September 15, 2005

Planning Programs and Project
Management Development

Mr. Michael Tehan
National Marine Fisheries Service
525 NE Oregon St.
Portland, OR 97232-2737

Dear Mr. Tehan:

Enclosed is the Biological Assessment and Essential Fish Habitat evaluation for the Operation and Maintenance program for the lower Columbia River. This assessment is for the 12 ESA-listed stocks and one candidate stock of salmonids that occur in or pass through the lower Columbia River. It has been determined that although the impacts are minimal, the maintenance activities will likely result in a take of listed or candidate stocks. Consequently we are requesting formal consultation for the listed stocks and formal conferencing for the candidate stock. As indicated in the 1999 Biological Opinion for this project we are required to re-initiate consultation prior to September 15, 2004. The attached Biological Assessment and this letter requesting formal consultation and conferencing fulfill that requirement.

If you have any questions or need any additional information, please contact Mr. Kim Larson of my staff at (503) 808-4776 or by email at kim.w.larson@usace.army.mil.

Sincerely,

Robert E. Willis
Chief, Environmental Resources Branch

Enclosure

BIOLOGICAL ASSESSMENT

COLUMBIA RIVER CHANNEL OPERATIONS AND MAINTENANCE

MOUTH OF THE COLUMBIA RIVER TO BONNEVILLE DAM

PREPARED BY
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT, PORTLAND, OREGON

September 2004

ACRONYMS AND ABBREVIATIONS

AMD	advanced maintenance dredging
BMP	best management practice(s)
BA	biological assessment
BiOp	Biological Opinion
cm	centimeter(s)
cfs	cubic feet per second
cy	cubic yard(s)
C&LW	Columbia and Lower Willamette River Project
Corps	U.S. Army Corps of Engineers, Portland District
CRCIP	Columbia River Channel Improvement Project
CRD	Columbia River datum
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyl dichloroethylene
DDT	dichlorodiphenyl trichloroethane
DMEF	Dredge Material Evaluation Framework
DMMS	Dredged Material Management Study
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended, 16 U.S.C. 1513 et seq
ESU	Evolutionary Significant Unit(s)
ETM	estuarine turbidity maximum
ISAB	Independent Scientific Advisory Board
km	kilometer(s)
MHHW	mean higher high water
MLLW	mean lower low water
$mgC/cm^2/day$	milligrams of carbon per square centimeter per day
mg/L	milligram(s) per liter
mm	millimeter(s)
mcy	million cubic yard(s)
MCR	Mouth of the Columbia River
NOAA Fisheries	formerly National Marine Fisheries Service (NMFS)
NTU	nephelometric turbidity unit
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSU	practical salinity unit(s)
RM	river mile
SEI	Sustainable Ecosystems Institute
Sq. nmi.	square nautical mile(s)
USGS	U.S. Geological Survey

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The U.S. Army Corps of Engineers, Portland District (Corps) has prepared this Biological Assessment (BA) for the Columbia River channel operations and maintenance activities (hereafter referred to as the maintenance activities) to evaluate potential effects on federally listed threatened and endangered salmonids and their critical habitat that may be associated with these activities. This BA evaluates annual maintenance dredging on the Columbia River from the mouth of the river [river mile (RM) -3] to RM 126 above Vancouver, Washington (see Figure 1-1). However, the action area for the analysis extends beyond the actual location of the dredging and disposal activities for the Project. The action area for this Project is defined as the mouth of the Columbia River (MCR) upstream to Bonneville Dam (RM 145), as well as a fan-shaped area of the Pacific Ocean extending out 12 miles from the mouth of the river. The lateral extension of the action area extends 300 feet shoreward of mean higher high water (MHHW). This BA also includes the removal of sand for commercial use, which is "permitted" under license agreement with the Corps' Waterways Maintenance Section. Those companies licensed to remove sand from the navigation channel are bound by the same conditions as the Corps when conducting maintenance dredging activities.

1.1 HISTORY OF CHANNEL MAINTENANCE PROJECTS

Since the late 1800s, the Corps has been responsible for maintaining safe navigation on the Columbia River. During this time, the Corps has taken many actions to improve and maintain the navigation channel. The channel has been dredged periodically to make it deeper and wider, as well as annually for maintenance. Maintenance dredging on the Columbia River has been conducted every year since 1906 (Corps 1998). To improve navigation and reduce the need for maintenance dredging, the channel has also been realigned and hydraulic control structures such as pile dikes and jetties have been built.

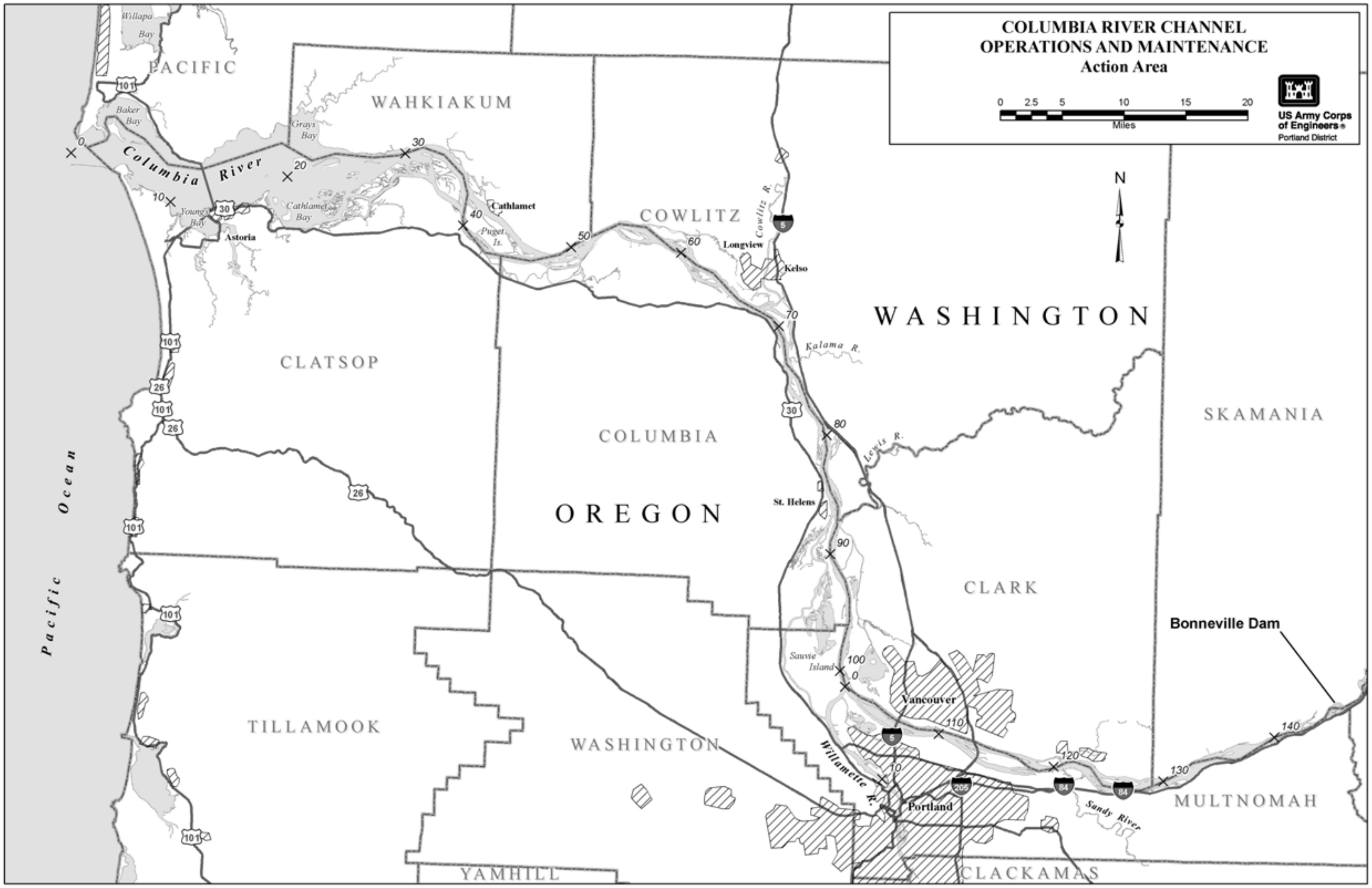
In 1878, Congress authorized the Columbia River Navigation Channel Project and directed the Corps to establish and maintain a 20-foot minimum channel depth. Maintaining this depth required dredging in only a few shallow reaches of the river where the natural controlling depths were in the 12 to 15 foot range (Corps 1999). In 1899, Congress increased the authorized navigation channel depth to 25 feet. The maintenance dredging associated with this increase was still limited to a few particularly shallow reaches where sporadic dredging was conducted, as needed (Corps 1999).

In 1912, the navigation channel depth was increased to 30 feet. At that time, the navigation channel width was established at 300 feet. Increasing the channel depth to 30 feet resulted in the need for increased maintenance dredging to ensure that authorized navigation depths were safe for shipping and to address shoaling associated with the new depth (Corps 1999).

In 1930, Congress increased the authorized depth to 35 feet. The navigation channel width also was increased to 500 feet and was realigned in certain reaches. The channel modifications were completed in 1935. From 1936 to 1957, Congress authorized additional channel alignment adjustments that added to the dredging requirements. During this period, dredging averaged 6.7 million cubic yards (mcy) per year.

By 1958, the channel alignment had stabilized, but maintenance dredging was augmented to increase the advanced maintenance dredging (AMD) depth from 2 to 5 feet in areas of active shoaling. This AMD approach enhances navigational safety by maintaining the authorized channel depth (which is necessary to ensure adequate under-keel clearance) during periods of channel shoaling that occur between maintenance dredging events. Advance maintenance dredging in the navigation channel is done at the same time as routine maintenance dredging.

Figure 1-1. Action Area



The current 40-foot navigation channel was authorized in 1962, and construction took place in stages from 1964 to 1976. The channel is 40-feet deep and 600-feet wide from RM 3.0 to 101.4; 40-feet deep and 400-feet wide from RM 101.4 to 105.5; and 35-feet deep from RM 105.5 to 106.5 (from the Burlington Northern and Santa Fe Railway Bridge to the Interstate 5 Bridge). The navigation channel generally follows the deepest part of the natural river channel. Most of the channel is naturally deeper than 40 feet; however, shoals tend to form in channel reaches where natural depth is less than 40 feet. Since 1976, maintenance dredging has averaged approximately 5.5 to 6.5 mcy per year (excluding emergency dredging related to the 1980 eruption of Mount St. Helens; Corps 1999).

The MCR Project was authorized separately from the lower Columbia River navigation channel. Initial authorization was in 1884; however, the originally authorized project depth of 40 feet was not completed until 1918. The South Jetty was completed in 1914 and the North Jetty completed in 1917. A spur jetty (Jetty A) was completed in 1939 for the purpose of channel stabilization. A 48-foot channel depth was authorized in 1954. The deepening of the northernmost 2,000 feet of the channel to 55 feet was authorized in 1983. Four to 5 mcy of sand are dredged at the MCR Project annually and placed at U.S. Environmental Protection Agency (EPA) approved disposal sites and one Clean Water Act site.

The South Jetty and North Jetty at the MCR were constructed to secure the federal navigation channel though the ocean entrance to the Columbia River. The South Jetty is about 6.6 miles long. The first 4.5 miles of the South Jetty were constructed from 1885 to 1895. It was extended to its present footprint length from 1913 to 1914; however, about 6,200 feet (head loss) have eroded. The North Jetty is about 2.5 miles long and was constructed from 1915 to 1917. About 1,900 feet of head loss has occurred. These existing project features were authorized by the River and Harbor Acts of July 5, 1884; March 3, 1905; and September 3, 1954. Portions of the South Jetty were repaired in 1982.

The jetties were constructed at the entrance to the Columbia River to confine tidal currents, to obtain scouring velocities in the bar and entrance channels, to help maintain the authorized channel dimensions, and to help protect vessels entering and exiting the river. The North and South Jetties at the MCR have experienced damage to both jetty heads and along the jetties at several locations.

The portion of the navigation channel from Vancouver, Washington to The Dalles, Oregon, was first authorized by Congress in 1937. The portion of the navigation channel from Vancouver to Bonneville Dam is authorized for maintenance to a depth of 27 feet. Currently, this portion of the navigation channel is maintained for barge traffic only. Based on draft requirements of the current users, the channel is maintained to a depth of 17 feet, with 2 feet of AMD (depth 19 feet).

The eight side-channel projects included in this BA were first authorized at various times, as shown below. More detailed descriptions for the side channel projects, as well as their recent dredging history, can be found in Section 2.2.3, *Project Description for Side-channel Projects*.

Baker Bay West Channel	1935
Chinook Channel	1938
Hammond Boat Basin	As part of the Columbia and Lower Willamette Project (C&LW)
Skipanon Channel	1930
Skamokawa Creek	1919
Wahkiakum Ferry/Westport Slough	1937
Old Mouth Cowlitz River	As part of the C&LW
Oregon Slough	1912

1.2 ENDANGERED SPECIES ACT CONSULTATION HISTORY

Section 7 of the Endangered Species Act (ESA) of 1973, as amended, requires that federal agencies ensure that their actions are, "…not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat" [16 USC Section 1536 (a)(2)]. The U.S. Fish and Wildlife Service and NOAA Fisheries (formerly National Marine Fisheries Service) share responsibility for the administration of the ESA. Pursuant to the ESA, federal agencies must consult with these agencies if their activities could affect listed species or their habitat. For the purposes of this consultation, 12 stocks of anadromous fish are listed under the ESA and are under the jurisdiction of NOAA Fisheries.

A BA is prepared to, "…evaluate the potential effects of the action on listed and proposed species and designated and proposed critical habitat" (50 CFR Section 402.12). In preparing a BA, the federal agency uses the best scientific and commercial data available to evaluate the potential effects of the action on listed species. Based on the effects that are identified through this process, the federal agency will determine whether formal consultation is necessary. When the federal agency completes its BA, it is submitted to NOAA Fisheries for review and formal consultation on whether the action will jeopardize the continued existence of the listed species or result in the destruction or adverse modification of their critical habitat. NOAA Fisheries then documents its findings and recommendations in a Biological Opinion (BiOp).

The Corps first prepared a BA for the maintenance activities for these projects, in April 1993 when the first stocks of salmon were listed for the Columbia River Basin. A BiOp based on the 1993 BA was issued by NOAA Fisheries in December 1993. A supplemental BA was prepared by the Corps and submitted to NOAA Fisheries in February 1999 (amended in July 1999) to reinitiate the consultation. The supplement incorporated the steelhead BA and BiOp that was prepared in 1998 when that species was listed. The supplement discussed the impacts to species listed since the previous consultation, as well as the changes in dredging and disposal practices that were developed during the *Dredged Material Management Study* for the lower Columbia River (see Corps 1998). A BiOp based on the 1998 supplemental BA was issued by NOAA Fisheries on September 15, 1999.

Essential fish habitat (EFH) has been defined by NOAA Fisheries for Pacific Coast salmonids within Amendment 14 to the *Pacific Coast Salmon Plan*, which was approved in September 2000 (NOAA Fisheries 2000). The important elements of salmon EFH are: (1) estuarine rearing; (2) early ocean rearing; and (3) juvenile and adult migration. Important features of estuarine and marine habitat are: (1) adequate water quality; (2) adequate temperature; (3) adequate prey species and forage food; and (4) adequate depth, cover, marine vegetation, and algae in estuarine and shoreline habitats. A separate EFH consultation is being conducted by the Corps and NOAA Fisheries for maintenance activities.

1.3 STATUS OF PREVIOUS CONSULTATIONS

In order to receive an incidental take authorization under Section 9 of the ESA, the Corps was given eight terms and conditions in the 1999 BiOp. The terms and conditions and the status of each are listed below.

1(a). The Corps shall modify the habitat on Rice Island by April 1, 2000, so that it is no longer suitable as a nesting site for Caspian terns or provide for the hazing of terns off the island in a manner that will preclude their nesting. The Corps shall ensure that any terns hazed off the island do not nest on any dredge spoil islands in the action area (other than East Sand Island). The Corps shall continue to prevent nesting of Caspian terns on disposal islands within the action area for the life of the project.

Response: An initial effort in 1999 by the Corps to seed wheat on Rice Island and bare sand portions of Miller Sands Spit and Pillar Rock Island to preclude Caspian tern (*Sterna caspia*) nesting was only marginally successful. Subsequently, the Corps, in concert with NOAA Fisheries, the Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, the Oregon State University-U.S. Geological Survey Caspian tern research group, and others including volunteers, modified the habitat on Rice Island through installment of silt fencing on the colony site. This reduced available nesting habitat from 4.6 acres used in 1998 to approximately 2.4 acres. Eagle decoys and limited hazing were implemented to preclude tern nesting elsewhere on Rice Island. Roby and others (1999) estimated that 8,096 pairs of Caspian terns nested on Rice Island in 1999. They estimated that approximately 1,400 pairs nested at East Sand Island where the Corps, in concert with the U.S. Marine Corps 6th Engineering Battalion, constructed approximately 7.4 acres of nesting habitat for terns.

The estimates of the number of breeding pairs that attempted to nest at the Rice Island and East Sand Island colonies in 2000 were 588 and 8,513 pairs, respectively (Collis et al. 2000). Habitat management efforts in 1999, combined with social facilitation (decoys, sound system) at East Sand Island, hazing activities, and possibly the effects of rocket netting terns at the Rice Island colony for banding and radio-tagging purposes, contributed significantly to the success of the relocation effort.

All Caspian terns in the Columbia River estuary have nested on East Sand Island since 2001. Hazing efforts have continued to be employed to preclude Caspian terns from Miller Sands Spit and/or Pillar Rock Island. Vegetation has overgrown the former Rice Island Caspian tern nesting site and the birds no longer attempt to nest there. Hazing efforts will continue into the future, as necessary, to preclude Caspian terns from nesting on Rice Island, Miller Sands Spit and Pillar Rock Island. As a result of these efforts, this term and condition has been met.

1(b). The Corps shall work with NMFS to identify methods to prevent cormorant usage of Corps-maintained pile dikes. The Corps shall then modify these pile dikes so that they are unable to be utilized by cormorants for resting and loafing or as feeding platforms. The Corps shall modify Corps maintained pile dikes located in the Columbia River Estuary around Rice Island, Miller Sands, and East Sand Island by April 1, 2000. The Corps shall monitor the success of the efforts in preventing cormorant usage in that area during the spring and summer of 2000. If the techniques are successful, the Corps shall begin modifications on all Corps maintained pile dikes throughout the action area in coordination with NMFS. If the techniques are unsuccessful, the Corps shall further coordinate with NMFS to develop other methodologies of prevention.

Response: In 2000, the Corps installed avian spike strips (bird excluders) on nine pile dikes at Columbia RMs 22.75, 23.07, 23.39, 23.71, 28.95, 29.15, 37.90, 38.25, and 38.26 to exclude cormorants from perching on the pilings and spreaders. Eight additional pile dikes were outfitted with these excluders in 2001 (RMs 4.01, 5.15, 6.37, 24.63, 26.86, 27.08, 51.10, and 51.42). Collis and others (2001) monitored cormorant use of pile dikes outfitted with avian excluders and determined that excluders were effective in reducing the number of foraging cormorants near pile dikes in the upper estuary (upstream of RM 22.75). In the lower estuary, the excluders worked where used, but the cormorants shifted to pile dikes without excluders. Collis and others (2001) suggested it was not desirable to place excluders on all pile dikes in the lower estuary given the presence of a small Brandt's cormorant colony on the pile dike at RM 4.47 and the presence of brown pelicans, an ESA listed species, that perch on pile dikes in the area.

Subsequent to installation of bird excluders on these pile dikes, it was observed that the excluders were subject to substantial damage from debris in the water column. Tidal inundation occurs generally twice a day for pilings and spreaders that comprise the bulk of a pile dike's structure. This inundation subjects them to debris and current velocity. These elements, working in conjunction, were observed to result in extreme physical damage to the excluders; over a period of 1 year, substantial loss occurred to the excluders. By the spring of 2003, virtually all bird excluders placed in 2000 (which received repairs in 2001) and those installed in 2001 were gone.

Bird excluders were not considered cost effective in dissuading cormorants from using pile dikes. Excluders cost $3.25 a lineal foot and approximately 27,600 lineal feet of pile dikes, including approximately 13,612 pilings, required placement of excluders. Additional costs are incurred for the labor and floating plant required for installing the excluders.

For 2003, the Corps installed bald eagle decoys and kites (strung from poles) at the pile dikes upstream of RM 22.75 and assessed their efficacy at excluding cormorants from the pile dikes. Bald eagle kites were damaged and lost to continuous exposure to strong winds; some may have been stolen although there is no definitive evidence that theft occurred. Consequently, bald eagle kites were not considered effective at excluding cormorants. Bald eagle decoys (painted silhouettes) also were determined to be ineffective based on common observations of cormorants perched within a few pilings of where they were placed.

The predation issue pertaining to double-crested cormorants in the Columbia River estuary presently transcends their foraging at pile dikes. The breeding population of double-crested cormorants at East Sand Island has increased from zero in 1977, to 91 pairs in 1989, 4,500 pairs in 1997, and by 2003 attained a level of 11,000 pairs. Comparable to Caspian terns, management measures to limit the breeding population of double-crested cormorants in the estuary are warranted in order to protect salmonid resources. Since the species is quite capable of foraging in open water with no nearby structures for loafing or perching, precluding their use of pile dikes will not successfully address the predation concern regarding juvenile salmonids in the Columbia River estuary.

The Corps initiated discussions with other federal agencies, and completed a briefing of Federal Caucus members (July 12, 2004) regarding future research and National Environmental Policy Act requirements that could lead to implementation of management measures to address the double-crested cormorant population in the Columbia River estuary. Implementation of management measures will not likely occur for 3 to 5 years provided the appropriate information can be gathered over the next few years.

1(c). The Corps shall work with NMFS to identify methods to dissuade cormorant usage of Corps maintained in-water structures (other than pile dikes and range markers). The Corps shall modify these structures located in the estuary by April 1, 2000 so that they are unable to be utilized by cormorants for resting, loafing or as feeding platforms. The Corps shall monitor the success of the efforts in dissuading cormorant usage during the spring and summer of 2000. If the techniques are successful, the Corps shall begin modifications on all Corps maintained in-water structures throughout the action area, with completion of the project by 2002. If the techniques are unsuccessful, the Corps shall coordinate with NMFS to determine a schedule for removal of these structures within the project area, with removal of all structures occurring prior to the expiration of this consultation in 2005. Installation of the proposed pile dike field at Jones Beach shall be held in abeyance until such time as the Corps demonstrates that techniques for dissuading cormorant usage are successful and that the techniques will be implemented on the proposed like dikes.

Response: The Corps does not maintain any in-water structures in the Columbia River estuary that this condition applies to.

1(d). The Corps shall remove all dredge range markers within the action area by April 1 of 2002.

Response: The Corps has completed removal of range markers in the action area. The range markers remaining in the action area represent structures transferred to the Bar Pilots Association, who utilize them for safe navigation of ocean-going vessels transiting the navigation channel.

2(a). The Corps shall place the discharge pipe deeper than 20 feet below the surface during flowlane disposal.

Response: This is an ongoing best management practice (BMP) for a pipeline dredge operation.

2(b). The Corps shall operate hydraulic dredges with the intake at or below the surface of the material being removed. The intake may be raised a maximum of three feet above the bed for brief periods of purging or flushing of the intake system. At no time shall the dredge be operated at a level higher than three feet above the bed. This includes water being taken in to flush the dredge during disposal.

Response: This is an ongoing BMP for pipeline and hopper dredge operations.

2(c). The Corps shall dredge side channels below John Day Dam during the November 1 to February 28 work window if a pipeline dredge is to be utilized. The Corps should pre-plan to dredge in those areas only during that time frame. Pipeline dredging operations above John Day Dam shall be conducted during the December 15 and March 15 work window.

Response: This is the standard method of operation.

2(d). The Corps shall work with NMFS to develop and conduct an analysis of entrainment by juvenile salmonids as part of dredging operations in side channel areas with waters less than 20 feet in depth. The analysis shall be completed and the results provided to NMFS by 2003.

Response: This analysis was not done because of the difficulties in conducting an entrainment study on pipeline dredges. In order to minimize the impacts of entrainment in the shallow water side-channel projects, the Corps has been using a clam shell dredge, which has less potential for entrainment than a hydraulic dredge. NOAA Fisheries agreed to this change in methodology and concurred that the analysis was not required.

1.4 RELATIONSHIP OF COLUMBIA RIVER CHANNEL OPERATIONS AND MAINTENANCE BIOP TO THE COLUMBIA RIVER CHANNEL IMPROVEMENT PROJECT BIOP

In December 1999, Congress authorized the improvement of the Columbia and Lower Willamette Rivers Federal Navigation Channel including deepening to 43 feet [Section 101(b)(13) of the Water Resource Development Act of 1999]. The plan, as authorized, would modify the existing federal navigation project for the Columbia River from RM 3.0 to 106.5 and the lower Willamette River from RM 0 to 11.6, and provide for construction of ecosystem restoration features. On May 20, 2002, NOAA Fisheries issued a BiOp for the Columbia River portion of the authorized project[1], known as the Columbia River Channel Improvement Project (CRCIP).

[1] The Willamette River portion of the authorized CRCIP was not covered under that consultation because the Willamette River will be reevaluated after resolution of sediment cleanup issues associated with its inclusion on the federal National Priorities List by USEPA under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The CRCIP BiOp covers the channel improvement and maintenance of the deepened channel. However, it does not include the MCR, side-channel projects, the shallow portion of Oregon Slough, or the dredged areas between Vancouver, Washington and Bonneville Dam. As sections of the CRCIP are completed, the CRCIP BiOp will take effect for that section, and the 40-foot channel operations and maintenance BiOp will become obsolete. Eventually, the CRCIP BiOp will be in effect for the entire main navigation channel from RM 3 to 106.5, and the BiOp resulting from this consultation will apply only to the MCR, side-channel projects, and from RM 106.5 upstream to Bonneville Dam. If reinitiation of ESA consultation is needed after completion of the CRCIP, the consultations for the two projects will be combined into one consultation.

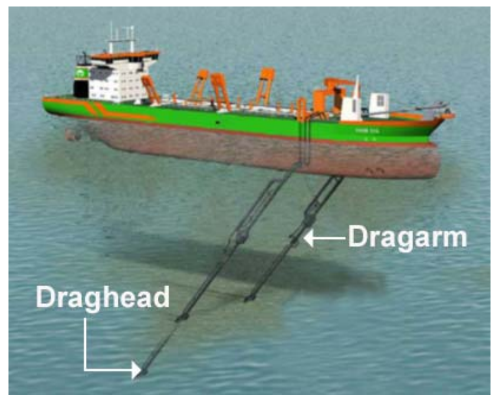
The consultation for the CRCIP focused on effects that could result from changes to physical parameters from deepening the channel. Therefore, a number of the issues in the CRCIP consultation are not an issue in this consultation where physical parameters will remain essentially unchanged. For other issues, such as turbidity and entrainment, near-shore disposal, contaminants, the impacts of the deepening are similar to those of maintenance dredging and were reviewed in detail. Where the analysis is relevant to this consultation, this BA notes that the CRCIP BA addressed it.

2. DESCRIPTION OF THE MAINTENANCE ACTIVITIES

2.1 DESCRIPTION OF DREDGES AND DISPOSAL OPERATIONS

2.1.1 Suction Dredging

2.1.1.1 Hopper Dredging



Suction Hopper Dredge

Hopper dredges use a draghead at the end of dragarms located on both sides of the dredge. The dragheads are lowered to the channel bottom, and suction from the pump is used to transport material through the dragarm and into the hold of the dredge. Hopper dredges collect dredged material in the hold or "hopper" of the vessel until it is near capacity. When the hopper is filled, the dragarms are raised and the vessel moves to the disposal site. Material from hopper dredges is normally disposed of using flowlane disposal or at ocean or Clean Water Act disposal sites. Some hopper dredges are of the "split hull" type, and some are of the "hopper door" type. In split hull hopper dredges, the hull is split open for discharging and the rate of discharge is varied by how far the hull is opened. In dredges with hopper doors, as the dredge is moving the hopper doors are opened and the material is discharged at varying rates, depending on how far the hopper doors are opened. Dredges normally draw from 19 to 29 feet when they are fully loaded, with an additional 2 to 3 feet of depth on dredges that have hopper doors open (like the *Essayons*). As the dredges discharge, they rise up in the water column to an unloaded draft of about 13 to 22 feet.

Hopper dredges conducting maintenance dredging currently handle about 7.5 to 8.0 mcy per year of material from the navigation channel and MCR. Hopper dredges provide flexibility for dredging operations because of their maneuverability. They are most often used on small-volume sand wave shoals in the river and on large shoals in the estuary and at the mouths of rivers.

Dredging in the lower Columbia River may be done for 3 to 10 days at the end of March or beginning of April while the government-owned hopper dredges *Yaquina* and/or *Essayons* are available[2]. This early dredging is designed to remove any dangerous sand waves formed since the last dredging cycle and to remove shoals that might obstruct navigation if left until the regular dredging season begins in May or June. Exact locations for dredging of sand waves are determined by spring and summer hydrographic surveys. Most of the hopper dredging in the river occurs from mid to late May through September or October using both contract and government dredges. The Corps' hopper dredge *Essayons* performs the

[2] The dredges used in the Portland District are shared with other Corps' Districts on the Pacific Coast. For this reason, availability has to be negotiated based on needs of other Corps' Districts and dredging windows imposed by other states.

majority of the hopper dredging in the Columbia River. Most of the channel is dredged to a maximum -45 feet Columbia River Datum (CRD)[3], or Mean Lower Low Water (MLLW), depending on the river reach.

Private dredgers may remove sand from shoals in the navigation channel under the Corps coordination for maintenance dredging. The private dredgers are subject to the restrictions and conditions of channel maintenance activities and must enter into a special agreement with the Portland District. Currently one local sand and gravel company has a license agreement with the Portland District for dredging sand from the river to use for commercial purposes. Columbia River Sand and Gravel can dredge in the 40-foot channel at specific locations from RM 83 to 106. All material dredged by Columbia River Sand and Gravel is off-loaded to shore by mechanical means. Other local companies are interested in removing sand from the navigation channel, but licensing agreements have not been signed to date.

Sand and gravel companies also may obtain a permit from the Corps' Regulatory Office to remove sand from the river. Permit dredging is covered under its own separate BiOp.

2.1.1.2 Pipeline Dredging

Pipeline dredges are used for large cutline shoals and areas with multiple sand wave shoals. A pipeline dredge uses a "cutter head" on the end of an arm that is buried about 3 to 6 feet deep in the river bottom material and swings in a 250- to 300-foot arc in front of the dredge. Dredged material is sucked up through the cutter head and the pipes, then pumped to upland disposal sites or disposed of in the flowlane, as described below.

Upland disposal sites are located throughout the action area. Material dredged from the channel is pumped to these sites by pipeline dredge. Dikes are constructed at these sites to contain the material and water. The return water is held in settling ponds controlled by weirs.

Pipeline Dredging

Maintenance dredging done by pipeline is currently performed using the Port of Portland's 30-inch (size of dredge pipe) dredge, the *Oregon*. In a typical maintenance season, the *Oregon* will begin river dredging at shoals in the estuary and then progress upstream. Location of the first dredging area, as well as subsequent areas, is determined by assessing hydrographic surveys a few weeks prior to the start of dredging. The majority of dredged material is placed in upland disposal sites, but some is placed in the flowlane. State water quality standards are met for return water from upland sites. The maintenance activities would use flowlane sites from 45 to 65 feet in depth with occasional exceptions when disposal would occur at 35 to 65 feet. Placement of material in flowlane sites during pipeline operations is done using a down pipe with a diffuser. The outfall pipe and/or diffuser plate extends 20 feet below the water surface. Material is spread to minimize mounding.

[3] The CRD also is known as the approximate low water plane. It is the reference datum for Corps' hydrographic surveys from Miller Sands Channel upstream. Downstream of this location, the elevation reference datum used is MLLW.

Pipeline dredging in the navigation channel typically occurs from mid-May through September each year, removing material from the navigation channel from RM 21 to 106.5. It should be noted that only the shoals that have formed in a reach are dredged, not the entire reach. Typical shoals would include an area 250- to 300-feet wide by 2,000- to 4,000-feet long.

Although many reaches of the navigation channel are annually dredged by pipeline, some of them may require dredging on a less frequent basis. Hydrographic surveys of the channel are updated throughout the dredging season and indicate which bars need to be dredged. A dredging schedule for pipeline dredging is usually developed 2 weeks in advance of mobilization to each work area, and is based on results of current hydrographic surveys.

2.1.2 Mechanical Dredging

Mechanical dredges remove material by scooping it up with a bucket. Mechanical dredges include clamshell, dragline, and backhoe dredges. Mechanical dredges are well suited for removing fine-grained material, cemented sands, gravels, or well-fractured rock outcrops. Mechanical dredges would only be used for maintenance dredging in discrete areas where other forms of dredging may not be effective. For example, mechanical dredges are often used under bridges and in other tight areas, like berthing areas, to remove small amounts of material.

2.1.2.1 Clamshell Dredging

Clamshell dredging is performed using a bucket operated from a crane or derrick that is mounted on a barge or operated from shore. Sediment from the bucket is usually placed on a barge for offloading and disposal to an upland or in-water site.

Because clamshell dredges are not self-propelled, they are not typically used in high traffic areas; rather, they are used in tighter spaces such as around docks and piers. Also, because they are usually situated on a barge, clamshell dredges can be used in restricted areas and shallow areas where draft restrictions may limit other choices. Clamshell dredges equipped with special buckets are often regarded as being particularly useful in silts or contaminated materials where water entrapment may be a problem. Clamshell dredges are used for the side-channel projects related to the Columbia River navigation channel.

Clamshell Dredge

2.1.2.2 Backhoe Dredging

Backhoe dredging is performed using a bucket on the end of a backhoe arm. Although the backhoe is typically mounted on a barge, it also could be a land-based piece of equipment. Backhoes can be used in both shallow- and deep-draft channels. Sediments removed by backhoe are usually placed on a barge for offloading and disposal to an upland or in-water site.

Backhoe dredges are often used to remove clays, rock, hard-packed materials, and fine-grained sediments, but also may be used in certain locations to remove sands. Like clamshell dredges, backhoes are often used in restricted areas near docks and in shallow-draft projects.

2.1.3 Advance Maintenance Dredging

Dredging deeper and wider than the authorized channel boundaries is a practice referred to as advanced maintenance dredging (AMD). The objective of AMD is to ensure that the project depth is available until the next year's dredging season. To achieve this objective on the Columbia River, the channel is dredged up to 5 feet below the 40-foot authorized depth and up to 100 feet outside the 600-foot channel where shoals encroach on the navigation channel. Over width dredging can occur on one or both sides of the channel depending upon shoaling patterns. The amount of AMD varies with the type of shoal and dredge. A review of AMD practices during the Maintenance Improvement Review (Corps 1988) found 5 feet of AMD to be sufficient on the Columbia River to minimize sand wave shoaling problems; however, overdepth dredging alone is not well suited for maintaining cutline shoals that have material moving in from the side slopes of the channel. Consequently, based on the recommendations from the Maintenance Improvement Review, the AMD for cutline shoals is done up to 100 feet outside the channel width on the Columbia to intercept material moving toward the navigation channel. Advanced maintenance dredging is not done to full depth or width at each shoal, and the amount done is based on the shoaling history of a particular area. For all other channels, the AMD is 2 feet. These areas include all of the side-channel projects being addressed in this BA, as well as the main Columbia River shallow-draft navigation channel above Vancouver, Washington.

2.1.4 Best Management Practices for Dredging

The impact minimization practices and BMPs used by the Corps for dredging operations are shown in Table 2-1.

2.1.5 Shoreline Disposal

Shoreline disposal is done primarily with pipeline dredges. Material dredged from the navigation channel is pumped onto shallow water and shoreline areas along the lower river. The combination of river flows, waves, and tidal effects subsequently erodes this material from the shoreline. Replacement of this material on a regular basis is known as shoreline disposal. In the last 5 years, the Corps has placed an annual average of 100,000 to 500,000 cubic yards (cy) of material on shoreline disposal sites.

The shoreline disposal process involves pumping dredged material through a floating discharge pipe from the pipeline dredge to an existing shoreline. The dredge first pumps a landing on the shoreline to establish a point from which further material placement occurs. Dredged material is pumped in a sand and water slurry (about 20 percent sand) and as it exits the shore pipe, the sand settles out on the shoreline while the water returns to the river. Settling rates of Columbia River sands are very quick and turbidity from the operation is minimal. After sufficient sand has settled out and begins to increase in height, it is moved by bulldozers to match the elevation of the existing shoreline at approximately the high water line. A typical shoreline disposal operation lasts from 5 to 15 days and the width of the shoreline created is approximately 100 to 150 feet. The process continues by adding to the shore pipe and proceeding longitudinally along the shoreline. The length of shoreline replaced is dependent on the quantity of material to be dredged from the shoal in the channel. After disposal, the slope of the shoreline is groomed to a steepness of 10 to 15 percent to prevent the possibility of creating areas where fish could be stranded on the new shoreline.

Table 2-1. Impact Minimization Practices and Best Management Practices for Dredging

Measure	Justification	Duration	Management Decision
Hopper Dredging			
Maintain dragheads in the substrate or no more than 3 feet above the bottom with the dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmon during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
Dredging in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28.	Areas less than 20 feet deep are considered salmon migratory habitat. Dredging or disposal in these areas could delay migration or reduce or eliminate food sources.	Continuous during dredging and disposal operations.	Maintain until new information becomes available that would warrant change.
Pipeline Dredging			
Maintain cutter head in the substrate or no more than 3 feet above the bottom with the dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmon during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
Dredging in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28.	Areas less than 20 feet deep are considered salmon migratory habitat, Dredging or disposal in these areas could delay migration or reduce or eliminate food sources.	Continuous during dredging and disposal operations.	Maintain until new information becomes available that would warrant change.
General Provisions for All Dredging			
The contractor shall not release any trash, garbage, oil, grease, chemicals, or other contaminants into the waterway.	Protection of water resources.	Life of contract or action.	If material is released, it shall be immediately removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground shall be excavated and removed and the area restored as directed. Any in-water release shall be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.
The contractor, where possible, will use or propose for use materials that may be considered environmentally friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal shall be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Disposal of hazardous waste.	Life of contract or action.	If material is released, it shall be immediately removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground shall be excavated and removed and the area restored as directed. Any in-water release shall be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.

The *Final Environmental Impact Statement for Columbia and Lower Willamette River Maintenance and Completion of the 40-foot Channel* (Corps 1975) identified more than 80 shoreline sites. For many of those, disposal replaced eroded sand from previous disposal operations. The number of shoreline sites was reduced from the original 80 sites to 14 sites as considered in a subsequent Environmental Assessment (Corps 1993). The reduction came as a result of concerns over protection of endangered juvenile salmon during ESA Section 7 consultation with NOAA Fisheries. Ten additional, previously used sites were studied in 1995 to determine their value as juvenile salmon rearing habitat and to see if they could be added to the list of approved sites. The *Dredged Material Management Plan* (Corps 1998) evaluated the 14 approved sites and the 10 additional sites studied in 1995 for inclusion in two of the study alternatives. It considered recent use of the sites and the biological studies to select the sites shown in the alternatives. Currently, a total of three sites are proposed for use as shoreline disposal sites; one site was proposed for long-term use (Miller Sands, designated O-23.5), and two other sites are being used either for shoreline disposal or other beneficial uses (Sand Island at RM 86.2 and a site near the mouth of Skamokawa Creek at RM 33.4).

2.1.6 Upland Disposal

Upland disposal is used by clamshell and pipeline dredges. Clamshell-dredged material deposited onto a barge can be off-loaded at a transfer point to be taken to an upland site. Pipeline dredges pump dredged material in a sand and water slurry directly into a diked upland site near the dredging area. Discharge of water from upland sites back into the river is controlled by the use of weirs. Water discharged from the site must meet state water quality discharge guidelines.

Not every site is used on an annual basis. The average annual total quantity of dredged material placed upland is approximately 2 mcy. This material is completely removed from the river system and does not reenter it. The following is a list of upland disposal sites that are likely to be used for maintenance of the navigation channel.

W-21.0 - Rice Island
O-27.2 - Pillar Rock Island
W-33.4 - Skamokawa
O-34.0 - Welch Island
O-38.3 - Tenasillahe Island
W-42.5 - upstream of Coffeepot Island
O-42.9 - Fort James
W-46.3 - Brown Island
O-46.8 - Jones Beach
O-57.0 - Crims Island
O-63.5 - Lord Island
W-63.5 - Reynolds Aluminum
O-64.8 - Dibblee Point
W-67.5 - International Paper Site
W-68.7 - Howard Island
W-70.1 - Cottonwood Island
W-71.9 - Port of Kalama property
O-75.8 - Sandy Island
O-82.6 - Reichold
O-86.2 - Sand Island, St. Helens
W-86.5 - Austin Point
W-97.1 - Fazio Sand & Gravel
O-105.0 - West Hayden Island

2.1.7 In-water Disposal

Most in-water disposal occurs in the flowlane (within or directly adjacent to the navigation channel) by hopper, pipeline, and clamshell dredges. The average annual quantity of material disposed in the flowlane is 4.3 mcy. This type of dredged material disposal is done throughout the navigation channel where depths range from 35 to 65 feet, but typically below 45 feet. These are not designated sites, but vary depending on the condition of the channel each year. As deeper flowlane areas are filled with dredged material, new deep areas are formed elsewhere as a result of natural river processes. The maintenance activites would use flowlane sites from 45 to 65 feet in depth with occasional exceptions when disposal would occur at 35 to 65 feet.

Hopper dredges collect dredged material in the hopper of the vessel until it is near capacity. When filled, the vessel moves to a flowlane site. As the dredge is running, the hopper doors open and the material is discharged at varying rates depending upon how far the hopper doors are opened. Material is spread out along the channel to avoid mounding. Flowlane discharge from pipeline dredges differs from hoppers in that material is continuously discharged during dredging operations. Placement of material at flowlane sites is done using a down-pipe with a diffuser plate at the end. This down-pipe extends 20 feet below the water surface to avoid impacts to migrating juvenile salmonids. During placement of dredged material, the down-pipe will continually be moved so that mounding on the bottom is minimized.

Harrington Sump is a designated in-water dredged material disposal site located along Rice Island from RM 20 to 22. This site is used by hopper dredges and sometimes by pipeline dredges for disposal of dredged material when performing maintenance dredging at Tongue Point Crossing and Miller Sands Channel. Approximately every 3 to 4 years the sump reaches capacity and needs to be dredged to provide new capacity. The sump is dredged to 45 feet below MLLW with a pipeline dredge and the material is pumped to Rice Island. On average, a total of 0.75 to 1 mcy of sand is removed from Harrington Sump each time it is dredged.

2.1.8 Ocean Disposal

The EPA is working to designate the Ocean Dredged Material Disposal Sites necessary for the continued maintenance of the MCR channel, and there are plans to use these to accomplish the work. However, if adequate (sufficient capacity) EPA-designated sites are not available (i.e., designation is not completed), sites selected under Section 103 of the Marine Protection, Research, and Sanctuaries Act and/or Section 404 of the Clean Water Act will be used.

The proposed Deep Water Site is a non-dispersive site (material placed at the site remains in the site) that consists of an inner “placement area” and a surrounding buffer. The overall site (placement area and buffer) has a rectangular dimension of 17,000 feet by 23,000 feet and occupies approximately 8,975 acres or 10.5 square nautical miles (sq. nmi.). The placement area (the inner box) has a rectangular dimension of 11,000 feet by 17,000 feet, occupying an area of approximately 4,293 acres or 5.0 sq. nmi., which is surrounded by a 3,000-foot buffer zone. Direct disposal of dredged material would be allowed only within the placement area using “drop zones” as specified in the *Site Management and Monitoring Plan* (being finalized by the Corps and EPA).

Material placed at the Deep Water Site is expected to remain in the site, eventually creating a fairly uniform mound approximately 40 feet in height. The coordinates, dimensions and depth of water of the proposed sites can be found in Table 2-2. No direct disposal of dredged material would be allowed anywhere in the buffer zone; however, dredged material sloughing off the developing mound may extend into the buffer zone.

Table 2-2. Deep Water Disposal Site Data

Deep Water Disposal Site (Including Buffer)	
Corner coordinates	Dimensions
46°11′03.03″ N, 124°10′01.30″ W 46°13′09.78″ N, 124°12′39.67″ W 46°10′40.88″ N, 124°16′46.48″ W 46°08′34.22″ N, 124°14′08.07″ W	17,000 feet wide by 23,000 feet long. Depth 180 feet to 310 feet. Buffer 3,000 feet wide.

Deep Water Placement Area	
Corner coordinates	Dimensions
46°11′06.00″ N, 124°11′05.99″ W 46°12′28.01″ N, 124°12′48.48″ W 46°10′37.96″ N, 124°15′50.91″ W 46°09′15.99″N, 124°14′08.40″ W	11,000 feet wide by 17,000 feet long. Depth 190 feet to 290 feet. [Surrounded by 3,000 ft-wide buffer].

The Shallow Water Site is a dispersive site (material placed at the site leaves the site) and consists of a placement area on the sea bottom and a smaller, specified "drop zone" for dredged material disposal. Because the proposed site is dispersive, no buffer zone is specified for the Shallow Water Site. The proposed site integrates the existing designated Site E and expands the width and length of the site as described in Table 2-3. The Shallow Water Site drop zone is approximately 531 acres or 0.626 sq. nmi. The overall site and placement area occupies approximately 1.198 acres or 1.4 sq. nmi. Site monitoring since 1997 showed that the released material temporarily deposited on the sea bottom as a truncated mound. The majority is subsequently eroded away to the north and northwest following the summer dredging season by the stronger winter waves and currents. The coordinates, dimensions, and depth of water of the Shallow Water Site are found in Table 2-3.

Table 2-3. Shallow Water Site Data

SHALLOW WATER PLACEMENT AREA AND DISPOSAL SITE

Corner coordinates	Dimensions
46°15′31.64″ N, 124°05′09.72″ W 46°14′17.66″ N, 124°07′14.54″ W 46°15′02.87″ N, 124°08′11.47″ W 46°15′52.77″ N, 124°05′42.92″ W	3,100 to 5,600 feet width by 11,500 feet long. Azimuth (long axis): 229° T. Depth: 45 feet to 75 feet. No Buffer.

SHALLOW WATER DROP ZONE

Corner coordinates	Dimensions
46°15′35.36″ N, 124°05′15.55″ W 46°14′31.07″ N, 124°07′03.25″ W 46°14′58.83″ N, 124°07′36.89″ W 46°15′42.38″ N, 124°05′26.55″ W	1,054 feet to 3,600 feet width by 10,000 feet long. Depth 45 feet to 75 feet.

The North Jetty Site is a Section 404 Clean Water Act Site that is near the MCR North Jetty and closely matches an historical placement site. The Corps began using this site in 1999 to protect the jetty from potential undermining. Approximately 100,000 to 500,000 cy of sand will be placed in this site each year. Site coordinates are as follows:

Corner Coordinates:	Dimensions:
46°15'45.67"N, 124°05'11.99"W	1,000-feet wide by 5,000-feet long
46°16'17.18"N, 124°04'17.99"W	Depth 40 feet by 70 feet
46°16'10.31"N, 124°04'08.72"W	
46°15'38.18"N, 124°05'02.73"W	

Table 2-4 summarizes the proposed dredging reaches, disposal locations, and types of disposal from the mouth of the Columbia River (RM -3) to Bonneville Dam (RM 145).

2.1.9 Best Management Practices for Disposal

Best management practices used by the Corps for disposal of dredge material are listed in Table 2-5.

Table 2-4. Proposed Dredging Locations, Disposal Locations, and Types of Disposal

River Reach	Dredging Locations	Disposal Locations, Type (U=upland, F=flowlane, S=shoreline, I=in-water, O=Ocean
RM 106.5 to 145 (Bonneville Dam)	Washougal Ranges, (RM 121.5-125.3) Lady Island Ranges (RM 117.8-121.5) Government Island Reach (RM 114-117.8) Airport Bar (RM 110.2-114.0)	Selected locations along the entire Reach - F
RM 98 to 106.5	Vancouver Turning Basin (RM 105.5) Lower Vancouver Bar (RM 101.3-104.6) Morgan Bar (RM 97.8-101.3)	West Hayden Island (RM 105.0) - U Selected locations along the entire Reach - F
RM 84 to 98	Willow Bar (RM 94.9-97.8) Henrici Bar (RM 90.4-94.9) Warrior Rock Bar (RM 87.3-90.4) St. Helens Bar (RM 83.8-87.3)	Fazio Sand & Gravel (RM 97.1) - U Austin Point (RM 86.5) - U Sand Island (RM 86.2) - S Selected locations along the entire Reach - F
RM 70 to 84	Upper Martin Island Bar (RM 80.3-83.8) Lower Martin Island Bar (RM 76.5-80.3) Kalama Ranges (RM 72.8-76.5) Upper Dobelbower Bar (RM 69.9-72.8) Kalama Turning Basin (RM 73.5)	Reichold (RM 82.6) - U Sandy Island (RM 75.8) - U Port of Kalama (RM 71.9) - U Cottonwood Island (RM 70.1) - U Selected locations along the entire Reach - F
RM 56 to 70	Lower Dobelbower Bar (RM 67.1-69.9) Slaughters Bar (RM 63.2-67.1) Walker Island Reach (RM 59.4-63.2) Stella-Fisher Bar (RM 55.6-59.4)	Howard Island (RM 68.7) - U International Paper (RM 67.5) - U Dibblee Point (RM 64.8) - U Lord Island (RM 63.5) - U Reynolds Aluminum (RM 63.5) - U Crims Island (RM 57.0) - U Selected locations along the entire Reach - F
RM 40 to 56	Gull Island Bar (RM 51.9-55.6) Eureka Bar (RM 48.2-51.9) Westport Bar (RM 44.5-48.2) Wauna and Driscoll Ranges (RM 40.8-44.5)	Brown Island (RM 46.3) - U Ft. James (RM 42.9) - U above Coffeepot Is. (RM 42.5) - U Selected locations along the entire Reach - F
RM 29 to 40	Puget Island Bar (RM 36.6-40.8) Skamokawa Bar (RM 32.6-36.6) Brookfield-Welch Island Bar (RM 28.8-32.6)	Tenasillahe Island (RM 38.3) - U Welch Island (RM 34.0) - U Skamokawa (RM 33.4) - U/S Selected locations along the e ntire Reach - F
RM 3 to 29	Pillar Rock Ranges (RM 25.2-28.8) Miller Sands Channel (RM 21.4-25.2) Tongue Point Crossing (RM 17.5-21.4) Upper Sands (RM 13.6-17.5) Flavel Bar (RM 10.0-13.6) Upper Desdemona Shoal (RM 4.4-10.0) Lower Desdemona Shoal (RM 3.0-4.4)	Pillar Rock Island (RM 27.2) - U Miller Sands (RM 23.5) - S Rice Island (RM 21.0) - U Harrington Sump (RM 21.0) - I Selected locations along the entire Reach - F
MCR RM -3 to +3	MCR channel (RM -2 to +2.5)	North Jetty site - I Deep Water site - O Shallow Water site - O

Table 2-5. Best Management Practices Used for Disposal

Measure	Justification	Duration	Management Decision
Flow Lane Disposal			
Dispose of material in a manner that prevents mounding of the disposal material.	Spreading the material out will reduce the depth of the material on the bottom, which will reduce the impacts to fish and invertebrate populations.	Life of contract or action.	Maintain until new information becomes available that would warrant change.
Maintain discharge pipe of pipeline dredge at or below 20 feet of water depth during disposal.	This measure reduces the impact of disposal and increased suspended sediment and turbidity to migrating juvenile salmonids, as they are believed to migrate principally in the upper 20 feet of the water column.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Upland Disposal			
Berm upland disposal sites to maximize the settling of fines in the runoff water.	This action reduces the potential for increasing suspended sediments and turbidity in the runoff water	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Maintain 300-foot habitat buffer.	Maintains important habitat functions.	Life of contract or action.	Maintain until new information becomes available that would warrant a change.
Shoreline Disposal			
Grade disposal site to a slope of 10 to 15 percent, with no swales, to reduce the possibility of stranding of juvenile salmonids.	Ungraded slopes can provide conditions on the shoreline that will create small pools or flat slopes that strand juvenile salmonids when washed up by wave action.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Ocean Disposal			
Dispose in accordance with the site management and monitoring plan.	This action minimizes conflicts with users and impacts to ocean resources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
General Provisions For All Disposal			
Dispose of hazardous waste.	The contractor, where possible, will use or propose for use materials that may be considered environmentally friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal of this material will be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water discharge will be immediately reported the nearest U.S. Coast Guard Unit for appropriate response.

2.2 ACTIVITIES PROPOSED WITHIN RESPECTIVE REACHES

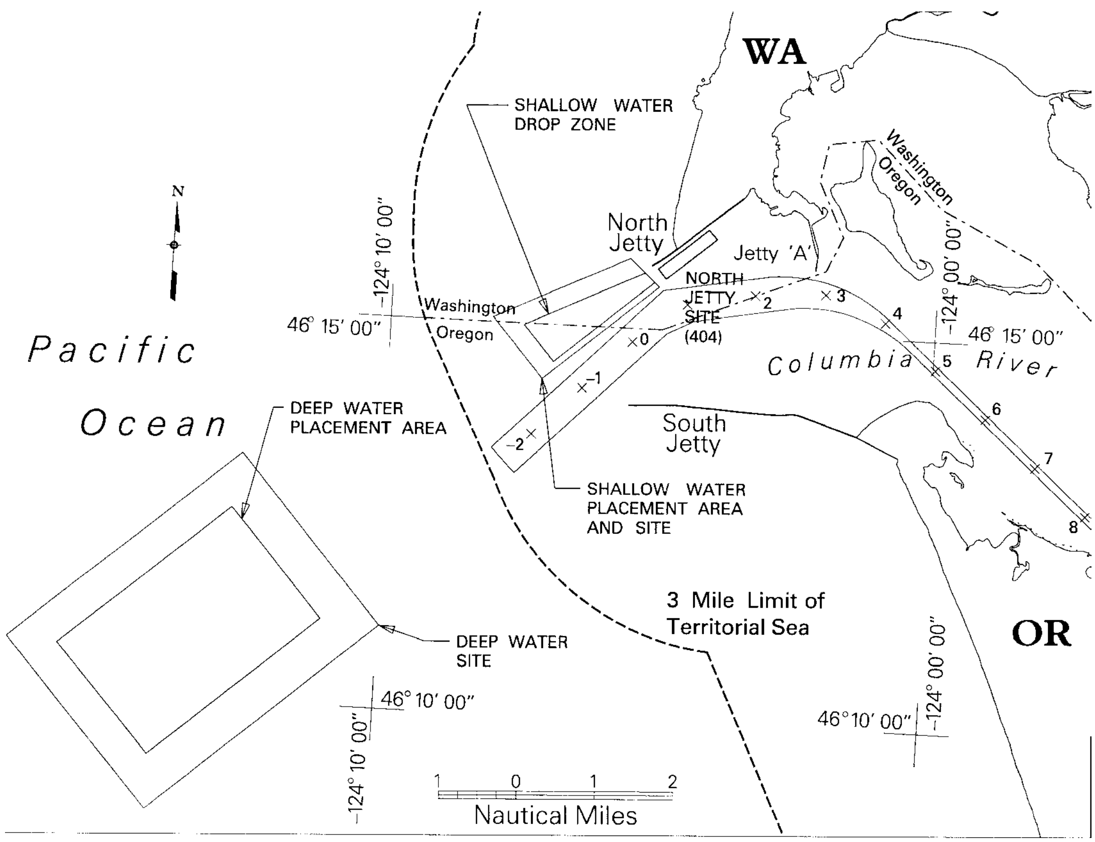
2.2.1 Mouth of the Columbia River (RM -3 to +3)

2.2.1.1 Project Description

The MCR channel is located where the Columbia River empties into the Pacific Ocean between the states of Oregon and Washington. The naturally occurring bar at the mouth of the river is one of the most treacherous in the world. The MCR Project was authorized to provide an entrance channel, which allows access to the deep-draft (40 feet) Columbia River navigation channel to Portland, Oregon, other Washington and Oregon ports, and the Columbia-Snake River inland waterway. The MCR channel decreases tide-caused delays for commercial ships crossing the sand bar and shoals found at the mouth of the river; provides improved safety by reducing the possibility of commercial ship grounding; and allows for compatible use by commercial and non-commercial vessels. There is no local sponsor for the Project.

The Project, as authorized, involves the dredging and redistribution of sedimentary material from the MCR channel (Figure 2-1). The authorized MCR channel is 2,640-feet wide and extends from deep water in the ocean, at approximately RM -3 upstream to RM +3. The MCR channel connects with the existing 40-foot deep Columbia River channel at RM 3. The northern side of the channel is 2,000-feet wide and is maintained to a depth of -55 feet MLLW. The southern 640 feet is maintained to -48 feet MLLW.

Figure 2-1. Mouth of the Columbia River Maintenance Dredging



Advanced maintenance dredging of up to 5 additional feet is authorized and commonly practiced to ensure that the 55-and 48-foot depth is available between dredge cycles.

Some areas of shoaling will become apparent during the winter months, but for most of the channel, the areas of obstructive shoaling are generally not known until the water (flow) levels begin to recede in the late spring. That is when the water velocities decrease and the energy to move the heavy sands through the system dissipates. As flows decrease, obstructive shoals form and grow in size. Prior to and during each dredging season, hydrographic surveys are used to determine exact dredging locations. These hydrographic surveys reveal how much material has accumulated in the channel and what disposal capacity is available in the dredged material disposal sites. After this information is developed, the Corps, in consultation with EPA, prepares an *Annual Use Plan* that establishes the year's operation and the day-to-day decision framework for the dredging season.

Most of the shoaling occurs from RM -2.0 to +2.5 where an average of 4.5 mcy of sediment is dredged each year. The volume dredged is dependent upon the flows in the Columbia River. During a high-flow year, less shoaling occurs. During a drought year, more shoaling occurs. The amount dredged after the 1996 flood was only 1.9 mcy.

Material in the MCR system is dredged using a medium-sized hopper dredge. This is due to sea conditions, tidal conditions, and weather conditions experienced at the MCR. Because of the weather and sea conditions and the shoaling process, timing of dredging in the MCR Project is inflexible. Dredging typically begins in June when either the government-owned hopper dredge *Essayons* or a contract hopper dredge begins dredging to remove sand shoals formed during the winter. The hopper dredging continues until October or November.

2.2.1.2 Dredging Frequency and Volumes

Dredging of the MCR occurs annually. Dredging has been done primarily with the Corps' hopper dredge *Essayons* and an additional contracted hopper dredge. Authorized depth for this portion of the Project is 55 to 48 feet with an AMD depth of 60 to 53 feet. Shown in Table 2-6 are the total amounts dredged by the *Essayons* and various contract dredges for the MCR Project for Fiscal Years 1998 to 2003.

2.2.2 Columbia River, MCR to Vancouver, Washington (RM 3 to 106.5)

2.2.2.1 Project Description

The Corps annually dredges material from shoaling areas in the Columbia River to maintain the authorized navigation channel. Dredging occurs at various locations from RM 3.0 to 106.5 near Vancouver, Washington. At each location, a dredge may spend anywhere from 3 days to 3 weeks removing sand from the navigation channel, depending on the size of the shoal to be dredged. At any time, there may be up to 2 dredges (a pipeline dredge and a hopper dredge) working at the same time, but in different locations. The authorized channel depth for this section of the Columbia River is 40 feet.

Because of the nature of the riverine shoaling process, timing of dredging in the main channel is relatively inflexible. Material eroding from the main channel side slopes is carried into the channel during the high flows of winter and spring. In many areas of the river, high winter flows cause the formation of sand waves on the bottom of the channel. Sand waves in the Columbia are typically 4- to 8-feet high and 300- to 400-feet long.

Table 2-6. Total Amounts Dredged for the MCR Project, 1999-2003

5-year Averages for MCR						
Dredge	**Year**	**Pump Time (min)**	**Dump Time (min)**	**Transit Time (min)**	**Non-effective Time (min)**	**Trips/Day**
Essayons	1999	638	113	240	449	8
	2000	666	119	281	374	9
	2001	671	100	259	410	9
	2002	612	112	393	323	7
	2003	667	103	285	385	8
	Average	*651*	*109*	*292*	*388*	*8*
Sugar Island*	2002	713	107	445	174	14
	2003	687	72	429	252	14
	Average	*700*	*90*	*437*	*213*	*14*
5-year Percent Averages for MCR						
Dredge	**Year**	**Pump Time (min)**	**Dispersal Time (min)**	**Transit Time (min)**	**Non-effective Time (min)**	**Trips/Day**
Essayons	1999	44%	8%	17%	31%	8
	2000	46%	8%	20%	26%	9
	2001	47%	7%	18%	28%	9
	2002	42%	8%	27%	22%	7
	2003	46%	7%	20%	27%	8
	Average	*45%*	*8%*	*20%*	*27%*	*8*
Sugar Island*	2002	50%	7%	31%	12%	14
	2003	48%	5%	30%	17%	14
	Average	*49%*	*6%*	*30%*	*15%*	*14*
Year:			1999	2000	2001	2002
Total days worked in MCR:			44	61	47	90
Total days worked by both dredges overlapping:			0	0	0	34
Percent of time both dredges in MCR:			0	0	0	38%

*For the years 1999-2001, the contract hopper dredges *Padre Island* and *Dodge Island* worked at the MCR. Both dredges are the same class of hopper dredge as the *Sugar Island* and have similar operational characteristics, as shown in this table.

As with the MCR Project, some areas of shoaling will become apparent during the winter months, but for most of the channel, the areas of obstructive shoaling are generally not known until the water (flow) levels begin to recede in the late spring. As the water velocities decrease, there is less energy to move the heavy sands through the system. Consequently, obstructive shoals form and grow in size. The Corps determines the location of shoals by performing hydrographic surveys on a monthly basis beginning in March or April and running through October. In addition, the Columbia River Pilots will call the Corps to report any problem area(s) they might have encountered while transiting the river.

The Corps also is authorized to maintain some of the side-channel projects and turning basins in the river. Depths and frequency of dredging at these locations vary and are project dependent. The following side-channel projects below Bonneville Dam are maintained by the Corps and are considered in this BA.

- Baker Bay West Channel (40,000 to 50,000 cy every 3 to 4 years) at RM 2.5.
- Chinook Channel (150,000 to 200,000 cy every 1 to 2 years) at RM 5.
- Hammond Boat Basin (infrequently) at RM 7.
- Skipanon Channel (20,000 to 50,000 cy every 1 to 3 years) at RM 10.
- Skamokawa Creek (infrequently) at RM 33.6.
- Westport Slough and Wahkiakum Ferry Channel (15,000 to 25,000 cy every 2 to 3 years) at RM 43.
- Cowlitz River Old Mouth (10 to 20,000 cy annually) at RM 67.
- Oregon Slough (50,000 cy every 3 to 5 years) at RM 109.

Material in the Columbia River system is dredged using pipeline, hopper, and clamshell dredges. The type of dredge used on a shoal depends on several factors, including dredge availability, size and location of the shoal, and disposal options available. Disposal areas include shoreline, upland, flowlane and in-water sites. The amount of dredging that is required varies annually and is dependent on the amount of shoaling present in the channel. Prior to and during each dredging season, bathymetric surveys are used to determine exact dredging locations.

2.2.2.2 Dredging Frequency and Volumes

Table 2-7 lists dredging locations, volumes of material dredged, and disposal locations for all sites that were dredged from 1998 to 2002.

Table 2-7. Columbia River Operations and Maintenance Dredging

Bar	River Miles	Volumes Dredged (cubic yards)						Equipment	Project Depth (feet)	Adv. Maint. Depth (feet)	Disposal Location	Period	Duration* (days)
		1998	1999	2000	2001	2002	5-yr. Avg.						
Lower Desdemona Shoal	4.4 - 6.4	0	0	301,339	621,922	549,230	294,498	hopper	40	42-45	flowlane	Year round	10-15
Upper Desdemona Shoal	6.4 - 10.0	138,997	121,851	24,213	161,473	0	89,307	hopper	40	42-45	flowlane	Year round	3-5
Flavel Bar	10.0 - 13.6	212,334	265,985	473,913	400	327,362	255,999	hopper	40	42-45	flowlane	Year round	5-15
Upper Sands	13.6 - 17.5	98,982	0	0	381,201	0	96,037	hopper	40	42-45	flowlane	Year round	2-10
Tongue Point Crossing	17.5 - 21.4	116,705	0	509,350	273,846	186,695	217,319	hopper & pipeline	40	42-45	flowlane/upland	Year round	2-10
Harrington Point Sump	20.2 - 21.75	906,765	0	0	21,299	911,040	367,821	pipeline	40	42-45	upland	Year round	20-25
Miller Sands Channel	21.4 - 25.2	1,070,604	465,679	1,459,167	127,900	739,388	772,548	hopper & pipeline	40	42-45	flowlane/upland	Year round	5-25
Pillar Rock Ranges	25.2 - 28.8	143,871	177,127	64,687	681,235	91,740	231,732	hopper & pipeline	40	42-45	flowlane/upland	Year round	3-25
Brookfield-Welch Island Reach	28.8 - 32.6	766,675	519,679	1,364,341	584,016	249,112	696,765	hopper & pipeline	40	42-45	flowlane/upland	Year round	10-40
Skamokawa Bar	32.6 - 36.6	227,896	281,965	0	373,606	281,338	232,961	hopper & pipeline	40	42-45	flowlane/upland	Year round	5-15
Puget Island Bar	36.6 - 40.8	0	216,800	283,007	407,214	350,766	251,557	hopper & pipeline	40	42-45	flowlane/upland	Year round	5-10
Wauna-Driscoll Ranges	40.8 - 44.5	270,844	250,166	201,521	259,679	182,790	233,000	hopper & pipeline	40	42-45	flowlane/upland	Year round	5-10
Westport Bar	44.5 - 48.2	0	1,036,085	3,126	1,690,520	862,483	718,443	hopper & pipeline	40	42-45	flowlane/upland	Year round	15-30
Eureka Bar	48.2 - 51.9	90,974	0	346,429	0	70,841	101,649	hopper & pipeline	40	42-45	flowlane/upland	Year round	2-5
Gull Island Bar	51.9 - 55.6	0	0	0	60,992	44,665	21,131	hopper & pipeline	40	42-45		Year round	2-3
Stella-Fisher Bar	55.6 - 59.4	469,440	1,340,194	35,224	70,508	449,907	473,055	hopper & pipeline	40	42-45	flowlane/upland	Year round	5-30
Walker Island Reach	59.4 - 63.2	54,261	17,925	0	70,571	39,627	36,477	hopper & pipeline	40	42-45	flowlane/upland	Year round	1-3
Slaughters Bar	63.2 - 67.1	377,912	821,969	331,506	43,642	0	315,006	hopper & pipeline	40	42-45	flowlane/upland	Year round	10-40
Lower Dobelbower Bar	67.1 - 69.9	0	0	911,122	31,289	413,763	271,235	hopper & pipeline	40	42-45	flowlane/upland	Year round	1-20
Upper Dobelbower Bar	69.9 - 72.8	173,708	18,063	166,276	351,688	0	141,947	hopper & pipeline	40	42-45	flowlane/upland	Year round	1-10
Kalama Ranges	72.8 - 76.5	249,861	50,196	108,253	108,542	0	103,370	hopper & pipeline	40	42-45	flowlane/upland	Year round	3-8
Lower Martin Island Bar	76.5 - 80.3	0	79,455	240,783	0	195,084	103,064	hopper & pipeline	40	42-45	flowlane/upland	Year round	3-5
Upper Martin Island Bar	80.3 - 83.8	20,492	55,144	261,758	5,484	23,152	73,206	hopper & pipeline	40	42-45	flowlane/upland	Year round	3-8
St. Helens Bar	83.8 - 87.3	273,878	31,118	294,344	0	240,466	167,961	hopper & pipeline	40	42-45	flowlane/upland	Year round	3-15
Warrior Rock Bar	87.3 - 90.4	275,371	0	16,478	0	11,576	60,685	hopper & pipeline	40	42-45	flowlane	Year round	2-5
Henrici Bar	90.4 - 93.9	43,563	140,659	448,464	0	23,008	131,139	hopper & pipeline	40	42-45	flowlane	Year round	1-9
Willow Bar	93.9 - 97.8	0	0	21,296	0	28,977	10,055	hopper & pipeline	40	42-45	flowlane/upland	Year round	1-3
Morgan Bar	97.8 - 101.3	0	0	0	0	0	0	hopper & pipeline	40	42-45	flowlane	Year round	>1
Lower Vancouver Bar	101.3 - 104.6	0	0	0	128,628	30,515	31,829	hopper & pipeline	40	42-45	flowlane/upland	Year round	1-2
Vancouver Turning Basin	104.6 - 106.4	521,540	0	0	82,753	30,965	127,052	hopper & pipeline	40	42-45	flowlane/upland	Year round	2-14

*Note: The dredging days are not always contiguous. Dredging may occur at more than one time of the year.

2.2.3 Project Description for Side-channel Projects

2.2.3.1 Baker Bay West Channel

The West Channel through Baker Bay begins outside the 40-foot federal navigation channel in the Columbia River near RM 2.5 and continues along the western edge of the bay for 2.5 miles to the entrance of Ilwaco Boat Basin. The authorized depth of the channel is 16 feet below MLLW. The channel width is 200 feet for the first 0.5 miles, then 150 feet for the remaining distance. The federally maintained channel ends at the turning and mooring basin, which is maintained by local interests. Advanced maintenance dredging of up to 2 feet is authorized and commonly practiced to ensure that project depth is available between dredging cycles. Dredging is typically done using a clamshell dredge, but a hopper or pipeline dredge has been used previously and may be used in the future. Material dredged from the channel is placed either in the Columbia River flowlane at RM 3 or on West Sand Island. All dredging work takes place during September and October to minimize impacts to crabs and endangered salmonid species.

The following are the total approximate amounts dredged by the contract dredge *DB Sea Vulture* for the Baker Bay Project for Fiscal Years 1997 to 2003.

1997-1999	0 cy
2000	186,306 cy
2001-2002	0 cy
2003	101,193 cy

It is anticipated that the Baker Bay Project will be dredged three times in the next 5 years.

2.2.3.2 Chinook Channel

The channel leading into Chinook, Washington begins near RM 5 in the Columbia River north of the 40-foot federal navigation channel, and continues to the Port of Chinook. It is a long, narrow channel through an area of extreme shoaling. The authorized depth is 10 feet below MLLW and the width is 150 feet. The 2-mile-long channel ends at the turning and mooring basin, which is maintained by local interests. The channel is dredged to 12 feet below MLLW to ensure that project depth is available between dredging cycles. The Chinook Channel is maintained by clamshell dredge. Material removed from this channel is placed in the estuary in-water disposal site Area D, north of the 40-foot federal navigation channel near RM 7. Dredging work takes place during September and October to minimize impacts to crabs and endangered salmonid species.

The following are the total approximate amounts dredged by the contract dredges *Seattle* and *DB Sea Vulture* for the Chinook Channel Project for Fiscal Years 1997 to 2003.

1997-1999	0 cy
2000	297,710 cy
2001-2002	0 cy
2003	144,168 cy

It is anticipated that the Chinook Channel Project will be dredged three times in the next 5 years.

2.2.3.3 Hammond Boat Basin

The Hammond Boat Basin is located 7 miles from the mouth of the Columbia River on the Oregon side. It was constructed in 1982. The access channel leading into the boat basin is authorized at 10-feet below MLLW and is 1,300-feet long and 100 feet wide. Primarily small boats use the channel. The Columbia River Bar Pilots moor one of their pilot boats in the basin. The channel is dredged to 12 feet below MLLW to ensure that project depth is available between dredging cycles. The Hammond Boat Basin has been maintained historically by pipeline dredge. The Hammond Boat Basin was last dredged in 1990. Approximately 18,000 cy of material was placed in an upland disposal site near the boat basin. Future maintenance will most likely be by pipeline dredge with associated upland disposal, or by clamshell dredge with associated flowlane disposal in the Columbia River. It is anticipated that the Hammond Boat Basin will be dredged once in the next 5 years.

2.2.3.4 Skipanon Channel

Skipanon Channel begins near RM 10 in the Columbia River and runs up the Skipanon River to Warrenton, Oregon. The channel is authorized to a depth of 30 feet below MLLW, but current users require a depth of only 16 feet. The channel width is 200 feet for the first 1.5 miles, and then it opens up into a turning basin with a width varying from 475 to 225 feet. Shoaling occurs in the turning basin area and from sands that encroach across the mouth of the river. The channel is dredged to 18 feet below MLLW to ensure that project depth is available between dredging cycles.

Skipanon Channel is maintained by both hopper and clamshell dredges. The government hopper dredge *Yaquina* maintains the outer entrance of the channel, and clamshell dredges remove material from throughout the entire channel. Dredged material is placed in the flowlane of the Columbia River downstream of the entrance to Skipanon Channel or at estuary in-water disposal site Area D near RM 7. The Project is dredged during September and October to minimize impacts to crabs and endangered salmonid species. In 2003, dredging was conducted by *DB Sea Vulture* at the mouth of Skipanon Channel only. Contaminated sediment was detected in one sediment sample (see sediment evaluation discussion below), but was well up-channel of the dredging. The following are the total approximate amounts dredged for the Skipanon Channel Project for Fiscal Years 1997 to 2003.

1998	13,927 cy
1999	9,754 cy
2000	266,845 cy
2001-2002	0 cy
2003	15,366 cy

It is anticipated that the Skipanon Channel Project will be dredged twice in the next 5 years.

2.2.3.5 Skamokawa Creek

The channel leading into Skamokawa, Washington begins outside the 40-foot federal navigation channel in the Columbia River from RM 33 to 34 and continues toward the town of Skamokawa, ending at the downstream entrance to Brooks Slough. The authorized depth is 6.5 feet below CRD with an additional 2 feet of advanced maintenance dredging depth to ensure that project depth is available between dredging cycles. The Project has not been dredged since 1992.

For the last 30 years, Skamokawa Creek has been maintained mostly by the government sand bypass dredge *Sandwick*. Material was flushed toward the Columbia River and carried downstream by the river currents. Prior to 1974 it was maintained by pipeline dredge. Future dredging would be done by clamshell dredge. Material would be placed in the flowlane in the Columbia River. Any dredging would occur during the preferred in-water work period from November 1 through February 28. Approximately 5,000 cy of material was dredged and disposed of by flowlane disposal at the mouth of Skamokawa Creek in 1993. There has been no subsequent dredging, and there are no plans by the Corps to dredge in the immediate future. Local entities are attempting to secure funding to dredge the channel, and it is anticipated that they may dredge once in the next 5 years.

2.2.3.6 Wahkiakum Ferry/Westport Slough

The Wahkiakum Ferry Channel runs between Puget Island and Westport Slough near RM 43 in the Columbia River. The channel is authorized to a depth of 9.5 feet below CRD and a width of 200 feet. Maintenance dredging is conducted to 12 feet below CRD to ensure that project depth is available between dredging cycles. The ferry channel has been dredged by clamshell dredge and the *Sandwick* in the past. Future dredging will be done by clamshell dredge with flowlane disposal of the material in the Columbia River or in an upland rehandle site. Dredging occurs during the preferred in-water work period from November through February. The following are the total approximate amounts dredged for the Wahkiakum Ferry/Westport Slough Project for Fiscal Years 1997 to 2003.

1998	*Sandwick* ([4]agitation dredging, volume unknown)
1999-2000	0 cy
2001	25,223 cy
2002	0 cy
2003	0 cy

It is anticipated that Wahkiakum Ferry/Westport Slough will be dredged twice in the next 5 years.

2.2.3.7 Old Mouth Cowlitz River

The Old Mouth Cowlitz River is located at RM 67 on the north side of the mainstem Columbia River at Longview, Washington. The site is no longer an active component of the Cowlitz River drainage and serves as a port access channel for log handling and rafting operations in the Port of Longview. The Project channel into the Old Mouth Cowlitz River is authorized at a depth of 8 feet below CRD and 150-feet wide. It runs from deep water in the Columbia River to a point approximately 3,800 feet upstream. The channel is dredged to -10 feet CRD to ensure that project depth is available between dredging cycles.

The channel has been dredged historically by pipeline, clamshell, and agitation dredging (a type of dredging done by the *Sandwick* which is no longer used). Future maintenance will be done using a clamshell dredge with placement of the dredged material in the flowlane of the Columbia River. Dredging occurs during the preferred in-water work period from the beginning of November 1 through February 28. The following are the total approximate amounts dredged for the Old Mouth Cowlitz River Project for Fiscal Years 1997 to 2003.

1997	*Sandwick* (agitation dredging, volume unknown)
1998	*Sandwick* (agitation dredging, volume unknown)
1999	0 cy
2000	*Sandwick* (agitation dredging, volume unknown)
2001	0 cy

[4] Agitation dredging is done using prop wash from a boat. The boat is anchored and the prop wash moves the sand out of the area. It is normally done during ebb tide so the material is carried downstream. Agitation dredging will not be done any longer on the Columbia River.

2002 *Sandwick* (agitation dredging, volume unknown)

It is anticipated that the Old Mouth Cowlitz River Project will be dredged three times in the next 5 years.

2.2.3.8 Oregon Slough

Oregon Slough, also known as North Portland Harbor, runs parallel to the Columbia River behind Hayden Island. The downstream end of Oregon Slough is located at RM 102.5 on the south side of the Columbia River just upstream of the confluence of the Willamette and Columbia Rivers. The channel into the Oregon Slough is authorized at a depth of 40 feet below CRD and 400-feet wide. It runs upstream approximately 1.5 miles along Port of Portland Terminal 6. The channel is dredged to 45 feet below CRD to ensure that project depth is available between dredging cycles. The entrance channel to the upstream end of Oregon Slough begins at RM 109 in the main navigation channel. The upper channel is authorized at a depth of 10 feet below CRD and 300-feet wide. It runs a distance of approximately 5,800 feet from the upstream entrance of the slough. The channel is dredged to 12 feet below CRD to ensure that project depth is available between dredging cycles.

The downstream end of Oregon Slough has been dredged historically by pipeline, clamshell and hopper dredging. Placement of the dredged material is in the flowlane of the Columbia River. Dredging may occur at any time during the year, but will normally occur from May through October similar to the deep-draft 40-foot channel. The upstream end of Oregon Slough has been dredged historically by pipeline and clamshell dredging. Future dredging will be done using a clamshell dredge. Placement of the dredged material is in the flowlane of the Columbia River. Dredging of this shallow-draft portion of the channel occurs during the in-water work period from November 1 through February 28.

No maintenance dredging of the downstream section of Oregon Slough occurred from 1997 to 2002. The last time dredging occurred in this location was 1996, when the hopper dredge *Essayons* removed 49,630 cy. The upstream section of Oregon Slough was last dredged in 2001 when a clamshell dredge removed 55,799 cy. The Project is dredged infrequently. However, it is anticipated that both the upstream and downstream sections of the Oregon Slough Project will be dredged once in the next 5 years.

2.2.4 Vancouver, Washington to Bonneville Dam (RM 106.5 to 145)

The main navigation channel from Vancouver, Washington (RM 106.5) to Bonneville Dam (RM 145) is authorized to a depth of -27 feet CRD. Up to 2 feet of advanced maintenance dredging is authorized in the navigation channel from Vancouver to Bonneville Dam. Based on the draft requirements of current users, the channel is maintained below Bonneville Dam only to -17 feet CRD. From RM 106.5 to about RM 125.3, the Corps has performed maintenance dredging using a hopper dredge at two or more locations every year. Maintenance dredging is done annually from Vancouver to Bonneville Dam and occurs during the in-water work period from November 1 through February 28. Each year, up to four locations (shown below) may be dredged. A total of 5 to 10 days of dredging is conducted each year to maintain all these locations. The following are the total approximate amounts dredged for the Oregon Slough Project.

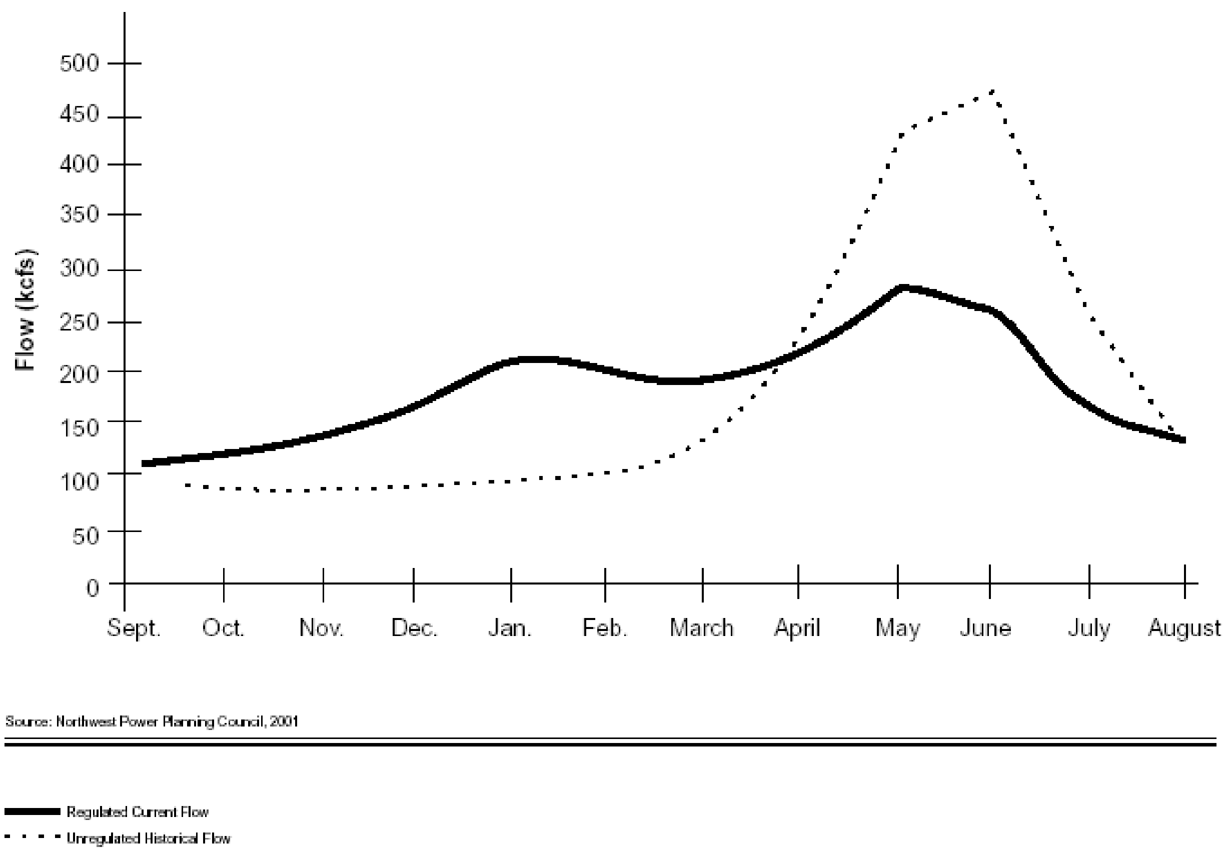
Location	Years Dredged	5-Yr. Avg. Annual Volume
Airport Bar (RM 110.2 to 114.0)	2001, 2002	9,212 cy
Government Island Reach (RM 114.0 to 117.8)	1999, 2000 2002, 2003	31,400 cy
Lady Island Ranges (RM 117.8 to 121.5)	1999, 2000, 2003	20,437 cy
Washougal Ranges (RM 121.5 to 125.3)	2000, 2001, 2003	21,605 cy

3. LOWER COLUMBIA RIVER ENVIRONMENTAL SETTING

3.1 HISTORICAL ENVIRONMENTAL CONDITIONS

The Columbia River has been affected and shaped over eons by a variety of natural forces, including volcanic activity, floods, and climate changes. These forces had and continue to have a significant influence on the environment of the Columbia River. In addition to natural processes, human activities over the past century also have had an effect on the Columbia River environment. Major changes included changes to flow hydrographs, isolation of the floodplain by development, and the dredging of navigation channels. The hydropower system has reduced the peak seasonal discharges and changed the velocity and timing of flows in the river. The Columbia River estuary historically received annual spring freshet flows that were 75 to 100 percent higher on average than current freshet flows (Figure 3-1). Historical winter flows (from October through March) also were approximately 35 to 50 percent lower than current flows (Figure 3-1). The greater historical peak and variable flows encouraged greater sediment transport and more flooding of wetlands, contributing to a more complex ecosystem than occurs today (ISAB 2000).

Figure 3-1. River Flows at Bonneville Dam



These variable and unregulated river flows affected nearly every aspect of the historical ecosystem, including such diverse components as the:

- Amount and distribution of woody debris,
- Complexity and extent of tidal marsh vegetation,
- Seasonal patterns of salinity and location of the estuarine turbidity maximum (ETM),
- Rates of sand and sediment transport,
- Variations in temperature patterns,
- Complexity and species composition of the food web, and
- Distribution and abundance of salmonid predators.

Historically, flooding occurred frequently and was important to habitat diversity in the river because it provided more flow to side channels and bays and deposited more woody debris into the ecosystem. Historically, the river banks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain. It is estimated that the historical estuary had 75 percent more tidal swamps than the current estuary because tidal waters could reach floodplain areas that are now diked. Historic flooding increased the habitat available for juvenile salmonids by providing them access to a wide expanse of low-velocity marshland and tidal channel habitats (Bottom et al. 2001). These habitats provided feeding and resting areas during the freshet season which supported a variety of salmon life history strategies that are no longer present in the river (Bottom et al. 2001).

3.2 CURRENT CONDITIONS

The Columbia River drains an area of 259,000 square miles and flows 1,243 miles from its headwaters in the Canadian Rockies of British Columbia, across the State of Washington, and along the border of Washington and Oregon to its mouth on the Pacific Ocean near Astoria, Oregon. Within the United States, there are 11 major dams along the main reach of the river. In addition, there are 162 smaller dams that form reservoirs with capacities greater than 5,000 acre-feet in the Canadian and United States portions of the basin (Fuhrer et al. 1996).

The Lower Columbia River Basin extends from Bonneville Dam to the mouth of the Columbia River, a distance of 146 miles. The basin drains an area of about 18,000 square miles, all to the west of the crest of the Cascade Range (Fuhrer et al. 1996).

Stream flow along the mainstem of the lower Columbia River is affected by spring snowmelt, winter rainstorms, and flow regulation by the dams located upstream of the action area. Although winter stream flows are high because of winter rains, they are generally not as high as during the snowmelt season. Daily flood control regulation is generally required during the spring snowmelt season. Stream flow peaks generally occur during April, May and June. Outflows from the dams located within the Columbia River system are regulated by the Corps between May and June in order to provide storage capacity to ameliorate peak flows. For example, during the 1993 Water Year, the regulated peak flow during the snowmelt season was 382,000 cubic feet per second (cfs) at The Dalles (Fuhrer et al. 1996). Local flooding in the lower Columbia River now begins when streamflow reaches about 450,000 cfs, while the unregulated peak flow would have been 602,000 cfs. Releases from the dams during the summer and fall are conducted to satisfy requirements for fisheries, irrigation, navigation, and pollution abatement (Fuhrer et al. 1996). Low stream flow volumes are generally realized from August through October.

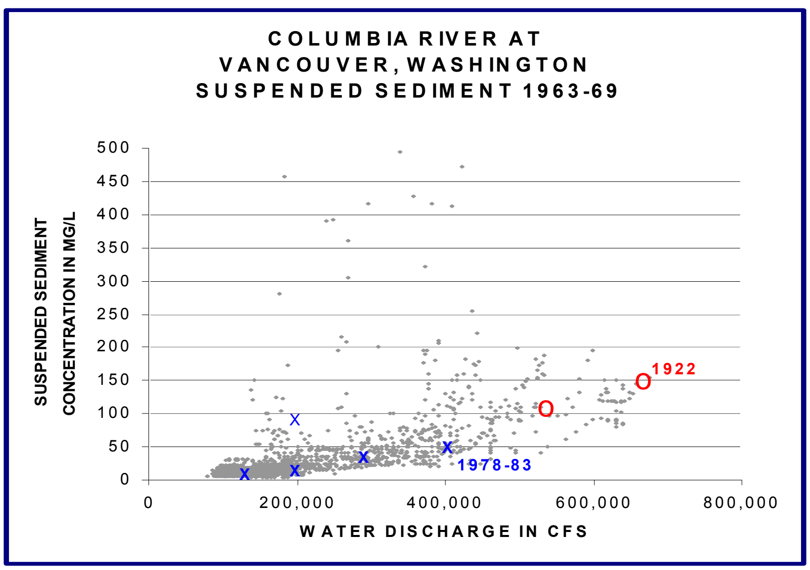
Fish passage has been a large concern along the lower Columbia River for many years. The dams located along the Columbia River are considered obstacles for migrating fish. All of these dams have a step-pool fishway bypassing the dam structure for adult fish passage. Many also have juvenile bypass facilities, as well as a barging program to transport the juveniles through the hydropower system.

3.2.1 Suspended Sediment

The primary factor controlling the suspended sediment volumes in the Columbia River is the large peak flows associated with interior basin spring freshets and the western subbasin winter flood events. These peak flows have been reduced during the latter half of the 20th century by flow regulation at upstream reservoirs, which has affected the volume of suspended sediment in the river. Flow regulation has reduced the 2-year flood peak discharge at The Dalles from 580,000 to 360,000 cfs (Corps 1999). The Corps has estimated that flow regulation has reduced the average annual suspended sediment load from the historical level of 12 mcy per year to 2 mcy per year (Corps 1986). This reduction is a result of the reduced transport potential caused by the lower discharges.

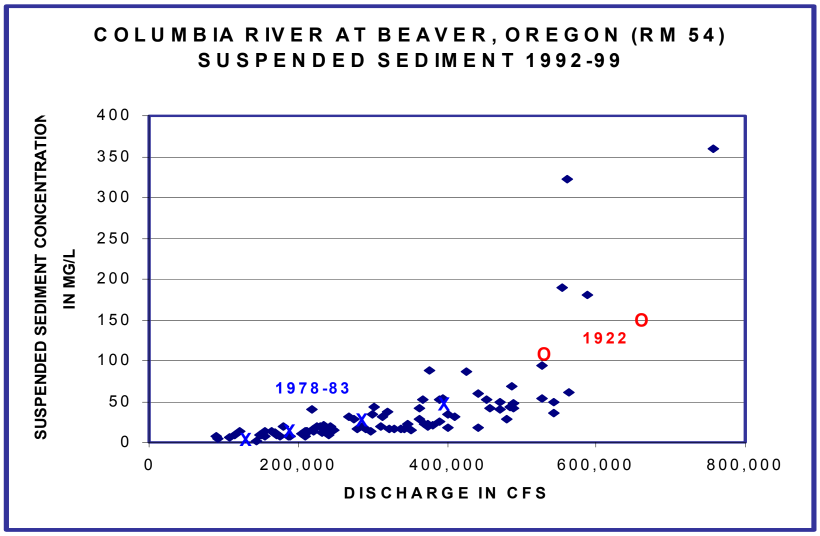
In addition to reductions in peak flow, the upstream dams have trapped some sediment in the reservoirs. A review of pre- and post-flow regulation data relating to suspended sediment, however, has revealed no change in the relationship between suspended sediment and river discharge, which indicates that there has been no change in the sediment supply (Eriksen, SEI Presentation 2001). A comparison of the suspended sediment data in Figure 3-2 to that in Figure 3-3 shows no significant differences in the suspended sediment/water discharge relationship between Vancouver, Washington (RM 106), and Beaver, Oregon (RM 54).

Figure 3-2. Suspended Sediment vs. River Discharge at Vancouver, Washington (RM 106).



Note: the 1963-1969 and 1978-1983 data are from USGS and the 1922 data are from the Corps.

Figure 3-3. Suspended Sediment vs. River Discharge at Beaver, Oregon (RM 54).



Note: the 1963-1969 and 1978-1983 data are from USGS and the 1922 data are from the Corps.

The present suspended sediment concentrations measured by the U.S. Geological Survey (USGS) at Beaver, Oregon have been in the range of less than 10 milligrams per liter (mg/L) at 100,000 cfs; about 20 mg/L at 200,000 cfs; from 20 to 50 mg/L at 300,000 cfs; and from 20 to 60 mg/L at 400,000 cfs. These ranges equate to suspended sediment discharges of 2,000 cy per day, 8,000 cy per day, 12,000 to 30,000 cy per day, and 16,000 to 48,000 cy per day, respectively. The suspended sediment gradation is similar to the historical gradation, consisting mostly of silt and clay size material, with sand constituting less than 30 percent of the load for discharges less than about 400,000 cfs (Corps 1999).

The 2 mcy per year average suspended sediment load in the river is delivered to the upper estuary just downstream of Puget Island and distributed throughout the estuary. Fine-grained suspended silt and clay particles may remain in the estuary for 1 to 4 months, depending on river and tidal flows (Jay, SEI Presentation 2001). In the estuary, local erosion and deposition processes can greatly alter the local concentrations. Wind waves and shifting tidal currents can erode material from the estuary's flats and shallow channels, causing increased suspended sediment. Suspended sediment deposition in the estuary still contributes to the creation of shallow water areas that ultimately support vegetation and become marsh or swamp areas, although the reduced sediment load probably has slowed the process. The deposition rate of silt and clay is most likely still in the range of 30 percent of the incoming volume. It is likely that most of the incoming sand is now deposited in the estuary. The amount of suspended sediment discharged to the Pacific Ocean is unknown. Because of the factors discussed above, it is likely that suspended sediment discharge to the ocean has decreased from historical levels. The average annual suspended sand discharge is probably much less than 0.5 mcy per year.

The following discussions of the side channel projects are taken from the Corps' sediment evaluation reports for each project. These reports are available at https://www.nwp.usace.army.mil/ec/h/hr/sqer.htm. Baker Bay acts as a sediment trap and most of the sediment is fine-grained material that has settled out from the Columbia River. Sediment is coarser closer to the entrance of the bay. Construction of Jetty A near the entrance to Baker Bay, as well as pile dike fields and the migration north of East and West Sand Islands as a result of navigation improvements, has constricted the entrance to the bay and reduced circulation. This has likely resulted in the sediments being finer now than historically. Sediment in the

Hammond Boat Basin is primarily sandy, clayey silt with 80 to 96 percent fines. It is likely that sediment type was less fine prior to breakwater construction because of the reduced circulation with the breakwaters in place.

Sediment in Skipanon Channel is primarily sandy silt with approximately 76 percent fines. Prior to constructing the channel, the sediment may have been finer because the channel area was likely shallower. Skamokawa Creek sediments are primarily sandy silt with concentrations of silt and clay up to 22 percent. It has a fairly large drainage area and alterations of the habitat in the basin have, over time, likely increased the sediment input into the mouth.

The Wahkiakum Ferry channel is part of the main Columbia River channel and is predominantly sand with only 1.2 percent fines. This is likely representative of historical conditions. The Westport Slough channel is a backwater slough area where the sediment consists primarily of sandy silt in the dredging area at the entrance. This material is likely coming from an upriver shoreline disposal site. Consequently, the material in the slough above the mouth is likely finer grained, which may be more typical of historical conditions.

At the Old Mouth Cowlitz River channel, the currents tend to eddy and the sediment is primarily from the Columbia and Cowlitz Rivers. The material is mostly silty sand with up to 96 percent fines. It is likely that this material is finer than historically found here since the mouth area functions as a sediment trap, and there is no flushing flow from upstream in the channel. Sediment in the Oregon Slough upper end channel is typical of the Columbia River, ranging from poorly graded sand to silty sand with fines less than 5 percent.

3.2.2 Bedload

The Columbia River's bedload transport also has been reduced because of the flow regulation at upstream reservoirs. Flow regulation has reduced the 2-year flood peak discharge from 580,000 to 360,000 cfs (Corps 1999). This peak discharge reduction has had an effect on bedload transport because at discharges below 300,000 cfs, the bedload transport rate is quite low and sand wave movement is typically only a few feet per day. However, when the flow exceeds 400,000 cfs, the bedload transport rate increases and sand waves can migrate downstream at around 20 feet per day (Corps 1999).

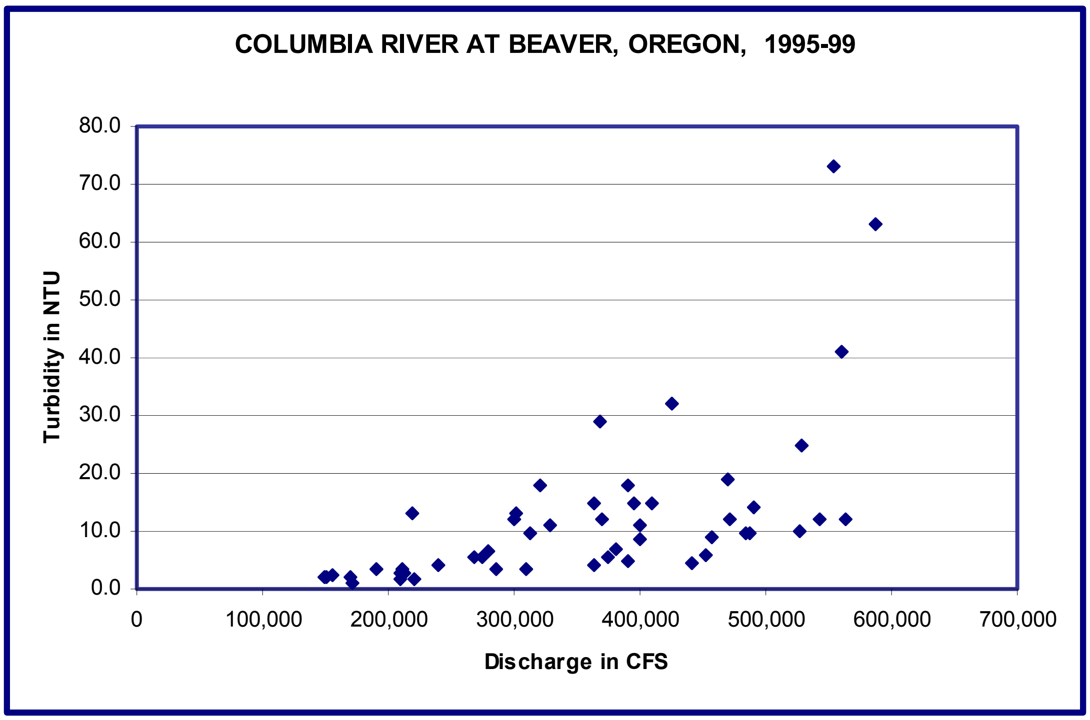
Sand waves in the reach downstream of Vancouver are generally large, with heights of 6 to 12 feet and up to 500-feet long. The post-regulation average annual bedload transport in the main river channel is estimated to be in the range of 0.1 to 0.4 mcy per year (Corps 1999).

Bedload transport in the estuary is highly variable. It is influenced by location, bathymetry, river discharge, ocean waves, and tidal currents. The main channel from RM 25 to 40 has sand waves comparable to those found in the riverine reach. From RM 25 to about RM 18, the main (south) channel sand waves remain downstream-oriented, but become progressively smaller. From RM 18 to 12, sand waves are generally small (<50 feet long), but can be directed either downstream or upstream, depending on flow conditions. Downstream of RM 12, the main channel sand waves are small and reverse direction with the tide. In the reach from RM 7 to 12, shallower areas adjacent to the main channel have been found to have small, downstream-directed sand waves, even when the main channel sand waves were reversing (CREDDP 1984) Small, reversing sand waves also were found in the Columbia River entrance during both high- and low-river discharge seasons. Current rate of bedload transport into the ocean is unknown.

3.2.3 Turbidity

Turbidity levels in the Columbia River roughly follow the river's hydrograph, rising during spring freshets and western subbasin winter floods. At any given river discharge, there are variations in the observed turbidity. For most of the year, turbidity levels are below 10 nephelometric turbidity units (NTU). The highest turbidity levels occur during western subbasin winter floods, reflecting the shift in the primary source of streamflow. All the turbidity levels over 20 NTU shown in Figure 3-4 occurred during high winter flows, with the two highest values occurring during the February 1996 flood (Corps 2001).

Figure 3-4. Turbidity Measured by the USGS at Beaver, Oregon (RM 54)



The turbid water from the riverine reach is distributed throughout the estuary. Jay (SEI Presentation 2001) estimated that the fine, suspended material that causes turbidity can remain in the estuary for up to 1 to 4 months, depending on tides, river flows, and travel paths. Local erosion and deposition processes can alter the local turbidity levels. Wind waves and shifting tidal currents can erode material from the estuary's flats and shallow channels, causing increased turbidity. Turbidity generated by waves and current actions in the shallow flats and channels in the estuary has probably not changed from historical levels. The tidal hydraulics also create a traveling zone of higher turbidity related to the upstream portion of the salinity wedge. An estuarine turbidity maximum (ETM) occurs in both the north and south channels of the estuary. The location of the ETM shifts with the tide and river discharge, similar to the movement of the salt wedge. Researchers have found the ETM in the south channel at various locations from RM 5 to 20 (CRETM-LMER 2000). Turbidity levels in the MCR reach are highly variable and depend on river flow and ocean conditions.

In the side channels with drainage areas, there have been periods of high turbidity during periods of high run-off in the basin. This high turbidity is caused primarily by suspended sediments due to logging and cultural use changes that have resulted in an increase in the amount of suspended sediment. Subsequently, turbidity has increased downstream in these side channel systems, as well as in the main Columbia River.

3.2.4 Bathymetry

There has been a great deal of change in the river bathymetry since the turn of the 20th century. Navigation development has deepened the channel in all three reaches, and the riverine and entrance channels have been narrowed. The riverbed from RM 106 to 146 remains generally broad and shallow. A shallow-draft navigation channel (currently maintained at -17 feet CRD) extends through this reach. Below RM 106, the depth of the thalweg has increased and portions of the river are narrower. The thalweg is now consistently more than 40 feet deep, with short reaches of over 70 feet. Dredge material disposal has been used to create shoreline and in-water fills that have narrowed the river and created small side channels. These fills exist throughout the riverine reach. The riverbed is still sandy and covered with sand waves. The riverbed side-slopes remain generally flat, with slightly steeper slopes near shorelines that are protected by pile dikes.

Bathymetry shifts more slowly because of the reduction in high discharges from flow regulation. New shallow side channels flow around islands that were created by past disposal, such as those at RM 98, 95, 81, 76, and 64 to 60. The estuary contains varying bathymetry where the main channel crosses from the north to south side of the estuary between Harrington Point and Tongue Point. The remnants of the old main channel still exist along the north side of the estuary upstream to about RM 20. Shallow, tidal, and subtidal flats occupy the central part of the estuary between those two large, deep channels. Several small channels cut the shallow flats. There are numerous channels around the many islands in Cathlamet Bay. The limited shoreline disposal in this reach has had little affect on the bathymetry. Disposal has created Rice, Miller Sands, and Pillar Rock Islands in areas that were once shallow water. Because the frequency and magnitude of high-flow events in the lower Columbia River has been reduced by flow regulation in the basin, changes in estuary bathymetry occur at a much slower rate than was historically the case.

At the MCR, the entrance channel depths of –48 and -55 feet MLLW are maintained by annual dredging and by the north and south jetties, which were constructed in the late 1800s and early 1900s. Peacock Spit on the north side of the North Jetty has been eroding since about 1940. Dredged material disposal at the Shallow Water Site has replaced some of the eroded sediment, while disposal at the Deep Water Site removes material from the littoral system.

Side channels with drainage areas have their own historic erosion/accretion patterns. Erosion occurs during high flows and has likely worsened in recent years because of logging and agricultural practices in the basin. Accretion normally occurs in slack water areas of the river, as well as at the mouth of the rivers as the flow hits the slack water of the Columbia River. This accretion will create a delta area that is gradually eroded away by the Columbia River. Side channels that are extensions off the main channel erode and accrete depending upon the Columbia River flow.

3.2.5 Water Quality

The lower Columbia River was evaluated in two studies (Tetra Tech 1995, 1996). The conclusion of these studies is that the river is classified as “marginally healthy” based on levels of dissolved oxygen, toxins and habitat conditions. Oregon and Washington have classified the lower Columbia River as water quality-limited and placed it on the Clean Water Act Section 303(d) list for the following parameters: from RM 0 to 35.2 for temperature and polychlorinated biphenyls (PCBs); from RM 35.2 to 98 for arsenic, dichlorodiphenyl trichloroethane (DDT), PCBs, and temperature; and from RM 98 to 142 for temperature, arsenic, DDT, PCBs, and polynuclear aromatic hydrocarbons (PAHs). In Washington, the river also is on the 303(d) list for dichlorodiphenyldichloroethane (DDD), Alpha BHC (a pesticide), mercury, dissolved gas, dieldrin, chlordane, aldrin, dichlorodiphenyl dichloroethylene (DDE), fecal coliforms, and sediment bioassay. In addition, the entire river is subject to an EPA total maximum daily load for dioxin.

The lower part of the Columbia River is influenced by the Pacific Ocean. Salinity intrusion can extend up to about RM 40 during low-flow periods. During high-flow periods, the river can be fresh water all the way to the MCR. The area of salt water influence divides the riverine reach from the estuary. Because of flow regulation in the Columbia River Basin, it is likely that the seasonal variability for salinity intrusion is reduced from historical levels (Thomas 1983, CREDDP 1984). Accordingly, it is likely that salinity extremes in the estuary are not as great as they were during historical extreme summer low flow and tidal conditions.

Baker Bay has historically had the highest salinity values of any bay in the lower river. Due to its proximity to the ocean, salinity levels are near oceanic values during flood tides. Although less saline during high river flows and ebb tides, it is still primarily a saltwater bay. Salinity levels at Hammond Boat Basin and Skipanon River are typical of the main estuary and fluctuate with river flow and tide.

Temperatures within the action area have generally been affected by the following Columbia River Basin-wide changes. These changes have combined to create river temperatures that can stress fish.

- Slowed river flow (both above upstream reservoirs and seasonally downstream as a result of reduced freshet flow volumes).
- Reduced riparian canopies over streamside vegetation.
- Agricultural runoff.
- Industrial discharges.
- Climate variations such as El Nino.

Overall contamination in the riverine reach reflects the increased number of sources from municipalities and industries. Contamination in the navigation channel is negligible due to extremely low organic carbon content. Contamination in the estuary is less than in the riverine reach because there are fewer and smaller urban and industrial sources of contamination. Increased dilution of both water and sediment from tidal mixing also lowers contaminant concentrations. Contamination is lowest in the MCR reach, principally because there are no sources other than transient shipping and the influence of upstream sources is greatly diluted by tidal mixing with ocean water.

Since the side channel projects have finer-grained sediment than the main navigation channel, there is a greater potential for contaminants to be present. Testing in these projects has shown few contaminant concentrations above screening levels.

Current levels of sediment contamination from PAHs, PCBs, and DDT and its metabolites are discussed in Appendix B of the CRCIP BA (Corps 2001). Within a short-term historical perspective, two of the contaminants assessed, PCBs and DDT, were much more prevalent historically (1960s and early 1970s) than they are today; their concentrations have continued to decline gradually since 1972, when use of DDT was banned. Apart from a variety of point sources of pollutants, the most notable feature of the sediment contamination in the lower Columbia River is its uniformity. This reflects the non-point source of contaminants and the high energy of the Columbia River, which tends to uniformly mix contaminants within the main river channel, resulting in little difference upstream to downstream. Differences in contamination are greatest when contamination in the navigation channel is compared to that in the shoreline sediments. Shoreline sediments, especially in areas where fine particulates deposit, may contain higher concentrations of contaminants because they contain higher amounts of the organic matter to which the contaminants sorb.

Because PCBs and DDT are distributed widely via atmospheric transport and non-point sources, such as soils and sediments which provide large reservoirs where these contaminants persist, the concentrations found in the environment apart from point sources of pollution do not change greatly in the lower Columbia River. Use of DDT peaked in the 1960s, and then slowly declined since it was banned in December 1972. Correspondingly, use of PCBs peaked in the 1970s and then was abruptly banned in 1977. Because both of these contaminants break down extremely slowly in the environment, their concentrations have declined very gradually over the past 25 years.

The PAHs differ from the organochlorine hydrocarbons in that they are generated by internal combustion engines and are derived from natural sources (e.g., forest fires). They represent a broad group of contaminants that range from ones that are rapidly broken down in the environment under most conditions (e.g., benzene, naphthalene) to those that tend to persist, such as benzo-a-pyrene in anaerobic sediments.

3.2.6 Habitat Types

3.2.6.1 Tidal Marsh and Swamp Habitats

Tidal marsh habitat areas are located between MLLW and MHHW and are dominated by emergent plants and low herbaceous shrubs. Tidal marsh habitat and its formation were extensively reviewed by reach for the Columbia River channel from RM 3 to 106.5 in the CRCIP BA (Corps 2001). Tidal swamp habitat is dominated by wetland woody shrubs and trees that sometimes extend below the MHHW, but typically are at elevations higher than those for tidal marshes (Thomas 1983). Tidal marsh and swamp habitats are the primary wetland and riparian communities adjacent to the river throughout the riverine and estuarine reaches. They are subject to tidally induced inundation and include salt water, brackish water, and fresh water components.

Diking and flow regulation have led to significant changes in the amount and location of tidal marsh and swamp habitats within the lower Columbia River. Highways, railroads, and diking have contributed to narrowing and confining of the river. Between the mouth of the Willamette River and the mouth of the Columbia River, diking and other activities have resulted in an estimated loss of about 52,000 acres of wetland/marsh and 27,000 acres of forested wetland since the 1870s. Much of this land is now in agricultural use. Riparian forests (cottonwood and ash-broadleaf forest) declined by approximately 14,000 acres through conversion of land to agriculture and upland development (Graves et al. 1995).

While there has been a net loss of tidal marsh and swamp habitat since the 1870s, new marsh and swamp areas are continuing to form within the estuary. This is occurring because disposal of dredged material has created new shoreline areas that have been colonized by vegetation and because natural accretion within shallow areas has combined with colonization by bulrush (*Scirpus* spp.) and other marsh vegetation (Thomas 1983). About 250 acres of tidal marshes have been added in the vicinity of Point Adams (an area that historically did not have marsh habitat) through natural vegetation colonization (Thomas 1983). The primary reason for this increase has been removal of wave action in certain areas of the MCR by construction of jetties, which has allowed colonization by vegetation in shoreline areas.

Current tidal marsh and swamp production is lower than historical levels in the riverine and estuarine portions of the lower Columbia River. The remaining tidal marsh and swamp habitats currently are located in a narrow band along the river banks and around undeveloped islands. Side channel and backwater habitats occur in large islands such as Wallace, Crims, Willow Grove, Fisher, Hump Walker, Lord, Howard, Cottonwood, Sandy, Martin, Burke, and Sauvie Islands.

Many insect species feed directly on the vegetation in freshwater wetlands and tidal marshes and swamps; consequently, they are directly dependent on marsh production and detritus. Emergent insects provide an important food source for juvenile salmonids in the estuary (Miller and Simenstad 1997, Simenstad and Cordell 2000). Some insects known to be of importance to salmonids include aphids, emergent chironomids, and other dipteran flies (Weitkamp 1994, Miller and Simenstad 1997, Simenstad and Cordell 2000).

Annual production by marshes in the riverine (fluvial) section of the study area averaged 401 grams of carbon per square meter. Rates of marsh production in the post-development period are probably similar to pre-development conditions. However, because of the decline in marsh area, total production throughout the study area has declined dramatically. Based on data from the estuary and fluvial systems, total emergent plant production has declined an estimated 72 percent (from 62,629 to 11,324 metric tons of carbon per year) since before 1870 (Sherwood et al. 1990).

Organic matter cycling from tidal channel tributaries to the main river channel likely continues to be a major source of nutrients within the estuary. However, the substantial reduction in the tidal marshes and swamps in all sections of the action area probably have substantially reduced the contributions of this material to nutrient levels in the system. In the Columbia River Basin, projected calculations indicate an 84 percent decline in macrodetritus input when compared with historical levels (Sherwood et al. 1990). While this would suggest a decrease in nutrients in the system as a result of the decrease in the input of nutrients from the breakdown of macrodetritus, increases from upstream sources of nitrogen or phosphates appear to provide adequate nutrient input to the river. With the exception of occasional short periods in the late spring and summer, nutrient supply is not a limiting factor in primary productivity within the estuary (CREDDP 1984).

Remineralization of nutrients from macrophyte biomass generally requires more time and energy than does that from phytoplankton. Furthermore, macrophyte detritus enters estuarine systems in fall and winter as opposed to spring and summer for phytoplankton (Thom 1984). Consequently, the timing of the release of nutrients to the water column has changed in the lower Columbia River, as compared with historical conditions.

3.2.6.2 Shallow Water and Flats Habitats

Shallow water and flats habitat occurs along the margins of shallow water areas of the lower Columbia River. Shallow water and flats habitat and its formation were extensively reviewed for the Columbia River channel from RM 3 to 106.5 in the CRCIP BA (Corps 2001). This habitat type is concentrated in the estuary and downstream portions of the riverine reach. Thomas (1983) estimated that shallow water and flats habitat covered 40,640 acres in 1870. Thomas (1983) and Sherwood and others (1990) have estimated that shallows and flats have increased by approximately 4,130 acres throughout most of the estuary. In particular, significant shoaling has occurred in Cathlamet and Baker Bays, which, in the case of Baker Bay, led to the creation of 3,620 acres of shallow water and flats habitat (Thomas 1983). Shallow water habitat at the MCR is decreasing because jetties have reduced or removed much of the wave energy that previously prevented formation of shallow water areas through erosion. Sand deposited in this area now forms sand dunes in areas that were formerly shallows and flats (Thomas 1983).

Shallow water and tidal flat habitats are highly productive for benthic invertebrates and particularly *Corophium salmonis,* which is an important food organism for juvenile salmonids. Juvenile salmonids, in particular subyearling fall chinook and chum salmon, may rear for up to several months in the shallow water flats habitat particularly in the estuary (Simenstad et al. 1982, Bottom et al. 2001).

3.2.6.3 Water Column Habitat

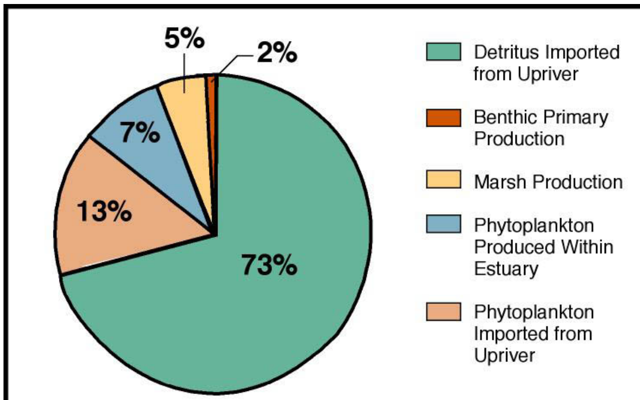
Water column habitat occurs in those portions of the river greater than 6 feet in depth. It is created and maintained by flow from the river's mainstem and tributaries. Water column habitat formation was extensively reviewed for the Columbia River channel from RM 3 to 106.5 in the CRCIP BA (Corps 2001). Water level and flows in the mouth and estuary are influenced by ocean tides. Tides also affect water level upstream of the estuary, but to a lesser extent. The water column, which is used primarily by stream-type juveniles and adult life stages of salmonids, also serves an important function as an importer of phytoplankton and microdetritus from upstream areas. In addition, the river transports sediments, most of which are fine sand and silt in suspension. Much of this sediment eventually settles out in the river, estuary, and mouth to form shoals and shallow flats.

Water column habitat currently serves as a carrier of imported phytoplankton and microdetritus from upriver to the lower Columbia River and estuary. With the substantial loss of marsh macrodetritus, coupled with an increase in phytoplankton production in upriver reservoirs, the lower river has now shifted from a dominance of macrophyte-derived nutrients to plankton-derived nutrients. The water column habitat now provides the major source of nutrients to the lower river from imported plankton.

3.3 Primary Production

A synthesis of information regarding historical conditions affecting habitat primary productivity was presented in the CRCIP BA (Corps 2001). Figure 3-5 demonstrates that most of the phytoplankton species within the lower Columbia River are freshwater species that originate from upstream reservoirs behind mainstem dams (Sherwood et al. 1990, Small et al. 1990). Dominant species include *Asterionella formosa, Fragilaria crotensis, Melosira granulata*, and *Melosira italica* (Small et al. 1990).

Figure 3-5. Carbon Sources in the Estuary



Source: Modified from Simenstad, 1984.
Note: Carbon is an indicator of primary productivity.

The highest productivity rates for phytoplankton in the system occur in May and July, with sites nearest tributary rivers having the greatest rates. Reported productivity rates from these areas range from 750 to 1,000 milligrams of carbon per square centimeter per day (mgC/cm^2/day). Rates in other areas range from

200 to 600 mgC/cm^2/day. Estimates of the annual input of imported phytoplankton to the estuary have increased on the order of seven times, going from 9,000 to 61,440 metric tons of carbon (Sherwood et al. 1990). Overall, phytoplankton production amounted to 37 percent of the total primary production in the lower Columbia system during studies conducted in the early 1980s (McIntire and Amspoker 1984). Production of imported phytoplankton in reservoirs above the dams accounts for the massive increase in input to the lower Columbia River system. In addition, production of imported phytoplankton in the lower Columbia River is enhanced by the increase in light penetration related to a reduction in the suspended detrital material, decreased vertical mixing, and increased retention time (Sullivan et al. 2001).

Production by resident phytoplankton species in the lower Columbia River does not currently appear to make up a significant part of the total primary production. An existing theory to explain this is that the low level of phytoplankton production within the estuary is a result of the relatively quick flushing time associated with the lower river (CREDDP 1984). Because the freshwater phytoplankton are moving quickly through the lower river estuary, it is suggested that they cannot build up concentrated communities before being exposed to lethal salinity levels. The current flushing time is 1 to 5 days, depending on flow and tidal conditions (CREDDP 1984).

Although resident phytoplankton production is not significant, increased light penetration under post-flow regulation conditions (e.g., reduced suspended detrital matter, lower vertical mixing rates) may have resulted in an increase in resident phytoplankton production (Sullivan et al. 2001), although the amount of change is not quantified.

Benthic (bottom-dwelling) algae producers include flowering plants (*Zostera marina, Potamogeton richarsonii, Ceratophyllum demersum, Elodea canadensis*), macroalgae (*Ulva* spp., *Enteromorpha* spp.), and microalgae communities (diatoms, primarily of the genera *Navicula* and *Achnanthes*) that attach to the substrate (McIntire and Amspoker 1984).

Historical data on benthic algae production are lacking. However, historical rates are likely similar to current rates but with overall production less than what was found historically. Sherwood and others (1990) estimated that benthic microalgae production in the fluvial through the MCR portion of the lower Columbia River has declined approximately 15 percent (from 1,825 to 1,545 metric tons of carbon) since before 1870. This loss may be related to a general decline in shallow flats and channels associated with marshes that were diked or filled. Sherwood and others (1990) suggest that possible reasons for this decrease are a reduction of the tidal prism, a net increase in sediment in the estuary, and reduction in river flow, resulting in:

- Decreased mixing;
- Increased stratification;
- Altered response to tidal forcing; and
- Decreased salinity intrusion length and transport of salt into the estuary.

Because of their distribution throughout the intertidal zones, diatoms are by far the most important benthic primary producer on the flats and in shallow water areas, and account for 7 percent of the primary production in the estuary (Figure 3-5). Annual benthic gross primary productivity rates in grams of carbon per square meter for various regions were 129 at Baker Bay, 94 at Youngs Bay, 34 at Grays Bay, 29 at Cathlamet Bay, and 37 in the upper estuary (McIntire and Amspoker 1984). The benthic algae production within the estuary has always tended to be limited to shallower areas (above the MLLW) and sheltered areas such as Youngs and Trestle Bays (Thomas 1983, CREDDP 1984). Indications are that the percentage of these habitat areas has actually increased by approximately 7 percent from 1870 levels, including 3,620 acres in Baker Bay (Thomas 1983, Sherwood et al. 1990).

McIntire and Amspoker (1986) found a strong correlation between light and benthic algae production and surmised that clearer water produced by the upstream impoundments would result in greater benthic algae production. Benthic microalgae likely enter the particulate organic matter pool used by benthic infauna and epibenthic invertebrates. These are important to the food web of salmonids (Simenstad et al. 1990).

Production of benthic microalgae is vital to the current lower Columbia River salmonid food web because microalgae serve as the primary food source for the benthic infauna (e.g., *Corophium*) currently preyed on by juvenile salmonids.

3.4 INVERTEBRATES

A synthesis of information regarding historical conditions affecting invertebrates was presented in the CRCIP BA (Corps 2001). Suspension feeders are organisms that feed in the water column through "filter feeding" (extracting organic matter from the water column by pumping or siphoning the water through their system). Examples of some of the significant suspension feeding organisms in the lower Columbia River include several species of copepod and freshwater cladocerans (e.g., *Bosmina* and *Daphnia* spp.).

However, the most productive groups of zooplankton suspension feeders are estuarine. The zooplankton tends to dwell in the bottom waters of the estuary, which often has an upriver flow (CREDDP 1984). They concentrate at the ETM, which is where the upriver, saline flow mixes with the downstream, freshwater flow. The ETM is rich with dead and dying phytoplankton that is unable to tolerate the salinity of the ETM. This provides plentiful food for the estuarine zooplankton. Because flow regulation has eliminated the high flows that tend to override the upstream saline bottom current, the estuarine zooplankton tend to remain in the estuary and multiply (CREDDP 1984). This dynamic has turned the ETM, with its suspension feeding base, into the richest, most abundant part of the modern food web in the estuary (Bottom et al. 2001). This food web, however, tends to support pelagic species such as anchovy, herring, shad, and longfin smelt. While some of these species may be prey for older salmon on the way out of the estuary, they do not benefit ocean-type juvenile salmonids, which tend to stay in shallow water areas (Bottom and Jones 1990).

Suspension/deposit feeders are benthic and epibenthic organisms that feed on or at the interface between the sediment and the water column. Suspension/deposit feeding typically involves sifting the upper level of sediment to obtain the associated organic materials. For example, *Corophium*, which are benthic infauna, construct a tube in the sediment from which they will occasionally make a foray to scoop in plant material and detritus from the surface (CREDDP 1984). Examples of suspension/deposit feeders include some species of mysids, some species of bivalves (e.g., *Macoma balthica* and *Corbicula manilensis*), and some species of amphipoda (e.g., *Corophium salmonis*, *Corophium brevis*, and *Corophium spinicorne*). Although the benthic/epibenthic food web, which was a prominent feature of the historical lower Columbia River ecosystem, no longer produces as varied or as rich a food web, the food it does produce is vital to juvenile salmonid survival (Sherwood et al. 1990). The primary suspension/deposit feeders used by salmonids in the estuary are *Corophium salmonis* and *Neomysis mercedis* (McCabe 1997).

Suspension/deposit feeders are important to adult salmonids because of their role in the production of prey. *Eurytemora* spp. and *Scottolana* spp. are known to be important prey for planktivorous fish, such as Pacific herring (*Clupea harengus pallasi*) and Pacific sand lance (*Ammodytes hexapterus*), which, in turn, are preyed on by all adult salmonid species.

Mobile macroinvertebrates are large epibenthic organisms that reside on the bottom of the river and can be suspension/deposit feeders. Examples of macroinvertebrates in the lower Columbia River include shrimp, *Crangon franciscorum*; mysids, *Neomysis mercedis*; and Dungeness crab, *Cancer magister* (CREDDP 1984). These species make up most of the standing crop of mobile macroinvertebrates in the estuary. *N. mercedis* and Dungeness crab are primarily brackish water organisms that occur in the lower estuary and occasionally in the central estuary when river flows are low and salinity extends farther upriver. *N. mercedis* has been found in shallow areas upriver as far as RM 43.2 (McCabe and Hinton 1996). *Crangon* spp. account for most of the density of mobile macroinvertebrates in the central and upper estuary. Density is typically less than one animal per cubic meter. They occur predominantly in the shallow areas over the tidal flats, but can be found in the channel areas during low river flows, possibly because during high flow the velocity is too great for them to be in the channel areas.

Macroinvertebrates feed on epibenthic zooplankton (e.g., copepods), benthic infauna (e.g., *Corophium* spp. and various polychaetes), and detritus (CREDDP 1984). Mobile macroinvertebrates, particularly mysids, are an important food source for juvenile salmonids (Miller and Simenstad 1997, Simenstad and Cordell 2000). Planktonic larvae forms, as well as other small benthic forms of this group, can be important in the diet of salmonids (Meyer et al. 1980, Bottom and Jones 1990, Healey 1991).

3.5 BENTHIC INVERTEBRATES

A synthesis of information regarding historical conditions affecting benthic invertebrates was presented in the CRCIP BA (Corps 2001). Benthic invertebrate populations consist of organisms that live both in the bottom (benthic) and on the surface of the bottom (epibenthic). Distribution and abundance of these organisms is directly related to sediment grain size and stability of the bottom habitat. In general, benthic invertebrate productivity is higher in areas that are more stable and have finer-grained sediment than in less stable, coarser-grained areas. For instance, McCabe and others (1986) found benthic invertebrate populations to be considerably less abundant in the higher current, coarser-grained sediment areas of the main navigation channel than in the shallower, fine-grained areas in side channels where currents are less strong. Salinity also can be a major factor affecting the distribution of some species in the estuary and lower river.

A species of particular importance in the estuary and the river is the amphipod, *Corophium salmonis*. It is a microscopic organism and important as a prey item for juvenile and adult salmonids, as well as other fish species. It occurs in both fresh water and estuarine environments and burrows into the bottom in primarily silty sands during the day. It migrates up into the water column at night to feed. This amphipod is abundant in Youngs and Cathlamet Bays and Desdemona Sands in the estuary and throughout the upriver area in suitable habitat. Its distribution in the estuary is dependent primarily upon salinity. Holton and Higley (1984) found that it prefers a salinity range from 0 to 14 ppt and that its distribution in the estuary changes with seasonal changes in salinity patterns. Its abundance can range from zero to as high as 75,000 individuals per square meter. This species also is able to recolonize a disturbed area rapidly. McCabe and others (1986) determined that population levels recovered relatively rapidly after a ferry access channel was dredged in the upper river. Complete recovery of the disturbed population was evident in less than 1 year.

Other groups of benthic invertebrates present in the river and estuary include oligochaetes, polychaetes, and nemertean worms, as well as mysids and insect larvae (Sandborn 1975). These groups, particularly the segmented worms, are generally associated with finer-grained organic sediments. Two clam species, *Macoma balthica*, and the Asian clam, *Corbicula manilensis*, also are abundant in the Columbia River. *Corbicula* occurs in the fresh water while *Macoma* occurs only in the estuary. It is especially prevalent in Baker Bay, the most saline bay in the estuary. Epibenthic species (larger invertebrates) in the river and estuary are crayfish, (*Pacifastacus trowbridgii)*, Dungeness crab, and sand shrimp (*Crangon* spp.). Crayfish are distributed throughout freshwater parts of the river, while Dungeness crab occurs primarily in the lower estuary and the ocean. Young-of-the-year crabs occur in the entrance channel while juvenile crabs move up and down the estuary depending on salinity levels, and are found as far upriver as Grays Bay. Sub-adult crabs (1st to 2nd year class) occur in large numbers in the Ilwaco and Chinook channels in Baker Bay in the winter. Adult crabs are found primarily in the lower part of the estuary and ocean (McCabe et al. 1986).

Baker Bay has likely always been important habitat for marine mobile macroinvertebrates. Sand and ghost shrimp are abundant throughout the bay, as are 2- to 3-year old Dungeness crabs as they rear during the winter.

Benthic populations in the ocean offshore of the Columbia River have been studied since the 1970s (Richardson et al. 1977). The first comprehensive study was done as part of a process to designate ocean disposal sites for material dredged from the Columbia River entrance channel. In 1992, another comprehensive study was done to evaluate additional offshore areas and to compare these results with earlier studies. A comprehensive study of the offshore area was done again in 1995 and 1996 (Hinton 1998) to help locate a new site or sites for both the MCR and CRCIP.

The species composition and abundance of the offshore benthic invertebrate community is determined by a variety of factors including river flow, upwelling, downwelling, seasonal winds, and sediment type. In general, abundance is greater offshore in the deeper (greater than 100 feet), more stable areas with fine to grained sediments than in the inshore areas where the bottom is more dynamic and the organisms are subjected to wave and current effects. Densities also appear to be higher to the north of the mouth of the Columbia River, particularly in the area known locally as the “mud hole,” where fine-grained sediment from the river accumulates. The offshore area also is highly variable in species composition and abundance (Siipola 1992). In some years, a single species such as the polychaete, *Owenia fusiformes,* can account for a large percentage of individuals present. Juveniles of the razor clam, *Siliqua* spp., also have been extremely abundant at some stations and in fact have resulted in some of the highest densities of benthic invertebrates collected off the Oregon Coast.

Epibenthic populations offshore are composed almost entirely of larger macrofauna. Dominant species include Dungeness crab, sand shrimp, and the mysid, *Neomysis kodiakensis*. The shrimp populations tend to be dominated by adults while the crabs are present in all life stages (megalops, small juveniles, and adults). Unlike Dungeness crab, sand shrimp spends its entire life cycle in the estuary. Adult and juvenile sand shrimp, however, occupy different areas depending on salinity levels. Juveniles tend to be in brackish shallow water areas while adults occur in deeper, more saline areas.

3.6 FISH

The Columbia River, the estuary, and the Pacific Ocean immediately offshore provide habitat for a variety of anadromous and resident fish species. Anadromous fish are present in the river almost year-round, either as adults migrating upstream to spawn or as juveniles migrating downstream to the ocean. Anadromous species include the following species: spring, summer, and fall chinook salmon (*Oncorhynchus tshawytscha*); coho salmon (*O. kisutch*); sockeye salmon (*O. nerka*); chum salmon (*O. keta*); pink salmon (*O. gorbuscha*); winter/summer run steelhead trout (*O. mykiss*); and sea-run cutthroat trout (*O. clarki clarki*). Other anadromous species include green sturgeon (*Acipenser medirostris*), white sturgeon (*A. transmontanus*), eulachon (*Thaleichthys pacificus*), American shad (*Alosa sapdissima*), river lamprey (*Lampetra ayresi*), and Pacific lamprey (*L. tridentate*).

Upriver migrating adult salmonids are present in the estuary and river throughout the year. The resident time in the estuary is usually short and they normally do not feed to any extent. However, some may hold in the estuary or lower river for some period of time before entering their spawning streams. Juvenile salmonids are present in the lower river in the early spring and summer during their migration to the ocean. Year-old juvenile spring chinook, coho and steelhead smolts (migrants that are actively migrating to the ocean) are migrating principally at the surface of the deeper water and move through the river and estuary without stopping. Chum and fall chinook have life stages that are migrating downstream but have not yet become smolts (these are referred to as subyearling fish). They migrate downstream at a slower rate and can be present in the lower river and estuary for extended periods of time. They rear in the shallow water areas and bays such as Cathlamet, Youngs and Grays Bays before they become smolts and migrate to the ocean. Most remain in the estuary throughout the summer while some may overwinter in the estuary before becoming smolts and migrating to the ocean.

Resident species consist of both cold water and warm water species. Cold water species include rainbow and cutthroat trout and mountain whitefish (*Prosopium williamsoni*). Warm water species include northern pikeminnow (*Ptychocheilus oregonensis*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*M. salmoides*), yellow perch (*Perca flavescens*), chubs, and crappies. Resident species remain in the river and estuary year-round during all phases of their life history.

4. LIFE HISTORY INFORMATION

4.1 SPECIES PRESENT

Five salmonid species having population segments that are federally listed under the ESA as endangered, threatened, or proposed for listing as threatened occur in the Columbia River below Bonneville Dam. These species include 12 Evolutionarily Significant Units (ESUs) identified by NOAA Fisheries. The ESUs addressed in this BA are listed in Table 4-1 and are described below.

Table 4-1. Federally Listed Salmonid ESUs

Species	Status	Life History Type	Date Listed	Critical Habitat Designated
Chinook (*Oncorhynchus tshawytscha*)				
Snake River spring/summer	Threatened[1]	Stream	4/22/92	Yes
Snake River fall	Threatened	Ocean	4/22/92	Yes
Lower Columbia River	Threatened	Ocean	3/24/99	
Upper Columbia River spring	Endangered[2]	Stream	3/24/99	
Upper Willamette River	Threatened	Ocean	3/24/99	
Chum (*Oncorhynchus keta*)				
Columbia River	Threatened	Ocean	3/24/99	
Sockeye (*Oncorhynchus nerka*)				
Snake River	Endangered	Stream	11/2/91	Yes
Steelhead trout (*Oncorhynchus mykiss*)				
Snake River	Threatened	Stream	8/18/97	
Lower Columbia River	Threatened	Stream	3/19/98	
Middle Columbia River	Threatened	Stream	3/25/99	
Upper Columbia River	Endangered	Stream	8/18/97	
Upper Willamette River	Threatened	Stream	3/25/99	
Coho *(Oncorhynchus kisutch)*				
Lower Columbia River/Southwest Washington	Candidate	Stream		

[1]Threatened–any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
[2]Endangered–any species that is in danger of extinction throughout all or a significant portion of its range.

Chum Salmon (Lower Columbia River). Chum salmon 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. Spawning habitat includes lower portions of rivers just above tidewater and in the side channel near Hamilton Island below Bonneville Dam. Spawning occurs in the mainstem Columbia River in areas where substrate (gravel) is typically 2 to 4 cm in diameter, although spawning in gravels from 15 cm and larger is known. Juveniles outmigrate during spring. Most juveniles spend little time in fresh water and rear extensively in estuaries.

Steelhead (Middle Columbia River). This population of steelhead is distributed from Wind River, Washington and Hood River, Oregon upstream to the Yakima River, Washington. This population migrates in fall/winter and spring/summer, and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1 to 7 years (average 2 years) in fresh water and outmigrate during spring and early summer.

Steelhead (Lower Columbia River). This population of steelhead is distributed from Wind River, Washington and Hood River, Oregon downstream to the mouth of the Columbia River. This population migrates in fall/winter and spring/summer, and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1 to 7 years (average 2 years) in fresh water and outmigrate during spring and early summer.

Steelhead (Upper Columbia River). This population is distributed from the Yakima River upstream to the United States/Canada border. Migration is in fall/winter and spring/summer, and spawning occurs in February and March. Spawning habitat includes the upper reaches of tributaries. Juveniles spend from 1 to 7 years (average 2 years) in fresh water and outmigrate during spring and early summer.

Steelhead (Snake River Basin). This population of steelhead occurs in all accessible tributaries of the Snake River. This population migrates in spring and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1 to 7 years (average 2 years) in fresh water and outmigrate during spring and early summer.

Sockeye Salmon (Salmon River tributary to the Snake River, Idaho). This population occurs in the Salmon River, a tributary to 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 fresh water and outmigrate in spring and early summer.

Chinook Salmon (Fall runs in the Snake River). This population of chinook salmon occurs in the mainstem Snake River and subbasins including the Tucannon, Grande Ronde, Imnaha, and Salmon Rivers. Adults migrate from mid-August to October and spawn from late August to November. Spawning occurs in the Snake River and lower reaches of tributaries to the Snake River. Juveniles outmigrate from early spring to summer as ocean-type subyearlings.

Chinook Salmon (Spring/summer runs in the Snake River). This population of chinook salmon occurs in the mainstem Snake River and subbasins including the Tucannon, Grande Ronde, Imnaha, and Salmon Rivers. Adults migrate in late winter to spring and spawn from late August to November. Spawning occurs in tributaries to the Snake River. Juveniles remain in fresh water from 1 to 3 years and outmigrate from early spring to summer as stream-type yearlings.

Chinook Salmon (Lower Columbia River). This population of chinook salmon occurs from the mouth of the Columbia River upstream to Little White Salmon River, Washington and Hood River, Oregon including the Willamette River up to Willamette Falls. Adults migrate in mid-August through October (fall run) and late winter to spring (spring run). Spawning occurs from late August to November. Spawning occurs in the mainstem Columbia River to upper reaches of tributaries in areas where substrate (gravel) is 6.5 to 13 cm in diameter and flows sufficient to percolate water into gravel are adequate. Juveniles outmigrate from early spring to fall depending upon run type.

Chinook Salmon (Upper Columbia River). This population of chinook salmon occurs 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.

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 between early March and late July, rear in freshwater for a year and migrate to sea the next season. Outmitration peaks in May, but extends from early April through June. They can return in 5 to 20 months to spawn.

4.2 JUVENILE LIFE HISTORY STRATEGY

The listed ESUs fall into two life-history strategies. Ocean-type salmon have juveniles that rear in fresh water for only a few days to a few months before migrating to sea during their first year of life. Stream-type salmon have juveniles that spend at least a year rearing in fresh water prior to their downstream migration. Individuals from each of these ESUs may be present within the action area as juveniles on their migration to the ocean, and again as adults during their return migration to spawn in the stream where they hatched. The amount of time spent in the action area during different life stages and at different seasons varies greatly among the ESUs.

Juvenile salmon are first observed migrating over Bonneville Dam as early as March (Blaine Ebberts, personal communication, Corps Portland District, 2004) The major portion of the migration, however, begins in April with a peak in late May and June and extending into July for ocean type chinook (Corps 2004). The early migrating chinook and chum are from the lower river area, including tributaries within the Bonneville Dam area. These very young fish are commonly the smallest migrants passing through the action area (Fish Passage Center, smolt index data, 2003) Other subyearling chinook migrating later in the year from upstream locations tend to be somewhat larger, with the largest subyearlings reaching the lower river from the upstream reaches in the autumn. Consequently, several different size groups of subyearling salmon appear in substantial numbers from March through about October.

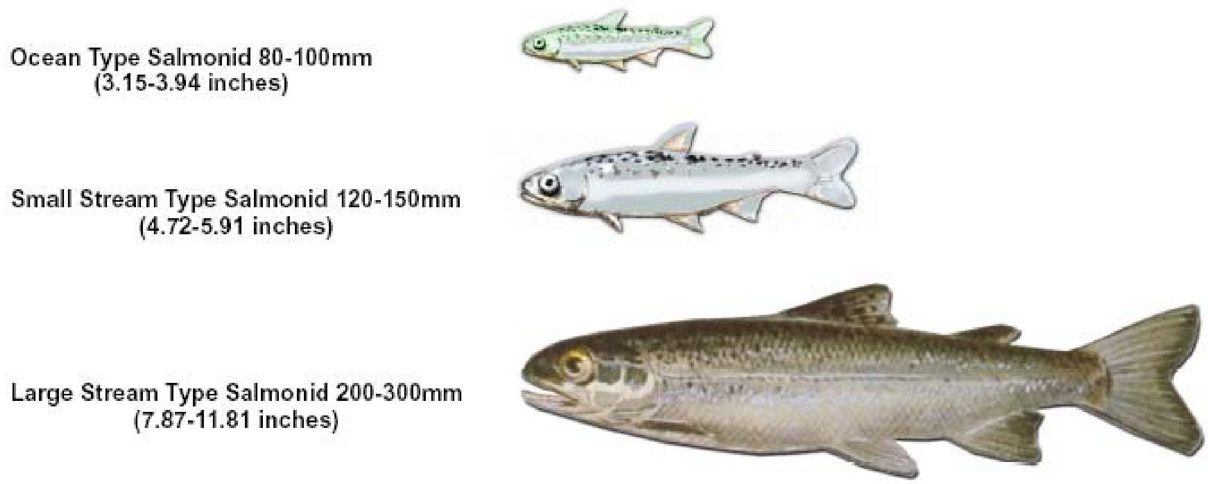
The smaller juvenile salmonids tend to rear and move relatively slowly through the lower river, primarily occurring in shallow water habitat for extended periods of time. Older subyearlings and smolts tend to move faster through the lower river, where they tend to be surface-oriented (Holmberg and Adams 2002). Mean travel times for these fish from Bonneville to the Interstate 205 Bridge near Portland are in the range between 14.1 to 14.4 hours. These data indicate that these species are moving through the action area very quickly and are not using the area for rearing (Table 4-2). Figure 4-1 shows some of the life stages of the listed species, as well as their relative sizes.

Table 4-2. Travel Time (hours) of Radio-tagged Juvenile Salmonids from John Day Dam to I-205 Bridge

Species	Number	Mean	Median	Std. Dev.	Range
Bonneville Forebay to I-205 Bridge					
CH1	1,379	15.7	14.4	6.5	10 - 121
STH	521	16.3	14.1	8.9	9 - 94
CH0	1,942	15.6	14.2	5.7	9 - 149

CH1 = stream-type chinook; STH = stream-type steelhead; CH0 = ocean-type chinook
Source: USGS 2002

Figure 4-1. Salmonid Sizes in the Lower Columbia River



General life history and associated environmental conditions for ocean-type and stream-type salmon are discussed in the following sections. The major river category or reach type (riverine, estuarine, mouth of the Columbia River, side channels) that the species types use during migration and rearing also are discussed.

4.2.1 Ocean-type Salmon

Ocean-type salmon ESUs in the Columbia River include some chinook (Lower Columbia River, Snake River fall, and Upper Willamette River spring) and chum salmon. Ocean-type salmon migrate downstream as subyearlings, generally leaving the spawning area where they hatched within days to months following their emergence from the gravel. They commonly spend weeks to months rearing within the action area prior to reaching the size at which they become smolts (70 to 100 mm) and migrate to the ocean.

The majority of ocean-type fish are present in the action area from early spring through late summer (Herrmann 1970, Craddock et al. 1976, Healey 1980 and 1982, Congleton et al. 1981, Dawley et al. 1986, Levings et al. 1986), though some are present year-round. The earliest subyearling migrants can be as small as 30 to 40 mm fork length (i.e., from snout to fork in the tail) when they arrive in the estuary because some of these fish are from lower river tributaries near the estuary. Later spring migrants are generally larger, ranging up to 50 to 80 mm, because they come from tributaries further upriver. Subyearlings from the mid-Columbia and Snake Rivers tend to be substantially larger (70 to 100 mm) by the time they reach the lower Columbia River and estuary. Subyearlings rear in the riverine reach from days to months depending upon how far upriver they are coming from. The migration rate for subyearlings moving through the riverine reach is likely to be a few to 10 kilometers (km) per day, while subyearlings migrating directly to the estuary migrate at rates of 15 to 30 km per day (MacDonald 1960, Simenstad et al. 1982, MacDonald et al. 1987, Murphy et al. 1989, Fisher and Pearcy 1990).

The different size of the subyearlings when they reach the estuary indicates that they are capable of using different habitats in the estuary and lower river. The larger subyearlings from the Snake River likely use a greater range of depth and current conditions than the smaller subyearlings of the lower Columbia River ESUs. The smaller subyearlings are commonly found within a few meters of the shoreline at water depths of less than 1 meter. Although they migrate between rearing areas over deeper water, they generally remain close to the water surface and near the shoreline during rearing, favoring water no more than 2 meters deep and areas where currents do not exceed 0.3 meters per second (Bottom et al. 2001). Larger ocean-type fish occur over deeper water and faster currents.

Young chinook in the lower Columbia consume a variety of prey, primarily insects in the spring and fall and *Daphnia* from July to October (Craddock et al. 1976). The amphipod *Corophium* is the dominant prey species in winter and spring (Dawley et al. 1986). Bottom and Jones (1990) reported that young chinook ate primarily *Corophium* males, which apparently are more readily available than the larger females.

Ocean-type fish commonly have the capacity to adapt to highly saline waters shortly after emergence from the gravel. Tiffan and others (2000) determined that once active migrant fall chinook passed McNary Dam (470 km upstream from the Columbia River's mouth), 90 percent of the subyearlings were able to survive challenge tests in 30 parts per thousand (ppt) sea water at 18.3°C. Other investigators have found that very small chinook fry are capable of adapting to estuarine salinities within a few days (Ellis 1957, Clark and Shelbourn 1985). Wagner and others (1969) found that all fall chinook alevins tested were able to tolerate 15 to 20 ppt salinity immediately after hatching.

It is likely that young salmonids pass through the MCR from spring through the autumn months. Outside the MCR, young salmonids enter the Columbia River plume and ocean environment. Pearcy and others (1990) found chinook in near-surface waters up to 46 km offshore from Oregon and Washington during the summer months, but absent from this area by mid-September. Orsi and others (2000) found that juvenile chinook, chum, and pink salmon were most abundant in the shoreline (strait) waters of southeast Alaska during June and July when zooplankton abundance was highest. Food availability also may be a factor in the timing of Columbia River salmon migration. However, Brodeur (1992) concluded that food availability off the Oregon and Washington coasts was not a limiting factor. Recent research by Casillas, Schiewe and others showed that the plume area can provide important transitional habitat for salmon by providing an important feeding area and potentially a refuge from predators (Casillas, pers. Communication). Their research indicated that frontal areas in the plume environment may be important feeding and rearing areas since the frontal areas are water mass boundaries that may concentrate food items. These areas may have a significant influence on the survival of juvenile salmon in the ocean.

4.2.2 Stream-type Salmon

Stream-type ESUs include some of the chinook salmon ESUs (Lower Columbia and Upper Columbia spring), sockeye, coho, and steelhead. They rear in fresh water, usually remaining in the stream where they hatched for a year or more before beginning their downstream migration to the ocean. Steelhead trout may rear in fresh water for several years before migrating to the ocean. Sockeye rear in lakes rather than in streams. Stream-type or yearling salmon migrate as relatively large smolts (generally 100 to 300 mm) and move quickly through the action area within days to weeks.

Smolts tend to be spring migrants that pass through the action area from early April through June (Corps 2004). Smolts are commonly found farther from shore with a deeper distribution than ocean-type migrants. Johnsen and Sims (1973) compared beach seine and purse seine catches of chinook from fresh water and brackish water sites in the lower Columbia River. The majority of chinook collected from the shoreline sites by beach seine was in the range of 50 to 80 mm, while the majority of chinook collected from deeper water by purse seine was in the range of 90 to 150 mm. These larger fish collected from offshore locations are the smolt-size juveniles characteristic of stream-type salmon.

Because of their relatively large size and rapid migration, stream-type juveniles have somewhat different habitat requirements in the lower Columbia River than subyearlings. These relatively large smolts have the physical capacity to deal with a much larger range of conditions than subyearlings.

Smolts are found in a wide range of current speeds as they move downstream. They tend to avoid low-velocity areas except during brief periods when they hold position against tidal or river currents. Schreck and Stahl (1998) and Schreck and others (1997, 2001) determined the swimming speed of yearling chinook and steelhead as they migrated from Bonneville Dam to the estuary. Yearling chinook moved about 140 km in 24 to 90 hours at a rate of 1 to 6 km per hour (0.7 to 3.7 miles per hour). Steelhead smolts have been found to migrate distances of 134 to 143 km in 32 to 90 hours, moving at an average rate of 3.3 km per hour (2 miles per hour; Durkin 1982, Dawley et al. 1986). These fish either remain in the channel where substantial current occurs or are actively swimming at a high rate. Continuous tracking of some individual fish indicates that they remain in major channels where substantial downstream currents occur, and that they move between channels.

Yearling salmonids in the lower Columbia River generally eat the same types of organisms as subyearlings. In the lower Columbia River, they consume diptera, hymenoptera, coleoptera, tricoptera, and ephemeroptera. In the estuary, their diet changes to diptera, cladocerans, and amphipods (*Corophium salmonis, C. spinicorne, Eogammarus confervicolus*; Dawley et al. 1986). As in the riverine reach, Bottom and Jones (1990) found young chinook ate primarily *Corophium* in winter and spring and *Daphnia* in summer.

Stream-type smolts are present in the estuary primarily in May and June, with small numbers appearing earlier and later in the year. Smoltification or physiological adaptation to migration and high salinity conditions begins in yearling salmonids before they begin their downstream migration. Salinity challenge tests have routinely shown that yearlings are capable of residing in moderate to high salinities (up to and greater than 20 ppt) long before they reach the saline water of the estuary. Sims (1970) reported that young chinook in the Columbia River that were marked one day in a freshwater area were found the next day in a high salinity area 43 km downstream. Movement from fresh water to salt water apparently does not place high metabolic demands on young salmon (subyearling or yearling). Bullivant (1961) found no significant difference in oxygen consumption rates in young chinook when in fresh water, dilute sea water, or sea water (35.4 ppt). He interpreted this lack of difference in oxygen consumption rates as an indication that the energy expended on osmoregulation was a small portion of the total energy consumption.

It is likely that fish move into the ocean relatively quickly, taking advantage of the outgoing tides that provide rapid currents into the open ocean. As with ocean-type salmon, steelhead and chinook were collected by Pearcy and others (1990) from near-surface waters up to 46 km offshore from Oregon and Washington during the summer months, but were absent from this area by mid-September. Food availability off the Oregon and Washington coasts was not a limiting factor for chinook (Brodeur 1992). In a similar study, Orsi and others (2000) found that juvenile chinook, coho, and sockeye salmon were most abundant in shoreline (strait) waters of southeast Alaska in June and July when zooplankton abundance was highest. These waters differ from open ocean conditions because the strait offers greater protection from surf conditions. Stream-type juveniles use the plume environment similar to ocean-type salmon, as described above.

4.3 ADULTS

Adult salmon migrate through the mouth of the Columbia River during their return to the Columbia River for their upriver spawning areas. Migration timing varies by ESU but is generally from early spring until winter. Adults may hold in the ocean and plume area and continue to feed until conditions are right for upstream migration. Once the adults begin migration, they generally move quickly through the lower river and do not feed.

Adult salmon generally are not exposed to temperatures in a lethal range because of their capacity to avoid high temperatures, together with their propensity to remain in relatively open water until they reach spawning areas. However, high temperatures can delay their migrations. There are several examples in the Columbia River of adult migrations halting due to high or low water temperatures. In 1941, extremely high water temperatures (22° to 24°C) apparently resulted in chinook, sockeye, and steelhead adults congregating in small, cold streams near the Bonneville and Rock Island Dams (Fish and Hanavan 1948). At the Okanogan River, Major and Mighell (1967) observed that temperatures greater than 21°C blocked sockeye migrations, while stable or even rising temperatures below 21°C did not block migration.

Spawning areas are present in the action area for chum salmon, fall chinook, and coho (Figure 4-2). Chum spawning areas have been identified from RM 113 to 114 on the north side of the main navigation channel and on the Oregon side of the channel approximately 2 miles above the confluence of the Sandy River. In addition, the area from RM 125.3 to 145 has spawning habitat in the side-channel area between the main channel and Ives and Pierce Island (Figure 4-2). Coho, fall chinook and chum salmon use this area for spawning extensively. Chum salmon primarily use the lower areas. All these sites are monitored and surveyed on a frequent basis by the Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service. Estimates of chum salmon spawning numbers are shown in Table 4-3. Approximately 196 coho and 2,873 fall chinook spawners were counted in the Ives Island area in 2003.

Table 4-3. Chum Salmon Spawning Ground Survey Counts

Columbia River Location	Live Fish	Carcasses	Total
RM 113	275	12	287
RM 136	976	79	1,055
RM 137	66	12	78
RM 139	142	26	168
Ives Island Area	1,381	354	1,735

4.4 RUN SIZE

The run size of salmon in the Columbia River has been decreasing since the turn of the century when over-fishing and habitat destruction severely reduced the numbers of spawning fish. Further declines in wild salmon numbers in the early 1990s prompted NOAA Fisheries to list the Snake River runs of sockeye, and spring/summer and fall runs of chinook salmon as endangered and threatened, respectively. In the late 1990s, additional runs of Columbia River and Willamette River Chinook and Columbia River chum salmon also were listed, as well as certain runs of upriver and Willamette River steelhead trout. The run size of salmon into the Columbia River from 1998 to 2000 is shown in Table 4-4.

Figure 4-2. Columbia River Spawning Areas

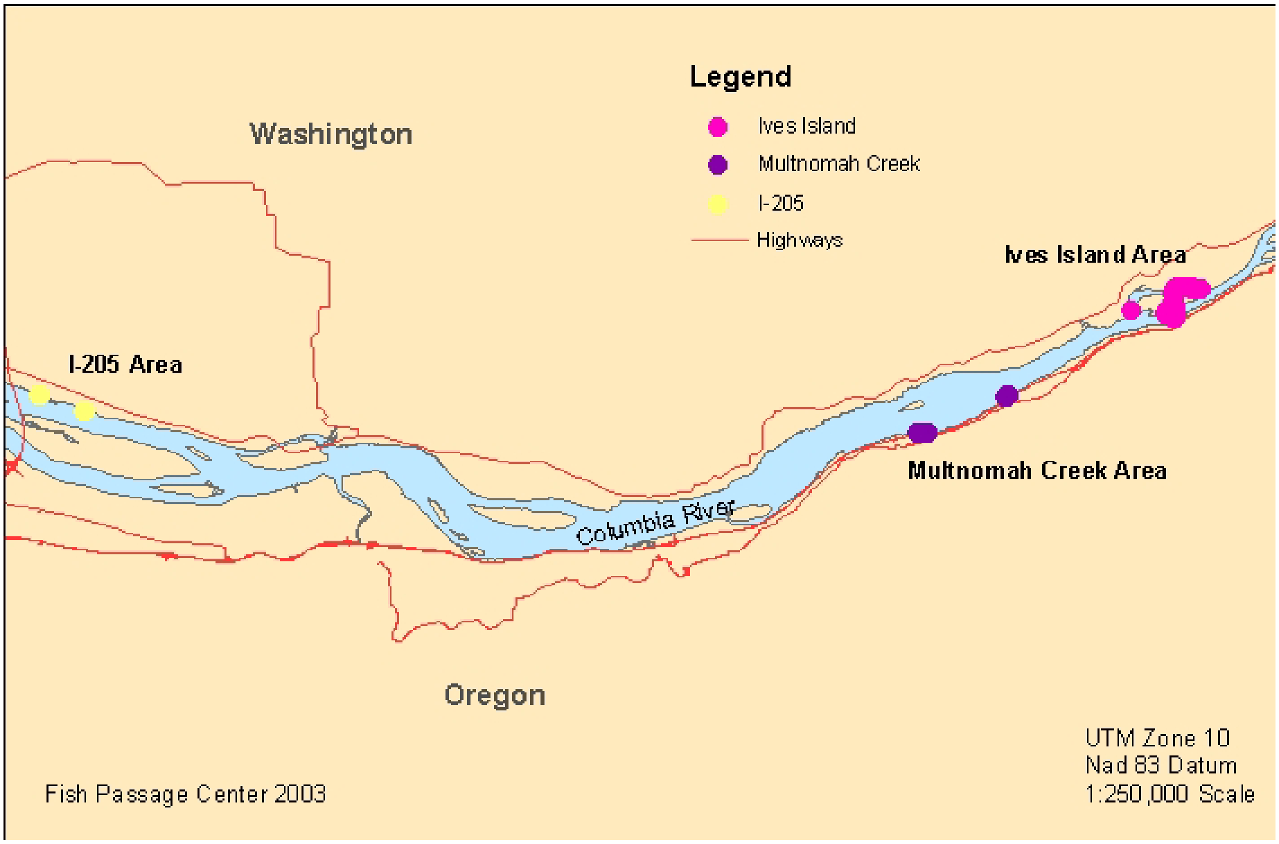


Table 4-4. Minimum Numbers of Salmon and Steelhead Entering the Columbia River, 1998-2000

Year	Chinook			Sockeye	Coho	Chum	Steelhead		Total
	Spring	Summer	Fall				Winter	Summer	
1998	94.1	24.1	295.6	13.2	193.6	1.9	23.6	216.0	862.1
1999	112.1	30.3	338.1	17.9	305.0	2.4	(13.2)	(243.1)	1,062.1
2000	274.0	44.4	323.9	93.7	624.3	2.5	(19.1)	(316.2)	1,698.1

In thousands, including jacks; numbers in parentheses indicate estimates.
Source: Norman and King 1997.

Baker Bay has historically provided an important rearing and transition area for juvenile salmonids. Its proximity to the ocean and marine environment with highly productive habitat is valuable to juvenile salmonids transitioning between the river and the ocean. The Skipanon River and Hammond Boat Basin also likely provided some level of off-channel habitat for juvenile salmonids.

4.5 CRITICAL HABITAT

Table 4-5 describes critical habitat as currently designated for the listed species within the action area. Critical habitat though originally designated for all 13 species was resended by court order in April 30, 2002 for 10 of the species. The only runs with critical habitat are Snake River sockeye, Snake River spring/summer and fall Chinook. Critical habitat in the action area generally extends bank-to-bank from Bonneville Dam to the tip of the MCR jetties (does not include the marine areas), and 300 feet inland on each side of the Columbia River for riparian area protection.

Table 4-5. Critical Habitat Designations and Descriptions

Species	Date of Critical Habitat Designation	Description of Critical Habitat[1]
Chinook Snake River spring/summer	October 25,1999	Columbia River and estuary to confluence with Snake River, Snake River and tributaries
Chinook Snake River fall	December 28, 1993	Columbia River and estuary to confluence with Snake River, Snake River and tributaries
Chinook Lower Columbia River	Not yet designated	
Chinook Upper Columbia River	Not yet designated	
Chinook Upper Willamette River	Not yet designated	
Chum Columbia River	Not yet designated	
Coho Lower Columbia River/SW Washington	Not yet designated	
Sockeye Snake River	December 28, 1993	Columbia River and estuary to confluence with Snake River, Snake River and tributaries
Steelhead Snake River	Not yet designated	
Steelhead Lower Columbia River	Not yet designated	
Steelhead Middle Columbia River	Not yet designated	
Steelhead Upper Columbia River	Not yet designated	
Steelhead Upper Willamette River	Not yet designated	

[1]Critical habitat includes the riparian areas adjacent to listed rivers and streams. Riparian areas are defined as those areas adjacent to a stream that provide the following functions: shade, sediment transport, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter (65 FR 7764). Critical habitat for salmonids in the Columbia River, as defined by NOAA Fisheries, ends at the jetties at the MCR and does not include marine areas.

5. EFFECTS OF THE ACTION

5.1 MOUTH OF THE COLUMBIA RIVER (RM -3 TO +3)

5.1.1 Proximity of Action

Dredging is done in the MCR in order to maintain the federally authorized width of 2,640 feet and a depth of 55 feet on the out-bound (north) side of the channel, and a depth of 48 feet on the narrower, in-bound side of the channel. Both lanes are dredged an additional 5 feet deeper to ensure that the authorized depth is available as long as possible between dredging cycles. Over the last 5 years, an average of approximately 4,200,000 cy of material has been dredged each year from the MCR Project. All stocks of Columbia River salmonids must pass through the MCR twice, first during their seaward migration as juveniles and then as part of their adult migration from the ocean to spawning grounds found throughout the Columbia/Snake/Willamette watershed areas. There are juvenile and/or adult salmonids migrating through the MCR year-round.

Disposal of dredged material is primarily performed using ocean disposal sites and a site on the river side of the north jetty (see Figure 2-1). All MCR disposal sites are located in areas where adult and juvenile salmon may occur.

5.1.2 Distribution

Although the MCR Project is defined as RM -3 to +3, dredging is primarily conducted from RM -2 to +2.5. The area from RM +2.5 to +3 is a deep hole that does not require dredging to maintain the necessary navigation channel depth. The ocean end of the channel (RM -3 to -2) also is deep enough so that dredging is not necessary at that location. Within the 4-mile stretch that is dredged annually, only hopper dredges are used. Operation of the dredge is expected to cause a minimal disturbance that would affect listed stocks of salmonids.

The proposed EPA Section 102 Deep Water Site is located approximately 4.5 miles from the shoreline. The dimensions of the site are 17,000 x 23,000 feet including a 3,000-foot buffer. The water depth ranges from 190 to 300 feet. The quantity of material placed in this area would be determined by the amount of shoaling, and the capacity and availability of other sites planned for use. Until this 102 site is designated, the Corps will continue to use the 103 site, which is a smaller site within the Deep Water Site.

The Shallow Water Site (includes the original Section 102 site “E” plus expanded Section 103 site) is located off the end of the north jetty and is highly erosive. Most of the material eroding from this site moves to the north where it could aid to offset ongoing erosion along the Washington shoreline. This site has supported large quantities of disposed material in recent years, as much as 3.7 mcy in a single year (1999). More recently, volumes ranged from 1.5 mcy in 2002 to 2.9 mcy in 2000.

The North Jetty disposal site is located on the river side near the MCR north jetty. The Corps began using this site in 1999 to protect the north jetty from potential undermining. In 1999, approximately 1 mcy of material was placed at this site. All subsequent years have had approximately half of that amount, with volumes ranging from 0.5 mcy in 2000 to 0.45 mcy in the 2003 dredging season.

5.1.3 Timing

Dredging and disposal typically occur from June through October. This coincides with juvenile out-migration for all of the listed salmonid species. This also coincides with adult upstream spawning migration for the following ESUs: summer run chinook, fall run chinook, summer steelhead, and coho.

5.1.4 Nature of Effects

5.1.4.1 Entrainment

Entrainment occurs when fish are trapped by the force of suction and carried into hopper or pipeline dredges. There are two potential ways salmonids could be affected by entrainment: (1) the direct entrainment of salmonids during dredging operations, and (2) the entrainment of salmonid prey species during dredging operations.

A number of entrainment studies have been conducted to assess the potential for entrainment of salmonids. The only documented entrainment of salmonids occurred during a study in which the dredge draghead was operated while elevated in the water column instead of on the channel bottom. Only three individuals were collected and they were hatchery fish from the lower river (R2 Resource Consultants 1999). In a study done by Larson and Moehl (1990) at the MCR over a 4-year period, no juvenile or adult salmonids were entrained during normal dredging operations. Pearson and others (2003) also found that no juvenile salmonids were entrained. The consensus of these and other studies (McGraw and Armstrong 1990, Buell 1992) is that most dredging occurs below the depth where salmonids migrate and/or in different locations from preferred salmonid habitat. Although salmonids can occur throughout the water column, most migrate in the upper 20 feet of the water column (Bottom et al. 2001). Juvenile ocean-type salmon, in particular, tend to stay in the channel margins or shallow, shoreline areas.

The Corps' dredging procedures call for the draghead to be buried in the sediment of the riverbed during dredging operations or raised no more than 3 feet off the river bottom when the pumps are running to further reduce the potential for fish entrainment. Adult salmonids have sufficient swimming capacity to avoid entrainment by dredging if they are present in the vicinity of dredges and if the draghead is above the riverbed when operating. As noted in the discussion of pipeline and hopper dredging in Section 2.2.1, the BMPs for dredging operations require that the dredge pump not be operated when the draghead is raised more than 3 feet above the river bottom.

Entrainment of prey species is discussed in Section 5.1.4.3, *Loss of Benthic Community*.

5.1.4.2 Fish Behavior (spawning, rearing, migration)

Dredging at the MCR is likely to only have a minimal effect on the behavior of juvenile and adult listed salmonid stocks in the area where the dredges are working. However, it is not anticipated that this will have a significant impact on salmonid migration because salmonids are not commonly found in the deeper areas that are dredged. Since the MCR is not an area where salmonids are known to spawn, there would be no impact to that portion of their life cycle. Also, the MCR is primarily a high-energy environment, subject to wave energy, tides, ocean currents, and freshwater flow levels moving through a constricted channel width, which is not the preferred area for salmonid rearing.

5.1.4.3 Loss of Benthic Community (feeding opportunities)

Dredging the MCR will cause a loss of benthic community in the area dredged. It is likely that benthic invertebrate prey such as *Corophium* will be entrained in active dredge areas within the navigation channel. Although these areas are moderately productive (McCabe et al. 1996), they are not a major source of food for organisms transitioning into and out of the river system. In the MCR, any feeding by salmonids is likely done in the water column and near the water surface, not in the deepest parts of the channel where dredging occurs. The benthic prey consumed by young salmonids primarily comes from the large areas of shallow water where channel dredging will not occur.

Entrainment of planktonic prey also potentially occurs during dredging. Prey resources such as *Daphnia* and similar organisms will be entrained. However, these planktonic invertebrates are numerous throughout the water mass of the lower Columbia River. The portion of the population lost through the small portion of the water mass entrained will be small as compared with the amount available.

Disposal of dredged material in all of the disposal sites will result in the burying of benthic organisms found below the hopper dispersal zone. It is likely that little feeding is occurring in the high-energy disposal areas along the North Jetty and the Shallow Water Site. Juveniles exiting the estuary feed predominantly in the frontal area of the plume. The Deep Water Site is below the frontal area and is deep enough that it would not be expected to be a feeding area for salmonids. Although the depth of the frontal area varies, it is never as deep as the 22 to 28 feet in depth where the material is discharged from the hopper dredge. Consequently, it is unlikely that any salmonids will be impacted by dredge disposal at the Deep Water Site.

5.1.4.4 Harassment/Displacement (acoustic effects)

It is likely that the noise and activity associated with dredging at the MCR will cause some harassment and displacement of juvenile and adult salmonids in the immediate area where the dredge is working. That is, fish would likely avoid the area if the noise of the dredging activity was disturbing to them. However, the area of disturbance around the dredge is very small relative to the entire MCR area, and the impact to salmonids is expected to be minimal since most fish are able to avoid the impact area and can find ample area for migrating around the dredge.

The disposal of materials from the hopper dredge will result in an increase in suspended solids at the disposal sites as they fall to the bottom and/or are carried with the current. This impact should be localized because the sediment is more than 98 percent sand, which does not stay suspended in the water column for any length of time. However, this can be affected by the amount of current in the area at the time of disposal. Larger currents may increase the size and duration of the turbidity plume which could increase the time fish are exposed to the increased turbidity

5.1.4.5 Sediment

Sediments from the federal navigation channels are evaluated to determine if they are acceptable for in-water disposal according to the requirements of the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act. The Corps began collecting sediment quality data from its projects in the late 1970s. These data are available at https://www.nwp.usace.army.mil/ec/h/hr/. A tiered sediment evaluation framework has been used since 1986. The tiered framework allows for more consistent design of testing programs that maintains statutory compliance while minimizing excessive testing of low-risk projects. The most recent version of this framework is the *1998 Dredge Material Evaluation Framework for the Lower Columbia River Management Area* (DMEF). The DMEF is a regional manual developed jointly with regional EPA, Corps, Oregon Department of Environmental Quality, and the Washington

Departments of Ecology and Natural Resources. The complete DMEF evaluation methodology can be found at https://www.nwp.usace.army.mil/ec/h/hr/Final/). If sediments are determined unsuitable for open water disposal, then disposal is limited to confined disposal and is subject to all environmental regulations governing the disposal of sediments not suitable for unconfined disposal.

Project sediment testing is performed typically at the MCR on a 10-year rotational cycle, unless some event occurs that would warrant more frequent sampling. The 10-year rotation allows the continued, even management of both budget and labor while providing sufficiently current sediment quality information to allow dredging to proceed unobstructed. Projects dredged less frequently, such as the side channel projects, are evaluated, sampled, and tested prior to dredging.

Corps' staff collects most sediment samples, though contracts also are used in specific cases when special equipment is required to collect samples. Contract laboratories conduct physical, chemical and biological analyses. Complete past and present chemical evaluations on all dredging projects can be found at https://www.nwp.usace.army.mil/ec/h/hr/htm.

The most recent sediment evaluation for the MCR Project was conducted in 2000. Samples were evaluated using screening levels found in the 1998 DMEF. Tier IIa (physical testing) and Tier IIb (chemical testing) was completed. Sediment represented by the surface grab sediment samples collected during the September 2000 sampling event consisted of 98.11 percent sand and 1.89 percent fines, with a median grain size of 0.16 mm. The potential dredging area consists of sand waves or cutline shoals, which by their highly active nature are homogeneous material and can be fully characterized by surface grab samples.

Chemical analytical analyses included inorganic metals (9), total organic carbon, pesticides, PCBs, phenols, phthalates, miscellaneous extractables, and PAHs. Three samples were submitted for dioxin/furan analyses. Results showed that few chemicals of concern were even detectable above the method detection levels. Those that were detectable were at levels well below the DMEF Tier IIb screening levels. Based on these analyses, the MCR meets the guidelines established in the DMEF for open, in-water, unconfined placement.

5.1.4.6 Water Quality (total suspended solids, turbidity, dissolved oxygen, resuspension of toxins)

Hopper dredges generally do not produce large amounts of turbidity or total suspended solids during dredging because of the suction action of the dredge pump and the fact that the draghead is buried in the sediment.

Although there is some evidence that dredging of fine sediments can create a situation that decreases dissolved oxygen in the water column, that situation does not occur in the MCR. The sediment dredged in this area is primarily sand (<2 percent fines) and therefore, it is unlikely that dissolved oxygen will be impacted either by the dredging or disposal of this sandy material. It is also true that toxins found in the sediment adhere to fine-grained material, not sand (EPA 1991). Because toxins should not be present in the first place, there is no expectation of a resuspension of toxins by either the dredging or disposal activity in this area.

Maintenance dredging will occur within the navigation channel and will remove sand and sediment only from that area. Disposal activities will involve only those materials removed during dredging. The material at the bottom of the navigation channel is composed of primarily sand (<2 percent fines). The likelihood of increased suspended solids causing gill clogging in migrating salmonids depends on a number of factors, including:

- Duration of exposure to suspended solids.
- Concentration of suspended solids.
- Particle size of suspended solids.
- Angularity of suspended solids.

The highest increases in suspended solids concentrations are anticipated to be localized and short-term, and occurring near the dredging and disposal operations. The likely exposure of salmonids will be to the low concentrations (0 to 2 mg/L increases) that will occur downstream from dredging and disposal operations. In addition, less than 1 percent of dredged material consists of the fines that cause gill clogging (Sigler et al. 1984). Accordingly, the anticipated slight increases in suspended solids will not be of sufficient intensity or nature to cause gill clogging in salmonids.

There is the potential for short-term and localized elevation of turbidity levels during maintenance dredging at both the dredging and disposal locations. Increases in turbidity are localized with levels of 5 to 26 NTUs possible (Corps 2001). These increases will be short term (less than 1 hour) and confined to areas where dredging and disposal will occur. In areas where neither dredging nor disposal is occurring, there could be a 0 to 1 NTU increase in background turbidity levels.

5.1.4.7 Physical Habitat Alteration (shoreline/river bottom)

Every dredging cycle returns the bottom depth to the authorized AMD depth. This means that there is a physical alteration of the bottom of the MCR annually as a result of channel maintenance activities conducted by the Corps. However, this bottom habitat is not where salmonids typically spend time. It also should be noted that the substrate found in the MCR is not a naturally stable environment. The bottom of the river in this high-energy environment is impacted daily by some combination of any or all of the following: tidal influx, waves, ocean currents, freshwater flow (particularly flooding), and ship traffic.

5.1.4.8 Plume/Saltwater Intrusion

The Columbia River plume is the zone of freshwater/saltwater interface where the fresh water exiting the Columbia Rivers meets and rises above the salt water of the Pacific Ocean, just seaward of the MCR. This multi-layered mixing zone plays an important role as habitat for juvenile salmonids. The first few weeks of their ocean life, some of which is spent in the plume, are critical for recruitment success of salmonids (Pearcy 1992). The Columbia River plume provides a high turbidity refuge from predation, provides fronts and eddies where prey became concentrated, and provides a stable habitat for northern anchovy spawning (Richardson 1981, Bakun 1996). A strong, quickly moving plume also helps juveniles move rapidly offshore through potential heavy estuarine and near-shore predation.

A study was conducted by Jay and others (2004-) to examine whether dredging materially affects MCR physical conditions important to juvenile salmonids. This study used hydraulic modeling to examine impacts of maintenance dredging on the properties of the water exiting the MCR to form the plume. Of primary interest was the effect on plume salinity and the plume lift-off point, which sets up the shape and size of the plume. The report concluded that overall maintenance dredging impacts on the physical properties of the plume habitat used by juvenile salmon appear to be small. The results of the study showed that the maximum change in plume initial salinity was predicted to be 1.8 practical salinity units (PSU), and the maximum change in plume initial depth was predicted to be 4.8 feet in the scenario of peak ebb at Buoy 10 (Jay et al. 2004).

Disposal at the Deep Water Site and the Shallow Water Site may result in the dredge material passing through the plume. This can occur if conditions are right for the plume to occur deeper than the draft of the dredge or for the plume to extend over the disposal site. Disposal of dredged material through the plume may result in some of the lighter fractions of the disposal material being entrained in the turbulent mixing area of the plume. Since these fractions most likely would be organic, it is likely that these could provide an addition food source for juvenile salmon or their prey feeding in the plume. Although fish can occur in the immediate offshore area to fairly deep depths, they are most likely in the upper part of the water column and primarily within the upper 12 meters (Emmett et al., In press) Although fish could occur in the water column below the dredge at the Deep Water Site, they likely would not occur there in any abundance because they would most likely be in the upper surface area feeding. Even if fish were present in the water column below the dredge during disposal, it is likely that would avoid the area during disposal.

It is unlikely that any salmonids will occur in the water column below the dredge at the Shallow Water Site because when the dredge is fully loaded, it would be close to the bottom and the fish are likely to avoid this area particularly during disposal.

The report also states that disposal at the Deep Water Site will have no impact on the plume because the site is located at a depth beyond which the plume would be impacted by changing the bottom profile. Study results suggest the following.

- Considering just the average pre-dredge and average post-dredge scenarios, maximum peak-ebb differences in salinity (0.4 PSU) and plume depth (1.21 feet) were much lower values than the maximum values indicated above.
- Tidal monthly and seasonal variations in initial plume properties (salinity, plume depth, and freshwater fraction) are much larger than those related to maintenance dredging.
- Flow regulation at upstream dams has greatly reduced seasonal variations in plume properties by reducing the seasonal range of river flow levels by 40 to 50 percent. The modeled relationship between dredging depth and salinity at Buoy 10 suggests that the annual dredging cycle partially compensates for the reduction in seasonal flow variability. However, seasonal differences in salinity are much larger than those related to the dredging cycle, so any compensation that does occur is modest relative to historical changes.
- The two extreme depth scenarios (5 feet deeper than the deepest post-dredge bathymetry and 5 feet shallower than the shallowest pre-dredge bathymetry, based on observations over the 1993 to 2002 period) confirm that changes in bed-depth in the 10 to 20 feet range have very little influence on initial plume properties.
- Changes in entrance depth cannot change the total export of fresh water to the plume. Thus, impacts of MCR maintenance on the plume are quite limited. Also, initial differences in the freshwater fraction produced in the MCR area are largely preserved as water parcels transit the plume near-field.
- Compensating initial differences in layer depth and salinity often, but not always, disappear (due to vertical mixing) as water parcels transit the plume near-field.
- Because the plume is highly mobile, variations in plume salinity, plume depth, and water parcel trajectories related to changes in coastal winds and currents are far larger than differences related to initial conditions in the MCR region. The effects of river-flow and tidal variability are also larger than those of MCR depth variability.
- Little or no differences in total plume surface area (controlled primarily by river flow and coastal mixing) and plume frontal properties are expected to result from the estimated changes in plume salinities and layer depths.

- Regardless of plume orientation (and the dredging cycle), a continuum of salinities exists within a relatively small area between low initial plume salinities and ocean surface salinities, which vary only modestly with winds and currents. Thus, while maintenance dredging results in modest changes in plume near-field salinities and depths, these are more likely to result in small spatial displacements in habitats (e.g., plume frontal zones) than changes in the areas of such habitats.
- The extreme depth scenarios (very deep or very shallow entrance) do not cause any quantum change in behavior of water parcels as they transit the plume. As expected, however, including the extreme depth scenarios slightly broadens the envelope of outcomes in the plume near-field.

Based on the small level of impact to the plume indicated by the study, it is unlikely there will be any effect on the habitat value of the plume to juvenile salmonids leaving the estuary from either dredging or disposal.

5.1.4.9 Stranding

Stranding typically occurs in the areas with gently sloped shorelines subject to wave action. Stranding is not an issue of concern in the MCR, because the channel is deep and confined by the jetties. Also, there are no shoreline areas in the MCR where fish could become stranded.

5.1.5 Duration

The deeper section of the MCR has been maintained at a depth of 55 feet since the most recent deepening process was completed in 1985. The dredging season is June through October. The exact length of the season varies depending on a number of factors such as the equipment used, amount of material to be dredged, weather/wave conditions in the vicinity of the dredge, and disposal operations. During the dredging season, the optimal schedule calls for the equipment to operate 7 days a week, 24 hours a day, with 4 to 8 hours of down time every 7th day for a crew change on the dredge. There also is occasional down time for repairs and maintenance of equipment, unfavorable weather or wave conditions, and to take on fuel and supplies.

While dredging, the disturbance is not constant. The hopper is filled to near capacity, then dredging stops and the vessel moves to the designated disposal site to empty the hopper. For the *Essayons*, this process of fill and release takes place an average of 8 times in a 24-hour period. There are some days during the dredging season when two dredges are working at the same time in this reach of the river. In 2003, the overlap in dredging schedules only occurred on 4 days (September 23 to 26). On those days, the two dredges were working on two different sections of the channel. The second dredge used in 2002 and 2003 dredging seasons was the *Sugar Island.* This dredge has a much smaller hopper capacity than the *Essayons* and consequently, fills and empties more frequently. In 2002 and 2003, the average for the *Sugar Island* was 14 trips per day.

5.1.6 Disturbance Frequency

This section of the river has been dredged annually to at least the 48-foot depth since 1958, and is expected to be dredged annually for the foreseeable future. As shown in Table 2-6, the dredges (*Essayons* and contract dredge) make about 8 to 14 trips a day from the dredging area to the disposal area. They only spend approximately 45 to 49 percent of the time they are working actually dredging. The remainder of the time (45 to 47 percent) is spent transiting and maintaining the dredge, and 6 to 8 percent is spent in disposal operations. Based on this, fish in the immediate area, are only subjected to dredging impacts approximately 50 percent of the time and disposal impacts 6 to 8 percent of the time, which would give them ample time to migrate through the area.

5.1.7 Disturbance Intensity

Dredging would most likely have a small impact on juvenile and adult salmonids as they migrate into and out of the estuary. This effect is expected to be minor because of the relative absence of fish from depths at which the dredging occurs, the low levels of total suspended solids produced by hopper dredging, and the availability of ample unaffected area for migratory activity.

5.1.8 Disturbance Severity

The potential for impacts to salmonids occurs every year. However, this effect is expected to be minor because of the relative absence of fish from the depths at which the dredging occurs, the low levels of total suspended solids produced by hopper dredging, and the availability of ample unaffected area for migratory activity.

5.2 ESTUARY (RM 3 TO 40)

5.2.1 Proximity of Action

Dredging is done in the Columbia River estuary in order to maintain the federally authorized width of 600 feet and a depth of 40 feet. The Corps is authorized to dredge the channel an additional 100 feet in width and 5 feet deeper to ensure that the authorized width and depth is available as long as possible between dredging cycles. Although the 5-foot AMD dredging is done routinely, the over-width dredging is used only used in situations where shoals are most likely to encroach on the channel and act to narrow the width, thus creating a navigation hazard between dredging cycles. All dredging in this reach of the river is done with a hopper or pipeline dredge. Disposal is currently either upland or flowlane; however, ocean disposal may be used in the future. The estuary provides habitat for all anadromous fish species in the Columbia/Snake/Willamette watersheds for some portion of their life cycle. There are juvenile and/or adult salmonids moving through this area year-round.

5.2.2 Distribution

The estuarine reach of the river is wider and shallower than the upstream or MCR reaches. With the wider riverbed, the speed of water flow is reduced. The water braids its way through islands and flat, shallow areas typical of estuaries in most large river systems. The navigation channel through the Columbia River estuary is only a small portion of the total estuarine habitat available to fish migrating through or rearing in the lower river system. The portion of the navigation channel that requires dredging represents an even smaller percentage of the overall area.

5.2.3 Timing

Dredging occurs between June and October although it can occur as early as March or April for a limited time, if necessary. Typically, a pipeline dredge begins work in June near Miller Sands Channel, and works for a 1 to 3 week period, after which it moves upstream to another location, such as the Brookfield-Welch Island Reach or Skamokawa Bar. It then works for another 1 to 3 week period before moving further upstream to the next restricting shoal to be dredged. During this time period, a hopper dredge may work in the estuary removing isolated sand waves. Hopper dredges typically work for 2 to 5 days on individual shoals. In some years, it is necessary for the pipeline dredge to move back downstream later in the summer if a hydrographic survey shows shoaling in the navigation channel. However, the normal progression of work for the pipeline dredge is to continue moving upstream as the dredging season progresses and remove the large shoals that restrict deep-draft traffic. This work coincides with juvenile out-migration for all ESU listed species of salmonids. This also coincides with adult upstream spawning migration for the following ESUs: summer run chinook, fall run chinook, summer steelhead, and coho.

5.2.4 Nature of Effects

5.2.4.1 Entrainment

It is not anticipated that any salmonids will be entrained during dredging operations in this reach because the draghead is located on the bottom of the navigation channel, an area which does not provide preferred salmonid habitat. Also, the area of possible entrainment is very small, leaving salmonids ample area to move away from the impact area. In addition, to further minimize the possibility of impact, the Corps uses the BMP that requires the draghead to be in or within 3 feet of the bottom while the pumps are running.

Any entrainment of salmonid prey species in the estuary will be limited to those found in the navigation channel where benthic productivity is low. *Corophium* and other benthic prey consumed by young salmonids come primarily from the large areas of shallow water in the lower Columbia River, where channel dredging will not occur.

Entrainment of planktonic prey also potentially occurs during dredging. Prey resources such as *Daphnia* and similar organisms will be entrained. However, these planktonic invertebrates are more abundant in the upper layers of the water column than in or near the deep-water bottom substrate where dredging is occurring. The portion of the population lost through the small portion of the water mass entrained will be small compared to the amount available to juvenile salmon in the upper water column.

5.2.4.2 Fish Behavior (spawning, rearing, migration)

Dredging in the deep-draft navigation channel of the Columbia River estuary is likely to have only a minimal affect on the behavior of juvenile and adult listed salmonid stocks from the disturbance created in the area where the dragheads and cutterheads are working. However, it is not anticipated that this disturbance will have a significant impact on salmonid migration because salmonids are not commonly found in the deeper areas that are dredged, and the area disturbed is small relative to the overall area available for migration. The estuary is not an area where salmonids are known to spawn, so there would be no impact to that portion of their life cycle. The estuary does provide large slack-water areas for rearing. Most rearing occurs in the upper part of the water column near the shore and in shallow-water areas (Bottom et al. 2001), where the mainstem navigation channel maintenance activities of dredging and flowlane disposal will not be occurring.

Disposal of dredged material in this reach occurs primarily by flowlane disposal, although shoreline and upland disposal also may be used. Flowlane disposal is done in the main channel of the river. When the hopper dredge uses flowlane disposal, the impact area is directly below the hopper and downstream of the hopper where the current carries the sediment load. Sand falls out of suspension quickly and therefore, the plume of suspended sediment quickly dissipates. When pipeline dredges use flowlane disposal, the end of the disposal pipe is placed at 20 feet in depth and the sediment is released at that depth. The plume from pipeline flowlane disposal would be deep enough to have little to no impact on salmonids.

Shoreline disposal at Miller Sands (RM 23.5) and near Skamokawa Creek (RM 33.4) has the greatest potential for impacting the shallow shoreline areas that are known to be utilized by migrating and rearing juvenile salmonids. However, it should be noted that shoreline disposal is used as shoreline disposal in areas that are highly erosive and do not contain many of the important habitat features that shallow water habitats typically include, such as low velocity, vegetation, and food sources. In an unstable bank environment, a higher level of suspended sediment and turbidity are a natural occurrence. In addition, while high levels of turbidity are know to affect salmonid physiology and feeding success, the combined background and project-related turbidity concentrations are well below known salmonid impact levels (Corps 2001).

Upland disposal would have some impact on the shallow shoreline areas. However, there would be less impact than for shoreline disposal because water flowing through the weirs of the diked upland sites allows for some settling of the suspended solids before the water is returned to the river system.

5.2.4.3 Loss of Benthic Community (feeding opportunities)

Although dredging the main navigation channel will result in a loss of benthic community in the areas dredged, the deeper areas where dredging occurs are not as productive as shallower areas because they are below the photic zone where light penetration increases productivity.

Flowlane disposal will have some impact on the limited benthic community of the navigation channel because that is where the majority of the dredge material will fall when released from the hopper or pipeline dredge. Any suspended sediment, which is carried by the current into shallower water, may act to cover invertebrates and their habitat. It is not expected that the amount of suspended sediments entering the shallower areas will be sufficient to cause significant impact to the invertebrate food source for salmonids.

Shoreline disposal will bury any benthic invertebrates in the area of disposal. The new substrate would be expected to recolonize as soon as the disturbance subsides. The impacts of this loss of benthic invertebrates would be expected to be minimal since the area impacted is small relative to the total size of the estuary. For upland disposal, the amount of impact would be less than with shoreline disposal because the amount of sediment in the outfall would be significantly less. As with the other forms of disposal, the area would be suitable for recolonization by invertebrates immediately after the disturbance stops.

5.2.4.4 Harassment/Displacement (acoustic effects)

It is likely that the noise and activity associated with dredging in the estuary will cause some harassment and displacement of juvenile and adult salmonids that are in the immediate area where the dredge is working. That is, fish would likely avoid the area if the noise of the dredging activity was disturbing to them. However the area of disturbance around the dredge is very small relative to the entire estuary area, and the impact to salmonids is expected to be minimal since most fish do not occur in this area and those that do are able to avoid the impact area and can find ample area for migrating and rearing away from the dredging activity. In fact, most migration and rearing would be expected to occur in shallower areas and not in the area where dredging is occurring.

The flowlane disposal of materials from the hopper dredge or pipeline will cause a disturbance at the disposal sites, which are generally the deepest parts of the channel. The nature of the disturbance is mostly related to the suspended solids released from the hopper or pipeline as they fall to the bottom and/or are carried with the current. This impact should be localized because the sediment is more than 98 percent sand, which does not stay suspended in the water column, although this is affected by the amount of current in the area at the time of disposal. Higher flows would increase the size of the turbidity plume. However, juveniles are generally not found at this depth and consequently, would not be impacted to any extent by the turbidity plume. Also, because of the draft of the dredge, it is within 10 to 15 feet of the bottom during disposal. This would also tend to minimize the chance of salmonids being in the area and affected by disposal.

5.2.4.5 Sediment

With few exceptions, the material in the Columbia River navigation channel, in the RM 3 to 40 reach through the estuary, consists of clean, medium- to fine-grained sands. Fines and organic content are generally less than 1 percent by weight. Three sampling events discussed below support this statement. Chemical analyses included inorganic metals (9), total organic carbon, pesticides, PCBs, phenols, phthalates, miscellaneous extractables, and PAHs. Dioxin/furans analyses were conducted on select samples. Results showed that few chemicals of concern were detectable above the method detection levels. Those that were detectable were at levels well below the DMEF Tier IIb screening levels. Based on these analyses, the material meets the guidelines established in the DMEF for unconfined, in-water placement. The historical data from several thousand additional sediment samples were also analyzed as part of the CRCIP. The results from this analysis further supported the conclusion that material in the navigation channel is clean and suitable for unconfined in-water disposal. This information was provided to NOAA Fisheries in an April 22, 2002 letter amending the CRCIP BA. NOAA fisheries reviewed this information and concurred with this analyzes in the CRCIP BiOp 2000. The Corps also continues to take samples and review samples taken by other entities to further its knowledge base on the quality of sediment in the Columbia River.

The main navigation channel, RM 10 to 13.5 near Astoria, was sampled on June 25, 2003. This material was sampled by a box-core sampler and consists of 99.05 percent sand and 0.95 percent fines with a median grain-size of 0.26 mm. One sample contained several fine-grained sediment clasts (clay balls), with 79 percent fines, which was not representative of the material in the area and was not included in the above calculation. Tier IIb chemical testing was conducted on the fine-grained material separately from the coarser-grained material. The resulting data showed slightly higher levels of most contaminants detected, above the surrounding coarser material, but all levels met the DMEF guidelines for in-water placement.

River miles 29 to 34 were sampled at Brookfield Mound and Skamokawa Turn on August 9, 2000 and September 7, 2000. The mound was sampled with box-core and vibra-core samplers. While this material is outside the federal channel, it is considered representative of the channel material, because it was created from material dredged from the channel. The combined average for all the material tested from August was 99.14 percent sand and 0.86 percent fines with a median grain size of 0.35 mm. The combined average for all the material tested from September was 99.30 percent sand and 0.70 percent fines with a median grain size of 0.36 mm.

River miles 6 to 45 were sampled by a box-core sampler in June 1997. The material consisted of 99.05 percent sand and 0.95 percent fines with a median grain size of 0.34 mm. Of the 28 samples collected from this reach, 3 samples contained uncharacteristic amounts of fine-grained material and were not used in the above calculations. One sample was collected well outside the channel and was not representative of channel material. The second sample was collected in the same area that contained the clasts as described in the Astoria sampling event; the fine-grained clasts in it were not analyzed separately, and as a result the clasts distorted the percentage of fines in the sample analyses. The clay balls were determined to be from an eroded embankment near the shore. The third sample contained more fines than the samples collected on either side of it. The level of clay in this sample was 0 percent, however. This sample was collected just downstream of the RM 29 sampling described above, which contained over 99 percent sand.

Shoaling in the Columbia River federal navigation channel consists primarily of sand waves. Sand waves, by the nature of their development across the channel and the continual building and cascading of the material, effectively separates the fine-grained particles from the sand and places the particles in suspension, where they are carried to the ocean in the current or deposited in slack-water areas. Because sand lacks the binding sites for contamination, this washing action also removes potential contaminants from high-energy areas like the channel. Even the fine-grained sediment on the Columbia River contains very few contaminants.

5.2.4.6 Water Quality (total suspended solids, turbidity, dissolved oxygen, resuspension of toxins)

Hopper and pipeline dredges generally do not produce large amounts of turbidity or total suspended solids during dredging because of the suction action of the dredge pump and the fact that the draghead head is buried in the sediment.

Although there is some evidence that dredging of fine sediments can create a situation that decreases dissolved oxygen in the water column, that situation does not occur in the main navigation channel within the estuary because of the lower percentage of fines. The sediment dredged in this area is primarily sand (<2 percent fines) and therefore, it is unlikely that dissolved oxygen will be impacted either by the dredging or disposal of this sandy material. It also is true that toxins adhere primarily to fine-grained material, not sand. For this reason, there is no expectation of a resuspension of toxins by either the dredging or disposal activity in this area. Increased turbidity from dredging activities are below the known turbidity levels that stimulate avoidance response by juvenile salmonids, as identified by Servizi and Martens (1992).

Pipeline and hopper dredges, when using flowlane disposal, release material into the water column at a depth of 20 feet. The plume from pipeline flowlane disposal would be deep enough to have little to no impact on salmonids. Shoreline disposal at Miller Sands has the greatest potential for creating turbidity by increasing total suspended solids in the vicinity of the disposal. It is possible that fish would avoid the area while disposal is taking place. Upland disposal also may cause a turbidity plume at the outfall from the diked disposal area. However, the water will be released from a settling area through an outfall weir and will have less impact than if no settling time was allowed. The area impacted will be at the point of discharge and downstream along the shore where the plume is expected to attenuate quickly.

Light reduction caused by water column turbidity is believed to be more important in controlling phytoplankton production than is inorganic nutrient limitation (Sullivan et al. 2001). The inverse correlation between phytoplankton production and river flow, and generally abundant nutrient levels suggest that diatom production within the action area is primarily limited by water retention time and light availability (Sullivan et al. 2001). Thus, dredging activities are not likely to cause detectable impacts to plant life.

5.2.4.7 Physical Habitat Alteration (shoreline/river bottom)

The dredging activity will deepen any shoals in the navigation channel to the authorized depth, as is done annually. The flowlane disposal will fill some deeper holes in the riverbed and will act to even out the riverbed while the dredging is taking place. In this dynamic environment, natural processes work to change the configuration of the river bottom, even while dredging and disposal is occurring. Shoreline disposal is used as shoreline disposal in the erosive environment of Miller Sands and Skamokawa. These are the only places in this reach where there will be any shoreline alteration. The alteration will involve placing material on eroding shorelines. Changes to the river bottom as a result of dredging and disposal are not expected to impact salmonids. Shoreline alteration may impact salmonids by causing them to move away from the shoreline while the disposal is taking place.

5.2.4.8 Saltwater Intrusion

The flow of fresh water at the MCR is tidally pulsed. Unlike some rivers with stronger river flow, the Columbia River plume forms only on ebb, because landward currents usually fill the entire entrance channel and block the exit of fresh water from the river during the flood (Jay et al. 2004). During low-flow conditions, salinity intrusion may extend to about RM 35 upstream from the MCR. Annual maintenance dredging of the MCR will not have a major influence on salinity intrusion into the estuary other than what currently occurs.

5.2.4.9 Stranding

Subyearling salmonids that rear in water less than 3 feet deep potentially could be stranded by water level fluctuations. Fish encounter continuous water fluctuations, with tidally produced declines occurring twice each day. Thus, they appear to be adapted to surviving water level declines of several to many inches per hour. Likewise, they commonly encounter storm-induced waves during their estuarine residence period. These waves range in height from 4 inches to several feet, depending on speed, fetch, and duration of the prevailing wind. These storm waves generally build up over short periods of time, likely giving the fish adequate opportunity to detect the worsening condition and to move away from shallow areas where they might be stranded.

In addition, the wakes of ships navigating the lower river can strand fish on exposed sand or behind structures on the shoreline. The stranding of fish from ship wash is directly related to the size of the waves generated. Wave size is primarily a function of ship speed and is secondarily influenced by channel depth, distance from shore, and vessel draft. This suggests that regulating speeds of commercial marine traffic is one way to reduce potential stranding by large draft vessels. However, more recent studies conducted in 1992 to 1993 and again in 2000 showed little stranding as a result of wave action generated by large draft vessels. Just five juvenile salmonids were found to have been stranded on shore as a result of wave action (Hinton and Emmett 1994), and five fish also were collected by Ackerman (2002). An additional study is currently underway (for the CRCIP) to further evaluate stranding. Result from this study will be available in 2005. Stranding has never been reported as a problem in the estuary. This is most likely because of the width and shallowness of the estuary as compared to the channel, and because the distance from the channel (and ships) to the shore allows ship wash to attenuate before reaching shore.

Historical data for the existing 40-foot channel shows that the total tonnage carried by ocean-going vessels calling at the lower Columbia River ports has more than tripled since Congress authorized the deepening from 35 to 40 feet in 1962, while the number of vessel transits has actually decreased slightly. Maintenance dredging will allow the continuation of the current level of use of the navigation channel by ship traffic. There will be no increase in the incidence of juvenile salmonid stranding as a result of maintenance activities.

The maintenance activities are not expected to produce either a direct or an indirect effect on stranding of young salmonids. The projects are designed to provide continued safe passage for existing maritime traffic levels and does not increase the number of ships using the channel. In addition, vessel speeds and wakes are not expected to change with channel maintenance. Therefore, the stranding conditions are not expected to change as a result of these maintenance activities.

5.2.4.10 Predation

Predation on juvenile salmonids by Caspian terns and to a lesser extent, double-crested cormorants, has become an increasing concern in recent years as the number of juvenile salmonids taken by these birds in the estuary became more apparent. Caspian terns have become a particular issue to the Project because they have established large breeding colonies on dredge material disposal islands such as Rice Island and Miller Sands. This issue has been a focal point of research and management actions in the Columbia River estuary since 1997.

Caspian Terns

Prior to 1984, although Caspian terns were present in the Columbia River estuary during spring migration (March to April) until fall migration (August to early September), they did not breed in the estuary. Aggregations of foraging adults would occur in the estuary during the summer months. Adults with fledglings were present from about July 1st and into August.

In 1984, Caspian terns established a colony on East Sand Island (RM 5) on a portion of the dredged material disposal site used in 1983. The colony moved to Rice Island (RM 21) in 1986; an estimated 1,000 pairs of Caspian terns were present at that time (Corps 2000, Roby et al. 2003). By 1998, the Caspian tern colony at Rice Island had attained an estimated population level of approximately 8,700 pairs (Collis et al. 2002, Roby et al. 2002). The 2003 population estimate for Caspian terns in the Columbia River estuary was 8,325 pairs. The nesting population of Caspian terns in the estuary represents around two-thirds of the West Coast population of this species, and is apparently the largest colony of Caspian terns in the world (Collis et al. 2003).

Biologists at NOAA Fisheries expressed concerns regarding Caspian tern predation. In 1997, the Oregon Cooperative Fish and Wildlife Research Unit and associates initiated research into the Columbia River estuary Caspian tern population and their diet. Estimates of juvenile salmonid consumption for 1997 and 1998 were 8.1 and 12.4 million fish, respectively, or approximately 73 percent of the diet of Caspian terns at Rice Island (Roby et al. 2003). These estimates represented a substantial portion (up to 15 percent) of the outmigrant population of juvenile salmonids from some ESA stocks reaching the Columbia River estuary (Roby et al. 2003).

A Caspian tern habitat and population management pilot study was implemented in 1999 to determine the feasibility of shifting the tern colony from Rice Island to East Sand Island. The pilot study was predicated upon the hypotheses that locating the tern colony at East Sand Island, where estuarine waters are more marine influenced, would provide for a more diversified tern diet and lessen the impact on outmigrant juvenile salmonids. An estimated 1,400 pairs of terns nested on East Sand Island in 1999, rising to 8,500 pairs in 2000, and culminating in the entire population nesting there from 2001 through 2003 (Collis et al. 2003). Habitat management to maintain approximately 6.5 acres of suitable nesting habitat at East Sand Island for Caspian terns is implemented annually by the Corps. Social facilitation measures, for example, tern decoys and a sound system to playback recordings of Caspian tern colony vocalizations, also are conducted annually.

Research on Caspian terns at East Sand Island has led to the determination that their diet is more diversified and is composed of a lesser amount of juvenile salmonids as compared to terns that nested at Rice Island. In 2000 to 2003, juvenile salmonids composed 24 to 47 percent of the diet of Caspian terns at East Sand Island, and in 1997 to 2000, juvenile salmonids composed 73 to 90 percent of their diet at Rice Island (Collis et al. 2003). Salmonid composition in the diet has declined each year from 2000 to 2003 at East Sand Island (Collis et al. 2003). This is apparently attributable to the shift in the colony location to an area with a more diverse prey species composition concurrent with improved ocean upwelling and thus productivity conditions, which are believed to have increased availability of alternative forage fish such as northern anchovy, herring, and sardines.

The decline in percent juvenile salmonids in the diet of Caspian terns at East Sand Island also is reflected in the total number of juvenile salmonids consumed (8.2 million in 2000, 5.8 million in 2001, 6.5 million in 2002, and 4.2 million in 2003). In 1998, the Caspian tern colony at Rice Island was estimated to consume 12.4 million juvenile salmonids. Therefore, although a significant reduction in the number of juvenile salmonids consumed by Caspian terns has been attained by management measures implemented to date, these terns still harvest a substantial number of juvenile salmonids annually. However, a reversal of ocean conditions could lead to Caspian terns focusing their foraging efforts once again on juvenile salmonids and result in increased harvest levels of out-migrants, including ESA-listed ESUs. The timing, length and severity of such a reversal cannot be predicted. Any such change, however, is independent of these activities; it will occur with or without maintenance dredging.

Double-crested Cormorants

Large numbers of double-crested cormorants are a recent phenomenon in the estuary. They previously nested at the Cape Disappointment headland and in 1980, also were observed nesting on remnant portions of the trestle at Trestle Bay (RM 7). Scattered groups of cormorants nest on range markers in the estuary, particularly near Miller Sands. In recent years, a colony of cormorants has occurred on the downstream end of Rice Island, adjacent to the Caspian tern colony location. An estimated 1,141 pairs were present in 1997, 795 pairs in 1998, no pairs in 1999 and 2000, 150 pairs in 2001, 50 pairs in 2002, 211 pairs in 2003, and no pairs in 2004 (D. Roby, USGS unpublished data). Peters and others (1978) did not record them nesting on East Sand Island in 1977. In 1989, 91 pairs of double-crested cormorants were present on East Sand Island, increasing to 4,500 pairs in 1997 and 11,000 pairs in 2003 (D. Roby, USGS unpublished data).

In 2003, the 11,000 pairs of double-crested cormorants nesting at East Sand Island were estimated to consume 4.8 million juvenile salmonids (approximately 9 percent of their diet) from the Columbia River estuary (D. Roby, USGS unpublished data). The percent salmonids in the diet of double-crested cormorants has varied from approximately 6 percent in 2002 to a high of about 26 percent in 2000 (D. Roby, USGS unpublished data). Their diet demonstrated an increase (percent composition) in juvenile salmonid consumption from 1997 through 2000 and a decrease through 2002 (D. Roby, USGS unpublished data). The trend in percent juvenile salmonids in cormorants' diets seems to mirror the improved ocean upwelling and thus productivity conditions, which are believed to have increased availability of alternative forage fish such as northern anchovy, herring, and sardines. Changes in diet, however, are indepent of and will occurwith or without maintenance dredging.

5.2.5 Duration

During the dredging season, the optimal dredging schedule calls for the pipeline dredge to operate 5 days a week, 24 hours a day, and for the hopper dredge to operate 7 days a week, 24 hours a day, with 4 to 8 hours of down time every 7th day for a crew change and to take on supplies. For both types of dredges, there also is occasional down time for repairs and maintenance of equipment, unfavorable weather or wave conditions, and to take on fuel. While dredging with the hopper dredge, the disturbance is not constant. The hopper is filled to near capacity, then dredging stops and the vessel moves to the designated disposal site to empty the hopper. The dredge moves from shoal to shoal impacting on certain areas. Therefore, impacts are for a shorter period within the overall operating cycle. While dredging with a pipeline dredge, the disturbance is constant while operating, but dredging periodically ceases so that the dredge and or pipelines can be repositioned. Upland, flowlane, and shoreline disposal are used by the pipeline dredge.

5.2.6 Disturbance Frequency

This reach of the river is dredged annually. The dredging season is June to October each year and is done with the pipeline dredge *Oregon* and either the Corps' hopper dredge *Essayons* or a contract hopper dredge. The dredge moves from shoal to shoal and at each location, a dredge may spend anywhere from 3 days to 3 weeks, depending upon the size of the shoal to be dredged. At any time, there may be up to two dredges (a pipeline dredge and a hopper dredge) working at the same time in this reach, but they will always be in different locations. Consequently, impacts to salmonids are localized and relatively short in duration at a given location.

5.2.7 Disturbance Intensity

The impact of dredging is primarily related to disturbance during migration causing fish in the immediate vicinity of the dredging operation to migrate around the dredge. Disposal operations, particularly shoreline and upland, would have more impact on the shallow rearing habitat; however, this impact is expected to be minimal because the habitat at shoreline disposal sites is poor because they are highly erosive. In addition, the size of the impact area is small relative to the total area of suitable habitat available.

5.2.8 Disturbance Severity

Severity of disturbance to salmonids is expected to be low. As discussed above, turbidity will be at a level below that known to adversely affect salmonids and shoreline disposal will occur in highly erosive areas that do not have the features typical of high quality salmonid habitat. Entrainment is unlikely at the depths at which dredging occurs, and will be further minimized by use of BMPs.

5.3 ESTUARY TO VANCOUVER, WASHINGTON (RM 40 TO 106.5)

5.3.1 Proximity of Action

Dredging is done in the Columbia River in order to maintain the federally authorized width of 600 feet and a depth of 40 feet up to RM 105.5. The channel from RM 105.5 to 106.5 is maintained to a depth of 35 feet and a width of 500 feet. The Corps is authorized to dredge the channel an additional 100 feet in width and 5 feet deeper to ensure that the authorized width and depth is available as long as possible between dredging cycles. Although the 5-foot AMD dredging is done routinely, the over-width dredging is only used in situations where shoals are most likely to encroach on the channel and act to narrow the width, thus creating a navigation hazard between dredging cycles. Disposal is primarily upland or flowlane, with limited shoreline disposal. The river provides habitat for all anadromous fish in the Columbia/Snake/Willamette watershed area for some portion of their life cycle. There are juvenile and/or adult salmonids moving through this area year-round.

5.3.2 Distribution

The river is generally narrower in this reach than in the estuarine portion. Consequently, the navigation channel contains a larger percentage of the total habitat available to fish migrating through this reach than in the estuary. The portion of the navigation channel that requires dredging, however, is generally the least productive of the habitat available and represents only a smaller percentage of the total overall area available in this reach.

5.3.3 Timing

Dredging typically occurs between June and October. Normally, a pipeline dredge begins work in the estuary in June in the Miller Sands Channel reach, but occasionally it begins the dredging season near the mouth of the Cowlitz River or in another location where a spring hydrographic survey shows that material needs to be dredged from the navigation channel. The dredge then moves downstream to work on large shoals and then proceeds upstream during the summer months and into the fall. Hopper dredges work in the river at any time from June to October, spending 2 to 5 days on sand waves at any location that requires dredging to maintain the authorized depth. This work coincides with juvenile out-migration for all species of salmonids, and also coincides with adult upstream spawning migration for the following ESUs: summer run chinook, fall run chinook, summer steelhead, and coho. However, the impact is localized and of short duration at any given location; the fish would be only be impacted for a short period of time.

5.3.4 Nature of Effects

5.3.4.1 Entrainment

Based on previous studies (see Section 5.2.4.1), it in not anticipated that any fish will be entrained during dredging operations in this reach.

It is likely that benthic invertebrate prey populations such as *Corophium* are less abundant in the riverine than in the estuarine portion of the river. It also is likely that juvenile salmonids spend less time rearing in this section of the river than they do in the estuary.

Entrainment of planktonic prey also potentially occurs during dredging. Prey resources, such as *Daphnia* and similar organisms, may be entrained. However, these planktonic invertebrates are numerous throughout the water mass of the lower Columbia River. The portion of the population lost through the small portion of the water mass entrained will be small compared with the total amount available.

5.3.4.2 Fish Behavior (spawning, rearing, migration)

Dredging in the Columbia River above the estuary is likely to have some small effect on the behavior of juvenile and adult listed salmonid stocks by creating a disturbance in the area where the dredges are working. However, it is not anticipated that this disturbance will have a significant impact on salmonid migration because they are not commonly found in the deeper areas that are dredged, and the area disturbed is small relative to the overall area available for migration, and salmonids are not commonly found in the deeper areas that are dredged. The area of the river below Vancouver is not an area where salmonids are known to spawn, so there would be no impact to that portion of their life cycle. This area does provide some areas of slack-water for rearing. Most rearing occurs in the upper part of the water column near the shore and in shallow backwater areas, where the navigation channel maintenance activities of dredging and flowlane disposal will not be occurring.

Disposal of dredged material in this reach is primarily by flowlane and upland disposal, although shoreline disposal also may be used. Flowlane disposal is done in the main channel of the river. When the hopper dredge uses flowlane disposal, the impact area is directly below the hopper and downstream of the hopper where the current carries the sediment load. Sand falls out of suspension quickly and therefore, the plume of suspended sediment quickly dissipates. When pipeline dredges use flowlane disposal, the end of the disposal pipe is placed at 20 feet in depth and the sediment is released deep in the channel. The plume from pipeline flowlane disposal would be deep enough to have little to no impact on salmonids.

Shoreline disposal at Sand Island (RM 86.2) has the potential to impact the shallow shoreline area that is used by migrating and rearing juvenile salmonids. However, the Sand Island disposal site is highly erosive and does not contain many of the important habitat features that shallow water habitats typically include, such as low velocity, vegetation, and food sources. In an unstable bank environment, a higher level of suspended sediment and turbidity are a natural occurrence. In addition, while high levels of turbidity are know to affect salmonid physiology and feeding success, the combined background and project-related turbidity concentrations are well below known salmonid impact levels (Corps 2001).

Upland disposal would have some impact on the shallow shoreline areas. However, there would be less impact than for shoreline disposal because outflow through the weirs of the diked upland sites allows for some settling of the suspended solids before the water is returned to the river system at the outfall.

5.3.4.3 Loss of Benthic Community (feeding opportunities)

Although dredging the main navigation channel will result in loss of benthic community in the areas dredged, the deeper areas where dredging occurs are generally not as productive as shallower areas because they are below the photic zone where light penetration increases productivity.

Flowlane disposal will have some impact on the limited benthic community of the navigation channel because that is where the majority of the dredge material will fall when released from the hopper or pipeline dredge. Any suspended sediment, which is carried by the current into shallower water, may act to cover invertebrates and their habitat. It is not expected that the amount of suspended sediments entering the shallower areas will be sufficient to cause significant impact to the invertebrate food source for salmonids. Shoreline disposal will bury any benthic invertebrates in the area of disposal. The new substrate would be expected to be recolonized as soon as the disturbance subsides. The impacts of this loss of benthic invertebrates would be expected to be minimal since the area impacted is small. For upland disposal, the amount of impact would be less than with shoreline disposal because the amount of sediment in the outfall would be significantly less. As with the other forms of disposal, the area would be suitable for recolonization by invertebrates immediately after the disturbance stops.

5.3.4.4 Harassment/Displacement (acoustic effects)

It is likely that the noise and activity associated with dredging will cause some harassment and displacement of juvenile and adult salmonids that are in the immediate area where the dredge is working. It is likely that most fish would avoid the area, if possible. The area of disturbance around the dredge is small relative to the entire river area, and the impact to salmonids is expected to be minimal since most fish are able to avoid the impact area. Ample area is available for migrating and rearing away from the dredging activity. In fact, most migration and rearing would be expected to occur in shallower areas and not in the area where dredging is occurring.

The flowlane disposal of materials from the hopper dredge or pipeline will cause a disturbance at the disposal sites, which are generally the deeper parts of the channel bed. The nature of the disturbance is mostly related to the suspended solids released from the hopper or pipeline as they fall to the bottom and/or are carried with the current. This impact should be localized because the sediment is more than 98 percent sand, which does not stay suspended in the water column, although this is affected by the amount of current in the area at the time of disposal. Higher flows would increase the size of the turbidity plume.

5.3.4.5 Sediment

The bed material which forms shoals in the federal navigation channel consists of clean sands low in fines and organic content. Shoals consist of sand waves or cutline shoals formed by bedload transport. Material distribution in these shoals is homogeneous due to source and consistency of the hydraulic regime, which form the shoals. Fines and organic materials are effectively removed during the shoaling process. Various studies have been conducted which verify this information.

As part of the CRCIP, the navigation channel in the RM 38 to 106.5 reach was sampled in June 1997. The material was sampled by a box-core sampler and consists of 99.75 percent sand and 0.25 percent fines, with a median grain-size of 0.61 mm. Of the 82 samples collected from this reach, 3 samples contained uncharacteristic amounts of fine-grained material and were not used in the above calculations. Two samples were collected well outside the channel or below -50 feet CRD and are not representative of the channel shoal material. The third sample was collected from the Morgan Bar dredged material flowlane disposal site which had received material from the Willamette River prior to the June 1997 sampling event. Subsequent sampling of this sample location at RM 100 was conducted in 2001. A composite of the three samples in 2001 was submitted for physical analysis. Mean grain size for the composite sample was 1.14 mm, with 10.23 percent gravel, 89.71 percent sand, and 0.06 percent fines.

In 2001, 25 samples were collected from the north side of the federal navigation channel and the adjacent near-shore area for PCB contamination at the former ALCOA aluminum plant (VANALCO at RM 103). This sampling was conducted to confirm PCB contamination and further characterize the federal channel and adjacent sediments for possible contaminants. Dredging in this portion of the channel was not scheduled or anticipated at the time. While PCBs were detected in near-shore samples, no PCBs were detected in samples from, or immediately adjacent to, the federal navigation channel at RM 103.

One vibra-core sample was analyzed in two 4-foot lifts. The two lifts were submitted for physical analyses including total volatile solids and were analyzed for metals (9 inorganic), total organic carbon, pesticides and PCBs, phenols, phthalates, miscellaneous extractables, PAHs, organotin, and dioxin/furan. An additional 24 surface grab samples were analyzed only for pesticides and PCBs. None of the contaminants tested were found to be at or above their respective screening levels in the two vibra-core samples. In the six grab samples taken nearest to the shore, Aroclor 1248 (a PCB) was found at levels that exceeded the screening level of 130 ug/kg for total PCBs. The sediment represented by these samples would need to be further characterized under Tier III testing to determine its suitability for disposal if dredging would be needed in this area. All samples showing contamination above screening levels were well outside the federal navigation channel, and would not be disturbed by normal maintenance dredging operations.

5.3.4.6 Water Quality (total suspended solids, turbidity, dissolved oxygen, resuspension of toxins)

Hopper and pipeline dredges generally do not produce large amounts of turbidity or total suspended solids during dredging because of the suction action of the dredge pump and because the draghead is buried in the sediment. Because of the sandy, large-grained content of the sediment, there is no expectation of a resuspension of toxins by either the dredging or disposal activity in this area.

Only fish in the immediately area of disposal would likely be impacted by the temporary increase in suspended sediments. The likelihood that this would occur is small, since most fish would avoid the area. Pipeline dredges, when using flowlane disposal, release material into the water column at 20 feet. The plume from pipeline flowlane disposal would be deep enough to have little to no impact on salmonids.

Shoreline disposal at Sand Island has the greatest potential for creating turbidity by increasing total suspended solids in the vicinity of the disposal. It is likely that fish would avoid the area while disposal is taking place. Upland disposal also may cause a turbidity plume at the outfall from the diked disposal area. However, the outfall will be released from a settling area through a weir and thus, will have less impact than if no settling time was allowed for outfall releases. The area impacted will be at the point of discharge and downstream along the shore where the plume is expected to attenuate quickly because of the sandy, large-grained content of the sediment.

5.3.4.7 Physical Habitat Alteration (shoreline/river bottom)

The dredging activity will remove any shoals in the navigation channel and return it to authorized depth. This is done annually and occurs in a less productive area of the river and consequently, does not significantly impact salmonid habitat. In some areas where the channel runs near the shore, there may be a potential for impacting shallow-water areas that are between the shore and the channel. In most cases where the channel is near the shore, it is on the outside bend of the river and the shore area drops off rapidly and does not provide the type of shallow-water flats that are productive and provide salmonid rearing habitat. Consequently, dredging in these areas will not cause increased impacts to shallow-water areas. Flowlane disposal will fill some deeper areas in the riverbed and will act to even out the riverbed while the dredging is taking place. In this dynamic environment, natural processes work to change the configuration of the river bottom, even while dredging and disposal is occurring. Shoreline disposal is used as shoreline disposal in the erosive environment of Sand Island (RM 86.2). This is the only place in this reach where there will be any shoreline alteration. The alteration will involve placing material on an eroding shoreline. Changes to the river bottom as a result of dredging and disposal are not expected to impact salmonids. Shoreline alteration may impact salmonids by causing them to move away from the shoreline while the disposal is taking place.

5.3.4.8 Stranding

Subyearling salmonids rearing in water less than 3 feet deep can potentially be stranded by water level fluctuations. Fish encounter continuous water fluctuations, with tidally produced declines occurring twice each day. Thus, they appear to be adapted to surviving water level declines of several to many inches per hour.

In addition, the wakes of ships navigating the lower river can strand fish on exposed sand or behind structures on the shoreline. The stranding of fish from ship wash is directly related to the size of the waves generated and the slope of the shoreline. Wave size is primarily a function of ship speed and is secondarily influenced by channel depth, distance from shore, and vessel draft. This suggests that regulating speeds of commercial marine traffic is one way to reduce potential stranding by large draft vessels. However, more recent studies conducted in 1992 to 1993 and again in 2000 showed little stranding as a result of wave action generated by large draft vessels. Just five juvenile salmonids were found to have been stranded on shore as a result of wave action (Hinton and Emmett 1994).

Historical data for the existing 40-foot channel shows that the total tonnage carried by ocean-going vessels calling at the lower Columbia River ports has more than tripled since Congress authorized the deepening from 35 to 40 feet in 1962, while the number of vessel transits has actually decreased slightly. Maintenance dredging will allow the continuation of the current level of use of the navigation channel by ship traffic. There will be no increase in the incidence of juvenile salmonid stranding as a result of the maintenance activities.

The maintenance activities are not expected to produce either a direct or an indirect effect on stranding of young salmonids. The Project is designed to provide continued safe passage for existing maritime traffic levels and does not increase the number of ships using the channel. In addition, vessel speeds and wakes are not expected to change with channel maintenance. Therefore, the stranding conditions are not expected to change as a result of the maintenance activities.

5.3.5 Duration

During the dredging season, the optimal dredging schedule calls for the pipeline dredge to operate 5 days a week, 24 hours a day, and for the hopper dredge to operate 7 days a week, 24 hours a day, with 4 to 8 hours of down time every 7th day for a crew change and to take on supplies. Typically, a pipeline dredge begins work in June near Miller Sands Channel, and works for a 1 to 3 week period, after which it moves upstream to another location, such as the Brookfield-Welch Island reach or Skamokawa Bar. It then works for another 1 to 3 week period before moving further upstream to the next restricting shoal to be dredged. The normal progression of work for the pipeline dredge is to continue moving upstream as the dredging season progresses and remove the large shoals that restrict deep-draft navigation. For both types of dredges, there also is occasional down time for repairs and maintenance of equipment, unfavorable weather or wave conditions, and to take on fuel. While dredging with the hopper dredge, the disturbance is not constant. The hopper is filled to near capacity, then dredging stops and the vessel moves to the designated disposal site to empty the hopper. While dredging with a pipeline dredge, the disturbance is constant while operating, but dredging periodically ceases so that the dredge and or pipelines can be repositioned. Upland, flowlane, and shoreline disposal are used by the pipeline dredge.

5.3.6 Disturbance Frequency

This section of the river is dredged annually. The dredging season is June to October each year and is done primarily with the pipeline dredge *Oregon*. The dredge operates 7 days a week, 24 hours a day, with 4 to 8 hours of down time every 7th day for a crew change on the dredge. Dredging occurs at various locations between RM 3.0 and 106.5 near Vancouver, Washington. At each location, a dredge may spend anywhere from 3 days to 3 weeks removing sand from the navigation channel, depending on the size of the shoal to be dredged. At any time, there may be up to two dredges (a pipeline dredge and a hopper dredge) working at the same time, but in different locations. There also is occasional down time for repairs and maintenance of equipment. While dredging with a pipeline dredge, the disturbance is continuous at a given location except when the dredge and/or pipelines are repositioned. Upland, flowlane, and shoreline disposal are used by the pipeline dredge.

5.3.7 Disturbance Intensity

The impact of dredging is primarily related to disturbance during fish migration, causing fish in the immediate vicinity of the dredge to migrate around the dredge. Dredging is unlikely to impact fish rearing in the shallower, off-channel areas. Dredge material disposal, particularly shoreline and upland disposal, would have more impact on shallow, rearing habitat as described above. The activity will impact salmonids, but the impact is expected to be minimal because of the size of the impact area relative to the area of suitable habitat available, and because of the short duration of the dredging activity at any given location (shoal or sand wave).

5.3.8 Disturbance Severity

Severity of disturbance to salmonids is expected to be low. As discussed above, turbidity will be at a level below that known to adversely affect salmonids and shoreline disposal will occur in highly erosive areas that do not have the features typical of high quality salmonid habitat. Entrainment is unlikely at the depths at which dredging occurs, and will be further minimized by use of BMPs.

5.4 VANCOUVER, WASHINGTON TO BONNEVILLE DAM (RM 106.5 TO 145)

5.4.1 Proximity of Action

Dredging is done in the Columbia River in order to maintain the federally authorized width of 300 feet. Although this reach has an authorized depth of 27 feet, the draft requirements of the current users allows for the depth to be maintained only to 17 feet. The Corps is authorized to dredge an additional 50 to 100 feet of width where necessary, and an additional 2 feet deeper to ensure that the necessary width and depth are available as long as possible between dredging cycles. All dredging in this reach of the river is done with the hopper dredge *Yaquina*. Disposal is done within the flowlane. This area is utilized by all Columbia and Snake River stocks of listed salmonids. It primarily serves as a migration route for adult salmon moving upstream to spawn and for juvenile salmon moving downstream toward the ocean. There are juvenile and/or adult salmonids moving through this area year-round. Chum, coho, and fall chinook salmon all spawn in this reach of the Columbia River. No spawning areas are close enough to the dredging operations to be impacted by dredging.

5.4.2 Distribution

The dredging activity is confined to that portion of the navigation channel where shoaling occurs. In this reach of the river, there are only four areas that require routine maintenance. Those areas are listed in Table 2-4 and all are located from RM 114 to 125.3. These areas represent a very small percentage of the overall area.

5.4.3 Timing

Because of the shallower dredging depth, dredging is limited to the in-water work period of November 1 through February 28. This period of time has been determined to be the period when juvenile and adult salmon are least abundant in the river. A small hopper dredge works for a total of 5 to 10 days in November and/or February in up to four different locations from RM 110 to 125. Normally the dredging takes place in February.

5.4.4 Nature of Effects

5.4.4.1 <u>Entrainment</u>

Because dredging occurs at a shallower depth in this reach, there is some possibility that entrainment of salmonids may occur. An entrainment study was done in this reach during the juvenile out-migration season in 1998 (R2 Resource Consultants 1999). No juvenile salmonids were collected during the study. This is likely because even though dredging is done at a shallower depth than the deep draft channel, it is unlikely that juvenile salmonids occur in the deeper parts of any reach. Also, dredging is further limited to the in-water work period when the listed salmonid species are least likely to be migrating through this reach and consequently, it is unlikely that any salmonids will be entrained.

It is more likely that benthic invertebrate prey will be entrained due to the shallower dredging depth. However, these areas are sufficiently deep that they do not constitute prime shallow-water habitat for benthic prey. The majority of benthic prey consumed by young salmonids is found in the near-shore and back-water areas, where the currents are slower, bottom topography is more stable, and productivity is higher.

Entrainment of planktonic prey also potentially occurs during dredging. Prey resources such as *Daphnia* and similar organisms will be entrained. However, these planktonic invertebrates are numerous throughout the water mass of the lower Columbia River. The portion of the population lost through entrainment will be small as compared to the total amount available in this reach of the Columbia River.

5.4.4.2 Fish Behavior (spawning, rearing, migration)

Dredging in the Columbia River from Vancouver, Washington to Bonneville Dam is likely to have virtually no impact on juvenile and adult listed salmonid stocks migrating through this reach. The area of disturbance during suction dredging is in the immediate vicinity of the dragheads and is at a depth where fish are not abundant, based on the entrainment data collected (R2 Resource Consultants 1999). In addition, the activity is timed to further minimize the impact, since there are fewer fish migrating during the dredging window than at other times of the year.

Spawning of fall chinook and chum salmon in the mainstem Columbia River has been documented just below Bonneville Dam at Ives and Pierce Islands (RM 141 to 144), at the Multnomah Falls to Horsetail Falls areas (RM 136 to 139), and downstream at RM 112 to 114 on the Washington side of the river. Since no dredging is done above RM 126, the upper two locations will not be impacted at all by the activity. For the sites from RM112 to 114, the dredging activity is in closer proximity to the known spawning areas. However, these locations are at least 500 to 1000 feet from the edge of the channel in an area where there is no over-width dredging. Also, dredging in this reach of the river is done late in the in-water work period (generally in February), not a period when spawning is likely to occur. Therefore, there is little chance that the maintenance dredging and disposal activities would impact spawning.

This area also provides some slack-water rearing areas for juvenile salmonids. Most rearing occurs in the upper part of the water column near the shore and in shallow, back-water areas where the channel maintenance activities of dredging and flowlane disposal will not be occurring. Also, during the time of year when maintenance activities are occurring, there are few juveniles in the river.

Disposal of dredged material in this reach is solely in the flowlane. Flowlane disposal is done in the main channel of the river. When the hopper dredge uses flowlane disposal, the impact area is directly below the hopper and downstream of the hopper where the current carries the sediment load. Sand falls out of suspension quickly and therefore, the plume of suspended sediment quickly dissipates.

5.4.4.3 Loss of Benthic Community (feeding opportunities)

Although dredging the main navigation channel will result in some loss of benthic community in the areas dredged, the deeper areas where dredging occurs are generally not as productive as shallower areas. The majority of benthic prey consumed by young salmonids is found in the preferred benthic invertebrate habitat in the near-shore and back-water areas, where the currents are slower and the bottom topography is more stable.

Flowlane disposal also will have some impact on the benthic community in the navigation channel because that is where the majority of the dredge material will fall when released from the hopper or pipeline dredge. Any suspended sediment, which is carried by the current into shallower water, may act to cover invertebrates and their habitat. It is not expected that the amount of suspended sediments entering the shallower areas will be sufficient to cause significant impact to the invertebrate food source for salmonids. The area would be suitable for recolonization by invertebrates immediately after the disturbance stops.

5.4.4.4 Harassment/Displacement (acoustic effects)

It is likely that the noise and activity associated with dredging will cause some harassment and displacement of juvenile and adult salmonids that are in the immediate area where the dredge is working. However, the maintenance dredging in this reach of the river is done only during the in-water work period when there are fewer salmonids in the river. Also, the area of disturbance around the dredge is very small and most fish would be able to find ample area for migrating and rearing away from the dredging activity. Most migration and rearing would be expected to occur in shallower areas and not in the area where dredging is occurring.

The flowlane disposal of materials from the hopper dredge will cause a disturbance at the disposal sites, which are generally the deepest parts of the channel bed. The nature of the disturbance is mostly related to the suspended solids released from the hopper. This impact should be localized because the sediment is more than 98 percent sand, which does not stay suspended in the water column, although this is affected by the amount of current in the area at the time of disposal.

5.4.4.5 Sediment

On August 25, 1999, 12 box-core surface sediment samples were collected from shoals at 6 stations in the Columbia River at RMs 106, 113, 114, 118 and 125. Four of the 12 samples were collected near the I-5 Bridge (approximate RM 106), 2 samples from the main channel, and 2 from the alternate barge channel, under the wide span of the I-5 Bridge, which connects to the main channel 7,500 feet upstream. Collection and evaluation of the sediment data was completed using guidelines from the DMEF. The material collected consisted of 8.7 percent gravel, 89.8 percent sand, and 1.6 percent silt/clay. The median grain size was 0.87 mm, in the range of coarse sand (mean 1.3 mm very coarse sand) and 0.87 percent volatile solids. The DMEF has characterized the sediment in this reach of the Columbia River as "exclusionary." Visual and laboratory physical analyses confirm the exclusionary ranking. The material represented by the samples collected from the Columbia River sites is considered suitable for either unconfined in-water or upland placement without further characterization.

5.4.4.6 Water Quality (total suspended solids, turbidity, dissolved oxygen, resuspension of toxins)

Hopper dredges generally do not produce large amounts of turbidity or total suspended solids during dredging because of the suction action of the dredge pump and because the draghead is buried in the sediment. Because of the sandy, large-grained content of the sediment, there is no expectation of a resuspension of toxins by either the dredging or disposal activity in this area.

Only fish in the immediately area of disposal would likely be impacted by the temporary increase in suspended sediments. The likelihood that this would occur is small, since most fish would avoid the area while disposal is taking place. The area impacted will be at the point of discharge and downstream where the plume is expected to attenuate quickly because of the sandy, large-grained content of the sediment.

5.4.4.7 Physical Habitat Alteration (shoreline/river bottom)

The maintenance activities will not result in any shoreline alteration in this reach of the river. The river bottom is deepened by dredging only in the four areas which are subject to shoaling. These areas are dredged on an as-needed basis and may not need to be dredged each year. The deepening of the shoaled areas in the channel and subsequent disposal in the deeper areas may cause fish to move away from these areas during the dredging and disposal activities. These areas are used primarily for migration and ample areas remain for this purpose.

5.4.4.8 Stranding

Stranding of fish due to deep draft navigation is not an issue in this reach of the river because the river traffic is shallow draft barges and tows, or small boats.

5.4.5 Duration

This section of the river is dredged on an as-needed basis, although at least two of the shoals have been dredged annually for the past 5 years. Rarely are all four shoals dredged in a single year. The dredging season occurs from November through February and dredging is done with the hopper dredge *Yaquina*. The dredge operates 7 days a week, 24 hours a day, with 4 to 8 hours of down time every 7th day for a crew change on the dredge. There also is occasional down time for repairs and maintenance of equipment. While dredging with a hopper dredge, the disturbance is not constant. The hopper is filled to near capacity, then dredging stops and the vessel moves to the designated disposal site to empty the hopper. Flowlane disposal is the only method of disposal used by the hopper dredge in this reach.

5.4.6 Disturbance Frequency

This section of the river is dredged annually although rarely are all four shoals dredged in the same year. It is expected that some dredging will take place in this reach annually for the foreseeable future.

5.4.7 Disturbance Intensity

The disturbance produced by dredging would most likely have no impact on juvenile and adult salmonids migrating upstream and downstream. This is primarily because dredging only takes place during the time of year when salmon are least likely to be found. As discussed for dredging in the other river reaches, the size of the disturbance would be small and intermittent in nature.

5.4.8 Disturbance Severity

Severity of disturbance to salmonids is expected to be low. As discussed above, turbidity will be at a level below that known to adversely affect salmonids. The most recent entrainment study entrained no salmonids, entrainment is unlikely at the depths at which dredging occurs, and will be further minimized by use of BMPs (including dredging windows).

5.5 SIDE-CHANNEL PROJECTS

5.5.1 Proximity of Action

Dredging is done in the Columbia River side-channel projects in order to maintain navigation from the main Columbia River navigation channel to eight different boat basins, harbors, and/or port facilities. All dredging and disposal sites are in areas where adult and juvenile salmonids may occur.

5.5.2 Distribution

The eight side-channel projects discussed in this BA include Baker Bay West (RM 2.5), Chinook (RM 5), Hammond Boat Basin (RM 7), Skipanon (RM 10), Skamokawa Creek (RM 33.6), Wahkiakum Ferry/Westport Slough (RM 43), Old Mouth Cowlitz River (RM 67), and Oregon Slough (RM 109). Depths and widths of the channels vary, as discussed below; however, all are authorized for 2 feet of AMD.

Baker Bay West Channel is located on the north side of the Columbia River estuary near RM 2.5. It is a 2.5-mile-long channel to the entrance of Ilwaco Boat Basin. The channel depth is 16 feet. The width for the first 0.5 mile is 200 feet, then 150 feet for the remaining distance.

The Chinook Channel is located near RM 5 on the north side of the Columbia River estuary. It is a 2-mile long channel that is 150-feet wide and 10-feet deep, which ends at the turning and mooring basin at Chinook, Washington.

The Hammond Boat Basin was created in 1982 by stone breakwaters constructed around a backwater area to create a mooring basin on the south side of the Columbia River estuary at RM 7. The channel extends from deep water in the Columbia River to 1,300 feet to the mooring area. The channel is 100-feet wide and 10-feet deep.

The Skipanon Channel, which is at the downstream end of the Skipanon River, is located on the south side of the Columbia River estuary at RM 10. The Skipanon River has a drainage area of about 15 square miles and it flows from Cullaby Lake at the headwaters downstream for 8 miles to the Columbia River. The channel was constructed at the mouth upstream to Skipanon RM 1.8. Though it is authorized to 30-feet deep by 200-feet wide, it is only maintained to a depth of 16 feet.

The Skamokawa channel is located at the mouth of Skamokawa Creek, which flows into the Columbia River at RM 33.6 on the north shore. The channel was constructed in 1920 and extends from deep water in the Columbia River upstream 16,000 feet to the junction of the creek and Brooks Slough, where the docks in the town of Skamokawa, Washington are located. The channel is 6.5-feet deep and 75-feet wide.

The Wahkiakum Ferry Channel and Westport Slough channels are located at RM 43. The Westport Slough channel is located at the entrance to Westport Slough. Westport Slough extends upstream beyond Clatskanie, Oregon. Wahkiakum Ferry Channel is a shallow draft channel cutting though historic shallow water habitat next to Puget Island and is part of the main Columbia River. Westport Slough is a backwater slough area. The channel is 200-feet wide and 9.5-feet deep.

The Old Mouth Cowlitz River channel is located at RM 67 on the north side of the Columbia River mainstem at Longview, Washington. The channel is 8-feet deep and 150-feet wide. It is approximately 3,800 feet long.

The upstream end of Oregon Slough is located at RM 109. It is 10-feet deep and 300-feet wide. It runs a distance of approximately 5,800 feet.

5.5.3 Timing

The dredging in-water work window for the lower estuarine side-channel projects (Baker Bay West and Chinook Channel) is September through October. The reason for this timing window is to minimize entrainment of 1- and 2-year old Dungeness crab that are found in large numbers rearing in Baker Bay in the winter months (McCabe and McConnell 1989) This timing window, although outside the normal in-water work window for salmonids, is still during a period time when juvenile salmonid abundance in Baker Bay is declining and would be less than in the spring and summer. In addition, since Baker Bay is used primarily by subyearling fall chinook that would be rearing in the area, it is more likely that they would occur in the shallow parts of the bay where food organisms are more abundant. Consequently, the fall in-water work window has been proposed as a compromise to minimize impacts to Dungeness crabs while minimizing impacts to salmonids to the extent possible.

For the upper side-channel projects (Hammond Boat Basin, Skipanon Channel, Skamokawa Channel, Wahkiakum Ferry/Westport Slough, Old Mouth Cowlitz, and Oregon Slough), dredging is done only during the in-water work period of November 1 through February 28. The timing of this work window is intended to minimize impacts to salmonids.

5.5.4 Nature of Effects

5.5.4.1 Entrainment

Five of the side-channel projects (Chinook, Skamokawa Creek, Wahkiakum Ferry, Old Mouth Cowlitz, and Oregon Slough) will be dredged only using a clamshell dredge. It is generally believed that clamshell dredging causes less entrainment than other types of dredging. Stevens (1981) collected data in Grays Harbor on entrainment by pipeline, hopper, and clamshell dredges, and also evaluated the impacts of dredging on fish as part of a Dungeness crab study in Grays Harbor. The study did not show any salmonids entrained. Armstrong and others (1982), in a similar study of the impacts of dredging on Dungeness crabs in Grays Harbor, reported catching one juvenile chum salmon. Both studies were conducted during the time period of early winter through late summer. It is generally believed that entrainment by clamshell dredging does not occur because juvenile and adult salmonids are able to avoid entrainment by the clamshell bucket, in part because they are alerted to its presence by a pressure wave created as the bucket is dropped through the water column. Based on this, clamshell dredging is not expected to entrain salmonids, even in shallow water areas.

In the Skipanon channel, the hopper dredge *Yaquina* will be used to dredge the outer, deepest portion of the channel (nearest the mainstem Columbia); the inner part of the side channels will be dredged using a clamshell dredge. Entrainment of salmonids using either the clamshell dredge or the hopper dredge in the deeper portion of the channel would not be expected.

In Baker Bay, clamshell, hopper, or pipeline dredging may be used. The Hammond Boat Basin will most likely be dredged using a pipeline dredge in the future. Because these dredging activities occur in shallower areas than the mainstem Columbia River dredging, there is some increased likelihood of entrainment of salmonids using the hopper or pipeline dredge. However, because the dredging will be done in the fall when salmon abundance is minimal, it is not expected to cause a significant impact.

Benthic invertebrates are expected to be entrained during dredging of the side-channel projects; however, the areas dredged are in the deeper channel areas, which are not as productive as the shallower areas that are not regularly disturbed by boat traffic.

5.5.4.2 Fish Behavior (spawning, rearing, migration)

Fish will be expected to move away from the dredging activity while migrating through or rearing in these areas. None of these areas provide spawning grounds for ESA-listed salmonids.

5.5.4.3 Loss of Benthic Community (feeding opportunities)

There will be some loss of benthic invertebrates in the areas dredged in all the side-channel projects. The areas to be periodically dredged are the deeper navigation channels and are not likely to be as productive as the surrounding shallow-water areas.

5.5.4.4 Harassment/Displacement (acoustic effects)

It is likely that the noise and activity associated with dredging will cause some harassment and displacement of juvenile and adult salmonids that are in the immediate area where the dredge is working. It is likely that most fish would avoid the area if possible. Even though migrating and rearing salmonids would be expected to occur in these shallower side-channel areas, the area of disturbance around the dredge is small relative to the area available, and the impact to salmonids would be expected to be minimal since most fish are able to avoid the impact area.

The flowlane disposal of materials from the side-channel projects would create a larger impact area than with the sandy mainstem Columbia River sediments because of the higher percentage of fines in the side-channel sediments. Salmonids would be expected to avoid the disposal activity and the area with the increased turbidity. In addition, since the work will be done during the in-water work window when fish abundance is minimal, the impacts to listed stocks also are expected to be minimal.

5.5.4.5 Sediment

Baker Bay West - Sediment quality evaluations have been carried out at various intervals since 1973, with the last investigation at Baker Bay being done in 1997. The June 1997 evaluations showed that the channel changes from sands at the mouth of the channel to silty sand at about channel mile 1.5. The chemical analysis of the silty sand samples indicated that the sediment is relatively free of contaminants. The pesticides of the DDT group were detected at vary low levels and in all samples the result showed the concentrations to be far below screening levels. The 1987 investigations detected cadmium and mercury in concentrations above the Oregon background level for sediments from the vicinity of the upstream end of the West Channel. At that time it was recommended to monitor the shoal.

Additional testing in 1992 and 1997 failed to detect cadmium in the samples and mercury was present at values that were below concern levels. All other metals that were detected during the 1997 investigations in West Channel were found at levels below screening levels. Of these, mercury at 0.1 ppm, in one sample was the only metal found at a concentration even approaching the threshold screening value, (0.15 ppm). Both the individual compounds detected and concentrations reported of the organochlorine pesticides vary among the study results. Values for Heptachlor and the DDT compounds found during this study, while present below concern levels, represent a change from 1992, when only Endosulfan II at less than 2 ppb was reported in one sample from the Ilwaco Boat Basin, and none of the DDT compounds were detected. Organochlorine pesticides also were detected around Ilwaco Boat Basin entrance.

If Baker Bay is to be dredged in the future, sediment evaluation testing will be conducted to ensure that the material is still acceptable for unconfined in-water disposal. The complete sediment evaluation reports can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Chinook Channel - Sediment sampling of the federal projects at Chinook Channel took place in 1980, 1986, 1987, 1992, and 1997. Chemical tests for contaminants in the bulk indicated that metals, pesticides and PCBs were below established guidelines. The 1980 elutriate tests, which predict the concentrations that could enter the water column during disposal, revealed that ammonia, cadmium and manganese release exceeded guidelines. Results from 1986, 1987 and 1992 tests followed the same basic pattern as those from 1980 and corroborated them. In these studies, elutriate tests showed that concentrations of cadmium and manganese were not above concern levels as in the 1980 tests. Phenols and PAHs were added to the list of contaminants looked for in those later studies. In 1992, EPA funded additional analysis of samples taken within the marina. The chemical results, with few exceptions, show the sediment is relatively uncontaminated. Over the years, more than 80 contaminants have been tested for in Chinook Channel sediment and elutriate samples.

The results of the 1997 physical and chemical analyses of the sediment confirm earlier studies and indicate that Chinook Channel sediment has not degraded significantly over the years (Figure 5-1). This and previous sediment quality evaluations have concluded that no unacceptable, adverse environmental impacts would be expected from its disposal. If Chinook Channel is to be dredged in the future, sediment evaluation testing will be conducted to ensure that the material is still acceptable for unconfined in-water disposal. Complete sediment evaluation reports for 1980, 1987, 1992, and 1997 can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Figure 5-1. Physical Analysis 1997

	mm	%			
sample	median grain size	sand	silt	clay	volitle solids
C-VV-1	0.12000	65.2	26.5	8.3	1.9
C-VV-2	0.05400	45.2	44.6	10.2	3.4
C-VV-3	0.08000	60.1	29.0	10.9	2.6
C-VV-4	0.00097	5.5	67.2	27.3	2.6
C-VV-5	0.00730	1.5	65.1	33.4	7.3
C-VV-6	0.00760	1.8	68.0	30.2	7.8

Hammond Boat Basin - Sediment samples were collected from the Hammond Boat Basin on September 15, 1994 (Figure 5-2). The material was primarily sandy, clayey silt. Existing data showed the sediment to be below established concern levels for all contaminants. Since the previous evaluation, conducted in 1987, the sediment changed little in terms of metals and PAHs.

Figure 5-2. Physical Analysis 1994

sample	median grain size mm	sand	silt %	clay	volatile solids
EPA					
HBB-BC-1	0.013	3.6	74.8	21.6	7.4
HBB-BC-2	0.018	5.9	76.2	17.9	7.3
HBB-BC-3	0.040	28	60.1	11.9	4.5
HBB-GC-7	0.017	8.9	71.5	19.6	5.8
Federal chl					
HBB-BC-4	0.033	15.2	68.9	16.0	6.4
HBB-GC-5	0.012	3.3	76.1	20.6	21.3
HBB-GC-6	0.013	4.4	73.8	21.8	6.6
mean	0.021	9.9	71.6	18.5	8.5

For the 1994 sampling, it was determined to be unlikely that unacceptable water column, benthic toxicity, or benthic bioaccumulation impacts would result from in-water or upland disposal of the sediment at that time. If this area requires dredging in the future, new sediment analyses will be conducted to ensure that the sediment is in compliance with the DMEF. The complete sediment evaluation report for 1994 can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Skipanon Channel - Due to DDT contamination detected in the 2001 sediment sampling event, bioassay analyses were conducted on sediment collected during the June 24, 2003 sampling event (Figure 5-3). This evaluation was conducted following procedures set forth in the 1998 DMEF. Since this site has a prior history of contamination, bioassay analyses were conducted. All chemical analyses results were below their respective DMEF Tier IIb screening levels except mercury in one sample.

The bioassay results for this site did not indicate any problems with the sample. However, another sample registered a "single-hit failure" for bioassay. This is the same area that exceeded DMEF Tier IIb screening levels for DDT in the 2001 sampling event, prompting this bioassay characterization. Sediment represented by this sample will need to be appropriately managed if dredged. The sediment represented by the balance of samples was determined to be suitable for unconfined, in-water placement without further characterization.

Figure 5-3. Physical Analysis 2003

Sample I.D.	Grain Size (mm)		Percent			
	Median	Mean	Gravel	Sand	Silt/Clay	Volatile Solids
SBIO-GC-01	0.021	0.049	0.00	21.07	78.93	6.66
SBIO-GC-02	0.035	0.050	0.00	30.65	69.35	7.36
SBIO-GC-03	0.013	0.042	0.00	16.02	83.98	5.60
SBIO-GC-04	0.017	0.049	0.00	31.80	68.20	7.75
*SBIO-GC-R	0.023	0.043	0.00	19.93	80.07	6.72
Mean	0.022	0.047	0.00	23.89	76.11	6.82
Minimum	0.013	0.042	0.00	16.02	68.20	5.60
Maximum	0.035	0.050	0.00	31.80	83.98	7.75

* SBIO-GC-R is sediment collected from a formerly tested, low-level contaminate area, used as a bioassay reference sediment.

Skamokawa Creek - Sediment sampling was conducted by the Corps in 1980. In 1980 there was some indication of elevated levels of ammonia, phenolics, and arsenic. Results of sediment evaluation can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

The Columbia River Estuary Study Task Force (CREST) conducted sediment sampling on 17 July 2003. Chemical analysis of the samples found no results that exceeded the screening levels found in the DMEF (1998). A copy of the Final Sampling Report can be obtained by contacting CREST, 750 Commercial St., Astoria, OR.

Wahkiakum Ferry - Sediment samples were collected on the Oregon side of the Wahkiakum/Westport Ferry channel in June 1998 (Figure 5-4) and analyzed using screening levels adopted for use in the DMEF (1998). In 1994, samples were taken on the Wahkiakum Ferry side. The results indicated that the dredge material from this project would be acceptable for both unconfined in-water and upland disposal. No significant adverse ecological impacts are expected from such disposal in terms of sediment toxicity. The complete sediment evaluation reports for 1994 and 1998 can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Figure 5-4. Physical Analysis 1998

Sample I.D.	Grain Size (mm)			%		
	Median	Mean		Sand	Silt/Clay	Volitle solids
WP-GC-01	0.10	0.06		76.7	23.3	2.7
WP-GC-02	0.11	0.06		80.2	19.8	2.1
WP-GC-03	0.09	0.06		66.2	33.8	3.6
WP-GC-03 Lab Dup	0.09	0.05		65.3	34.7	N/A
WP-GC-05	0.10	0.06		76.8	23.2	2.5
Mean	0.10	0.06		75.0	25.0	2.7
Maximum	0.11	0.06		80.2	34.7	3.6

Old Mouth Cowlitz - The most recent sediment samples were taken on 10 September 2003 (Figure 5-5). Physical analysis of samples resulted in classification of the sediment as silt, silty sand, and silt with sand. Chemical analyses indicated only very low levels of contamination in any of the samples with all levels well below their respective DMEF screening levels. No pesticides, PCBs, phenols, phthalates, miscellaneous extractables or tributyltin were detected in any of the samples. Several low and high molecular weight PAHs were detected, but at very low levels. The analytical results of this characterization are consistent with historical data. Sediments represented by all samples in this sampling event are determined to be suitable for unconfined, in-water placement without further characterization. The complete sediment evaluation reports for 1990, 1991, 1996, and 2003 can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Figure 5-5. Physical Analysis 2003

Sample I.D.	Grain Size (mm)		Percent			
	Median	Mean	Gravel	Sand	Silt/Clay	Volatile Solids
OMCR-GC-01	0.009	0.034	0.00	2.62	97.38	2.01
OMCR-GC-02	0.026	0.038	0.00	17.59	82.41	2.17
OMCR-GC-03	0.033	0.076	0.78	22.29	76.93	1.55
OMCR-BC-04	0.070	0.054	0.00	57.07	42.93	1.31
OMCR-BC-04 DUP	0.070	0.056	0.00	58.81	41.19	1.26
Mean	0.032	0.051	0.16	25.11	74.70	1.75
Minimum	0.009	0.034	0.00	2.62	42.93	1.26
Maximum	0.070	0.076	0.78	58.81	97.38	2.17

Oregon Slough - The most recent sediment samples of material in the downstream Oregon Slough channel were taken in March of 1996. Physical analysis of samples resulted in classification of the sediment as silt with variable percentages of sand. Sediment testing was conducted on the sediment for metals, pesticide, PCB, and organotins (TBT and MTB) according to EPA protocols and was all found to be below established concern levels. Sediments represented by all samples in this sampling event are determined to be suitable for unconfined, in-water placement without further characterization. Sampling and analysis was conducted prior to establishment of the DMEF.

The latest sediment samples from the upstream Oregon Slough channel were taken in June 2001 (Figure 5-6). Physical analysis of samples resulted in classification of the sediment as poorly graded sand with one sample classified as silty sand. All samples were submitted for physical and chemical analysis including volatile solids content, acid volatile sulfides, metals, organochlorine pesticides, organotins, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs). The pollutant content of the sediment in all cases was found to be below levels of concern. Based upon DMEF standards, all sediment was determined to be suitable for unconfined, in-water placement without further characterization. The complete sediment evaluation reports for 1996 and 2001 can be found at www.nwp.usace.army.mil/ec/h/hr/sqer.htm.

Figure 5-6. Physical Analysis 2001

Sample I.D.	Grain Size (mm)		Percent			
	Median	Mean	Gravel	Sand	Silt/Clay	Volatile Solids
OS-VC-01A	0.24	0.34	0.37	99.22	0.41	0.52
OS-VC-01 DUP	0.21	0.27	0.00	97.25	2.75	0.44
OS-VC-02	0.19	0.26	0.00	98.66	1.34	0.63
OS-VC-03	0.18	0.13	0.00	97.87	2.13	1.72
OS-VC-04	0.19	0.83	0.00	82.37	17.63	1.76
Mean	0.20	0.37	0.07	95.07	4.85	1.01
Minimum	0.18	0.13	0.00	82.37	0.41	0.44
Maximum	0.24	0.83	0.37	99.22	17.63	1.76

5.5.4.6 Water Quality (total suspended solids, turbidity, dissolved oxygen, resuspension of toxins)

Because the side-channel projects have smaller grained sediments, there is more total suspended solids and turbidity associated with dredging and disposal of material. There also is more potential for the presence of toxins in the sediment. The only side-channel project that has shown levels of concern for toxins in its most recent testing is Skipanon Channel. Sediment testing in this and all areas with a prior history of detectible levels of contaminants would be done before any future dredging, so that materials can be appropriately managed to minimize resuspension of toxins.

The decrease in water clarity due to increased total suspended solids in the water column can affect the ability of fish to see and catch food. Suspended sediment also can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Although concentration and duration of exposure are the primary effects on fish, other factors influence the degree of the effects and ability of fish to clear the gills (Servizi and Martens 1987). Water temperature can affect tolerance to total suspended solids by further stressing the fish (Servizi and Martens 1991). Even in the side channels where sediments are finer-grained than in the main navigation channel, the increased total suspended solids due to dredging is expected to have only a minimal impact on salmonids migrating through or rearing in the side-channel areas. Because of the intermittent and temporary nature of the increase in total suspended solids, and that fish can move to avoid the turbidity plume, the impacts to salmonids are expected to be minimal.

Dredging fine sediments would likely create a sediment plume that may not disperse as quickly as in the sandier setting of the main navigation channel. This could decrease dissolved oxygen in the water column due to higher biological oxygen demand in the resuspended sediments. Dredging and disposal of fine sediments also could change the electrical conductivity of the water, which also impacts dissolved oxygen solubility. During dredging in Grays Harbor, Smith and others (1976) measured dissolved oxygen at 2.9 mg/l, and LaSalle (1990) found a decrease in dissolved oxygen of 16 to 83 percent in the mid-to-upper water column from nearly 100 percent close to the bottom. Decreases in dissolved oxygen have been shown to adversely affect swimming performance in salmonids (Bjornn and Reiser 1991). Reductions in dissolved oxygen due to dredging could delay or slow migration of adult salmonids and displace rearing juvenile salmonids if dredging affects water column dissolved oxygen, as described above.

However, the lower Columbia River has an abundance of oxygen due to spill operations at upstream dams. The dissolved gas saturation during the summer months (June to August), well downstream of Bonneville Dam at RM 42, ranged from 102 to 122 percent during 1993 to 1998 (see http://www.nwd-wc.usace.army.mil/tmt/wcd/tdg/months.html). Dredging and disposal operations may increase the conductivity of water locally and raise the biological oxygen demand there, which would in turn lower the oxygen solubility and decrease the amount of dissolved oxygen available. However, it is very unlikely that the impacts on dissolved oxygen in this supersaturated environment would be sufficient to impact salmonids.

5.5.4.7 Physical Habitat Alteration (shoreline/river bottom)

Side-channel dredging and disposal will have no impact on the shoreline. However, each time one of the side channels is dredged, it returns the bottom depth back to the authorized AMD depth, which means that there is a physical alteration of the bottom. This physical alteration is not expected to directly impact salmonids.

5.5.4.8 Stranding

No stranding has been reported for any of the side-channel projects. Dredging the side-channel projects is not expected to have any effects on juvenile salmonid stranding in the main river or in the side-channel projects themselves. Fish are normally stranded by wave action on shorelinees adjacent to the main navigation channel by deep-draft ships. The side-channel projects are separated from the main navigation channel and since they are shallow-draft channels, they do not have any deep-draft navigation. The dredging of the side-channel projects will not cause any change in the deep-draft navigation system.

5.5.5 Duration

The dredging in-water work window for the two lower estuarine side-channel projects (Baker Bay West and Chinook) is September through October. The reason for this timing is to minimize entrainment of Dungeness crab populations found in Baker Bay. For the upper six side-channel projects, dredging is allowed during the in-water work period of November 1 to February 28. The timing of these work windows is intended to minimize impacts to salmonids. Length of time for dredging varies with the type of equipment used, the amount of material to be dredged, weather/wave conditions in the vicinity of the dredge, and disposal operations. The dredge may work in any given side channel from 3 to 30 days. However, regardless of the dredging method, dredging is not continuous during any dredging day.

5.5.6 Disturbance Frequency

Dredging in the eight side-channel projects is done on an as-needed basis. Since 2000, dredging has not occurred in 2 consecutive years at any of the locations. As discussed, the effects are expected to be very small. The disturbance caused by dredging will not occur annually.

5.5.7 Disturbance Intensity

The disturbance produced by dredging in the estuarine side channels would most likely only have a small impact on juvenile and adult salmonids while migrating and rearing in the estuary. This disturbance is expected to be minor because of the size of the disturbance area relative to the area of the estuary. There is sufficient suitable habitat area available for the fish to find safe passage and rearing habitat away from the dredging or disposal areas. Dredging also is intermittent in nature, which allows the fish some period of undisturbed migration even during the dredging season. The disturbance in the riverine side-channel projects also may have a small impact on salmonids and their prey species, although these areas may not be as critical to migrating and rearing fish as the more highly productive estuarine areas.

5.5.8 Disturbance Severity

The disturbance caused by dredging the side-channel projects will not occur annually. As a result, the potential for impacts to salmonids utilizing any given area does not occur annually. Dredging will occur only during the in-water work period and the accepted BMPs for dredging and disposal are designed to minimize impacts to listed salmonid species. Consequently, effects to listed stocks of salmonids are expected to be minor.

5.6 Cumulative Effects

Cumulative effects are defined in 50 CFR (402.02) as, "Those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation." The action area under consideration encompasses the lower Columbia River (from Bonneville Dam to RM 40), the estuary (from RM 3 to 40), the MCR (from RM -3 to +3), and the eight side-channel projects.

The project area is currently a disturbed ecosystem altered by previous dredging to establish the navigation channel, disposal of dredged material, diking and filling, sewage and industrial discharges, water withdrawal, and flow regulation, to highlight a few of the anthropogenic activities that have occurred over the last 100 years. Future federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities, are being (or will be) reviewed through separate Section 7 consultation processes and are not considered cumulative effects.

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, 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, added to the geographic scope of the project area, which encompasses numerous government entities exercising various authorities and many private land holdings, make any analysis of cumulative effects difficult. This section identifies representative actions and ongoing state and Tribal fish and habitat restoration plans that, based on currently available information, are reasonably certain to occur. It also identifies, to the extent currently possible, existing goals, objectives, and proposed plans by state and Tribal governments, and local actions.

5.6.1 State Actions

Each state in the Columbia River Basin administers the allocation of water resources within its borders. Water resource development has slowed in recent years. Most arable lands have already been developed, the increasingly diversified regional economy has decreased demand, and there are increased environmental protections. If, however, substantial new water developments occur, cumulative adverse effects to ESA-listed salmonids are likely. Through restrictions in new water developments, vigorous water markets may develop to allow existing developed supplies to be applied to the highest and best use. Interested parties have applied substantial pressure, including ongoing litigation, on the state water resource management agencies to reduce or eliminate restrictions on water development. Therefore, it is impossible to predict the outcomes of these efforts with any reasonable certainty.

In the past, each Columbia River Basin state's economy depended on natural resources, with intense resource extraction. Changes in the states' economies have occurred in the last decade and are likely to continue, with less large-scale resource extraction, more targeted extraction, and significant growth in other economic sectors. Growth in new businesses, primarily in the technology sector, is creating urbanization pressures and increased demands for buildable land, electricity, water supplies, waste-disposal sites, and other infrastructure.

Economic diversification has contributed to population growth and movement in all four states, a trend likely to continue for the next few decades. Such population trends will result in greater overall and localized demands for electricity, water, and buildable land in and near the action area; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure. The impacts associated with these economic and population demands will probably affect habitat features such as water quality and quantity, which are important to the survival and recovery of the ESA-listed salmonids. The overall effect will be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address impacts to habitat features. Oregon also has a statewide, land use planning program that sets goals for growth management and natural resource protection. 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 the adverse effects discussed above.

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.

5.6.2 Oregon

Most future actions by the State of Oregon are described in the *Oregon Plan for Salmon and Watersheds,* and include the following programs designed to benefit salmon and watershed health in the lower Columbia River.

- Oregon Department of Agriculture water quality management plans.
- Oregon Department of Environmental Quality development of Total Maximum Daily Loads (TMDLs) in targeted basins; implementation of water quality standards.
- Oregon Watershed Enhancement Board funding programs for watershed enhancement programs, and land and water acquisitions.
- Oregon Department of Fish and Wildlife and Oregon Water Resources Department programs to enhance flow restoration.
- Oregon Water Resources Department programs to diminish over-appropriation of water sources.
- Oregon Department of Fish and Wildlife and Oregon Department of Transportation programs to improve fish passage; culvert improvements/replacements.
- Oregon Division of State Lands and Oregon Parks Department programs to improve habitat health on state-owned lands.
- State agencies funding local and private habitat initiatives; technical assistance for establishing riparian corridors; and TMDLs.

If the foregoing programs are implemented, they may improve habitat features considered important for ESA-listed salmonids. The *Oregon Plan* also identifies private and public cooperative programs for improving the environment for ESA-listed salmonids. The success and effects of such programs will depend on the continued interest and cooperation of the parties.

5.6.3 Washington

The State of 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 Department 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 State'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.

As with the State of Oregon's initiatives, Washington's programs are likely to benefit ESA-listed salmonids if they are implemented and sustained.

5.6.4 Local 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. However, future development in Oregon will be governed for the foreseeable future by Oregon's statewide land use planning program, and Washington's will be governed by its Growth Management Act, both of which address 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 action area.

Most local governments in Oregon and Washington are considering ordinances to address effects on aquatic and fish habitat from different land uses. The programs are part of state planning structures. Some local government programs, if submitted, may qualify for a limit under NOAA Fisheries 4(d) rule and/or a Section 10 Habitat Conservation Plan process which is designed to conserve ESA-listed salmonids. Local governments may also participate in regional watershed health programs, although political will and funding will determine participation and, therefore the effect of such actions on ESA-listed salmonids.

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.

5.6.5 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, such as the ones described below, 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 (eels), 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 Northwest.

5.6.6 Private Actions

The effects of private actions 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. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects are even more so.

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 North American Joint Waterfowl Plan, 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.

5.6.7 Cumulative Effects Summary

Non-federal actions are likely to continue to affect ESA-listed salmonids. The cumulative effects of non-federal actions in the action area that are reasonably certain to occur are difficult to analyze, considering the broad geographic landscape covered by this BA, the geographic and political variation in the project area, the uncertainties associated with state, Tribal, and local government and private actions, and ongoing changes to the region's economy. Many negative effects, such as impacts to fish habitat from continued urbanization, water extraction, and water quality alterations, 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. Consequently, plans that have not been applied are not considered in this analysis.

5.7 EFFECTS DETERMINATION

Based on the analysis in Section 5 of this BA, the maintenance dredging program for the Columbia River in the project area is likely to have an effect on listed species in the following ways. The effect is either a direct effect from the possibility of entrainment of listed fish or a minor avoidance based on noise, or an indirect effect by altering habitat in the river bottom, decreasing food sources, and/or increasing suspended sediment and turbidly levels by dredging and disposal. In addition, migrating juveniles and adults may move away from dredging and disposal activities. The BA concludes that these effects are minor.

Impacts to designated critical habitat also have been evaluated and determined to not appreciably diminish the value of habitat to the recovery of listed species because (1) effects to habitat, such as turbidity, are temporary and below levels known to adversely affect salmonids, (2) shoreline disposal occurs in highly erosive areas that do not provide inputs that are valuable to salmon, (3) upland disposal is occurring in areas previously used for disposal that do not provide riparian vegetation, significant detrital input, or insects, and are not considered important to the species' recovery, (4) flowlane disposal occurs at a depth not heavily used by salmonids, alters bathymetry in a way that does not diminish the value for migration to the limited extent migration may occur at that depth, and (5) dredging and disposal effects to prey species and food chain processes are small and temporary.

The Corps concludes that the impacts to the listed species and the critical habitat are minor and have been further minimized to the extent possible by utilizing the best management practices for dredging and disposal as outlined in Section 3. However, because an impact to the species and critical habitat is still occurring, the Corps is requesting formal consultation for the listed species for the Columbia River maintenance dredging program. The Corps also believes that the impact from the maintenance dredging program to lower Columbia River coho, a candidate species, will not jeopardize the species or it's habitat but will still have an impact. Consequently we are requesting formal conferencing for this species.

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Environmental Resources Branch

Mr. Michael Tehan
National Marine Fisheries Service
1201 NE Lloyd Blvd., Suite 1100
Portland, OR 97232

Dear Mr. Tehan:

We are providing this letter and attachments to confirm specific information previously discussed and provided to your staff after the transmittal of the Biological Assessment (BA), Columbia River Channel Operations and Maintenance Project, dated September 2004.

We are also requesting the on-going ESA consultation on the Columbia River Channel Operations and Maintenance Project be modified to include the critical habitat (proposed on 14 December 2004) for the following ESUs that are found within the action area of the channel maintenance activity:

- Lower Columbia R. Chinook Salmon ESU
- Upper Willamette R. Chinook Salmon ESU
- Upper Columbia River Chinook Salmon ESU
- Columbia R. Chum Salmon ESU
- Upper Columbia R. Steelhead ESU
- Snake R. Basin Steelhead ESU
- Middle Columbia R. Steelhead ESU
- Lower Columbia R. Steelhead ESU
- Upper Columbia R. Steelhead ESU

It is our determination that the analysis provided in the BA has adequately assessed the impacts of the project on the critical habitat PCEs and that any adverse effects to proposed or designated critical habitat would not appreciably diminish habitat value to the recovery of the ESA-listed species.

Corrections and clarifications to the BA

Dredging and Disposal Operations

- CORRECTION: Section 2.1.6 Upland Disposal (page 2-6) - In the first paragraph please delete clamshell as an option for upland disposal in the first sentence and delete the entire second sentence. Clamshell dredging with upland disposal is currently not done through routine maintenance of the Federal project.

Activities Proposed within Respective Reaches

MCR

Columbia River, MCR to Vancouver

- CLARIFICATION: The information provided in the NMFS Biological Opinion dated February 16, 2005 for the Columbia River Channel Improvement Project (CRCIP) includes 20 years of maintenance for that project. The CRCIP BiOp will be enforced for all areas that are deepened and for the maintenance of those areas once they are deepened. As the CRCIP project progresses, eventually the entire navigation channel will be covered by the CRCIP opinion. In the interim, the portions of the channel that have not been deepened will be covered by this 40 ft. Columbia River Channel Operation and Maintenance consultation.

Side Channels

- CORRECTION: Section 2.2.3.1 Baker Bay West Channel (page 2-16), 6th sentence in the first paragraph, replace"…and may be used in the future." And insert, "For the purposes of this BA, only a clamshell and hopper dredge will be used." In the next to the last sentence of the first paragraph - please delete the portion of the sentence which reads "…or on West Sand Island." Upland sites have been used historically, but currently none are available for use in this area.
- CORRECTION: Section 2.2.3.3 Hammond Boat Basin (page 2-17), next to the last sentence in that section - please replace the portion of the sentence that reads "… with associated upland disposal". Upland sites have been used in the past, but currently none are available for use in this area.
- CORRECTION: Section 2.2.3.6 Wahkiakum Ferry/Westport Slough (page 2-18), second to the last sentence in the first paragraph - please replace the portion of the sentence that reads "…or in an upland rehandle site." An upland rehandle site has been used in the past, but currently none are available for use in this area.
- CLARIFICATION: Section 2.2.3.8 Oregon Slough (page 2-19). Only the upper, shallow-draft portion of Oregon Slough is considered a side channel. The lower portion of the Oregon Slough is maintained to 40 feet as part of the main-stem navigation project and is covered under the main-channel navigation authorization. The upper portion is maintained to the much shallower -10 CRD (with an additional 2 feet of AMD) and is dredged intermittently as needed.

Vancouver to Bonneville Dam

- CLARIFICATION: Section 2.2.4 Vancouver, Washington to Bonneville Dam (RM 106.5 to 145) (page 2-19). The Corps is not proposing to conduct any dredging from RM 125.4 to RM 145. Even though the Corps is authorized to maintain a navigation depth of -27 ft. CRD with a 2-ft AMD, the channel is maintained only to -17 CRD with a 3-ft AMD. Current users above RM 106.5 do not require the -27 ft. channel depth, and the lock sills at Bonneville would not allow passage of vessels with a draft of over 17 feet. For these reasons, there is no expectation of the need to dredge to the deeper, authorized -27 ft channel depth. Therefore, the proposed action needs to clearly reflect that no dredging will occur deeper than -20 ft. CRD.
- CORRECTION: In Section 2.2.4 (page 2-19), in the first paragraph, 5th sentence, please delete “and occurs during the in-water work period from November 1 through February 28” and insert “will occur August 1 through September 30.”
- CLARIFICATION: In Section 2.2.4, RM 106.5 to 123.5 will be dredged to a maximum depth of 17 with 3 AMD. The minimum depth dredged is 12 feet.

Additional Information for Consideration

Side Channels

In the event that side channel material is determined through reanalysis to not be suitable for unconfined open water disposal through regionally agreed upon dredged material evaluation processes, we will pursue appropriate alternative actions (no action, upland disposal, confined aquatic disposal, treatment or others) and insure appropriate environmental coverage for these actions.

Critical Habitat

The measure to maintain a 300-foot habitat buffer should apply only to new upland disposal sites which are not proposed in this BA. The use of former and present disposal sites would be precluded if this 300 foot buffer is applied. These former disposal sites do not have significant fish and wildlife habitat value in the 300 foot area along the shore presently and they are not expected to have such value in the future.

Contaminants

Enclosure 1 contains copies of the information provided to NMFS previously for the CRCIP, including correspondence and data on Polynuclear Aromatic Hydrocarbons (PAH) and PCBs as well as other chemicals of concern. The Corps has sorted our database for PAH and PCB and furnished 1,300 records for PAHs and 1,062 records for PCBs within the project area. We applied the NMFS threshold values to these data to determine if there are any exceedances for PAH and PCBs. It was determined there are no samples within the navigation channel that exceed the NMFS threshold values. Several areas outside the channel exceed the “Dredged Material Evaluation Framework” (DMEF) and/or NMFS concern levels. Specifically, PAHs exceed NMFS values at the Skipanon Channel and PCBs exceed both the DMEF and NMFS values at Vanalco on the Columbia River and DDT and TBT (porewater) at Oregon Slough (lower) exceeded DMEF screening levels in 1996. Also enclosed is a CD-ROM containing the Corps’ complete database, as of April 19, 2003 and various other documents and information. Sample station CR-BC-76 was resampled in June 2001, the report date was December 2001.

In addition, please consider the sediment quality information that was hand delivered to you on February 15, 2005 in a meeting with the Corps and members of your staff. We also suggest that you clearly delineate the application of the sediment quality data between the main navigation channel and the side channels, as there are significant differences in the sediment type and effect between these sites.

Disposal Impacts

Enclosure 2 includes the information discussed at the meeting on February 28, 2005 which concludes that it is unlikely that pelagic fish like ESA-listed salmonids are not likely to be harmed or killed as a result of in-water disposal.

Side Slope Adjustment

Enclosure 3 contains an explanation of side slope adjustments due to channel development.

If you have any questions or need any additional information, please contact Mr. Kim Larson of my staff at (503) 808-4776 (e-mail - kim.w.larson@usace.army.mil) or Ms. Carolyn Schneider at (503) 808-4770 (e-mail – carolyn.b.schneider @usace.army.mil).

Sincerely,

Robert E. Willis
Chief, Environmental Resources Branch

3 Enclosures and CD ROM