CHAPTER 3

LOWER COLUMBIA RIVER MANAGEMENT AREA

3.1 OVERVIEW

The area covered by this manual is called the Lower Columbia River Management Area (LCRMA). The LCRMA includes the following water bodies: (1) the Lower Columbia River from its mouth near Ilwaco, Washington to Bonneville Dam at river mile (CRM) 148; (2) the segment of the mid-Columbia River extending from Bonneville Dam upstream to McNary Dam; (3) the Willamette River from its confluence with the Lower Columbia River upstream to its headwaters, and (4) all side channel and tributaries branching from the lower and mid-Columbia River and Willamette River. The LCRMA is shown in Figure 3-1.

The scope of the LCRMA was chosen because all of the water bodies are connected in a common watershed and they fall under a common regulatory jurisdiction, the USACE, Portland District. A minor exception to this regulatory scheme is a small number of non-port (private) dredging projects on the Washington side of the river which fall under the USACE, Seattle District. Within this broad reach, the mainstem navigation channel runs the full length of the river varying in depths of 55 feet at the entrance, 40 feet to Portland/Vancouver, 32 feet to Bonneville Dam and 15 feet to McNary Dam. The navigation channel in the Lower Willamette River is maintained at a depth of 40 feet.

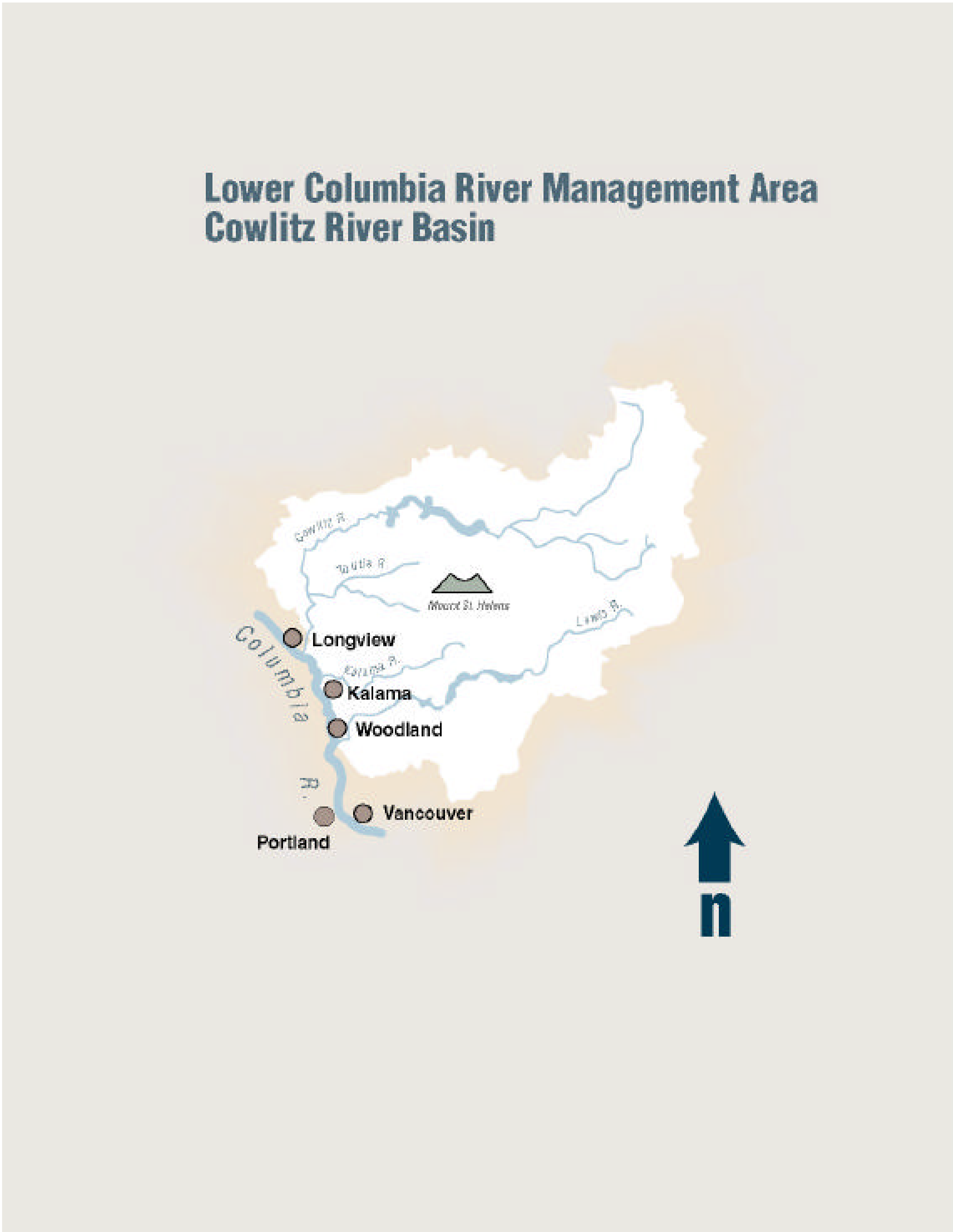
The following sections provide a general description of the LCRMA and a summary of hydrodynamic characteristics that have, or may have, a relationship to dredging and disposal. Much of the focus is on the Lower Columbia River segment of the LCRMA since that is where the majority of dredging and disposal takes place.

3.2 GENERAL DESCRIPTION OF THE LCR

The Lower Columbia River (LCR) forms the border between Washington and Oregon and supports the most concentrated population and industrial base along the U.S. portion of the river. The utility of the LCR as a major shipping channel has encouraged the development of major port facilities and heavy industrial activity in the population centers. Major population centers include Astoria, Rainier, Portland, St. Helens and Troutdale in Oregon and Longview-Kelso, Kalama, Vancouver, and Camas-Washougal in Washington. Land use adjacent to the river is devoted mainly to forestry and, to a lesser extent, agriculture, urban and suburban development, and residential use.


Lower Columbia River Management Area
Lower Columbia River Basin
Astoria
Longview
Kalama
St. Helens
Woodland
Vancouver
Portland
Bonneville
The Dalles
John Day
McNary Dam
Pasco
Richland
Kennewick
WA
OR
Walla Walla
Pendleton
Heppner
Maupin
John Day
Bend
n


Lower Columbia River Management Area
Willamette River Basin
Columbia R
Portland
Salem
Albany
Corvallis
Eugene
n


Lower Columbia River Management Area
Cowlitz River Basin
Mount St. Helens
Longview
Kalama R.
Kalama
Woodland
Columbia R.
Vancouver
Portland
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The LCR is augmented by several major tributaries, including the Grays, Cowlitz, Kalama, Lewis, and Washougal Rivers in Washington and the Youngs, Clatskanie, Willamette, and Sandy Rivers in Oregon. The LCR supports major salmon and sturgeon fisheries and provides habitat in the form of three national wildlife refuges (Lewis and Clark, Julia Butler Hansen, and the Ridgefield National Wildlife Refuges) and a wildlife management area (Sauvie Island Wildlife Management Area). The estuarine portion of the LCR provides critical nursery and feeding habitat for many important fish and invertebrate species.

The LCR is differentiated into an estuarine reach downstream of CRM 25 and a free-flowing riverine reach upstream to Bonneville Dam.

3.2.1 Estuarine Reach. The LCR River estuary averages 4-5 miles wide and extends upstream to about CRM 25. The estuary is divided into two primary paths of current flow, a north and a south channel. The south channel is an extension of the main river channel upstream of the estuary and carries most of the river discharge. The navigation channel follows the south channel through the estuary. The south channel is heavily ebb dominant, giving the estuary a net clockwise circulation pattern. The north channel extends upstream to about CRM 20 and is connected to the main river channel by shallow cross channels and tidal flats.

Tides at the entrance of the estuary are diurnal, the mixed type characteristic of the Pacific Coast. The influence of the tides on the Columbia River and its estuary is manifested in three primary ways: (1) intrusion of saline, ocean water, (2) periodic river flow reversal, and (3) water-level fluctuations.

Intruding ocean water tends to move upstream like a wedge under the less dense river water and may extend as far as CRM 20, near Harrington Point. The extent of intrusion varies with the tidal stage and the river flow, with maximum intrusion occurring during the highest high tide when river flow is at its lowest. Turbulence causes the intruding ocean water to mix slowly upward with the river water so that the water near the bed has a net movement upstream, whereas less saline surface water has a net movement downstream.

As the tide advances upriver, it causes a river flow reversal, surface and bottom, that has been observed as far upstream as Prescott at CRM 72. A third effect of the tides is that of fluctuations in water level which decrease with increased distance from the mouth. The tidal effect during low river flow varies from 7 to 8 feet at Astoria, Oregon to 1 to 2 feet at Bonneville Dam.

Between CRM 20 and 30, the main channel shifts to the north side while numerous shallow channels flow through Cathlamet Bay to the south. Upstream of CRM 30, the river has a single main channel, with occasional side channels around islands. In the main channel, typical peak ebb velocities are in the 3 feet per second (fps) range, with freshet velocities over 6 fps.

3.2.2 Free-flowing Riverine Reach. Upstream of CRM 25, to the confluence with the Willamette River, the main channel of the LCR generally varies from 1700 ft to 3000 ft wide, with minor bifurcations. Select river reaches have been constricted by pile dikes and sand fills in efforts to decrease shoaling in the mainstem navigation channel. The amount of constriction varies from a few hundred feet to several thousand feet. Bends within the river tend to have very long radii, typically over 15,000 feet. Sharper bends only occur where basalt cliffs control the river's alignment.

The bed of the main channel is composed of deep deposits of mostly fine and medium sand. Silt and clay make up less than 1 percent of the main channel bed material. Natural riverbanks consist of basalt or erosion resistant silt and clay deposits. These riverbank deposits range from 20 ft to 150 ft thick and overlay much deeper sand deposits. Sandy beaches occur only where dredged material has been placed along the shore. There has been little change in the river's location in the last 6,000 years.

The upper reach of the LCR extends immediately upstream of the Willamette River to Bonneville Dam. Major tributaries in this segment include the Washougal River in Washington and the Sandy River in Oregon. Flow is regulated and moderated by upstream dams.

River stage elevation may vary as much as 7 feet in a day near Bonneville Dam due to power peaking requirements. Because of the limited drainage area of the tributaries, the tributary inflow in this reach contributes minimally to winter flooding, and is not a factor during spring flooding.

The main channel of the Columbia River in this reach is slightly meandering and contains several bifurcations caused by mid-channel islands such as Government and Reed Islands. The flood plain is generally narrow (less than one mile wide) through the Columbia River Gorge which starts at the Sandy River. The flood plain is several miles wide near the downstream end of the reach, but flood flow is restricted by levees that extend downstream on both sides of the river to Vancouver and Portland. Channel hydraulics in the upper reach is complex because of the presence of mid-channel islands and rapidly varying discharges from Bonneville Dam.

Bedload sediments in the upper reach are quite diverse. Downstream of the Sandy River (CRM 121), bed sediments in the navigation channel and secondary channels are composed predominantly of fine to coarse sand, 0.250 millimeter (mm) to 1.0 mm in size. From the Sandy River upstream to Bonneville Dam, bed sediments range from fine sand to cobble size (0.250 mm to 256 mm). The navigation channel in the upper reach is at lesser dimensions than downstream reaches, 27 feet deep by 300 feet wide. As a result, dredging requirements are much less than any other segment. The primary purpose for dredging in this reach of the LCR is for structural fill or for making concrete.

3.3 SHOAL PROCESSES IN THE LCR

Shoal dynamics in the LCR is of particular interest because of its effect on the origin and movement of a large volume of sediment. Currently an average annual volume of 5 to 7 million cubic yards (mcy) of sediment is dredged from the LCR. A sediment budget for the LCR has been developed by the Portland Corps District to identify the historic source of shoal material in the mainstem navigation channel. Suspended and bedload transport have been analyzed, as well as pre- and post-regulation sediment transport.

3.3.1 Suspended Load. The LCR experiences a low volume of suspended load (i.e., sediment transported in the water column), much of which is carried out to sea. What remains tends to be deposited in the estuary's bays and shallow backwaters and sloughs. Only a small percentage of suspended sediment contributes to the shoaling problems that occur annually in the mainstem navigation channel. Generally 80-90 percent of the suspended sediment is silt or clay size which is not found in significant quantities in the bed of the navigation channel. Sand, which makes up about 99 percent of the bed material, is generally less than 15 percent of the suspended load, and increases to over 30 percent only when the discharge exceeds 400,000 cubic feet per second (cfs).

3.3.2 Bedload. As one method to determine pre- and post-dam conditions, bedload in the LCR has been estimated by the U.S. Geological Survey by relating unmeasured load to river discharge. This method resulted in estimates of 1.5 mcy/yr (before dams) and 0.2 mcy/yr (after dams). A second estimate was made by equating bedload transport to the movement of the sand waves present on the bottom of the river. Sequential surveys were made of two sets of sand waves, one during high flow conditions and the second during average discharge conditions. The analyses of those surveys and flow conditions resulted in bedload estimates ranging from 0.1 mcy/yr to 0.4 mcy/yr. The analysis also found that large sand waves only moved several hundred feet a year.

3.3.3 Shoal Material. Comparing the average maintenance dredging volume of 6.5 mcy/yr to an average total bed material transport rate of 1.0 mcy/yr indicates less material is being transported into the LCR than is dredged from the navigation channel. Therefore, the main source of shoal material must be within the LCR itself. Bathymetric surveys indicate that there has been significant bed degradation in areas adjacent to the most commonly dredged reaches. Significant beach erosion also occurs at many of the shoreline and/or beach nourishment disposal sites. These sandy shorelines are much more easily eroded than the natural silt/clay banks.

Given the small amount of bed material inflow and the stability of the natural banks, the most likely sources of shoal material are riverbed degradation outside of the navigation channel and erosion from beach nourishment and shoreline disposal sites. Where dredged material has been removed from the active sediment transport system, there has been a gradual lowering of riverbed elevations and a corresponding reduction in shoaling.

3.3.4 Shoaling Processes. The vast majority of shoaling in the navigation channel is the direct result of bedload transport. The two dominant shoal forms are large sand waves and cutline shoals. Sand waves are present throughout the river channel and cause shoals across the channel where wave crests rise above the channel design depth of -40 ft Columbia River Datum (CRD). Cutline shoals are much larger and run parallel to the channel. Cutline shoals develop at the same locations year after year.

Sand waves of 8 to 10 ft in height can form ridges across the navigation channel. The volume of an individual sand wave shoal is small, generally less than 30,000 cy, but they are numerous enough to represent a significant amount of the annual maintenance dredging. Sand wave shoals do not appear at the same location each year because of the time required for the waves to form and grow. The main source of material for sand waves is the bed of the navigation channel. Sand wave shoals are unlikely to occur where the channel bottom is deeper then 45 feet CRD.

Cutline shoals form along the navigation channel dredging cutline, parallel to flow, and can extend several thousand feet along the channel. The primary cause of cutline shoals is gravity pulling bedload down the side-slopes and into the main navigation channel. Cutline shoals begin forming at the edge of the dredged cut and grow out toward the center of the navigation channel. In the LCR, these shoals occur on the inside of long bends and on straight river reaches. They are especially severe in areas of the river that were less than 40-ft deep prior to construction of the existing channel. Cutline shoals are much larger than sand wave shoals and the 12 largest cutline shoals account for nearly half the volume of material dredged annually.

3.4 MAINSTEM NAVIGATION CHANNEL OF THE LCR

Dredging has been required to construct and maintain each stage of the mainstem navigation channel of the Lower Columbia River since 1906. Each stage of development has had an impact on channel depths as well on widths. At present, thalweg depths are generally near 50 ft throughout most of the LCR. This is only slightly deeper than prior to channel development when much of the main river channel had natural thalweg depths in the 35-ft to 45-ft range. However, the controlling depth or the minimum depth available anywhere along the navigation channel, has increased from about 12 ft prior to development, to 40 ft for the present channel. Typically, depths across the entire channel have also increased in reaches with large hydraulic control structures or high dredging rates. Channel areas with depths of over 50 ft occur mainly on the outside of bends and around rock outcroppings.

A period of riverbed adjustment has followed each development stage of the mainstem navigation channel. The amount of dredging required to maintain the channel during these adjustment periods has depended on the magnitude of the disturbance to the preexisting riverbed. Development actions have included channel deepening, constrictions (pile dikes), realignments, and fills. Deepening of the channel may be viewed as low intensity disturbances that impact large areas and significantly increase maintenance dredging. Many of the other developments (constrictions, realignments and fills) have also caused high intensity, local area disturbances that resulted in significant increases in maintenance dredging. Because of the frequency and variation of channel development activities, there is no simple correlation between channel depth and dredging requirements. Future maintenance dredging will depend on the magnitude of the overall disturbance to the riverbed and management of the river's peak flows.

3.5 MAINTENANCE DREDGING AND DISPOSAL IN THE LCR

The Portland District primarily with hopper and pipeline dredges does the majority of the dredging in the LCR. A few select shoaling locations are dredged by clamshell and a few by the “Sandwick”, a propwash dredge. 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. Currently, most placement is done at unconfined aquatic sites (called flowlane disposal) with the remainder (1 to 2 mcy/yr) placed on upland sites or at beach nourishment sites.

3.5.1 Hopper Dredging. Hopper dredges currently do about 3 mcy/yr of dredging in the LCR and 3-5 mcy/yr at the mouth. Most of this dredging is done by the Corps' hopper dredge, the "Essayons." Hopper dredges provide flexibility for dredging operations because they can operate anywhere on the river and can be rapidly deployed to problem shoals. Hopper dredges are most often used upriver on small volume shoals, such as sand wave areas, and on larger shoals in the estuary. The "Essayons" may spend several weeks in the early spring and in the fall dredging small shoals in the river upstream of CRM 25.

During the summer, dredging in the estuary work is done as backup work for the dredging at the mouth of the river. When the entrance becomes too rough or foggy for hopper dredges to work, they move to one of the estuary bars to dredge. The main restriction on the use of hopper dredges is the limited availability of in-water disposal sites with enough deep water to allow disposal without creating a new shoal. Flowlane disposal, in which material is deposited in deep-water areas adjacent to the navigation channel, is used for hopper operations upstream of CRM 25. In the estuary, hopper disposal is done at a large disposal site (called Area D) located away from the navigation channel near CRM 6 and at Harrington Sump, an in-water rehandling site located near CRM 21.

3.5.2 Pipeline Dredging. Pipeline dredges are used for large cutline shoals and areas with multiple sand wave shoals. About 3.5 mcy/yr are dredged by the pipeline dredge owned by the Port of Portland, the "Oregon". Pipeline dredging is done mostly during the summer. Typically, the "Oregon" is scheduled to start at one end of the navigation channel and work its way to the other end. This minimizes the amount of time spent moving the dredge and related equipment.

The most frequent pipeline disposal practice is to place the dredged material slurry along the shoreline near the dredging site. These shoreline or beach nourishment sites occupy about half of the total shoreline upstream of the estuary. Many of the beach nourishment sites are actively eroding and need a resupply of sand every 2-3 years. Upland disposal is an efficient disposal method but there are only a limited number of sites available. About half of the pipeline disposal is done at upland sites. In a few cases, pipeline disposal is done at flowlane sites with the use of a downspout that discharges dredged material at least 20 feet below the surface.

3.5.3 Advance Maintenance Dredging. Advance maintenance dredging (AMD) is the removal of sediment beyond the prescribed channel dimensions for the purpose of reducing costs by decreasing the frequency of dredging. AMD of up to 5 ft in depth is authorized for the mainstem channel. Five feet has been found to be sufficient to minimize sand wave shoaling problems, but is not well suited for cutline shoals. For the past 25 years, AMD has been done outside the channel boundaries to intercept material moving toward the large cutline shoals. Advanced maintenance dredging is also done for some side-channel projects which experience rapid shoaling, such as the Baker Bay/Chinook Marina channel. This channel is dredged to a dimension that is 5 feet deeper and 150 feet wider than the authorized channel dimensions.

3.6 RIVER CONTROL STRUCTURES IN THE LCR

Pile dikes are a common hydraulic control measure used in the river to improve channel alignment for navigation, reduce cross-sectional area, restrict flow in back channels, and provide bank protection. The Corps initiated pile dike construction in 1885, but the bulk of the pile dike system was built between 1917 and 1939. The last significant additions to the pile dikes system were built during construction of the 40 ft channel in the 1960s to further constrict flow and reduce erosion at dredged material disposal sites. The Corps currently maintains a total of 236 pile dikes within the LCR.

Sand fills, constructed with dredged material, have also been used extensively to reduce channel cross-section and control channel alignment. Most fill material has been placed along the shoreline to constrict flow. Upstream of CRM 20, nearly half the shoreline along the main channel is composed of dredged material fill. Dredged material has also been used to create several islands to control channel alignment, such as Coffeepot, Lord, Sandy, Goat, and Sand Islands. Pile dike fields protect most of these dredged material fill sites from erosion.

River control structures aid channel maintenance by controlling flow alignment, reducing erosion, and providing areas for disposal. The current network of control structures provides a smooth channel alignment that reduces erosion and aids navigation. The pile dike fields protect many millions of cubic yards of disposal material from erosion. However, the system has reached, and often exceeded, its limits for disposal site protection. Many shoreline sites have been filled beyond the limits of erosion protection provided by the dike fields and are actively eroding. Recent investigations by the Corps have recommended construction of additional pile dikes to protect disposal sites at Miller Sands, Pillar Rock, Puget Island, and Westport bars.

3.7 SEDIMENT QUALITY CHARACTERISTICS OF THE LCR

The following discussion of sediment quality characteristics is focused primarily on the reaches and/or locations where maintenance dredging is a common requirement. Some sediment characterization, such as was done for the Bi-state Study, includes a fairly broad survey of the entire Lower Columbia River. The information presently available to characterize the quality of sediments in the LCR includes: (1) published and unpublished surveys done by the Portland District Corps of Engineers; (2) the Bi-state Study[1]; (3) proposed projects such as port development, water-dependent industries, and marinas; (4) approvals/permits for point source discharges, such as industry and sewage outfalls; and (5) studies done by the U.S. Geological Survey and others to evaluate specific contaminants and/or reaches of the Lower Columbia and/or Willamette Rivers.

No single source of sediment information can be relied upon to portray the status of sediment quality because each source presents only a brief snapshot of the conditions encountered at a specific point on the river at a specific time of the year. For example, the Lower Columbia River is such a dynamic system that what was found before the flood events of 1996/97 may not be so today. The sediment survey done for the Bi-state Study is probably the most comprehensive survey done to date; however, it too presents limitations in that it was a one-time sample of the river (circa 1993) and it only sampled the top 2 centimeters of sediment.

3.7.1 Grain Size. Grain size is a commonly measured sediment parameter because it involves a relatively inexpensive test and the results are applicable to dredged material management decisions. Sediment in the LCR ranges from gravel-sized material to very fine clay.

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[1] The Bi-state Study undertook a systematic assessment of sediment quality of the lower Columbia River from the mouth to Bonneville Dam. The survey results are contained in *Task 6: Reconnaissance Report* dated May 17, 1993 and *Task 7: Conclusions and Recommendations* dated May 25, 1993. The survey obtained sediment samples from 54 locations, 40 of which were intentionally positioned to collect fine-grained sediment. The investigators targeted those locations because of the general finding that finer-grained sediment is more likely to contain contaminants. Sediment samples were collected in a range of water depths but the majority (40) were from depths of 5 to 20 feet; 7 from depths of 20-30 feet and 6 from depths over 30 feet. As a general guideline, resource agencies consider water depths of less than 20 feet to be the most biologically productive zone of the river and of special importance as the shallow water corridor used by out-migrating juvenile salmon.

Based upon historical survey data collected by the USACE, Portland District, sediment from the main navigation channel of the LCR has been found to be predominantly fine to medium-sized sand with less than 1.0 percent silt, clay and finer material. The most recent survey of channel sediment was done in 1997 in connection with the proposal to deepen the navigation channel. Out of a total of 89 samples, only six had a fines content greater than 5 percent. Of these six samples, four had a fines content greater than 20 percent. All but one of these samples was collected outside of the areas dredged to maintain the channel. This one exception is associated with the Morgan Bar disposal area that receives fine-grained material from the Willamette River.

Sediments sampled in the side channel projects by the Corps have been found to vary considerably more in grain size composition, particularly as channels near their destination, such as at a marina. Areas of finer-grained sediment accumulation are generally believed to be areas where sediment contaminants are more likely to be found. This is because many chemical compounds have electrochemical properties that cause an affinity for finer-grained sediment. However, sediments with greater than 20 percent fines have been subjected to additional chemical testing and, in the majority of cases, found to not exceed screening value guidelines in existence at the time of sampling. Only 2 samples were collected from the navigation channel.

Higher levels of contamination in fine-grained sediments were also not found in the surveys done for the Bi-state Study. As summarized in the *Integrated Technical Report* dated May 20, 1996, page 35: *Only trace metal concentrations were higher in the finer-grained backwater sediments (1993 survey) compared to the more open-water sediment stations sampled in 1991. These higher metals concentrations were generally due to the natural association of metals with finer-grained sediment, although some locations did appear to have elevated concentrations potentially related to human inputs . The expected higher concentrations of organic pollutants in backwater sediments were not observed in the 1993 survey.*

3.7.2 Metals. All of the metals noted below are natural components of soils and sediments of the Lower Columbia River drainage basin. The concentration of individual metals may vary depending upon additional inputs from human activity or sources.

Bi-state Study. The Bi-state Study reconnaissance survey provides a fairly comprehensive snapshot of the chemical composition of Lower Columbia River sediments. Many of the metals listed in Table 8-1 were found in the finer-grained sediment samples but none at levels that exceed the screening level guidelines (SL) adopted in this manual. Likewise, none of the coarser-grained samples had any metal exceedances above SL

The relatively low level of metals in Lower Columbia River sediments is summarized in the Reconnaissance Report, page 3-81: *Metals were the most frequently detected substances in sediment samples from the study area. The high detection frequency, which occurs at* *concentrations above the detection limits of conventional laboratory techniques, is due to the natural occurrence of many of these metals in Columbia River sediments. In most locations, the degree to which the metals exceeded the predicted distribution of average concentrations was not great, indicating limited alteration of the sediment quality by anthropogenic influences in the areas sampled.*

Portland Corps' 1997 Survey. The 1997 sediment survey reaffirmed the results of the Bi-state Study in that main channel sediments contain very low levels of metal. Only about one third of the samples had any metal detects, and of those, none exceeded the screening levels shown on Table 8-1. The results of the survey are summarized as follows:

Arsenic: 66 non-detects, range of detects = 1.0-3.0 ppm, screening level = 57.0 ppm.
Cadmium: all non-detects
Copper: 66 non-detects, range of detects = 4.0 – 33.0 ppm, screening level = 390 ppm.
Lead: 66 non-detects, range of detects = 1.0-10.0 ppm, screening level = 450 ppm.
Mercury: 88 non-detects, one detect = .07 ppm, screening level = 0.41 ppm.
Nickel: 66 non-detects, range of detects = 5.0-22.0 ppm, screening level = 140 ppm.
Silver: 88 non-detects, one detect = 1.0 ppm, screening level = 6.1 ppm.
Zinc: 66 non-detects, range of detects = 28.0-85.0 ppm, screening level = 410 ppm.

3.7.3 Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are a broad range of contaminants associated with forest fires, combustion of fossil fuels, petroleum spills, wood treatment facilities that use creosote, and urban stormwater discharges. PAHs are typically concentrated with finer-grained sediment downstream of urban areas.

Bi-state Study. This study detected relatively few instances of significant PAH contamination in Lower Columbia River sediment. The few samples where PAHs were detected are located downstream of larger urban areas and may be associated with stormwater runoff.

Portland Corps' 1997 Survey. A similar trend of low levels of PAH contamination was determined during this sediment characterization survey. Of the 22 samples analyzed, 18 had detectable quantities of low molecular weight PAHs (LPAH) ranging from 1 to 112 parts per billion (ppb). The screening level for LPAH is 5,200 ppb. Similarly, 15 samples had detectable levels of high molecular weight PAHs (HPAH) with a range of 1 to 407 ppb; the screening level for HPAH is 12,000 ppb.

Ecology. Sediments from Columbia River port locations at Kalama, Longview, and Ilwaco were examined during a screening survey conducted by the Department of Ecology, Survey Report 26-00-01, Dec 1988. PAHs were the major concern among the contaminants analyzed. PAH concentrations were elevated in sediments below Reynolds Aluminum in Longview (950 mg PAH/kg organic carbon). Contaminants at all other sites were found at relatively low concentrations or were undetectable. Bioassays performed on two species did not show any significant mortality. Further sampling in the vicinity of the Reynolds site was recommended to determine the extent of PAH contamination.

3.7.4 Pesticides and Polychlorinated Biphenyls (PCBs). The use of herbicides and insecticides (pesticides) has been and continues to be a common practice in the Columbia River drainage basin. Historic pesticide residues, such as DDT, continue to be detected in Lower Columbia River sediments, albeit low levels, even though some have been out of production for years. This situation reflects the persistent nature of these types of chemicals. The continued occurrence of pesticides is linked to widespread agricultural land uses in the drainage basin and the effects of ever-increasing urbanization adjacent to the river. PCBs are industrial chemicals used as cooling fluids and lubricants in transformers, capacitors, and other electrical equipment. Although also banned from production for some time, transformers manufactured or imported prior to the ban are still in use and continue to be potential sources of PCBs, particularly at sites where discarded transformers are stored or recycled.

Bi-state Study. When adjusted for non-detects, only 3.0 percent of the sampling stations yielded detectable levels of pesticides. While admittedly still persistent in the Lower Columbia River, the report considered pesticides in sediments to be a minor problem. Similarly, PCBs were detected very rarely in the sediment and were determined to not be a problem.

Portland Corps 1997 Survey. The Corps' survey reflects the findings of the Bi-state Study; only a few stations revealed any pesticides or PCBs and of those that did, the levels of detection were well below levels of concern.

3.7.5 Dioxin/Furans. At present there are no effects-based reference values for these compounds. The presence of these compounds in the environment is associated with chlorophenol production, wood-treating facilities, the aerial application of phenoxy herbicides (2,4-D and 2,4,5-T), effluent discharges from kraft pulp mills and chlorinated municipal treatment plants, and from combustion events.

Most of the research with regard to dioxins/furans has concentrated on the "bad actor" or 2,3,7,8-TCDD and little or no information exists on the other congeners. It is generally accepted that the higher weighted dioxins/furans are not as readily taken up or bioaccumulated by organisms and are less toxic. These higher weighted dioxins/furans occur naturally as combustion byproducts from such things as forest fires and wood stoves.

The Columbia River has recently been identified by EPA as "water quality limited" due to the prediction that dioxin (2,3,7,8-TCDD) concentrations in the water exceed the water column criteria for consumption of contaminated fish and water and the finding that tissue levels in Columbia River fish exceed the human cancer risk factor. EPA has developed a total maximum daily load (TMDL) allowance to better regulate the discharge of dioxin from U.S. pulp and paper mills located in the river basin, with the goal of reducing levels to below the water quality standard. Further investigations are being conducted to provide additional information to refine the TMDL and monitor the effect of regulatory actions.

Bi-state Study. Dioxins and furans were analyzed in 20 of the survey sampling stations and detected at each one. However, this could be expected since a very low detection limit was achieved for the reconnaissance survey, less than one part per trillion, and these compounds are known to be have a very widespread distribution in the Lower Columbia River watershed. Levels of 2,3,7,8-TCDD ranged from undetects to a high of 12.0 part per trillion (pptr). Levels of 2,3,7,8-TCDF were higher with a range of 6.0 to 123.0 ppt. The highest concentrations of these compounds occurred downstream of the Multnomah Channel and the cities of St. Helens, OR and Longview, WA. Each of these locations is affected by an active or historical discharge from a bleach kraft pulp mill.

1990 Portland Corps' Survey. Sediment samples specifically targeted for the determination of potential dioxin/furan contamination were collected within the navigation channel alignment at various locations along the Lower Willamette River (LWR) and Lower Columbia River (LCR) in May of 1990. Samples from the LWR were taken in the Portland Harbor reach (WRM 4 to 11). Samples from the LCR were taken at Camas (CRM 118), St. Helens (CRM 85), Longview (CRM 63 to 65) and Wauna (CRM 38 to 43). Most sample locations were chosen from within the normal dredging boundaries, including the channel and sideslopes, where dioxins/furans were most expected to be found.

In the LCR, samples were taken near or downstream of discharges from pulp and paper mills. Sample locations were chosen from shoals or where previous sampling had indicated the presence of similar hydrophobic organic compounds (i.e. PCBs, PAHs, pesticides) and where previous analyses by the Oregon Department of Environmental Quality indicated that dioxins/furans were present.

A total of nineteen samples or composites were obtained from the channel areas of the two rivers and analyzed for dioxins/furans. The isomer 2,3,7,8-TCDD was confirmed in only two of the nineteen analyses, both from the Lower Willamette River, at 0.63 part per trillion (pptr) and 0.62 pptr. The associated furan isomer (2,3,7,8-TCDF) was detected at concentrations ranging from a low of 0.73 pptr to a high of 110.0 pptr, also in the LWR samples. One sample was collected from the Doan Lake area where contamination of DDD, DDT and PAHs have been noted in the past. Though 2,3,7,8-TCDD and the lower-weighted dioxins were found only at low levels, the higher-weighted less toxic dioxins and the furans are significantly elevated above background. Further testing and evaluation was recommended in this area.

Though various isomers of dioxin/furan were detected in all of the samples tested, many of the individual isomer concentrations found in the LCR samples were attributed to background levels in the analytical system. In addition, concentrations found in samples from the LCR were orders of magnitude below those found in the Lower Willamette River samples. No significant dioxin/furan contamination was found in the sediments of the LCR.

3.8 MID-COLUMBIA RIVER (BONNEVILLE DAM TO McNARY DAM)

The 146 miles of mid-Columbia River in the reach between Bonneville Dam and McNary Dam also forms the boundary between Washington and Oregon. This reach of the river has mile after mile of open country, with widely spaced, small population centers. The only major city within this reach (over 10,000 population) is The Dalles, Oregon. The major tributaries to the mid-Columbia River between McNary and Bonneville Dams include the Umatilla, John Day, Deschutes, Klickitat, and White Salmon Rivers.

This reach of the Columbia River is almost totally regulated by four dams (McNary, John Day, The Dalles and Bonneville). The John Day Dam is the only dam in this reach that provides flood control in addition to providing a slack water reservoir. When high runoff is forecast, the pool is lowered to provide space for control of about 500,000 acre-feet of floodwaters. The other three dams are known as run-of-river dams and have no flood storage capacity.

3.8.1 Hydrodynamics. The volume of sediments transported by the Columbia River and its major tributaries is small compared to other major rivers in the United States. Sedimentation in the middle Columbia River reservoirs is a minor problem except at isolated areas, such as where local sediment bearing tributaries enter the reservoirs. As the dams do not have large storage capacities, river flows are strong and resident time for the water is short. Because of these flow regimes, fine-grained material is held in suspension and transported through and out of the system.

The slack water pools provide sufficient depth for navigation without the need for dredging of the federal channel. The federal channel is authorized to 15 feet. Recent dredging of the federal projects has been limited to the upstream end of the new navigation-lock at Bonneville, the forebay of the second Bonneville powerhouse, and at river mile 214 in Lake Celilo.

3.8.2 Sediment Quality Characteristics. Sediments in the mid-Columbia reach, that are dredged, are primarily fine to medium sands and gravels with very low organic content. Most of the dredged sediments have qualified for unconfined aquatic disposal back into the river although several projects have utilized the clean dredged material for beneficial upland purposes.

3.9 LOWER WILLAMETTE RIVER

The Willamette River basin lies entirely within the State of Oregon occupying a total area of about 12,000 square miles. The Willamette Valley forms a north-south trough through the northwestern portion of the state, with a width of about 75 miles from the crest of the Coast Range on the west to the crest of the Cascade Range on the east and has a length of 150 miles.

The Willamette River has a total length of approximately 187 miles, flowing principally northward through the central part of the Willamette Valley to its confluence with the Lower Columbia River at CRM 101. Its upper 133 miles flows northward in a braided, meandering channel. Through most of the remaining 54 miles, it flows between higher and more defined banks unhindered by falls or rapids, except for the basaltic intrusion which blocks the valley at Oregon City and creates Willamette Falls. The stretch below the falls is subject to ocean tidal effects which are transmitted through the Columbia River. Portland Harbor is located in the Lower Willamette River from its mouth upstream to approximately WRM 14.

3.9.1 Hydrodynamics. The Willamette River contributes a mean annual discharge of about 38,490 cfs to the Lower Columbia River. Peak flows, with a range of 20,800 to 130,000 cfs, occur in the high rainfall months of November through January; low flows, with a range of 5,000 to 7,100 cfs, occur in the lesser rainfall months of July through September. Flooding in the Lower Willamette Basin occurs frequently with an average of one or two floods in the winter season and with severe floods occurring about every ten years. Flows in the Willamette River are significantly regulated by reservoirs and hydroelectric dams located on the tributaries.

The Lower Willamette River is considered to be that portion of the river in close proximity to metropolitan Portland. In general, this area is bounded on the south at river mile (WRM) 25 on the Willamette River below Willamette Falls at Oregon City. Because of the Lower Willamette River's low elevation and proximity to the coast, tidal effects on river stage can be significant. River stage is also influenced by the regulation of upstream water storage projects as well as natural stream-flows on both the Columbia and Willamette Rivers.

The Willamette River's average annual suspended sediment load is estimated to be 1.7 mcy/yr. Less than 20 percent, or about 0.3 mcy/yr, of that material is sand, the rest is silt or clay. The Lower Willamette River's transport capacity is very low and fine sediments are deposited within the Portland Harbor reach. The bed material in the lower reach varies from fine sand and medium sand at the mouth, to over 80 percent silt and clay in the upstream part of the navigation channel. Given the channel dimensions and the type of bed material, bedload transport in the Willamette River is estimated to be insignificant.

3.9.2 Sediment Quality Characteristics. Sediments dredged from the Lower Willamette River range from clean sand to clayey, sandy silt high in organic content. A cutline shoal develops between RM 8.0 and 10.1 along the west side of the channel. This is the primary location requiring maintenance dredging every 2 to 5 years. Other areas are not dredged or dredged infrequently. Willamette River sediments have been subjected to chemical characterization because of the physical characteristics of the material dredged and close proximity of numerous known sources of contamination. The bulk of the material evaluated from the present 40-foot channel has repeatedly been found to be suitable for unconfined aquatic disposal, but some material has been found to contain chemicals-of-concern above established concern levels. Sediments from outside of the main channel tend to be finer and more likely to be contaminated. Information on sediment quality is included in the previous discussion on dioxin/furans sampling in the Lower Columbia and Willamette Rivers (Section 3.7.5).

3.10 SIDE CHANNEL PROJECTS

The Portland District maintains several navigation projects or channels that branch from the mainstem Lower Columbia River to select points in Washington and Oregon. Many of these channels provide access that benefits commercial enterprises, such as access to moorage facilities for commercial fishing fleets and forest product or other water-dependent companies. The Baker Bay/Ilwaco Marina navigation channel provides access to a federal facility, a Coast Guard station, while another provides the access route for a Washington State ferry. In some cases, access to moorage facilities also benefits recreational boaters. In a less typical case, the dredging of the Cowlitz River navigation channel serves as a means to reduce flooding in the upper watershed. Severe flooding could have resulted from the blockage of the channel by material swept into the river by the eruption of Mt. St. Helens.

3.10.1 Baker Bay West Channel, WA (CRM 2.5). The side channel known as the Baker Bay West Channel branches off from the entrance channel and provides access to the Baker Bay Coast Guard Station and the large marina at Ilwaco, WA. Between 1984 -1990, an average of 111,000 cys of fine to silty sand was dredged annually from about three major shoals in the channel. The dredged material has been disposed of at the unconfined aquatic (estuarine) site designated as Area "D" (hopper and clamshell) or on adjacent sand islands (pipeline).

3.10.2 Baker Bay/Chinook Channel, WA (CRM 5.0). The Chinook Channel provides access to the large marina at Chinook, WA by means of a long narrow channel that cuts through a reach of extreme shoaling. Because of extreme shoaling conditions, advanced maintenance dredging is done in certain sections of the channel. From 1986 to 1990 clamshell dredges have removed an average of 177,000 cys of fine to silty sand sediments with disposal at Area "D".

3.10.3 Hammond Boat Basin, OR (CRM 7.0). The Hammond project consists of an access channel through breakwaters to a mooring basin used primarily by small boats. The channel was last dredged by pipeline in 1990 when 15,300 cys of fine to silty sand was disposed of on an adjacent upland site.

3.10.4 Skipanon River, OR (CRM 11.0). The authorized project for the Skipanon Channel provides for an entrance channel from the Columbia River to the boat basin. Shoaling occurs at the entrance due to the deposition of sand across the mouth of the Skipanon River. Deposition also occurs in the inner reaches of the channel near the boat basin. The sandy dredged material has been found suitable for unconfined aquatic disposal at Area "D". The finer silty sediments from the inner reaches have been tested at regular intervals and disposed at upland confined sites. The outer channel requires dredging about every third year by hopper whereas the inner reach is dredged about once every five years.

3.10.5 Tongue Point/Cathlamet Bay (CRM 18.5). The authorized project includes an access channel from the Columbia River to commercial moorages and a turning basin inside Cathlamet Bay. The project was last dredged in 1989 and has not required any maintenance dredging since then.

3.10.6 Skamokawa Creek (CRM 33.6). The authorized project provides for an access channel from the Columbia River through the mouth of Skamokawa Creek to Brooks Slough. The channel provides navigation access to a boat launch facility and to upriver private and commercial vessel moorages. The channel is maintained every 3 to 5 years with either a pipeline or the agitation dredge. Use of the pipeline allows beneficial placement of the dredged material on the beach nourishment site at the nearby county park.

3.10.7 Elochoman Slough (CRM 39). The authorized project is an access channel from the Columbia River 1.5 miles up the Elochoman Slough to the mouth of the Elochoman River. The channel provides access to a marina and to a water-dependent forest products company. The channel is maintained every 3 to 5 years by use of the agitation dredge.

3.10.8 Wahkiakum Ferry, WA/Westport Slough, OR (CRM 43.2). The authorized project is a navigation channel extending from the ferry landing on Puget Island, WA to the mouth of Westport Slough on the Oregon side of the river. The channel provides access for the small ferry that traverses the river at this location. The channel tends to shoal fairly rapidly at the reaches closest to the shorelines on each side. Maintenance of the channel is done by clamshell or agitation dredge every 2 to 3 years.

3.10.9 Cowlitz/Old Mouth Cowlitz River (CRM 67.7). One of the authorized projects is an access channel from the Columbia River 3,800 feet up the Old Mouth Cowlitz River. The channel provides access for the transportation of log rafts to commercial facilities at Longview, WA. This channel is maintained annually by agitation dredging. Another authorized project provides for an access channel up the Cowlitz River to Ostrander, WA. Significant volumes of sediment were removed from this reach following the eruption of Mt. St. Helens, but has since stabilized to the point that maintenance dredging is very infrequent.