stocks, one of which was reclassified as endangered. The status of the eastern stock, which includes the population inhabiting the waters of the Washington coast, remains unchanged. In 1993, NMFS designated critical habitat for the Steller sea lion. No designated critical habitat occurs in Washington.

Two types of terrestrial habitats are utilized by Steller sea lions: rookeries are areas where adults congregate for breeding and pupping, and haul-outs are areas used for rest and socializing. Sites used as rookeries during the breeding season may be used as haul-outs during the remainder of the year. Steller sea lions haul-out on offshore islands, reefs, and rocks, while rookeries generally occur on beaches. Preferred rookeries and haul-out areas are located in relatively remote areas where access by humans and mammalian predators is difficult. Locations are specific and change little from year to year.

When not on land Steller sea lions are generally seen inshore, less than 5 miles from the coast. Steller sea lion foraging patterns vary depending upon age, season, and reproductive status, as well as the distribution and availability of prey. Foraging patterns of females during the winter months vary considerably; individuals travel an average of 440 feet and dive an average of 5.3 hours per day. The diet of Washington's Steller sea lions is not well known; primary prey items may include cod, pollock, rockfishes, herring, and smelt. They appear to be largely opportunistic feeders.

Steller sea lions may be observed along the Washington coast year round, but they are most abundant during March-April and August-November, and least abundant during breeding season in May-July (Gearin and Jeffries 1996). No breeding rookeries have been identified in Washington waters. The majority of Washington's Steller sea lion haul-out sites are located along the northern outer coast. Willapa Bay has several documented haul-out areas used regularly by harbor seals, but there is no documentation that these sites are used by Steller sea lions (Jeffries et al. 2000).

4.4 Cultural Resources

A professional cultural resources reconnaissance survey was conducted for the proposed project. The survey consisted of an examination of the archaeological and historic site records at the Washington State Office of Archaeology and Historic Preservation (OAHP) and a pedestrian survey of the project area. The records search indicated that no properties listed on the National Register of Historic Places (NRHP) and no sites or structures listed on the state inventory are located within the proposed project area. Background research indicated that a historic-period Native village was located near the mouth of the Willapa River, but outside of the proposed project area. The pedestrian survey sampled a small portion of the project area and did not find any evidence of prehistoric or historic-period cultural material. The project area at the time of the survey was densely overgrown with waist-high grass, resulting in limited ground surface exposures.

4.5 Socio-Economic Resources

4.5.1 Land and Shoreline Use

Within the 600,000-acre Willapa Basin, approximately 78% of land is in timber production (Willapa Alliance 1998, as cited by WSCC 1999). Less than 3% of this timberland is in permanent conservation, and only a small fraction is old growth timber. The remainder of the basin consists of estuary/wetland (12%), agriculture (6%), and residential uses (4%) These percentages have remained essentially unchanged since 1950 (Willapa Alliance 1998, as cited by WSCC 1999). Many of the rural lands along the Willapa River are used for raising cattle and other livestock.

Historic uses of the project property have included cattle grazing, human residence, and waterfowl hunting. Livestock, primarily dairy cattle, had year-round access to pasturelands. All remaining livestock was removed from the WDFW property in 2001. Structures on the site included homes and carports, barn and shop buildings, open-sided cattle sheds, pump houses, and fences. Human waste was disposed of via four septic systems. Three of these septic systems have been pumped out and removed; the site of the fourth is expected to be filled and capped with asphalt for a highway pull-out. The remaining structures were demolished by WDFW in 2002.

4.5.2 Economy

Major industries in Pacific County include tourism, logging, lumber manufacturing, oyster harvesting, seafood canning, crabbing, commercial and sport fishing, dairy farming, and cranberry production. In 1990, the County's economy was more dependent on employment in forestry, fisheries, manufacturing, and personal services than Washington state as a whole (Cook and Jordan 1994). Employment in distributive, social, and producer services was under-represented in Pacific County by comparison.

Many farms along the Willapa basin's river valleys raise beef and dairy cattle, with related production of hay, silage, and calves. During the 1990's, beef cattle production in Pacific County declined while numbers of dairy cattle slowly increased (Willapa Alliance, n.d.). Changing markets, the cyclical nature of worldwide beef prices, an oversupply of milk, waste management restrictions, and rising property prices have lead to a consolidation of the number of cattle farms. In Pacific County, this trend has resulted in fewer farms with more head of cattle per farm, and operations which import more feed and silage than in the past (Willapa Alliance, n.d.).

Many of the private tidal flats in the bay are managed as oyster mariculture sites. Pacific and neighboring Grays Harbor counties are home for two-thirds of the oyster industry in Washington (Conway 1991, as cited by USFWS 1997). Washington Department of Fish and Wildlife reported a five-year average of 462,000 gallons of Pacific oysters harvested in Pacific County (Hoines 1996, as cited by USFWS 1997). In Pacific County, the oyster growing and processing industry employed 480 workers with a total labor income of $6.3

million, accounting for one out of every twelve jobs in 1990 (Conway 1991, as cited by USFWS 1997).

4.5.3 Recreation

There are two museums, 10 historic sites, and 20 parks or other recreational facilities in Pacific County, including Willapa National Wildlife Refuge; Fort Canby, Fort Columbia and Leadbetter State Parks; and Bush Pioneer and Bruceport County parks.

Recreational uses of Willapa Bay include motor-boating, kayaking, canoeing, sailing, hunting, fishing, clamming, wildlife viewing, and camping. Due to shallow water depths, large tidal ranges, swift currents, frequent high winds, and unpredictable weather patterns in the bay, all forms of boating are limited both spatially and temporally. Most boating occurs at higher tidal stages. Within the bay, recreational clamming is limited to public lands with firm sandy substrates, primarily along the west shore of Long Island.

4.5.4 Mosquitoes

Over 25,000 lineal feet of ditches with very limited circulation are present on the project site. As a result, the project site supports large numbers of freshwater mosquitoes. Tide gates prevent fish, which prey on mosquito larvae, from entering the ditches.

4.5.5 Transportation, Public Services, and Utilities

State highways provide primary access to many parts of Pacific County. One of the most vital connections is US 101, which runs through the project area. The portion of US 101 which runs through the project site has 11 foot wide lanes and variable-width shoulders (between 3 feet and 8 feet, with a 4 foot average). Current average daily traffic is 3,600 vehicles; 13% of this total is composed of truck traffic.

The Willapa Harbor Airport is located on the right bank of the Willapa River across from the project site.

The only utilities on the project site are those along US 101. Pacific County Public Utilities District #2 has an aerial 12.5kv 4-wire line at approximately 40 feet left of the highway centerline. Century Telephone Company has a buried 25 &106x cable at approximately 39-40 feet left of centerline. These utilities will be relocated within the highway right-of-way by WSDOT as part of raising the highway.

4.5.6 Aesthetics and Noise

The WDFW property is visible from US 101. Since purchasing the property, WDFW has demolished several houses and auxiliary structures. A broad, flat expanse of pasture grasses with very few trees characterize the landscape on the river side of the highway. The landward boundary of the WDFW property is a steep hillside in timber production. Timber

in portions of this area was harvested during the summers of 1998 and 2001. A variable-width forested buffer remains adjacent to the bottomland.

Vehicle traffic on US 101 is the main source of noise at the project site. Boat traffic along the river and airplane traffic associated with an airport across the river from the WDFW property also contribute to ambient noise levels.

5 Future Without-Project Conditions

In its current state, the freshwater wetlands on the project site do provide habitat for wetland-associated birds, habitat for amphibians, limited organic matter production/export, and flood flow alteration (Null 2002). While freshwater wetlands are important along river floodplains, the habitat functions they provide are better suited to freshwater reaches of the Willapa River upstream of the project area. This type of freshwater wetland is fully functional only when there is a free and open connection to the river. At this location in the landscape, fish and other estuarine organisms require intertidal wetlands for their survival.

If no action is taken on the WDFW property, it is likely that the dike would remain in place. Historic tidelands would remain cut off from the river, precluding the re-establishment of salt marsh vegetation on the property. The remnant tidal sloughs would continue to be isolated from the river, preventing fish access to productive feeding areas, and limiting detritus production and export. The importance of these types of habitats for young fish cannot be overstated. Estuaries provide juvenile salmonids with abundant prey during critical growth periods. It is thought that one reason for the declines in some salmon runs over the past century is limited estuarine food resources during the out migration period (Simenstad et al. 1982). Tidal sloughs also provide juveniles with refuge from high stream flows and predators.

If no action is taken on the WDFW property, the capacity of the lower Willapa River to support the variety and abundance of life it did historically would remain reduced. An estimated 99% of upper intertidal wetlands in the vicinity of South Bend have been diked. These 400 acres would remain isolated from the river, unable to contribute to the productivity of Willapa Bay. The restoration of estuarine habitats is essential for the conservation and recovery of depressed Pacific salmon populations (Simenstad and Cordell 2000).

At some point in the future, the dike could fail during a storm event. A partial dike failure would result in a return of tidal inundation to the property. However, the spatial extent, frequency, depth, and duration of inundation would not be equivalent to that which would occur as a result of the implementation of the restoration measures purposed in Section 6. For instance, swales and existing drainage ditches on the property could trap fish as the tide ebbed. Such pools of stagnant water could hamper the formation of a complex network of channels and recolonization of the area by salt marsh vegetation. In addition, highway flooding could result from an unplanned breach, particularly if it occurred during a large storm event.

WSDOT will elevate US 101 in the near future. WSDOT is aware of the uncertain future of the old dike, and the possibility of flooding along this stretch of highway. WSDOT also has a requirement to elevate the roadway as mitigation for the State Route 105 highway project in another area of Pacific County. This mitigation requirement was meant to enable the larger restoration effort to occur. Design work for the highway construction is well underway, and WSDOT plans to begin the permit process this year.

6 Plan Formulation

During the feasibility phase of this Willapa 1135 study, planning efforts were directed towards formulating a viable, cost-effective alterative that would restore important intertidal habitat in an estuary adversely affected by Corps disposal of dredged material into intertidal wetlands.

Habitat needs/problems and restoration opportunities were identified through meetings with an inter-agency technical committee. This workgroup included representatives of the Washington State Departments of Wildlife (WDFW) and Transportation (WSDOT), the US Department of Agriculture Natural Resource Conservation Service (NRCS), the US Fish and Wildlife Service (USFWS), and Ducks Unlimited. The interagency committee developed the objectives for the proposed restoration work, provided needed data and field studies, and contributed technical expertise during plan formulation.

6.1 Initial Screening

Several possible restoration measures were considered by the inter-agency technical committee. Each measure was evaluated against the objectives and planning criteria presented in Section 2.4 of this document. Three measures were excluded from further analysis because they did not meet one or more of the planning criteria. Those measures, and the reason(s) for their exclusion, are described below. The restoration measures evaluated further are described in Section 6.2.

- The group considered breaching the dike in one or more places rather than removing it entirely. However, breaching the dike would not meet the technical criteria related to wetting and circulation. In most natural tidal marshes, channel systems are not the exclusive conduit for tidal exchange. In a study of water movement and sedimentation processes within a natural marsh in the United Kingdom, French and Stoddart (1992) found that marsh edge sheet flow accounted for up to 39% of water movement into the marsh on a typical high spring tide, and up to 47% on the ebb. Leaving the dike in place would have implications for tidal circulation and sedimentation processes, as sheet flow along the 11,000 foot long dike-river face would be blocked.
- The group considered removing the dike without filling all of the existing borrow and drainage ditches. Upon review, it was determined that the grading work was necessary to meet the technical criterion related to adequate circulation of tidal waters to all parts of the marsh plane on both ebb and flood tides (see Section 2.4.2 for a list of all the

technical criteria). If the ditches were not filled, they would capture the tidal energy needed to scour a complex network of channels. In addition, a project that did not include grading and filling of existing drainage ditches would not satisfy the technical criterion related to drainage of tidal waters off the restored marsh plane. If the site were not graded to provide positive drainage on ebb tides, standing water could result in local topographic depressions. This may lead to fish strandings, water quality degradation due to elevated temperatures and low dissolved oxygen levels, and high water salinities which could form salt pans and make it difficult for vegetation to establish.

- The group considered site revegetation to meet the general criterion relating to restoration of native tidal marsh and associated plant communities (see Section 2.4.1 for a list of all the general criteria). However, this feature would be technically risky. This is because the project area has subsided since it was diked. It will likely take several years for the marsh plane to accrete to elevations that would support target salt marsh plant species.

6.2 Proposed Restoration Measures

Each of the possible restoration measures carried forward and formally evaluated by the Corps is described in Sections 6.2.1 through 6.2.7 below. Optional project features that could be added to any combination of measures are described in Section 6.2.8. A summary of all proposed measures can be found in Table 2. Project alternatives, described in Section 6.3, consist of various combinations of these measures.

6.2.1 Measure 1. Dike Removal

This measure includes removal of the dike, which would result in the inundation of approximately 250 acres of WDFW property on the north-east (river) side of US 101. Features of this measure include:

- Removal of approximately 11,000 linear feet of dike along the Willapa River. The material removed would be placed in the borrow ditch running along side of the dike. The borrow ditch fill is necessary to ensure that tidal waters scour complex tidal channels, rather than pond and potentially trap fish. About 129,000 cubic yards (CY) of material would be excavated from the old dike, and about 45,000 CY of this material would be placed in the borrow ditch directly adjacent to the dike.
- Filling of five drainage ditches and the US 101 borrow ditches to ensure drainage of tidal waters. This is necessary to ensure that tidal waters scour complex tidal channels, rather than pond and potentially trap fish. This work would require approximately 31,000 of fill material.
- Construction of one cross dike, approximately 1200 feet long, to prevent inundation of neighboring properties downstream of the WDFW property. This work would require the import of approximately 9000 CY fill material from off-site.

- Import of about 14 CY of rock for non-erodible plugs to prevent the filled borrow ditch from eroding at the junction with the remnant channels.

Measure 1 could be combined with any or all of the channel measures listed below. Measures 2 through 7 are dependant on the construction of Measure 1. Since channel construction as proposed in Measures 2 - 7 would require additional excavation, the quantity of material that had to be imported to the site in order to fill the drainage ditches and build the cross levee would be reduced with each subsequent measure implemented.

Important note on quantities. All of the descriptions in this and subsequent sections are based on the quantities in the draft engineering report attached in Appendix B. As part of the review of the draft engineering report, it has been determined that export of material from the site can be avoided. The final ERR/EA will reflect that all excavated material will be used as fill in the drainage and borrow ditches. This will be accomplished by excavating the old dike only to the extent that the excavated material will fit in the borrow ditch. As a result, the remnant of the dike and the fill in the ditch may not be flush with the pasture elevation (currently between +5 and +8 feet NAVD 88 datum) at the end of construction, but will be a small berm instead. The top of the berm will be at about the same elevation of the mudflat/marsh fronting the dike. When quantities are provided in the final engineering report, the quantities in this section will be revised to match that report.

6.2.2 Measure 2. Excavation of Tidal Channel #5

This measure would affect the portion of the property on the river side of US 101. Measure 2 is dependant on the construction of Measure 1, because the channels would not develop properly if they were not subject to tidal influence or if borrow ditches captured the tidal flows meant to flood them. This also applies to Measures 3 through 7. Measure 2 may be combined with all or none of the remaining measures described below. Features of Measure 2 include:

- Excavation of one primary tidal channel. The excavation in the primary channel will remove blockages and even the grade of the ~2000-foot long channel, one of eight remnant channels evident in historical aerial photographs of the project site. This remnant channel has been named channel #5 (see Figure 3); channel numbers noted in subsequent measures also refer to the location of historic channels. The material excavated would be used to fill the borrow and drainage ditches on the project site.
- “Nicking” of two secondary tidal channels near the center of the WDFW property. "Nicking" involves minor excavation at the mouth of the secondary channel to encourage future channel enlargement by tidal flows. The grading will occur in two locations totaling about 1400 feet in length. The secondary channel “nicks” would be 139 feet and 171 feet long and placed to take advantage of existing swales and remnant channels on the property. It is expected that tidal action would increase the length of these secondary channels.
- This measure would require the import of about 4 CY of rock to protect the channel from enlarging into the US 101 road bed, and generate about 8,600 CY of material to be moved elsewhere on-site.

6.2.3 Measure 3. Excavation of Tidal Channel #1

This measure would affect property on the river side of US 101. Measure 3 is also dependant on the construction of Measure 1. This measure may be combined with all or none of the other channel measures. Features of this measure include:

- Excavation to remove blockages and even the grade of one primary tidal channel. The work would involve about 200 feet of the approximately 670-foot long channel #1 (see Figure 3). About 6,200 CY of material would be excavated.
- This measure would require the import of about 4 CY of rock, and generate about 6,200 CY of material to be moved elsewhere on-site.

6.2.4 Measure 4. Excavation of Tidal Channel #2

This measure would affect property on the river side of US 101. This measure is dependant on the construction of Measure 1. Measure 4 may be combined with all or none of the other channel measures. Features of this measure include:

- Excavation to remove blockages and even the grade of one primary tidal channel. The work would involve about 800 feet of the approximately 1570-foot long channel, following the alignment of channel #2 (see Figure 3).
- This measure would require the import of about 6 CY of rock, and generate about 4,200 CY of material to be moved elsewhere on-site.

6.2.5 Measure 5. Excavation of Tidal Channel #7

This measure would affect property on the river side of US 101. This measure is dependant on the construction of Measure 1. Measure 5 may be combined with all or none of the other channel measures. Features of this measure include:

- Excavation of one primary tidal channel and nicking of one secondary tidal channel. The primary channel excavation will remove blockages and even the grade through about 900 feet of tidal channel #7, which is approximately 1970 feet long. The secondary channel nick would be 100 feet long and placed to take advantage of an existing swale. It is expected that tidal action would increase the length of the secondary channel.
- This measure would require the import of about 6 CY of rock, and generate about 500 CY of material to be moved elsewhere on-site.

6.2.6 Measure 6. Excavation of Tidal Channel #8

This measure would affect property on the river side of US 101. This measure is dependant on the construction of Measure 1. This measure may be combined with all or none of the other channel measures. Features of this measure include:

- Excavation to remove blockages and even the grade of one primary tidal channel and one secondary tidal channel. Primary channel #8 is approximately 2000 feet long. The secondary channel is about 780 feet long. The excavation would occur in about 200 feet of the primary channel, and in almost all of the 780-foot secondary channel.
- This measure would require the import of about 4 CY of rock, generate about 3,700 CY of material to be moved elsewhere on-site.

6.2.7 Measure 7. Excavation of Tidal Channel #5a and Bridge Construction

This measure would result in the inundation of approximately 102 acres of WDFW property on the south-west (inland) side of US 101. This measure is dependant on the construction of Measure 1 and Measure 2. This measure may also be combined with all or none of the other channel measures. Features of this measure include:

- Construction of a bridge with a 70-foot span to convey tidal waters to the inland side of US 101. The bridge is not part of the Corps' cost-shared project; it will be funded by the Natural Resource Conservation Service (NRCS) and constructed by the Washington State Department of Transportation (WSDOT). While this feature would normally be funded through the Corps as part of the Section 1135 project, the NRCS participation and funding has already been negotiated through the interagency technical committee. The Corps has agreed with this funding arrangement, but has included the costs associated with the bridge in the cost estimate and incremental cost analysis.
- Filling of farm ditches on inland side of the highway. The largest ditches are a total of 1800 feet long and will require about 4,600 CY of material to fill. Other low-lying swales would require fill as well. To the extent possible, fill from the excavation actions associated with the project will be used.
- Excavate about 500 feet of the existing 2400-foot long remnant primary channel #5a inland of the highway. A secondary channel, about 1200 feet long, would be excavated to the northwest. This secondary channel does not currently exist, but is needed to connect existing swales and ensure drainage of this area during ebb tides.
- Construction of one cross dike to prevent inundation of an outstanding access easement across one of the parcels acquired by WDFW (the Nielson property). The dike will run parallel to the existing road across the Neilson property and maintain access to a neighboring property owned by the Weyerhaeuser Corporation. The dike will have a top elevation of +15.5, a top width of 12 feet, and 2:1 side slopes. One end of the dike will tie into US 101, and the other end will tie into the Weyerhaeuser hillside. The elevation of the dike was determined by the current dike elevations. The existing dike is not flat on top, but provides approximately 100-year level of protection. The new dike, at elevation 15.5, will also provide 100-year level of protection.
- This measure would require the import of about 6 CY of rock to prevent the channels from enlarging towards the US 101 road bed, and the movement of about 6,200 CY of material from elsewhere on-site.

A variety of hydrologic and engineering studies were conducted to provide data needed to design the conveyance structure through US 101. Aerial photographs of the project site in 1939 were analyzed to determine the location and size of historic tide channels on the property. Eight locations where historical channels crossed the US 101 alignment were identified and named crossings #1 - #8, as noted in Figure 3 (Herrera Environmental Consultants 2001). Channel characteristics in Potter Slough, an undisturbed reference marsh located directly upstream of the project area, were evaluated to develop empirical relationships used to design channel cross sections. Hydrodynamic modeling of tidal inundation in the pasture with the dike removed and flow movement across the US 101 corridor was performed by Philip Williams & Associates, Ltd. using the MIKE11 program. This modeling enabled an evaluation of various alternative configurations of hydraulic openings though the highway, the determination of hydraulic opening size(s) needed to prevent muting of tide flows through the openings, checking flow velocities in those openings for effects on fish passage and channel/embankment scour, and the selection of the preferred number and size of hydraulic openings (Herrera Environmental Consultants 2001).

Initially, it was determined that three hydraulic openings at crossings #2, #5, and #7 would reproduce most of the historical channel network and meet the project objectives (Herrera Environmental Consultants 2001). MIKE11 models of three design alternatives were developed: (1) three ConSpan arch culverts with widths of 24 feet (crossing #2), 42 feet (crossing #5), and 24 feet (crossing #7); (2) two ConSpan arch culverts with widths of 24 feet (crossing #2) and 24 feet (crossing #7), with a single span bridge at crossing #5; and (3) bridges with 70 foot[1] top spans at crossings #2, #5, and #7. The models demonstrated that all of these alternatives provided full tidal inundation on both sides of the highway. Since the cost savings for the culverts were not significant and culverts would require more maintenance than bridges, the interagency committee selected the three bridge option.

However, subsequent cost estimates showed that it was unlikely that three bridges could be funded without demonstrating a significant increase in biological function. Philip Williams & Associates then modeled the following additional alternatives: (1) a single 70-foot span bridge at crossing #5; (2) a span at crossing #5 to keep velocities below 1 foot per second during a mean tide; and (3) two 70-foot span bridges at crossings #2 and #5.

The 1 foot per second (fps) velocity criterion relates to fish passage. For projects in estuarine systems, the National Marine Fisheries Service (NMFS) has proposed a maximum fish passage velocity criterion of 30 cm/second (1 fps), not to be exceeded more than 10% of the time on an ebb tide. This criterion is based upon laboratory studies in the 1960s and 1970s and a recent modeling effort for the Columbia River estuary (Bottom et al. 2001).

The results of the additional modeling were as follows (Philip Williams & Associates 2002):

[1] The 70 foot length was selected because this is the largest bridge which can be constructed with a single span (i.e., no piers in the center of the channel) without using a much more costly structure.

- The single 70 foot span bridge at crossing #5 resulted in high tides inland of the highway that were 6 inches lower than tides in the Willapa River. Average channel velocities exceeded 1 fps for 17% of the time during a mean tidal cycle.
- The span length necessary to meet the NMFS criterion is 80 feet. With the wider span, high tides inland of the highway were 4 inches lower than Willapa River tides.
- The two 70 foot spans at crossings #2 and #5 had average velocities that exceeded 1 fps less than 10% of the time. High tides inland of the highway were 3 inches lower than Willapa River tides.

Philip Williams & Associates (2002) also analyzed the distribution of velocities across the proposed channel(s). Modeling results showed velocities as low as 0.3 fps near the channel banks, even when average ebb velocities were exceeding 1 fps. These results are similar to WSDOT measurements in Potter Slough.

After the interagency committee considered the costs of the various alternatives, the single 70 foot span was selected as the preferred alternative. This design satisfies most of the project criteria, while providing nearly a full restoration of tidal range without the need for a bridge with piers of a specially-engineered span. Crossing #5 drains the largest historical channel, and could develop a drainage network that would provide a full range of tidal habitats (PWA 2001). While this design does not meet the proposed NMFS passage criterion as averaged over the entire channel, there would be lower velocity areas along the channel margins where juveniles could move when higher velocities are encountered. This design does meet the WDFW passage criteria of 4 fps (WAC 220-110-070).

6.2.8 Other Project Measures Considered

The following project measures could be combined with any or all of the restoration measures.

6.2.8.1 Measure 8: Highway Pull-out

This option involves the construction of a 0.34 acre highway pull-out designed to satisfy the social criteria for providing public access for education opportunities and wildlife-oriented recreation. The turnout would provide safe access to parking and a viewing area on the northeasterly side of the US 101. The pull-out would be located on an existing elevated pad, where a recently-demolished residence was located.

None of the measures meet the social criteria without the addition of this feature. A WDFW objective for the project is public access, which is an important element to the local community. The local community did not support a project that removed so much land from local use without the inclusion some kind of feature to keep the property accessible to the community.

6.2.8.2 Measure 9: Spartina Control

WDFW has an established program to control the invasive exotic salt marsh grass *Spartina* in Willapa Bay. As part of this on-going program, WDFW crews sprayed a 5 acre *Spartina* meadow fronting the project site, as well as a larger meadow across the Willapa River, with herbicides during the summer of 2002 to eliminate an immediate seed source. Follow-up treatments are expected during the summer of 2003. The treatment method for *Spartina* outside of the dike is the herbicide glyphosate as a ground application. Airboats are used, and each application takes approximately two days. This work is handled as part of an ongoing WDFW control program in the area, and is not part of the cost-shared Corps' project.

Measure 9 involves a *Spartina* control program within the project footprint. The proposed control program, described below, would supplement WDFW's ongoing efforts to remove source material in the vicinity of the restoration site.

- After the dike is removed, the project site would be monitored for *Spartina* infestation within the project footprint. Monitoring for *Spartina* within the dike would begin in the growing season immediately following the dike removal. Monitoring would consist of ground surveys for seedlings, and would occur throughout the growing season (May-October). Any *Spartina* found within the project footprint would be removed. Seedlings would be removed manually. If all seedlings are pulled each year, manual removal is expected be effective in future years. If seedlings became clones and meadows formed, herbicide would need to be used to prevent further infestation. WDFW crews would perform this work.

The proposed control measures are consistent with the 1993 *Noxious Emergent Plant Management Environmental Impact Statement* prepared by the Washington State Departments of Agriculture, Ecology, Fish and Wildlife, Natural Resources, and the Washington State Noxious Weed Control Board. The control work to be conducted outside of the dike will be part of an established WDFW program supervised by the Washington State Department of Agriculture (WSDA).[2]

Rodeo® (glyphosate) is the only herbicide approved by the Environmental Protection Agency and Department of Ecology for use on *Spartina* in Washington (Washington Noxious Weed Control Board 2001). All WDFW staff responsible for herbicide application will hold valid pesticide licenses, and have passed the Washington State Department of Agriculture (WSDA) aquatic pest control exam. Herbicides would be applied to *Spartina* consistent with the pesticide label, and restrictions imposed by the US Environmental Protection Agency, Ecology, and USFWS. All work will comply with the current state NPDES permit for *Spartina* control (Ecology 2002). This permit requires that herbicide treatments occur only between July 1 and October 31.

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[2] The WSDA is the lead state agency for the eradication of *Spartina*. WSDA holds the NPDES permit for use of herbicides to control aquatic noxious weeds in Washington State.

6.2.8.3 Measure 10: Sand Cap at Feed Lot Site

At a site that was used as a feed lot for a cattle farm that occupied the northeast portion of project property, an investigation found creosote contamination remaining from the demolition of a building. Signs of creosote contamination were visible where piles were pulled from the ground. A more recent visual investigation found no creosote at the surface, but was unable to rule out the presence of creosote below ground. As part of this project, a 3-foot deep cap of sand will be placed over the barn footprint to isolate any remaining creosote at that site. A cap is presumed to be more cost effective than an exhaustive investigation to preclude the presence of creosote.

6.2.8.4 Measure 11: Fence along Downstream Property Boundary

Since the property directly downstream of the project site is managed as pasture for cattle, a fence will be built at the downstream project boundary, northeast of US 101, from the highway property line to the river. The fence will keep cattle off of the project site.

Table 2. Summary of Proposed Measures

		Area Inundated (acres)	Channel Length (feet)
Measure 1	Dike Removal	249	0
Measure 2	Primary Channel #5 Secondary Channels #5 and #5b	--	2310
Measure 3	Primary Channel #1	--	1270
Measure 4	Primary Channel #2	--	1570
Measure 5	Primary Channel #7 Secondary Channel #7a	--	2070
Measure 6	Primary Channel #8 Secondary Channel #8	--	2480
Measure 7	US 101 Bridge Secondary Channel #5a	102	1200
Measure 8	Highway Pull-Out	--	--
Measure 9	*Spartina* Control	--	--
Measure 10	Sand Cap	--	--
Measure 11	Fencing	--	--
	Total for all Measures:	351 acres	10,900 feet

Note: The area inundated figures exclude the cross dike and pull-out acreage, so these numbers are lower than the total number of acres acquired by NRCS and WDFW.

6.3 Project Alternatives

The project team formed alternatives by combining various restoration measures and optional features. With the exception of the no action alternative, all the alternatives meet each of the

objectives and planning criteria developed by inter-agency technical committee and presented in Section 2.4 of this document.

Thirteen cost effective plans can be created from the measures described above. However, three combinations stand out for further analysis. The alternatives listed below were chosen for further analysis because they provide much greater benefits at only slightly more costs than the other cost effective plans. For more information on the other cost effective plans, see the economics appendix (Appendix D). As required by the National Environmental Policy Act (NEPA), the "no action" plan is carried through the analysis to the selection of the preferred plan.

6.3.1 Alternative 1: No Action

Under the no action alternative, the dike surrounding the waterward perimeter of the property would remain in place. At some point in the future, a dike breach could occur. A dike failure would result in a return of tidal inundation to the property. However, swales and existing drainage ditches on the property could trap fish as tides ebbed. Pools of stagnant water could hamper the formation of dendritic channels and recolonization of the area by salt marsh vegetation. Because raising US 101 is a mitigation requirement for WSDOT, the highway will be raised in the "no action" alternative.

This alternative does not meet the study objectives and planning criteria presented in Section 2.4 of this document. However, the no action alternative is included in the output and economic evaluations as a baseline against which the restoration alternatives can be compared.

6.3.2 Alternative 2: Minimum Project

Alternative 2 consists of the following measures, as shown in Figure 4:

- Measure 1: dike removal, filling of ditches, grading, new cross dikes
- Measure 8: US 101 pull-out
- Measure 9: *Spartina* control
- Measure 10: sand cap
- Measure 11: fencing

6.3.3 Alternative 3: Partial Site Restoration

Alternative 3, shown in Figure 5, consists of all measures included in Alternative 1, and adds the following measures:

- Measure 2: primary channel #5 and secondary channels #5 and #5b
- Measure 3: primary channel #1

- Measure 4: primary channel #2
- Measure 5: primary channel #7 and secondary channel #7a
- Measure 6: primary channel #8 and secondary channel #8

6.3.4 Alternative 4: Complete Site Restoration

Alternative 4 consists of implementing all of the proposed restoration measures, as shown in Figure 6. It includes all the Alternative 2 and Alternative 3 measures, and adds the following measure:

- Measure 7: US 101 bridge and secondary channel #5a

This alternative includes all of the measures, and restores the all possible portions of the site to tidal inundation.

6.4 Evaluation of the Alternatives

Benefit-cost evaluation is an integral part of most Corps civil works projects. For traditional Corps projects such as navigation and flood control, benefits and costs are quantified in monetary terms. This enables an easy comparison to determine the "optimal" project. The optimal project is that alternative which has the greatest net benefits (benefits minus costs).

Quantifying environmental benefits in monetary terms is much more difficult and controversial. Recognizing this difficulty, the Corps does not perform a traditional benefit-cost evaluation for ecosystem restoration projects. However, since costs and benefits are an important consideration in determining whether a particular restoration project merits investment, and to identify the optimal level of investment, an alternative tool is used in place of the traditional benefit-cost evaluation. This tool is a cost-effective and incremental cost evaluation (CE/ICA). Although this approach does not result in strict decision criteria, it is a useful tool to identify the most cost-effective and efficient project alternative(s).

As part of CE/ICA, potential project benefits are quantified using non-dollar outputs that differ depending on the type of restoration project being considered. Examples might include habitat units or a similar habitat index. It is important to recognize that the selected measure typically can't include all components of an ecosystem which would benefit from the restoration action(s). The project outputs should be viewed as only a proxy for the project benefits.

The first step of the CE/ICA is to select a method to determine project environmental outputs. Next, the those outputs are quantified for each of the alternatives. A computer model is then used to calculate the cost per unit of output for each alternative and all possible combination of alternatives. Those alternatives which are not cost effective (i.e., those having a lower output for a higher cost, or a higher cost for similar outputs compared to other alternatives) are eliminated. Of the remaining alternatives, the relationship between changes in costs for every change in output are then evaluated. From this analysis, increases in

incremental cost per incremental output are identified and used to help determine the recommended alternative(s).

6.4.1 Environmental Outputs of the Restoration Alternatives

Two metrics have been used to quantify the benefits associated with each of the proposed restoration alternatives:

Area opened to tidal inundation is a measure of the quantity of habitat restored;

Total edge is a measure of the quality of habitat restored.

Total edge was selected as the quality metric for two reasons: the ease of which this characteristic could be quantified using GIS technologies, and the biological importance of channel edge to vegetation and estuarine organisms in marsh habitat.

Regions near the edges of tidal channels generally support denser vegetation than adjacent marsh planes (Mitsch and Gosselink 1993). Channels margins are though to be extremely productive for salt marsh vegetation because of the circulation provided by flowing water (Coats et al. 1995). This is because channels result in sediments that are more readily oxygenated, salinities that are more stable at lower intertidal elevations, more nutrients supplied to the plants, and toxic materials are washed away (Coats et al. 1995).

Kneib (1987) showed that small pools of water on the marsh surface could provide low tide refuge for some larval and small post-larval organisms, but larger nekton must retreat to subtidal habitats. Since nekton that penetrate the marsh far from channels may be more susceptible to stranding, water in natural and created channels provide refuge if they do not drain completely at low tide. Peterson and Turner (1994) found that most shrimp, crabs, and fishes utilizing a Louisiana salt marsh were found within 3 meters of a tidal creek.

The importance of such channels in created salt marshes has been demonstrated as well. Minello et al. (1994) examined the relationship between marsh edge and animal use in a marsh created on dredged materials in Galveston Bay, Texas. They found that the habitat value of created salt marshes can be enhanced by incorporating tidal creeks into project design. Minello and his colleagues added edge to a created marsh with no channels and little marsh edge by constructing experimental channels. During subsequent sampling of the experimental and control marsh sectors they found that the channels significantly increased densities of shrimp and small forage fishes on the marsh surface, as well as polychaete prey along the channels. Densities of some shrimp species were 4.6 to 13 times higher near the channels. The channels also appeared to have increased dissolved oxygen levels in the inner marsh, and reduced sediment pore water salinities near the channels.

For this project, the environmental outputs (area inundated and total edge) for each alternative were calculated using FRAGSTATS, a computer program for spatial pattern analysis. This program utilizes a GIS database to calculate several habitat metrics which characterize aspects of the landscape, including total edge. Please see Appendix C for an

explanation of the steps taken to generate a GIS database for the project and run the FRAGSTATS analysis.

The results of the FRAGSTATS analysis for each alternative are provided in Table 3 and graphically in Figures 7 - 9; outputs for each individual restoration measure are provided in Table 5 in Appendix C. Total edge was weighted to reflect the biological value of the different types of edges present at the project site (e.g., marsh-channel, marsh-river, marsh-forested buffer, marsh-dike, marsh-road). These weights were based upon the biological importance of the edge type and the comparisons required as part of the output analysis. The channel edge was weighted highest because it allows fish and other organisms to access the site, and improves site hydrology. The river edge, while also very important from hydrological and biological perspectives, was weighted lower because of continuity among almost all of the alternatives considered. The hill slope along the landward margin of the property has value as a source of woody debris, shade, and fallout insects, but is not as important as the channels or river edge. The highway and dike edges were weighted as zero, since they provide no habitat value and their edge lengths are the same when comparing most of the alternatives.

For the purposes of this evaluation, the no action alternative assumes zero acres inundated and no biologically significant edge (e.g., only dike-river edge). While the dike may not remain fully functional over the 50-year project life, any failure would not result in the types of habitat benefits that a restoration project would create. In many respects, the outputs would be negative. Standing water would collect in existing drainage ditches and topographic depressions. This would lead to fish strandings, water quality degradation due to elevated temperatures and low dissolved oxygen levels, and high water salinities which could form salt pans and make it difficult for vegetation to establish.

Table 3. Environmental Outputs of the Project Alternatives

		Area Inundated (acres)	Total Edge (feet)
Alternative 1	No Action	0	0
Alternative 2	Measure 1	249	1,845
Alternative 3	Measures 1 - 6	249	27,635
Alternative 4	Measures 1 - 7	351	39,962

6.4.2 Cost Effectiveness and Incremental Cost Analysis

Costs for all of the alternatives have been developed in MCACES format. The complete cost estimate is included in Appendix B. The Incremental Cost Analysis can be found in Appendix D.

6.4.3 Selection and Justification of the Preferred Plan

While there are thirteen cost effective plans, the combination of measures presented as Alternatives 2, 3, and 4 stand out for consideration. Alternative 2 is the least expensive project that meets many of planning criteria presented in Section 2.4.2. Alternative 3, with the addition of tidal channels, provides significant hydrologic improvements over Alternative 2 at little additional cost. Alternative 3 represents the most beneficial plan without the cost jump needed to build the bridge and include the land on the south side of the highway. Alternative 4 is the most expensive project, but it provides the most benefits, and is the only "best buy" among all of the cost effective plans. "Best buy" means that the alternative provides the lowest incremental cost per unit of benefit.

The "no action" alternative meets some of the planning criteria. The "no action" alternative would not meet the drainage/fish stranding criterion, as the borrow ditch would not be filled. This alternative also does not meet the circulation criterion, as the blockages in the remnant channels would remain. This alternative does not meet the social criterion, as no recreational/educational opportunity will be created. Any benefits associated with the no action alternative would not be realized until the dike failed, which may or may not occur within the 50 year project life.

Alternative 2 meets many of the planning criteria. However, Alternative 2 fails to fully meet the drainage/fish stranding criterion and the circulation criterion. Alternative 2 does not include excavation of blockages in the remnant channels, nor excavation of the secondary channels. Tidal waters would flood the entire area on the river side of US 101, but the circulation and fish access would be inhibited by the lack of channels. Pools could form behind the channel blockages, possibly stranding fish until the next flood tide.

Alternatives 3 meets all of the planning criteria. By adding the tidal channel measures, Alternative 3 addresses the hydrologic shortcomings of Alternative 2. Since these shortcomings are eliminated at relatively little cost, the project team rejected Alternative 2. The small cost difference is because the channel excavations eliminate the need to import material to fill the drainage ditches. Under Alternative 3, tidal waters would not flood the 100 acres of land acquired by NRCS and WDFW on the landward side of US 101, so the substantial environmental outputs obtainable if Measure 7 were implemented would not be realized.

Alternative 4 meets all of the planning criteria and represents the highest quality project that the inter-agency technical committee has envisioned for the site. Alternative 4 opens about 100 acres on the landward side of US 101 to tidal inundation, providing a significant increase in environmental outputs over Alternative 3. The incremental cost analysis (Appendix D) shows that Alternative 4 provides benefits at a lower unit cost than Alternative 3. The project partners have sufficient funding and real estate to support Alternative 4, and the desire to build it. For these reasons, the project team selects Alternative 4, Complete Site Restoration, as the preferred plan.

7 Recommended Plan

7.1 Plan Features

The preferred plan is implementation of Alternative 3, which consists of Measures 1-7, and the four option items. Specific features of the project to be constructed by the Corps, as well as project elements to be implemented by partnering agencies, are shown on Figures 10 – 13 in Appendix A, and described below in the order in which they will be constructed. It is expected that two summer construction seasons will be required to complete construction.

Excavate remnant channels. Five primary channels (8,500+ feet in length) and five secondary channels (2,400+ feet in length) will be restored to allow for natural tidal hydrology and fish access to the interior of the site. Channel grading will follow the alignments of remnant tidal channels. Excavators will be used to remove blockages within the channel alignments, provide grade control, and connect the channels to the river. It is likely that only a portion of the total length of the remnant channels will be excavated. The excavated material will be hauled on-site with dump trucks to be used for fill. This will minimize the need for imported fill material.

The channels will be excavated before the old dike is removed, so during construction the only connection to the river would be through one tide gate that empties into Potter Slough. The tide gate appears to be ineffective, and does not drain the site. Therefore, no action to isolate the tide gate is anticipated. If turbid water is seen in the vicinity of the tide gate the gate will be blocked to prevent discharge into Potter Slough. After work is complete for the summer, the blockage will be removed. It is not anticipated that any road improvements will be required on site for the dump trucks. However, if road improvements are required, they would be removed at the end of the first construction season.

Fill borrow ditches. Several borrow ditches associated with US 101 and farm drainage ditches have been identified for filling to restore natural tidal hydrology and prevent fish strandings. Prior to removing the old dike, all of these ditches will be filled. To the extent possible, the fill will be obtained from the excavation of remnant channels. The fill will be moved on-site via dump trucks, and will be spread with a bulldozer. General site grading to eliminate existing swales that could prevent restoration of natural tidal hydrology will also occur. A vibratory roller may be used to compact the material. If imported material is required, it will be transported to the site on US 101 by dump truck.

New dike on former Nielson property. The new ~500 foot long cross dike on the former Nielson property will be constructed with imported fill material. Material will be hauled to the site on US 101, and construction access will occur along the driveway that is adjacent to the dike alignment. The material will be hauled by single unit dump trucks or trucks and pups. The material will be spread by bulldozer and compacted by a vibratory roller. Due to expected settlement of the dike, the dike will be topped off in the second construction season using similar construction methods. The finished dike will be top-soiled and seeded.

New dike on former Graves property. The new ~1,400 foot long cross dike on the former Graves property will be constructed with imported fill material. Material will be hauled to the site on US 101, and construction access will occur along the driveway that is adjacent to the dike alignment. Single unit dump trucks or trucks and pups will haul the material. The material will be spread by bulldozer and compacted by a vibratory roller. Due to expected settlement of the dike, the dike will be topped off in the second construction season using similar construction methods. Top soil and seed will be placed on the finished dike.

Measures to prevent US 101 flooding. Survey information along the inside of the highway curve is insufficient at this time to determine if flood events will flow around the highway curve in the drainage ditch. The project team will consider a short dike between the highway and the hillside at the downstream end of the project to address the issue of flooding, if necessary. Other option the team would consider is to flood fight that location if it appeared the highway would flood during a storm event.

Highway pull-out. The raised highway pull-out will be located on the river side of the highway near Potter Slough. The parking surface will be at the roadway elevation. This feature will require placement of about 4600 CY of fill plus about 100 CY of asphalt. The parking area will be about 15,000 square feet.

Sand Cap at Former Feed Lot. The consultant hired by NRCS to investigate the site for water quality concerns found some signs of creosote contamination where piles were pulled from the ground. The piles supported a pole barn at the former feed lot. The current recommendation is to place a 3-foot deep sand cap over the footprint of the former barn to prevent migration of creosote out of the ground in into the project area where the creosote might impact the ecosystem.

Excavate old dike, fill borrow ditch. Approximately 10,000 linear feet of dike along the Willapa River will be excavated down to the elevation of the mudflat fronting the dike. The dike material will be place in the adjacent borrow ditch. The first excavation effort will open the remnant channels to the river, which will also provide drainage for the borrow ditch and an escape route for any fish which have accessed the site during construction activities. An excavator situated on top of the dike will move the material. Each work area will be enclosed with a silt curtain. Due to the tidal cycle and the depth of the old borrow ditch, it is not possible to avoid placing material in the ditch while water is in the ditch. It is anticipated that work will occur at more than one site on the dike in order to expedite the work. Inlets for each of the 5 primary channels in the mudflat on the river side of the existing dike will also be excavated.

Water quality monitoring. Due to concerns of resource agencies and oyster growers downstream of the project site, water quality will be monitored during removal of the dike. The Washington Department of Health will monitor fecal coliform levels and the Corps will monitor turbidity levels in the Willapa River.

Spartina Control. After construction of all the project elements is complete, the Corps and WDFW will implement the *Spartina* control program described in Section 6.2.8.2. Herbicide application will be used only as a last resort within the project footprint.

Post-Construction Monitoring. Post-construction monitoring of site hydrologic/hydraulic development, vegetation, and fish/bird usage will occur, under guidance from USFWS, for a period of 10 years. The Corps' contribution to the inter-agency monitoring effort is described below in Section 7.3.

During construction of the Corps/WDFW cost-shared project, partnering agencies will be constructing associated project features, including:

- WSDOT will raise approximately 1.23 miles of US 101 bisecting the project area to prevent the highway from flooding once the site is open to inundation of tidal waters.
- NRCS will fund WSDOT to install a 70-foot free span bridge for conveyance of tidal waters to the back side of the highway.
- NRCS and Ducks Unlimited will install a water control structure and perform grading work to facilitate the management of 22 acres adjacent to the project site for freshwater waterfowl habitat.

Brief descriptions of these elements of the project are described below. WSDOT and NRCS/DU will be obtaining separate environment permits for these elements of the project.

Highway raising and bridge installation. WSDOT will raise US 101 to an elevation of 15.5 feet, which is one foot higher than the 100-year flood event. The highway raising will require about 100,000 CY of imported fill. In addition, a 70-foot bridge span will be placed to allow flooding of the land behind the highway. WSDOT will construct the bridge and the channel below the bridge. NRCS will fund the bridge and channel work. The bottom of the bridge will be above elevation 14.5, the 100-year flood event elevation. The new road grade is being designed by WSDOT, and will meet WSDOT requirements for safety. The design does accommodate the fact that the road embankments on both sides will be inundated by the tides. The road will provide uninterrupted access, and will not be subject to closure due to tidal inundation.

Freshwater waterfowl habitat improvements. The restoration of the Olsen property is being prioritized to help offset the loss of freshwater waterfowl habitat that will occur when the remainder of project area is restored to estuary. The property is owned in fee title by Phil Olsen and is protected by an underlying permanent wetland easement through the Wetland Reserve Program of the Natural Resources Conservation Service. The Olsen area consists of 22 acres on the downstream end of the 400 acre estuarine restoration project area. Restoration will focus on waterfowl and shorebird habitat improvements. The east boundary of the Olsen property abuts the western boundary of the estuarine restoration project. A dike will be constructed in this location as part of the estuarine restoration project to prevent tidal inundation of the Olsen property and other private ownerships to the west. No fish are currently present on the Olsen property.

On the west edge of the Olsen property, a small levee (2 to 3 feet in height) will be constructed to retain seasonal freshwater. High spots exist in that area and borrow material will be used to construct this levee to the 8 foot elevation. A water control structure, which will connect to the upstream end of an old remnant slough, will be installed in the newly constructed west levee. Historic micro-topographic features will be re-established adjacent to the remnant slough to create a more diverse hydrologic and vegetative community. Existing swales and shallow depressions will be enhanced to allow for more open freshwater habitat. Habitat mounds, adjacent to the open water areas, will mimic the natural landscape and will serve to provide higher ground and to direct water flow during flood conditions.

The water control structure will be used to retain freshwater in the old remnant slough and four adjoining swales, providing seasonal or semi-permanent hydrology. The structure will provide the opportunity for moist soil management in the swales to maintain the optimum plant community for waterfowl and shorebird habitat. The restoration practices on the Olsen property are scheduled to occur during the dry summer months prior to the construction of the large dike that will separate it from the estuarine restoration area. Restoration funds will be provided through the USDA's Wetland Reserve Program.

7.2 Operations and Maintenance

The only maintenance effort anticipated for the Corps project is the maintenance of the two new dikes and the fence. While the Corps does not consider this project to be a flood damage reduction project, the Corps will provide guidance to WDFW on Corps standards for dike maintenance. The interagency project team has agreed that the Corps levee maintenance standards are appropriate for this project.

WSDOT will maintain the bridge. The design of the highway is such that the full levee height can not be maintained to the tie-in point at the highway. The road crown will be built to an elevation of +15.5' (NAVD 88 datum), which is the same as the elevation proposed for the top of the new dikes. Since the tie-in point is at the road shoulder, which is at elevation +14.5 feet, the dikes will be built to elevation +15.5 feet except that they will slope down to the tie in point. Therefore, there is slight chance that water could over-top the dikes at the tie-in points during extreme events. During extreme events, the Corps could use a flood fight authority to provide any needed reinforcement at these low points. Since a flood fight operation could be required during any events of that magnitude anyway, this is not presumed to be an additional effort.

7.3 Post-Construction Monitoring

Post-construction monitoring is needed to ensure both the biological and functional effectiveness of this restoration effort. Monitoring will be focused on the factors that are targeted for improvement. Sampling will occur in years one, three, and five post-construction. This is to provide reasonable assurances that the system has met project performance criteria. It is important for the monitoring to extend to a point somewhere after the period of most rapid change and into the period of stabilization of the system. This

approach is consistent with what is recommended in *Planning Aquatic Ecosystem Restoration Monitoring Programs* (IWR Report 96-R-23, 1996).

Seattle District will fund survey work to monitor plant survivability (percent cover), fish use (primarily juvenile salmon), and cross sectional area at the mouth of the sloughs where they meet the Willapa River. The Corps monitoring effort will compliment the monitoring efforts of our partnering agencies. USFWS has taken the lead in developing a monitoring plan, and the Corps effort will be consistent with this plan to the extent that the Northwestern Division-approved budget permits.

The Corps portion of the monitoring cost represents about 3% of the total 1135 project budget. A July 31, 2001 memo from HQUSACE, signed by James Johnson, has approved monitoring costs in excess of the Corps' 1% policy. The memo waives the 1% limitation, and approves monitoring costs of $80,000. All monitoring relates back to the project objectives outlined in Section 2.4.

Estimated monitoring costs are expected to be $80,000 ($40,000 biological and $40,000 physical). The needs for monitoring costs in excess of the Corps of Engineers 1% policy include:

- The project is located along the main stem of the river. The project area experiences wide ranges in both tidal inundation and river flow. This makes for a difficult estimation of the invert elevation of the outlet channels. It is necessary to dedicate some monitoring money to physically survey these elevations to make sure that they were done correctly and determine if they need to be modified. This is also a highly erosive environment due to the same hydraulic features and there is a need to physically monitor channel morphology over time to insure that the slough channels are stable.
- One of the stated objectives of the project is to provide off-channel rearing and feeding habitat for juvenile salmonids. Fish have been unable to access this site for almost 100 years. There is little existing information documenting fish occurrence, density, residency, and timing in restored off-channel tidal habitats in the Pacific Northwest. Monitoring data would provide invaluable information for similar restoration projects planned by Seattle District and other agencies. It will be instrumental in evaluating the success of the project. This type of fish monitoring is usually done over a four-month period during smolt out migration period.

Standardized monitoring protocols (e.g., Simenstad 1991) will be used for monitoring the site. This is so the information obtained will be consistent with other studies and can provide meaningful results. It may cost more to implement these procedures, but by following such procedures the information become useful to a larger audience. This approach seems to be consistent with the conclusion expressed in *National Review of Non-Corps Environmental Restoration Projects* (IWR Report 95-R-12, 1995).

8 Environmental Consequences of the Selected Plan

8.1 Physical Characteristics

8.1.1 Geology

Based on topographic surveys conducted during investigations of the project site and adjacent un-diked marshlands, the ground surface within the project area appears to be approximately 2 feet lower in elevation than the Potter Slough reference area (Herrera Environmental Consultants 2002). Once the project site is inundated by tidal waters, the elevation will rise through natural accretion of sediments on the marsh plane. Accretion rates in restored wetlands in Grays Harbor have been measured at approximately 1/8 inch (3.5 mm) per year (Thom 1992).

8.1.2 Hydrology

Implementation of the preferred plan would result in a conversion from pasture to mudflat with a network of pilot channels constructed to a "short term" equilibrium dimensions determined in the geomorphic analysis (PWA 2001). These channels will begin adjusting from their constructed forms and patterns in response to the constant flooding and ebbing of the tides. Sediments will accrete, and vegetation will start to establish on the margins of the mudflat, gradually encroaching on the banks of the tidal sloughs and marsh interior. Over several years the tidal channels should begin to approach the long term equilibrium dimensions predicted by PWA using the un-disturbed analogues at Potter Slough (PWA 2001). As sedimentation continues, vegetation will fully colonize the tidal slough banks and marsh interior, reducing the tidal prism significantly. Marsh channel tidal flows and velocities will decrease in response to the reduced tidal prism.

The re-introduction of tidal influence associated with the preferred alternative is not expected to affect groundwater or private wells in the project vicinity. Tidal influence is limited to groundwater near the ground surface, and typically does not extend below 20 feet in depth. Most wells in the project vicinity tap into a groundwater discharge zone 60 to 100 feet or more below the surface. This regional aquifer is discharging from depth towards sea level, that is, it has a hydraulic head generally in the range of 20 to 30 feet. This water is, in essence, "under pressure" that would prevent the intrusion of brackish water from the surface. For wells outside of the zone of tidal influence (i.e., outside of the immediate project area), brackish water intrusion into the groundwater becomes even less of an issue. Only shallow wells located within the project footprint would be likely to be affected by the intrusion of brackish water. Therefore, any project-related impacts would not be significant.

8.1.3 Water Quality

Over the long-term, water quality within a restored project site would be expected to be an improvement over the no action alternative due the reintroduction of tidal flushing. However, short-term impacts to water quality would result from construction activities.

Parameters of concern and methods which will be employed to reduce impacts are described individually below.

A Section 401 Water Quality Certification will be obtained from the Washington Department of Ecology during the Plans & Specifications Phase (i.e., the detailed design phase) of the project. The Corps will not sign the Project Cooperation Agreement (PCA), which is required for construction to begin, without a 401 Certification. All protective measures and monitoring required by the State will be implemented during construction.

Turbidity. The construction of the highway, the new dikes, the vehicle pull out, the waterfowl habitat, and the interior grading features will be accomplished while the old dike is still in place. The only connection to the Willapa River prior to the removal of the old dike is through one tidegate that empties into Potter Slough. Because the interior construction will occur during the summer dry season, flow out through the tidegate is not expected. If turbid water reaches the tidegate, it can be blocked for the duration of that construction season.

During the removal of the old dike, the construction site will flood twice daily during high tides. Prior to starting work each day, and during low tide, the construction crew will place a silt curtain around that day's work site. It is anticipated that there will be at least two crews working in two locations, but there may be more. Each crew would follow this procedure. During detailed Plans & Specifications phase of this project, the interagency team will continue to evaluate additional management practices that could minimize turbidity releases from the site.

In addition, turbidity will be monitored during construction. Measurements will be taken both upstream and downstream of the project site. Testing intervals can be expected to be every two hours initially, decreasing to twice daily if state standards are not exceeded. Ecology may determine that additional monitoring is necessary during their evaluation of the proposed project. The project team is also considering what additional measures could be taken in order to ensure that the project does not harm the oyster industry in Willapa Bay.

The increase in turbidity associated with implementation of the preferred alternative is not expected to be significant for the following reasons: most excavation and grading work will occur one year before the dike is removed, allowing for some degree of stabilization before the site is inundated; all practicable construction techniques will be implemented to reduce the introduction of suspended sediments into Willapa Bay during dike removal; turbidity monitoring will occur during construction; all state requirements for the protection of water quality will be met; and construction activities most likely to result in sediment releases will be short-term (~3 months).

Fecal Coliform. Results of the Battelle sampling effort (Diefenderfer and Ward 2002) indicate that, given the current designation of the receiving waters adjacent to the site, fecal coliform contamination on the WDFW property would constitute only minimal risk to human health via a shellfish consumption exposure pathway. The number of fecal coliform bacteria in samples from the project site was less than or equal to the number in the river samples in six of the seven samples collected in January (Diefenderfer and Ward 2002). In samples

collected during the month of May, four had bacteria levels lower than those in the river, and four had levels above. The samples with the higher concentration were located in stagnant areas conducive to bacteria growth; such conditions would not exist after the dike breach occurred. Diefenderfer and Ward (2002) concluded that if coliform contamination is transported with fine sediments into the river adjacent to the project site, they will be diluted before reaching the approved harvest areas downstream of the site in the same manner as treated sewage from the City of South Bend is diluted. Therefore, impacts are not expected to be significant. As a precaution, the Washington Department of Health will monitor fecal coliform levels in the Willapa River adjacent to and downstream of the project site during dike removal.

Biological Oxygen Demand. The Washington State Department of Ecology (Ecology) has proposed a dissolved oxygen Total Maximum Daily Load (TMDL) standard for portions of the lower Willapa River. The proposed project is not expected to further reduce dissolved oxygen levels in the Willapa River or affect Ecology's TMDL proposal. In a May 15, 2001 letter to Mr. Greg Schirato of WDFW, Mr. Darrell Anderson, the Supervisor of the Water Cleanup/Technical Assistance Unit in the Ecology Southwest Regional Office, stated that any biological oxygen demand (BOD) generated on the project site would be considered part of the background condition. In fact, over the long-term the preferred alternative may improve water quality conditions as compared to the no action alternative. Mr. Anderson stated that the removal of cattle from the project site is considered a reduction in anthropogenic sources of BOD and bacterial contaminants and, therefore, an improvement in water quality conditions. Ecology's position is that reducing human impacts and returning the site to more natural conditions would be inherently consistent with state water quality standards.

Herbicide Applications. The degree of water-quality degradation associated with herbicide application for *Spartina* control would be dependent upon the amount of Rodeo® tank mix that reaches the water and its subsequent biodegradation. Because *Spartina* intercepts most of the ground-applied herbicide tank mix (Major and Grue 1997), and over spray or drift are minimal, the primary source for glyphosate and adjuvant[3] introduction into seawater results from the initial washing of target vegetation by the first tidal inundation or rainfall that occurs before chemical incorporation into *Spartina* tissue (USFWS 1997). The NPDES permit for this work requires that treatments shall not occur when a tidal regime leaves plants dry for less than four hours (Ecology 2002).

Dilution, dissipation, and biodegradation quickly diminish waterborne concentrations of glyphosate and adjuvant. Paveglio et al. (1996) found that concentrations of glyphosate and nonylphenol polyethoxylates in seawater were below detection limits (0.5 and 2.0 ppb,

[3] Adjuvants are any chemical added to a herbicide tank mix. They are used for a variety of reasons: to improve the wetting or spreading of spray drops; to increase penetration of the herbicide into plant cells (surfactants); to reduce herbicide losses from evaporation; to retard foaming in spray tanks; to increase the viscosity of a tank mix to reduce drift; to prevent/reduce over-spray or multiple treatment of sprayed areas (dyes); and to buffer the pH of diluting water (USFWS 1997).

respectively) 1 day post-treatment (2 tidal cycles) after aerial application of Rodeo® (4.7 liters/ha) and X-77® Spreader (1.0 liter/ha) to control *Spartina* in Willapa Bay.

Herbicide application will be used as a last resort on the project site. The primary method of *Spartina* control will be manual removal of seedlings. This method should be effective if all seedlings are produced each year. Herbicides would be used on the project site only if seedlings become clones and meadows formed. Any impacts associated with herbicide application are expected to be minor, of short duration, and highly localized.

8.1.4 Air Quality

There will be some minor short-term impacts to air quality due to the use of construction equipment (such as excavators, dump trucks, and bulldozers). Slight elevation of carbon dioxide and particulates levels are expected in the immediate construction area. Since these impacts would be temporary, minor in scope, and highly localized, they are not expected to be significant.

8.1.5 Hazardous and Toxic Wastes

Results of the Battelle sampling effort (Diefenderfer and Ward 2002) indicate that there is little or no reason to believe that persistent contaminants of concern are present on the project site at levels which could produce unacceptable ecological or human health risks. In most cases, contaminants of concern were either not detected, or detected in quantities that do not represent concern based upon a review of various regulatory guidance and scientific literature. In a few cases, detected values exceeding regulatory criteria were noted, particularly for pesticides/herbicides. These areas of the study area appear to be segregated "hotspots" and contribute little to the overall ecological conditions currently present or expected in the future. Thus, Diefenderfer and Ward (2002) found it unlikely that a complete exposure pathway can be inferred that would create unacceptable ecological risk at the organism, community, or population level before or after dike breaching.

The proposed project has incorporated measures to reduce the potential for harm associated with creosote residue at the former feed-lot site. As recommended by Diefenderfer and Ward (2002) a sand cap three feet in depth will be placed where creosote was detected prior to inundation of the property. Diefenderfer and Ward (2002) determined that this measure will reduce any environmental risk presented by these potential point sources.

Spartina control actions are not expected to result in significant impacts to sediments in and adjacent to the project area. Glyphosate is not environmentally persistent and would not accumulate within sediment from ground applications of Rodeo® tank mixes. Drift of Rodeo® tank mixes to non-target areas associated with ground applications to *Spartina* would be minimal under favorable environmental conditions (USFWS 1997). The NPDES permit for this work requires that broadcast applications of herbicides shall not be made when the wind speed at the application site exceeds ten miles per hour (Ecology 2002).

8.2 Natural Resources

8.2.1 Vegetation

The restoration of tidal hydrology will displace existing vegetation on the project site, as this vegetation will not be able tolerate daily inundation and increased salinity. Most of the project site will be left to recolonize naturally; predicted vegetation communities are described below. The US 101 road embankment and cross dikes will be seeded with tufted hairgrass (*Deschampsia cespitosa*) below +10' and a filter strip of bentgrass (*Agrostis* spp.) between +10' and +14' in elevation. Existing topsoil from may be stripped from the pasture and placed on the areas to be seeded.

Wetlands. The proposed action would result in the conversion of approximately 400 acres of freshwater (palustrine) wetlands to estuarine intertidal wetlands. Approximately 340 acres of wetlands on the project site have been designated as prior converted cropland by the NRCS; the proposed action would restore these palustrine wetlands to the estuarine intertidal wetlands that were present historically.

In terms of the Washington wetland rating system (Ecology 1993), this conversion would result in the loss of approximately 380 acres of Category II wetlands and approximately 20 acres of Category III wetlands, but a gain of approximately 400 acres of Category I[4] wetlands. As defined by the Ecology rating system, Category I wetlands are the highest quality wetlands in the state. Large estuarine wetlands are classified as Category I because estuaries are extremely productive ecosystems where tremendous quantities of sediments, nutrients, and organic matter are exchanged between terrestrial, freshwater, and marine communities; this productivity benefits an enormous variety of plants and animals (Ecology 1993).

Approximately 0.75 acre of undiked Category I salt marsh would be disturbed during excavation of three channel inlets on the river side of the dike (see Figure 10).

The WSDOT wetland delineation identified several principal functions of the freshwater wetlands on the project property, including habitat for wetland-associated birds, habitat for amphibians, organic matter production and export, and flood flow alteration. With the exception of habitat for amphibians, the re-introduction of tidal inundation will maintain or improve these functions. In addition, the proposed action would provide rearing habitat for commercially and recreationally important fish species.

Inside the diked area, ground surface elevations are generally lower and less heterogeneous than in the Potter Slough reference marsh area, suggesting compaction and subsidence from extended periods of grazing and lack of tidal influence. Topographic mapping of the

[4] A wetland can be rated as Category I if it meets any one of five Category I criteria (Ecology 1993). After implementation of the preferred alternative, the project would meet Criterion 4c, which classifies estuarine wetlands over 5 acres in size as wetlands with irreplaceable ecological functions.

restoration site shows that most of the property between + 5 and + 9 feet elevation, with some areas below +5 feet elevation (NAVD 88 datum).

Combined with this elevation data, information from the Batelle/WSDOT vegetation survey described in section 4.2.1 can be used to predict the vegetation communities that will likely colonize the marsh when it is restored to tidal action (Herrera Environmental Consultants 2002). Generally, above +9 feet (NAVD 88 datum) *Distichlis spicata* is expected to dominate. Between +7 feet and +9 feet, *Deschampsia caespitosa* will likely dominate, with *Distichlis spicata* and *Salicornia virginica* also present. Between +5 feet and +7 feet there will likely be competition between *Carex lyngbyei* and *Spartina alterniflora*; some areas of bare mud are also expected in this range. *C. lyngbyei* and bare mud would be present below +5 feet. Although *S. alterniflora* was not documented below +5 feet at Potter Slough, it is likely to be a dominant competitor in this elevation range.

Based on studies in a formerly diked wetland in nearby Grays Harbor, vegetation composition on the project site is expected to change dramatically in the first five to six years following dike breaching (Thom et al. 2002). Bare areas will likely dominate the site during the first few years, until elevation builds through accretion of sediments. Accretion rates in restored wetlands in Grays Harbor have been measured at approximately 1/8 inch (3.5 mm) per year (Thom 1992). During the first 1 to 6 years, it is likely that ephemeral species such as *Atriplex patula* and *Cotula* spp. will colonize the bare areas. *Salicornia* and *Carex* will likely follow these early colonizers, with *Distichlis* and *Deschampsia* gradually becoming more abundant over the first decade. Because of its wide salinity tolerance, *Carex* may dominate in areas of freshwater seepage at the landward edge of the site.

Spartina Control. Since *Spartina* would be expected to rapidly colonize bare areas very soon after dike removal, aggressive control measures would be implemented. These measures are described in Section 6.1.9.2. Taking no action to control *Spartina* in and adjacent to the restoration site would have more adverse impacts than reasonably applied control measures. Delays in initiating control measures would result in geometric increases in impacts and control costs.

8.2.2 Wildlife

Implementation of the preferred alternative would re-establish natural estuarine habitat processes, and therefore favor the native fauna of the area. The existing grazed wet pasture habitat would be returned to the natural condition of a mosaic of mudflat, marshes, and channels. As the restoration takes place and tidal inundation occurs, plant an animal communities will shift towards those species using a terrestrial/ freshwater habitats to those species using marine/estuarine habitats.

Waterfowl (e.g. ducks, geese, swans) and other water-dependant birds (e.g. herons, egrets, osprey, eagles), not only play a major ecological role in estuarine systems, but also provide recreational opportunities for hunters, photographers, and bird watchers. Many species are highly dependent upon wetlands and submerged aquatic vegetation for their survival.

8.2.3 Fisheries

Short-Term Construction Effects. As discussed in Section 8.1.3, short-term impacts to water quality—particularly turbidity—would result from construction activities associated with implementation of the preferred alternative. Several management measures, also described in Section 8.1.3, will be implemented to reduce the impact of increased suspended sediment concentrations on fish in the Willapa River. In addition, the removal of the dike, which is the part of the proposed action expected to have the largest impact on turbidity levels in the river, will occur outside of the juvenile salmonid out migration season (March 1 – June 15) so that smolts, the life history stage most sensitive to elevated turbidity levels, would not be affected by construction activities.

Potential physiological effects of increased suspended sediment concentrations on salmonids include: biochemical stress responses (elevated plasma glucose and cortisol levels), impaired osmoregulatory capacity, gill flaring (a response to gill irritation equivalent to a cough), impaired oxygen exchange due to clogged or lacerated gills, and reduced tolerance to infection. For short-term exposures (<4 days) to sublethal concentrations (14,400 mg/l), osmoregulatory capacity is not impaired (Servizi 1990). Sockeye have been shown to exhibit gill damage at exposures of 3,100 mg/l over 96 hours (Servizi 1990). Biochemical responses and gill flaring appear to be reversible, as recovery occurs when the stressor is removed or the fish escapes the plume. However, if the stress is chronic, a metabolic cost may be incurred (Servizi 1990).

Effects of increased suspended sediment concentrations on salmonids may also include deterrence from migratory paths, and reduced foraging success. The impact of turbidity on fish foraging behavior is not clear (Gregory 1990). Some experimental work has demonstrated declines in foraging rates and reaction distances toward planktonic prey with increasing turbidity, while one study indicates that the feeding of Pacific herring larvae may be enhanced by suspended sediment concentrations as high as 1000 mg/l (Gregory 1990). Laboratory tests have also shown that some juvenile salmonids tend to swim near the surface when exposed to suspended sediments, which may make them more vulnerable to bird predation (Servizi 1990).

Laboratory experiments like those cited above have yielded some information on the response of fish to elevated suspended sediment concentrations, but applicability of this information is highly subjective given the often conflicting results attributable to variations in experimental design. In addition, bioassay-type tests generally measure an endpoint, often mortality, under conditions dissimilar to those organisms encounter in the field. Dose-response relationships measured under laboratory conditions tend to simulate a worse-case scenario for motile organisms, which can often avoid unsuitable conditions (Clarke and Wilber 1999). Under most scenarios, fish and other motile organisms encounter localized suspended sediment plumes for exposure durations on a temporal scale of minutes to hours (Clarke and Wilber 1999). A few generalizations can be taken from this research, however. Smolts are the life history stage most sensitive to elevated turbidity. For this reason, dike removal will occur outside of the salmonid out migration period. It is also clear that turbidity

levels are unlikely to cause acute physiological injury to adult fish at any time during removal of the dike.

Construction activities associated with implementation of the preferred alternative would degrade water quality on a relatively localized and temporary basis, not over the long term nor Bay-wide. Given the width of the Willapa River and volume of water discharged, suspended sediment concentrations high enough to cause adverse effects would be diluted quickly and relatively limited in extent. Adult salmonids are expected to avoid these areas readily, while juveniles would be less able to avoid such areas. Therefore, dike removal would not occur during the juvenile out migration period. This timing restriction will reduce the potential for exposure of juveniles to adverse conditions. Therefore, impacts are not expected to be significant.

Long-Term Habitat Effects. The preferred alternative is expected to result in an increase in the capacity of the Willapa River to support fish populations and allow fish to utilize habitat within the project site. Under the no action alternative, fish would not have access to the project site.

It is likely that restored channel and marsh habitats will be utilized primarily by juvenile chum and summer Chinook salmon out migrants as areas for physiological transition, refuge, feeding, and growth during late spring through early summer. However, these shallow vegetated areas and dendritic channel systems may also provide functions to a number of other salmonid species, including coho salmon, steelhead, cutthroat trout, and char. Early out migrating coho fry (age-0 fry or pre-smolts) may feed and rear in productive estuarine habitats for extensive periods, a life-history strategy that may be especially prevalent in areas like the Willapa Basin where coastal populations reside in streams with seasonal low flows and elevated temperatures. Age 1+ coho smolts also utilize shallow intertidal marsh habitats for feeding and cover during out migration. Coastal cutthroat trout juveniles and adults feed and migrate over a variety of substrates within estuarine habitats during the spring to fall. While coastal cutthroat trout rarely over winter in saltwater, they can be found in tidal freshwater areas of estuaries as they await favorable conditions to move upstream.

Fish access marshes primarily through tidal channels during cycles of tidal pulsing. Access is constrained by channel depth, which is dependant on the tide stage. In Pacific Northwest estuaries, only the larger tidal channels tend to be deeper than the mean lower low water elevation, so most channels dewater completely during spring low tides. Young salmonids occupy a matrix of estuarine habitats rather than a particular habitat, and may benefit if there is a place where they can reside during low tides in close proximity to where they are feeding in the marshes. If flow-restricted areas move fish far from productive feeding areas, this would theoretically be a detriment to the fish. Marshes with deeper channels tend to have areas where fish can find refuge during low tides. Once the tide rises, the fish can again move up into smaller channels to feed. By incorporating larger/deeper channels into the preferred alternative, the site would potentially provide expanded periods of utilization of the system by these fish.

Based on post-construction monitoring of other Northwest dike breach and slough construction projects (Cordell et al. 1998, Simenstad et al. 2001, Tanner et al. 2002), it is expected that juvenile salmonids will access the project site in numbers roughly comparable natural sloughs shortly (1 to 5 years) after dike removal is complete. However, preferred benthic prey resources may not be available within the project site during this time frame. As the transition from a freshwater pasture to a saltwater marsh progresses, there will be large fluctuations in densities and assemblage structure of juvenile salmonid invertebrate prey organisms (Cordell et al. 1998). During this transition period, it is expected that the diets of salmonids in the newly restored habitat would consist of a higher proportion of fallout insects.

Effects of *Spartina* Control Efforts. Paveglio et al. (1996) examined the fate of the herbicide formulation commonly used to treat *Spartina* infestations in Willapa Bay. Study plots were located in three locations in southern Willapa Bay. The plots consisted of 25% *Spartina* (clones and seedlings) and 75% mudflat with eelgrass. Rodeo® and X-77® Spreader were applied aerially at low tide. These conditions approximate a worst-case scenario for over-spray associated with the treatment of *Spartina* in Willapa Bay (Paveglio et al. 1996). Concentrations of the Rodeo® and X-77® Spreader in spray deposit, sediment, off-site seawater, seawater, and *Spartina* were measured at 1, 14, 28, and 119 days post-treatment.

Results of the fate analysis were then compared to concentrations of the same herbicide formulation found to elicit toxicological responses in laboratory studies. The concentration of glyphosate found during the first tidal inundation of the study was 23,000 to 56,000-fold less than the 96 hour LC50 concentrations (the dose that results in the death of 50% of the organisms in the bioassay test) for Chinook and coho, and 108-fold less than the concentration that did not disrupt seawater adaptation or growth of coho salmon smolts (Paveglio et al. 1996). The maximum concentration of glyphosate in seawater during this study was 25 to 39,000-fold less than the 96 hour LC50 concentration for fertilized eggs of Atlantic oysters (*Crassostrea vulgaris*), fiddler crabs (*Uca pugilator*), grass shrimp (*Palaemonetes vulgaris*), a marine diatom (*Skeletonema costatum*), mysid shrimp (*Mysidopsis bahia*), and sea urchins (*Tripneustes esculentus*).

Paveglio et al. (1996) concluded that because glyphosate tightly adsorbs to the soil, does not bioaccumulate, and a large margin exists between maximum concentrations of glyphosate found in seawater in his study and concentrations that result in acute and subacute impacts to aquatic organisms, it is unlikely that toxicological effects to marine organisms from glyphosate in seawater would result from Rodeo® treatment of *Spartina*.

In a companion study, Simenstad et al. (1996) did not detect short (28 days post-treatment) or long-term (119 days post-treatment) effects to epibenthic invertebrate communities within the test plots.

Based on the results of these and other studies (e.g., Kubena et al. 1996), the use of herbicides to control *Spartina* is not likely to result in significant effects to fish or their prey organisms.

8.3 Threatened and Endangered Species

8.3.1 Bald Eagle

Construction activities associated with implementation of the preferred alternative will occur outside of the bald eagle wintering period (October 31 – March 31) and during a time when eagles are more tolerant of noise disturbance. No communal night roosts or perch trees would be physically disturbed by construction activities. Likewise, the preferred alternative would have no effect on the nest site approximately 1.5 miles from the project site.

The project area provides important bald eagle feeding habitat, particularly during the wintering season. Anadromous fish returning to spawn, waterfowl, and shorebirds are the primary prey items in and around Willapa Bay and its associated drainages.

Foraging bald eagles may be displaced by the noise of heavy equipment, but are not expected to be significantly disrupted by project construction. Eagles tend to tolerate more disturbance at feeding sites than in roosting areas (Steenhof 1978). Implementation of the preferred alternative is not expected to have a significant effect on the availability of prey within the project area. Re-introduction of tidal inundation to the project site will result in the displacement of some prey items, namely rodents and small mammals, currently on the property. However, the project would provide habitat for waterfowl and shorebirds, which are prey items.

The proposed project is *not likely to adversely affect* the bald eagle.

8.3.2 Marbled Murrelet

Construction activities associated with implementation of the preferred alternative would occur adjacent to murrelet foraging habitat. Noise levels are a concern since heavy equipment operation will produce noise above ambient levels. The effects of human disturbance on murrelets at sea is not well documented, but they apparently habituate to heavy levels of boat traffic (Strachan et al. 1995). Marbled murrelets are relatively opportunistic foragers; they have a flexibility in prey choice which likely enables them to respond to changes in prey abundance and location (USFWS 1996). This indicates that if murrelets are present in the immediate vicinity of heavy equipment and they are disturbed while foraging, they would likely move without significant injury.

Construction activities are not expected to result in a reduction in the abundance or distribution of murrelet prey items. Increases in turbidity associated with dike removal could reduce visibility in the immediate vicinity of the project site, thereby reducing foraging success for any murrelets that remain in the area. Any reduction in availability of food would be highly localized and would be expected to subside rapidly.

Construction activities would have no effect on murrelet nests or nesting habitat.

The proposed project is *not likely to adversely affect* the marbled murrelet.

8.3.3 Northern Spotted Owl

The operation of heavy equipment associated with the implementation of the preferred alternative will produce elevated noise levels. There are no established guidelines for disturbance since spotted owls, like many raptors, have a variable tolerance for disturbance and human activity. However, USFWS guidance suggests that loud or disruptive activities located within a 0.25 mile radius of activity centers or nest sites be conducted outside of the nesting period (USFWS 1999). No USFWS critical habitat units are located within one mile of the project site (2/4/02 Species List Query by Curtis Tanner, USFWS Western Washington Office).

The preferred alternative would have no impact on owl nesting, roosting, or foraging habitat.

The proposed project will have *no effect* on the Northern spotted owl.

8.3.4 Steller Sea Lion

Given the lack of rookery and major haul-out areas in and near Willapa Bay, implementation of the preferred alternative would have no effect on breeding habitat or behavior. No haul-out sites will be physically disturbed. Noise associated with upland construction activities would not result disturb any sea lions in the Willapa River. There would be no reduction in the abundance and distribution of Stellar sea lion prey items associated with the proposed project. Increases in turbidity associated with dike removal are not expected to reduce visibility to the extent that foraging success could be impacted.

The proposed project would have *no effect* on the Steller sea lion.

8.4 Cultural Resources

The Willapa Bay estuary has experienced earthquake-induced subsidence at numerous times in the past, resulting in lowering of the ground surface. Past subsidence in the northeast corner of the estuary is evidenced by the documentation of a number of archaeological deposits below the present high tide line. The documentation of submerged sites in the vicinity of the project area, combined with the presence within the project area of geomorphological features likely to contain cultural resources, such as two large sloughs and the shore of the Willapa River, provide sufficient justification for archaeological monitoring in selected areas during ground disturbing activities.

Prior to the initiation of construction, the State Historic Preservation Officer (SHPO) will be consulted concerning details of the proposed archaeological construction monitoring. A Memorandum of Agreement (MOA) that covers the proposed monitoring, the process to be followed if an archaeological site is discovered, and the subsequent reporting back to OAHP at the completion of the project will be developed between the Corps, OAHP, and the Shoalwater Bay Tribe.

8.5 Socio-Economic Resources

8.5.1 Land and Shoreline Use

The preferred alternative is consistent with the shoreline policies contained in the 2000 Pacific County Shoreline Master Program (County Resolution No. 2000-039). Specific shoreline policies (contained in Section 3. Introduction to Policies and Regulations, B. Shoreline Policies) with which the preferred alternative has been designed to satisfy include:

- 4.(b.) Reclaim and restore areas which are biologically and aesthetically degraded to the greatest extent feasible.
- 4.(c.) Preserve scenic vistas, aesthetics, and vital estuarine estuaries for fisheries and wildlife protection.
- 5.(b.) Design public access projects such that they provide for public safety and minimize potential impacts to private property and individual privacy.
- 7.(b.) Encourage educational projects and programs that foster a greater appreciation of the importance of shoreline management, maritime activities, environmental conservation, and maritime history.
- 11.(b.) Invasive, noxious weeds causing irreparable damage to the shoreline environmental should be removed with all due diligence.
- 25.(e.) Locate and design recreational developments to preserve, enhance, or create scenic views and vistas.
- 29.(a.) Allow location, design, construction, and maintenance or removal of dikes and levees so that they will not cause significant damage to adjacent properties or valuable resources.

The Corps will prepare a detailed coastal consistency statement to establish that the proposed action complies with the policies, general conditions, and general activities specified in the Pacific County Shoreline Master Program. The Corps will then submit the consistency determination to the Department of Ecology and Pacific County for review.

8.5.2 Economy

The impacts of the loss of approximately 420 acres of pasture land are not expected to be significant to the agricultural sector of Pacific County's economy. The Findings of Fact and Conclusions of Law associated with Pacific County Resolution 98-089, which adopts the 1998 Pacific County Comprehensive Plan, found that: "…it is highly questionable whether a reasonable monetary rate of return can be obtained from farming activities that do not involve aquaculture or cranberry production. Commodity crops are virtually nonexistent in Pacific County." Farmland within Pacific County designated as prime by a 1986 USDA Soil Conservation Service Soil Survey has severe limitations based on high rates of erosion and excessive water in or on the soil. Only land devoted to aquaculture and cranberry production was designated "Agricultural Land of Long-term Commercial Significance" by the Pacific County Comprehensive Plan. As described in previous sections of this document, the

proposed project is not expected to result in significant impacts to oyster aquaculture downstream of the project site. High soil and porewater salinities on the project site would make cranberry farming on the property problematic.

The acquisition of land by the NRCS and WDFW provided financial relief to willing sellers of former agricultural lands.

8.5.3 Recreation

The implementation of the preferred action will make available for public access lands currently off-limits to the general public. Construction of the highway pull-out provides parking and other amenities to assist the public in viewing and learning from the site.

8.5.4 Mosquitoes

Under the no action alternative, over 25,000 lineal feet of ditches with very limited circulation are present on the project site. As a result, the project site supports large numbers of freshwater mosquitoes. Tide gates prevent fish, which are prey on mosquito larvae, from entering the ditches.

Since implementation of the proposed project would change hydrology of the project site from fresh water to salt water, the composition of the mosquito community would be expected to shift to those species tolerant of increased salinity, such as the golden marsh mosquito *Aedes dorsalis*. Overall, a reduction in mosquito abundance is expected to result from the proposed project.

The proposed project would offer two types of mosquito control benefits: source reduction and biological controls. The source reduction benefit consists of eliminating larval habitats or rendering them unsuitable for larvae development. The ditches currently on the site would be eliminated by filling them with dike material. In addition, the construction of an interconnected system of channels that regularly flood and drain would re-introduce moving water to the property, which is detrimental to mosquito larvae. The biological control benefit consists of the re-introduction of fish to the property, which is expected to reduce the reproductive success of mosquitoes within the project site. Small fish, including juvenile salmon, are known to be very effective predators of mosquito larvae and adults.

Studies of a salt marsh in San Francisco Bay after a levee breach support the idea that hydrologic restoration may be a means of mosquito control and management (Liu n.d., and Kramer et al. 1995). These studies noted a reduction in the salt marsh mosquitoes *Aedes dorsalis* and *A. squamiger* after a levee breach allowed bay water to flood study wetlands. The authors suggest that enhanced tidal circulation might have reduced mosquito abundance by impeding the conditioning process of the eggs, by promoting predation on eggs and larvae, or by decreasing the amount of standing water available for breeding (Kramer et al. 1995).

Implementation of the preferred alternative is not expected to increase the risk of contracting West Nile virus in Pacific County. In parts of the country where West Nile is present, the virus has been detected in as many as 40 mosquito species. Only seven mosquito species present in Washington are among those in which the virus has been detected: *Culex pipiens, Culex tarsalis, Aedes vexans, Aedes cinereus, Anopheles punctipennis, Coquillettidia perturbans,* and *Ochlerotatus japonicus* (Tom Gibbs, Washington Department of Health Zoonotic Disease Program, pers. comm.). Only one of these species, *Culex tarsalis,* is commonly found in salt marshes. *Culex tarsalis* is a widespread species also found in a wide variety of permanent and semi-permanent freshwater habitats, such as wet pastures, woodland pools, riparian areas, and woodland pools. It is likely that the project site currently provides larval habitats for *Culex tarsalis, Aedes vexans,* and *Aedes cinereus.*

8.5.5 Transportation, Public Services, and Utilities

Lane closures will be accomplished by contractor-piloted traffic control and flaggers as needed. Standard Traffic Control method will apply. Emergency services, school buses, and public transit may be impacted. These will be given preferential treatment and allowed to pass through the work zone. No impacts to utilities are anticipated.

Highway US 101 will not be flooded by the implementation of the preferred alternative. WSDOT will raise US 101 to an elevation of 15.5 feet, which is one foot higher than the 100-year flood event. The bottom of the bridge will be above elevation 14.5, the 100-year flood event elevation. The new road grade is being designed by WSDOT, and will meet WSDOT requirements for safety. The design does accommodate the fact that the road embankments on both sides will be inundated by the tides. The road will provide uninterrupted access, and will not be subject to closures due to tidal inundation.

8.5.6 Aesthetics and Noise

Implementation of the preferred alternative will result in a short-term degradation of visual resources as compared to the no action alternative. The re-introduction of tidal waters onto the project site will result in dying and decaying vegetation, which will be visible from US 101. However, after vegetation begins to colonize the restored area, the project site will transform into a natural, scenic vista that is compatible with the surrounding landscape and enhances views of the Willapa River.

The operation of heavy equipment associated with the project will temporarily increase ambient noise levels in the immediate project vicinity. These increases will be temporary, minor in scope, and highly localized. Therefore, they are not expected to result in significant impacts.

9 Cumulative Effects

Cumulative impacts are assessed by evaluating the incremental effects of past, present, and future actions. The purpose of this project is to counteract some of the degradation that

occurred when intertidal wetlands were diked and filled along lower Willapa River. The preferred alternative will not reverse all adverse impacts associated with past development, but it is an improvement over the no action alternative. The project has been designed to restore ecological functional connections between habitats along the lower Willapa River and throughout Willapa Bay, so that overall impacts should be beneficial to species that use these habitats.

10 Cost Estimate and Schedule

10.1 Real Estate

The Real Estate plan, prepared in accordance with ER 405-1-12, Change 31 of 1 May 1998, is presented in Appendix E. The estimated LERRD credits associated with this project are $181,000.

10.2 Project Cost Estimate

This section shows the cost of the Corps' cost-shared work only. In addition to the Corps' cost-shared work, WSDOT is funding construction of the road and NRCS is funding construction of the highway bridge and waterfowl habitat improvements.

The construction cost estimate prepared using MCACES is presented in Appendix B.

Table 4. Project Modification Costs

				Federal Funding Needs				
	Totals	Non-Federal	Federal	Prior years	FY03	FY04	FY05	Out years
Report	172.0		172.0	165.0	7.0	0.0	0.0	0.0
P&S	80.0		80.0		80.0	0.0	0.0	0.0
Construction	2,150.0	600.5	1,549.5		1,166.3	323.3	0.0	60.0
Totals	2,402.0	600.5	1,801.5	165.0	1,253.3	323.3	0.0	60.0

Dollars in thousands

Sponsor LERRD credit is estimated at $181,000. Sponsor cash contribution is estimated at $419,500.

10.3 Design and Construction Schedule

Due to the simple nature of the work and the method of construction, the feasibility level design will be sufficient to accomplish the Federal cost-shared construction. The Plans and Specifications phase will be used to obtain permits and familiarize the construction supervisors with the project. WSDOT and NRCS are proceeding now with preparation of bid packages for the highway, bridge, and waterfowl feature construction.

Five agencies are involved in constructing features of this project. WDFW has removed structures and retired wells in the area to be inundated. WSDOT will reconstruct the highway and construct the bridge. The Corps will grade the area to be inundated, build the new dikes, and remove the old dike. NRCS will contract the construction of features in the waterfowl habitat area in partnership with Ducks Unlimited. The work to be done by the three construction agencies must proceed in order, and will be accomplished in three phases:

Phase 1 (Summer 2003):

- Raise US 101 and build the bridge.
- Grade the inundation area.
- Excavate remnant channels.
- Build the highway turnout.
- Build the new cross dikes. The construction of the new dikes is anticipated to require two construction seasons because they will need to settle.
- Build the waterfowl habitat features.

Phase 2 (Summer 2004):

- Remove the old dike.
- Connect restored tidal channels to the River.
- Top off the new cross dikes.
- Monitor water quality during in-water construction.

Phase 3 (Spring 2005 and beyond):

- Implement *Spartina* control program.
- Implement monitoring program to evaluate site performance.

The Phase 1 work is anticipated to occur in 2003, if all environmental approvals are received in time. WSDOT and the Corps will be handling all environmental compliance tasks separately, and each agency will proceed with their portion of the work as soon as possible.

The Phase 2 work will proceed the year after Phase 1 is complete. The removal of the old dike is dependent on the completion of all of the Phase 1 work, with the exception of the waterfowl habitat improvements. If construction of the waterfowl features is delayed, the removal of the old dike can proceed on schedule.

Following completion of construction, the Corps will participate in 10 years of interagency monitoring efforts led by USFWS. The approved cost of the Corps' portion of the monitoring effort is $80,000.

10.4 Non-Federal Responsibilities

The non-federal sponsor, Washington Department of Fish and Wildlife (WDFW), is responsible or the operation and maintenance requirements. Additionally, WDFW will provide all necessary lands, easements and rights of way (LERRD) for construction and operation/maintenance of the project in perpetuity. All LERRD that WDFW provides will be credited towards the overall 25% local share of the implementation costs.

11 Coordination and Local Support

11.1 Public and Agency Coordination

The local sponsor, WDFW, has coordinated with Pacific County and the City of South Bend regarding the planning for this project. Inclusion of the US 101 pull-out resulted from this early coordination.

USFWS has hosted most of the inter-agency committee meetings. USFWS has also hosted a meeting with NMFS and the project team on Endangered Species Act issues relating to this project.

The Clean Water Act public notice for the preferred plan was sent out on September 12, 2002. The Corps has coordinated with Washington Department of Ecology (Ecology) in preparation of their review of the project for the 401 Water Quality Certification.

11.2 Views and Preferences of Project Partners

The project partners support the preferred plan. A letter of support from WDFW is included in Appendix H. The inter-agency committee—made up of representatives from the Corps, WDFW, NRCS, WSDOT, USFWS, and Ducks Unlimited—meets regularly. All participants contributed to the development of the recommended plan, and have voiced their preference for that plan.

12 Environmental Compliance

12.1 National Environmental Policy Act

This Environmental Assessment (EA) satisfies the documentation requirements of the National Environmental Policy Act (NEPA). A draft Finding of No Significant Impact (FONSI) is included in Appendix G. After the comment period for this document has ended, this EA will be finalized and it is anticipated that the Commander of the Seattle District will sign the FONSI.

12.2 Endangered Species Act

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

The USFWS has participated on the inter-agency project team and is assisting with the Corps' Section 7 consultation. USFWS is currently assessing the applicability of a Programmatic Biological Opinion for restoration activities to this project. If this project can proceed under conditions of the Programmatic documents, a streamlined consultation is expected. Only those elements outside of the scope of the Programmatic documents (e.g., herbicide application associated with *Spartina* control) would require addition documentation.

12.3 Clean Water Act

Under Section 404 of the Clean Water Act (CWA), a permit is required for discharges of dredged or fill material into water of the United States. Waters of the United States are defined to include wetlands. However, if the lead agency for a project is the Corps of Engineers, a permit is not issued. Instead, Corps staff prepares a 404(b)(1) evaluation, which demonstrates compliance with the substantive requirements of the CWA.

The Corps issued a 404 Public Notice for this project on September 12, 2002 (Reference Number: CENWS-PL-02-03). Once the comment period is complete, a 404(b)(1) evaluation will be prepared.

Under Section 401 of the CWA, a Water Quality Certification is required for activities which may result in any discharge into the navigable waters. The certification, issued by the Washington State Department of Ecology (Ecology), ensures that the discharge will comply with the applicable provisions of Sections 301, 302, 303, 306 and 307 of the CWA. In order to obtain the required certification, the State of Washington may require a temporary modification to state water quality standards.

Public Notice CENWS-PL-02-03 served as an application for a Section 401 Water Quality Certification from the Department of Ecology. The Water Quality Certification will be obtained during the Plans and Specifications phase of the project, after further coordination with Ecology and USFWS regarding turbidity control methods.

12.4 Coastal Zone Management Act

The Coastal Zone Management Act of 1972, as amended, requires Federal agencies to carry out their activities in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved Washington Coastal Zone Management (CZM) Program. The Shoreline Management Act of 1972 (RCW 90.58) is the core of authority of Washington's CZM Program. Primary responsibility for the implementation of the SMA is

assigned to local government. Pacific County implemented the SMA through the preparation of a Shoreline Master Program, which was approved by the Department of Ecology.

Pursuant to National Oceanic and Atmospheric Administration (NOAA) Federal consistency regulations (15 CFR 930) and Washington State shoreline management permit procedures (WAC 173-27), the Corps will prepare a evaluation to establish that the proposed action complies with the policies, general conditions, and general activities specified in the Pacific County Shoreline Master Program. The Corps will then submit the consistency determination to the Department of Ecology and Pacific County for review.

12.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (16 USC 470) requires that a federal agency having direct or indirect authority to issue a license authorizing an undertaking shall take into account the effect of the undertaking on historic properties.

The Section 106 process includes research and field investigation in consultation with the Washington State Office of Archaeology and Historic Preservation (OAHP), the Advisory Council on Historic Preservation, and concerned Tribes and local governments. The process generally includes identifying historic properties that may be affected by the project; gathering information sufficient to evaluate the eligibility of properties found for the National Register; and consulting among agencies and other concerned parties to avoid or mitigate adverse impacts on significant properties.

To comply with the National Historic Preservation Act, a historic site records search was conducted at the Washington State Office of Archaeology and Historic Preservation (OAHP) and a pedestrian archaeological reconnaissance survey was conducted of a portion of the proposed project area. Construction monitoring by an archaeologist will occur in selected areas due to the possible presence of buried cultural resources. Prior to the initiation of construction, the State Historic Preservation Officer (SHPO) will be consulted concerning details of the proposed archaeological construction monitoring. A Memorandum of Agreement (MOA) that covers the proposed monitoring, the process to be followed if an archaeological site is discovered, and the subsequent reporting back to OAHP at the completion of the project will be developed between the Corps, OAHP, and the Shoalwater Bay Tribe.

12.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act 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 US Fish and Wildlife Service (USFWS) habitat surveys evaluating the likely impacts of proposed actions, which provide the basis for recommendations for avoiding or minimizing such impacts.

Coordination with USFWS has been ongoing throughout the study process. The USFWS is a member of the interagency committee involved in planning of the proposed restoration project, and USFWS involvement on the committee is expected to continue thought the life of the project.

The USFWS has prepared a *Preliminary Draft FWCA Report* to document USFWS involvement in the project during the Feasibility Phase, describe the project features, and identify any concerns that need to be addressed in more detail during the Plans and Specifications phase of the project. This report can be found in Appendix F.

12.7 Magnuson Fishery Conservation and Management Act

The Magnuson Fishery Conservation and Management Act requires Federal agencies to consult with the National Marine Fisheries Service (NMFS) regarding actions that may affect Essential Fish Habitat (EFH) for Pacific coast ground fish, coastal pelagic species, and Pacific salmon. The Act defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Descriptions of EFH are provided in Fishery Management Plans produced by the Pacific Fisheries Management Council.

An EFH evaluation will be included in any ESA Section 7 documentation required by USFWS and NMFS.

12.8 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 prohibits the unauthorized obstruction or alteration of any navigable water of the United States. Activities that involve the construction of dams, bridges, dikes etc. across any navigable water, or placing obstructions to navigation outside established Federal lines and excavating from or depositing material in such waters, require permits from the Corps. The Corps conducts public interest reviews to ensure that proposed projects comply with Section 10, and as part of these reviews coordinates with other Federal, State, and local agencies.

Once the comment period for Public Notice CENWS-PL-02-03 is complete, an evaluation documenting the Corps' findings regarding this project pursuant to the Rivers and Harbors Act will be prepared.

12.9 Clean Air Act

The Clean Air Act required states to develop plans, called State implementation plans (SIP), for eliminating or reducing the severity and number of violations of National Ambient Air Quality Standards (NAAQS) while achieving expeditious attainment of the NAAQS. The Act also required Federal actions to conform to the appropriate SIP. An action that conforms with a SIP is defined as an action that will not: (1) cause or contribute to any new violation of any standard in any area; (2) increase the frequency or severity of any existing violation

of any standard in any area; or (3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

The project area is not located in a non-attainment area, and any adverse impacts to air quality associated with the project will be temporary and highly localized, so the project will not cause or contribute to any new violation of any standard in any area.

12.10 Washington State Hydraulic Code

Work that uses, diverts, obstructs, or changes the natural flow or bed of any freshwater or saltwater of the state requires a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW). The statutory authority for this requirement is contained in Chapter 75.20 RCW and Chapter 220-110 WAC. The HPA is not a Federal requirement, and the Corps will not obtain an HPA, nor will the Corps be subject to the terms of an HPA obtained by the local sponsor.

However, the local sponsor is planning to obtain an HPA for the proposed construction work. The WDFW Area Habitat Biologist responsible for issuing HPAs in the project area has provided technical support for this program and is a member of the interagency committee that is involved in planning of the proposed restoration project. Her involvement on the committee is expected to continue thought the life of the project. The Corps expects that the final project will be in compliance with any conditions of the HPA.

12.11 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.

The Shoalwater Bay Tribe constitutes a distinct, separate community of Native Americans who rely on Treaty-reserved fish for subsistence, economic, and spiritual purposes. The implementation of the preferred alternative is not expected to result in any disproportionate adverse environmental effects or impacts on the health of tribal members, or other minority/low-income populations.

The project does not involve the siting of a facility that will discharge pollutants or contaminants, so no human health effects would occur. No interference with treaty rights is anticipated, as construction would not physically interfere with fishing in usual and accustomed places, and the restoration plan is intended to beneficially impact fishery resources. Implementation of the proposed projects would not negatively affect property values in the area, or socially stigmatize local residents or businesses in any way.

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This report draws on previous work from a variety of sources, including those listed in the reference section. Not all sources were directly credited. This is common in documents of this type and does not represent either a lack of appreciation nor an attempt to claim their work as our own. The following staff contributed to the preparation of this document:

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15 Conclusion

Based on the preceding environmental assessment, this project is not a major Federal action significantly affecting the quality of the human or natural environment, and therefore does not require preparation of an environmental impact statement.

16 Recommendation

I recommend that the proposed work be authorized and funding allotment of $2,230,000 be made available to complete construction. The proposed work would improve fish and wildlife habitat along the Willapa River near South Bend, Washington, as generally described in this report, with such modifications by the Chief of Engineers as may be advisable to meet provisions of Section 1135 of the 1996 Water Resources Development Act, as amended. Authorization is subject to cost sharing and financing arrangements with the local sponsor, the Washington Department of Fish and Wildlife, and is based on the cost sharing and financing requirements as contained in Public Law, 99-662, as amended. Prior to construction, and during Plans and Specifications stage, the local sponsor will: provide all lands easements, and rights of way necessary for the project; hold and save the United States free from damages due to the construction or operation and maintenance of the project; and operate and maintain the project after construction.

Date: _____ _____

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