US Army Corps of Engineers ®
Portland District

DRAFT
Integrated Implementation Report and Environmental Assessment

Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge

Section 536 Habitat Restoration Project Lower Columbia River and Estuary

Brooks Slough on the Julia Butler Hansen National Wildlife Refuge

Project Partners:
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service

August 2007

ABBREVIATIONS AND ACRONYMS

AAHU	average annual habitat unit(s)
BMP	best management practices(s)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Corps	U.S. Army Corps of Engineers
CRM	Columbia River mile(s)
cy	cubic yard(s)
DMEF	Dredged Material Evaluation Framework
DPS	Distinct Population Segment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FONSI	Finding of No Significant Impact
FY	fiscal year
HTRW	hazardous, toxic, and radioactive waste
IDC	interest during construction
IWR	Institute for Water Resources
JARPA	Joint Aquatic Resources Permit Application
JBH NWR	Julia Butler Hansen National Wildlife Refuge
LCFRB	Lower Columbia Fish Recovery Board
LCREP	Lower Columbia River Estuary Program
MDL	method detection limit
MRL	method reporting limit
mg/L	milligrams per liter
ND	non-detect
NMFS	National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
O&M	operations and maintenance
PCBs	polychlorinated biphenyls
SEF	Sediment Evaluation Framework
SHPO	State Historic Preservation Office
ug/kg	micrograms per kilogram
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology

English to Metric Conversion Factors

To Convert From	To	Multiply by
feet (ft)	meters	0.3048
miles	kilometers (km)	1.6093
acres	hectares (ha)	0.4047
acres	square meters (m^2)	4047
square miles (mi^2)	square kilometers (km^2)	2.590
acre-feet	hectare-meters	0.1234
acre-feet	cubic meters (m^3)	1234
cubic feet (ft^3)	cubic meters (m^3)	0.02832
feet/mile	meters/kilometer (m/km)	0.1894
cubic feet/second (cfs or ft^3/s)	cubic meters/second (m^3/s)	0.02832
degrees fahrenheit (°F)	degrees celsius (°C)	(Deg F - 32) x (5/9)

EXECUTIVE SUMMARY

Over the past 100 years, dike and levee building, agricultural and urban development, navigation channel operation and maintenance, hydrosystem operations, and other activities have reduced the amount of available wetland habitat in the lower Columbia River and estuary by about 75% over historical levels. The U.S. Army Corps of Engineers, Portland District and the project sponsor, the U.S. Fish and Wildlife Service, propose to restore tidal flow and fisheries access to 87 acres of slough habitat, and restore 210 acres of native riparian forest habitat on the Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge located at Columbia River miles 34 to 36 near Cathlamet, Washington.

The proposed project will benefit a multitude of fish and wildlife species, including 13 Columbia River salmonid Evolutionarily Significant Units that are listed under the Endangered Species Act, and the endangered Columbian white-tailed deer, as well as bald eagles, waterfowl, and Neotropical migratory bird species. Proposed restoration of tidal sloughs and riparian forest habitat, particularly their connectivity to the mainstem Columbia River, will better mimic the more natural riparian forest/tidal channel habitats that were historically abundant in the Columbia River estuary than under present conditions. A monitoring effort will measure the response of juvenile salmonids to the restoration measures.

Restoration of habitat for juvenile salmonids migrating through the lower Columbia River and the estuary is an important component of regional recovery plans. The proposed project addresses some of the limiting factors and fish and wildlife needs identified in the 2001 *Lower Columbia River and Columbia River Subbasin Summary*. The proposed project also is consistent with and will help achieve the Northwest Power and Conservation Council's biological objectives outlined in the 2000 *Columbia Basin Fish and Wildlife Program*. The proposed project addresses habitat restoration requirements for listed salmonids and will aid in U.S. Fish and Wildlife Service's recovery efforts for the endangered Columbian white-tailed deer.

This integrated Implementation Report and Environmental Assessment examines existing conditions on the Julia Butler Hansen National Wildlife Refuge, proposes alternatives for restoring important habitat functions on the refuge, identifies a preferred restoration alternative, and evaluates the potential environmental impacts of the preferred alternative in accordance with the National Environmental Policy Act.

Julia Butler Hansen National Wildlife Refuge
Section 536 Habitat Restoration Project

Integrated Implementation Report and Environmental Assessment

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Note: * Indicates information required for National Environmental Policy Act compliance.

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1. INTRODUCTION

1.1. Purpose and Need*

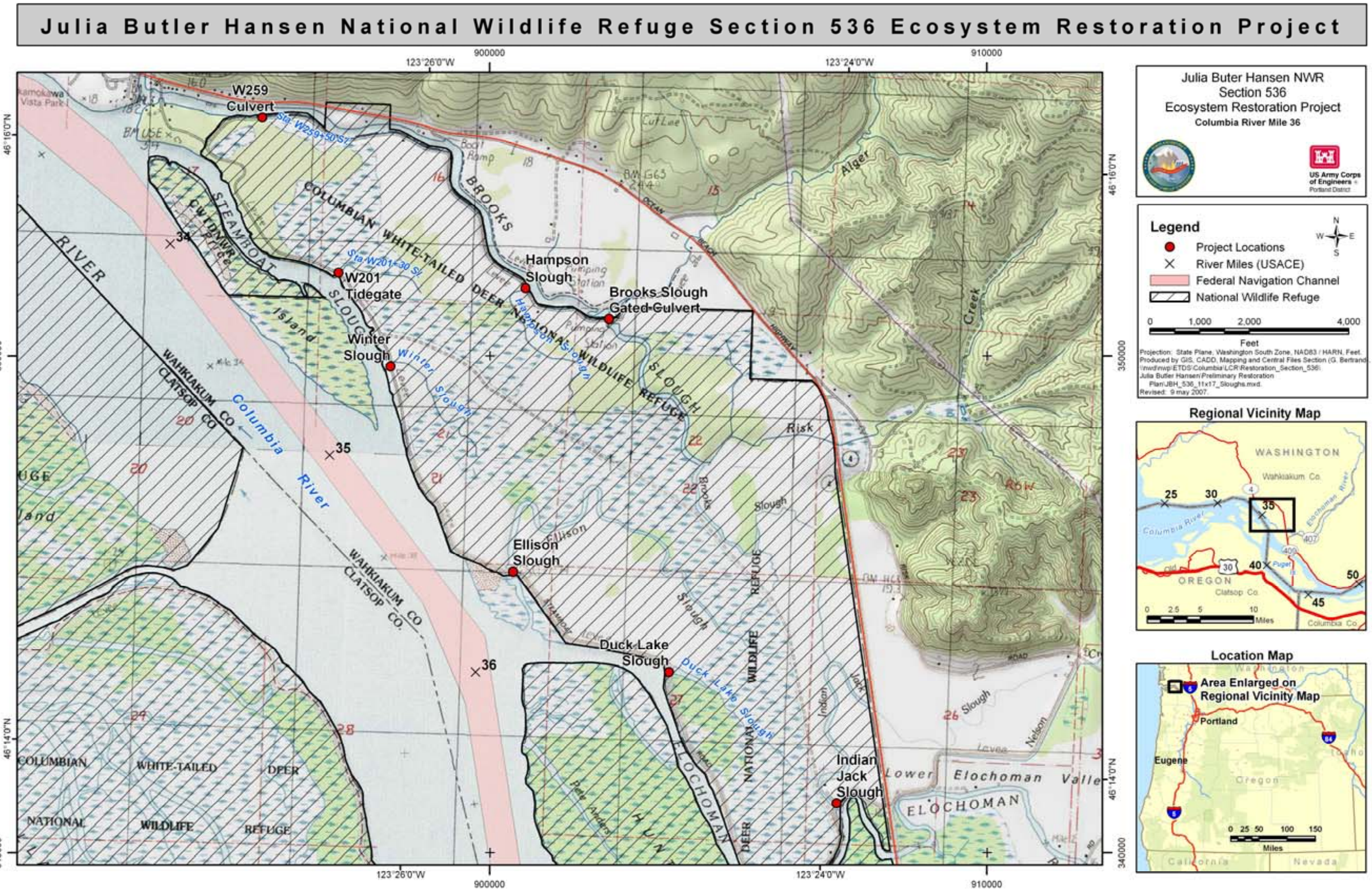
The purpose of the Julia Butler Hansen National Wildlife Refuge (JBH NWR) Section 536 Habitat Restoration project is to restore fish passage and muted tidal influence to sloughs and develop riparian forest habitat on the refuge to benefit many fish and wildlife species in the lower Columbia River and estuary (Figure 1). The proposed project will provide improved habitat conditions and access/egress to juvenile salmonid rearing/foraging habitat for threatened fall Chinook salmon (*Oncorhynchus tshawytscha*) subyearlings and for threatened chum salmon (*Oncorhynchus keta*), both Endangered Species Act (ESA)-listed Evolutionarily Significant Units (ESUs), as well as for coho salmon (*Oncorhynchus kisutch*), a candidate species for listing. Other salmonids including endangered Snake River sockeye salmon (*Oncorhynchus nerka*), threatened steelhead trout (*Oncorhynchus mykiss*), and coastal cutthroat trout (*Oncorhynchus clarki*) also are expected to benefit indirectly from the restoration of tidal flows to sloughs on the JBH NWR. The proposed project also would provide for habitat improvements for waterfowl, bald eagles (*Haliaeetus leucocephalus*), and Neotropical migratory birds, and would contribute to the recovery of the federally endangered Columbian white-tailed deer (*Odocoileus virginianus leucurus*). A monitoring effort will measure the response of fish, especially juvenile salmon, and Columbian white-tailed deer to the restoration measures.

The need for habitat restoration at JBH NWR is predicated upon the significant historic losses of tidal slough and tidal swamp habitats along the lower Columbia River. Over the last century, the amount of tidal swamp habitat (including tidal sloughs in the region) has decreased by about 78% over historical levels because of dike and levee building and associated development activities (NPCC 2002). The project area itself is currently a disturbed ecosystem previously altered by diking, drainage, clearing of tidal swamp forest and subsequent agricultural use.

Riparian plant communities dominated by Oregon ash (*Fraxinus latifolia*) and black cottonwood (*Populus trichocarpa*) forest have declined about 86% from historical levels, and forested swamp dominated by Sitka spruce (*Picea sitchensis*) has declined about 70% (Graves et al., 1995; Corps 1996). Restoration of riparian habitat to benefit juvenile salmonids migrating through the lower Columbia River and estuary is an important component of regional recovery plans and the successful reestablishment of healthy, self-sustaining populations. The lower river and estuary are critical areas for migrating juveniles, especially anadromous salmonids federally listed as threatened or endangered, because these areas provide refugia from predators, feeding grounds, and areas to transition physiologically from freshwater to saltwater.

Columbian white-tailed deer are also expected to derive benefits via improved habitat conditions attributable to lessened frequency and duration of flooding and an increase in riparian forest acreage. Project partners include the U.S. Army Corps of Engineers (Corps) and the U.S. Fish and Wildlife Service (USFWS). The USFWS is the sponsor for the proposed project.

Figure 1. Julia Butler Hansen National Wildlife Refuge Vicinity Map



This integrated Implementation Report and Environmental Assessment examines existing conditions on the JBH NWR, proposes alternatives for restoring important habitat functions on the refuge, identifies a preferred restoration alternative, and evaluates the potential environmental impacts of the preferred alternative. The Environmental Assessment integrated into the Implementation Report satisfies the requirements of the National Environmental Policy Act.

1.2. Study Authority

Section 536 of the Water Resources Development Act of 2000 (Public Law 106-541) authorized the Lower Columbia River Ecosystem Restoration Study to bring together and implement current efforts by a number of governmental and private organizations to identify and cost share restoration projects. These organizations include the National Estuary Program, six state agencies from Oregon and Washington, four federal agencies, recreation, ports, industry, agriculture, labor, commercial fishing, environmental interests, and private citizens. The purpose of the Section 536 study is to carry out ecosystem restoration projects necessary to protect, monitor, and restore fish and wildlife habitat based on recommendations made by the Lower Columbia River Estuary Program (LCREP). Section 536 is principally focused on fish and wildlife habitat needs as outlined by LCREP and allows for immediate identification and construction of restoration projects.

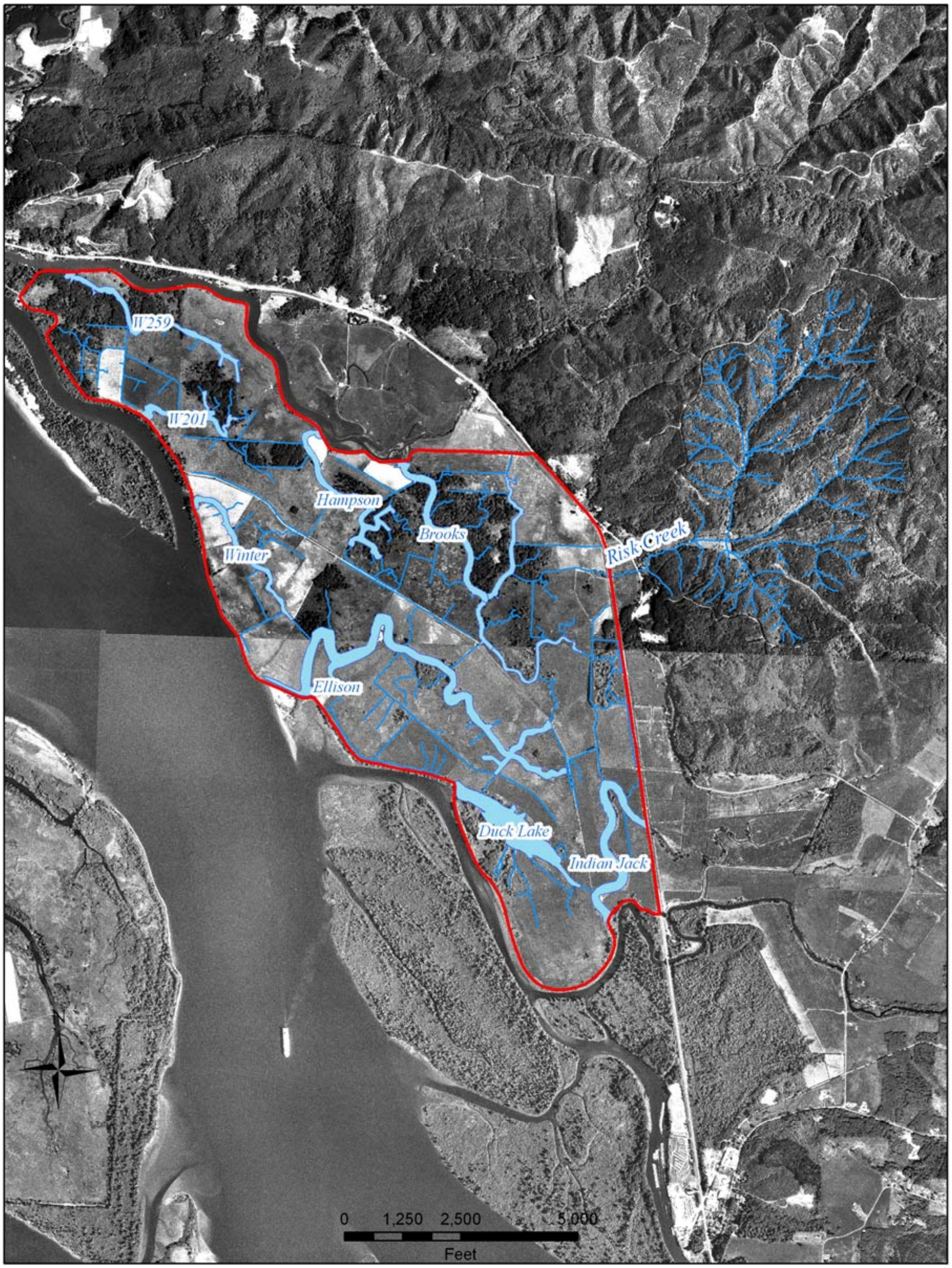
1.3. Study Area Description

The proposed project is located on the JBH NWR (Figures 1 and 2) within the Columbia River estuary. Located in southwestern Washington and northwestern Oregon, the JBH NWR was established in 1972 specifically to protect and manage the federally endangered Columbian white-tailed deer. The refuge contains over 5,600 acres of pastures, forested tidal swamps, brushy woodlots, marshes, and sloughs along the Columbia River in both Washington and Oregon. The mainland portion of the JBH NWR is bordered by the Columbia River to the west, the Elochoman River to the south, Brooks Slough and Skamokawa to the north, and Washington Highway 4 to the east. The refuge was previously altered through homesteading, wetland drainage, agricultural production, flood control construction, and grazing by cattle. Cattle still graze on the refuge principally in the context of habitat management.

The JBH NWR is beyond the salinity gradient in the Columbia River, but is still subject to tidal fluctuations. A flood control levee separates the mainland portion of the refuge from the tidal and river stage influence of the Columbia River. The flood control levee blocks tidal influence to sloughs that bisect the refuge lands. Small tributaries, principally Nelson Creek and Risk Creek, discharge water from the adjacent hills to the refuge, although the bulk of Nelson Creek is diverted from the refuge, upstream of Risk Road to a channel leading to the Elochoman River

The project area footprint is composed of all sloughs within the refuge plus Risk Creek (Figure 2). Riparian forest reestablishment will also occur at selected locations on the refuge adjacent to the sloughs. Several non-native plant species have become established, including reed canarygrass, Himalayan blackberry, and pasture grasses. Vegetation present along the slough shorelines varies from a narrow riparian forest strip to a predominant non-native vegetative cover of reed canarygrass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor*). Some areas along the sloughs are also subject to grazing by cattle. The JBH NWR has reestablished riparian forest stands at scattered locations throughout the refuge. Conditions for successional natural replacement of riparian forests are severely limited due to the dense ground cover.

Figure 2. Project Area Sloughs, Julia Butler Hansen National Wildlife Refuge



Eight sloughs, formerly tidally influenced, are present in JBH NWR. These sloughs are interconnected by a series of drainage ditches and channels. Brooks, Ellison, and Indian Jack are the largest sloughs. Brooks Slough discharges water via three tide gates and a pump station from the interior of the JBH NWR to the downstream portion of Brooks Slough, which is not encased by levees. Neither Ellison nor Indian Jack sloughs have water control structures for discharge of water. Ellison Slough is cut off via the flood control levee from the Columbia River at the mouth of the Elochoman River. Indian Jack Slough is cut off via the flood control levee from the Elochoman River near Highway 4.

Three other sloughs have tide gates for discharge of interior waters: Duck Lake, a slough at levee station W259+50 and a slough at levee station W201+30. Duck Lake discharges to the Elochoman River. The W201+30 Slough discharges via a recently installed side-opening tide gate to Steamboat Slough, a side-channel of the Columbia River. The W259+50 Slough discharges through a partially failed (wedged open) tide gate to the lower end of Brooks Slough. The partially failed tide gate allows tidal inflow into the interior portions of the refuge under current conditions although not of sufficient volume presently to cause adverse flooding of refuge lands.

The two remaining sloughs, Winter and Hampson, do not discharge water from the interior; Winter Slough is a cut-off channel from the Columbia River and Hampson Slough is cut off from Brooks Slough.

Nelson Creek formerly connected to Indian Jack Slough and discharged to the Elochoman River. Currently, a small culvert with a flap gate under Highway 4 represents the connection between Nelson Creek and Indian Jack Slough. The majority of Nelson Creek flows are presently diverted upstream of the refuge, partially on Columbia Land Trust land and primarily further upstream near Risk Creek Road. Risk Creek is channelized beginning at Highway 4 and running to Brooks Slough within the refuge.

1.4. Problems and Opportunities

The loss of riparian forest and wetland habitats in the lower Columbia River and estuary has been well documented (Graves et al., 1995; Corps 1996). The Northwest Power and Conservation Council's *Lower Columbia River and Columbia River Estuary Subbasin Summary* (NPCC 2002) states that, "Extensive losses of habitat have occurred in the lower Columbia River and Estuary provinces as a result of dredging, filling, diking, and channelization. Estimates from 1870 to 1970 indicate that 20,000 acres of tidal swamps (with woody vegetation; 78% of estuary littoral area), 10,000 acres of tidal marshes (with nonwoody vegetation) and 3,000 acres of tidal flats have been lost." The original extent of tidal marsh and swamp in the estuary has been reduced by more than half (LCREP 1999). The LCREP Management Committee identified habitat loss and modification as one of seven priority issues of concern to the estuary. Also, one of the technical recommendations of *Wy-Kan-Ush-Mi Wa-Kish-Wit Spirit of the Salmon* (Nez Perce et al., 1995) is to protect and restore critical estuary habitat. The estuary wetlands provide habitat for all Columbia Basin salmon stocks at some period in their life cycle. The Independent Scientific Advisory Board report, *The Columbia River Estuary and the Columbia River Basin Fish and Wildlife Program* (November 2000) hypothesized that the significant loss of peripheral wetlands and tidal channels in the estuary has been detrimental to salmonids.

The JBH NWR tidal sloughs and drainage patterns were altered by construction of the flood control levee on the refuge's perimeter and diversion/channelization of streams that discharged to the refuge lands. As a result, tidal influence to these now interior or cut-off sloughs has been blocked.

Drainage ditches were excavated throughout the land base and tide gates were added to prevent tidal inundation and facilitate drainage. These alterations were initiated for agricultural purposes. Establishment of the JBH NWR occurred after development of the flood control levees, associated tide gates, and stream diversions. These features continue to alter the site's hydrology.

The tidal sloughs have been degraded by lack of water circulation, siltation, and an accumulation of organic material. Restoration of tidal exchange to these sloughs would improve water circulation, address the accumulation of silts and organic material, and improve fisheries access and egress particularly for juvenile salmonids. Juvenile anadromous salmonid access to tidal sloughs on the refuge is probably limited to the stations W201+30 and W259+50 sloughs where a side-opening tide gate and a failed tide gate, respectively, provide access and egress. From a visual perspective, water quality and circulation are better at these sloughs than for the other sloughs on the refuge. Duck Lake and Brooks sloughs also have tide gates present, but poor fisheries habitat parameters in these sloughs plus access/egress constraints substantially limit use by juvenile anadromous fish.

Losses of estuarine and tidal riverine wetland habitat have affected all salmonid species using the Columbia River system. Juvenile salmon are known to use tidal habitats in the vicinity of JBH NWR. Studies have shown that both yearling and subyearling Chinook salmon use shallow, intertidal areas (Durkin 1982; McCabe et al., 1986). Subyearling Chinook salmon, which use the mainstem Columbia River and estuaries extensively for rearing, have been most affected by losses of shallow, intertidal areas caused by activities such as diking and draining. Other species such as chum and some coho salmon that use estuarine areas and migrate to the lower Columbia River as fry and fingerling also are likely to have been impacted by these activities. Coastal cutthroat trout also makes extensive use of the lower Columbia River and the estuary for feeding and migration. Loss of detrital and invertebrate export from these sloughs would have reduced forage availability for juvenile salmonids rearing in or transiting through the estuary.

The nature and extent of tidal exchange restoration needed is tempered by the presence of Columbian white-tailed deer, a federally endangered species. Their management represents a priority goal for the JBH NWR. Riparian forest establishment would benefit Columbian white-tailed deer, as well as other species such as bald eagles and Neotropical migratory birds. Riparian forest habitat also would provide for future detrital and invertebrate export to the estuary.

1.5. Planning Criteria

The overall purpose of the Implementation Report is to investigate and recommend habitat restoration alternatives for JBH NWR that would be applicable for restoring tidal flow and fisheries access/egress, to the extent practicable, to former tidal sloughs on the refuge. Riparian forest adjacent to the existing sloughs would also be restored. Restoration of Risk Creek flow to its natural channel would be explored to the extent practicable.

1.5.1. General Criteria

- Compatibility with refuge management objectives for Columbian white-tailed deer.
- Compatibility with other habitat restoration efforts in the lower Columbia River and estuary by federal, state and local agencies, and private organizations.
- Conduct analyses of environmental benefits and costs in accordance with Corps regulations to ensure that any plan is viable and cost effective.
- Protect public health, safety, and well being.

1.5.2. Technical Criteria

- Restoration of tidal flow and circulation for the restored tidal sloughs will be based upon the station W259+50 Slough which has a partially failed tide gate that allows for an approximate three foot stage variation and does not flood adjacent refuge lands.
- Size and capacity of tide gates and culverts will be based upon an intensive hydrologic and hydraulic evaluation.
- A 5-foot tidal slough stage elevation (all elevations in NAVD88) was established as an upper limit for protection of Columbian white-tailed deer habitat per discussion with refuge management.

1.5.3. Environmental Criteria

- Maintain Columbian white-tailed deer habitat and ensure the influx of tidal waters does not adversely affect their habitat.
- Restore tidal flow, circulation, and fisheries access/egress and to existing sloughs.
- Restore off-channel rearing/foraging habitat and ingress (access into)/egress (exit out of) for listed salmonids and other native fish species.
- Restore riparian habitat for Columbian white-tailed deer, waterfowl, bald eagles, and Neotropical migratory birds.

1.6. Relationship to Regional Studies and Projects

The overall vision for the *Columbia Basin Fish and Wildlife Program* (NPCC 2000) states, "Wherever feasible, this program will be accomplished by protecting and restoring the natural ecological functions, habitats, and biological diversity of the Columbia River Basin." The habitat strategies section of the program emphasizes the importance of protection and restoration of mainstem habitat conditions. Strategies include restoring ecosystems, not just single species (JBH NWR actions would restore tidal connection to Columbia River sloughs and riparian forest habitat, which are vital components of the estuary ecosystem); use native species wherever feasible (recovery of Columbian white-tailed deer, reestablishment of native fish access/egress and habitat); and include the estuary. The basin-level biological objectives in the program call for coordinating wildlife mitigation activities with fish mitigation and restoration efforts by combining wildlife habitat restoration and acquisition with aquatic habitats. The restoration objectives for JBH NWR link the restoration of aquatic and riparian habitat for listed salmonid (juveniles) ESUs with protection and restoration of habitat for Columbian white-tailed deer and other wildlife. Riparian forest habitat will provide nesting and foraging habitat for Neotropical migratory birds.

The habitat restoration objectives for JBH NWR are consistent with the *Provisional Statement of Biological Objectives for Environmental Characteristics at the Basin Level* (Appendix D of the *Columbia Basin Fish and Wildlife Program*). For example, biological objective 2 aims to: (1) increase the connections between rivers and their floodplains, side channels and riparian zones; and (2) manage riparian areas to protect aquatic conditions and form a transition to floodplain terrestrial areas and side channels. Biological objective 4 aims to increase energy and nutrient connections within the system to increase productivity and expand biological communities. The report, *Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon* (Bottom et al., 2001) recommends a management action to, "Protect and restore opportunities for salmon to access emergent and forested wetlands in the estuary and riparian wetlands in the tidal floodplain." The restoration objectives for JBH NWR would address these needs by reconnecting tidal flow to a number of sloughs thus providing improved flow and fisheries ingress/egress, enhancing productivity and connectivity in these sloughs, and establishing riparian forest to provide detrital nutrients.

The restoration objectives for JBH NWR also would complement the following projects that restore tidal wetlands and other key habitats, and monitor salmonid use in the lower Columbia River and estuary.

- Grays Bay Estuary. The Columbia Land Trust, Ducks Unlimited, USFWS, Washington Department of Fish and Wildlife (WDFW), Natural Resources Conservation Service, National Fish and Wildlife Foundation, and Lower Columbia Fish Recovery Board (LCFRB) are cooperating to acquire, restore, and enhance 350 acres of tidally influenced palustrine forested (low salinity) wetland (the total of approved and highly ranked projects is over 800 acres). Monitoring of fish use is a critical element of this project.

- Lord Island Protection. The Columbia Land Trust purchased Lord Island [Columbia River mile (CRM) 63.5] to preserve the habitat values of more than 200 acres of tidal wetland and riparian forest. The Oregon Watershed Enhancement Board and the National Fish and Wildlife Foundation funded the project. This conservation project was strongly supported by the local community.

- Klaskanine River Estuary. The Columbia Land Trust and Ducks Unlimited are restoring tidal wetlands to this estuary, located in the North Coast Basin.

- Chinook River Section 536 Environmental Restoration. The Corps, WDFW, Sea Resources, Columbia Land Trust, Ducks Unlimited, USFWS, and other agencies are proposing to restore tidal influence to the Chinook River and estuary, located near the mouth of the Columbia River in Washington.

- Crims Island Section 536 Environmental Restoration. A joint effort by the Corps, USFWS, Bonneville Power Administration, American Rivers, and the Columbia Land Trust to restore 115 acres of riparian forest, 75 acres of tidal marsh habitat, and 17 acres of tidal channel habitat on Crims Island in the lower Columbia River.

- Project EST-P-02 of the Corps' Anadromous Fish Evaluation Program. This project specifically examines a broad range of ecosystem functions that relate to juvenile salmonid habitat use of estuarine habitats.

2. AFFECTED ENVIRONMENT*

2.1. Geology and Soils

The Soil Survey of Wahkiakum County (SCS 1986) classifies the soil on the refuge as Ocosta silty clay loam. The typical profile is described as a 7-inch-thick surface layer of dark grayish brown silty clay loam followed by 5 inches of mottled, dark grayish brown silty clay loam, 8 inches of dark grayish brown silty clay, 2 inches of black sapric material (highly decomposed organic soil material), and very dark grayish brown clay to a depth of 60 inches or more. Permeability is described as very slow. The water table in the Ocosta soil is generally at a depth of 1 to 2 feet.

Soil descriptions in boring logs from 1966 and earlier generally agree with the Soil Survey description of the soil in the top 5 feet of the profile. The upper soil in the profile is generally silt. The boring logs show an underlying deposit of silty sand beginning at an elevation ranging from about -5 to -15 feet mean sea level. The full thickness of the silty sand deposit is not known; borings terminated at elevations from -28 to -37 feet were still in the silty sand. Soil descriptions in the boring logs also indicate that the levee is made of the native, near-surface silt.

The Soil Survey classifies the soil at the Ellison Slough location, south of the levee to the Columbia River (Figure 3), as Fluvaquents, tidal (this is a very deep but poorly drained soil type that is typical of soils found on floodplains and deltas). The profile is stratified sand to silt. This soil is less plastic than the Ocosta soil covering the rest of the refuge.

Figure 3. Ellison Slough Location, Looking South from Levee toward Columbia River

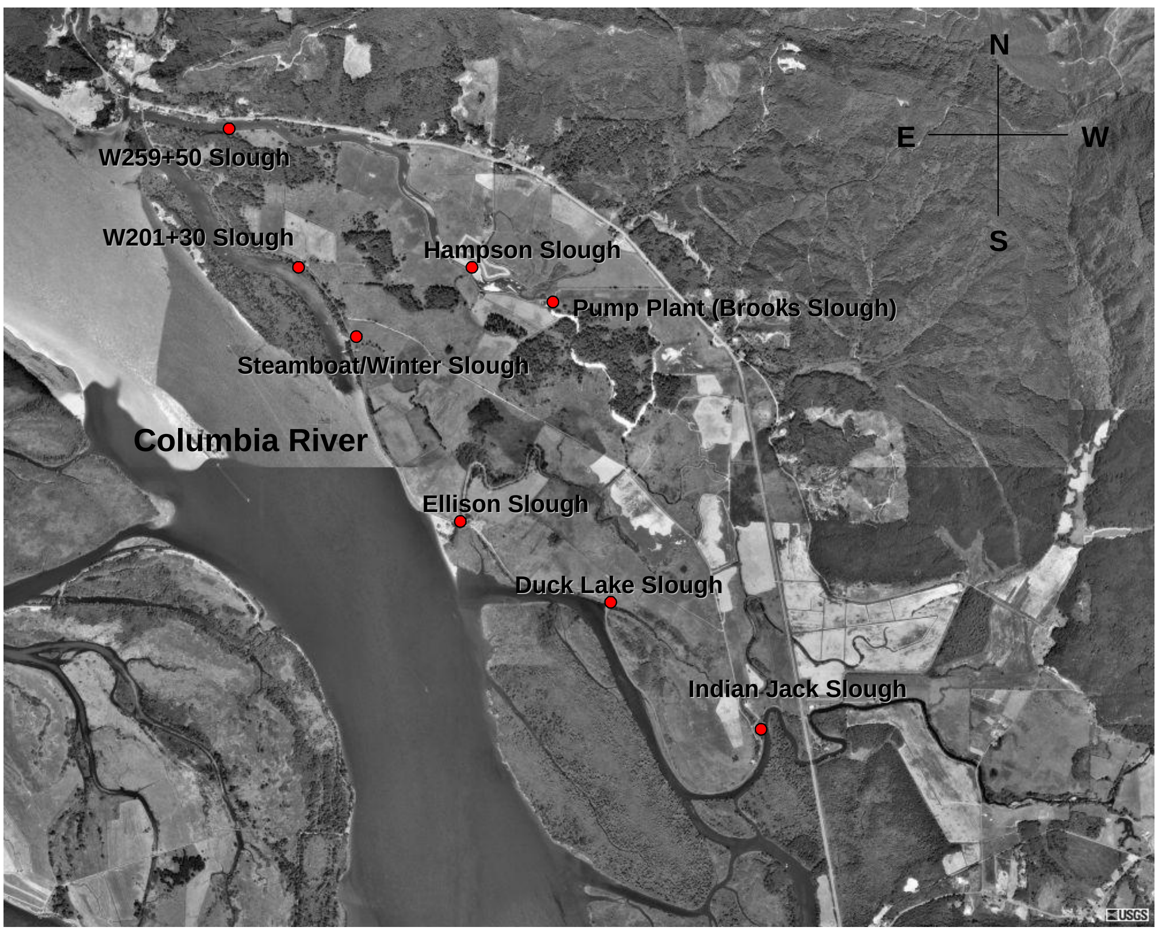
2.2. Sediment Quality

Sediment sampling was performed to characterize existing conditions at the eight slough locations and determine the presence and nature of contamination, if any, in the sediments. Sediment samples were collected using a petite ponar at the sites listed in Table 1 and shown on Figure 4.

Table 1. Sediment Sampling Locations, July 26, 2006

Site Identifier	Site Name	Latitude	Longitude
JBH-G-01	Indian Jack Slough	46° 13’ 52.1”	123° 23’ 56.7”
JBH-G-02	Duck Lake Slough	46° 14’ 17.5”	123° 24’ 45.1”
JBH-G-03	Ellison Slough	46° 14’ 38.2”	123° 25’ 30.2”
JBH-G-04	Steamboat/Winter Slough	46° 15’ 17.8”	123° 26’ 8.9”
JBH-G-05	W201+30 Slough	46° 15’ 34.4”	123° 26’ 25.3”
JBH-G-06	W259+50 Slough	46° 16’ 5.3”	123° 26’ 48.6”
JBH-G-07	Hampson Slough	46° 15’ 32.7”	123° 25’ 33.3”
JBH-G-08	Pump Plant (Brook’s Slough)	46° 15’ 27.2”	123° 25’ 6.5”

Figure 4. Sampling Locations on Julia Butler Hansen National Wildlife Refuge



Sediment was collected at each site, on both the right- and left-hand side of the road/levee and combined into one sample per site. Sediment was collected at the internal slough (within the refuge) and the external slough (that connects to the Elochoman/Columbia rivers) and mixed together into one sample at each site. All eight samples were analyzed for the following parameters: chlorinated herbicides (EPA 8151A), organochlorine pesticides (EPA 8081A), polychlorinated biphenyls (PCBs; EPA 8082), physical grain size, total metals, and total organic carbon (EPA 9060). The sediment samples were collected using laboratory provided sample containers, packed in ice, and delivered to the laboratory and analyzed within the specified holding times.

Collection and evaluation of the sediment data was completed using guidelines from the Dredged Material Evaluation Framework (DMEF) and the Sediment Evaluation Framework (SEF) for the Pacific Northwest. The DMEF is a regional manual developed jointly by the Corps, U.S. Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (ODEQ), and the Washington Departments of Ecology and Natural Resources (WDOE and WDNR). The SEF is a consolidated and revised version of the DMEF and provides a framework for the assessment and characterization of freshwater and marine sediments in Idaho, Oregon, and Washington. The SEF was developed by the Corps, EPA, ODEQ, WDOE, WDNR, Idaho Department of Environmental Quality, National Marine Fisheries Service (NMFS), and the USFWS. Sediment sample results were compared to DMEF and SEF screening levels in order to determine if the chemicals identified pose a risk to aquatic biota and/or human health.

As shown in Table 2, the chlorinated herbicides 2,4-D and 2,4-DB (used for broad-leaf weed control) were found in small amounts at sites JBH-G-02 (Duck Lake Slough), JBH-G-05 (W201+30 Slough), JBH-G-07 (Hampson Slough), and JBH-G-08 (Pump Plant). All amounts of chlorinated herbicides measured were estimated by the lab due to such low concentrations detected in each sample. Furthermore, all herbicides detected were well below the method reporting limit (MRL).

Table 2. Chlorinated Herbicides in Sediment Samples, July 26, 2006

Analyte mg/kg	Site Identifier							
	JBH-G-01	**JBH-G-02**	**JBH-G-03**	**JBH-G-04**	**JBH-G-05**	**JBH-G-06**	**JBH-G-07**	**JBH-G-08**
Dalapon	<51 U	<57 U	<22 U	<28 U	<37 U	<37 U	<33 U	<44 U
Dicamba	<16 U	<18 U	<6.6 U	<8.5 U	<12 U	<12 U	<9.9 U	<14 U
MCPP	<8400 U	<9400 U	<3600 U	<4600 U	<6000 U	<6100 U	<5300 U	<7200 U
MCPA	<14000 UI	<11000 U	<4200 U	<5400 U	<7100 U	<7100 U	<6200 U	<8500 U
Dichlorprop	<12 U	<35 UI	<4.8 U	<6.2 U	<8.1 U	<8.2 U	<7.1 U	<9.7 U
2,4-D	<14 U	<110 UI	<6.1 UI	<7.8 UI	19 J	<10 U	13 J	26 J
2,4,5-TP (Silvex)	<12 U	<13 U	<4.8 U	<6.2 U	<8.1 U	<8.2 U	<7.1 U	<9.7 U
2,4,5-T	<12 U	<14 U	<4.9 U	<6.4 U	<8.4 U	<8.4 U	<7.4 U	<10 U
2,4-DB	<13 U	84 JP	<5.4 U	<7.0 U	<9.2 U	<37 UI	19 JP	<11 U
Dinoseb	<58 U	<66 U	<25 U	<32 U	<42 U	<42 U	<37 U	<50 U

Qualifier Codes:
Symbol (<) = Non-detect (ND) at the value listed [Method Detection Limit (MDL)].
U = The compound was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
I = The MRL/MDL has been elevated due to a chromatographic interference.
P = The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP pesticides).
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
Note: No screening levels have been developed for these contaminants due to their relatively short half-life.

Even though the majority of organochlorine pesticides have been banned for use within the United States, they are still found in some soils and waters due to their persistence and long half-life. Small amounts of these broad spectrum pesticides were found in five of the eight sediment samples collected at JBH NWR; however, all contaminants detected were below DMEF and SEF screening levels (Table 3). The organochlorine pesticide 4,4'-DDT was detected in the sediment sample collected at site JBH-G-01 (Indian Jack Slough); however, as stated above, the value was below the DMEF screening level of 6.9 milligrams per liter (mg/L). The pesticide 4.4'-DDE was detected in the sample from site JBH-G-02 (Duck Lake Slough), while no pesticides were detected in the JBH-G-03 (Ellison Slough) sample. Four pesticides including Heptachlor, 4,4'-DDE, 4, 4'-DDD, and 4,4'-DDT were detected in small amounts in the Steamboat/Winter Slough sample. Both 4,4'-DDE and 4,4'-DDD were detected in the JBH-G-05 (W201+30) sample while only 4,4'-DDE was detected in the JBH-G-06 (W259+50) sample. No organochlorine pesticides were detected in the samples collected at Hampson Slough or the Pump Plant sites.

Historically, PCBs were used in many industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper, and many other applications. Prior to the late 1970s when the production of PCBs was banned, more than 1.5 billion pounds of PCBs were manufactured in the United States. Of the sediment samples colleted at JBH NWR, the only site where PCBs were detected was in sample JBH-G-01 (Indian Jack Slough). The PCB Aroclor 1260 was detected in the amount of 42 mg/kg, which is well below the screening level (Table 3).

Grain size distribution is an important characteristic of sediments and can be used to determine the ability for soils to absorb pollution. The more clay that is present in soil, the more absorption potential the soil has. Grain distribution was determined by using a sieve analysis for gravel and sand determination and a hydrometer analysis for silt and clay analysis. Tables 4 and 5 list the particle size determination for the eight sediment samples collected at JBH NWR. The sediment sample collected at JBH-G-01 (Indian Jack Slough) was made up of 58% gravel and sand and 42% silt and clay. Sample JBH-G-02 (Duck Lake Slough) was much less sandy with 23.7% gravel/sand and 76.3% silt/clay. Sample JBH-G-03 (Ellison Slough) was a sandy with 97.27% gravel/sand and 2.73% silt/clay. Sample JBH-G-04 (Steamboat Slough) was made up of 47.9% sand/gravel and 52.1% silt/clay. Sample JBH-G-05 was made up of 35.2% gravel/sand and 64.8% silt/clay, while JBH-G-06 was made up of 30.5% gravel/sand and 69.5% silt/clay. Sample JBH-G-07 (Hampson Slough) contained 54.8% gravel/sand and 45.2% silt/clay. Sample JBH-G-08 collected at the Pump Plant was made up of 38.7% gravel/sand and 61.3% silt/clay.

According to the DMEF, arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc are all natural components of soils and sediments of the lower Columbia River drainage basin; however, the concentration of individual metals may vary depending upon additional inputs from human activity or sources. Sediment samples were analyzed for nine metals (Table 6). The percent of total organic carbon also was analyzed using the EPA method 9060. Low levels of some metals were found but did not approach the screening levels under the DMEF and SEF. Antimony was not detected above the MRL of 150 mg/kg at JBH-G-03 (Ellison Slough) or JBH-G-07 (Hampson Slough). Antimony, arsenic, cadmium, mercury, and silver were not detected above the MRL at JBH-G-01 (Indian Jack Slough). Calcium was found in all samples with the highest reading (7,470 mg/kg) at JBH-G-02 (Duck Lake Slough). This alkali earth element is not a contaminant and is naturally occurring. No metals were measured in the sediments above the screening limits under the DMEF and SEF.

Sediment obtained from the project area (tide gate locations) was tested and determined to be suitable for unconfined, in-water disposal, or could be exposed to water after excavation without further characterization.

Table 3. Organochlorine Pesticides and PCBs from Sediment Samples, July 26, 2006

Analyte		Screening Level µg/kg*	Screening Level µg/kg**	JBH-G-01	JBH-G-02	JBH-G-03	JBH-G-04	JBH-G-05	JBH-G-06	JBH-G-07	JBH-G-08
Pesticides	gamma-BHC (Lindane)	10	-------	<1.5 UI	<0.61 U	<1.0 UI	<0.30 U	<0.40 U	<0.40 U	<0.35 U	<0.47 U
	Heptachlor	10	-------	<0.71 UI	<0.33 U	<0.13 U	0.40 JP	<0.21 U	<0.34 UI	<0.19 U	<0.51 UI
	Aldrin	10	-------	<1.7 UI	<2.0 UI	<0.23 U	<0.43 UI	<0.80 UI	<0.40 U	<0.35 U	<0.47 U
	Dieldrin	10	-------	<1.1 U	<1.7 UI	<0.45 U	<0.58 U	<0.76 U	<0.76 U	<0.67 U	<0.91 U
	4,4’-DDE	6.9	-------	<0.37 U	1.4 J	<0.16 U	0.95 J	2.4	0.94 J	<0.23 U	<0.32 U
	4,4’-DDD			<1.5 UI	<1.7 UI	<0.19 U	0.73 JP	2.4 P	<1.4 UI	<0.58 UI	<0.71 UI
	4,4’-DDT			4.4 P	<1.7 UI	<0.098 U	0.40 JP	<0.71 UI	<1.1 UI	<0.15 U	<1.3 UI
	Chlordane	10	-------	<24 UI	<17 UI	<2.2 U	<7.6 UI	<8.2 UI	<6.5 UI	<6.5 UI	<8.9 UI
PCBs	Aroclor 1016	130	120	<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			<5.8 U	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U
	Aroclor 1016			42	<6.6 U	<2.5 U	<3.2 U	<4.2 U	<4.2 U	<3.7 U	<5.0 U

Site Identifiers: JBH-G-01 through JBH-G-08

Qualifier Codes:
Symbol (<) = Non-detect (ND) at the value listed (MDL).
U = The compound was analyzed for, but was not detected (Non-detect) at or above the MRL/MDL.
I = The MRL/MDL has been elevated due to a chromatographic interference.
P = The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP pesticides).
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
* Screening levels based on the DMEF guidelines.
** Screening levels based on the SEF guidelines.

Table 4. Gravel and Sand Sieve Analysis, July 26, 2006

Description	Particle Distribution in Percent (%)								
	Sieve Size (mm)	JBH-G-01	JBH-G-02	JBH-G-03	JBH-G-04	JBH-G-05	JBH-G-06	JBH-G-07	JBH-G-08
Gravel, medium	4.0	0.7	2.3	5.5	0.4	11.2	7.4	16.7	0.6
Gravel, fine	2.0	0.9	2.4	4.0	0.1	1.4	0.2	1.0	0.7
Sand, very coarse	1.0	7.0	2.6	5.0	0.8	2.5	0.6	1.8	4.8
Sand, coarse	0.5	4.1	3.0	25.9	2.3	2.0	1.6	2.9	3.2
Sand, medium	0.25	7.7	3.2	36.4	12.6	2.4	2.0	6.4	5.2
Sand, fine	0.125	22.2	3.8	18.5	20.8	4.9	5.0	9.4	9.8
Sand, very fine	0.063	15.4	6.4	2.0	10.9	10.8	13.7	16.6	14.4

Table 5. Silt and Clay Hydrometer Analysis, July 26, 2006

Particle Diameter (mm)	Particle Distribution in Percent (%)							
	JBH-G-01	JBH-G-02	JBH-G-03	JBH-G-04	JBH-G-05	JBH-G-06	JBH-G-07	JBH-G-08
0.074	9.1	15.2	1.3	13.4	10.6	11.2	0.4	3.0
0.005	25.4	36.3	1.0	29.3	33.4	35.4	33.6	36.6
0.001	7.5	21.6	0.4	9.4	20.0	21.1	11.2	21.7

Table 6. Total Metals and Total Organic Carbon (TOC), July 26, 2006

Analyte mg/kg	Screening Level mg/kg*	Screening Level mg/kg**	JBH-G-01	JBH-G-02	JBH-G-03	JBH-G-04	JBH-G-05	JBH-G-06	JBH-G-07	JBH-G-08
Antimony	150	--------	0.05 u	0.08	0.04 u	0.06	0.15	0.07	0.04 u	0.06
Arsenic	57	20	4.09	11.1	0.35 b	2.65	5.08	6.03	4.69	6.21
Cadmium	5.1	1.1	0.35	0.66	0.04 b	0.32	0.79	0.51	0.31	0.43
Calcium	--------	--------	7140	7470	1770	4690	5700	7450	4180	5710
Copper	390	80	46.3	54.3	5.12	23.9	31.3	27.8	16.5	29.9
Lead	450	340	5.49	10.7	1.20	7.32	11.9	9.61	7.57	11.0
Mercury	0.41	0.28	0.048	0.099	0.007 b	0.055	0.133	0.062	0.046	0.062
Silver	6.1	2.0	0.122	0.169	0.013 b	0.089	0.140	0.148	0.103	0.137
Zinc	410	130	84.1	108	16.1	60.4	86.0	82.8	64.0	96.6
TOC %	N/A	N/A	3.73	4.05	0.50	1.65	2.79	2.75	3.30	4.50

Qualifier Codes:
u = The compound was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
b = The Analyte was found in the associated method blank at a level that is significant relative to the sample result.
* Screening Levels based on the DMEF Guidelines.
** Screening Levels based on the SEF Guidelines.

2.3. Hydrology

Figure 2 shows the project area footprint with primary drainage channels and individual sloughs. The hydrology of the project area is directly affected by three factors: stage elevation of the Columbia River, drainage from the Risk Creek Basin, and interior drainage from the area within the flood control levee. The Risk Creek Basin is approximately 718 acres in extent with a general change in elevation of 324 feet. The area within the flood control levee is about 1,900 acres with a general change in elevation of 2.42 feet with a general gradient directed toward Brooks and Ellison sloughs. Risk Creek was initially diverted away from the flood control levee protected area. Recently the diversion structure was breached which allowed the stream to again flow directly into the levee protected area and discharge into Brooks Slough. The area within the flood control levee is drained by a network of canals that are connected to four sloughs with tide gates.

The drainage area delineation of the JBH NWR can be classified according to three primary hydrologic regimes: a tidal regime, a reservoir regime, and a terrestrial regime. Although each drainage area within JBH NWR is related to the others due to surface and subsurface connectivity, the classification of hydrologic regimes is governed by their inflow/outflow characteristics. Figure 5 shows the classified hydrologic regimes within the project area footprint.

2.3.1. Tidal Regime

The tidal regime is controlled by the inflow/outflow tidal signal of the Columbia River. The tidal range within the boundary of the JBH NWR is currently limited by the inlet/outlet (hydraulic control structures) characteristics at two sloughs. The two sloughs governed by the tidal regime are located at levee stations W201+30 and W259+50. The W201+30 Slough has a modified tide gate that allows for some inflow during the initial stages of the flood tide. A failing tide gate at the W259+50 Slough allows for substantial, although still impeded, tidal ingress and egress.

The hydraulic control structure at the W259+50 Slough consists of a light-weight, buoyant, top-hinged tide gate connected to a 60-inch by 60-inch concrete box culvert with a construction date stamp of 1922. The hydraulic control structure at the W259+50 Slough operates over a wide range of efficiency. As the head difference between the headwater (interior) and the tailwater (river) increases, so does the discharge efficiency of the hydraulic control structure. The outflow through the tide gate behaves much like an open culvert condition with minimal losses and outlet control at the control structure. Figure 6 shows the tide gate at a partially opened position.

Figure 5. Hydrologic Regimes at Julia Butler Hansen National Wildlife Refuge

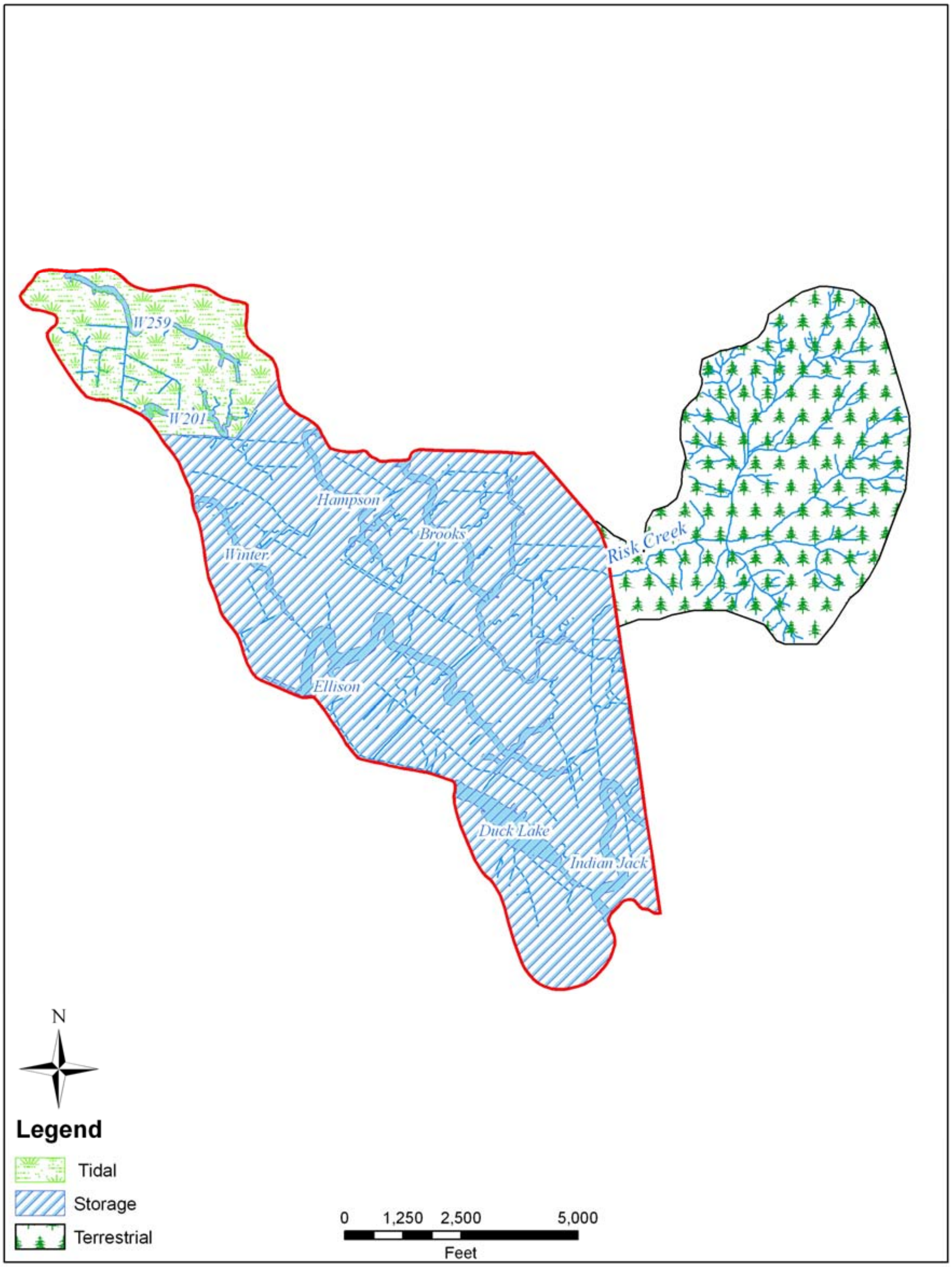


Figure 6. Damaged Tide Gate at W259+50 Slough (looking down, gate is wedged open)

The tide gate at the W259+50 Slough does not behave the way it was designed (i.e., discharge interior waters and block inflow). The tide gate is damaged and allows for a tidal inflow through an area of approximately 5 square feet. This inflow area allows a tidal surge to move back into the slough once the tide level rises above the slough surface water elevation. The flood and ebb of tidal waters results in an approximate water level fluctuation range of 3 feet within the W259+50 Slough as measured at the culvert inlet.

The hydraulic control structure at the W201+30 Slough consists of a side-opening tide gate with a delayed closure device connected to a 48-inch corrugated steel culvert. The tide gate and culvert were installed by the Corps in 2003 in order to test the tide gate capabilities to allow for limited inflow through the culvert. The outlet behaves with high discharge efficiency (near open culvert). The delayed closure device consists of a cam and float system which prevents full closure of the tide gate until the buoyancy of the float rotates the cam and allows full closure of the gate. Figure 7 shows the gate in the open position; Figure 8 depicts the gate in the partially closed position. The small inlet created by the float/cam system allows for a limited inflow for a short period of the flood tide. This small inflow does create a limited water circulation near the culvert but otherwise is too small to effect the stage change of the slough.

Figure 7. Open Tide Gate at W201+30 Slough

Figure 8. Partially Closed Tide Gate at W201+30 Slough

A canal that connects the W259+50 and W201+30 sloughs is an efficient hydraulic connection that allows an approximate water level fluctuation range of 1.6 feet within the pool at the W201+30 Slough culvert inlet. The water level fluctuation attributable to the canal overcomes the muted tidal inflow from the cam/float system of the W201+30 Slough tide gate. Due to the high discharge efficiency of the tide gate at the W201+30 Slough culvert at low tide, the large inflow during flood tides at the W259+50 Slough tide gate, as well as the hydraulic connection and flow circulation between the two sloughs, behaves more as one system rather than two separate slough systems. This water circulation pattern is also distinct from the balance of the project area footprint.

2.3.2. Reservoir Regime

The reservoir regime is primarily controlled by tide gates at Brooks and Duck Lake sloughs that only open when the Columbia River stage is below the water surface elevation of the associated sloughs. Consequently, each slough behaves like a reservoir. The majority of the project area is controlled by this regime and consists of six interconnected sloughs: Brooks, Hampson, Winter, Ellison, Indian Jack, and Duck Lake. These sloughs interact with the other hydrologic regimes although a number of factors limit their interaction. Channel roughness/capacity, culverts, and stage/volume relationships are the principal limiting factors. For example, although Hampson Slough is connected directly to the tidal regime of the W201+30 Slough, its water level fluctuation range is negligible as compared with the tidal regime experienced in that slough. The dense vegetation, narrow channel, and small culverts of the connecting channel reduce the water level fluctuation as it approaches the larger Hampson Slough. Even if these restrictive features were removed, the stage/volume relationship of Hampson Slough would require a much greater inflow/outflow capacity within the tidal regime to cause any noticeable change in water level fluctuation within Hampson Slough. Similar limitations affect the interaction between the reservoir regime and the terrestrial regime.

The tide gate structures and flood control levee prevent any inflow except from the W201+30 and W259+50 sloughs which function as a separate system, direct runoff within the levee, groundwater inflow/outflow, and terrestrial inflow from Risk Creek and an unnamed streams. The inflow is limited during the dry season to groundwater interaction via a sandy/silt medium along each slough channel. This groundwater interaction was observed even among blind sloughs that had been disconnected by beaver dams. These disconnected sloughs still continued to have a water level fluctuation of approximately 0.1 to 0.3 feet within a tide cycle. This observation follows similar results obtained from the monitoring of ground water at the Webb Wildlife Mitigation Project near CRM 46. Data taken from five piezometers at the Webb location with similar soil strata indicated a rapid response of water levels in the main drainage channel with the tidal cycle. The groundwater interaction is overcome by the direct runoff and the terrestrial regime input during the wet season.

The Columbia River stage decreases during the dry season reducing the groundwater input to the project area. The JBH NWR sloughs gradually reduce stage by approximately 2 feet from the wet season to the dry season.

2.3.3. Terrestrial Regime

The terrestrial regime consists of three perennial streams which either directly or indirectly affect the project site. Risk Creek is a small stream that drains into the project area from the adjacent foothills. Nelson Creek is slightly larger and originates in the adjacent foothills but is diverted from the refuge. The Elochoman River skirts the refuge to the south and southwest. The Elochoman River has a significantly larger drainage area than the Risk Creek. Both Nelson Creek and the Elochoman River indirectly affect the project site due to the presence of hydraulic control structures. The Elochoman

River is separated from the project site by a flood control levee that prevents any direct effect. Nelson Creek historically flowed directly into Indian Jack Slough; however, Nelson Creek was previously diverted upstream of Risk Road to a channel leading to the Elochoman River. Additional water within a cutoff portion of Nelson Creek/Indian Jack Slough upstream of Highway 4 on Columbia Land Trust lands is removed at a pump station and discharged into the rerouted Nelson Creek channel. Highway 4 behaves like a levee with only a 30-inch culvert allowing local runoff to reach that portion of Indian Jack Slough on JBH NWR.

The indirect effects of Nelson Creek and the Elochoman River are seen only in rare high flow events such as the November 2006 storm. The Elochoman River floodplain historically encompassed the footprint of the project site. Although the stage during the November 2006 storm never overtopped the portion of the flood levee adjacent to the JBH NWR, it was high enough to overtop the flood control levee upstream of Highway 4 and subsequently Highway 4, which allowed weir flow into JBH NWR to occur for approximately 18 hours.

Risk Creek flows directly into the project site with minimal flows during the dry season and continuous flow throughout the winter. The gradient of the stream basin indicates a rapid response time to rainfall. The basin is primarily covered in forest; however, this may change due to logging practices in the upper reaches of the basin. The stream generates a significant volume of inflow into the project site during high rainfall events.

2.3.4. Climatology

Rainfall records were taken from the National Weather Service precipitation gage #451205 at Cathlamet, Washington, located about 3.6 miles southeast of the project site (Table 7).

Table 7. Precipitation Data for Gage #45105 at Cathlamet, Washington

Month	Mean (inches)	High (inches)	Year	Low (inches)	Year
January	11.95	23.3	1971	0.74	1985
February	8.77	22.29	1961	1.01	1993
March	8.17	15.4	1997	0.88	1965
April	5.94	11.82	1996	1.75	1977
May	3.9	9.64	1984	0.84	1982
June	2.94	6.1	1984	0.89	1961
July	1.2	5.26	1983	0	2003
August	1.94	7.27	2004	0	2002
September	3.64	9.83	1959	0.03	1991
October	6.9	14.29	1967	0.58	1987
November	11.58	22.09	1995	3.28	1976
December	12.4	21.84	1996	3.11	1985
Annual	79.33	106.67	1996	60.85	1978
Winter	33.13	54.75	1999	12.42	1977
Spring	18.01	27.72	1997	7.94	1965
Summer	6.08	11.3	1983	1.7	1970
Fall	22.11	35.19	1995	8.26	1993

Period of record 1959 to 2006. Source Western Regional Climate Center
http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa1205

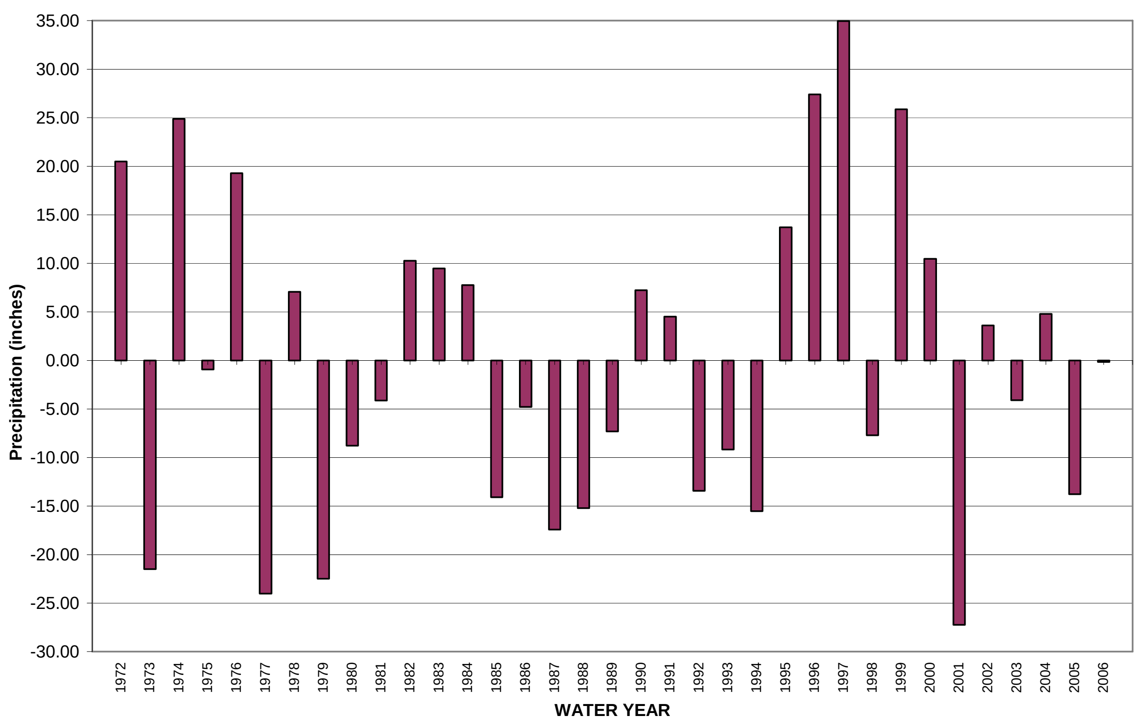
On average, there are 185 days per year with rainfall amounts equal or above 0.01 inches, 139 days equal or above 0.10 inches, 56 days equal or above 0.50 inch, and 20 days equal or above 1.0 inch. Extreme and long-duration precipitation events were evaluated from the precipitation probabilities for 2-, 5-, 7- and 10-day duration events from the Western Regional Climate Center and are presented in Appendix A. The ten highest daily rainfall events for the period of record are presented in Table 8. The second and fourth highest daily rainfall events for the locality occurred consecutively in November 2006.

Table 8. Ten Highest Daily Rainfall Events

Rank	Date	Precipitation (inches)	Rank	Date	Precipitation (inches)
1	12/02/1977	6.50	6	01/17/2005	5.18
2	11/07/2006	6.35	7	11/28/1995	4.65
3	11/25/1999	5.74	8	01/23/1982	4.60
4	11/06/2006	5.60	9	02/09/1990	4.43
5	02/08/1996	5.21	10	01/11/1972	4.38

Figure 9 shows the departure from average of precipitation gage #451205. Water year 2006 showed the least departure from average at -0.15 inches for the period of record while water year 1997 showed the greatest departure from average at 34.95 inches.

Figure 9. Annual Precipitation Depth Departure from Average per Water Year



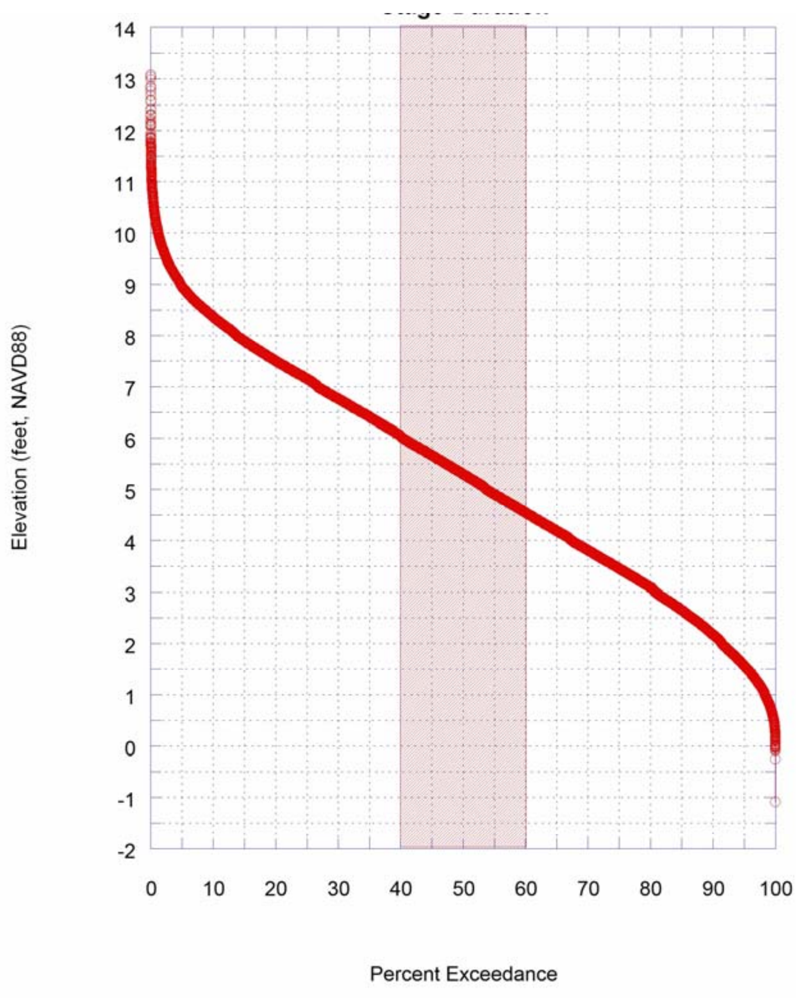
The majority of the area within the flood control levee is composed of poorly drained wetlands with some pasture and riparian forest land coverage. The upper reaches of the Risk Creek Basin consists of Montesa and Elochoman silt loams and is primarily forested with dense evergreen forest. Because of the combination of steep gradients and the poorly drained soils, the project area responds quickly to any rainfall. Some interception and storage is available within the perched wetlands and forested areas of the JBH NWR; however, data shows that with even small storms the sloughs respond quickly and can rise out of their banks during heavy precipitation events, particularly during the winter season. Based on recorded data, it is estimated that any rainfall above 1 inch within 24 hours will result in stages that exceed channel storage within the JBH NWR.

Due to insufficient temperature data for the Cathlamet gage, temperature data for Clatskanie, Oregon located 14 miles east-southeast of the project site was used to estimate average temperatures. Average daily high temperatures range from 44.2° to 74.2°F and average daily low temperatures range from 33.4° to 53.2°F.

2.3.5. Columbia River Stage

The Skamokawa stage gage (#9440569) located on Steamboat Slough near the W201+30 Slough was used in order to analyze the historical tailwater conditions of the Columbia River at the project site. The data was collected at 6 minute intervals with minimal data gaps. Frequency information for the Columbia River near the project site was derived from a complete series of the 6 minute interval data from 1990-2006. The frequency information is presented in Figure 10 as a stage-duration curve comparing the elevation versus the percent chance of exceedance.

Figure 10. Skamokawa Stage Duration Curve, 1990-2006



The median 6 minute interval stage elevation of 5.3 feet (all elevations in NAVD88) corresponds with the 50% chance of exceedance. Moreover the mean 6 minute stage elevation (5.3 feet) matched with the median stage elevation. The maximum and minimum stage elevations were 13.1 feet and -1.1 feet elevation, while 95% of the data fell between the elevations of 1.2 feet and 9.5 feet.

2.4. Floodplains

The mainland portion of the JBH NWR is located within the Columbia River floodplain. The refuge is upstream of the saline gradient, but still subject to tidal action. The presence of large dams upstream from the refuge and development of floodplains has had a significant influence on the frequency and duration of large scale flood events. Much of the mainland portion of the refuge is comprised of wetlands. Eight main sloughs and numerous, interconnecting drainage ditches are present within the mainland portion of the refuge. The flood control levees, drainage ditches, and tide gates on certain sloughs were constructed to allow drainage of the land for agricultural and grazing uses. These features remain functional currently for refuge management purposes.

A flood control levee encompasses the mainland body of the refuge but does not provide protection to the 100-year level. The top elevation of the flood control levee ranges from 12.1 to 15.1 feet. The 100-year flood elevation ranges from 13.5 feet downstream to 13.7 feet at the upstream end of the diking district. Flood events in February 1996, January 2006, and November 2006 resulted in overtopping of the flood control levees and/or Highway 4, flooding the refuge. Flooding in January 2006 resulted from a combination of high Columbia River stage occurring concurrently with high tidal stages. Elochoman River flood waters in November 2006 overtopped the flood control levee off refuge (east of Highway 4) and subsequently overflowed Highway 4, flooding the entire mainland refuge. This flooding was attributable to very heavy and prolonged precipitation. High Columbia River and tidal stages probably accounted for the February 1996 flood event. Heavy and prolonged precipitation preceded the February 1996 event. Thus, the floodplain at the JBH NWR does provide flood storage capability during certain flood events but otherwise is disconnected from daily tidal inundation and river flooding of the land base.

Discharge of internal drainage and floodwaters that enter the mainland portion of the JBH NWR is accomplished via tide gates on Duck Lake, W201+30, W259+52, and Brooks sloughs. A pumping station is also present at the Brooks Slough tide gate location. There is a lag time between the incursion of floodwaters and their expulsion. For the November 2006 flood event, approximately 2 weeks were required to discharge entrapped waters and reach normal water levels with the current water control structures.

2.5. Water Quality and Quantity

Construction of flood control levees around the perimeter of the mainland portion of the JBH NWR has altered the connectivity of the inland wetlands and tidal channels to the Columbia River. Historic tidal sloughs on the JBH NWR have been degraded by direct fill, siltation, and diversion of flow from upslope sources. The flood control levees eliminated tidal ingress and egress contributing substantially to water stagnation in these sloughs. The present tide gates and pump station serve to discharge water but appear to only marginally improve water quality compared to sloughs without these features. The W259+50 (failing tide gate) and W201+30 (replaced tide gate; side-opening) sloughs show markedly improved water quality due to greater interchange of water with the Columbia River. These two sloughs are also connected which likely aids flushing and turnover of water held in each.

The 303(d) list of water quality-limited streams shows the Columbia River, including the study area, as exceeding several parameters, including dissolved oxygen, temperature, total dissolved gas, and fecal coliform, and has been found to have exceedance for several pollutants, including 4,4'-DDE, arsenic, bis(2-ethylhexyl)phthalate, Dieldrin, PCB-1248, PCB-1254, and PCB-1260.

2.6. Hazardous, Toxic, and Radioactive Waste

A Level I Contaminant Survey (Environment Site Assessment) for the JBH NWR was conducted by environmental specialists with the Corps on July 28, 2006 and February 28, 2007. The survey showed that there were, "No storage, release, disposal, or migration of petroleum products, or hazardous substances in excess of threshold quantities as defined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 101(14) and appearing at 40 CFR 302.4"… on the property. A field investigation completed on July 28, 2006 concluded there is no evidence of storage, release, or disposal. A review of aerial photographs, environmental websites, and interviews with refuge employees did not disclose the use or storage of hazardous, toxic, and radioactive waste (HTRW) on the property.

There was an old shop building located near Ellison Slough that was recently removed. During the field investigation, a work crew was on site and indicated there was not any HTRW observed during their site cleanup work and the remaining debris will be cleared. The old shop area may be used as a contractor work/staging area and soil disposal area for the proposed project.

A search for federal hazardous waste facilities listed on EPA's CERCLA Information System database revealed one active site on the refuge. The site was listed in 1988 and classified as a "drug dump" located near the information kiosk adjacent to Highway 4; the site has since been cleaned. A search for Washington hazardous waste facilities listed on the Confirmed and Suspected Contaminated Sites database (WDOE) revealed no facilities within 1 mile of the property.

2.7. Aquatic and Riparian Habitat

The JBH NWR contains numerous natural and managed wetlands. The natural wetlands have formed due to topography and underlying soil conditions. Managed wetlands differ from their natural counterparts in that the natural topography has been altered due to excavation, lowering site elevation. The managed wetlands also have water control structures such as low elevation levees and the vertical riser and weir. These wetlands fill in the fall and winter from accumulation of rain and overland flow. The refuge staff uses flashboards placed in the weirs to control water levels in the managed wetlands. Removal of the flashboards allows water to drain via the vertical riser attached to a horizontal culvert to adjacent drainage ditches and then to the former tidal sloughs. Water is discharged from those sloughs equipped with tide gates to either the Elochoman or Columbia rivers. In the summer, the refuge staff allows the wetlands to dry up either due to evaporation or via drainage into the adjacent sloughs. This annual wet-dry cycle permits the growth of moist soil vegetation. Periodically, the USFWS will implement tillage and other management measures to control reed canarygrass.

The depth of water in the managed wetlands is typically 18 to 24 inches; natural wetlands may be shallower or deeper depending upon site specific topography. The water surface elevation in both natural and managed wetlands is generally higher than the water surface elevation in adjacent sloughs, except during heavy rains when the sloughs rise and spill into the wetlands. Soil conditions strongly influence water accumulation and percolation in these wetlands. Infiltration of wetland water into the ground is limited, thus water ponds in shallow swales underlain by the low-permeability silt and clay. This poorly draining soil separates the wetlands from the more permeable silty sand deposit below thus allowing water to stand for extended periods of time above the ground surface elevation. The silt and clay layer limits drainage to sloughs, thus accounting for the wetland waters being perched higher than the surface water in the sloughs.

The eight sloughs that bisect the JBH NWR were historically subject to tidal inundation. Wahkiakum County Diking District No. 4 was organized in 1922 and their construction efforts led to the formation of flood control levees containing 2,260 acres in two separate parcels. The mainland portion of the JBH NWR encompasses the largest parcel (about 2,000 acres) of the diking district. Various improvements to the District's levees and flood protection, including revetments, a pumping plant, emergency repairs, tide boxes, and drainage ditches were installed between 1935 and 1968. These flood control features essentially eliminated tidal influence and fisheries passage into these eight sloughs.

The Brooks, Duck Lake, W259+50, and W201+30 sloughs were equipped with tide boxes between 1922 and 1936. The 5-foot by 6-foot concrete tide box at W259+50 Slough appears to be of original construction based upon the year (1922) engraved in the concrete and the apparent age and structural nature of the failing tide gate at this location. The Brooks Slough pump station and other tide gates and tide boxes associated with the JBH NWR portion of District 4 appear to have been replaced over time. An experimental side-opening tide gate with a cam-action was installed at W201+30 Slough in 2004 in an effort to improve fish passage into and fisheries habitat parameters of the slough. Subsequently, it was determined that the W259+50 and W201+30 sloughs were interconnected by drainage ditches and culverts. This interconnection may have been responsible for the perceived improvements in the fisheries habitat/water quality parameters of W201+30 Slough.

Present aquatic habitat conditions are variable amongst the eight sloughs on the JBH NWR. Because of its partially failed tide gate and inability to fully close, the W259+50 Slough exhibits a tidal range in water elevation and improved water circulation. Habitat conditions for fish, based upon preliminary observations of turbidity, temperature, and water fluctuation, appear improved when contrasted to refuge sloughs without water exchange. Fisheries habitat conditions for the W201+30 Slough also appear improved post-installation of the side-opening, cam-action tide gate that opens to Steamboat Slough, a side channel of the Columbia River. As noted above, there is an interconnection at the W259+50 Slough, which probably contributed to the improved fisheries habitat conditions. Indian Jack, Hampson, Winter, and Ellison sloughs have very turbid, densely vegetated waters with no tidal interchange as each lacks a tide gate. Brooks Slough has three tide gates plus a discharge pump station. Although water is discharged from Brooks Slough, the water in the slough tends toward stagnant in the summertime. Juvenile anadromous fish passage and usage in Brooks Slough has not been determined. The eighth slough, Duck Lake, is connected via a culvert and tide gate to the lower Elochoman River just upstream from its confluence with the Columbia River. Water in Duck Lake Slough is characterized as turbid and stagnant.

The sloughs present within the refuge lack current velocity which influences the plant species growing within their confines. Parrot feather milfoil, an introduced noxious weed (Class B, Washington) is present in abundance within the refuge sloughs. White water lilies, a second noxious weed (Class C, Washington) is abundant in Indian Jack and Hampson sloughs. Reed canarygrass, also a Class C noxious weed is present in or adjacent to these sloughs. It even occurs as floating islands in some sloughs. Duckweed is abundant on the surface of some sloughs, such as Duck Lake.

Riparian forest is generally present along limited areas of the slough shorelines on JBH NWR. Dominant riparian tree species are black cottonwood, red alder, Sitka spruce, Oregon white ash and willow species. Understory species within riparian zones include wild rose, willows, non-native blackberries, and red-osier dogwood. The USFWS has been establishing riparian forest stands throughout the refuge. Deer/elk proof fencing has been utilized by the USFWS to facilitate establishment of riparian trees and shrubs which otherwise would succumb to deer and elk use as browse or rubs.

Emergent wetlands are dominated by the non-native reed canarygrass, and have few areas of native forbs, such as wapato, water plantain, rushes, and bulrushes. The managed wetland areas on the refuge are periodically dewatered and tilled to limit reed canarygrass and favor moist soil and emergent wetland plant species. These areas occur adjacent to, yet are separated by distance from the sloughs with the exception of connecting ditches or channels. Reed canarygrass grows in all habitat types, while Himalayan blackberry is present in scrub-shrub and forested areas and along fence lines.

2.8. Fish and Wildlife

2.8.1. Fish Species

Upriver migrating adult salmonids are present in the Columbia River and estuary throughout the year. Their residence time in the estuary is usually short and they normally do not feed to any extent. However, some migrating adult salmonids may hold in the lower river or estuary for some period of time before entering their spawning streams. Their presence in the JBH NWR area would be expected to be transitory except for those fish entering the Elochoman River or small tributaries in the general area. Nelson Creek does support runs of anadromous salmonids and research efforts are underway to determine species composition and a preliminary estimate of numbers present. Nelson Creek is currently diverted from its historic channel near the junction of Risk and Nelson Creek Roads and thus, neither the stream nor anadromous fish enter the refuge. Risk Creek may support an anadromous fish run and research efforts are underway to determine their presence. For adult anadromous fish to reach Risk Creek, they must first pass through the Brooks Slough tide gates, then travel through Brooks Slough to the mouth of Risk Creek and then ascend the creek passing through or over a collapsed culvert on the refuge, through a box culvert under Highway 4, then through a perched culvert subject to high velocity flows under Risk Creek Road to reach the stream sections not impacted by culverts. A former barrier dam, upstream of Risk Creek Road, that channeled Risk Creek to a diversion channel has been breached and no longer prevents a barrier to fish passage.

Juvenile salmonids are present in the lower Columbia and Elochoman rivers in the early spring and summer during their migration to the ocean. Actively migrating year-old juvenile spring Chinook, coho, and steelhead smolts migrate principally at the surface over the deeper water portion of the Columbia River and move through the lower river and estuary. Chum and fall Chinook have life stages that include migrating downstream, but do not become smolts at this time and are referred to as subyearling fish. These subyearling fish migrate downstream at a slower rate and can be present in the lower river and estuary for extended periods of time. They rear in shallow-water areas and bays such as Cathlamet, Youngs and Grays Bays before becoming smolts and migrating to the ocean. Most remain in the estuary during the summer, while some may overwinter in the estuary before smolting and migrating to the ocean. These subyearlings will likely make direct use of the sloughs at JBH NWR where tide gates to improve fisheries access are proposed.

Northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), banded killifish (*Fundulus diaphanous*), and large-scale suckers (*Catostomus macrocheilus*) occur in the mainstem Columbia River, side channel, sloughs and tidal marsh channels in the JBH NWR area. Common carp (*Cyprinus carpio*) are abundant in tidal marsh, slough and side channel habitats. Three-spine stickleback (*Gasterosteus aculeatus*) also occurs in these habitats. Warmwater gamefish such as largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomeiui*), pumpkinseed (*Lepomis gibbosus*), and bluegill (*Lepomis macrochirus*) occur in JBH NWR sloughs.

2.8.2. Wildlife Species

Various species of birds and mammals compose the wildlife community at JBH NWR. These species are associated with the principal habitat types on the refuge, which are riparian forest, wetland, and grassland. Although loons, grebes, cormorants, gulls, and terns are present in the open water habitat adjacent to the NWR, they are not a common component of the avifauna occurring on the mainland portion of the NWR in the areas proposed for habitat restoration.

Waterfowl particularly puddle ducks and Canada geese (*Branta canadensis*) are seasonally very abundant on JBH NWR. The refuge provides waterfowl nesting and foraging habitat, such as wetlands and pastureland for Canada geese, mallards (*Anas platyrhynchos*), northern pintails (*Anas acuta*), and American wigeon (*Anas americana*), and supports good concentrations of ducks and geese during migration periods and winter. Mallards, northern pintails, American wigeon, green-winged teal (*Anas crecca*), and Canada geese (several subspecies) are probably the most abundant wintering species. Mallards and wood ducks (*Aix sponsa*) are probably the principal nesting waterfowl species on the refuge.

Raptors (hawks, owls) occur throughout the JBH NWR area with a number of species present either as residents and/or wintering birds. Bald eagles are relatively abundant and represented by resident and wintering birds; a nesting pair occurs on Hunting Island and another on Price Island adjacent to the mainland body of the refuge. Peregrine falcons (*Falco peregrinus*) also are present and occur as resident, migrant and/or wintering birds. The abundance of shorebirds, waterfowl, and non-game birds in the area are attractive to peregrine falcons. Red-tailed hawks nest on the refuge and wintering birds also would be expected to occur. Northern harriers and white-tailed kites are present as residents, migrants, and wintering birds, particularly in the grasslands, which provide good foraging habitat. Cooper's (*Accipiter cooperii*) and sharp-shinned hawks (*Accipiter striatus*) may nest in the riparian forest stands. American kestrels (*Falco sparverius*) are present and ospreys (*Pandion haliaetus*) occur throughout the general area. Osprey nest on navigation aids, dolphins, and range markers, and on natural locations such as snags. The existing riparian forest stands currently or in the future will provide nesting platforms for osprey. Great horned (*Bubo virginianus*) and western screech owls (*Otus kennicottii*) are the most abundant owl species, particularly in riparian forest habitat. Barn owls (*Tyto alba*) are likely present although abundance is unknown. Short-eared (*Asio flammeus*), northern pygmy (*Glaucidium gnoma*), and northern saw-whet (*Aegolius acadicus*) owls may occur as migrants and wintering birds, and some nesting effort by these species may occur on the refuge.

Upland gamebirds, with the possible exception of ruffed grouse (*Bonasa umbellus*), are not expected to be present in any numbers on JBH NWR. Band-tailed pigeons (*Columba fasciata*) and mourning doves (*Zenaida macroura*) may be present. Rails and coots are present, with sora (*Porzana carolina*) and Virginia rails (*Rallus limicola*) primarily associated with nontidal wetlands. American coots (*Fulica americana*) use the tidal marsh habitat, sloughs, and backwater channels associated with the refuge.

Numerous bird species frequent JBH NWR in abundance and include species such as Vaux's swifts (*Chaetura vauxi*), rufous hummingbirds (*Selasphorus rufus*), belted kingfishers (*Ceryle alcyon*), downy (*Picoides pubescens*) and hairy woodpeckers (*Picoides villosus*), northern flickers (*Colaptes auratus*), six species of swallows, black-capped chickadees (*Poecile atricapillus*), Bewick's wrens (*Thryomanes bewickii*), kinglets, Swainson's thrushes (*Catharus ustulatus*), and several warbler and sparrow species. Riparian, slough, wetland, and pastureland habitats at JBH NWR are important to many of these species. Common yellowthroats (*Geothlypis trichas*) and song sparrows (*Melospiza melodia*) are common nesting species on the refuge. Blackbirds forage in wetland vegetation and swallows forage on insects over the wetlands, sloughs, pastureland, and open-water habitats.

The endangered Columbian white-tailed deer is the mammal of most concern at JBH NWR. The deer are located throughout the mainland portion of the refuge. Other populations occur on Tenasillahe Island, a unit of the JBH NWR, Puget Island, and in the Clatskanie bottomlands near Westport. These deer do occur throughout the project area. Roosevelt elk also occur in the project area and are subject to management measures to limit their population due to conflicts with Columbian white-tailed deer.

Beaver, nutria, raccoon, muskrat, mink, and otter represent furbearers in the project area. The introduced nutria is very abundant, inhabiting tidal marshes, sloughs, ponds, backwaters, and diked agricultural and wetland habitat. Beavers are abundant and are associated with sloughs with adjacent riparian forest habitat as are the other furbearers noted. Otter are abundant and well distributed throughout the lower Columbia River (Henney et al., 1996). Mink populations in the lower Columbia River were very low with only one family group and four individuals noted during summer surveys and only two animals reported by trappers (Henney et al., 1996). Fox, skunk, opossum, and coyote occur throughout the project area.

About 32 small mammal species may occur in the project area, excluding bats. Shrews and deer mice are expected to be the most abundant species (Hinchberger 1978). Vole species would be most abundant in agricultural croplands, particularly pasturelands and grain stubble left standing over winter. Nine or more species of bats may occur throughout the general area using riparian and coniferous forest habitat, buildings, bridges, and other structures for roost and maternity sites.

2.9. Threatened and Endangered Species

The USFWS listing of federally threatened and endangered species that may be present in Wahkiakum County, Washington are listed in Table 9. Thirteen ESUs of Columbia River anadromous salmonids may occur in the area. Critical habitat designations and descriptions for listed anadromous salmonid ESUs are provided in Table 10. The bald eagle was delisted by the USFWS in June 2007. No plants or invertebrate species are listed for Wahkiakum County.

Table 9. Federally Listed Species for Wahkiakum County, Washington

ESU (fish) or Common Name (wildlife/plants)	Scientific Name	Federal Status
Columbia River Chum Salmon	*Oncorhynchus keta*	Threatened; Critical Habitat
Steelhead Trout	*Oncorhynchus mykiss*	
Lower Columbia River		Threatened; Critical Habitat
Middle Columbia River		Threatened; Critical Habitat
Upper Willamette River		Threatened; Critical Habitat
Upper Columbia River		Endangered; Critical Habitat
Snake River		Threatened; Critical Habitat
Chinook Salmon	*Oncorhynchus tshawytscha*	
Lower Columbia River		Threatened; Critical Habitat
Upper Willamette River		Threatened; Critical Habitat
Upper Columbia River Spring		Endangered; Critical Habitat
Snake River Fall		Threatened; Critical Habitat
Snake River Spring/summer		Threatened; Critical Habitat
Snake River Sockeye Salmon	*Oncorhynchus nerka*	Endangered; Critical Habitat
Lower Columbia River Coho Salmon	*Oncorhynchus kisutch*	Threatened
Green Sturgeon (Southern DPS)	*Acipenser medirostris*	Threatened
Bull Trout	*Salvelinus confluentus*	Threatened
Steller Sea Lion	*Eumetopias jubatus*	Threatened; Critical Habitat
Columbian White-tailed Deer	*Odocoileus virginianus leucurus*	Endangered
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened; Critical Habitat
Northern Spotted Owl	*Strix occidentalis caurina*	Threatened

Table 10. Critical Habitat Descriptions for Anadromous Salmonid ESUs

Species	Date of Critical Habitat Designation	Description of Critical Habitat [1]
Chinook Snake River spring/summer	October 25,1999	Columbia River to confluence with Snake River, Snake River & tributaries.
Chinook Snake River fall	December 28, 1993	Columbia River to confluence with Snake River; Snake River & tributaries.
Chinook Lower Columbia	January 2, 2006	Columbia River to confluence with Hood River & tribs.
Chinook Upper Columbia	January 2, 2006	Columbia River to Rock Island Dam & tributaries.
Chum Columbia River	January 2, 2006	Columbia River to confluence with Hood River & tribs.
Sockeye Snake River	December 28, 1993	Columbia River to confluence with Snake River; Snake River & tributaries.
Steelhead Snake River	January 2, 2006	Columbia River to confluence with Snake River; Snake River & tributaries.
Steelhead Lower Columbia	January 2, 2006	Columbia River to confluence with Hood River & tribs.
Steelhead Middle Columbia	January 2, 2006	Columbia River to confluence with Yakima River & tributaries.
Steelhead Upper Columbia	January 2, 2006	Columbia River to Rock Island Dam & tributaries.
Chinook Upper Willamette	January 2, 2006	Columbia River to confluence with Willamette River; Willamette River & tributaries.
Steelhead Upper Willamette River	January 2, 2006	Columbia River to confluence with Willamette River; Willamette River & tributaries.

[1] Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 CFR 319.11).

2.9.1. Listed Fish Species

Chum Salmon

Lower Columbia River chum salmon (threatened) are distributed from Bonneville Dam to the mouth of the Columbia River. Adults migrate from early October through November and spawning occurs in November and December. A majority of spawning habitat is in lower portions of rivers just above tidewater (Grays River, Washington) and in the side channel near Hamilton Island below Bonneville Dam. Spawning occurs in the mainstem Columbia River in areas where substrate is gravel. Juveniles outmigrate during spring. Most juveniles rear extensively in estuaries. Currently, limited documentation exists on juvenile chum salmon use of the project area. The ESU would be expected to occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Steelhead Trout

Steelhead trout that may be present in the project area include the following ESUs: the threatened Middle Columbia River, endangered Upper Columbia River, threatened Upper Willamette River, threatened Lower Columbia River, and threatened Snake River Basin ESUs. Steelhead populations in the Columbia River Basin include two spawning migrations: winter-run and summer-run. Spawning habitat for steelhead include upper reaches of tributaries. Juveniles spend from 1-7 years (average 2) in freshwater and outmigrate during the spring and early summer, primarily in the main channel. The Southwest Washington steelhead ESU are found in the Elochoman River. The listed steelhead ESUs would occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Sockeye Salmon

Sockeye salmon (endangered) occur in the Salmon River, a tributary of the Snake River. This population migrates in spring and summer and spawning occurs in February and March. Spawning occurs in inlets or outlets of lakes or in river systems. Juveniles rear in freshwater for one year and outmigrate in spring and early summer as yearlings. Sockeye would not be expected to occur in the project area. The ESU would be expected to occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Chinook Salmon

Adult Snake River fall Chinook salmon (threatened) enter the Columbia River in July and August and reach the mouth of the Snake River from the middle of August through October. Spawning occurs in the Snake River and lower reaches of tributaries to the Snake River in October and November. Juvenile Snake River fall Chinook salmon move seaward slowly as subyearlings or ocean-type. Studies of the downstream migration of Chinook salmon in the lower Columbia River concluded that they were present from June to October. Chinook salmon tend to linger in the lower Columbia River and may spend a considerable portion of their first year in the estuary. Adults return to the Snake River at ages 2-5, with age 4 the most common spawning age. While no documentation exists on the use by this species in the project area, their life cycle suggests use of backwater habitat like that present at JBH NWR. The ESU would be expected to occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Adult Snake River spring and summer Chinook salmon (threatened) migrate upstream past Bonneville Dam from March through May and June through July, respectively. Spring and summer runs of Chinook salmon in the Snake River prefer smaller, higher elevation streams and tend to migrate quickly to sea as yearling or stream-type smolts. The ESU would be expected to occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Fall run Lower Columbia River Chinook salmon (threatened) are predominant in this region, and return to the river beginning in late August to spawn. Spawning occurs from late August to November. Juveniles outmigrate from early spring to fall depending upon run type. While no documentation exists on the use by this species in the project area, their life cycle suggests use of use of backwater habitat like that of the JBH NWR area for rearing prior to ocean entry.

Upper Columbia River Chinook salmon (endangered) occur in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Adults migrate from late winter to spring and spawn from late August to November. Spawning occurs in the mainstem Columbia River to upper reaches of tributaries. Juveniles outmigrate from early spring to summer. Subyearling Chinook salmon are most likely to use the project area for rearing during migration downstream. Subyearling Chinook enter the estuary in late May and again between July and August. Some subyearling salmon reside in the estuary for as long as several months and rear in backwaters and other shallow water habitats. The lack of systematic surveys of juvenile salmonids in estuarine, shallow-water habitats limits the interpretation of current habitat use of the project area.

Upper Willamette River Chinook salmon (threatened) occurs above Willamette Falls in three major tributaries, the McKenzie River and South and North Forks of the Santiam River. Adult spring-run Chinook enter the Columbia River in March and April, but they do not ascend Willamette Falls until May or June, and spawn from late August to early October. Juveniles outmigrate from early spring to summer. This ESU would be expected to occur in the Columbia River, immediately adjacent to the project area during juvenile and adult migration periods.

Coho Salmon

Lower Columbia River Coho occur in the lower Columbia River as both adults and juveniles. Spawning occurs primarily in tributaries to the lower Columbia River below Bonneville Dam. Adults migrate upstream beginning in the fall. Spawning occurs in the late fall and early winter. Juveniles emerge from redds over a 3-week period from early March and late July, rear in freshwater for a year and migrate to sea the next season. Outmigration peaks in May, but extends from early April through June. Coho can return in 5 to 20 months to spawn. Pre-construction monitoring in the project area detected juvenile coho salmon using the W259+50 Slough.

Green Sturgeon

The green sturgeon is a widely distributed, marine-oriented sturgeon found in nearshore waters from Baja California to Canada (NMFS 2007). Green sturgeon are anadromous, spawning in the Sacramento, Klamath and Rogue rivers in the spring (NMFS 2007). Spawning occurs in deep pools or holes in large, turbulent river mainstreams. Specific characteristics of spawning habitat are unknown but are likely large cobbles, but can range from clean sand to bedrock (NMFS 2007). There are two Distinct Population Segments (DPS) defined for green sturgeon – a northern DPS with spawning populations in the Klamath and Rogue rivers and a southern DPS that spawns in the

Sacramento River (NMFS 2007). The southern DPS was listed as threatened in 2006. The northern DPS remains a species of concern.

Information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall in the northwestern United States. Most green sturgeon are taken as by-catch in fisheries for salmonids, *Oncorhynchus* spp. and white sturgeon, *Acipenser transmontanus* (Moyle 2002; Adams et al., 2002). Green sturgeon enter the Columbia River at the end of spring with their numbers increasing through June (personal communication, B. James, WDFW, 2007). The greatest numbers are caught in the estuary in July through September. The majority of green sturgeon are caught in the lower reaches of the Columbia (29,132 from RM 1-20 and 8,086 from RM 20-52) based upon harvest information from 1981-2004 (B. James, WDFW, e-mail comm. 2007). A few green sturgeon may be found as far upriver as Bonneville Dam, but there are no known spawning populations in the Columbia River and its tributaries. Preliminary work by Israel and May (2006) has determined that 80% or greater of green sturgeon in the Columbia River estuary during late-summer and early fall months were Southern DPS origin.

Bull Trout

The Columbia River downstream from Bonneville Dam serves as foraging, over-wintering, and migratory habitat for bull trout. Bull trout have been reported from the lower reaches of the Kalama River, Lewis River, and Sandy River. Documentation for this is provided in the Proposed Designation of Critical Habitat published in the *Federal Register* on November 29, 2002 and the draft Bull Trout Recovery Plan (USFWS 2002). Bull trout have been reported recovered in the mainstem Columbia River at Jones Beach (CRM 46) about 10 miles upstream of JBH NWR. Therefore, it is probable that bull trout occur in limited numbers in the mainstem Columbia River in the vicinity of the project location. Their presence probably coincides with the appropriate water temperature range in the Columbia River.

Critical habitat for bull trout reaches downstream from The Dalles Dam to the Pacific Ocean. Major tributaries include the Lewis, Kalama, and Cowlitz rivers upstream of the Elochoman River. Historically, bull trout may have inhabited areas within the Cowlitz and Kalama Rivers, but current distribution within each basin is unknown.

2.9.2. Listed Wildlife Species

Steller Sea Lion

Steller sea lions may occur in the Columbia River near the project area although this area is outside of the critical habitat designated for this species. In California and Oregon, all major Steller sea lion rookeries (Rogue Reef – Pyramid Rock; Orford Reef – Long Brown Rock and Seal Rock) and associated air and aquatic zones constitute critical habitat for the species. Critical habitat includes an air zone that extends 3,000 feet above areas historically occupied by sea lions at each major rookery in California and Oregon, measured vertically from sea level. Critical habitat includes an aquatic zone that extends 3,000 feet seaward in state and federally managed waters from the baseline of each major rookery in California and Oregon. No critical habitat has been identified in Washington by NMFS.

Columbian White-tailed Deer

The mainland portion of the JBH NWR represents one of two secure and viable habitats for the Columbian white-tailed deer; Tenasillahe Island, a unit of the JBH NWR, represents the other. Riparian forest, old fields, agricultural pasturelands, Sitka spruce swamp, wetlands, and hybrid popular plantations are habitats inhabited by this subspecies within the Columbia River estuary. The current vegetative cover of areas immediately adjacent to the proposed restoration areas is primarily riparian forest, old fields, wetlands dominated by reed canarygrass and agricultural pasturelands.

Marbled Murrelet

Critical habitat for the marbled murrelet in southwest Washington consists of parcels in Grays Harbor, Pacific, and Wahkiakum counties owned or administered by Grays Harbor County (1,565 acres), Washington State Parks (359 acres), Bureau of Land Management (1,151 acres), and private landowners (18,822 acres). Marbled murrelets are not expected to occur in the project area because the site does not contain suitable nesting habitat for this species. The remnant stands of riparian and coniferous forest on JBH NWR do not provide the nesting habitat attributes of old growth coniferous forest habitat sought by marbled murrelets.

Northern Spotted Owl

Northern spotted owls are not expected to occur in the project area because the site does not contain suitable nesting habitat for this species. The remnant stands of riparian and coniferous forest on JBH NWR do not provide the nesting habitat attributes of old growth coniferous forest habitat sought by northern spotted owls.

Bald Eagle

The bald eagle was delisted by the USFWS in June 2007. Bald eagles that constitute nesting pairs in the Columbia River estuary are considered year-around residents. Four bald eagle pairs nest either on or near the mainland portion of the JBH NWR. Bald eagles occur at the refuge as resident nesting adults and wintering/transient birds. They use the riparian and coniferous trees along the rivers and side channels for hunting and loafing perches. The refuge also supports wintering eagles. Garrett and others (1988) estimated a maximum wintering population of 170 bald eagles downstream of Longview, Washington. Wintering birds are most abundant in the estuary and at the Sauvie Island-Vancouver Lowlands. The number of wintering bald eagles fluctuates annually, probably in response to local and external weather patterns and prey availability. Regardless, the lower Columbia River downstream of Portland, including the JBH NWR, represents an important wintering area for bald eagles. Migrant bald eagles also are expected to occur as transients in the proposed general area although their number cannot be determined.

2.10. Cultural and Historic Resources

The general location of the JBH NWR was believed to have contained several Native American villages during the 1700s. The NWR was surveyed for cultural resources in 1980 (Gilbow et al., 1981). Their survey included archival and museum research and an on the ground intensive survey and subsurface testing by hand auger. No cultural resource sites were found in their searches of the National Register of Historic Places, Washington Archaeological Research Center, Oregon Museum of Anthropology, Historic Buildings Survey, or the Historic American Engineering Record. The authors noted that while it was possible that cultural resources exist on the JBH NWR, the combination of erosion and sedimentation associated with the Columbia and Elochoman rivers (pre-flood control levee) had either destroyed or buried the evidence. Gilbow and others (1981) reported that many canoe burials, three Indian villages or camp sites and a number of historic era structures, particularly those associated with the fishing industry were once reported present, but no surface evidence remained at the time of their extensive survey. Due to extensive vegetative cover, they recommended that only areas subject to physical modification be surveyed or tested for cultural resources. They noted that there was the possibility of unearthing artifacts, particularly around the mouth of the Elochoman River.

The flood control levee that protects the JBH NWR was initially constructed by Wahkiakum County Diking District No. 4, which was organized in 1922. The 5-foot by 6-foot concrete tide box at W259+50 Slough appears to be of original construction based upon the year engraved in the concrete (1922) and the apparent age and structural nature of the failing tide gate. Corps involvement with the diking district ranges from 1935-1936 when an emergency levee repair occurred, to 1968 when two revetments were constructed. The pump station and other tide gates/tide boxes associated with the diking district appear to have been replaced over time. The proposed action will entail ground disturbance activities within the footprint of the flood control levee where the sloughs may have or did originally discharge to the adjacent body of water. These are relatively small, confined disturbance areas. Ground disturbance associated with riparian forest establishment will be comparable to agricultural tillage operations that occurred on these grounds prior to establishment of the JBH NWR.

2.11. Socio-economic Resources

The JBH NWR mainland unit lies between river miles 34-37 in the Columbia River estuary in an area that historically was a complex of tidal sloughs and intertidal marsh/spruce swamp habitat. The refuge area was subsequently diked and drained for agricultural purposes resulting in the conversion and loss of fish and wildlife habitat. Fisheries access to sloughs and side channels was cutoff via construction of the flood control levee.

Currently the land is managed principally for Columbian white-tailed deer, with management practices focusing on improving forage for deer and including controlled cattle grazing in permanent pastures, mowing of grass and weeds, and plowing and seeding fields, wetland enhancement and riparian forest establishment. Socio-economic activities associated with the refuge include some grazing by cattle, wildlife viewing, and recreational fishing on the Columbia River shoreline.

2.12. Air Quality/Noise/Light

The WDOE Air Quality Program website reports that Cowlitz County has good air quality (https://fortress.wa.gov/ecy/aqp/Public/databyarea.shtml). The proposed action is in Wahkiakum County, immediately west of Cowlitz County. Wahkiakum County is rural in nature with no industrial complexes of any size. Although there are no onsite sources of pollution at the JBH NWR or nearby, the Longview, Washington industrial complex might influence air quality at JBH NWR when wind carries emissions downriver. However, JBH NWR is greater than 30 miles downstream of Longview, Washington.

Sources of noise include recreational and commercial river traffic and mainland traffic on Highway 4. None of these sources are considered significant. Virtually no artificial lighting is present at JBH NWR except security lighting around refuge facilities and a few residences.

3. FUTURE WITHOUT PROJECT CONDITIONS

If no action is taken, the inadequate fish passage and habitat conditions associated with the sloughs on the JBH NWR will continue in the future. Absent management efforts, these sloughs will fail to achieve their potential under a modified infrastructure and water management scheme to provide modest improvements in fish passage and habitat conditions. Neither Wahkiakum County nor Diking Improvement District No. 4 possesses the financial means to address improvements independently. While the USFWS owns the lands underlying the flood control levees, the diking district holds the easement for the flood control levees and maintains the tide gates and trash racks. Wahkiakum County owns the culverts under the levees. The USFWS does not have the authority to unilaterally enact modifications to the flood control structural features. Therefore, those features (flood control levees, culverts, and tide gates) that inhibit or prevent fish passage to the sloughs are unlikely to be modified in the future.

The lack of riparian forest has limited detritus, or debris, and invertebrate production and export, as well as the use of the JBH NWR by many species of wildlife, including the endangered Columbian white-tailed deer. Riparian forest restoration actions have been implemented on the JBH NWR on a limited scale and currently address a small portion of the available land for restoration. The USFWS will continue to address riparian forest restoration on refuge lands contingent upon available funding and management priorities. The scale of the USFWS's efforts to restore riparian forest habitat is anticipated to remain relatively modest in terms of acreage restored annually over the next decade.

4. ALTERNATIVES*

4.1. Initial Screening

The initial screening of potential restoration measures at JBH NWR was based on interagency meetings between the USFWS and the Corps, including site visits, to assess management objectives for the refuge and potential restoration measures to accomplish them. These meetings were subsequently expanded to include staff from Wahkiakum County, Diking District No. 4, the NMFS, Columbia Land Trust, Washington Department of Transportation, and Natural Resource Conservation Service. The primary management objectives included restoration of tidal flows to the refuge sloughs and riparian forest habitat development to benefit of Columbian white-tailed deer, Neotropical migrant birds, and anadromous fish. The provision of fish friendly tide gates was identified as a possible means to improve fish passage and slough use by juvenile salmonids. Detrital and invertebrate export from the sloughs via the tide gates to the Columbia and Elochoman rivers was an additional benefit. Riparian forest development would entail tillage, tree plantings, and fencing based upon the refuge's previous experience in developing riparian forest stands.

Hydraulic engineering investigations were initiated to develop a hydraulic model for the refuge. Water elevations in the sloughs were measured with data recorders as were river and tidal stages at points exterior to the sloughs. Rainfall, tidal and Columbia River stage records for the area were evaluated; rainfall records extended back to the 1950s for the refuge. Existing tide gates on the refuge were observed and their functional characteristics and capabilities were assessed. Hydraulic connections amongst the interior sloughs, specifically drainage ditches and culverts, were located, mapped and measured for incorporation into the hydraulic model. Surveys were conducted to determine levee cross-sections, culvert invert elevations and diameters, and channel profiles for interior sloughs. Temporary bench marks were installed. Information derived from a levee overtopping event in January 2006 and Elochoman River flooding in November 2006 which resulted in substantial flooding of the refuge's interior was also evaluated.

Based upon discussions with refuge staff, an interior water surface elevation of 5 feet (all elevations in NAVD 88) was determined to be the maximum permissible water elevation. Water levels that exceed 5 feet would compromise the refuge's primary purpose to protect and manage the endangered Columbian white-tailed deer. The purpose of this information collection and analysis was to determine what potential management measures could be accomplished at the interior sloughs that would allow for fish passage and improved fisheries habitat conditions while not compromising the refuge's primary management objective for Columbian white-tailed deer.

4.2. Proposed Restoration Measures for Fish Passage Improvements

A number of potential measures to either provide and/or improve fish passage for the refuge sloughs were evaluated. Installation of culverts and tide gates at those sloughs without the structures was the first consideration. For those sloughs with existing culverts and tide gates, retrofitting with fish friendly tide gates was an initial consideration; culvert and tide gate replacement was considered secondarily. Tide gate size (diameter), means of opening (top-hinged vs. side-hinged), dual-purpose combination gates (hydraulic pressure opening, self-regulating tide gate in combination with a sluice gate, manual opening and closing slide gate), restrained, side-hinged tide gates, additional culverts with tide gates, seasonal operation and/or tide gates with fish-flaps were also considered.

Typical tide gates, regardless of whether they open via a top or side-hinge, rely upon the hydraulic pressure provided by a higher water surface on the interior than the exterior to open. Thus, they typically open on the outgoing tide. River and tidal stage in combination with the amount of interior drainage influence the number and period of openings by tide gates. High river and tidal stages in the winter can substantially restrict their opening and discharge capability. Combination gates would provide the opportunity to allow free water exchange between the river and slough during lower river stages. Fish flaps are a small (typically 2-4 foot wide), hinged door with flotation chambers on the tide gate that opens outward and comprises only a small portion of the total surface area of the tide gate. The intent of fish flaps is to allow water and fisheries ingress during the rising tide. They can be locked down during high flows to preclude interior flooding issues. This element was only initially considered due to the potentially high water velocities being propelled through the door, thus deeming it unusable for fish.

The provision of new culverts and tide gates, coupled with installation of larger culverts with side-hinged tide gates and/or dual-purpose gates and fish-flaps was expected to address improved fish passage. The side-hinged, self-restrained tide gate has the potential to allow ingress and egress of tidal waters and fish while requiring minimal operational adjustment or maintenance. Improved inflows and outflows would allow for improved fish passage and fish utilization of interior slough habitat. Greater water circulation than under present conditions would also serve to improve fisheries habitat conditions for the interior sloughs. Overall, installation of these features would also result in increased discharge efficiency for the refuge, potentially improving deer habitat conditions. Given the two flooding events in 2006, increased discharge efficiency would provide for more stable habitat conditions for Columbian white-tailed deer. Flooding precludes deer from utilization of their habitat, forcing deer to the dikes or other areas of limited high ground and potentially off-refuge if events are prolonged. Deer mortalities can result from floods, particularly if prolonged flooding of their habitat occurs.

The interior (refuge) portion of Risk Creek was historically channelized and does not exhibit the sinuous channel configuration streams of this nature generally exhibit. The proposed measures include removing a broken culvert, creating an open channel, and construction of a sinuous channel downstream of the culvert location.

4.2.1. Restoration of Tidal Water Exchange for Interior Sloughs

Tidal slough restoration was predicated upon installation of new culverts and tide gates and retrofitting existing tide gates where appropriate to allow for inflow of tidal waters to each slough. The current management focus for JBH NWR is Columbian white-tailed deer. Thus, breaching the flood control levee to restore tidal water exchange was not a consideration. Modifications to the existing tide gates and installation of others that would allow for the management of interior water levels that would maintain deer habitat yet allow for tidal exchange was thus the best available option. Provision of a greater exchange of water would allow for improvements in fisheries habitat parameters and juvenile anadromous fish passage, both ingress and egress, compared to the existing condition. Water exchange would also allow for export of detritus and invertebrates to the Columbia River, an action beneficial to fish resources in the mainstem.

Currently the JBH NWR sloughs are either entirely disconnected from the Columbia and/or Elochoman rivers by a flood control levee or else are connected via culverts and tide gates to these rivers to drain the interior lands of the refuge. Two exceptions are present: the W201+30 and W259+50 sloughs do allow for inflow of tidal waters. A side-hinged, cammed tide gate, installed in 2003 at W201+30 Slough allows for a minor amount of inflow and an old, failing tide gate at

W259+50 Slough allows for substantial inflow of tidal waters. It is anticipated that in the near future, maintenance actions would be initiated by the USFWS at W259+50 Slough to repair the tide gate and attain positive closure.

4.2.2. Restoration of Riparian Forest

The riparian forest component of the restoration effort would be directed at establishing riparian forest vegetation on lands now characterized by grasslands rather than the riparian forest of their natural state. The present condition of much of the refuge land is a reflection of past agricultural practices when the land was cleared and pasturelands established. Reed canarygrass now dominates these former pasturelands and has effectively precluded reestablishment of riparian forest habitat. The USFWS has established a number of riparian forest stands in recent years. They have utilized mowing, repetitive tillage, plantings, protective mesh around seedlings and cuttings, and elk-proof fencing to accomplish establishment of riparian forest habitat. Their methodology would be utilized under this proposed action to establish riparian forest habitat given its proven track-record. There are approximately 210 acres of former pasturelands that would be restored to riparian forest. Approximately 70 acres of riparian forest would be developed annually over a 3-year period to lessen the potential for impacts to Columbian white-tailed deer. Once the native riparian forest cover is reestablished it will provide shade conditions along the sloughs and other waterways that will result in cooler peak summer water temperatures for out-migrating salmonids. It will also improve important cover and feeding opportunities for the deer and neo-tropical migrating birds. Invertebrate and detrital production from the riparian forest will benefit fisheries resources in the adjacent sloughs and allow for export to the Columbia River.

4.2.3. Risk Creek Restoration

A culvert for an interior access road presently restricts water flow in Risk Creek within the refuge. Overflow is diverted into the adjacent pasturelands during high flow events which poses a serious problem for juvenile salmonid outmigrants. The failing culvert also represents an impediment to upstream passage, and spawning areas, of adult salmonids. Further, the stream was channelized in the past and does not exhibit the sinuous channel configuration streams of this nature generally exhibit. The proposed measures, culvert removal, and construction of a sinuous channel downstream of the culvert location would allow greater ingress and egress of adult and juvenile salmonids.

4.3. Array of Restoration Measures by Site

The conceptual restoration measures were further developed in order to meet some or all of the planning criteria and restoration objectives (see Sections 1.5 and 1.6) for JBH NWR to varying degrees. Restoration measures considered at each site are described below.

4.3.1. No Action Alternative

Under the No Action Alternative, no habitat restoration actions would be implemented at JBH NWR.

4.3.2. Indian Jack Slough

Sheet piles or cofferdams would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Channel construction would not be enclosed by cofferdams due to wet soil conditions and length of channel. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. Large trees may need to be removed if there is threat to structural stability of the levee. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls comprised of either cast-in-place, pre-cast concrete, or steel would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cubic yards (cy) of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. A discharge channel from the tide gate to the Elochoman River will be constructed via blasting or excavation. For all sites, best management practices (BMPs) will follow EPA's National Pollutant Discharge Elimination System (NPDES) BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. About 19 acres of riparian forest vegetation would be planted along the shorelines.

4.3.3. Duck Lake Slough

Sheet piles or a cofferdam would be placed on the exterior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Existing riprap will be temporarily removed during construction to facilitate placement of the sheet pile cofferdam. A culvert plug or cofferdam would be used on the interior end of the existing culvert to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height.

Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The existing 70-inch diameter steel culvert may be cut and shortened on the riverward end to further facilitate fish passage. The existing trash rack and walkway will be removed. A headwall, comprised of either cast-in-place, pre-cast concrete, or steel, would be constructed at the riverward end of the culvert. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline.

A side-hinged restrained tide gate will be installed on the riverward headwall, replacing the existing top-hinged steel tide gate. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if log boom replacement is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams and culvert plugs would be removed upon completion of each individual structure, at low tide, to minimize the environmental impacts. The sidewalls of the cofferdam may remain as a permanent retaining wall structure and would include handrails or possibly a walkway. Existing steel pilings may be removed, or capped and left in place for minimum environmental disturbance. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 20 acres of riparian forest vegetation would be planted along the shorelines.

4.3.4. Ellison Slough

Sheet piles or cofferdams would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Channel construction would not be enclosed by cofferdams. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls comprised of either cast-in-place, pre-cast concrete, or steel would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. A discharge channel from the tide gate to the Elochoman River will be constructed via blasting or excavation. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). An interior channel will be excavated from the flood control levee to the Ellison Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Ellison Slough only upon completion of construction to minimize potential turbidity. Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 54 acres of riparian forest vegetation would be planted along the shorelines.

4.3.5. Winter Slough

Sheet piles or cofferdams would be placed on the interior and exterior. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls, comprised of either cast-in-place, pre-cast concrete, or steel, would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately one year to determine if a log boom is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure, at low tide, to minimize the environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails.

An interior channel will be excavated from the flood control levee to the existing Ellison Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Ellison Slough only upon completion of excavation to minimize potential turbidity. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 20 acres of riparian forest vegetation would be planted along Winter Slough.

4.3.6. W201+30 Slough

Temporary sheet piles or cofferdams would be placed on the interior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Work will include removal of existing vegetation which is obstructing the existing culvert; approximately 20 cy of riprap will be placed around the interior end of the culvert and it will be cut and beveled to preclude future debris build-up. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. About 24 acres of riparian forest vegetation would be planted along the shorelines.

4.3.7. W259+50 Slough

Temporary sheet piles or a cofferdam would be placed on the exterior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. A culvert plug or coffer dam would be used on the interior end of the culvert to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. A side-hinged, restrained tide gate will be retrofitted on the existing riverward headwall. Guard rails may be placed on both sides of the levee roadway. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom replacement is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. About 9 acres of riparian forest vegetation would be planted along the shorelines.

4.3.8. Hampson Slough

Sheet piles or a cofferdam would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Interior channel construction, via excavation, would not be enclosed by cofferdams.

Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. The majority of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee. Headwalls, comprised of either cast-in-place, pre-cast concrete, or steel, would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline.

A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately one year to determine if a log boom is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. An interior channel will be excavated from the flood control levee to the existing Hampson Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Hampson Slough only upon completion of construction to minimize potential turbidity. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 21 acres of riparian forest vegetation would be planted along the shorelines.

4.3.9. Brooks Slough

Temporary sheet piles or a cofferdam would be placed on the exterior end of the existing three culverts to preclude entrance of tidal and/or slough waters into the construction area. Culvert plugs or cofferdam would be used on the interior end of the culverts to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands.

A side-hinged, restrained tide gate will be retrofitted on the existing riverward headwall for one of the culverts. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom replacement is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams and culvert plugs would be removed upon completion of each individual structure at low tide to minimize environmental impacts. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. About 39 acres of riparian forest vegetation would be planted along the shorelines.

4.3.10. Risk Creek

Approximately 1,000 lineal feet of channel will be excavated and realigned to form a sinuous channel. About 4 acres of riparian forest vegetation would be planted along the shorelines.

4.3.11. Nelson Creek

In addition, improvements at Nelson Creek were considered. Initially at the request of the USFWS, a bridge to allow deer passage under Washington Highway 4 was considered as an alternative, but issues such as lack of control of the volume of water coming into the refuge, as well as a very significant cost increase, made it impracticable to carry forward. Another option considered was installation of a 6-foot by 6-foot box culvert under Highway 4 with a slide gate installed on the upstream end of the box culvert to allow for water control during local flood events, plus riparian forest vegetation planted along the shorelines of Nelson Creek. Nelson Creek is being dropped from further consideration as part of this project due to issues related to private lands and potential delays in implementation of the project. Restoration elements at Nelson Creek may be considered as a separate project at a later time.

4.4. Evaluation of the Restoration Benefits

An analysis of project benefits is provided in the following sections for the No Action Alternative and by restoration site.

4.4.1. No Action Alternative

For the No Action Alternative, the tidal sloughs, Risk Creek, and riparian forest habitats (currently grasslands) on the refuge would remain degraded. Tidal water and fisheries ingress and egress would continue to be limited by the lack of tide gates suitable for inlet and discharge of water plus fisheries passage. The tidal slough habitats would continue to be isolated from the river, preventing juvenile salmonid and other fish access to productive feeding areas. Additionally, fisheries habitat quality in the refuge sloughs would remain degraded. The lack of riparian forest would limit invertebrate and detritus production and export, and the use of the mainland portion of the refuge by many species of wildlife, including Columbian white-tailed deer and Neotropical migrant birds. This alternative does not meet the planning criteria and restoration objectives discussed in Sections 1.5 and 1.6 of this report. However, the No Action Alternative is included in the output and economic evaluations as a baseline against which the restoration alternatives are compared.

4.4.2. Indian Jack Slough

The proposed actions at this site would lead to improvements to 7.9 acres of fisheries habitat, allow for juvenile salmonid ingress and egress where currently it does not exist, and provide for restoration of 18.6 acres of riparian forest habitat. Invertebrate production and detrital export from the riparian forest habitat would increase post-project from the current condition associated with a reed canarygrass dominated grassland. A projected net gain of almost 18 average annual habitat units (AAHUs) was estimated for juvenile salmonids with implementation of the restoration action. Riparian forest restoration via plantings and natural seeding would convert the grasslands along the slough shorelines into a Sitka spruce-black cottonwood-Oregon white ash-willow species riparian forest with an understory of red-osier dogwood, elderberry, snowberry and other tree, shrub and grass/forb species. It is anticipated that the initial restoration of riparian forest habitat would substantially increase use of the area by Neotropical migrants. The level of these riparian associated outputs would be expected to increase with maturation of the riparian forest habitat and the development of snags and large woody debris accumulating on the forest floor. An estimated gain of almost 10 AAHUs was forecast for Neotropical birds with project implementation. Columbian white-tailed deer would benefit from the cover and forage provided by riparian forest restoration. An estimated 13 AAHUs would be attained for deer with riparian forest restoration.

4.4.3. Duck Lake Slough

The proposed actions at this site would lead to improvements to 7.6 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress where currently it is severely impaired by a heavy, top-hinged tide gate, and provide for restoration of 20.2 acres of riparian forest habitat. A projected net gain of almost 23 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 10.6 AAHUs was forecast for Neotropical birds with project implementation. Approximately 14 AAHUs would be attained for deer with riparian forest restoration.

4.4.4. Ellison Slough

The proposed actions at this site would lead to improvements to approximately 22 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress where currently it does not exist, and provide for restoration of 54.2 acres of riparian forest habitat. A projected net gain of almost 74 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 28.4 AAHUs was forecast for Neotropical birds with project implementation. Approximately 38 AAHUs would be attained for deer with riparian forest restoration.

4.4.5. Winter Slough

The proposed actions at this site would lead to improvements to approximately 6 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress where currently it does not exist, and provide for restoration of 20.2 acres of riparian forest habitat. A projected net gain of almost 19 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 10.6 AAHUs was forecast for Neotropical birds with project implementation. Approximately 14 AAHUs would be attained for deer with riparian forest restoration.

4.4.6. W201+30 Slough

The proposed actions at this site would lead to improvements to approximately 4 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress, and provide for restoration of 24.3 acres of riparian forest habitat. A projected net gain of approximately one AAHU was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 12.7 AAHUs was forecast for Neotropical birds with project implementation. Approximately 17 AAHUs would be attained for deer with riparian forest restoration.

4.4.7. W259+50 Slough

The proposed actions at this site would lead to improvements to approximately 6 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress, and provide for restoration of 9 acres of riparian forest habitat. A projected net gain of approximately 15 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of almost 5 AAHUs was forecast for Neotropical birds with project implementation. Approximately 6 AAHUs would be attained for deer with riparian forest restoration.

4.4.8. Hampson Slough

The proposed actions at this site would lead to improvements to approximately 8 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress where currently it does not exist, and provide for restoration of 21 acres of riparian forest habitat. A projected net gain of almost 18 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 11 AAHUs was forecast for Neotropical birds with project implementation. Approximately 15 AAHUs would be attained for deer with riparian forest restoration.

4.4.9. Brooks Slough

The proposed actions at this site would lead to improvements to approximately 25 acres of fisheries habitat, allow for improved juvenile salmonid ingress and egress, and provide for restoration of 39 acres of riparian forest habitat. A projected net gain of almost 45 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 20 AAHUs was forecast for Neotropical birds with project implementation. Approximately 27 AAHUs would be attained for deer with riparian forest restoration.

4.4.10. Risk Creek

The proposed actions at this site would lead to improvements to approximately 1 acre of fisheries habitat, allow for improved adult salmonid passage upstream and juvenile salmonid outmigration and provide for restoration of 3.5 acres of riparian forest habitat. A projected net gain of almost 2 AAHUs was estimated for juvenile salmonids with implementation of the restoration action. An estimated gain of 2 AAHUs was forecast for Neotropical birds with project implementation. Approximately 2 AAHUs would be attained for deer with riparian forest restoration.

4.5. Cost Effectiveness and Incremental Cost Analyses

In conjunction with the environmental analysis of potential projects, cost effectiveness and incremental cost analyses of potential alternatives are required. The following explanations clarify the difference between cost effectiveness and incremental cost analyses, and the purposes for each.

- *Cost effectiveness analysis* is conducted to ensure that the least cost solution is identified for various levels of environmental output. Its purpose is to eliminate inefficient alternatives, based on comparing environmental outputs with *average cost* of an alternative.
- *Incremental cost analysis* is conducted to show changes in costs for increasing levels of environmental outputs. It provides data for decision-makers to address the question, “Is the next level worth it?” It measures the incremental or *additional cost* of the next additional level of environmental output.

The without-project condition (No Action Alternative) represents the conditions at JBH NWR in the absence of the proposed restoration project. It serves as the basis for comparison with the alternatives or with-project conditions. In addition to the No Action Alternative, there are nine individual sites being considered in this restoration study. Each of the sites can stand alone as an alternative or can be combined with any of the other sites to comprise another alternative.

The non-monetary benefits (environmental outputs) of the environmental restoration alternatives are measured in average annual habitat units, hereafter environmental outputs. It should be noted that the average annual environmental outputs listed represent the net increase in output above and beyond the without-project condition. The implementation costs for the project include the costs associated with the project, including development costs and operations and maintenance (O&M) costs. In order to compare costs with average annual environmental outputs, it is necessary to convert implementation costs to average annual costs. The stream of costs associated with the project occurs at various points in time. Therefore, all costs were present-valued (or future-valued) to the beginning of the period of analysis, and amortized at the Fiscal Year (FY) 2007 federal discount rate of 4.875% over the 50-year project life, to develop equivalent average annual costs.

For determining the economic cost of the project and its various components, a calculation is made to determine the cost of interest during construction (IDC). This interest is added to the other costs of the project and is included as part of the average annual cost. The IDC is included as an economic cost, but it is not included as a financial cost. The IDC is calculated using the FY 2007 discount rate of 4.875% for costs incurred during construction of the project.

The O&M costs for the project include removing the fencing around the riparian plantings (estimated at approximately $210,000), repairing/refurbishing tide gates (estimated at approximately $20,000 each, for a total of $160,000 at about year 25 of the project life), plus an expected O&M cost of approximately $2,000 per site each year. Using the FY 2007 discount rate of 4.875% to convert to equivalent average annual costs over the project life, the O&M costs are estimated at $27,945 on an annualized basis. The project costs are expressed in terms of average annual dollars per average annual environmental output.

Table 11 summarizes the net gains in average annual environmental outputs, the average annual costs, and the average annual cost per environmental output for each site. The table shows that the average annual cost per environmental output is directly associated with the number of environmental outputs gained by development of each site. Note that the No Action condition is listed first and the average annual environmental outputs represent the net gain over No Action.

Table 11. Average Annual Environmental Outputs, Average Annual Costs, and Average Annual Cost per Environmental Output

Sites	Average Annual Output	Average Annual Cost ($)	Average Annual Cost per Output ($)
No Action	0	0	0
Indian Jack Slough	40.54	38,500	950
Duck Lake Slough	47.52	28,737	605
Ellison Slough	140.25	55,939	399
Winter Slough	43.62	39,112	897
W201+30 Slough	31.13	17,949	577
W259+50 Slough	26.24	16,592	632
Hampson Slough	43.74	39,484	903
Brooks Slough	92.36	28,997	314
Risk Creek	5.88	5,435	924

The Corps' Institute for Water Resources (IWR) Cost-Effectiveness and Incremental Cost Analysis software (IWR-PLAN; http://www.pmcl.com/iwrplan/GenInfoOverview.asp) was used to array the potential combinations of all of these sites, resulting in 512 possible combinations. Of those, 77 were cost-effective. Combinations that had a higher cost for a given level of environmental output were not cost-effective and were dropped from further consideration.

The 77 cost-effective combinations serve as the supply schedule of the average annual cost for each level of output, which serves as the basis from which to derive the incremental cost analysis. Incremental cost analysis is required to address whether the incremental or additional cost of the next level of output is worth it. In environmental studies, the comparison is between dollar incremental costs and non-dollar incremental units of output. In order to facilitate the required calculations, IWR-PLAN was used to do the calculations necessary to eliminate the irregular, non-continuously increasing cost changes that occur in the incremental average annual cost per output calculations.

For the final incremental cost analysis, it was necessary to do a series of calculations to determine the lowest average cost for additional output from amongst the remaining levels of output. Each of the recalculations begins with the previous step's lowest average cost level of output set as the new "zero level." The calculation in this step uses the additional cost and additional outputs above those of the previously identified level of output with the lowest average cost (for further details on this process, refer to *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps*, IWR Report 94-PS-2, October 1994). Table 12 summarizes the final incremental cost analysis results.

Table 12. Summary of Final Incremental Cost Analysis

Alternative	Total Average Annual Output	Total Average Annual Cost ($)	Added Average Annual Cost ($)	Added Average Annual Output	Incremental Average Annual Cost per Output ($)
No Action	0	0	0	0	0
Brooks	92.36	28,997	28,997	92.36	314
Brooks, Ellison	232.61	84,936	55,939	140.25	399
Brooks, Ellison, W201+30	263.74	102,885	17,949	31.13	577
Brooks, Ellison, W201+30, Duck Lake	311.26	131,622	28,737	47.52	605
Brooks, Ellison, W201+30, Duck Lake, W259+50	337.50	148,214	16,592	26.24	632
Brooks, Ellison, W201+30, Duck Lake, W259+50, Winter	381.12	187,326	39,112	43.62	897
Brooks, Ellison, W201+30, Duck Lake, W259+50, Winter, Hampson	424.86	226,810	39,484	43.74	903
Brooks, Ellison, W201+30, Duck Lake, W259+50, Winter, Hampson, Risk Creek	430.74	232,245	5,435	5.88	924
Brooks, Ellison, W201+30, Duck Lake, W259+50, Winter, Hampson, Risk Creek, Indian Jack	471.28	270,745	38,500	40.54	950

Table 12 shows the change from one combination to the next. For instance, moving from the alternative that includes Brooks only to the alternative that includes Brooks and Ellison shows a change of 140.25 additional average annual environmental outputs (232.61 outputs for Brooks and Ellison minus 92.36 outputs for Brooks only); an additional average annual cost of $55,939 ($84,936 cost for Brooks and Ellison minus $28,997 cost for Brooks only); and an additional or incremental $399 average annual cost per average annual environmental outputs ($55,939 incremental cost divided by 140.25 incremental environmental outputs).

The column on the right in the table summarizes the incremental average annual cost per output; its purpose is to show potential breakpoints where gaining the next level of output shows a significant increase in costs. In this case, the most significant breakpoint is between the alternative that includes

Brooks, Ellison, W201+30, Duck Lake, and W259+50 sloughs, and the next alternative that adds in Winter Slough.

4.6. Selection of Preferred Alternative

The results of the quantitative cost effectiveness and incremental cost analyses described above show that the most cost effective, incrementally justified alternative for the JBH NWR Section 536 habitat restoration project would include Brooks, Ellison, W201+30, Duck Lake, and W259+50 sloughs. In this case, however, other considerations regarding the potential of the alternatives shown in the table led the team to select a preferred alternative with a greater suite of restoration elements, as discussed below. Therefore, the Corps and USFWS recommend selection of the alternative that includes all nine of the restoration sites, given:

- The significance of outputs for ESA salmonids and Columbian white-tailed deer.
- The high quality and unique restoration potential of the proposed project.
- The efficient use of scarce side channel fisheries habitat.
- The demonstration of ESA recovery and land use harmony for the proposed project.
- Other benefits such as improving the productivity of the lower Columbia River and estuary.

The potential to address Federal Columbia River Power System recovery goals for ESA-listed salmonid ESUs is an important consideration for this action. Given the limited opportunities presently available to recover side channel fisheries habitat in the lower Columbia River, it is recommended that all sloughs at JBH NWR be restored to tidal/river influence and thus juvenile salmonid use. This would contribute toward attainment of the Federal Columbia River Power System objective and fully utilize the side channel resources available at JBH NWR. Selection of a project alternative that encompasses fewer sloughs would forego an important habitat restoration opportunity in the lower Columbia River.

The implementation of a large scale tidal/river waters habitat restoration project on public lands in the lower Columbia River provides a unique opportunity to demonstrate restoration capability and compatibility with flood control objectives. Similar actions then could potentially occur in the future on private lands currently protected by flood control levees. This opportunity may be especially important as the region strives to develop actions to restore Columbia River salmonid ESUs. A demonstration first on public lands should aid public acceptance. Restoration actions directed at all sloughs on the JBH NWR would demonstrate that a maximum effort is compatible with resource management objectives on lands protected by flood control structures, whether they are privately or publicly held.

Non-quantifiable benefits would also be obtained with project implementation. The export of detritus and invertebrate fauna from the side channels will add to the productivity of the lower Columbia River and estuary. These exports would benefit fisheries condition and survivability, aiding efforts to restore listed salmonid ESUs. Full implementation of the proposed project at JBH NWR would also aid the conservation and management of Columbian white-tailed deer. While much of the gain in conservation and management can be attained with a lesser suite of alternatives than a full build out, the maximum restoration plan would incrementally improve conditions for these listed species and aid their recovery.

5. PREFERRED ALTERNATIVE*

5.1. Plan Features

The Preferred Alternative is the implementation of the full suite of restoration measures identified in Table 12 for Indian Jack, Duck Lake, Ellison, Winter, W201+30, W259+50, Hampson, and Brooks sloughs plus Risk Creek. The Corps has determined that installation of side-hinged, self-restrained tide gates, coupled with riparian forest habitat restoration at each slough, except W201+30 Slough, would substantially improve fisheries habitat and ingress/egress for approximately 87 acres of slough and stream habitat and up to 210 acres of riparian forest habitat. This would provide substantial benefit for listed Columbia River salmonid ESUs and the Columbian white-tailed deer.

5.2. Operations and Maintenance

Operations and maintenance activities at JBH NWR pertain primarily to the riparian forest habitat to be developed on approximately 210 acres and the tide gates, culverts, trash racks and or log booms associated with each slough. Minimal O&M activities are forecast for the riparian forest and tide gates, culverts, trash racks and log boom components of the overall restoration project. Three to five years post-planting, deer and elk proof fencing protecting the riparian forest restoration plantings would be removed. Fence removal will constitute the bulk of the O&M requirement for riparian forest habitat. No substantial O&M work should be required for the riparian forest habitat post fence removal. The remaining O&M effort for riparian forest will primarily involve weed management and supplemental plantings of trees and shrubs. Hand cultivation and herbicide treatment, typically hand application, will be used to control herbaceous weeds and blackberries which are expected to readily pioneer into the riparian restoration areas. Supplemental planting of trees and shrubs will use seedlings obtained on site from natural established plants and cuttings and commercial seedlings obtained locally to fill gaps in the stand.

A multi-person labor crew would be used to accomplish the O&M activity. They would collect and plant supplemental trees and shrubs during February and March. Hand cultivation and herbicide treatment of herbaceous weeds (e.g., thistle, ragwort, reed canarygrass, etc.) would occur in June. Hand-spraying of herbicide (possibly Rodeo©), would be used to minimize drift onto desired vegetation and to allow direct targeting of unwanted species.

Periodic debris removal at the tide gates and interior ends of the culverts may be required. Several factors will negate the need for debris removal on a more intensive basis. Interior log booms and trash racks/pilings installed where necessary will keep most large woody debris from the culverts and tide gates. The wide opening for the tide gates to 75 degrees should flush most small debris through. Further, the tide gates are designed to allow tidal flooding and discharge which will aid flushing any accumulated debris away from the structures during each tide cycle. The exterior tidal channels developed at Indian Jack and Ellison sloughs are anticipated to be self-maintaining and no intervention would be required. The O&M costs for the water control structures, including periodic inspections, are anticipated to run approximately $2,000 per structure annually.

The O&M costs for the project include: removing the fencing around the riparian plantings (estimated at approximately $210,000), repairing/refurbishing tide gates (estimated at approximately $20,000 each, for a total of $160,000, at about year 25 of the project life), plus an expected O&M cost of approximately $2,000 per site each year. Using the FY 2007 discount rate of 4.875% to convert to equivalent average annual costs over the project life, the O&M costs are estimated at $27,945 on an annualized basis.

5.3. Pre- and Post-construction Monitoring

A pre- and post-construction monitoring effort will measure the response of juvenile salmonids to tidal slough fish passage and habitat improvements, and the response of Columbian white-tailed deer and Neotropical birds to riparian forest restoration on the JBH NWR. The monitoring will provide needed information regarding ingress/egress and habitat use of tidal sloughs equipped with self-restrained, side-hinged tide gates by juvenile salmonids in the lower Columbia River and estuary. To date, relatively few studies have been conducted on the efficacy of tide gates designed to improve juvenile salmonid ingress and egress in the estuary. Juvenile salmon are known to make substantial use of natural tidal slough habitats in the vicinity of JBH NWR which serve as reference sites for the pre-construction monitoring effort. Pre-construction studies will assess species composition, presence, and use by anadromous fish of JBH NWR sloughs and determine if adult salmonids are ascending Risk Creek.

The USFWS Columbia River Fisheries Program Office is implementing the pre-construction monitoring and will monitor and evaluate post-construction the fish response to restored tidal slough fish passage and habitat restoration on JBH NWR. Their objectives include:

- Determine whether adult anadromous salmonids are present in the upper reaches of tributaries before and after modifications are made to tide gates or other restoration activities associated with the lower reaches of tributaries.
- Assess the periods, frequency, and duration that tide gates (as presently configured, after modifications, and newly installed) are likely conducive to passage by juvenile and adult salmonids, specifically during October to June.
- Describe presence, distribution, and biological characteristics (e.g., species, size) of fish inhabiting mainland sloughs at JBH NWR and compare to that observed at reference sloughs.
- Characterize habitats at mainland sloughs at Julia Butler Hansen NWR and compare to that observed at reference sloughs.

Metrics used to compare pre and post conditions include fish community structure, residence time, and growth/weight. Juvenile salmonid use will be captured in the restored tidal sloughs plus at natural tidal sloughs on JBH NWR to establish a baseline condition. The sampling timeframe would be February to June. Monitoring efforts for juvenile salmonid usage of tidal sloughs would occur in fiscal years 2007 and 2008.

The USFWS will monitor the use by Columbian white-tailed deer and Neotropical migrant birds of restored riparian forest habitat on JBH NWR.

6. ENVIRONMENTAL CONSEQUENCES*

6.1. Geology and Soils

Soil elevations at the sites will generally not be altered via excavation and deposition. Cut and fills through the flood control levee will generally result in a minor volume of excess soil material due to the volume of the new culverts and the controlled-density fill used to encase the culverts. The excess material would be spread on the interior slope of the flood control levee in a shallow lift. The construction of interior and exterior channels at Ellison Slough plus an exterior channel at the outlet for Indian Jack Slough will alter soil elevation for small, discrete locations. Some minor excavation at other culvert inlets and outlets may occur but not to the extent proposed for Ellison and Indian Jack Sloughs. It is proposed to excavate exterior pilot channels at Indian Jack and Ellison Sloughs via blasting thus resulting in dispersal of soil from the constructed channel in a shallow lift on the adjacent land. The interior channel at Ellison Slough would have to be excavated from the culvert inlet to the existing slough channel. This excavated material will then be evenly redistributed on a JBH NWR area to be designated by the refuge and subsequently planted with riparian vegetation.

Post-construction, tidal flows through the culverts and side-hinged, self-restrained tide gates will be substantially greater than what exists under current conditions, even for those sloughs currently equipped with tide gates. Sediments within the interior sloughs are anticipated to be mobilized and exported on ebb tides as new interior tidal channels are formed or enlarged, and a new equilibrium between the tidal flows and the channel substrate is attained. The material exported from the tidal sloughs may collect near the outlets or be discharged to the Columbia River. Observation at the mouth of W201+30 slough, fitted in 2003 with a side-hinged tide gate, revealed the presence of a narrow, low-flow channel but no accumulation of sediments in a delta. Similar results are expected for the other sloughs where installation of side-hinged, self-restrained tide gates will occur. The blasted channels at Ellison and Duck Lake sloughs would form pilot channels. Subsequent ebb and flood of tidal waters will carve these pilot channels to the appropriate depth and configuration required to handle tidal flows and should mimic natural tidal channel configurations. The volume of material to be mobilized at these locations is not expected to be significant.

Riparian forest restoration will initially entail substantial tillage of the soil in order to suppress reed canarygrass and pasture grasses that currently dominates this acreage. Historically, these soils were drained, logged, the land cleared and pasturelands established. The proposed tillage action is comparable to that which occurred when the land was initially tilled. Although soils will be disturbed, there will be no overall shift in soil type, and soils are expected to continue to provide a suitable growing medium for native species. No geological features are present. Geology and soils would not be significantly affected by the proposed restoration project.

For the No Action Alternative, little change would be expected in geology or soil condition over time. Grassland vegetation has been static since inception of the refuge and the flood control levee has essentially precluded erosion of cutoff sloughs that bisect the refuge.

6.2. Sediment Quality

As discussed in Section 2.2, sediment sampling at the eight sloughs did not detect any levels of chlorinated herbicides, organochlorine pesticides, PCBs, and metals above the DMEF and SEF screening limits. All sediments tested were determined to be suitable for unconfined, in-water disposal, or could be exposed to water after excavation without further characterization. The construction plan calls for installing interior and exterior cofferdams (sheet piling) and the use of pumps to maintain a dry environment at each tide gate construction area. Construction in the dry will minimize sediment escape from restoration actions into the waters of the Columbia River. Construction of exterior channels via blasting or excavation would occur at low tide to minimize sediment output to the waters of the Columbia River.

Some sediment discharge from the tidal sloughs would be expected once tidal flows are restored to the area. These discharges would lessen over time as tidal channels reach equilibrium relative to the volume of water within each slough and velocities associated with tidal flood and ebb. Riparian restoration actions plus pioneering vegetation should minimize the potential for sediment runoff from areas targeted for riparian forest reestablishment.

6.3. Hydrology

The change in tide gates at the existing hydraulic control structures and the addition of new structures at Indian Jack, Ellison, Hampson, and Winter sloughs is expected to significantly change the existing hydrology. It is estimated that the hydrology of the modified sloughs will behave similarly to the slough at station W259+50. The restoration of the tidal signal to each slough will allow for the reservoir regime system to transform to a more natural tidal regime system with greater flow interaction between sloughs. Although the water level fluctuation will increase for each slough, the range will be site specific and limited due to slough storage capacity, culvert size, invert elevation, channel capacity, and tide gate operation.

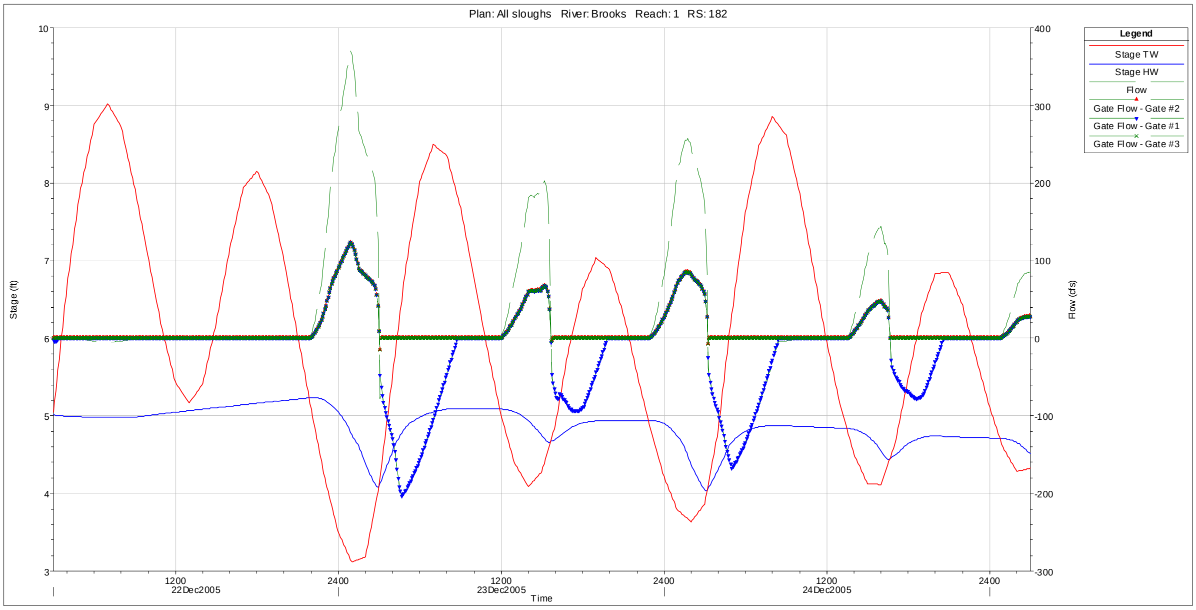
Based upon the limiting threshold elevation of 5.0 feet within the refuge, the tide gates will operate in corresponding fashion. The operating upper limit criteria were estimated based upon the requirements from refuge staff and the developed stage duration curve (see Figure 10). Using these criteria, the elevation of 5 feet was selected as the maximum elevation to signal a closure of the tide gate. Although the maximum elevation of 5 feet was selected as proper operating range, this should be further evaluated through adaptive management in order to meet the Columbian white-tailed deer management goals of refuge staff. A range between 4 to 5 feet would provide the tidal signal within the refuge while meeting the limiting threshold elevation of 5 feet within the refuge. Figure 11 shows the estimated behavior of a representative slough (Brooks Slough).

Note that the side-hinged, self-restrained tide gate will behave like a standard tide gate when the tailwater (river) is below the headwater (interior). However, the gate will continue to stay open until the tailwater reaches 5 feet to trigger the closure of the tide gate. It is estimated that the entire system, primary channels, and secondary channels will behave with a tidal signal. Due to the lag time within the network of channels, the exchange of flow between channels will be significantly increased.

6.4. Floodplains

Proposed restoration measures are intended to reconnect the tidal sloughs of JBH NWR to the extent practicable to the Columbia and Elochoman River and attain a modified tidal influence within the eight sloughs. The proposed action will not restore floodplain connectivity as flood protection will be maintained by the existing levees and the side-opening, restrained tide gates installed as part of the proposed action. No incremental loss of floodplain storage will result due to implementation of the proposed action. For the No Action Alternative, JBH NWR sloughs would remain poorly connected to the Columbia River and associated tidal influence.

Figure 11. Estimated Tide Gate Flow Pattern at Brooks Slough



6.5. Wetlands

The proposed tide-gate installations on JBH NWR sloughs will not cause an increase in drainage of the wetlands on the refuge. There was concern early in the study that lowering the elevation of the sloughs by adding and/or improving tide gates and their function would increase drainage of the adjacent natural and managed wetlands. While a drop in slough level may cause a drop in the groundwater level in the silty sand deposit, the wetlands would not be affected as they are perched above a low-permeability silt and clay soil layer atop the silty sand deposit. No project-related excavation is planned for the wetlands, thus no disturbance to the low permeability silt-clay layer will occur.

6.6. Water Quality and Quantity

Construction activities that require use of heavy equipment and excavation of substrate in the project area may affect water quality. An increase in turbidity may result from additional input of sediment into the various sloughs during construction. However, since the majority of excavation work will be constructed behind cofferdams (sheet piling or comparable structure) and in the dry, introduction of sediment into the sloughs is expected to be minor and settlement should occur prior to releasing the water into the Columbia River. Cofferdams would be removed at low tide to minimize environmental impact upon completion of each individual structure. An exception would be exterior channel construction; whether via blasting or excavation, these areas would not be enclosed by cofferdams. Bare ground exposed during construction and throughout the revegetation period may contribute turbidity to the surrounding waters through runoff. Use of straw or other erosion protection measures will be used to control sediment runoff. Water quantity (tidal flow) will be temporarily restricted in the project area by the cofferdams during the construction period, but will be restored following completion of construction activities. The project will return more natural tidal fluctuations to the JBH NWR sloughs than presently occurs.

Best management practices will be employed to reduce the pollutant emissions from heavy equipment, such as oils, fuels, or grease. Cofferdams will be installed at low tide at the inlet and outlet locations during culvert installation through the flood control levees to minimize turbidity and sediment discharge to the adjacent water bodies. For cast in place concrete headwalls, waste water will be collected, stored, and disposed of properly. Erosion protection measures will be used to control sediment runoff from excavated material. Soil excess to backfill requirements will be placed in a shallow lift on the interior slope of the flood control levee above the ordinary high water mark or at an approved USFWS disposal location and seeded with grasses to prevent erosion. It is proposed to use explosives to construct outlet channels for Indian Jack and Ellison Sloughs. The tidal wetlands at the outlet of these sloughs would incur greater damage from excavators and trucks hauling the overburden compared to a shallow, scattered deposition of mud and vegetation associated with an operation to blast a pilot discharge channel. Riparian forest restoration tillage actions will occur in late summer when the site is dry and runoff from precipitation is least likely. Buffer strips of dense vegetation will be left around riparian restoration areas to capture sediments in any runoff. Additional erosion control measures may be employed, if necessary.

The construction measures associated with implementation of the preferred alternative may result in temporary reductions in water quality. However, it is unlikely that water quality conditions in the Columbia River would be measurably degraded. Water quality or quantity is not expected to experience significant, adverse effects as a result of the proposed project.

For the No Action Alternative, water quality would remain degraded. No net changes would be expected for water quantity.

6.7. Hazardous, Toxic, and Radioactive Waste

As discussed in Section 2.6, a Level I Contaminant Survey (Environmental Site Assessment) for the JBH NWR was conducted by environmental contaminant specialists with the Corps. Based on the site history and conditions observed during the site visits, the Corps concluded that there were no apparent contaminant threats to fish and wildlife resources on or near the property.

6.8. Aquatic and Riparian Habitat

Improvements to tidal fluctuation in the JBH NWR sloughs associated with implementation of the restoration action will impact the aquatic plant habitat established in the sloughs. Most aquatic plant beds in the JBH NWR sloughs are formed by exotic species. Increased inflow and discharge into these sloughs is anticipated to result in channelization, sediment movement and redistribution and thus a reduction in the extent and distribution of these aquatic plant beds. Overall, the preferred alternative is expected to result in conditions more favorable to native aquatic plant species in these sloughs. The construction of exterior channels at Indian Jack and Ellison sloughs is expected to have only a temporary, adverse effect on the tidal marsh vegetation at each location.

The Preferred Alternative would restore tidal influence to 87 acres of slough habitat and 210 acres of riparian forest habitat on JBH NWR. The increased area of riparian habitat would result in increased detrital input and invertebrate production that is anticipated to benefit fisheries resources, including listed salmonid ESUs. Increases in detrital input and invertebrate production from riparian forest habitat should increase as trees mature over time. Large woody debris input to the river should begin 25 years or more into the future. Restoration of riparian forest would provide for greater species richness and diversity of vegetation, and structural complexity would be increased over the present situation of a pastureland.

For the No Action Alternative, the sloughs at JBH NWR will remain in their degraded condition and juvenile salmonid use will remain impeded by the lack of tide gates and the poor operating condition of existing tide gates.

6.9. Fish and Wildlife

6.9.1. Fish Species

The proposed tide gate improvements would improve tidal circulation, allow for greater ingress and egress of juvenile salmonids, and increase detrital and invertebrate export. Invertebrate production may increase and would be more available to rearing fish that access the JBH NWR sloughs. Bottom dwelling invertebrates including *Corophium* and chironomids are major food items in the diets of juvenile Chinook salmon in the lower Columbia River (Craddock et al., 1976) and Columbia River estuary (McCabe et al., 1983). Foraging conditions for juvenile salmonids would be expected to improve with provision of more slough habitat and better access to the sloughs. Improvements in detrital and invertebrate export associated with project implementation would be expected to benefit the food chain elsewhere in the estuary, including fish that utilize benthic invertebrates.

6.9.2. Wildlife Species

Restoration of the tidal flows to sloughs at JBH NWR may slightly alter waterfowl use patterns of this habitat. For periods when the tide gates are closed and water levels are up, waterfowl use patterns should be comparable to the present situation. During discharge and low water periods, waterfowl use may be confined to low water channels and exposed mudflats. Given the extensive waterfowl use of natural tidal channel habitat and associated marshes in the Columbia River estuary, implementation of the proposed action should not be deleterious to waterfowl. Foraging conditions for wading birds such as great blue herons will change with the water level of the sloughs. These changes are primarily related to depth of water and location where it is advantageous for herons to forage. These changes are not considered adverse and are comparable to natural situations in non-diked tidal lands.

The improvements to existing tide gates and addition of new tide gates are anticipated to improve discharge of interior waters from the JBH NWR. This could be particularly important during high precipitation events, normally in fall and winter, when interior waters can not be discharged efficiently or timely due to high tailwater elevations and limited discharge capability under existing conditions. The addition of more tide gates that have greater efficiency than the current situation would allow for faster discharge of interior waters and thus less inundation of deer habitat. This would improve their ability to utilize existing forage resources and limit exposure and heat loss. For flood events when refuge lands are inundated, removal of flood waters from refuge lands would occur faster and more efficiently. This should reduce the time period when deer are forced into less optimal habitat or off refuge and reduce winter mortalities.

The restoration of 210 acres of riparian forest habitat would benefit a multitude of wildlife species, particularly as the riparian forest habitat matures. Columbian white-tailed deer would benefit substantially from the provision of additional forage plus thermal and hiding cover.

Neotropical migratory birds should substantially benefit from establishment of riparian forest habitat. Their use of this habitat would begin almost immediately as early seral stage species would first take advantage of the seedling trees that are established. As the riparian forest matures, species composition of birds present also would change. Birds would be expected to utilize the riparian forest habitat for nesting, foraging, and cover. Mature trees, 50 years or more into the future, would be expected to provide snags and large trees suitable for cavity nesting birds and would be able to support large nest structures built by red-tailed hawks, osprey, and perhaps bald eagles.

Mammalian use would be expected to increase in terms of number of species and overall numbers with the restoration of riparian forest habitat. These include small mammals, such as mice, voles, moles, and bats. The development of understory vegetation and the formation of a surface duff layer would favor mice, voles, and moles. Development of an overstory, and subsequent cavity bearing trees, would favor bats through provision of forage (insects), cover, and eventually maternal dens.

Larger mammals, such as raccoons, mink, otter, and beaver should attain habitat gains with restoration of tidal slough and riparian forest habitat. Riparian forest habitat would provide forage resources, cover and/or den locations for these species. Increased fisheries and wildlife use of tidal slough habitat would benefit raccoons, mink, and river otter which prey on some of the species comprising these species complexes.

6.10. Threatened and Endangered Species

Biological Assessments were prepared for the proposed restoration project (one prepared for NMFS and one for USFWS jurisdictional species) and are included in Appendix C. Provided below is a summary of the impact assessment and conclusions from the Biological Assessments.

6.10.1. Listed Fish Species

The restoration actions on JBH NWR would target improved tidal flow and fisheries ingress and egress to 87 acres of slough habitat and 210 acres of riparian forest habitat. The proposed action would partially address historic losses of off-channel salmonid rearing habitat. Tidal slough habitat is important to juvenile salmonids for rearing and refugia habitat. The 13 Columbia River anadromous salmonid ESUs listed under the ESA (see Table 9) will benefit, to varying degrees, from the habitat restoration measures targeted in the Preferred Alternative. Subyearling fall Chinook, coho, and chum salmon would be expected to utilize the JBH NWR sloughs in greater numbers than current monitoring efforts have determined based upon increased opportunities to access these sloughs. Other listed ESUs would be expected to indirectly benefit from increased detrital and invertebrate export into the Elochoman and Columbia rivers.

The Preferred Alternative may cause temporary and short-term impacts to anadromous salmonids during construction. The probability for direct mortality to juveniles or adults of listed salmonids during construction would be very low because of their low abundance in the area during late summer, when water temperatures are characteristically high, and because of the temporary nature of the construction activity. Surface water runoff post-construction may temporarily increase suspended sediment levels in the slough. Elevated turbidity levels have the potential to disrupt feeding and growth patterns of juveniles. Since no spawning occurs on JBH NWR, no direct impacts to redds, eggs or alevins would be anticipated. Because of the erosion and sedimentation control measures that will be used during construction and the duration of the impact, any potential impacts would be expected to be small. Construction activities would cause noise and vibration that may be detected by fish and could alter fish behavior in the area. However, since these construction activities would be intermittent and short-term, they would not be expected to have a significant impact on listed fish. Marginal disruption of rearing habitat would occur in the project area during the construction period. However, this project will ultimately increase available rearing and refugia habitat and their function. The restoration of additional rearing habitat and back channels would not be expected to have overall significant adverse effect on salmonids. Instead, the project has been designed to improve habitat for salmonids in the lower Columbia River and estuary.

Based on the analysis of effects and consideration of conservation measures that would be implemented to avoid or reduce effects, it is concluded that the proposed action *may affect, but is not likely to adversely affect* the 13 Columbia River anadromous salmonid ESUs.

Critical Habitat

The proposed action will not affect critical habitat for listed anadromous salmonids – the freshwater spawning sites with water quantity and quality conditions and substrate that support spawning, incubation, and larval development. The side channel habitats at JBH NWR do not provide these spawning habitat requirements nor would the proposed action impact these physical attributes.

The proposed action will provide juvenile salmonids access superior to the existing condition to freshwater rearing sites. Project-related improvements to tidal connectivity and water circulation will provide the water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility. Water quality and forage supporting juvenile development will also improve under the proposed action. Many of the natural cover features such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks are present in the side channel habitat for which juvenile salmonid access improvements will occur.

The JBH NWR sloughs proposed for improvements do not represent direct freshwater migration corridors for ESU salmonids with the possible exception of Brooks Slough, provided that an anadromous run is still extant in Risk Creek, a tributary of Brooks Slough. The habitat conditions and access through the Brooks Slough tide gate would be suitable for adult migration

Although the JBH NWR sloughs are within the zone of tidal influence on the Columbia River, they are upstream of salinity intrusion; thus, the critical habitat requirements for estuarine areas do not pertain to the proposed action. Also, the JBH NWR sloughs are not within nearshore marine areas; thus, these critical habitat components do not pertain to the proposed action.

Essential Fish Habitat

Freshwater essential fish habitat for Chinook and coho salmon consists of four major components: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adults migration corridors and adult holding habitat. Important features for spawning, rearing, and migration include adequate substrate composition, water quality (dissolved oxygen, nutrients, temperature, etc), space, access and passage, and flood plain and habitat connectivity. The Preferred Alternative will enhance salmonid habitat quality and rearing habitat by restoring and enhancing former tidal slough habitats. Proposed actions will substantially increase salmonid ingress and egress to former tidal slough habitat and restore riparian forest habitat.

Based on essential fish habitat requirements of Chinook and coho salmon, the potential direct, indirect, and cumulative effects of the habitat restoration project on JBH NWR are not likely to adversely affect any identified salmonid essential fish habitat, but will provide additional salmonid essential fish habitat.

The only managed groundfish species in the project area is starry flounder (*Platichthys stellatus*), which use the area as rearing and feeding areas for both juveniles and adults. Existing essential fish habitat for starry flounder is limited and likely of poor quality because of the lack circulation and poor water quality. Completion of the restoration actions on JBH NWR will improve and increase the essential fish habitat for starry flounder.

Bull Trout

Bull trout are unlikely to occur in the project area in any appreciable numbers. Construction timing would occur during a period when water temperatures in the mainstem Columbia River are unsuitable for this species. Also, habitat conditions in the JBH NWR sloughs are not suitable for this species. After construction, increased detrital and invertebrate export to the Columbia River may potentially benefit this species. Therefore, it is concluded that the proposed action *may affect, but is not likely to adversely affect* bull trout or their critical habitat.

Green Sturgeon

The proposed action at JBH NWR occurs from RM 34-36, which is within the range on the Columbia River where the second largest number of green sturgeon was incidentally harvested from 1981 to 2004. Recreational sturgeon fishing, principally from the bank, occurs in deep water at the JBH NWR downstream of the Elochoman River mouth to the entrance to Steamboat Channel, immediately upstream of the mouth of Winter Slough. It is unknown if green sturgeon are harvested at this location though the likelihood exists based upon the number of green sturgeon caught between RM 20-52.

Dietary information from a few green sturgeon collected in Willapa Bay indicated that these fish fed on burrowing shrimp (Moser and Lindley 2006). These authors speculated that green sturgeon move out over mud flats during high tide to feed on burrowing shrimp in Willapa Bay. They noted that estuaries are apparently important habitats for green sturgeon. Burrowing shrimp do not occur at the JBH project location. Large macroinvertebrates, such as *Corbicula* and *Macoma*, crayfish, and scavenged fish represent the probable dietary items in this area of the Columbia River estuary. These prey species are either not present or have a limited presence at the very riverward end of the existing and proposed tidegate locations because these construction locations are typically high tidal marsh rather than the mudflat/shallows where these prey species occur.

The proposed construction of tidal channels exterior to the flood control levee would occur in tidal marsh rather than tidal flat habitat. The higher elevation and vegetated nature of tidal marsh habitat compared to tidal mudflat lessens the likelihood that green sturgeon are present at these locations. Further, exterior channel construction actions would occur during low tide when all fish are absent from the tidal marsh. Thus, it is unlikely that construction actions would affect green sturgeon and would be expected to have only a limited and temporary adverse impact on potential prey resources for the species. Long-term, the re-opening of these sloughs to Columbia River tidal and river stage effects is expected to result in discharge of nutrients, invertebrates, and vegetative debris to the Columbia River estuary which should improve foraging resources for green sturgeon. Therefore, it is concluded that the proposed action *may affect, but is not likely to adversely affect* green sturgeon.

6.10.2. Listed Wildlife Species

Steller Sea Lion

Steller sea lions may occur in the Columbia River off the proposed project area during the construction period. The proposed project area is outside the critical habitat designated for Steller sea lions in Oregon; no critical habitat is designated in Washington. Therefore, it is concluded that the proposed action *may affect, but is not likely to adversely affect* Steller sea lions or their critical habitat.

Columbian White-tailed Deer

One focus for the proposed restoration project is to improve the overall habitat conditions on JBH NWR for the endangered Columbian white-tailed deer. The installation of new and replacement of existing tide gates with a new design will improve interior drainage on the refuge. This will improve overall habitat conditions for deer and increase their survivability during periods of heavy precipitation and lessen impacts of flood events.

Development of riparian forest habitat along the sloughs within the refuge will provide required thermal and hiding cover and forage resources for the species. The end result would be a more equitable distribution of riparian forest, wetlands, and pastureland than what currently occurs.

The riparian forest development component of the proposed restoration project may initially result in some localized disturbance and a temporary loss of forage resources to Columbian white-tailed deer. Deer would be expected to avoid the construction area(s) during the day. Tillage operations and subsequent fencing to preclude big game access to the riparian restoration areas would preclude use of riparian restoration acreage by deer for 3-5 years. Thus, the USFWS has submitted a riparian restoration plan that would incrementally phase in this element at approximately 70 acres per year to minimize impacts to deer.

The area affected by restoration construction represents only a small percentage of the mainland refuge habitat. Further, the proposed restoration actions are not dissimilar from management actions, such as revetment, mowing, weed control, and wetland enhancement that have occurred in recent years on the refuge. Those actions have not had a demonstrable adverse affect on the species. Therefore, it is concluded that the proposed action *may affect, but is not likely to adversely affect* Columbian white-tailed deer. Post-construction, the restoration of riparian forest habitat will be extremely beneficial to the species.

Marbled Murrelet

Marbled murrelets are not known to occur on the JBH NWR. Further, the proposed action would not impact habitat potentially used by this species. Critical habitat designated in southwest Washington does not encompass the JBH NWR. Therefore, it is concluded that the proposed action would have *no impact* on marbled murrelets or their critical habitat.

Northern Spotted Owl

Suitable habitat for the Northern spotted owl would not be impacted by the proposed action. Over the long-term, the mature riparian forest that develops as a result of the proposed action may provide migratory corridor habitat for the species. Therefore, the proposed action would have *no impact* on northern spotted owls.

Bald Eagles

The bald eagle was delisted by the USFWS in June 2007. Two nesting pairs of bald eagles occur adjacent to the mainland JBH NWR project locations. Both pairs nest on islands with the nearest nest approximately 1,400 feet from the nearest proposed affected area. The nest locations are separated from the project locations by side channels and are well screened from construction activities by mature stands of trees, including cottonwoods and Sitka spruce. Furthermore, construction of the proposed restoration actions would be scheduled for mid to late summer, which would serve to reduce potential disturbance to nesting eagles. Tillage to prepare the proper soil conditions for riparian forest establishment would occur during or after the fledging period and occur in locations not utilized typically by bald eagles for foraging activities. Given the intervening vegetative screening and distance between the nest locations and proposed restoration area, construction related disturbance would be minimal or non-existent to the nesting pairs. The Corps' bald eagle monitoring actions for the lower Columbia River also would provide information on nesting status that may be utilized to direct the timing of construction actions. Given the reproductive performance associated with this bald eagle territory, it is most likely that no young approaching fledging would be present during the primary construction start. Foraging eagles may be disturbed by construction activities. However, suitable alternative perching and foraging areas are available on the nearby Hunting and Price Islands and the Columbia River shoreline.

Over the long-term, the restoration of riparian forest habitat plus improvements to fish habitat and possibly fish populations are expected to benefit bald eagles. Riparian forest habitat will ultimately provide potential nesting and perch/foraging sites for this species. Improvements to fisheries habitat and populations would improve forage resources for bald eagles.

6.11. Cultural and Historic Resources

The potential for cultural resources in the project area, including the ground area at JBH NWR considered for riparian forest restoration, is expected to be minimal. The general location of the refuge was believed to have contained several Native American villages during the 1700s. The refuge was surveyed for cultural resources in 1980 (Gilbow et al., 1981). The survey included archival and museum research and an on-the-ground intensive survey and subsurface testing by hand auger. No cultural resource sites were found in their searches of the National Register of Historic Places, Washington Archaeological Research Center, Oregon Museum of Anthropology, Historic Buildings Survey, or the Historic American Engineering Record. The authors noted that while it was possible that cultural resources exist on the refuge, the combination of erosion and sedimentation associated with the Columbia and Elochoman rivers (pre-flood control levee) had either destroyed or buried the evidence. Gilbow and others (1981) reported that many canoe burials, three Indian villages or camp sites, and a number of historic era structures, particularly those associated with the fishing industry were once reported present, but no surface evidence remained at the time of their survey. The entire mainland portion of JBH NWR is low lying ground that historically would have been tidal marsh and tidal Sitka spruce swamp and less likely to be inhabited.

The flood control levee was initially built in the early 1920s and the primary focus of this proposed action would entail excavation through the borrow soil initially excavated to form the levee. Riparian restoration actions would occur on lands within the mainland portion of the refuge that were historically used for dairy and/or beef cattle production.

It is unknown if cultural resources are presently buried within the affected area. The USFWS cultural resource records will be reviewed and the proposed project will be coordinated with the Washington State Historic Preservation Office (SHPO). Excavation below the base of the flood control levee would have the most potential to directly impact subsurface cultural deposits if they are present. The proposed tillage of former pasturelands for riparian forest restoration is not expected to exceed the tillage depth incurred during prior agricultural operations. Heavy equipment may damage artifacts through pressurization or direct excavation damage. However, based on knowledge regarding prehistoric settlement patterns, it is unlikely that the mainland portion of the JBH NWR was the site of a village or settlement.

The concrete box culvert at W259+50 Slough has an imprinted date of 1922 in the concrete facing of the headwall. By virtue of age, this concrete box culvert and probably the associated tide gate, based upon design and method of operation, are cultural resources. The proposed action is to retrofit a side-hinged restrained tide gate to the existing concrete box culvert to replace the failing, apparently original tide gate, thus retaining the bulk of the structure. Construction impacts to this structure will be minimized to the extent practicable.

In order to assess for impacts to unknown cultural resources during excavation of new channels the following recommendations are made. First, an observer will inspect the excavation as it progresses to assess cultural resource presence and provide construction guidance in the case of discovery. Secondly, an observer will monitor tillage operations for riparian forest restoration to assess cultural resource presence and provide guidance in the case of discovery. Further details regarding the potential for cultural resources to be present onsite will be considered by the SHPO. All project construction activities will be in full compliance with regulatory laws and regulations. As a result, no significant, adverse effects on cultural resources would be expected as a result of implementation of the Preferred Alternative.

For the No Action Alternative, cultural resource conditions are not likely to change significantly. However, natural river and climate fluctuations may contribute to the degradation of cultural resources that may be present.

6.12. Socio-economic Resources

The proposed action would have no bearing on socio-economic resources and land uses associated with the JBH NWR. Current uses of refuge lands are limited to conserve and protect the Columbian white-tailed deer. Wildlife observation and recreational fishing activities are not expected to be impacted. No substantial change in cattle grazing activity on JBH NWR is foreseen due to project implementation. No significant adverse effects are expected for public services or utilities as a result of the Preferred Alternative. Also, no adverse effects to land uses would be expected as a result of implementation of the Preferred Alternative.

Restoration of tidal flow and fisheries access to JBH NWR sloughs and riparian habitat development within the refuge will improve fish and wildlife habitat once construction is complete. This may improve recreational value for wildlife observation. Improvements for fisheries access and habitat are forecast to benefit ESA-listed anadromous fish which will aid their recovery. Access to the refuge post-construction will continue to be managed by the USFWS. During construction, recreational value will be temporarily diminished as a result of the noise and activity of heavy equipment and people onsite. Present recreational use is expected to be maintained during construction as access to the refuge will be maintained. The Preferred Alternative is not expected to have significant adverse effects to recreation at JBH NWR.

During construction, the aesthetic value of JBH NWR will be temporarily degraded. Lands tilled for riparian forest development will represent exposed mineral soil for approximately one year plus and will be enclosed by elk/deer proof fencing for 3-5 years. Relatively rapid growth of riparian plantings and ground cover by the second year will negate the bare ground appearance. Tillage operations would be comparable to those that occur on private lands for agricultural purposes. Fence lines, except near the county road, will blend into the vegetative background and subsequently be removed. Cuts through the flood control levee, post-construction, will hardly be noticeable given soil stabilization with grass. Following construction, the presence of riparian forest habitat will significantly enhance aesthetic value. Adverse effects to aesthetics will not be significant for the Preferred Alternative.

6.13. Air Quality/Noise/Light

Impacts to air quality and noise arising from the Preferred Alternative would occur during initial construction efforts. These impacts would result from use of heavy equipment and explosives to form pilot tidal channels at Indian Jack and Ellison sloughs. Construction related impacts would be both minor and temporary in nature. Vegetative buffers and/or distance minimize impacts to wildlife resources associated with the JBH NWR and human residents north of Highway 4 or at the west end of the refuge. Post-construction, there would be no adverse effects expected to air quality and noise. No impacts associated with light would be expected.

For the No Action Alternative, air quality, noise, and light conditions would not change.

6.14. Cumulative Effects

Cumulative effects are defined as, "The impact on the environment which results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 *Code of Federal Regulations* Section 1508.7). Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

As discussed in Section 1.4, the need for habitat restoration is predicated upon the significant historic losses of tidal slough and tidal swamp habitats along the lower Columbia River. Over the last century, the amount of tidal swamp habitat (including tidal sloughs in the region) has decreased by about 78% over historical levels primarily because of dike and levee building and associated development activities (NPCC 2002). The project area itself is currently a disturbed ecosystem previously altered by diking, drainage, clearing of tidal swamp forest and subsequent agricultural use. Current management practices focus on conservation of the Columbian white-tailed deer.

The USFWS is currently engaged in restoration actions on the JBH NWR to restore riparian forest and wetland habitats. Also, future restoration actions are being considered for the Nelson Creek drainage immediately upstream of the JBH NWR by the USFWS, Columbia Land Trust, and Natural Resource Conservation Service. The effects of these current and future restoration actions would be beneficial for fish and wildlife resources, including ESA-listed salmonid species, in the JBH NWR area.

State, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water use patterns, including ownership and intensity/type of land use, any of which could affect ESA-listed salmonids or their habitats. Even actions that are already authorized are subject to political, legislative, and fiscal uncertainties. These realities make any analysis of cumulative effects difficult.

6.14.1. Actions by States

In July 2000, the governors of Idaho, Montana, Oregon, and Washington released their *Recommendation for the Protection and Restoration of Fish in the Columbia River Basin* with the stated goal of, "…protection and restoration of salmonids and other aquatic species to sustainable and harvest able levels meeting the requirements of the Endangered Species Act, the Clean Water Act, the Northwest Power Act and tribal rights under treaties and executive orders while taking into account the need to preserve a sound economy in the Pacific Northwest." The recommendations include the following general actions related to the lower Columbia River.

Habitat Reforms

- Designate priority watersheds for salmon and steelhead.
- Provide local watershed planning assistance and develop the priority plans by October 1, 2002 and for all Columbia River Basin watersheds by 2005.
- Integrate federal, state, and regional planning processes with the Northwest Power and Conservation Council's amended Fish and Wildlife Program.
- Cooperate with federal, tribal, and local governments to implement the National Estuary Program for the lower Columbia River estuary, including creation of salmon sanctuaries.

Funding and Accountability

- Seek funding assistance for existing activities designed to improve ecosystem health and fish and wildlife health and protection.
- Work regionally to create a standardized and accessible information system to document regional recovery progress.

If these recommendations are implemented by the states individually and collectively, they should have beneficial effects on ESA-listed salmonids and their habitats.

Washington State enacted a Growth Management Act to help communities plan for growth and address the effects of growth on the natural environment. If the programs continue, they may help lessen the potential for adverse effects to the environment.

Washington has various strategies and programs designed to improve the habitat of ESA-listed salmonids and assist in recovery planning. Washington's 1998 Salmon Recovery Planning Act provided the framework for developing watershed restoration projects and established a funding mechanism for local habitat restoration projects. It also created the Governor's Salmon Recovery Office to coordinate and assist in the development of salmon recovery plans. For example, Washington's Statewide Strategy to Recover Salmon is designed to improve watersheds.

The Watershed Planning Act, also passed in 1998, encourages voluntary planning by local governments, citizens, and Tribes for water supply and use, water quality, and habitat at the water resource inventory area or multi-water resource inventory area level. Grants are made available to conduct assessments of water resources and to develop goals and objectives for future water resources management. The Salmon Recovery Funding Act established a board to localize salmon funding. The board will deliver funds for salmon recovery projects and activities based on a science-driven, competitive process. These efforts, if developed into actual programs, should help improve habitat for ESA-listed salmonids.

Washington's Department of Fish and Wildlife and tribal co-managers have been implementing the Wild Stock Recovery Initiative since 1992. The co-managers are completing comprehensive species management plans that examine limiting factors and identify needed habitat activities. The plans also concentrate on actions in the harvest and hatchery areas, including comprehensive hatchery planning. The WDFW and some western Washington treaty tribes also have adopted a wild salmonid policy to provide general policy guidance to managers on fish harvest, hatchery operations, and habitat protection and restoration measures to better protect wild salmon runs.

Washington's Forest and Fish Plan were promulgated as administrative rules. The rules are designed to establish criteria for non-federal and private forest activities that will improve environmental conditions for ESA-listed salmonids. The Washington legislature may amend the Shoreline Management Act, giving options to local governments for complying with endangered species requirements in marine areas.

Washington also established the Lower Columbia Fish Recovery Board to begin drafting recovery plans for the lower Columbia region. The future impacts of the Board's efforts will depend on legislative and fiscal support. The Washington Department of Transportation is considering changing its construction and maintenance programs to diminish effects on stream areas and to improve fish passage.

Water quality improvements will be proposed through development of TMDLs. The State of Washington is under a court order to develop TMDL management plans on each of its 303(d) listed streams. It has developed a schedule that is updated yearly; the schedule outlines the priority and timing of TMDL plan development.

Washington closed the mainstem Columbia River to new water rights appropriations in 1995. All applications for new water withdrawals are being denied based on the need to address ESA issues. The state established and funds a program to lease or buy water rights for instream flow purposes. This program was started in 2000 and is in the preliminary stages of public information and identification of potential acquisitions. These water programs, if carried out over the long term, should improve water quantity and quality in the state.

Washington's programs are likely to benefit ESA-listed salmonids if they are implemented and sustained.

6.14.2. Local Government Actions

Local governments will be faced with similar and more direct pressures from population growth and movement. There will be demands for development in rural areas, as well as increased demands for water, municipal infrastructure, and other resources. The reaction of local governments to growth and population pressure is difficult to assess without certainty in policy and funding. Future development in Washington will be governed by its Growth Management Act, which addresses issues of natural resource protections.

Increased industrialization associated with regional economic trends and growth patterns also may have the potential to result in additional dredging around dock facilities, alteration and loss of riparian areas, increased pollution, alteration and loss of shallow water habitat, and potential additional dredging for deeper access channels to enable ports to compete with other west coast port facilities. Because there is little consistency among local governments regarding current ways of dealing with land use and environmental issues, both positive and negative effects on ESA-listed salmonids and their habitats from other development caused by regional and national growth trends will probably be scattered throughout the area.

The Lower Columbia River Estuary Partnership works with private environmental groups, federal, state, and local governments on ecosystem protection of the lower Columbia River. Through continued implementation of their *Comprehensive Conservation and Management Plan*, the Partnership encompasses a watershed wide perspective, cross cutting political boundaries to address land use, water quality, and species protection. The Partnership coordinates and implements a program for conservation of the lower Columbia River. It also is actively working on recovery planning for salmonids. Thus, there is potential for a comprehensive, cohesive, and sustained program for species recovery in the lower Columbia River.

6.14.3. Tribal Actions

Tribal governments participate in cooperative efforts involving watershed and basin planning designed to improve aquatic and fish habitat. Tribal governments have to apply and sustain comprehensive and beneficial natural resource programs to areas under their jurisdiction to have measurable positive effects on ESA-listed salmonids and their habitats.

One Tribal program illustrates future tribal actions that should have such positive effects. The *Wy-Kan-Ush-Mi Wa-Kish-Wit*, or *Spirit of the Salmon* plan is a joint restoration plan for anadromous fish in the Columbia River Basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. It provides a framework for restoring anadromous fish stocks, specifically salmon, Pacific lamprey, and white sturgeon in upriver areas above Bonneville Dam. The plan's objectives related to the estuary are as follows:

- Protect the remaining wetlands and intertidal areas in the estuary upon which anadromous fish are particularly dependent.
- Undertake an immediate assessment of remaining and potential estuary habitat.
- Protect existing estuary habitat complexity.
- Evaluate and condition additional proposals for hydroelectric and water withdrawal developments, navigation projects, and shoreline developments on the basis of their impact on estuarine ecology.
- Identify and implement opportunities to reclaim former wetland areas by breaching existing dikes and levees.
- Reestablish sustained peaking flows that drive critical river and estuarine processes.

The plan emphasizes strategies and principles that rely on natural production and healthy river systems. The plan's technical recommendations cover hydroelectric operations on the mainstem Columbia and Snake Rivers; habitat protection and rehabilitation in the basin above Bonneville Dam, in the Columbia estuary, and in the Pacific ocean; fish production and hatchery reforms; and in river and ocean harvests. Overall, future implementation of the *Spirit of the Salmon* plan should have positive, cumulative effects on ESA-listed salmonids and their habitats.

The Nez Perce, Warm Spring, Umatilla, and Yakama tribal governments are now seeking to implement this plan and salmon restoration in conjunction with the states, other tribes, and the federal government, as well as in cooperation with their neighbors throughout the basin's local watersheds and with other citizens of the Pacific Northwest.

6.14.4. Private Actions

The effects of private actions on lands adjacent to JBH NWR are the most uncertain. Private landowners may convert their lands from current uses, or they may intensify or diminish those uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or they may result from growth and economic pressures. Presently, there are indications of growth in rural housing on lands adjacent to the refuge based upon installation of new roads, land clearing, and construction of probable housing sites. Changes in ownership patterns will have unknown impacts. The nature, extent, and timing of any of these private actions that may occur on adjacent lands, as well as their effects, are highly unpredictable.

There are a number of private environmental groups working in the lower Columbia River on conserving and restoring ecosystem functions that benefit salmonids. Those groups include the Pacific Coast Joint Venture, Ducks Unlimited, Sea Resources, the Columbia Land Trust, and the Columbia River Estuary Study Task Force. As independent organizations, each environmental group has its own charter and functions independently. However, these groups are coordinating their work through Lower Columbia River Estuary Partnership's science workgroup. Overall, their actions should have positive cumulative effects on ESA-listed salmonids and their habitats.

6.14.5. Cumulative Effects Summary

Non-federal actions are likely to continue to affect ESA-listed salmonids. The cumulative effects of non-federal actions in the project area that are reasonably certain to occur are difficult to analyze. Negative effects, such as impacts to fish habitat from logging, agriculture, or rural housing development are reasonably certain to occur. However, state, tribal, and local governments have developed plans and initiatives to benefit ESA-listed salmonids. The Lower Columbia River Estuary Partnership's *Comprehensive Conservation and Management Plan* is another important tool currently being used to coordinate organizations as they conduct habitat conservation, restoration, and recovery actions that benefit anadromous fish. Although state, tribal, and local governments have developed plans and initiatives to benefit listed salmon and steelhead, they must be applied and sustained in a comprehensive manner before they can be considered "reasonably foreseeable" and considered in the cumulative effects analysis.

7. COST ESTIMATE AND SCHEDULE

7.1. Real Estate

The USFWS owns in fee title the JBH NWR lands required for project purposes. Wahkiakum County Diking Improvement District No. 4 has an easement for the flood control levee. Wahkiakum County operates and maintains the culverts under the flood control levee to which the tide gates are attached. Installation of culverts and tide gates would involve District No. 4's easement.

Real Estate actions for implementation of the Preferred Alternative are limited in scope to obtaining a right-of-entry for the Corps' and its contractors to construct the various project features on USFWS property and District No. 4's easement. There are no concerns regarding obtaining a right-of-entry from the USFWS, which is a project partner with the Corps.

7.2. Project Cost Estimate

For implementation, the Corps considers the fully funded cost estimate. This cost estimate is inflated to reflect expected inflation to a point midway through the construction of the project (see Appendix B). The fully funded cost estimate for the Preferred Alternative is shown in Table 13.

Table 13. Fully Funded Cost Estimate, Preferred Alternative

Cost Category	Estimated Cost ($1000s)
Total Construction Costs	$4,006,300
Project Studies and Cultural Resources	$645,000
Planning, Engineering and Design	$198,400
Construction Management	$300,500
Total Project Cost	$5,150,200

7.3. Operation and Maintenance

Operation and maintenance (O&M) of the restored habitats on the JBH NWR will be the responsibility of the USFWS. It is estimated that the USFWS will assume O&M responsibility 3 years after initial construction. Future actions associated with O&M will likely pertain to control of invasive plants such as purple loosestrife, Canadian thistle, and reed canarygrass. Purple loosestrife will invade the site due to the extensive infestation in the lower Columbia River. The restoration should benefit from the ongoing and forthcoming efforts by various federal, state, and local governments to implement biological controls for purple loosestrife. The initial preparations to restore riparian forest vegetation are intended to provide trees and shrubs a sufficient window (2-5 years) in which to attain sufficient growth to out compete herbaceous weeds and reed canarygrass and subsequent damage resulting from deer and elk. Attainment of a riparian forest stand initially will limit future riparian O&M requirements.

Responsibility for operation and maintenance of the tide gates will remain with Wahkiakum County Diking Improvement District No. 4. Culvert maintenance would be the responsibility of the Wahkiakum County.

7.4. Design and Construction Schedule

Schedule	Date
Draft Integrated Implementation Report and Environmental Assessment; Public Notice (30 days)	August 17, 2007
Independent Technical Review (ITR)	August 27, 2007
Finding of No Significant Impact	September 1, 2007
Plans and Specifications	October 15, 2007
BCOE Review	October 24 – November 6, 2007
Incorporate BCOE and ITR Review Comments	November 8-14, 2007
Permits issued (JARPA, NPDES, SWP)	December 1, 2007
Plans and Specifications to Contracting	December 1, 2007
Contract Advertisement	December 19, 2007 – January 8, 2008
Bid Opening	January 9, 2008
Contract Award	January 10, 2008
Notice to Proceed	February 1, 2008
Phase I Construction (riparian plantings)	July 15 - October 15, 2008
Phase II Construction (culverts/tide gates)	July 15 - October 15, 2008

7.5. Sponsor Responsibilities

The Section 536 authority allows for projects on federal land. These projects are sponsored by the agency that owns the land, which in the case of JBH NWR is the USFWS. There would be no cost share requirement associated with the restoration. The Corps and USFWS will enter into a Memorandum of Agreement; the Corps will fund the restoration action and the USFWS will provide the lands and O&M requirements.

8. Coordination and Local Support*

8.1. Public and Agency Coordination

The JBH NWR habitat restoration project has received substantial agency coordination. The restoration measures for JBH NWR have been coordinated with representatives from the USFWS and NMFS. Washington Department of Transportation and Wahkiakum County officials have attended project meetings during project planning. Columbia Land Trust has also attended meetings on the proposed project as consideration was initially given to including their property north of Highway 4 in the project scope. The USFWS representatives from the Columbia River Fisheries Program Office have collected data on baseline fisheries use in the project area. The public and agency entities comprising the Lower Columbia River Estuary Partnership have previously reviewed the restoration opportunities at JBH.

The Integrated Implementation Report and Environmental Assessment will receive a 30-day public and agency review. Comments received from this review will be considered and incorporated into the proposed project, as appropriate. A draft Joint Aquatic Resources Permit Application (JARPA) has been provided to the WDOE for review. The JARPA will be finalized prior to completion of the Integrated Implementation Report and Environmental Assessment; the latter document will serve to satisfy the requirements of the Washington State Environmental Protection Act.

8.2. Views and Preferences of Project Partners

The USFWS, NMFS, and other resource agencies, including non-governmental organizations, are strongly supportive of the restoration of tidal slough and riparian forest habitat along the lower Columbia River. These habitat elements have incurred substantial historic losses due to diking and conversion of lands to urban and agricultural development. Invasive plants, particularly reed canarygrass and purple loosestrife, also are contributing to the qualitative loss of tidal habitat.

The preferences of project partners regarding the nature and extent of tidal slough and riparian forest habitat restoration have been vetted through numerous interagency meetings and site visits. Costs and incremental gain in habitat and/or value to species groups were considered in the restoration analysis and were the basis for modification of some restoration actions proposed by participants. Overall, the proposed restoration project at JBH NWR attains the general preferences of the project partners.

9. COMPLIANCE WITH LAWS AND REGULATIONS*

9.1. National Environmental Policy Act

The Environmental Assessment integrated into the Implementation Report satisfies the requirements of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.).

9.2. Endangered Species Act of 1973

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. Biological Assessments (BAs) were prepared for the proposed action; one addressed federally listed species under the jurisdiction of the NMFS and the other addressed federally listed species under the jurisdiction of the USFWS. The Julia Butler Hansen Columbian White-tailed Deer NWR is preparing the BA for species under USFWS purview. The BAs will be provided to the respective agencies for review and consultation.

9.3. Clean Water Act

Section 401 of the Clean Water Act of 1977, as amended, requires certification from the state or interstate water control agencies that a proposed water resources project is in compliance with established effluent limitations and water quality standards. The proposed action will be in compliance with the Clean Water Act via public review of the project under both Sections 404 and 401, and with the issuance of a Section 401 Water Quality Certification from WDOE. A Section 404(b)(1) Evaluation was prepared for the proposed action (see Appendix C) and was provided to the WDOE.

9.4. Magnuson-Stevens Fishery Conservation and Management Act

An assessment for Essential Fish Habitat was prepared for the proposed project and will be provided to NMFS for review and consultation.

9.5. Clean Air Act

The Clean Air Act of 1970, as amended, established a comprehensive program for improving and maintaining air quality in the United States. Its goals are achieved through permitting of stationary sources, restricting the emission of toxic substances from stationary and mobile sources, and establishing national ambient air quality standards. Title IV of the Act includes provisions for complying with noise pollution standards. Impacts to air quality and noise would occur during initial construction efforts. These impacts would result from using heavy equipment and would be minor and temporary in nature. Vegetative buffers and/or distance will minimize impacts to wildlife associated with the refuge and human residents north of Highway 4 and at the west end of the refuge.

9.6. National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires that a federally assisted or federally permitted projects account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the National Register of Historic Places. The USFWS is conducting a cultural resources review and will coordinate the proposed project with the Washington SHPO to achieve compliance with the Act.

9.7. Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act provides for the protection of Native American and Native Hawaiian cultural items, established ownership and control of Native American cultural items, human remains, and associated funerary objects to Native Americans. It also establishes requirements for the treatment of Native American human remains and sacred or cultural objects found on federal land. This Act also provides for the protection, inventory, and repatriation of Native American cultural items, human remains, and associated funerary objects. The USFWS is conducting a cultural resources review and will coordinate the proposed project with the Washington SHPO to achieve compliance with the Act.

9.8. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934 states that federal agencies involved in water resource development are to consult with the USFWS and state agency administering wildlife resources concerning proposed actions or plans. The proposed project is jointly sponsored by the USFWS and will be coordinated with the WDFW in accordance with the Act.

9.9. Comprehensive and Environmental Response, Compensation and Liability Act

The location of the proposed project is not within the boundaries of a site designated by the USEPA or the State of Washington for a response action under Comprehensive and Environmental Response, Compensation and Liability Act, nor is it a part of a National Priority List site.

9.10. Executive Order 11988, Floodplain Management

This executive order requires federal agencies to consider how their actions may encourage future development in floodplains, and to minimize such development. The proposed project will not result in development within the floodplain and will not affect the management of floodplains.

9.11. Executive Order 11990, Protection of Wetlands

This executive order requires federal agencies to protect wetland habitats. This proposed project is in compliance with Executive Order 11990.

9.12. Executive Order 12898, Environmental Justice

This executive order requires federal agencies to consider and minimize potential impacts on subsistence, low-income or minority communities. The goal is to ensure that no person or group of people should shoulder a disproportionate share of the negative environmental impacts resulting from the execution of domestic and foreign policy programs. The proposed project will not cause changes in population, economics, or other indicators of social well being. The proposed project will not result in a disproportionately high or adverse effect on minority or low-income populations. There are no environmental justice implications resulting from the proposed project.

9.13. Analysis of Impacts on Prime and Unique Farmlands

No impacts to prime and unique farmlands would occur from the proposed project.

9.14. Coastal Zone Management Act

Consistency determinations have been prepared and submitted to Washington Department of Ecology for concurrence.

10. CONCLUSIONS AND RECOMMENDATION

10.1. Conclusions

This Integrated Implementation Report and Environmental Assessment included an examination of all practicable alternatives for meeting the study purpose to restore tidal slough and riparian forest habitats on JBH NWR to benefit many fish and wildlife species in the lower Columbia River and estuary. The need for habitat restoration at JBH NWR is predicated upon the significant historic losses of tidal slough and associated riparian forest habitat along the lower Columbia River. Habitat restoration at JBH NWR also addresses the habitat requirements of ESA-listed fish and wildlife species.

The Preferred Alternative is in excess of an incrementally justified and cost-effective alternative that also meets the needs of the sponsor, the USFWS. The Corps recommends selection of the Preferred Alternative that includes all nine of the sites, given:

- Significance of outputs for ESA-listed salmonids and Columbian white-tailed deer.
- High quality unique restoration opportunity.
- Efficient use of scarce resources.
- High restoration output target.
- Demonstration of recovery and land use harmony.
- Other outputs extremely likely.

The Preferred Alternative provides substantial benefits to many fish and wildlife species, including 13 ESA-listed anadromous salmonids and the endangered Columbian white-tailed deer, as well as bald eagles, waterfowl, and Neotropical migratory birds, at a reasonable construction and operation and maintenance cost. A monitoring program will measure the response of fish, especially juvenile salmonids, to the restoration measures.

Restoration of habitat for juvenile salmonids migrating through the lower Columbia River and estuary is an important component of regional recovery plans. The proposed project addresses numerous limiting factors and fish and wildlife needs identified in the 2001 *Lower Columbia River and Columbia River Subbasin Summary*. It is consistent with and will help achieve the Northwest Power and Conservation Council's biological objectives outlined in their 2000 *Columbia Basin Fish and Wildlife Program*. The proposed project addresses the 2000 *Federal Columbia River Power System Biological Opinion* Reasonable and Prudent Alternatives for listed salmonids and will aid in USFWS recovery efforts for the endangered Columbian white-tailed deer.

The proposed project has been reviewed in light of overall public interest, which includes the views of the sponsor and interested agencies. The Corps has concluded that the total public interest would be served by the implementation of the Preferred Alternative for habitat restoration on JBH NWR.

10.2. Recommendation

I have given careful consideration to all significant aspects of this study in the overall public interest, including the environmental, social and economic, and engineering aspects, and the requirements of the sponsor, the U.S. Fish and Wildlife Service. The Preferred Alternative described in the Integrated Implementation Report and Environmental Assessment provides the optimum solution for restoring critical side channel and associated riparian forest habitats to benefit many fish and wildlife species in the lower Columbia River and estuary, including 13 ESA-listed anadromous salmonid ESUs and the endangered Columbian white-tailed deer.

I recommend that the Preferred Alternative for the Julia Butler Hansen National Wildlife Refuge Habitat Restoration Project be implemented under Section 536 of the Water Resources Development Act of 2000 (Public Law 106-541). The fully funded cost estimate for the Preferred Alternative is $5,150,200.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

Date: ____________________

____
THOMAS E. O'DONOVAN
Colonel, EN
Commanding

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Appendix A
Precipitation Probabilities

Figures A-1 to A-4 present the precipitation probabilities developed by the National Weather Service Western Regional Climate Center.

Figure A-1. Precipitation Probability in a 2-Day Period

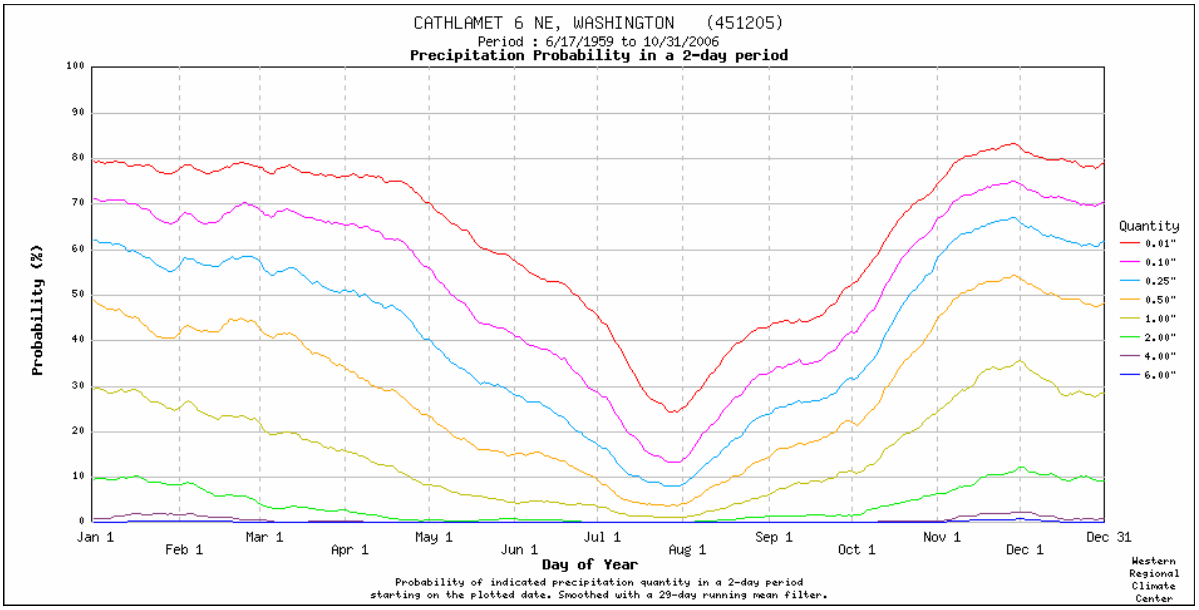


Figure A-2. Precipitation Probability in a 5-Day Period

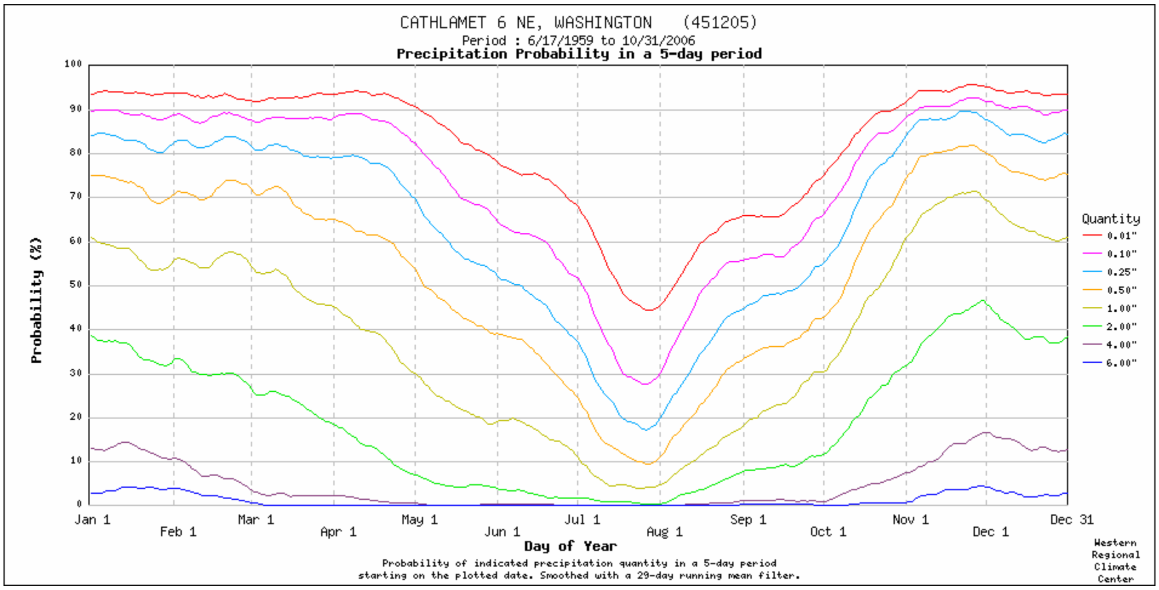


Figure A-3. Precipitation Probability in a 7-Day Period

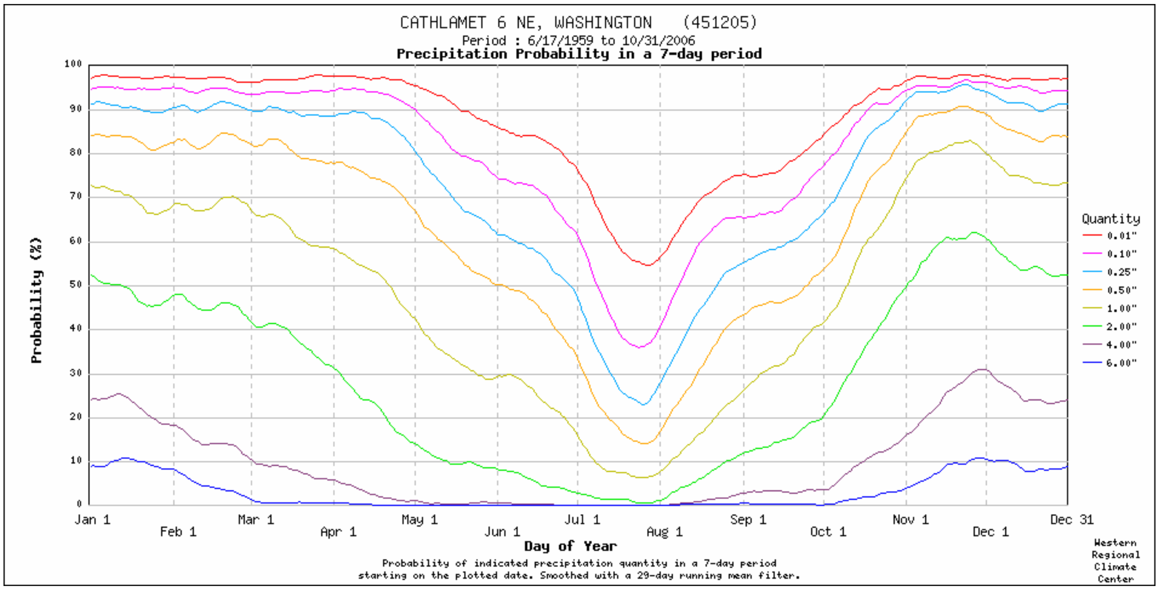
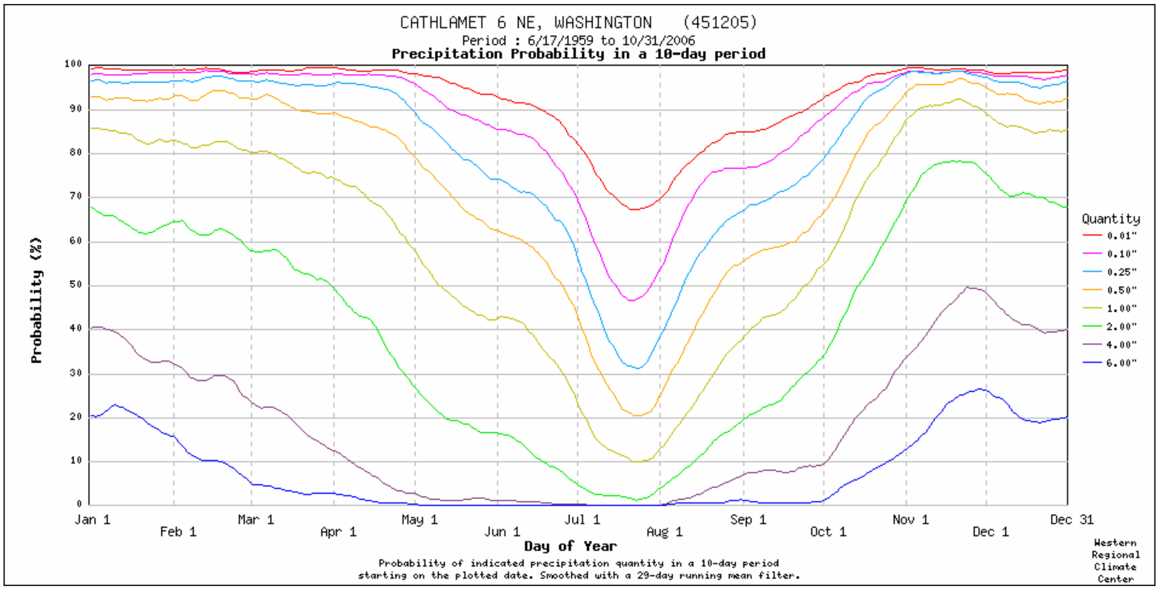


Figure A-4. Precipitation Probability in a 10-Day Period



Appendix B
Cost Estimate

****TOTAL PROJECT COST SUMMARY**** PAGE 1 OF 1

PROJECT: Julia Butler Hansen Section 536 Feasibility Phase — DISTRICT: PORTLAND — 9-Aug-07

LOCATION: Wahkiakum County, WA — P.O.C.: PAT JONES, CHIEF, CONSTRUCTION AND COST ENGINEERING SECTION

CURRENT MCACES ESTIMATE PREPARED: Apr-07 — AUTHORIZ./BUDGET YEAR: 2007 — FULLY FUNDED ESTIMATE

EFFECTIVE PRICING LEVEL: Apr-07 — EFFECT. PRICING LEVEL: APR 07

ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
06- - -	FISH AND WILDLIFE FACILITIES	3,118.4	623.7	20%	3,742.1	0.0%	3,118.4	623.7	3,742.1	Sep-08	6.0%	3,305.5	661.1	3,966.6
	ENVIRONMENTAL MONITORING	31.2	6.2	20%	37.4	0.0%	31.2	6.2	37.4	Sep-08	6.0%	33.1	6.6	39.7
	TOTAL CONSTRUCTION COSTS =====>	3,149.6	629.9	20%	3,779.5	0.0	3,149.6	629.9	3,779.5		6.0%	3,338.6	667.7	4,006.3
01 - - -	LANDS AND DAMAGES	0.0	0.0	0%	0.0	0.0%	0.0	0.0	0.0	xxxxx	0.0%	0.0	0.0	0.0
18- - -	CULTURAL RESOURCES	15.0	0.0	0%	15.0	0.0%	15.0	0.0	15.0	xxxxx	0.0%	15.0	0.0	15.0
22- - -	FEASIBILITY STUDIES	600.0	30.0	5%	630.0	0.0%	600.0	30.0	630.0	Jun-07	0.0%	600.0	30.0	630.0
30 - - -	PLANNING, ENGINEERING AND DESIGN	157.5	31.5	20%	189.0	0.0%	157.5	31.5	189.0	Mar-08	5.0%	165.4	33.1	198.4
31 - - -	CONSTRUCTION MANAGEMENT	236.2	47.2	20%	283.5	0.0%	236.2	47.2	283.5	Sep-08	6.0%	250.4	50.1	300.5
	TOTAL COST =========>	4,158.3	738.7	18%	4,896.9	0.0%	4,158.3	738.7	4,896.9		5.2%	4,369.3	780.9	5,150.2

Appendix C
Section 404(b)(1) Evaluation

I. Introduction

Section 404 of the Clean Water Act of 1977, as amended, requires that all civil works projects involving the discharge of dredged or fill material into waters of the United States be evaluated for effects prior to making the discharge. This evaluation assesses the effects of fill, consisting of native soil, greater than incidental fallback that may occur during the placement of seven water control structures (culverts with tide gates), repair of an eighth culvert and tidegate,, construction of interior and exterior channels, disposal of project derived backfill and restoration of 210 acres of riparian forest along the existing sloughs and adjacent habitats. The proposed project includes excavation of less than one acre of flood control levee and tidal slough channel below the ordinary high water mark and in tidal marsh habitat combined plus restoration (tillage) of 210 acres of riparian forest habitat.

The U.S. Army Corps of Engineers, Portland District (Corps), in partnership with the U.S. Fish and Wildlife Service (USFWS), has initiated a Section 536 Habitat Restoration Project on the Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge (JBH NWR) in the Columbia River estuary. The purpose of the habitat restoration project is to restore tidal flow to slough channels cut off by the construction of a flood control levee and to restore 210 acres of riparian forest habitats on the refuge mainland to benefit many fish and wildlife species in the lower Columbia River and estuary. The JBH NWR is located at Columbia River miles 36-38 on the Washington shore near Cathlamet, Washington. The JBH NWR was historically homesteaded and used for agriculture (dairy and beef cattle grazing). Refuge lands were later acquired by the USFWS for the conservation and management of endangered Columbian white-tailed deer (*Odocoileus virginianus leucurus*), which is listed as endangered under the Endangered Species Act (ESA). The diking district remains operational in order to maintain habitat for Columbian white-tailed deer.

The proposed project specifically provides juvenile salmonid refugia and rearing/foraging habitat for ESA-listed lower Columbia River fall Chinook (*Oncorhynchus tshawytscha*, threatened) sub-yearlings, chum salmon (*Oncorhynchus keta*, threatened), as well as coho salmon (*Oncorhynchus kisutch*), a threatened species. Other Columbia River juvenile salmonids including Snake River sockeye salmon (*Oncorhynchus nerka*, endangered), steelhead (*Oncorhynchus mykiss*, threatened), and coastal cutthroat trout (*Oncorhynchus clarki*) also are expected to benefit from habitat restoration at JBH NWR through detrital export to the river and estuary and associated benefits for benthic invertebrates.

The proposed restoration project is also expected to restore habitat for Neotropical migratory birds and will contribute substantially to habitat restoration and recovery of the endangered Columbian white-tailed deer. The proposed project will also increase the export of detrital nutrients to the estuary. A monitoring program will measure the response of fish, especially juvenile salmon, and vegetation to the restoration measures. The USFWS monitors the deer population annually.

The need for habitat restoration at JBH NWR results from the significant historic losses of side channel (tidal sloughs at JBH NWR) and tidal swamp (riparian forest) habitat along the lower Columbia River. Over the last 100 years, the amount of available tidal slough and riparian forest habitat, comprised of Sitka spruce, Oregon ash and black cottonwood, in this region has decreased significantly over historical levels, primarily because of flood control levee construction and associated development, principally agricultural, but also urban, industrial and navigation development. Restoration of habitat for juvenile salmonids migrating through the lower Columbia River and estuary is an important component of regional recovery plans. The lower Columbia River and estuary are critical areas in the migration corridor for Columbia Basin anadromous fish, especially chum and chinook, because these areas provide refugia from predators, feeding grounds, and areas to transition physiologically from freshwater to saltwater.

II. Description of the Proposed Action

Proposed Action

The preferred alternative includes restoration of tidal connectivity to seven sloughs, repair of water control structures at an eighth slough and channel improvements to Risk Creek, as well as the restoration of 210 acres of riparian forest habitat. Tidal exchange would be restored through installation of tide gates designed to allow ingress and egress of tidal waters while maintaining prevailing land management practices within the diking district and the JBH NWR. The tide gate design selected for implementation is a side-hinged, self-restrained tide gate (hydraulic ram actuated by a float set at a predetermined elevation). The selected tide gate would be 72-inches in diameter and would improve discharge of interior waters while allowing for considerable tidal inflow during each flood tide. This tide gate design would be installed at Indian Jack, Duck Lake, Ellison, Winter, W259+50, Hampson and Brooks sloughs; no tide gates are currently present at Indian Jack, Ellison, Winter and Hampson sloughs. The side-hinged, cammed tide gate at W201+30 Slough would not be replaced due to the good interconnection with W259+50 Slough plus good discharge and existing, although limited, infill capability.

The restoration action would allow for greatly improved fisheries ingress and egress to these sloughs plus substantially improve fisheries habitat conditions through improved water quality parameters and water circulation. An estimated 87 acres of primary and secondary slough habitat would become available for juvenile salmonid use. Detrital and invertebrate export to the Columbia River is also anticipated to increase with installation of the selected tide gate design.

Riparian forest restoration would be a companion element to the tide gate retrofit effort. Approximately 210 acres of riparian forest is slated for development along the sloughs within the refuge. The development and subsequent maturation of riparian forest habitat would provide detrital and invertebrate input to these sloughs and ultimately shade and large woody debris input. These attributes would benefit ESA-listed salmonids.

The riparian forest component of the restoration effort would be directed at establishing riparian forest vegetation on lands now characterized by grasslands rather than the riparian forest of their natural state. The present condition of much of the refuge land is a reflection of past agricultural practices when the land was cleared and pasturelands established. Reed canarygrass now dominates many of these former pasturelands and has effectively precluded reestablishment of riparian forest habitat. The USFWS has established a number of riparian forest stands in recent years throughout JBH NWR. They have utilized mowing, repetitive tillage, plantings, protective mesh around seedlings and cuttings, and elk-proof fencing to accomplish establishment of riparian forest habitat. Their methodology will be used for the proposed action to establish riparian forest habitat given its proven track-record.

Project benefits for native fish and wildlife would be achieved by the following specific restoration measures.

Indian Jack Slough. Sheet piles or cofferdams would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Channel construction would not be enclosed by cofferdams. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls comprised of either cast-in-place, pre-cast concrete, or steel would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cubic yards (cy) of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. A discharge channel from the tide gate to the Elochoman River will be constructed via blasting or excavation. For all sites, best management practices (BMPs) will follow EPA's National Pollutant Discharge Elimination System (NPDES) BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (available at http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. About 19 acres of riparian forest vegetation would be planted along the shorelines.

Duck Lake Slough. Sheet piles or a cofferdam would be placed on the exterior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Existing riprap will be temporarily removed during construction to facilitate placement of the sheet pile cofferdam. A culvert plug or cofferdam would be used on the interior end of the existing culvert to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height.

Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The existing 70-inch diameter steel culvert may be cut and shortened on the riverward end to further facilitate fish passage. The existing trash rack and walkway will be removed. A headwall composed of either cast-in-place, pre-cast concrete, or steel, would be constructed at the riverward end of the culvert. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline.

A side-hinged restrained tide gate will be installed on the riverward headwall, replacing the existing top-hinged steel tide gate. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if log boom replacement is necessary. For all sites, best management practices (BMPs) will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams and culvert plugs would be removed upon completion of each individual structure, at low tide, to minimize the environmental impacts. The sidewalls of the cofferdam may remain as a permanent retaining wall structure and would include handrails or possibly a walkway. Existing steel pilings may be removed, or capped and left in place for minimum environmental disturbance. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 20 acres of riparian forest vegetation would be planted along the shorelines.

Ellison Slough. Sheet piles or cofferdams would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Channel construction would not be enclosed by cofferdams. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls comprised of either cast-in-place, pre-cast concrete, or steel would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. A discharge channel from the tide gate to the Elochoman River will be constructed via blasting or excavation. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). An interior channel will be excavated from the flood control levee to the Ellison Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Ellison Slough only upon completion of construction to minimize potential turbidity. Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 54 acres of riparian forest vegetation would be planted along the shorelines.

Winter Slough. Sheet piles or cofferdams would be placed on the interior and exterior. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls, comprised of either cast-in-place, pre-cast concrete, or steel, would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately one year to determine if a log boom is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure, at low tide, to minimize the environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. An interior channel will be excavated from the flood control levee to the existing Ellison Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Ellison Slough only upon completion of excavation to minimize potential turbidity. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 20 acres of riparian forest vegetation would be planted along Winter Slough.

W201+30 Slough. Temporary sheet piles or cofferdams would be placed on the interior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Work will include removal of existing vegetation which is obstructing the existing culvert; approximately 20 cy of riprap will be placed around the interior end of the culvert and it will be cut and beveled to preclude future debris build-up. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom is necessary. About 24 acres of riparian forest vegetation would be planted along the shorelines.

W259+50 Slough. Temporary sheet piles or a cofferdam would be placed on the exterior end of the culvert to preclude entrance of tidal and/or slough waters into the construction area. A culvert plug or coffer dam would be used on the interior end of the culvert to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out, and then a transfer pump would discharge the clean water to adjacent refuge pasture lands. A side-hinged, restrained tide gate will be retrofitted on the existing riverward headwall. Guard rails may be placed on both sides of the levee roadway. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom replacement is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. About 9 acres of riparian forest vegetation would be planted along the shorelines.

<u>Hampson Slough</u>. Sheet piles or a cofferdam would be placed on the interior and exterior ends of the culvert to preclude entrance of tidal and/or slough waters into the construction area. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of approximately 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Interior channel construction, via excavation, would not be enclosed by cofferdams.

Pumps may be required to maintain dry conditions within the work area. Collection and disposal of construction water will require a pump for collection and transfer to the settling tanks. The tanks provide enough residence time for the larger solids to settle out and a transfer pump would discharge the clean water to adjacent refuge pasture lands. The flood control levee would then be excavated to approximately -2 foot elevation. The 72-inch diameter by approximately 50-feet-long culvert would have an invert elevation of approximately -1 foot. High density polyethylene, concrete, or steel culverts would be set on top of, and encapsulated in, approximately 1 foot of controlled density fill. A comparable material, such as low permeability granular fill, may be used in place of controlled density fill. Most of the material used for fill of the levee cut would consist of the overburden excavated from the flood control levee.

Headwalls, comprised of either cast-in-place, pre-cast concrete, or steel, would be constructed at both ends of the culverts. Backfill will be placed and compacted above the culvert and the country road restored and widened to facilitate future operation and maintenance. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline.

A side-hinged, restrained tide gate will be installed on the riverward headwall. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately one year to determine if a log boom is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams would be removed upon completion of each individual structure at low tide to minimize environmental impacts. The sidewalls of the cofferdam will remain as a permanent retaining wall structure and would include handrails. An interior channel will be excavated from the flood control levee to the existing Hampson Slough channel; the bulk of this interior channel can be excavated in the dry and opened to Hampson Slough only upon completion of construction to minimize potential turbidity. Approximately 5 pilings may be installed on the riverward side to deflect large woody debris. About 21 acres of riparian forest vegetation would be planted along the shorelines.

Brooks Slough. Temporary sheet piles or a cofferdam would be placed on the exterior end of the existing three culverts to preclude entrance of tidal and/or slough waters into the construction area. Culvert plugs or cofferdam would be used on the interior end of the culverts to block water. Sheet piles would be driven in place using a hydraulic excavator boom and/or a vibratory hammer during low tide when water does not cover the site to minimize the environmental impact. Cofferdam piling will be sunk to a depth of about 1.5 times the height of the piling that extends above the ground surface; piling height will equal flood control levee height. Pumps may be required to maintain dry conditions in the work area. Collection and disposal of construction water will require a pump for collection and transfer to settling tanks. The tanks provide enough residence time for larger solids to settle out, and a transfer pump would discharge the clean water to adjacent refuge pasturelands.

A side-hinged, restrained tide gate will be retrofitted on the existing riverward headwall for one of the culverts. An interior log boom is optional. The interior slough will be monitored for debris accumulation for approximately 1 year to determine if a log boom replacement is necessary. For all sites, BMPs will follow EPA's NPDES BMP Construction Site Planning and Management/Erosion Control/Runoff Control/Sediment Control/Material Management Guide (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm). Temporary cofferdams and culvert plugs would be removed upon completion of each individual structure at low tide to minimize environmental impacts. Approximately 50 cy of riprap will be placed as necessary to prevent erosion around the culvert (interior and exterior ends) and on the immediate adjacent shoreline. About 39 acres of riparian forest vegetation would be planted along the shorelines.

Risk Creek. Approximately 1,000 lineal feet of channel will be excavated and realigned to form a sinuous channel. About 4 acres of riparian forest vegetation would be planted along the shorelines.

Purpose and Need

The purpose of the habitat restoration project is to restore fish passage and muted tidal influence to sloughs and develop riparian forest habitat on the JBH NWR to benefit many fish and wildlife species in the lower Columbia River and estuary. The proposed project will provide improved habitat conditions and access/egress to juvenile salmonid rearing/foraging habitat for fall Chinook salmon subyearlings and for chum salmon, both threatened species, as well as for coho salmon, a candidate species for listing. Other salmonids including endangered Snake River sockeye salmon, threatened steelhead trout, and coastal cutthroat trout also are expected to benefit indirectly from the restoration of tidal flows to sloughs on the JBH NWR. The proposed project also would provide for habitat improvements for waterfowl and Neotropical migratory birds, and would contribute to the recovery of endangered Columbian white-tailed deer. A monitoring effort will measure the response of fish, especially juvenile salmon, and Columbian white-tailed deer to the restoration measures.

The need for habitat restoration at JBH NWR is predicated upon the significant historic losses of tidal slough and tidal swamp habitats along the lower Columbia River. Over the last century, the amount of tidal swamp habitat (including tidal sloughs in the region) has decreased by about 78% over historical levels because of dike and levee building and associated development activities. The project area itself is currently a disturbed ecosystem previously altered by diking, drainage, clearing of tidal swamp forest and subsequent agricultural use.

General Description of Dredged or Fill Material

The material to be excavated during project construction is native soil which is described in the Soils section of the EA. The Soil Survey of Wahkiakum County (SCS 1986) classifies the soil on the refuge as Ocosta silty clay loam. The typical profile is described as a 7-inch-thick surface layer of dark grayish brown silty clay loam followed by 5 inches of mottled, dark grayish brown silty clay loam, 8 inches of dark grayish brown silty clay, 2 inches of black sapric material (highly decomposed organic soil material), and very dark grayish brown clay to a depth of 60 inches or more. Permeability is described as very slow. The water table in the Ocosta soil is generally at a depth of 1 to 2 feet.

Soil descriptions in boring logs from 1966 and earlier generally agree with the Soil Survey description of the soil in the top 5 feet of the profile. The upper soil in the profile is generally silt. The boring logs show an underlying deposit of silty sand beginning at an elevation ranging from about -5 to -15 feet mean sea level. The full thickness of the silty sand deposit is not known; borings terminated at elevations from -28 to -37 feet were still in the silty sand. Soil descriptions in the boring logs also indicate that the levee is made of the native, near-surface silt.

The Soil Survey classifies the soil at the Ellison Slough location, south of the levee to the Columbia River (Figure 3), as Fluvaquents, tidal (this is a very deep but poorly drained soil type that is typical of soils found on floodplains and deltas). The profile is stratified sand to silt. This soil is less plastic than the Ocosta soil covering the rest of the refuge.

The excavated material will be used as backfill for the cuts through the flood control levee required for installation of culverts, tidegates, and their associated infrastructure.

Description of the Proposed Discharge Sites

Soil excess to backfill requirements will be placed in a shallow lift on the interior slope of the flood control levee above the ordinary high water mark or at an approved USFWS disposal location and seeded with grasses to prevent erosion. It is proposed to use explosives to construct outlet channels for Indian Jack and Ellison Sloughs. The tidal wetlands at the outlet of these sloughs would incur greater damage from excavators and trucks hauling the overburden compared to a shallow, scattered deposition of mud and vegetation associated with an operation to blast a pilot discharge channel.

III. Alternatives

A number of potential measures to either provide and/or improve fish passage for the refuge sloughs were evaluated. Installation of culverts and tide gates at those sloughs without the structures was the first consideration. For those sloughs with existing culverts and tide gates, retrofitting with fish friendly tide gates was an initial consideration; culvert and tide gate replacement was considered secondarily. Tide gate size (diameter), means of opening (top-hinged vs. side-hinged), dual-purpose combination gates (hydraulic pressure opening, self-regulating tide gate in combination with a sluice gate, manual opening and closing slide gate), restrained, side-hinged tide gates, additional culverts with tide gates, seasonal operation and/or tide gates with fish-flaps were also considered.

IV. Factual Determinations

a. Physical Substrate Determinations and Actions to Minimize Adverse Effects

Substrate within the project area is generally silt. The boring logs show an underlying deposit of silty sand, beginning at an elevation ranging from about -5 to -15 feet mean sea level. The full thickness of the silty sand deposit is not known; borings terminated at elevations from -28 to -37 feet mean sea level were still in the silty sand. Soil descriptions in the boring logs also indicate that the flood control levee is made of the native, near-surface silt. The Soil Survey classifies the soil at Ellison Slough, south of the levee and extending to the Columbia River, as Fluvaquents, tidal (a very deep but poorly drained soil type that is typical of soils found on floodplains and deltas). The profile is stratified sand to silt. This soil is less plastic than the Ocosta soil covering the rest of the refuge.

Excavation for installation of new culverts and tide gates will occur through the existing flood control levee. Cofferdams will protect these excavation areas and the interior of the diking district during construction from tidal action. Excavation of exterior channels at Indian Jack and Ellison Sloughs and an interior channel at Ellison, plus potentially Winter, and Hampson sloughs, will result in physical removal of soil during the construction and post-construction process. Post-construction, the ingress and egress of tidal waters is expected to carve a channel suitable for the water volume that will be exchanged between the river and the interior sloughs. Overall, no significant, adverse effects are expected on geology, soils, sediments, or any other physical substrate conditions.

b. Water Circulation, Fluctuation and Salinity Determinations

<u>Water</u>. The proposed action would restore water exchange between side channel habitat (JBH sloughs) and the Columbia and Elochoman rivers. It would not result in the consumption or loss of water. Water quality in the existing side channels would be improved through implementation of the proposed action.

<u>Current Patterns and Water Circulation</u>. Restoration of muted tidal flows through the newly installed tide gates will improve water circulation and allow more frequent natural fluctuations of tidal flows within the refuge sloughs. Water circulation and fluctuation will be greatly improved and more closely resemble expected natural conditions in the refuge sloughs.

1. <u>Normal water fluctuations</u>. The installation of self-restrained, side-hinged tidegates will result in a muted normal water fluctuation relative to Columbia River stage and tidal stage. The current condition precludes normal water fluctuation as the existing tidegates are setup for discharge purposes and unless malfunctioning, do not allow for inflow.
2. <u>Salinity gradients</u>. Not Applicable. The JBH refuge occurs well upstream of the uppermost salinity intrusion in the Columbia River estuary.
3. <u>Actions to minimize adverse effects</u>. These include the installation of cofferdams during construction to negate impacts from sediment on water quality. The proposed action would also occur during late summer when river stage is lowest, thus keeping water off the construction sites to the extent practicable. Exterior channels at Ellison and Indian Jack Sloughs would be excavated via blasting to preclude heavy equipment's larger scale impact to these wetland areas.

c. Suspended Particulate/Turbidity Determination and Actions to Minimize Adverse Effects

During construction, suspended particulate and turbidity levels may increase in the various sloughs as a result of construction activity and restoration. The use of appropriate best management practice erosion control measures are expected to avoid and minimize any temporary impacts to the Columbia River, Elochoman River, and side channels. The principal measure will be the use of cofferdams to exclude construction actions from the adjacent water bodies. Removal of cofferdams during low tide should lessen turbidity and suspended particulates when the tide gates first become operational. An exception would be exterior channel construction; whether via blasting or excavation, these areas would not be enclosed by cofferdams. Bare ground exposed during construction and throughout the revegetation period may contribute turbidity to the surrounding waters through runoff. Use of straw or other erosion protection measures will be used to control sediment runoff. Restoration of tidal circulation to the JBH NWR sloughs is expected to result in slight increases in turbidity within the Columbia River until tidal channelization through accumulated sediments reaches an equilibrium point. The material exported from the tidal sloughs may settle near the outlets or be discharged to the Columbia River. Water quantity (tidal flow) will be temporarily restricted in the project area by the cofferdams during the construction period, but will be restored following completion of construction activities. The project will return more natural tidal fluctuations to the JBH NWR sloughs than presently occurs.

Observation of the mouth of W201+30 Slough, fitted in 2003 with a side-hinged tide gate, did reveal the presence of a narrow, low flow channel but no accumulation of sediments in a delta. Similar results are expected for the other sloughs where installation of side-hinged, self-restrained tide gates would occur.

It is proposed to use explosives to construct outlet channels for Indian Jack and Ellison sloughs. The blasted channels at Ellison and Duck Lake sloughs would form pilot channels. Subsequent ebb and flood of tidal waters will carve these pilot channels to the appropriate depth and configuration required to handle tidal flows at these locations and should mimic natural tidal channel configurations. The volume of material to be mobilized at these locations is not anticipated to be significant. The tidal wetlands at the outlet of these sloughs would incur greater damage from excavators and trucks digging and then hauling the overburden compared to a shallow, scattered deposition of mud and vegetation associated with an operation to blast a pilot discharge channel.

Riparian forest restoration tillage actions will occur in late summer when the site is dry and runoff from precipitation is least likely. Buffer strips of dense vegetation will be left around riparian restoration areas to capture sediments in any runoff. Buffer areas of vegetation will be retained between the sloughs and riparian restoration areas to lessen the potential for sediment export. Turbidity attributable to the restoration action will be temporary in nature, localized and rapidly dispersed, resulting in little affect on the instream habitat.

Erosion protection measures will be used to control sediment runoff from excavated material. Soil excess to backfill requirements will be placed in a shallow lift on the interior slope of the flood control levee above the ordinary high water mark or at an approved USFWS disposal location and seeded with grasses to prevent erosion. Additional erosion control measures may be employed, if necessary. Turbidity will be monitored before, during, and after construction.

d. Contaminant Determinations and Actions to Minimize Adverse Effects

1. General evaluation of dredged fill material (see EA Section 2.2).
2. Chemical, biological, and physical evaluation and testing (see EA Section 2.2).

Sediment obtained from the project area (tide gate locations) was tested and determined to be suitable for unconfined, in-water disposal, or could be exposed to water after excavation without further characterization.

Best management practices will be employed to reduce the pollutant emissions from heavy equipment, such as oils, fuels, or grease. Cofferdams will be installed at low tide at the inlet and outlet locations during culvert installation through the flood control levees to minimize turbidity and sediment discharge to the adjacent water bodies. For cast in place concrete headwalls, waste water will be collected, stored, and disposed of properly.

The construction measures associated with implementation of the preferred alternative may result in temporary reductions in water quality. However, it is unlikely that water quality conditions in the Columbia River would be measurably degraded. Water quality or quantity is not expected to experience significant, adverse effects as a result of the proposed project.

e. Aquatic Ecosystem and Organism Determinations and Actions to Minimize Adverse Effects

1. Threatened and endangered species: The proposed action is anticipated to benefit listed Columbia River Evolutionary Significant Units of salmonids through restoration of juvenile salmonid foraging and refugia habitat. The development of 210 acres of riparian forest habitat would substantially benefit Columbian white-tailed deer.

2. Fish, crustaceans, mollusks, and other aquatic organisms in the food web: The proposed action would also benefit these species through restoration of habitat and improved connection to riverine habitat, allowing for species access and export of detritus and invertebrates that would benefit the estuarine food chain.

3. Other wildlife: Neotropical birds would benefit substantially from the provision of 210 acres of riparian forest habitat which would provide forage, cover, and nesting substrate for many different avian species. Other fauna characteristic of floodplain riparian forest habitat would also benefit from this habitat improvement.

4. Sanctuaries and refuges: The proposed action would occur on the Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge. The action is consistent with refuge purposes and objectives for the listed deer and would benefit the species through improvements to 210 acres of riparian forest habitat.

5. Wetlands: The proposed action will not result in the fill or drainage of wetland habitat on the JBH refuge. An evaluation of soil characteristics was completed to ensure that improved discharge of water resulting from new tidegates and retrofitted tidegates would not drain water from existing wetlands. The excavation of exterior channels at Indian Jack and Ellison Slough locations by blasting will result in a thin layer of material (soil and vegetative) being deposited over adjacent vegetated shallows. A similar effort at South Slough Sanctuary (Coos Bay, Oregon) demonstrated no long term adverse impact to the surrounding vegetation and rapid colonization of the area disrupted during channel construction.

6. Mud flats: The proposed action will not impact mud flats. This habitat occurs outside the project footprint.

7. Vegetated shallows: Vegetated shallows will be impacted at the Indian Jack and Ellison Slough locations when discharge channels are excavated. The excavation of exterior channels at these locations by blasting will result in a thin layer of material (soil and vegetative) being deposited over adjacent vegetated shallows. A similar effort at South Slough Sanctuary (Coos Bay, Oregon) demonstrated no long term adverse impact to the surrounding vegetation and rapid colonization of the area disrupted during channel construction.

8. Coral reef: Not applicable.

9. Riffle and pool complexes: Not applicable.

10. Municipal and private water supplies: Not applicable.

11. Recreational and commercial fisheries: The proposed action could benefit recreational and commercial fisheries through enhancement of juvenile salmonid habitat and their increased survival and fitness, leading to increased returns of adult salmon and steelhead.

12. Water-related recreation: There will be no impact to water-related recreation associated with this project.

13. Aesthetics: The proposed action would temporarily impact the scenic and aesthetic qualities of the shorelines and vistas at the Julia Butler Hansen NWR. The impact to these qualities would arise from the construction actions for the culverts, tidegates, interior and exterior channels and riparian forest restoration that would result in exposure of bare soil. Reseeding of the impacted area would quickly recover these disturbed lands. Excavation of internal and external channels for water conveyance are expected to be naturally revegetated within 1-3 years and thereafter be indistinguishable from natural channels. Riparian forest restoration would initially convert current grasslands to bare soil comparable to typical agricultural actions. Deer and elk proof fences constructed around these restored stands would be visible. Planting of tree and shrub seedlings and cuttings plus natural regeneration of grasses and forbs would restore vegetative cover in 1-2 years. Riparian stands at approximately three years of age would be sufficiently tall and dense to virtually preclude observation of the deer and elk proof fences except at close range; these fences would be removed 3-5 years post planting. The scenic and aesthetic qualities of the shoreline would be comparable to present conditions approximately one year post-construction once revegetation occurs. The scenic and aesthetic qualities of the interior portions of the refuge would improve with riparian forest establishment and subsequent maturation. Slough waters post-construction would improve in color and clarity from the present muddy brown coloration and be cooler than current condition due to the emplacement of tidegates and culverts that allow for daily tidal interchange with the Columbia River.

    There would be no impact to utilization of the resources of the area. The proposed action would restore damaged natural resource features (internal sloughs and riparian forest) to a higher quality than currently exists and would aid the conservation and management efforts for Columbian white-tailed deer through habitat improvements in both quality and acreage. The upstream and downstream effects of the proposed development have been considered and no degradation of the shoreline area is forecast.

14. Parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves: The proposed action is on a National Wildlife Refuge. The management purpose of the refuge, the conservation of Columbian white-tailed deer, would not be compromised and the riparian forest restoration component of the proposed action would benefit the deer and many other wildlife species through provision of forage and cover.

    Excavation and fill may cause some temporary turbidity and disturbance or loss of bottom dwelling organisms within the existing slough channels. However, once construction is complete, the natural nutrient cycling is expected to be enhanced as a result of improved tidal circulation. Temporary losses of benthic organisms will be recouped and should increase following improvement in circulation and increases in the slough area affected by tidal exchange. Improved nutrient cycling benefits productivity of benthic invertebrates, which subsequently improves overall productivity of the estuary.

The 210 acres of existing pasture/grassland habitat (historically Sitka spruce tidal swamp) will be denuded of vegetation during the initial stages of riparian forest restoration. Terrestrial, avian and amphibian organisms are expected to incur some losses and move out of the area as tillage begins. As riparian forest and ground cover vegetation develops many of these grassland species will reoccur on site. As riparian forest habitat develops and matures plant and animal species composition will change as succession advances. Post-construction riparian areas will have a greater percentage of native plant species, since non-native species will be controlled initially and three years of operation and maintenance activities are anticipated. No sensitive plant species are anticipated to be present given the long agricultural history of the area and the dense stands of pasture and reed canarygrass that currently cover the riparian restoration areas. Ground cover vegetation is expected to develop naturally from seeds in the soil bank for the riparian restoration areas. The tidal sloughs will have a more natural tidal regime post-construction, resulting in improved habitat for aquatic species. Overall, the project is designed and intended to benefit fish and wildlife species that are part of or rely upon the aquatic ecosystem.

f. Proposed Disposal Site Determinations

Tillage of pastureland for riparian forest restoration would not violate Environmental Protection Agency or State water quality standards or violate the primary drinking water standards of the Safe Drinking Water Act (42 U.S.C. 300 et seq.), through introduction of substances into surrounding waters or exacerbation of existing contaminant conditions. Buffer strips would minimize the potential for introduction of sediments into surrounding waters. Disposal of excess excavated materials from the flood control levee cuts for culvert construction would be placed on the interior slope of the flood control levee in a shallow lift and stabilized with seeded grasses. Material excavated from the interior channel locations, principally Ellison Slough, would be disposed of at a USFWS approved disposal location on the refuge, and stabilized with vegetation. The construction of exterior pilot channels at Indian Jack and Ellison Sloughs would result in side casting of soil in a shallow layer on adjacent tidal marsh habitat. No adverse impact to the tidal marsh habitat is forecast. Tidal flow in and out of Indian Jack and Ellison Sloughs will finish carving these channels with sediment exported from the immediate area, mimicking a natural tidal channel development process. Disposal related impacts are anticipated to be minor in scope and temporary in nature.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

The excavation and tillage actions are not expected to have significant adverse cumulative effects on the aquatic ecosystem. Modification of and addition of tide gates at JBH NWR sloughs will have a beneficial effect on the aquatic ecosystem, listed species utilizing the area, and their habitats. Riparian forest restoration actions are not expected to adversely affect the aquatic ecosystem. The project is expected to incrementally reverse adverse cumulative effects that have previously occurred in the general project area.

h. Determination of Secondary Effects on the Aquatic Ecosystem

The proposed action would increase the area of tidally influenced slough habitat in the lower Columbia River and estuary available to fisheries resources. The proposed action would improve detrital and invertebrate export to the Columbia River and estuary. Fish and wildlife populations that rely completely or incidentally upon estuary habitats are expected to benefit from the restoration action.

V. Findings of Compliance

Based upon the foregoing factual determinations and following requirements of the 404(b)(1) Guidelines, the proposed disposal site(s) for the discharge of dredged or fill material complies with the Guidelines.

A. Alternatives

There is no practicable alternative, which would have less adverse impact on the aquatic ecosystem.

B. Restrictions on Discharge

1. Does not cause or contribute to violations of State water quality standards.
2. Does not violate any applicable toxic effluent standard or prohibition under Section 307 of the Act.
3. Does not jeopardize the continued existence of species listed as threatened or endangered under the ESA or result in the destruction or adverse modification of critical habitat.
4. Does not violate any requirement imposed under the Marine Protection, Research and Sanctuaries Act of 1972.

C. No Significant Degradation

Does not cause or contribute to significant degradation of waters of the United States through effects to:

Human health or welfare, including effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.

Life stages of aquatic life and other wildlife dependent on aquatic ecosystems.

Aquatic ecosystem diversity, productivity, and stability, including effects to loss of fish and wildlife habitat or loss of capacity of wetland to assimilate nutrients, purify water or reduce wave energy

Recreational, aesthetic, and economic values

D. Minimization of Impacts

Appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.