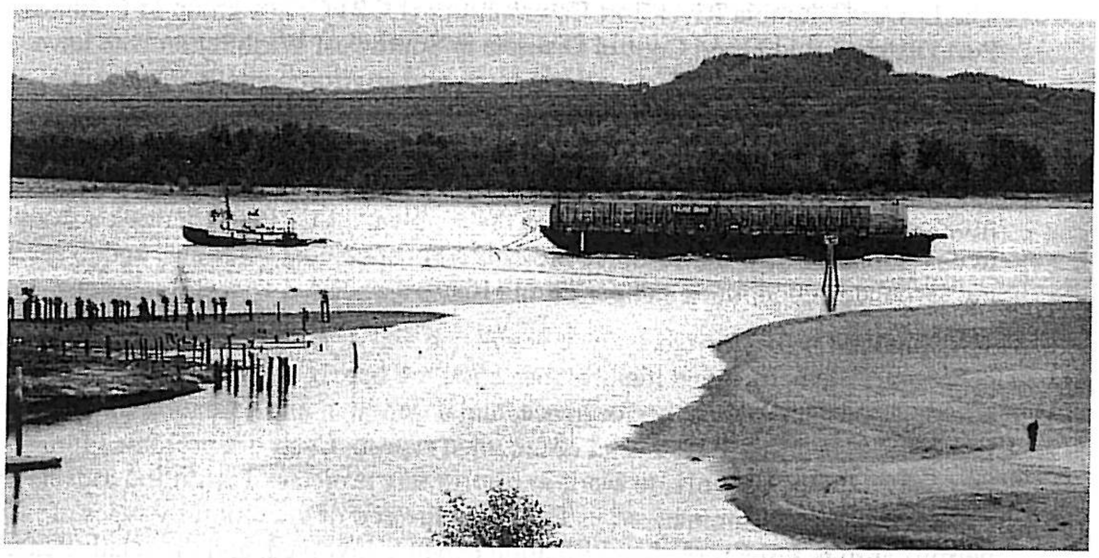
Projects and Solutions to
Water Resource Problems on Lower Columbia River



Prepared for Lower Columbia River Port Communities

Pacific County
Port of Chinook
Port of Ilwaco
Port of Wahkiakum County #1
Port of Wahkiakum County #2
Wahkiakum County
Wahkiakum County Consolidated Diking District #1

Produced in cooperation with U.S.D.A. Forest Service

February 2002

PACIFIC
INTERNATIONAL
ENGINEERING PLLC

Technical Memorandum

Projects and Solutions to Navigation Problems on Lower Columbia River

Executive Summary

The Lower Columbia River Port Communities (LCRPC) is a group of Counties, Port Districts, and Flood Control Districts in Southwest Washington who have cooperated to find cost-effective, long-term, and environmentally responsible methods to protect their resources from both erosion and sedimentation. Natural and engineered modification of processes active in the lower Columbia River appear to have affected certain navigation, bank protection, and flood control projects of the LCRPC. In response to the problems, LCRPC undertook a study to develop a list of water resource projects and conceptual solutions, and to assess the associated economics and permitting issues associated with the solutions.

Thirty solutions to 14 projects were developed and described in terms of technical concepts, initial costs, and maintenance costs. A matrix summarizing projects, solutions, costs, expected performance, and urgency in implementing the solution is presented in Table 1 at the end of the main report. Costs are presented for comparative analysis only, to assist in prioritizing projects. Permitting aspects of the solutions were summarized in Table 2 at the end of the report by types of permits required, the probable mitigation expense involved, and the relative ease of obtaining permits to implement the solution. A discussion of environmental permits and issues applicable to all the projects is presented in Appendix A.

Solutions to eleven projects involve dredging. Dredging solutions are assumed to be accomplished with dredging equipment acquired by the LCRPC through a government grant, and cost estimates account for only dredge production and maintenance. Some solutions require a relatively large initial cost, as for constructing a revetment. Comparison among solutions should be made with the awareness that life-cycle costs for dredging solutions do not involve initial purchase costs.

Some solutions rely on a changed procedure by the Portland District Corps of Engineers in scheduling maintenance dredging. Priorities in Operations and Maintenance expenditures are set at the Portland District generally according to the relative economic activity level at the individual projects. Because the natural resource bases of the local economy have declined, governments are encouraging tourism development to preserve the communities' economies. Recreational boating could be a mainstay of the revenue source for the ports, but the marinas require reliable entrance and access channels. The irony is that these marinas, which are also federal projects, appear to be given a low priority in receiving

maintenance dredging for their access channels, presumably because the Ports' commercial economics are at a low level. A solution would be to again count recreational benefits, as was done prior to the 1980s, for economic justification for federal maintenance expenditures. That solution could be implemented through changes requiring Congressional action.

Introduction

The Lower Columbia River Port Communities (LCRPC) contracted Pacific International Engineering^{PLLC} (PI Engineering) to assist in developing a list of water resource projects in Pacific and Wahkiakum Counties. Other tasks contracted to PI Engineering are to develop conceptual solutions (task 2), assess the associated economics and permitting issues (task 3), and assist LCRPC in prioritizing the projects and developing briefing documents for use in securing funding for selected projects (task 4). This Technical Memorandum summarizes results of the first 3 tasks for potential projects identified in site visits made on September 12, 2001 and in subsequent communications with LCRPC. Economic benefits of the separate projects are discussed in conceptual terms. Cost estimates and technical characteristics of the solutions presented in the report are developed only to the conceptual level and cannot be used for design, permitting, or construction purposes. Costs are presented for comparative analysis only, to assist in prioritizing projects. A matrix summarizing projects, solutions, costs, and expected performance is presented in Table 1 at the end of the main report. A discussion of environmental permits and issues applicable to all the projects is presented in Appendix A. Ease of permitting the individual solutions is summarized in Table 2 at the end of the main report.

The projects are listed below and their locations are shown in Figures 1 and 2.

1. County Sand Pit Deficit of Dredged Material
2. Brown Slough Pump Station Bank Erosion
3. Grove Slough Pump Station Sedimentation
4. North Welcome Slough Rd. Bank Erosion
5. Ferry Terminal Sedimentation
6. Pancake Point Shore Erosion
7. Cathlamet Channel Sedimentation
8. Cathlamet Marina Sedimentation
9. Skamokawa Creek Channel Sedimentation
10. Grays River Channel Sedimentation
11. Deep River Navigation Channel Sedimentation
12. Port of Chinook Marina Channel Sedimentation
13. Port of Chinook Shore Erosion
14. Port of Ilwaco Maintenance Dredged Material Disposal

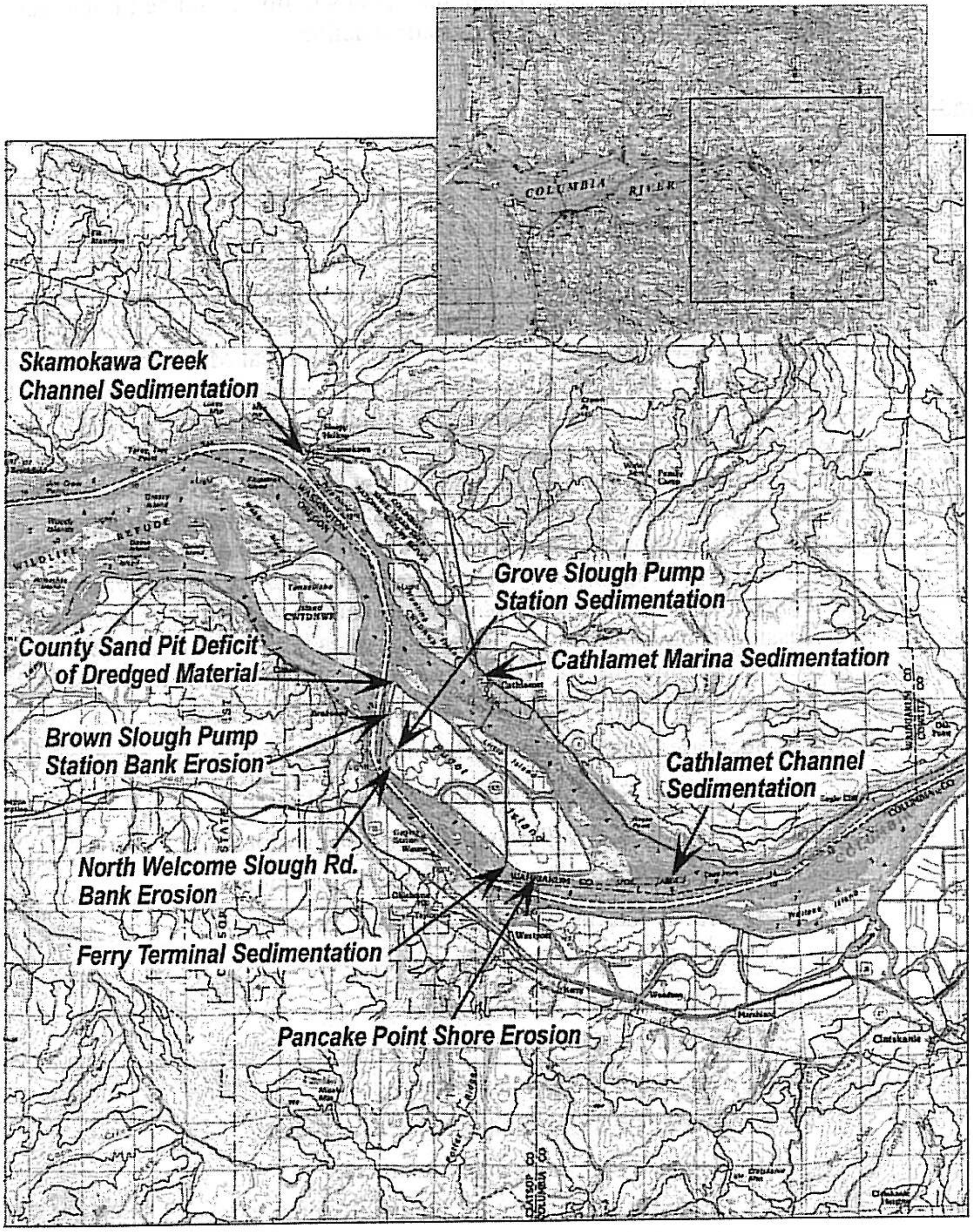


Figure 1 Puget Island and Cathlamet Region Projects

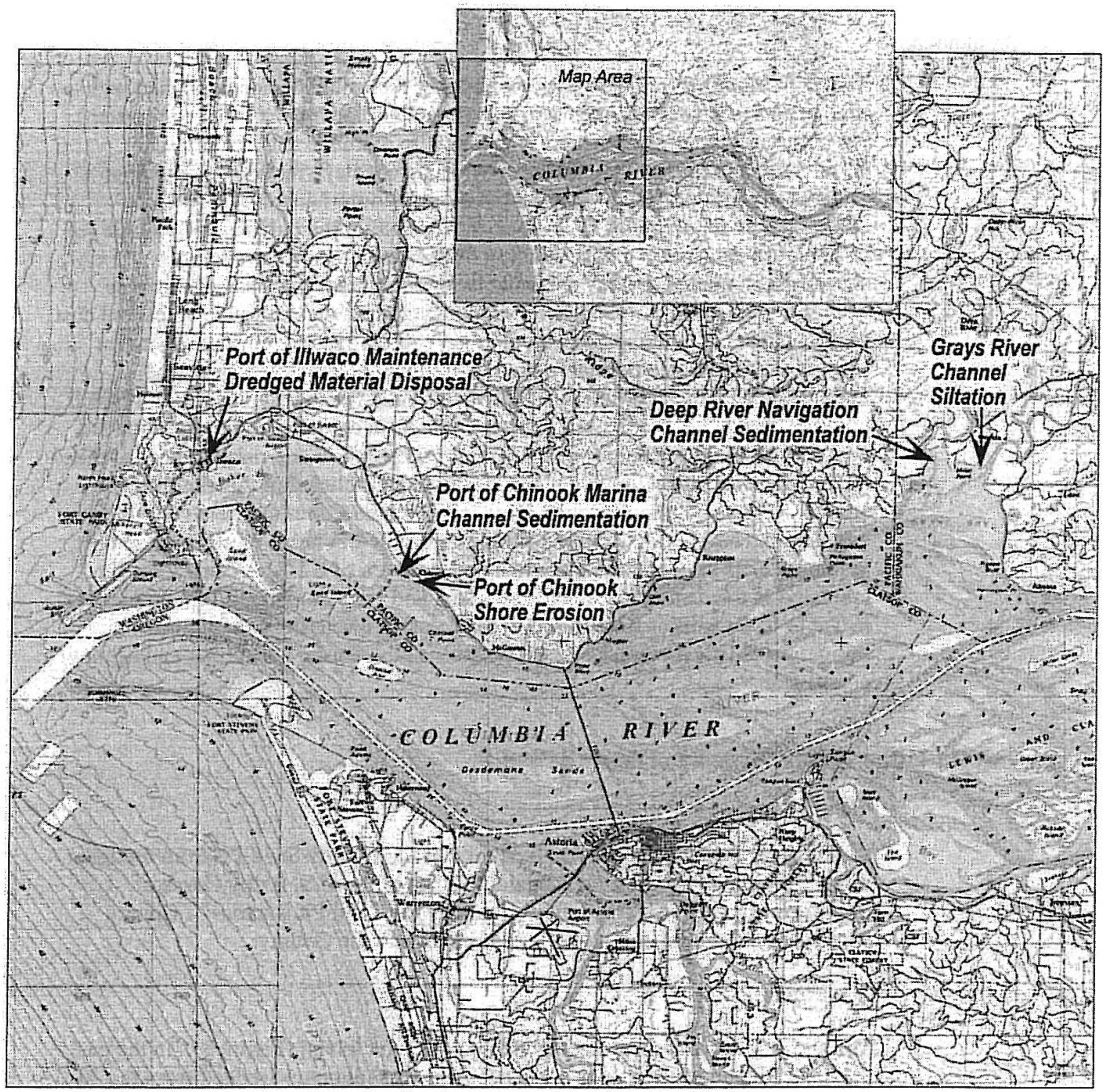


Figure 2 Port of Chinook and Ilwaco Region Projects

Assumptions

Solutions to eleven projects involve dredging that could be accomplished with a dredge approximately 12 inches in size (impeller diameter of the dredge pump). An option for the project owners is to purchase a dredge and associated equipment, and perform the dredging with current staff, instead of relying on contract dredging. An option is for the owners comprising the LCRPC to coordinate under a type of Inter-Local Agreement in the purchase of a single set of dredging equipment and scheduling of their maintenance dredging. Government-funded grants are available for equipment purchase of this type. Therefore, the possibility exists for dredging equipment to involve no capital cost to the LCRPC. Dredging costs would then consist of fuel, reimbursement for labor if staff from one port were used in dredging at a different port, and maintenance on the equipment. Under these conditions dredging with a 12-inch pipeline dredge not requiring a booster could be accomplished for an estimated unit cost of $1.00 per cubic yard. Costs for preparation and management of diked upland disposal sites are unknown and cannot be included in this preliminary analysis. Some solutions require large initial expenditures and relatively little ongoing expenses. Costs of the solutions are stated in terms of a life-cycle cost, assuming a 50-yr economic life and a discount rate of 6 1/8 percent. Costs are tabulated in the discussion of each solution, and are summarized for comparison in Table 1. Permitting costs listed in the solution discussions do not include mitigation. Mitigation costs would be determined during permitting and agency negotiation.

Project 1 County Sand Pit Deficit of Dredged Material

Problem

Wahkiakum County has not received sand at the County Sand Pit from dredging in the Columbia River by the Portland District of the U.S. Army Corps of Engineers since 1996. The deficit of sand at the Sand Pit is a loss of County construction material and also a loss of income to the County.

Description

The site is located at the downstream end of Puget Island (Figure 3). In the past, the Sand Pit had been used as a disposal site for sediments dredged from the 40-ft navigation channel in the adjacent reach by the Portland District. The estimated capacity of the site is approximately 50,000 cubic yards (cu yd). An earthen dike was constructed around the disposal site and a 60-inch diameter culvert was installed as part of an overflow weir. Under contract to the Portland District, the Port of Portland's cutterhead pipeline dredge, *Oregon,* discharged the dredged slurry at the disposal site. Return water was drained through the culvert back into the river. Because the flow through the culvert could not keep up with the discharge from the pipeline dredge, the filling process alternated between filling the Sand Pit and nourishment of the adjacent beach. The disposed material was a source of sand for public works projects, including flood protection. Estimated demand for sand from this pit by public works is approximately 15,000 cu yd per yr. The County also sells sand to other private purchasers.

The channel reach from which material is dredged is part of the Columbia and Lower Willamette Rivers below Vancouver, Washington and Portland, Oregon Federal Navigation Project. The existing project was authorized by the Rivers and Harbor Act of 27 February 1911 and subsequently modified by many Acts. The current condition is a channel 40 ft deep and 600 ft wide from Vancouver, Washington, to the mouth of Columbia River. The current 40-ft depth authorization is contained in the Rivers and Harbor Act of 23 October 1962 (House Document No. 452, 87th Congress, 2nd Session, U.S. Public Law 87-874-76, Stat. 1177). The Portland District maintains the channel with regular dredging and disposal of shoal material. Puget Island Bar has one major shoal, which develops between River Mile 37.4 and 38.7. Puget Island Bar has been dredged during channel maintenance by pipeline dredge once in the past ten years, removing 474,000 cu yd per year and dredged material has been disposed at the Sand Pit and outer adjacent shoreline. Hopper dredges have maintained this reach in seven of the past ten years, removing an average of 355,000 cu yd of material per year.

The Sand Pit is a permitted disposal site (designation W-38.7). The Portland District ceased placing material at the Sand Pit site in 1996 mainly because operational efficiency and environmental restrictions have changed. The efficiency of using a pipeline dredge decreased in recent years as the depth of the shoal began to stabilize. The thinner dredging cut has reduced the required dredging volume per unit area and forced the dredge to change position more for the same volume dredged than previously. Frequent movement of the dredge is inefficient for a pipeline system and is better suited to a hopper dredge. However, the Portland District's hopper, *Essayons*, is capable of disposing only at in-water sites and currently cannot place material at the Sand Pit.

The drainage capacity of the disposal site dewatering system is a secondary reason that the Portland District has not resumed material placement at the Sand Pit. In previous pipeline operations, filling in the pit would be alternated with beach nourishment. Beach nourishment practices are now heavily restricted by the Endangered Species Act (ESA). If upland placement is resumed, beach nourishment is not likely to occur. Operational delays would result if pumping were stopped to allow for settling and drainage in the Sand Pit. Such would be the case if a pipeline dredge the size of the *Oregon* performed future dredging.

Figure 3 County Sand Pit

An additional problem related to the cessation of upland disposal, although not directly related to the Sand Pit, is shoreline retreat just upstream of pile dike 38.25. A bulkhead was constructed at the erosion area apparently in an attempt to reduce shoreline retreat (Figure 4). The Portland District was concerned that material disposed on the beach at that location would eventually make its way directly to a bar, requiring dredging again.

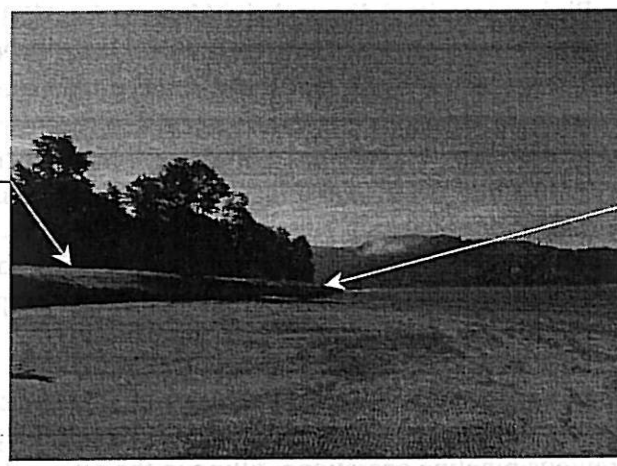


Figure 4 County Sand Pit – Looking South

Assumptions

- Shoaling in the Puget Island reach has diminished to the rate that channel maintenance there in average years will be accomplished by hopper dredges.
- The dredge *Oregon* that historically placed sand at the Sand Pit site will not be available for this project.

- The overflow weir can be modified to accommodate the settling rate and return water flow rate required for a dredge having a smaller rated production than the dredge *Oregon.*
- Dredged material will no longer be placed on the beach adjacent to the Sand Pit.
- The capacity of the site is approximately 50,000 cu yd.

Solutions

Two potential alternative solutions are discussed below: Hopper Dredge and Cutterhead Pipeline Dredge. The County is exploring development of a disposal site with a larger capacity elsewhere on Puget Island. Ideally, this site would both benefit the Portland District and provide the County with enough sand to meet its needs. The alternative is in a discussion stage only and no other details are provided in this technical memorandum.

Hopper Dredge

The Hopper Dredge solution assumes that a hopper dredge with pump-out capabilities is employed to dredge the Puget Island reach and dispose material at the Sand Pit. Because the Portland District's *Essayons* is not now equipped to pump out, a private contractor might be hired to perform the work. A pump-out station (barge or mono-buoy) would be deployed waterward of the Sand Pit site at a depth allowing for staging and safe operations of the hopper dredge. It is believed that appropriate depths are available in the vicinity of 1,000 ft from the disposal site, which would allow direct pump-out without a booster pump. A pipeline would extend from the pump-out station to the Sand Pit. The overflow weir at the Sand Pit would be modified to discharge water from the pit between dredging and disposing cycles.

Hydraulic evaluation of any disposal scenario should be undertaken during the next phase of the design (if this alternative is selected for further consideration) to better determine the requirements of the weir.

Prior to any placement at the Sand Pit, the perimeter dike that contains the pumped dredge slurry must be prepared for new material placement. The eastern end of the dike near Ostervold Road must be closed. The proper dike elevation, thickness and slopes must be determined or verified during the next phase of the study or design.

Costs to implement the pump-out hopper dredge solution include environmental permitting, engineering design, and construction. Engineering is expected to include a hydraulic evaluation of the settling pond and return water weir system, designing the new work, determining quantities, and specifying grades and dimensions of the placed material. Rehabilitating the containment dike is a cost for resuming disposal at the Sand Pit. Additional costs include the cost difference between disposal in-water by the *Essayons* (the current method), and disposal at the Sand Pit by a contract hopper dredge with pump-out capabilities. The cost difference is estimated to be $3.75 per cu yd. Costs are summarized in the table below.

Hopper Dredge	Estimated Cost
Environmental Permitting	$25,000
Engineering Design	$14,000
Construction	- 0 -
Ongoing Differential Cost, Bottom Dump vs Pump	$70,000 (average annual)

Cutterhead Pipeline Dredge

The Cutterhead Pipeline Dredge solution assumes dredging and placing sand at the Sand Pit by a relatively small cutterhead dredge. A 16-inch pipeline dredge could dredge to the depth required to maintain the navigation channel. A smaller 12 inch- to 16-inch dredge could maintain the sides of the channel down to a depth of 30 ft. The County would dredge the channel reach adjacent to the Sand Pit and place sand at the site through a floating pipeline. Dredging the navigation channel could be accomplished under the existing permit. Because a smaller dredge has a relative low production rate, no modification to the weir may be required. The time required to fill the Sand Pit may be 2 to 4 weeks depending on the size of the dredge and dredging schedule.

It should be noted that no new construction work is required for this solution. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate unit cost of $1.00 per cu yd for dredging and disposal, not counting site preparation. Dredging is approximately $50,000 for a 50,000 cu yd volume every third year. Costs are summarized in the table below.

Cutterhead Pipeline Dredge	Estimated Cost
Environmental Permitting	$25,000
Engineering Design	$14,000
Construction (Equipment Purchase)	$750,000
Ongoing Dredging and Disposal	$19,000 (average annual)

Conceptual Net Benefits

The primary benefit will be the replenishment of an upland sand source on Puget Island. The disposed material would be a source of sand for public works projects, as well as a source of revenue from the sale of material to private individuals and contractors. The County currently charges $1.50 per cu yd for material in the Sand Pit. The assumed usage of the disposed material is 50,000 cu yd every 3 years.

Project 2 Brown Slough Pump Station Bank Erosion

Problem

The bank line is retreating toward the revetment that protects the pump station and roadway dike in the vicinity of the pump station outfall. Bank retreat has progressed to the extent that protection of the reventment toe is required to control the risk of erosion of the dike. Erosion of the dike would endanger the pump station and a stretch of Ostervold Road. At the current rate of bank retreat, erosion of the dike and the county road atop it could occur within 5 to 10 years.

Description

The project area is near the pump station on Ostervold Road at the outlet of Brown Slough (Figure 5). The station pumps water from the slough that drains the inner portions of Puget Island. The bank along the project area has been eroding for several years. A rock revetment was constructed under an emergency authorization as a result of erosion of local property during a flood in December 1984. Figure 5 shows the extent of localized bank retreat at the pump station discharge outfall. Flow discharging across the beach, in combination with Columbia River flows, appears to erode the sand at the bank, resulting in a distinct zone of bank retreat.

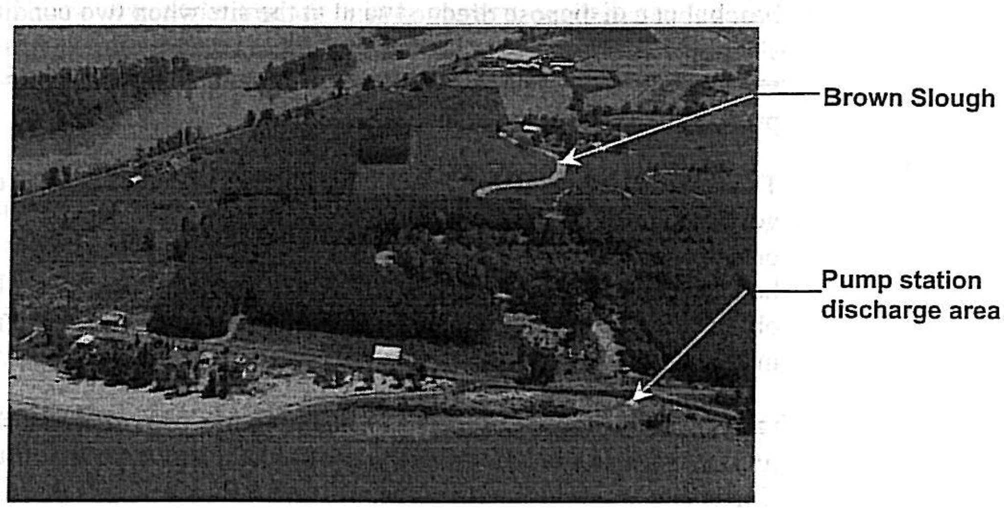


Figure 5 Brown Slough Pump Station

Raising of a pre-existing dike and construction of a dike and pump station were authorized by the Flood Control Act of 1936, which was modified with Acts of 1938 and 1950. The initial authorization is contained in House Resolution 8455, 74th Congress. The Portland District constructed the pump station in the late

1970s. The Portland District constructed the revetment under emergency authorization (Public Law 84-99) in December 1984. Maintenance for the dike and revetment is the responsibility of Wahkiakum County Consolidated Diking District No. 1.

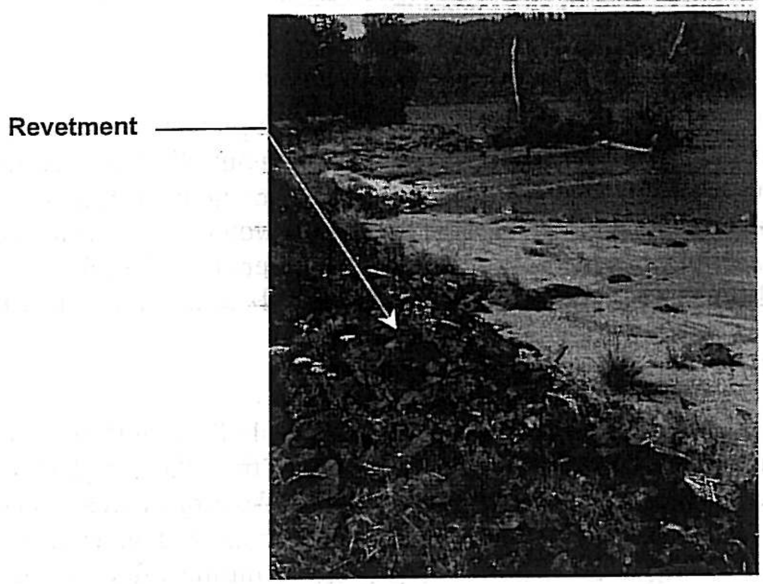


Figure 6 Revetment at Brown Slough Pump Station Outlet

The Portland District does not have responsibility to maintain the width of the beach, but can dispose dredged sand at the site when two conditions are met. These are: 1) no increase in cost of dredging and disposal (those requesting the sand may subsidize), and 2) all environmental clearances are in place. The project site is not a designated disposal site.

The current interpretation of authorities by the Portland District is that the Federal government has no responsibility to prevent the narrowing of the beach at the outfall location, but the Diking District is obligated to maintain the dike once it begins to be impacted by the river. The Diking District would be required to obtain a Corps of Engineers permit, among others, before undertaking maintenance involving work waterward of the Ordinary High Water (OHW) Line.

Observations during the site visit in September 2001 revealed that some of the revetment rock has been displaced onto the beach at the toe of the revetted slope. Currents and waves destabilize the revetment rock and increase the structure's risk of erosion and threaten the dike and road and low-lying interior areas.

Assumptions

- Bank retreat is occurring only at shallow depths; the main channel is not encroaching toward the dike.

- Erosion at the pump station discharge location is caused in part by flow discharging from the pump station outfall in combination with Columbia River flows.
- A deficit of sand at this part of the bank line is caused in part by increased levels of energy reaching the bank, and dredging upstream in the navigation channel, with disposal of sand that bypasses the erosion area. The combination of these factors removes sediment from the upper bank that would otherwise buffer the dike from erosive forces.
- Vessel wakes and pressure field forces from deep-draft vessels traveling in the navigation channel are sources of energy impinging on the revetment and bank.

Solutions

Two potential alternative solutions are discussed below: Rock Revetment Rehabilitation and Beach Nourishment.

Rock Revetment Rehabilitation

The Revetment Rehabilitation solution includes reinforcing the toe of the dike and the pump station outfall with rock having a size that would withstand erosive forces from currents, wind waves, and vessel generated waves. An engineered rock toe of the revetment would protect the dike from future scour and undermining. New armor rock would be sloped back from the new toe to midway up the existing revetment to replace missing rock. The existing rock would function as bedding for the new rock layer. An engineered revetment toe would be a relatively permanent solution, although revetment maintenance would be expected in 20 to 30 years.

An engineering analysis and design for this solution would determine the size and amount of rock, cross section dimensions, and frequency of maintenance if this solution is selected for further analysis. For this comparative analysis, a 3-ft toe thickness, 3-ft toe width, and a 7:1 slope back to the existing revetment are assumed. These dimensions apply to 200 ft of shore, 100 ft on either side of the pump station outlet. Approximately 2.6 tons per lineal ft (520 tons of rock over the 200 ft) would be placed for the rock revetment solution. At an estimated cost of $30 per ton of riprap rock and added costs for excavation, bedding, and contingencies, the revetment would cost approximately $40,000 for initial construction. Maintenance is expected to be about 15 percent of initial cost every 20 years, on average. Costs are summarized in the table below.

Revetment Rehabilitation	Estimated Cost
Environmental Permitting	$15,000
Engineering Design	$6,000
Construction	$40,000
Revetment Maintenance	$150 (average annual)

Beach Nourishment

The Beach Nourishment solution includes placement of imported or dredged sand at the beach in front of the existing revetment. Placing sand in the eroded area would restore the beach to its former width, but would not reduce the forces responsible for eroding the sand. The Beach Nourishment solution would have a shorter life-cycle, and would require replenishment more frequently than maintenance of an engineered riprap toe. An analysis would likely be required to determine that sand placed at that location would not be re-deposited on the Puget Island Bar and increase the Portland District's maintenance cost of the navigation channel.

An engineering analysis and design for this solution would determine the amount and quantity of sand, location, and frequency of re-nourishment if this solution is selected for further analysis. A preliminary estimate of 25,000 cu yd of sand would be required for sand placement at the bank every 10 years. The sand can be removed from the navigation channel during maintenance dredging. The cost differential for 25,000 cu yd sand placement from navigation channel dredging, compared to the usual disposal method (which is flow lane disposal), is estimated at $4 per cu yd, or $100,000. For comparing this solution with others, however, sand is assumed to be placed from dredging by equipment owned by entities comprising the LCRPC and acquired with a grant. The cost for dredging with a locally-owned 12-inch dredge is estimated to be $1.00 per cu yd. Costs are summarized in the table below.

Beach Nourishment	Estimated Cost
Environmental Permitting	$15,000
Engineering Design	$10,000
Construction	-0-
Ongoing Placement	$3,400 (average annual)

Conceptual Net Benefits

Benefits of reinforcing the dike toe are the continued protection of the road, dike, and pump station, as well as a reduced threat of a dike breach. Benefits of placing sand in the eroded area are also the protection of infrastructure as well as creation of a sandy bank area for recreational use or possible habitat development. The sandy bank is not expected to be permanent.

Project 3 Grove Slough Tide Gate Sedimentation

Problem

Sedimentation is plugging the tide gates at the discharge point of the Grove Slough Pump Station. The plugged tide gates prevent gravity flow of water draining to the slough, requiring significantly increased pumping.

Description

The project is located on Ostervold Road near the Grove Slough Pump Station and tide gates (Figure 7). Construction of the dike and pump station were authorized by the Flood Control Act of 1936, and modified by Acts of 1938 and 1950. The initial authorization is contained in House Resolution 8455, 74th Congress. The Portland District constructed the pump station in the late 1970s. After the facilities were constructed, Wahkiakum County Consolidated Diking District No. 1 assumed responsibility for their maintenance.

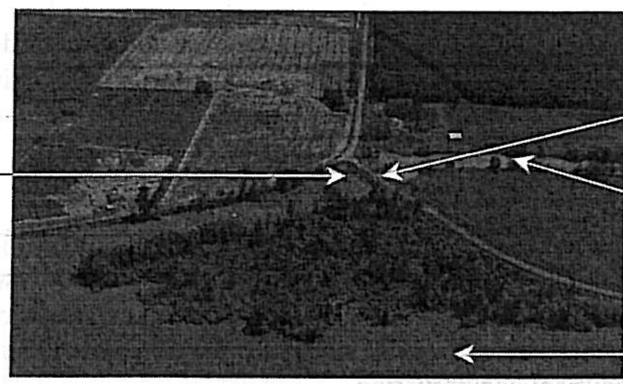


Figure 7 Grove Slough Pump Station

Sediment is transported into the slough and settles to the bottom, blocking the 3 tide gates installed for flood control of the island interior. Deposition and blockage prevents the gates from controlling the water level inside the diked area, increasing the demands on the pump station and, consequently, increasing electrical and maintenance costs. Additionally, the pump station discharge capacity may be insufficient to prevent flooding of the island interior during a heavy and sustained rainfall.

Sources of sediment that deposit at the tide gates could be suspended sediment carried to the slough mouth by Columbia River flows, or as local observers have indicated, waves created by passing deep-draft ships that travel up the slough to the tide gates. These ship-generated waves are capable of transporting material on the slough bottom and erode material from the sides of the slough. Transport due to ship-generated waves near the Columbia River bankline is a general phenomenon and was documented in the Portland District Planning Division Technical Report, *Investigation of Bank Erosion at Sauvie Island, Oregon*, dated September 1986.

The Diking District last dredged the slough about 15 years ago. Approximately 20,000 to 25,000 cu yd of dredged material was removed by a cutterhead pipeline dredge and placed on nearby private land. After dredging, the gates operated nearly 10 years before silt blockages occurred. For the last 5 years, silt has blocked the tide gates.

Assumptions

- Sediment settles at the outlet of the tide gates and causes the gates to be inoperable.
- The rate of sedimentation will continue to be low. The slough was last dredged approximately 15 years ago. The siltation did not affect tide gate operation about until about 5 years ago.

Solution

The rate of infill is not rapid, judging from the history of dredging and deposition at the site. Therefore, implementing a maintenance dredging program to remove the deposition in front of the tide gates is an appropriate solution.

Maintenance Dredging

This solution consists of dredging sediment from a 1,000-ft length of the slough from the tide gates towards the river. The dredged depth would provide for normal tide gate operation and allow for some accumulation. The maintenance dredging interval is assumed to be once every 10 years, but would depend on actual sediment accumulation.

The costs for this solution include permitting, engineering design, and dredging and disposal of slough sediments. Engineering includes the development of plans and specifications for a dredging contract. Dredging and disposal includes mobilization and demobilization, site work, production dredging, and hydrographic surveying. Disposal costs will depend on the method of disposal. The Diking District has recently researched costs for this dredging project. One estimate for contract dredging is about $100,000 to dredge a 7 ft-deep and 120 ft-wide channel a distance of 900 ft from the tide gates, with flow lane disposal of 28,000 cu yd downstream from Puget Island. Upland disposal on nearby property would cost roughly twice as much ($200,000). Upland disposal involves constructing a perimeter dike to contain the dredged material during dewatering and instillation of a weir to control flows back to the slough or river (depending on where upland disposal site is located). Dredging for this solution, however is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate dredging cost of $1.00 per cu yd, with in-water disposal. Upland disposal is assumed to add $4.00 per cu yd to the dredging cost. The assumed maintenance dredging rate is that calculated from the most recent dredging cycle, 28,000 cu yd per 10 years. Costs are listed in the table below.

Maintenance Dredging	Estimated Cost
Environmental Permitting	$15,000
Engineering Design	$10,000
Construction	- 0 -
Ongoing Dredging with in-water disposal	$3,800 (average annual)
Ongoing Dredging with upland disposal	$19,000 (average annual)

Conceptual Net Benefits

The benefits from this solution would be reduced electrical demand and lengthened maintenance and replacement cycles of the pump station components. Additionally, the area served by the pump station will be subjected to less risk of interior flooding during long periods of heavy rainfall.

Project 4 North Welcome Slough Road Bank Erosion

Problem

Bank erosion is progressing toward the dike near River Mile 40 and unless halted, will threaten both the dike and North Welcome Slough Road with erosional damage.

Description

Approximately one mile of bankline along North Welcome Slough Road (Figure 8) is exposed to currents and vessel-generated wave forces. Bank erosion at the site was apparent during the September 2001 site visit. The region beginning approximately 1000 ft upstream of the Bonneville Power Administration (BPA) tower is of particular concern because the river level during freshets has begun to encroach upon the dike toe. Although no erosion of the dike itself has been observed, the bank is reported to be losing approximately 3 ft/yr. At this rate of bankline retreat the dike could experience damage within 5-10 years.

Construction of the dike was authorized by the Flood Control Act of 1936, which was modified with Acts in 1938 and 1950. The initial authorization is contained in House Resolution 8455, 74th Congress. After the dike was constructed, Wahkiakum County Consolidated Diking District No. 1 assumed responsibility for its maintenance.

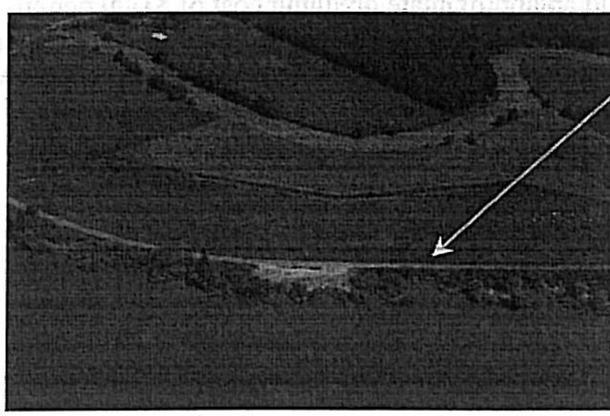


Figure 8 North Welcome Slough Road

Assumptions

- Bank retreat is occurring at only shallow depths; the main channel is not encroaching toward the dike.
- A deficit of sand in this portion of the bankline is caused in part by increased levels of energy reaching the shoreline, and dredging upstream in the navigation channel with disposal that bypasses the erosion area. The combination of these factors removes sediment from the upper bank that would otherwise buffer the dike from erosive forces.
- Vessel wakes and pressure field forces from deep-draft vessels traveling in the navigation channel are sources of energy impinging on the bank.

Solutions

Two alternate solutions, Rock Revetment and Steel Sheetpile Wall, are proposed to control bank erosion and control the risk of damage to the dike and road. A rock revetment with a protective toe constructed waterward of the dike along the erosion area would be a relatively low maintenance solution. A steel sheetpile wall driven to design depth just waterward of the North Welcome Slough Road would be a relatively permanent solution.

Rock Revetment

The Rock Revetment solution assumes construction of a rock revetment along the bank in regions that are encroaching on the dike. The structure would be composed of rock having a size to withstand forces from waves and currents. The top elevation of the revetment would match the road and the face would extend at a 2:1 slope until intersecting the mudline. A toe would be constructed at the waterward edge to protect the structure from being undermined. It is assumed that approximately 450 ft of bankline would be protected with an engineered revetment, requiring about 1,170 tons of rock. The estimated construction cost is $50,000 for the revetment alternative. Maintenance is assumed to amount to 15 percent of initial construction quantities every 20 years.

Rock Revetment	Estimated Cost
Environmental Permitting	$10,000
Engineering Design	$10,000
Construction	$50,000
Maintenance	$190 (average annual)

Sheetpile Wall

The sheetpile wall solution consists of driving sheetpile sections vertically into the ground just waterward of the dike road to form a continuous wall. Assuming that the dike elevation where the sheets are driven is at +10 ft and the mud line at –3 ft, the sections must be driven 34 ft into the ground. The wall will control breaching of the dike and can be constructed in the dry. Approximately 15,300 sq ft of sheetpile wall will be constructed (approximately 33.8 sq ft per l ft of construction).

It is assumed that approximately 450 ft of bankline would be protected with sheetpile wall. Approximately 15,200 sq ft of steel sheetpiling could be installed for this solution, at an estimated cost of $260,000.

Sheetpile Wall	Estimated Cost
Environmental Permitting	$25,000
Engineering Design	$25,000
Construction	$260,000
Maintenance	- 0 -

Conceptual Net Benefits

The benefits from preventing further erosion by reinforcing the bank include protecting North Welcome Slough Road from damage and preventing a breach in the dike that could cause extensive damage to properties on the island's interior.

Project 5 Ferry Terminal

Problem

Sediment deposition and shoaling along the ferry route at the Puget Island Ferry Terminal frequently causes a hazard to ferry navigation. The channel between the ferry terminal and Columbia River is a federal navigation project, and the Portland District maintains the channel. Excessive sediment accumulation between times of maintenance dredging creates a navigation hazard for ferry operations.

Description

The Ferry Terminal is located near the intersection of Hwy 409 and West Sunny Sands Road (Figure 9). A ferry operator indicated that ferry navigation has been complicated by the formation of a shoal along the ferry route, particularly at low river stages. The shoal has formed approximately 150 ft offshore and upstream of the ferry landing.

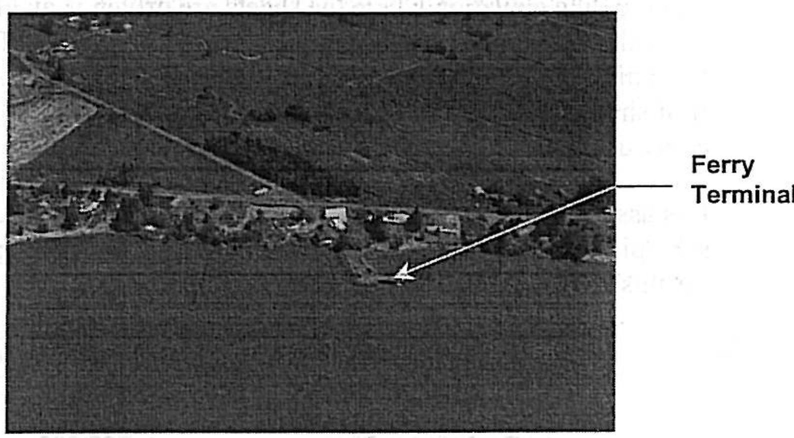


Figure 9 Ferry Terminal

The Portland District dredge *Sandwick* typically performs agitation dredging of the channel between the Ferry Terminal and the Columbia River every two years. This maintenance frequency has not been sufficient to maintain adequate depth. The channel to the ferry landing is a federal small navigation project authorized under Section 107 of the 1960 Rivers and Harbor Act. The Detailed Project Report, dated May 1993, recommended a channel 9 ft-deep by 200 ft-wide. The Project Cooperation Agreement between Wahkiakum County and the Corps of Engineers was signed October 1993.

Assumptions

- Bedload sediment is transported from upstream in the Columbia River and deposited to form a shoal across the ferry terminal access channel.

- The hydraulic functioning of pile dikes located upstream might have an effect on the shoal formation. Changes in erosion and deposition patterns in response to this structural modification or from placement of sand at the Pancake Point erosion area can be predicted by employing hydraulic modeling and observation at similar structures.

Solutions

Two alternative solutions are proposed to improve navigation in the ferry channel: Coordinated Dredging Schedule and Increased Advanced Maintenance Dredging.

Coordinated Dredging Schedule

A Coordinated Dredging Schedule is a yearly or bi-yearly dredging schedule developed by the Portland District and coordinated with Wahkiakum County. A dredging schedule would be based on the rate of sedimentation in the channel. The rate would be determined through analysis of hydrographic surveys made at least annually. Projections of channel condition one year into the future, based on a series of surveys and experience with historical dredging frequency, could be a practical method of anticipating dredging needs one year ahead.

A Coordinated Dredging Schedule will provide the County with the information regarding dates, dredging equipment to be used, dredging depth and width, and volumes of dredging for the upcoming years assuming that Columbia River flows are within a given range. In addition, this schedule will inform the County about the reasons that dredging might not be scheduled. In turn, the schedule will provide the Portland District with information on critical conditions in the channel and expectations of ferry operators regarding the channel depth for the upcoming year. Information provided by the community may help the Portland District in planning, permitting of dredging work, and re-allocation of dredging funds if possible. A Coordinated Dredging Schedule is a management solution, can be implemented by an agreement such as a Memorandum of Understanding, and does not incur a capital expense to the local entity. The Coordinated Dredging Schedule and the procedure of approval of the schedule would be develped at the next stage of the study and design, if this solution is selected.

Because the channel is a federal navigation project, increasing the dredging frequency or changing the method of dredging to meet navigation needs would not be charged to the local sponsor, but would be accomplished according to Operations and Maintenance priorities at the Portland District. Coordination is recommended between the County and the Portland District in developing the schedule. County engineering costs are estimated be $5,000. Costs to the local entity are summarized in the table below.

Coordinated Dredging	Estimated Cost
Environmental Permitting	- 0 -
Engineering and Design	$5,000
Construction	- 0 -
Ongoing Dredging and Disposal	- 0 -

Advanced Maintenance Dredging

The Advanced Maintenance Dredging solution would reduce the frequency of required maintenance dredging by developing a larger capacity for encroachment of the shoal in the channel. The Portland District dredge *Sandwick* relies on directed propwash and is quite variable in its ability to create a uniform advanced maintenance dredging depth. The effectiveness of the *Sandwick* is highly dependent on the experience of the operator. Sediment not flushed thoroughly from the channel can still settle in areas that may soon pose a hazard to navigation. Therefore, a small pipeline dredge is recommended for developing a larger advanced maintenance clearance.

Advanced Maintenance Dredging would be optimized through the analysis of sedimentation rates under a separate study if this solution is selected. Four feet of overdredging the channel alignment is assumed to produce depths consistent with a schedule of maintenance dredging every 2 years. The dredged material could then be disposed of at selected in-water or upland disposal locations.

A possible site for upland disposal is located 1,000 ft upstream at Pancake Point, at the designated disposal site W-43.8. Disposal there has the added benefit of providing sediment to a bank location where erosion is currently threatening private landowners. The erosion is described below under Project 6 Pancake Point Bank Erosion.

Use of a pipeline dredge may not be an economical solution for the Portland District. Under this condition, the local sponsor would be required to pay the incremental cost for dredging and disposal. Considering the uncertainties in the type of the dredge and other technical characteristics, cost estimates for this solution are based on the assumption that dredging is conducted with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal within 1,000 ft of the dredge plant.

If disposal of sediment dredged from the ferry access channel is at Pancake Point the cost to this project would be reduced by the beneficial use value of the disposed material. Costs for disposing 10,000 cu yd every 3 years to the local entity are summarized in the table below.

Advanced Maintenance Dredging	Estimated Cost
Environmental Permitting	$20,000
Engineering and Design	$15,000
Construction Cost	- 0 -
Ongoing Dredging and Disposal	$3,800 (average annual)

Conceptual Net Benefits

Benefits include the improved navigational safety of the Puget Island – Westport Slough ferry operation. Improved channel depth translates to increased reliability of the ferry and, therefore, increased ridership and improved safety for vessel operations and the travelling public. If sand is disposed of at Pancake Point, an additional benefit would be the restoration of an eroding beach and the protection of private properties along the shore.

Project 6 Pancake Point Bank Erosion

Problem

Erosion between the river bank and the dike is threatening private properties.

Description

The project is located at the southeast end of Puget Island (Figures 10 and 11). A site visit and discussion with the County Engineer indicated that the bankline is subject to erosion at the landward terminus of the timber pile dike. The Portland District placed dredged sand on the bank out to the bend in the dike alignment in the 1970's and 80's. The site is designated as disposal site WK-B-43.8. Loss of placed material and bank line retreat where a pile dike intersects the bank is commonly observed on the lower Columbia River. Bank line retreat results from waves and currents transporting sand away from the site. Retreat can become severe after several years of progressive loss, with no dredged material replaced at the bank.

The disposal site and the channel reach from which material is dredged are part of the Columbia and Lower Willamette Rivers below Vancouver, Washington and Portland, Oregon Federal Navigation Project. The existing project was authorized by the Rivers and Harbor Act of 27 February 1911 and subsequently modified by many Acts. The current condition is a channel 40 ft deep and 600 ft wide from Vancouver, Washington, to the mouth of Columbia River and including several other project features, such as small-boat basins and channels. The current 40-ft depth authorization is contained in the Rivers and Harbor Act of 23 October 1962 (House Document No. 452, 87th Congress, 2nd Session, P.L. 87-874-76, Stat.

1177). The site is adjacent to the Middle Westport Bar in Wauna and Driscoll Ranges of the navigation channel which have 3 major shoal areas. In the past, the bar was dredged with a pipeline dredge and material was disposed of at upland sites, one of which was the Pancake Point location. However, shoaling in this reach in recent years has decreased to the level that the hopper dredge *Essayons* is more efficient in maintaining this part of the channel. The site has not received dredged material in recent years because the *Essayons* disposes dredged sediment at an in-water disposal site in the depth range 45 to 65 ft, termed flow-lane disposal. With the listing of salmonids under the ESA, disposing sediment between the landward terminus of the pile dike and the bend in the dike may present permitting challenges.

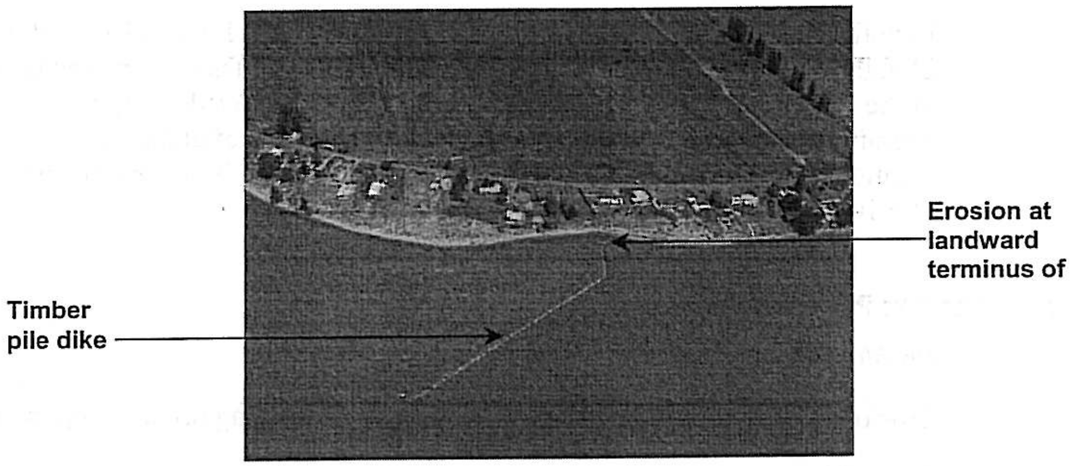


Figure 10 Pancake Point

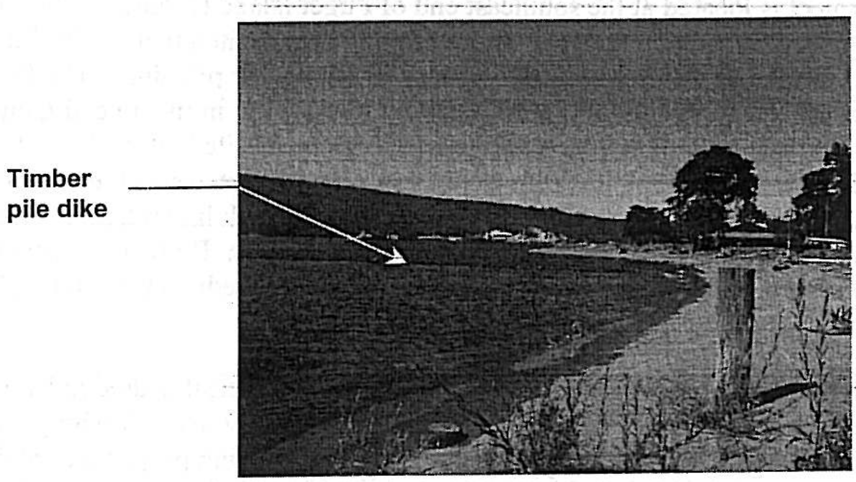


Figure 11 Pancake Point – Looking East

Assumptions

- Dredged sand placed at the Pancake Point site would remain in place long enough for economical disposal, estimated to be at least 10 years.
- Bank retreat occurs only at shallow depths.

Solutions

Two general solutions were developed to address shore erosion: Beach Nourishment and Buried Rock Revetment. Beach Nourishment may be accomplished in two different ways, with a hopper dredge having pump-ashore capability and cutterhead pipeline dredge. These two methods are considered as separate solutions below: Hopper Dredge Nourishment and Pipeline Dredge Nourishment. These solutions differ in their technology and may have different funding mechanisms.

Hopper Dredge Beach Nourishment

Beach nourishment assumes placement of dredged sand along 600 ft of bankline at the landward terminus of the pile dike. The volume of placed sand would be evaluated during the next phase of the study, if this solution is selected. It is estimated that 60,000 cu yd of dredged material would be sufficient for a 10-yr period. The Portland District is authorized to maintain the Wauna and Driscoll Ranges and the project site is a designated disposal site. Therefore, material could be placed there if environmental permits were obtained and any cost differential was contributed by another source. The Hopper Dredge Beach Nourishment solution assumes that a hopper dredge with pump-out capability is employed to dredge the Wauna and Driscoll Ranges and dispose of material at Pancake Point. Because the Portland District's *Essayons* is not equipped to pump out, a private contractor might be hired to perform the work. A pump-out station (barge or mono-buoy) would be deployed waterward of Pancake Point at a depth allowing staging and safe operation of the hopper dredge. Adequate depths are expected to be available within 1,000 ft of the disposal site, which permits direct pump-out without a booster pump. A pipeline would extend from the pump-out station to Pancake Point project area.

Costs to implement the Hopper Dredge Beach Nourishment solution include the cost difference between disposal in-water by the *Essayons* (the current method), and disposal at Pancake Point by a contract hopper dredge with pump-out capabilities. The cost difference is estimated to be $3.75 per cu yd. Costs also include environmental permitting, engineering and design, and construction.

Hopper Dredge Beach Nourishment	Estimated Cost
Environmental Permitting	$20,000
Engineering Design	$15,000
Construction	- 0 -
Ongoing Dredging and Disposal	$31,000 (average annual)

Pipeline Dredge Beach Nourishment

The Pipeline Dredge Beach Nourishment solution assumes that beach nourishment is accomplished by a small cutterhead pipeline dredge operated by local entities. Dredging may be conducted at the edge of the navigation channel, from the Wauna and Driscoll Ranges or other sites. It is assumed that sand mining in the 40-ft channel limits could be accomplished under existing permits. Alternatively, dredging may be accomplished at the Ferry Terminal, just downstream. The volume of sand needed for beach nourishment is estimated to be 60,000 cu yd per 5 yr. Placement of dredged sand would occur along 600 ft of bankline at the landward terminus of the pile dike.

It should be noted that no new construction is required for this solution. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal within 1,000 ft of the dredge, or $60,000 for a 60,000 cu yd volume. Costs are summarized in the table below.

Pipeline Dredge Beach Nourishment	Estimated Cost
Environmental Permitting	$20,000
Engineering Design	$15,000
Construction	- 0 -
Ongoing Dredging and Disposal	$8,200 (average annual)

Buried Rock Revetment

The Buried Rock Revetment solution consists of burying a protective armor layer in the bank material to control bank line retreat. Burying the rock would prevent blocking the view of houses that the rock is meant to protect. The volume of the buried revetment would be large enough to allow self-stabilization as the bankline eroded to the revetment. An engineering analysis and design for this solution would determine size and amount of rock, cross section dimensions, and frequency of maintenance if this solution is selected. For comparative analysis only, it is assumed a 4-ft toe thickness, and 6-ft toe width are applied to 600 ft of shore. Approximately 1.5 tons per lineal ft (900 tons of rock over the 600 ft) would be placed for the Buried Rock Revetment solution. At an estimated cost of $30 per ton of riprap, and considering excavation, bedding material, and contingencies, the revetment would cost approximately $50,000 for initial construction. Maintenance is expected to cost an average of about 15 percent of initial cost every 20 years. Costs are summarized in the table below.

Buried Rock Revetment	Estimated Cost
Environmental Permitting	$15,000
Engineering Design	$10,000
Construction	$50,000
Maintenance	$600 (average annual)

Conceptual Net Benefits

Benefits include improved stability of the property and reduced risk of damage by loss of land to the structures located between the dike and the bank of Columbia River.

Project 7 Cathlamet Channel Sedimentation

Problem

Sedimentation affects two reaches of Cathlamet Channel. Shoaling near the downstream end of Puget Island prevents barges loaded for coast-wise transport from moving into Cathlamet Channel from Columbia River. River barge movement is also restricted at low river stages. The second troublesome reach, Cathlamet Channel between the bridge (connecting the City of Cathlamet and Little Island) and the upstream end of Puget Island, is so shallow at low river stages that navigation is hazardous for recreational boats.

Description

Cathlamet Channel is a secondary channel of Columbia River that flows on the north side of Puget Island. The 40-ft navigation channel is on the south side of Puget Island. Depths as shallow as 12 ft extend from the downstream end of Little Island toward Light 41. The shoal depth limits the draft of barges transported between the Columbia River navigation channel and deep water at the docks at the City of Cathlamet. This limitation restricts the efficiency of barge operations and types of products handled at this location.

A portion of the lower reach of Cathlamet Channel contains a federal navigation project, authorized in the Rivers and Harbor Act of 8 August 1917 (House Document No. 120, 63rd Congress, 1st Session). The existing project provides for a channel 10 ft deep and 300 ft wide and 2.4 miles long and snagging and clearing of the channel. The channel extends generally from the bridge downstream to Navigation Marker 41 where the channel connects with the Columbia River main channel.

Sand that is dredged by the Portland District to maintain the 40-ft navigation channel has been disposed of near the upstream end of Puget Island at disposal site W-46.3. The disposal location and the presence of pile dikes at the entrance to Cathlamet Channel contribute to diminishing the flow rate and the ability of the flow to flush sediment through Cathlamet Channel. As a result, deposition in the channel between the upstream end of Puget Island and the bridge has created shoal depths for shallow-draft boats, which frequently use the channel. Log rafts were formerly transported in the channel, but the channel is too shoal to safely operate a tug. Water depth is 4 to 5 ft at low river stages. The Coast Guard has marked the alignment of deeper water with one red and 2 green buoys, but boaters are occasionally at risk of running aground on shifting shoals in this portion of Cathlamet Channel.

Assumptions

- Dredged material from maintenance of the Columbia River navigation channel that is disposed at the upstream end of Cathlamet Channel is a source of sediment that shoals Cathlamet Channel.
- Increasing the river flow in Cathlamet Channel by dredging a channel would decrease the flow in the main navigation channel.

Solutions

Potential solutions to both problem reaches involve a combination of dredging in Cathlamet Channel and limiting the location of dredged material disposal at the upper end of Puget Island. The volume or location of disposing dredged material at the W-46.3 disposal site could be limited for the purpose of minimizing sediment infill in Cathlamet Channel. Because the main channel flow might decrease by routing more flow in Cathlamet Channel, a significant hydraulic and sediment transport modeling effort would be required to analyze the effects of modifying current Portland District dredging and disposal practices in this reach of Columbia River.

Downstream Barge Channel

The dredging solution in the downstream reach of Cathlamet Channel is dredging to 20 ft below Columbia River Datum (CRD) to provide safer navigation for river barges transiting the reach between Columbia River and the docks at the City of Cathlamet. Dredging would be accomplished by local interests because current depths exceed the 10-ft authorized depth. An alternative would be to change the authorized depth through a Congressional process, requiring economic justification and several years of review.

The approximate channel dimensions to accommodate the river barges is 20 ft deep by 300 ft wide. The volume of dredging required to produce those dimensions is estimated to be 100,000 cu yd. Dredging and open water disposal is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal at the County Sand Pit. Maintenance dredging is estimated to be 20 percent of the initially dredged amount every 10 years. Costs are summarized in the table below.

20-ft Barge Channel	Estimated Cost
Environmental Permitting	$20,000
Engineering Design	$15,000
Construction	- 0 -
Ongoing Dredging and Disposal	$7,900 (average annual)

Upstream Boat Channel

The upper Cathlamet Channel reach is proposed to be dredged to the dimensions of 8 ft deep by 75 ft wide (allowing for 2-way traffic). Disposal of dredged material could be at the County Sand Pit at the downstream end of Puget Island if the material is of the type that meets the needs of the County. Otherwise, disposal at other upland sites bordering Cathlamet Channel or flow lane disposal may be options.

A small pipeline dredge operated by a local entity is assumed to dredge and pump sand to the County Sand Pit or other permitted sites for both reaches of the channel. It should be noted that no new construction work is required for this solution. To compare this solution with others, the construction cost assumes purchasing a dredge, workboat, pipeline, and associated equipment for $375,000.

Costs to implement solutions will include engineering, permitting, dredging, disposal, and any mitigation. Engineering is anticipated to include a significant hydraulic modeling effort because potential impacts to the flow and sediment transport patterns in the Westport Bar to Puget Island Bar reach must be quantified.

Assuming that sediments dredged in Cathlamet Channel can be disposed of at locations in proximity to the project area, dredging costs would be based on the volume dredged to create a channel 8 ft deep by 75 ft wide by 5.5 miles long. The channel length assumed to be above project depth (an average of 2 ft) is 10,000 ft. The resulting volume is about 55,000 cu yd. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate dredging cost of $1.00 per cu yd. Maintenance dredging is estimated to be 20 percent of this volume every 5 years at $1.00 per cu yd. Costs are summarized in the table below.

Small-Boat Channel	Estimated Cost
Environmental Permitting	$30,000
Engineering and Design	$50,000
Construction (purchase)	-0-
Ongoing Dredging and Disposal	$5,500 (average annual)

Conceptual Net Benefits

Benefits from deeper depths across the shoal located between Little Island and the Columbia River navigation channel result from more efficient barge operation and reduced risk of damage from vessels striking bottom. Benefits attributable to a safe and reliable small-boat navigation channel in Cathlamet Channel consist of reduced damage to boats, improved safety, and increased economic activity resulting from more channel users and boating visitors to Cathlamet. Benefits would be calculated from the increased number of visitor-days and an average amount of money spent daily per visitor, as well as the decline in damage repair to boats expected to run aground if no solution is implemented. Another category of benefits is improved flow and transport conditions in Elochoman Slough. Hydraulic modeling might establish that increased flow in Cathlamet Channel could improve flow speed and decrease the deposition rate in Elochoman Slough. Blockage of the slough by sedimentation at the mouth of Elochoman River has been thought to lead to deposition in the upstream part of the slough, particularly at the entrance to Cathlamet Marina. A reduction of required maintenance dredging at the marina entrance that could be shown to be the result of Cathlamet Channel dredging would count as a benefit to the dredging project.

Project 8 Cathlamet Marina Sedimentation

Problem

Sediment deposition in the marina entrance interferes with navigation. Shallow depths at "A" Dock, resulting from slumping of the breakwater, interferes with moorage and presents a risk of damage to the fuel dock and a safety threat to people and property.

Description

The entrance to Cathlamet Marina is on Elochoman Slough, about one-fourth mile from where the slough enters Cathlamet Channel. Elochoman Slough enters Columbia River at another location farther downstream. A shoal tends to form where

Elochoman River enters the slough. During winter high flows, the Elochoman River flow is partially blocked by the shoal and backs up to enter Cathlamet Channel at the upper end of the slough. That flow is certain to carry sediment, which would drop out of the flow where the current speed slowed near the marina entrance and cause deposition there. Another possible mechanism is that sediment carried by flow from Cathlamet Channel could enter Elochoman Slough and deposit where the flow path expands at the end of the "spit" that forms the west side of the marina.

The Cathlamet Marina is part of the federal Elochoman Slough navigation project. The project was authorized by the Rivers and Harbor Act of 26 August 1937 (House Document No. 510, 74th Congress, 2nd Session), and subsequently modified under Section 107 of the 1960 Rivers and Harbor Act, as amended by Section 310 of the 1965 Rivers and Harbor Act, to include an entrance channel and breakwater to a small-boat basin at Cathlamet. The authorization provides for navigation channel in the slough 10 ft deep and 100 ft wide for 1.5 miles, with a turning basin, a marina entrance channel 6 ft deep by 50 ft wide, and a breakwater with a top width of 10 ft and a top elevation of 12 ft. The slough was last dredged in 1990, when 59,000 cu yd was removed and disposed of at the in-water site near Marker 41.

Shoal material was removed from the marina entrance with a clamshell dredge and barge in 1989. Agitation dredging has been performed a few times at the shoal area since then.

Several hundred cu yd of sediment at "A" Dock (Figure 12) was excavated by a contractor for the Port in 2001 and hauled to an upland site. The material at "A" Dock evidently slowly slumped from the spit of land constructed to separate the marina from Elochoman Slough. The spit material is thought to have a high clay content that facilitates slumping. The slumped material could damage floats and create a safety and navigation hazard to boaters.

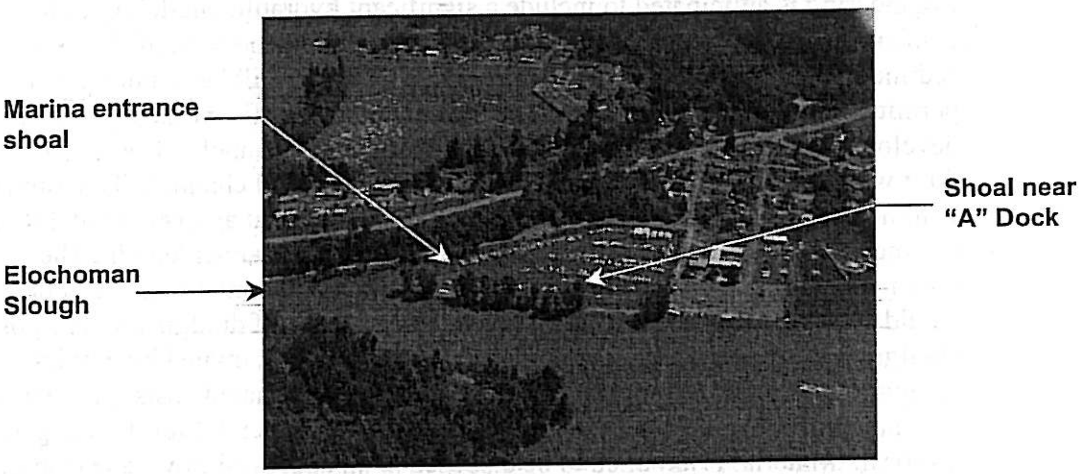


Figure 12 Cathlamet Marina

Assumptions

- The source of marina shoaling is sediment from Cathlamet Channel during some flow conditions, and by Elochoman River sediment in other flow conditions. Sedimentation occurs because the downstream portion of the slough is constricted by sediment infill.
- The shoal at the marina entrance has a high content of fine material that falls out of suspension in slow-moving currents in Elochoman Slough
- The soil strength of the spit that separates the marina from Elochoman Slough is insufficient for the structure to stand at its constructed slope.

Solutions

Two solutions of the entrance shoaling problem are discussed below: Flow Improvement and Dredging. A solution to the slumping of the breakwater at "A" Dock is also described below.

Flow Improvement

The Flow Improvement solution includes increasing channel dimensions through the full length of the slough to its lower end where it joins the Columbia River. Dredging larger slough dimensions would require a significant modeling effort to show that the marina entrance would benefit from the improved hydraulics and sediment transporting capacity. Other areas in the slough would likely benefit from the improved hydraulics also, and the benefits would likely be necessary to justify the substantial amount of required dredging.

Costs to implement the Flow Improvement solution to entrance shoaling include environmental permitting, engineering, dredging, disposal, and mitigation. Engineering is anticipated to include a significant hydraulic modeling effort to confirm that improving slough dimensions can achieve the desired flow and sedimentation rates. Developing upland disposal sites will be required, and permitting and ownership issues are expected to be significant factors in site development. Dredging would create and maintain a channel at least 5 ft deep by 50 ft wide by 2 miles long beyond the limit of the federal channel. The estimated volume of initial dredging is based on the assumption that an average of 2 ft of sediment thickness would require removal for the full channel length. The volume could range as high as 50,000 cu yd. Sediment contamination, if present, would significantly increase the difficulty and expense of dredging and disposal. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal. Material is assumed to be disposed at an approved flow-lane disposal site by way of a dump barge. Channel sedimentation and maintenance requirements are assumed to be 20 percent of the original volume every 5 years, at a unit cost of $1.00 per cu yd. Costs are summarized in the table below.

Flow Improvement	Estimated Cost
Environmental Permitting	$30,000
Engineering Design	$50,000
Construction	- 0 -
Maintenance	$5,000 (average annual)

Maintenance Dredging

The second possible solution is to continue dredging the shoal at the marina entrance as needed. Historical information indicates that the shoal should be dredged approximately every 4 to 5 years. Although shoal removal by agitation dredging might be an economical solution to a localized problem, permanent removal of the shoal material from the system would lead to a longer period of clear channel between dredging. For this purpose a pipeline dredge or clamshell dredge may be more efficient.

The estimated average volume removed from the marina entrance per dredging event is 1,500 cu yd. Dredging is assumed to be accomplished every 5 years with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal. Costs are summarized below.

Entrance Dredging	Estimated Cost
Environmental Permitting	$5,000
Engineering Design	$5,000
Construction	- 0 -
Maintenance	$400 (average annual)

Breakwater Rehabilitation

Possible solutions to the problem of breakwater material slumping into the moorage area range from removing the breakwater and reconstructing it with structural fill, to shoring that section of the breakwater or replacing it entirely with a structure, such as sheet pile or a pile-and-lagging wall system. Replacing the section of the breakwater with a rock rubble structure in the section that causes difficulty at "A" Dock is judged to be the most practical engineering solution, but may be a permitting challenge.

The cost of replacing the failing breakwater is based on the assumption of removing the existing breakwater and building a new breakwater in the section that affects "A" Dock. The breakwater is assumed to be rebuilt according to an engineered section, using rock rubble and riprap, and a completed top elevation of

12 ft. Applying an approximate cost of $1,350 per lineal ft for 300 ft yields an estimated cost of $405,000. Maintenance is expected to cost 10 percent of initial cost every 20 years. Costs are estimated below.

Breakwater Rehabilitation	Estimated Cost
Environmental Permitting	$15,000
Engineering and Design	$15,000
Construction	$405,000
Maintenance	$1,000 (average annual)

Conceptual Net Benefits

Providing adequate and reliable depths benefit the project by attracting more tenants to the marina and increasing the number of transient visitors and amount of fuel sales due to a safer channel and a more desirable mooring facility, justifying charging a higher moorage rate.

Project 9 Skamokawa Creek Channel Sedimentation

Problem

Deposition at the mouth of Skamokawa Creek has created a hazard for vessels navigating between the creek mouth and Columbia River.

Description

The project site is at the mouth of Skamokawa Creek. Boat moorage is located in Brooks Slough and a boat ramp is located on the creek. Fishing vessels and recreational boats access the Columbia River through the mouth of Skamokawa Creek. Deposition has created hazardous depths at low stages in the creek mouth (Figures 13 and 14). The Portland District regularly maintained the creek channel mouth with agitation dredging in the past, but has not dredged there in recent years. This site is suited for maintenance dredging by the *Sandwick* because the distance from the shoal area to deep water is short enough for the agitated sediments to be transported to deeper water in Columbia River. Analysis of records of previous surveys indicates that sediment fills the authorized channel at a rate of 6,000 cu yd per yr if depth is attempted to be maintained at 6.5 ft.

Skamokawa Creek is a federal navigation project. The project was authorized by the Rivers and Harbor Act of 2 March 1919 (House Document No. 111, 63rd Congress, 1st Session). Authorization provides for a channel 6.5 ft deep and 75 ft wide for 1,600 ft from the confluence of Skamokawa Creek and Columbia River upstream to the mouth of Brooks Slough. The project is currently inactive.

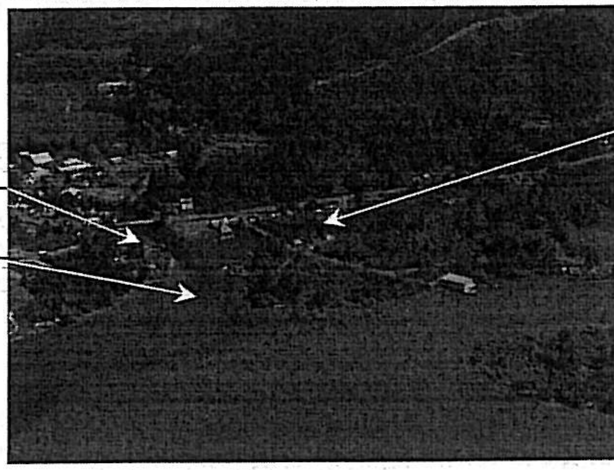


Figure 13 Skamokawa Creek Outlet

The shoal at the mouth appears to have a controlling depth so shallow that it might constrict creek flows when Skamokawa Creek is in flood and cause elevated backwater levels, endangering low lying properties along the creek.

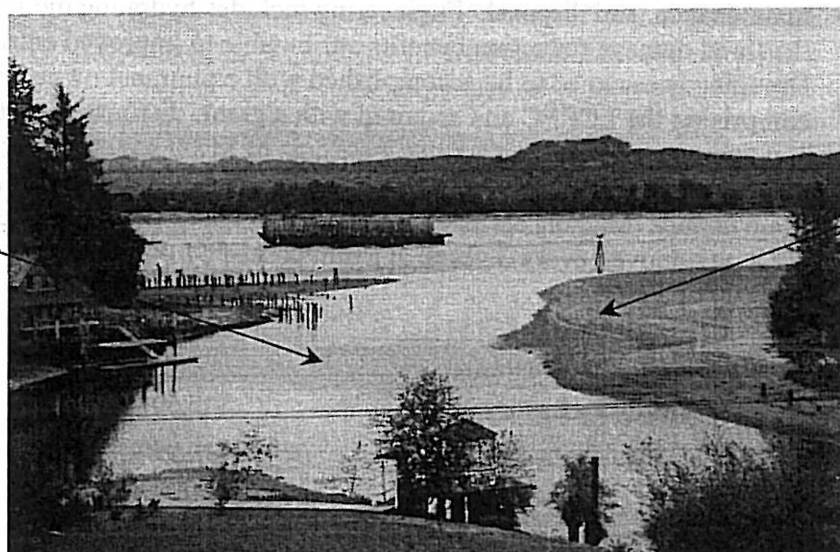


Figure 14 Skamokawa Creek – Looking South

Assumptions

- Shoal material is predominantly sand with a Columbia River source.
- The mechanisms for sediment transport are river currents and vessel wakes that transport material to the creek mouth from adjacent bank locations.

Solution

Two solutions are discussed below: Activate Project and Local Dredging.

Activate Project (Federal Dredging)

To activate the project a special study would evaluate whether dredging by the Portland District would be justified by potential demand for channel use. Channel use would need to be quantified as National Economic Development benefits, a method by which benefits and costs are calculated for Federal projects. If the Federal project could be activated, no costs would be borne by local interests.

Local Dredging

Dredging entirely by local interests is a possibility, and would depend on the ability of locals to secure funding. The proximity of the disposal area at Skamokawa Park, used in maintaining the 40-ft navigation channel, would facilitate dredging the creek mouth with a small pipeline dredge. That site is designated disposal site W-33.4.

Costs to implement a maintenance dredging plan at the creek mouth includes environmental permitting, engineering design, initial dredging, periodic maintenance, and disposal. Engineering includes hydraulic modeling to quantify the flood damage reduction benefits attributable to improved entrance hydraulics. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal. The estimated cost of initial dredging of 10,200 cu yd is $10,200. Maintenance dredging assumes at that 20 percent of the initial dredging volume must be removed every 5 years, at a unit cost of $1.00 per cu yd. Costs are summarized below.

Dredging by Local Interests	Estimated Cost
Environmental Permitting	$15,000
Engineering Design	$10,000
Construction	- 0 -
Ongoing Dredging and Disposal	$1,500 (average annual)

Conceptual Net Benefits

Benefits include the value of the dredged sand, improved economic activity attributable to more reliable channel depths, and any decreased risk of flood damage due to improved flow conditions at the creek mouth.

Project 10 Grays River Outlet Sedimentation

Problem

Sedimentation at the mouth of Grays River constricts the flow at the outlet in Grays Bay, raising the base level of the river and increasing the risk of upstream flooding.

Description

The project is located in the mouth of Grays River at Grays Bay. Grays River has a high sediment load relative to its size. Sediment is deposited at the mouth where the river spreads out upon entering the bay (Figure 15). The shoals obstruct flow and raise upstream water elevations, resulting in increased incidence of flooding during heavy rainfall events. The affected area is mostly rural. Many family farms and the communities of Grays River and Rosburg are affected almost every year by overbank flows.

Grays River is a federal navigation project, authorized under the Rivers and Harbor Act of 2 March 1907 (Rivers and Harbors Committee Document No. 1, 59th Congress, 2nd Session). While the project was active the Portland District was responsible for removal of snags and obstructions from the channel and overhanging trees from the banks between the mouth and the town of Grays River, 8 miles above the mouth. This is now listed as an inactive project.

Figure 15 Grays River Mouth

Assumptions

- Siltation at and near the river mouth is raising the base level of Grays River and increasing flooding potential along the lower reaches of the river.

- The benefits of improving the flow-carrying capacity of lower Grays River are almost exclusively flood reduction benefits. Reactivating the federal project with the existing authorization would not benefit the communities because federal activity would be limited to clearing and snagging.

Solution

The solution to the problem of insufficient channel capacity is to remove sediment that has filled the lower Grays River in that reach that is prone to flood damage. The amount of sediment to be removed initially and in a maintenance cycle have not been determined, but to estimate the costs as a means of comparison with other solutions, the following assumptions were made. Initially 5 ft of sediment would require dredging from the channel over a width of 200 ft and length of 5 miles, resulting in a volume of about 978,000 cu yd. Because of the probability of encountering large-size bottom sediment near the bottom of the dredge cut, contract clamshell dredging is assumed, with in-water disposal with a bottom-dump barge. The estimated dredging and disposal cost is $4.00 per cu yd. Maintenance dredging of 100,000 cu yd is assumed every fifth year, on average, with the same dredging and disposal method and unit cost. These assumptions are preliminary and would require detailed examination if this solution is selected. Construction or modification of levees, in combination with dredging, would likely be part of an overall flood control plan, should the project proceed to the next phase of study. Difficulties to be considered in further development of the project are the availability of in-water disposal sites, and the relatively short dredging window, owing to the fact that endangered fish species are present in this reach of Grays River. A detailed hydraulic evaluation of Grays River would be required to optimize the amount and location of dredging and levee construction for alleviating flooding. Costs are summarized in the table below.

Dredging	Estimated Cost
Environmental Permitting	$100,000
Engineering Design	$100,000
Construction	$3,912,000
Ongoing Dredging and Disposal	$69,000 (average annual)

Conceptual Net Benefits

Dredging Grays River and protecting the adjacent properties from flooding would provide a significant economic benefit by allowing more economic development of the property and decreasing incidence of flooding losses.

Project 11 Deep River Channel Sedimentation

Problem

Shoals and bars at the mouth of Deep River and shallow depth in the Deep River channel prevent potential vessel navigation to an upstream marine commercial site.

Description

The project site is in Deep River, which empties into Grays Bay, a northern part of Columbia River Estuary (Figure 16). Grays Bay also receives runoff from Grays River, capable of producing a relatively high sediment discharge. Deposition in Grays Bay constricts the mouth of Deep River and causes hydraulic conditions that cause deposition in the lower reaches of the river channel.

Deep River is a federal navigation project, although it is now inactive. As recent as 20 years ago, the Portland District maintained the channel. The project was authorized under the Rivers and Harbor Act of 3 March 1925 (House Document 218, 68th Congress, 1st Session). The authorization provides for a channel through the entrance shoals in Grays Bay 8 ft deep, 100 ft wide and 1.5 miles long, then a channel from the river mouth to the town of Deep River 8 ft deep, 60 ft wide and 4.5 miles long. After the Portland District ceased channel maintenance and the navigation project had been declared inactive, the log sorting yard remained open for many years until Weyerhauser shut down operations on the river in 1990. Reportedly, the propeller wash from the tugs transiting the channel kept it sufficiently clear for rafting logs. Since commercial marine traffic ended in 1990 the channel has shoaled to the point that tugs and barges can no longer access the sorting yard.

Wahkiakum County is planning to develop the site of the former sorting yard for a marine commerce park, and river-going tug and barge access will once again be needed.

Figure 16 Deep River

Assumptions

- Sediment from Grays Bay is settling in the channel mouth and at entrance bars, limiting navigation access at the mouth as well as in the lower reaches of the river.
- Sediment deposited in the channel is primarily fine-grained. Upland disposal would require a relatively large site because of the capacity needed for relatively slow dewatering of the disposed material.

Solutions

Dredging is required to return Deep River to navigability. Two solutions for providing the dredging are presented below. They are Reactivate Federal Channel and Local Interests Dredging.

Reactivate Federal Channel

The Deep River project remains a federal navigation project, although it has not been maintained for many years and is listed as inactive. Dredging by the Portland District could re-establish the authorized channel dimensions from Grays Bay to any location below the head of navigation at River Mile 6. The proposed commercial site is at River Mile 3.5. Returning the Deep River project to an active project would entail formally requesting the Portland District to resume dredging and supplying the Portland District information on economic activity that would justify federal interest. The Portland District would perform a study of the Benefit-to-Cost (B:C) Ratio. Project economics would be required to be favorable (B:C Ratio greater than 1.0) as well as rank high enough to receive priority in the scheduling of maintenance dredging. Because the Reactivate Federal Channel solution is an administrative action, costs would be 100 percent federal (not counting local sponsor time and expense in providing economic documentation) and neither initial construction nor ongoing channel maintenance would be charged to the local sponsor.

Local Interests Dredging

The second solution is for local interests to acquire funding to dredge and maintain the entrance and channel. The amount of sediment to be removed initially and in a maintenance cycle have not been determined, but to estimate the costs as a means of comparison with other solutions, the following assumptions were made. Initially 5 ft of sediment would require dredging from the channel over a width of 60 ft and length of 3.5 miles, a volume of about 205,000 cu yd. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimate costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd for dredging and disposal, not counting site preparation. Initial dredging is estimated to cost $205.000. Maintenance dredging of 20,000 cu yd is assumed every fifth year at a unit cost of $1 per cu yd. Costs are summarized in the table below.

Dredging	Estimated Cost
Environmental Permitting	$50,000
Engineering Design	$30,000
Construction	$205,000
Ongoing Dredging and Disposal	$17,000 (average annual)

Conceptual Net Benefits

Dredging Deep River and the entrance bars would provide a significant economic benefit by allowing access for commercial traffic to the Deep River Log Sorting yard.

Project 12 Port of Chinook Marina Channel Sedimentation

Problem

Sediment deposition in the marina access channel between times of maintenance dredging creates a navigation and safety hazard for vessels entering and departing the Port.

Description

The project is an access channel in Baker Bay extending from Columbia River near the upstream end of Sand Island to the west side of the Port of Chinook Marina (Figure 2). Deposition in the channel has created a risk of grounding or damaging vessels entering and leaving the Port, particularly for larger fishing boats. The Portland District maintains the channel with dredging and monitors the channel condition by comparing annual surveys. Dredging is planned from observing shoaling patterns. Shoaling rates in the channel are not constant from year to year, and at times dredging has been on a reactive basis to requests from the Port and subject to budget limitations. Typically, dredging occurs no sooner than one year after inadequate channel depths are reported. Maintenance dredging in the channel commonly achieves depths 12 ft below mean lower low water (MLLW) datum. Dredging occurs an average of once in 4 years. The average annual dredging quantity in the past 5 years is 116,400 cu yd. The average annual maintenance expenditure over the past 5 years is $372,000, with 100 percent Federal contribution. A hopper dredge normally maintains the channel, and disposes the material at an in-water site.

Columbia River between Chinook, Washington and the Head of Sand Island is a federal navigation project. The project was authorized by the Rivers and Harbor Act of 20 June 1938 (House Document No. 50, 75th Congress, 2nd Session), and modified by the Rivers and Harbor Act of 3 September 1954 (Senate Doc. No. 8, 83rd Congress, 1st Session). Authorization provides for a channel 10 ft deep and 150 ft wide for approximately 2 miles, from deep water in Columbia River to a turning basin at Chinook. A turning and mooring basin 10 ft deep and varying in width from 275 ft to 500 ft, and 660 ft long is maintained by the Port of Chinook.

Assumptions

- Sediment deposited in the Chinook Marina Channel originates upstream in the Columbia River and is transported into Baker Bay and the project area by currents and wave action.
- The rate of deposition is equal to the rate of sediment removal to maintain project dimensions, 116,400 cu yd per yr. The rate of infill varies from year to year and is controlled by Columbia River hydrology and storm activity in Baker Bay.

Solution

Three solutions to the sedimentation problem are proposed below: Coordinated Dredging Schedule, Advance Maintenance Dredging, and Disposal/Habitat Island.

Coordinated Dredging Schedule

The Coordinated Dredging Schedule solution is a dredging schedule having an appropriate cycle length developed by the Portland District and coordinated with the Port of Chinook. A dredging schedule would be based on the rate of sedimentation in the channel. The rate would be determined through analysis of hydrographic surveys made at least annually. A projection of channel conditions one year into the future, based on a series of surveys and experience with historical dredging frequency, could be a practical method of anticipating dredging needs one year ahead.

A Coordinated Dredging Schedule would provide the Port of Chinook with the information regarding dates, location, and volumes to be dredged. This schedule would also inform the Port of the reasons if dredging is not scheduled. In turn, the schedule would provide the Portland District with the information on critical conditions in the channel and expectations of the Port regarding channel depth in the coming year. The information provided by the Port of Chinook may help the Portland District in planning and permitting dredging work, and reallocation of dredging funds if required. The Coordinated Dredging Schedule is a management solution, may be implemented with an agreement such as a Memorandum of Understanding, and does not require capital expenses. The Coordinated Dredging Schedule format and procedure of approval would be developed at the next stage of the study if this solution is selected.

Advanced Maintenance Dredging

Advanced Maintenance Dredging would reduce the frequency of required maintenance dredging by developing a larger capacity for encountering shoal material in the access channel. Currently, the Portland District dredges 2 ft deeper than the authorized depth of 10 ft, a permitted practice known as advanced maintenance dredging. Increasing the advanced maintenance dredging from 2 to 4 ft may allow the channel depth to stay below the authorized depth much longer. The Portland District also dredges the channel 50 ft wider in the vicinity of Chinook Channel Marker 5, a location of rapid encroachment at the channel side. Dredging the channel there up to 50 ft wider than currently could lengthen the time in which project dimensions are met. Advanced maintenance dredging would be optimized with a detailed analysis of sedimentation rates of the channel in a subsequent phase of study if this solution is selected for further development Expanding channel dredging by way of the Advanced Maintenance Dredging solution would be a policy decision by Portland District. This alternative would rely on realigning Operations and Maintenance priorities. An increase in Portland District's Operations and Maintenance budget might be required to accomplish the additional dredging.

Disposal/Habitat Island

The Disposal/Habitat Island would be developed from dredged material to block the drifting of bay sediments laterally into the channel. In addition, this island could attenuate the wave impact on the revetment and reduce the cost of revetment rehabilitation. Creating a disposal island to block the drifting of bay sediments laterally into the channel has been effective at other locations, but processes governing sediment response to island creation are site specific. The biological productivity of Baker Bay would require that this concept undergo much study before being advanced as a viable engineering solution to counter the rapid channel infill.

Conceptual Net Benefits

Costs to implement more frequent dredging would be greater than the costs of the current maintenance if the method of disposal remains the same. The fixed cost of mobilization would be incurred with each dredging event and dredging would occur more frequently. Because channel maintenance is currently a federal responsibility, costs incurred with a changed schedule would be borne by the federal government. Dredging a wider section at the shoal area would involve more volume per dredging event, but might result in lower total cost if the fixed costs of dredging (mobilization, etc.) were incurred less frequently. Disposing of dredged material to create a nearshore island could decrease overall costs. Modeling of hydrodynamics and sediment transport would be required to determine if nearshore island creation would result in physical processes that reduce channel infill. Environmental studies would also be required to show that environmental effects could be mitigated. If studies showed that the nearshore island would be effective in blocking movement of material into the channel, the dredging volume would decrease and dredging and disposal could be done with a pipeline dredge, resulting in a lower unit cost. No project costs are calculated for the recommended solutions because of the many offsetting factors.

Benefits of channel maintenance that improves project reliability derive from creating a safer navigation channel to Chinook Marina. At times when the channel is shoal, boats are at risk of damage by running aground. Knowledge that hull damage or bent propeller or shaft is possible by navigating the channel is a deterrent to attracting tenants and transient boaters. A reliable channel would remove the risk of injury to people and damage to property, and lead to greater economic activity associated with the marina. Higher moorage rates could be justified, generating additional revenue for the Port of Chinook.

Project 13 Port of Chinook Shore Erosion

Problem

Shore erosion east of Chinook Marina is threatening the rubble revetment that protects the marina parking lot and disposal area. The revetment is in a poor state of repair. The parking lot could be eroded without erosion protection at the shoreline.

Description

The project site is directly east of Chinook Marina (Figure 17) and at the shore of Baker Bay. Material dredged from the marina basin is placed on the upland at the site and spread to create a parking lot. The Port is permitted to maintenance dredge up to 20,000 cu yd per yr from the marina and turning basin. Dredging is accomplished with a private pipeline dredge. A rock revetment was constructed in the early 1980's (Figure 18) to protect the edge of the parking lot. Over the years the revetment has sustained damage from wave action, resulting in loss of bedding material and displacement of the riprap onto the shore. Subsequent maintenance of the revetment has involved replacing the rock and placing concrete rubble on the slope with an excavator, but an engineered section has not been maintained. Although the Port of Chinook has maintained the revetment to the best of its ability, progressive damage is greater than can be repaired by local interests alone. Revetment failure is leading to erosion of the parking lot and release of the dredged fine material into Baker Bay, which is an area known to be productive for crab and salmon.

The Port of Chinook maintains a turning and mooring basin 10 ft deep and varying in width from 275 ft to 500 ft, and 660 ft long, from which the parking lot material is dredged. Columbia River between Chinook, Washington and the Head of Sand Island is a Federal navigation project. The project was authorized by the Rivers and Harbor Act of 20 June 1938 (House Document No. 50, 75th Congress, 2nd Session), and modified by the Rivers and Harbor Act of 3 September 1954 (Senate Doc. No. 8, 83rd Congress, 1st Session). Authorization provides for a channel 10 ft deep and 150 ft wide for approximately 2 miles, from deep water in Columbia River to a turning basin at the Port of Chinook.

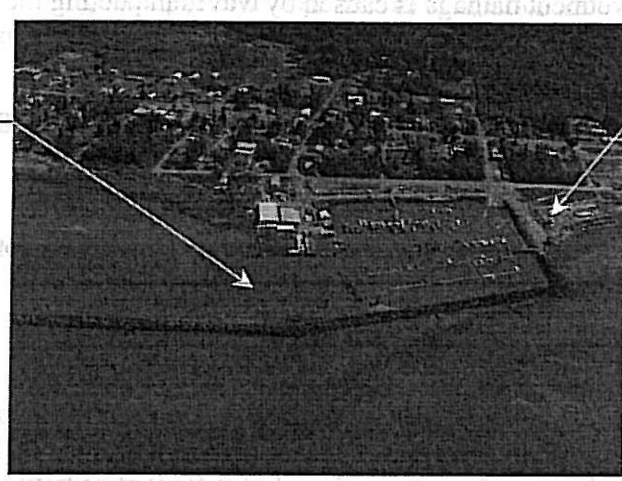


Figure 17 Chinook Marina

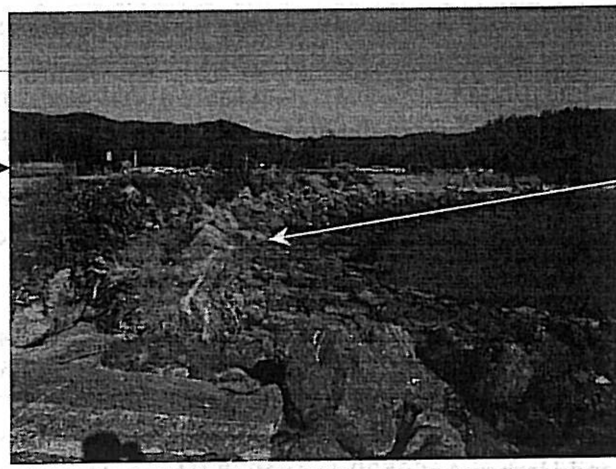


Figure 18 Chinook Marina Parking Lot Revetment – Looking East

Assumptions

- Revetment damage is caused by waves impacting the shore. The site is exposed to high storm waves generated in and entering the mouth of the Columbia River at high tide.
- The existing riprap is no longer supported by bedding material.

Solutions

Two solutions of the problem are discussed below: Revetment Rehabilitation and Beach Nourishment.

Revetment Rehabilitation

Rebuilding the revetment is required to prevent further loss of shore and upland material. An engineered revetment section will include the addition of an armor layer with stones large enough and of sufficient density to withstand expected wave forces. A bedding layer of smaller stones would be designed to support the larger rock and not be lost through the interstices of the armor. Some of the existing revetment material may be suitable for reuse in the bedding layer. The crest elevation of the new revetment will be sufficient to prevent excessive overtopping, which would significantly increase the usability of the parking lot.

Revetment construction will include the placement of bedding and armor stones in an engineered section along the shoreline fronting the parking lot. The stone size would be based on an engineering analysis of expected wave conditions. Preliminary and final design of the revetment rehabilitation alternative will be required if this solution is selected as a preferred one. Design of the shore protection should be accomplished in a way to increase the capacity of the site for receiving and dewatering material dredged from the marina. For a basis of comparison approximately 3,900 tons of rock is estimated for constructing the revetment along the entire length of the parking lot.

Costs to implement a solution to stabilize the shoreline and protect the upland consist of planning, engineering, permitting, and construction. Engineering includes designing the new work, determining quantities, and specifying materials. Revetment construction costs are based on an assumed cross section requiring 8 tons of rock per ft of shoreline. Costs are estimated at $250 per ft of a revetment for an approximate length of 685 ft. Maintenance is estimated to cost 20 percent of initial construction every 20 years. Costs are summarized in the table below.

Revetment	Estimated Cost
Environmental Permitting	$20,000
Engineering Design	$15,000
Construction	$171,000
Maintenance	$900 (average annual)

Beach Nourishment

The Beach Nourishment solution includes periodic placement of sandy dredged material at the toe of the existing revetment to control erosion. The source of beach nourishment is initially identified as material dredged from the marina access channel. A pipeline cutterhead dredge would dredge the channel and place dredged material at the shore, which would bury the revetment and create a more natural shoreline. Disposal at the shoreline would also facilitate more economical dredging and disposal. A pipeline dredge could be used, as opposed to the current practice of dredging with a hopper dredge and transporting dredged material to the disposal site at Area D, near Columbia River Mile 6.5. The dredge size, pipeline dimensions, and beach nourishment technology would be identified during the next stage of the study and design if this solution is selected. As a basis of comparison at the conceptual stage, a 12-inch dredge and 4,000 ft of pipeline are assumed. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $2.00 per cu yd, including the booster pump.

Placing dredged material with a small pipeline dredge to build up the shore and bury the existing rubble revetment could have a cost of $2 per cu yd, but could reduce the cost of dredging the marina access channel by $1 per cu yd. Studies of movement of sand placed at this shore would be required to determine if sand dispersed from the site would be harmful to the environmental resources of the area, and if the material would re-enter the channel at such a rate to make the process unfeasible. The beach renourishment rate is assumed to be 30,000 cu yd every third year. Costs are summarized in the table below.

Beach Nourishment	Estimated Cost
Environmental Permitting	$20,000
Engineering Design	$15,000
Construction	$750,000
Ongoing Dredging and Disposal	$8,700 (average annual)

Conceptual Net Benefits

Benefits of stabilizing the shore at the parking lot are associated with containment of the fine material placed there from marina dredging. Erosion of that material would reintroduce the fine material into the Baker Bay system, increasing the turbidity and causing negative environmental impacts. Preventing wave overtopping and loss of parking area for vehicles and boat trailers of marina users increases the value of the Port of Chinook property and the desirability of using the marina. Placing sand at the shoreline to protect the parking lot by using a pipeline dredge would provide a positive cost differential to the channel maintenance dredging program. Extending the time that the Port can use an upland disposal site adjacent to the marina has direct economic benefits to the Port.

Project 14 Port of Ilwaco, Dredged Material Disposal

Problem

The existing dredged-material disposal site does not have sufficient capacity to accept the required maintenance dredging volumes from the Ilwaco marina. A second problem is difficulties in navigating the curved entrance channel between Sand Island and the Port.

Description

Regular dredging is required to maintain safe navigation and maneuvering at the Port of Ilwaco. The Portland District dredges the access channel in Baker Bay, but currently does not dredge within the marina.

The marina is over 40 acres in extent and is maintained by the Port of Ilwaco to authorized depths of 10 and 12 ft below mean lower low water (MLLW) datum. The marina is part of the federal navigation project, Columbia River at Baker Bay, authorized under the Rivers and Harbor Act of 11 December 1933, and modified by Acts of 30 August 1935, 2 March 1945, and 17 May 1950. The existing authorization provides for a West Channel 16 ft deep, 200 ft wide for 2,000 ft, then 150 ft wide for 2.5 miles extending from deep water in Columbia River near Jetty A to the town of Ilwaco. Other project features are an East Channel (now impassable) 10 ft deep, 200 ft wide and 4 miles long extending from deep water in Columbia River near the east end of Sand Island to the town of Ilwaco.

The Port of Ilwaco dredges inside the marina with a small cutter-head pipeline dredge owned by the Port. The estimated average volume of maintenance dredging is between 20,000 and 30,000 cu yd per yr. However, these volumes vary considerably from year to year. For example, during the past 2 years, the Port of Ilwaco has dredged and disposed of approximately 150,000 cu yd of sediment, about 3 times the average dredging rate. The dredged material has been pumped to an upland disposal site adjacent to the marina at the shoreline of Baker Bay.

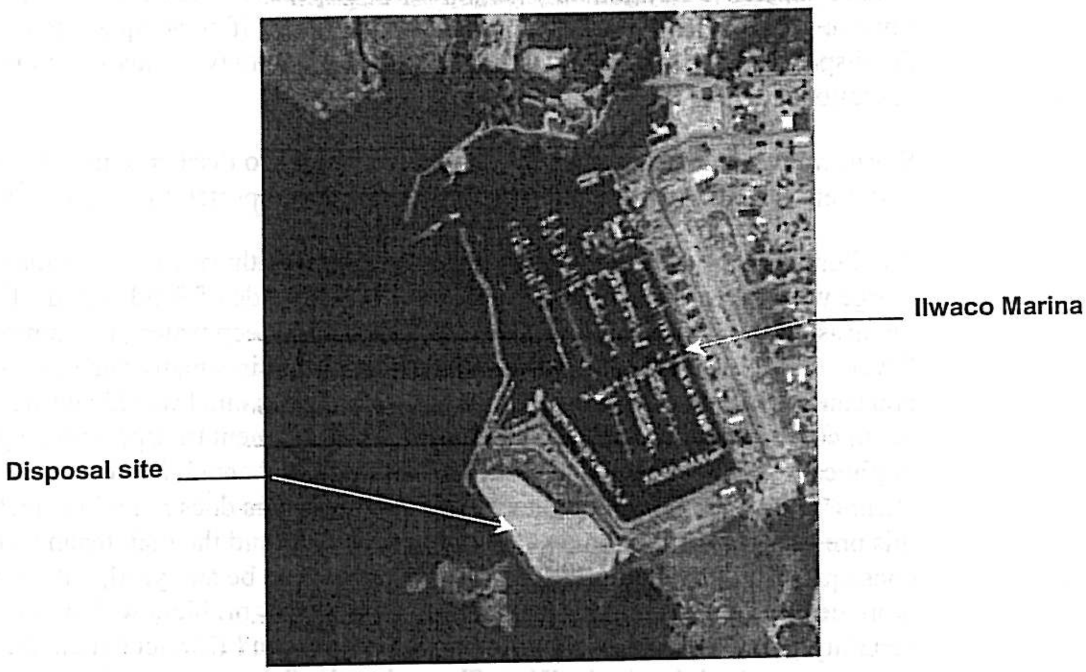


Figure 19 Ilwaco Marina

Upland disposal site capacity is limited at the Port. Several times during the last few years, the Port enlarged the size of the disposal site by raising the crest elevation of the containment dike. The Port recently spent about $50,000 for disposal site preparation, including raising the dike elevation and creating cells within the containment area to allow for dewatering of material placed in the previous year and disposal of material of the current year. With these measures, the Port has one or two more years of capacity at the existing site. Further elevation increases may not be feasible because the dike material has low strength. Figure 20 shows the recent condition of the Port's disposal site.

Figure 20 Port of Ilwaco upland disposal site

Preliminary coordination with resource agencies indicated that developing a new open water or nearshore disposal site will be difficult and, if permitted, would require expensive mitigation. Mitigation for disposal site expansion will likely involve purchasing and/or developing new wetlands. If no adequate solution of the disposal site problem is found, the Port of Ilwaco may be unable to maintain operational depths in the marina.

Storm water drainage from parts of the town of Ilwaco discharge into the marina. Sediment from particular locations in the marina is reported to contain a pesticide.

The Port has proposed creating a straight channel southward from the marina, to merge with the existing access channel on the west side of Sand Island. The intent is to provide easier access to the marina from deep water in Columbia River. Currently, navigating the curved channel requires many changes of course, and can be risky during storms at night. A straight channel would be safer if depth could be maintained. Hydrodynamic and sediment transport processes might cause more dredging to maintain the straight channel than the current channel alignment. The complexity of these processes does not allow analysis at this preliminary level of study. Sediment processes and the maintenance dredging consequences of changing the channel alignment can be analyzed, but a separate, more detailed study would be required to address this problem with any level of certainty. The Port has also requested that the Portland District extend the limit of maintenance dredging in the West Channel to the fish processor docks and to the fuel dock. A similar limit of dredging is common at other federal Section 107 projects, and the Portland District acknowledges the authority for dredging to the docks at Ilwaco is ambiguous. Currently the Portland District ends it's dredging about 200 ft outside the tip of the west breakwater. An authoritative interpretation would settle the question of dredging responsibility.

Assumptions

- Sampling and site characterization can delineate sediment in the basin that is suitable for open water disposal.
- Unsuitable sediment is located in the vicinity of the outfalls and will be disposed at the upland disposal site.
- Most sediment dredged from the basin is suitable for open water disposal.

Solutions

Four potential solutions to the problem of limited disposal site capacity are described below. They are identified as Improvement to Existing Practice, East Jetty; Open Water Disposal, and Nearshore Fill.

Improvement to Existing Practice

The Improvement to Existing Practice solution includes restoration of the upland disposal site by excavating the dredged material and stockpiling it at landfill sites. Several potential sites are available for placement of dry dredged material (discussion with Mack Funk, Director, Port of Ilwaco). Sites include private, municipal, and industrial properties. Potential sites for stockpiling are in the vicinity of 2 to 6 miles from the marina. It is assumed that no disposal fee will be required for the placement of dredged material at these sites.

Improvement to Existing Practice is an appropriate means to manage dredged material. The Port of Ilwaco has experience with relocating a small amount of dredged material from the upland disposal site to a nearby site. This experience shows that processes for drying, stockpiling, loading, transporting, and disposing should be modified. Details for each element of the process would be developed in the next phase of the project if this solution is selected. As a basis of comparison only, it is assumed that one excavator, one dozer, and 2 trucks will be required to operate the disposal sites. Cost of handling dredged material is estimated to be $5 per cu yd of in place dredged material. To compare this solution with others, it is assumed that purchase of the equipment is funded by a grant. Costs are summarized in the table below.

Improvement to Existing Practice	Estimated Cost
Environmental Permitting	$5,000
Engineering Design	- 0 -
Construction	- 0 -
Maintenance	$150,000

East Jetty

The East Jetty solution assumes construction of a jetty to protect the east side of the entrance channel, and extends from the west end of the south breakwater. The purpose of the East Jetty is to reduce maintenance dredging requirements in the marina entrance and develop a site for future beneficial use of dredged material.

The East Jetty is expected to reduce the amount of sedimentation in the basin and therefore, required maintenance dredging. East jetty construction was considered previously by the Portland District (USAED Portland, November 1963) in order to reduce maintenance requirements in the basin and in the entrance channel.

The area created where the East Jetty would join the existing breakwater may be converted into a high value intertidal habitat. To achieve this, the dredged material is proposed to be placed by pipeline dredge between East Jetty and existing breakwater at specific elevations. Considering the potential reduction of maintenance dredging, it is estimated that this site may be a beneficial use of dredged material for the Port of Ilwaco for the next 25 to 30 years. Maintenance dredging is assumed to generate 30,000 cu yd of fill yearly, at a unit cost of $1.00 per cu yd.

The length of the jetty and the cross section configuration would be determined during preliminary design. For the present analysis the length of the jetty is assumed to be 300 ft and the cross section configuration similar to that of the existing breakwater. The breakwater has a crest elevation of +14 ft MLLW and a crest width of 12 ft. A unit cost of $30 per ton was applied to the rock quantity to yield a construction cost of $477,000, including a 15 percent contingency. Maintenance is assumed to cost 15 percent of initial construction cost every 20 years. Costs are summarized in the table below.

East Jetty	Estimated Cost
Environmental Permitting	$30,000
Engineering Design	$30,000
Construction	$477,000
Maintenance and Ongoing Dredging and Disposal	$34,000 (average annual)

Open Water Disposal

The Open Water Disposal solution includes dredging the basin with a pipeline dredge and pumping the sediment to a bottom dump barge. A bottom dump barge would be staged outside the entrance to the basin at a depth that allows safe loading operations. The preferred location of the barge is at the junction of 2 channels at West Channel Mile 3. Maximum distance from the barge to the farthest dredging site in the basin is estimated to be 3,500 ft. This distance is sufficient to pump dredged slurry with a small dredge having 200 to 300 horsepower.

The bottom dump barge would be equipped with a diffuser that collects overflow water from the surface of the barge hopper and discharges it near the channel bottom. The diffuser would be designed to provide flow with minimal velocities at the bottom. The overflow water discharges through the diffuser and dilutes in the water column. No detectable change in water turbidity is expected at the barge. Diffuser technology is a standard technology in the dredging industry. An example of a similar application of diffuser technology in Washington is at the La Conner Marina Dredging Project, accomplished from 1994 to 1995. Water quality monitoring conducted during dredging operations at La Conner Marina showed no detectable change in suspended sediment concentration relative to background conditions in the vicinity of the barge equipped with a diffuser.

Upon filling the barge with dredged material, it is transported to the open disposal site and sediment is disposed. The actual time to fill the barge with dredged material depends on many variables such as size of the barge, dredge equipment, and operational details. The filling time should not exceed 4 hours. Considering barge capacity in the range of 2,000 to 4,000 cu yd, and maintenance dredging of 30,000 cu yd, the dredging period would be 10 to 15 days. Dredging is assumed to be accomplished with equipment owned by entities comprising the LCRPC and acquired with a grant. Estimated costs for labor, fuel, and maintenance yield an approximate cost of $1.00 per cu yd. Additionally, the cost for transporting sediment for open water disposal is estimated at $1 per cu yd. Maintenance dredging is assumed to generate 30,000 cu yd of sediment annually at a unit cost of $1.00 per cu yd. Costs are summarized in the table below.

Open Water Disposal	Estimated Cost
Environmental Permitting	$30,000
Engineering Design	$15,000
Construction	- 0 -
Ongoing Dredging and Disposal	$64,000 (average annual)

Nearshore Fill

The Nearshore Fill solution includes building a confined dike in the exterior or interior (if area is available) of the Port of Ilwaco and filling it with dredged material. The size of confinement should provide capacity for 25 to 50 years of maintenance dredging. Considering a rate of dredging of 30,000 cy per yr and conversion to consolidated disposed sediment, the capacity of the disposal site must be in the range 0.6 to 1.2 million cu yd. Specific location, alignment, dimensions, and capacity would be determined by a special study and design if this solution is selected. Cost estimates for this solution includes construction of the confined dike and water discharge facilities only. The dike is assumed to be constructed with a sheetpile wall 850 ft long. The top elevation is assumed to be at elevation +14 ft MLLW. The cost of the sheetpile wall, including the tie-back system, was estimated for this conceptual design at $2,230,000. The steel sheets are assumed to be protected with corrosion-resistant coatings, requiring no maintenance. Design refinements, including use of the open-cell sheetpile concept, in the next stage of project development could result in a cost reduction if this solution is selected. Maintenance dredging is assumed to be accomplished by a locally-owned pipeline dredge at a cost of $1.00 per cu yd. Costs are summarized in the table below.

Nearshore Fill	Estimated Cost
Environmental Permitting	$50,000
Engineering Design	$75,000
Construction	$2,230,000
Maintenance and Ongoing Dredging and Disposal	$34,000

Summary

Solutions to 14 projects were developed and described in terms of technical concepts, initial costs, and maintenance costs. Permitting aspects of the solutions were summarized in terms of types of permits required, the probable mitigation expense involved, and the relative ease of obtaining permits to implement the solution. Table 1, presented below, was prepared to assist the LCRPC in ranking the projects according to priority of accomplishing them. The table lists the projects and the costs, expected performance, and urgency of the need to implement the solutions. Dredging solutions are assumed to be accomplished with dredging equipment acquired by the LCRPC through a government grant, and account for only production and maintenance costs. Some solutions require a relatively large initial cost, as for constructing a revetment. Comparison among solutions should be made with the awareness that life-cycle costs for dredging solutions do not involve initial purchase costs.

Some solutions rely on a changed procedure by the Portland District Corps of Engineers in scheduling maintenance dredging. Priorities in Operations and Maintenance expenditures are set at the Portland District generally according to the relative economic activity level at the individual projects. Prior to the 1980s, the formula for calculating economic benefits for small navigation projects included recreational benefits. During the 1980s that policy changed, so that only commercial benefits counted toward economic justification. That was a time when commercial and charter fishing declined at the ports in the LCRPC. Because other natural resource bases of the local economy have also now declined, governments are encouraging tourism development to preserve the communities' economies. Recreational boating could be a mainstay of the revenue source for the ports, but the marinas require reliable entrance and access channels. The irony is that these marinas, which are also federal projects, appear to be given a low priority in receiving maintenance dredging for their access channels, presumably because the Ports' commercial economics are at a low level. A solution would be to again count recreational benefits for economic justification for federal maintenance expenditures. The Portland District is restricted by laws under which it operates, and that solution could be implemented through changes made by Congressional action.

Table 1 LCRPC Projects and Solution Evaluations

Name	Solution	Cost Initial	Cost Life-Cycle	Performance (Achieve Objective)	Urgency of Implementation	Permitting Ease
redged Material	Hopper Dredge	$0	$70,000	High, recurring action	Low	High
	Cutterhead Pipeline Dredge	$0	$19,000	High, recurring action	Moderate	High
n Bank Erosion	Revetment Rehabilitation	$40,000	$2,736	High, permanent	High	Moderate
	Beach Nourishment	$0	$3,400	Moderate, recurring action	High	Moderate
Sedimentation	Dredging and In-Water Disposal	$0	$3,800	High, recurring action	Highest	Moderate
	Dredging and Upland Disposal	$0	$19,000	High, recurring action	Highest	Moderate
Bank Erosion	Rock Revetment	$50,000	$3,400	High, permanent	Moderate	Low - Moderate
	Sheetpile Wall	$260,000	$17,000	High, permanent	Low	Low
n	Coordinated Dredging	$0	$0	Moderate, recurring action	High	Moderate
	Advanced Maintenance	$0	$3,800	Moderate, recurring action	High	Moderate
n	Hopper Dredge Nourishment	$0	$31,000	High, recurring action	Moderate	Low
	Pipeline Dredge Nourishment	$0	$8,200	High, recurring action	Moderate	Low
	Buried Revetment	$50,000	$3,800	High, permanent		Low
ownstream Barge Channel)	Dredging	$0	$7,900	High, recurring action	Moderate	High
pstream Boat Channel)	Dredging	$0	$5,500	Moderate, recurring action	Low	
ation	Flow Improvement	$0	$5,000	Low, recurring action	Low	Low
	Dredging	$0	$400	High, recurring action	High	Moderate
	Breakwater Rehabilitation	$405,000	$27,000	High, recurring action	Moderate	
l Sedimentation	Activate Project	$0	$0	High, recurring action	Low	High
	Local Dredging	$0	$1,500	High, recurring action	Moderate	High
tion	Dredging	$3,912,000	$322,000	Low, recurring action	High	Low
annel Sedimentation	Dredging	$0	$17,000	High, recurring action	Moderate	Low
annel Sedimentation	Coordinated Dredging Schedule	$0	$0	High, recurring action	High	Moderate
	Advanced Maintenance	$0	$0	High, recurring action	High	Moderate
	Disposal/Habitat Island	-	-	Low, recurring action	Low	Low
sion	Revetment Rehabilitation	$171,000	$12,000	High, permanent	High	Moderate
	Beach Norishment	$0	$11,000	Moderate, recurring action	Low	Moderate
ged Material Disposal	Improvement to Existing Practice	$0	$150,000	High, recurring action	High	High
	East Jetty	$477,000	$64,000	Moderate, permanent	Moderate	Low
	Open Water Disposal	$0	$64,000	High, recurring action	High	Low
	Neashore Fill	$2,230,000	$176,000	High, permanent, finite life	Moderate	Low

ons are listed as zero
ipment is assumed. See
r further explanation.

initial costs and recurring
nomic life with a discount

Table 2 Environmental Permits Required for LCRPC Project Solutions															
LCRPC Project	***HPA***	***Section 10***	***Section 404***	***NWP 13***	***NWP 31***	***NWP 35***	***BE/EFH***	***CZM***	***SEPA***	***NEPA***	***401 Certification***	***Aquatic Use***	***Shoreline Permit/Conditional Use***	***Mitigation Required***	**Permitting Efficacy**
County Sand Pit Deficit of Dredged Material															
Hopper Dredge Alternative	X					X	X	X	X	X	X	X	X	S	High
Cutterhead Dredge Alternative	X					X	X	X	X	X	X	X	X	S	High
Brown Slough Pump Station Bank Erosion															
Rock Revetment Rehabilitation	X			X			X	X	X	X	X	X	X	S-	Moderate
BeachNourishment	X			X			X	X	X	X	X	X	X	VS	Moderate
Grove Slough Pump Station Sedimentation															
Maintenance Dredging	X				X		X	X	X	X	X	X	X	S-	Moderate
North Welcome Slough Rd. Bank Erosion															
Rock Revetment Alternative	X			X			X	X	X	X	X	X	X	VS	Low to Moderate
Sheet Pile Wall Alternative	X			X			X	X	X	X	X	X	X	VS	Low
Ferry Terminal Sedimentation															
Coordinated Dredging Alternative	X					X	X	X	X	X	X	X	X	S	Moderate
Advanced Dredging Alternative	X	X	X				X	X	X	X	X	X	X	S	Moderate
Pancake Point Shore Erosion															
Rock Revetment Rehabilitation	X	X	X				X	X	X	X	X	X	X	VS	Low
Beach Nourishment	X	X	X				X	X	X	X	X	X	X	VS	Low
Cathlamet Channel Sedimentation															
Dredge and Disposal Alternative	X					X	X	X	X	X	X	X	X	S	High
Cathlamet Marina Sedimentation															
Flow Improvement Alternative	X	X	X				X	X	X	X	X	X	X	VS	Low
Dredging Alternative	X	X	X				X	X	X	X	X	X	X	S	Moderate
Skamokawa Creek Channel Sedimentation															
Activate Project Alternative	X					X	X	X	X	X	X	X	X	S	High
Local Dredging	X					X	??	X	X	X	X	X	X	S	High
Deep River Navigation Channel Sedimentation															
Reactivate Project Alternative	X	X	X				X	X	X	X	X	X	X	VS	Low
Local Interest Dredging	X	X	X				X	X	X	X	X	X	X	VS	Low
Grays River Channel Siltation															
Dredge Alternative	X					X	X	X	X	X	X	X	X	VS	Low
Port of Chinook Marina Channel Sedimentation															
Coordinated Dredging Alternative	X	X	X			X	X	X	X	X	X	X	X	S	Moderate
Advanced Dredging Alternative	X	X	X			X	X	X	X	X	X	X	X	S	Moderate
Disposal/Habitat Island Alternative	X	X	X			X	X	X	X	X	X	X	X	VS	Low
Port of Chinook Shore Erosion															
Rock Revetment Rehabilitation	X	X	X				X	X	X	X	X	X	X	S	Moderate
Beach Nourishment	X	X	X				X	X	X	X	X	X	X	VS	Moderate
Port of Ilwaco Maintenance Dredged Material Disposal															
Improvement Alternative	X												X	NA	High
East Jetty Alternative	X	X	X				X	X	X	X	X	X	X	VS	Low
Open Water Disposal Alternative	X	X	X				X	X	X	X	X	X	X	VS	Low
Nearshore Fill Alternative	X	X	X				X	X	X	X	X	X	X	VS	Low
Efficacy means = Ease of permtting															
S = Significant															
VS = Very significant															

APPENDIX A
Environmental Permits for LCRPC Projects

Lower Columbia River Port Communities Preliminary Permit Feasibility Analysis

Introduction

Pacific International Engineering, PLLC has been contracted by the Lower Columbia River Port Communities (LCRPC) to conduct a permit feasibility analysis for multiple water resource projects in Pacific and Wahkiakum counties. Each of the projects involves a certain degree of dredging, disposal and / or bank stabilization. This feasibility analysis provides a description of the permits and approvals that would be required to implement any of the solutions and the level of mitigation that will likely be required for each of the proposed projects and associated solutions. Information gathered from this effort will be used in conjunction with the conceptual solutions model developed to assist in prioritization of the following projects and to refine the permitting constraints and mitigation requirements.

Projects

- County Sand Pit Deficit of Dredged Material
- Brown Slough Pump Station Bank Erosion
- Grove Slough Pump Station Sedimentation
- North Welcome Slough Rd. Bank Erosion
- Ferry Terminal Sedimentation
- Pancake Point Shore Erosion
- Cathlamet Channel Sedimentation
- Cathlamet Marina Sedimentation
- Skamokawa Creek Channel Sedimentation
- Port of Chinook Marina Channel Sedimentation
- Port of Chinook Shore Erosion
- Port of Ilwaco Maintenance Dredged Material Disposal
- Deep River Navigation Channel Sedimentation
- Grays River Channel Siltation

Permits, Certifications, and Approvals

The following is a general description of federal, state and local permits, certifications, and or approvals typically associated with dredge/disposal and or bank stabilization projects. The permitting schedule was based solely on the requirements of the regulatory agencies, with no consideration to funding source (e.g., federal funding or local entity funding). As a result the permit schedules depicted on Table 1 may be subject to change depending on the source of funding. For example, if the Corps and a port were to cost-share any of these projects the permitting requirements at the federal level would be different then a non-federally sponsored/cost-shared project.

Federal

- *Section 10-Work in Navigable Waters/Section 404-Discharge of Dredge and Fill Material* - A U.S. Army Corps of Engineers (Corps) permit is required when locating a structure, excavating, or discharging dredged or fill material in waters of the United States or transporting dredged material for the purpose of dumping it into ocean waters. Typical projects requiring these permits include the construction and maintenance of piers, wharfs, dolphins, breakwaters, bulkheads, groins, jetties, mooring buoys, and boat ramps. However, not every activity requires a separate, individual permit application. Certain activities and work can be authorized by letters of permission (LOP), nationwide permits (NWP), or regional permits (RP). Though many permits are issued within 30 to 45 days, processing usually takes much longer depending on project complexities and other approvals that are required. There are no fees associated with a Section 10 or 404 permit. Some NWPs that may be applied to some projects are listed below:

- *Nationwide Permit 13 (Bank Stabilization)* - Bank stabilization activities necessary for erosion prevention provided the activity meets all of the following criteria:

  a. No material is placed in excess of the minimum needed for erosion protection;
  b. The bank stabilization activity is less than 500 feet in length;
  c. The activity will not exceed an average of one cubic yard per running foot placed along the bank below the plane of the ordinary high water mark or the high tide line;
  d. No material is placed in any special aquatic site, including wetlands;
  e. No material is of the type, or is placed in any location, or in any manner, so as to impair surface water flow into or out of any wetland area;
  f. No material is placed in a manner that will be eroded by normal or expected high flows (properly anchored trees and treetops may be used in low energy areas); and,
  g. The activity is part of a single and complete project.

  This NWP may not be used for the channelization of a water of the United States. There is no fee for processing a Nationwide Permit 13 and processing time varies.

- *Nationwide Permit 31 (Modification of Existing Flood Control Projects)* - Discharges of dredged or fill material for the maintenance of existing flood control facilities, including debris basins, retention/detention basins, and channels that were:

  (i) Previously authorized by the Corps by individual permit, general permit, or by 33 CFR 330.3 and constructed; or

(ii) Constructed by the Corps and transferred to a local sponsor for operation and maintenance.

The maintenance is limited to that approved in a maintenance baseline determination made by the District Engineer (DE). The prospective permittee will provide the DE with sufficient evidence for the DE to determine the approved and constructed baseline. Subsequent to the determination of the maintenance baseline and prior to any maintenance work, the permittee must notify the DE in accordance with the Notification general condition.

All dredged material must be placed in an upland site or a currently authorized disposal site in waters of the United States, and proper siltation controls must be used. This NWP does not authorize the removal of sediment and associated vegetation from natural water courses. (Activities that involve only the cutting and removing of vegetation above the ground, e.g., mowing, rotary cutting, and chain-sawing, where the activity neither substantially disturbs the root system nor involves mechanized pushing, dragging, or other similar activities that redeposit excavated soil material, does not require a Section 404 permit in accordance with 33 CFR 323.2(d)(2)(ii)). Only constructed channels within stretches of natural rivers that have been previously authorized as part of a flood control facility could be authorized for maintenance under this NWP.

Upon receipt of sufficient evidence, the DE will determine the maintenance baseline. The maintenance baseline is the existing flood control project that the DE has determined can be maintained under this NWP, subject to any case-specific conditions required by the DE. In determining the maintenance baseline, the DE will consider the following factors: the approved facility, the actual constructed facility, the Corps constructed project that was transferred, the maintenance history, if the facility has been functioning at a reduced capacity and for how long, present vs. original flood control needs, and if sensitive/unique functions and values may be adversely affected. Revocation or modification of the final determination of the maintenance baseline can only be done in accordance with 33 CFR Part 330.5. This NWP cannot be used until the DE determines the maintenance baseline and the need for mitigation and any regional or activity-specific conditions. The maintenance baseline will only be determined once and will remain valid for any subsequent reissuance of this NWP. However, if the project is effectively abandoned or reduced due to lack of proper maintenance (a new determination of Nationwide Permits / Seattle District / 16 June 2000), a maintenance baseline would be required before this NWP could be used for subsequent maintenance.

Mitigation. In determining the need for mitigation, the DE will consider the following factors: any original mitigation required, the current environmental setting, and any adverse effects of the maintenance project that were not mitigated in the original construction. The DE will not delay needed maintenance for completion of any required mitigation, provided that the DE and the applicant establish a schedule for the identification, approval, development, construction and completion of such required mitigation. There is no fee for processing a Nationwide Permit 31 and processing time varies.

- *Nationwide Permit 35 (Maintenance Dredging of Existing Basins)* - Excavation and removal of accumulated sediment for maintenance of existing marina basins, access channels to marina basins or boat slips, and boat slips to previously authorized depths or controlling depths for ingress/egress, whichever is less, provided the dredged material is disposed of at an upland site and proper siltation controls are used. There is no fee for processing a Nationwide Permit 35 and processing time varies.

- *Biological Evaluation of Endangered Species Act Listed Species/Essential Fish Habitat* – A Biological Evaluation/Biological Assessment (BE/BA) is prepared as a condition of Section 7 of the Endangered Species Act (ESA) process to determine whether a proposed major construction activity with a federal nexus (i.e., permitted or funded by a federal agency) is likely to jeopardize the continued existence of listed species, candidate species, or designated critical habitat. The Essential Fish Habitat (EFH) component is a condition of the Magnuson-Stevens Fishery Conservation and Management Act. It is intended to emphasize the importance of habitat protection to healthy fisheries and to strengthen the ability of the National Marine Fisheries Service (NMFS) and the Fisheries Management Councils to protect the habitat needed by the fish they manage. As a result the EFH process requires that EFH be defined and adverse effects and conservation measures be identified for species managed by NMFS that occur within the immediate area that the project is occurring. There are no fees associated with the Services (NMFS/US Fish and Wildlife Service [USFWS]) review of the Biological Evaluation or that of the EFH review by NMFS. The review process can take up to a year or longer if formal consultation is required.

Federal agencies making decisions on permits or licenses are required to comply with the National Environmental Policy Act (NEPA). NEPA requirements are very similar to those of the State Environmental Policy Act (SEPA) (see below under State). There are activities defined in federal codes that are Categorically Excluded (CE), or excluded with a Documented CE (DCE). Projects that do not fit into the CE or DCE classifications require an environmental assessment (EA). The EA is either prepared by the lead federal agency (the federal agency that is permitting or funding the project) or the applicant in coordination with the lead federal agency. The EA is used by the lead federal agency to determine the extent of environmental impacts associated with the project. Though the lead federal agency is responsible for the content of the assessment, the applicant may be asked to contribute extensive information. If a project is determined to be environmentally significant, a NEPA EIS is required. If the NEPA lead federal agency determines a project will not significantly impact the environment, that agency issues a Finding of No Significant Impact (FONSI). There are no fees associated with either the SEPA or NEPA process.

State

- *Hydraulic Project Approval* - Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state, requires a Hydraulic Project Approval (HPA) from the Department of Fish and Wildlife (WDFW). A complete application package for an HPA must include a completed Joint Aquatic Resource Permit Application (JARPA) form, general plans for the overall project, and complete plans and specifications of the proposed work within fresh or salt waters of the state. The application also needs to include complete plans and specifications for the protection of fish life. WDFW is required to make a permit decision within 45 days of receiving a complete application, unless agreed to between WDFW and the applicant. The SEPA process (i.e., Exemption, Determination of Non-significance [DNS], Mitigated DNS, Determination of Significance [DS] and completion of an Environmental Impact Statement [EIS]) must be completed before an HPA can be issued (see below). There are no fees associated with the HPA.

- *Coastal Zone Management Certification/Approval* - A certification with Washington's Coastal Zone Management (CZM) Program is required for Corps authorized projects, and other federally licensed or permitted projects. Unlike other certifications that are issued by the State, the project proponent prepares the Coastal Zone Certification, which includes a project description, a brief assessment of the impacts, and a statement that the project complies with the CZM Program. Ecology reviews the Certification and the proposed project for consistency with state environmental requirements, including shoreline permits (see Local section below). If the project is consistent, Ecology concurs with the certification in writing. There are no fees for the CZM Certification.

- *Sate Environmental Policy Act /National Environmental Policy Act* - The SEPA process is intended to ensure that environmental values are considered by state and local government officials when making decisions about plans and projects. For nongovernmental projects, the SEPA process starts when a permit application is submitted to an agency. In this case the counties would be the lead SEPA agency. If the project is not exempt, the lead agency will ask the applicant to fill out a SEPA environmental checklist. This checklist, divided into different elements of the environment such as air, water, etc., asks questions about how the project will affect these elements. Based on the answers to the checklist and the reviewer's knowledge about the project site, the lead agency will determine the types of impacts the project may have on the environment. If the project will have a probable significant adverse environmental impact, the lead agency prepares a DS and an EIS will be required. ElSs are documents that evaluate alternatives and elements of the environment associated with each alternative to determine the effects of the alternatives on the built and natural environment, and looks at ways the project could be changed to minimize problems, and options for mitigating probable adverse environmental impacts. The projects identified for the LCRPC will not require an EIS. Instead, the lead agency is more likely to issue either a DNS, which documents the agency's decision that, in their opinion, there will not be a significant adverse environmental impact, or a MDNS, which documents that the project will not have a probable adverse significant environmental impact provided that certain mitigation measures are implemented as part of the project. If permits are required from more than one agency, the DNS/MDNS will have a 14 day comment period. For these DNSs, permit processing can proceed after the close of the comment period. A state or local agency may adopt a NEPA document as a SEPA document if the original document is found to be adequate. When both federal (NEPA) and state (SEPA) environmental documents are required, the NEPA and SEPA processes may be combined.

- *Washington Department of Ecology for 401 Water Quality Certification* - A water quality certification (certification) is required for any project requiring a Section 404 permit (i.e., discharge of material to waters of the U.S.), including the discharge of dredge and fill material into waters of the U.S., including wetlands. Many excavation activities that occur in streams, wetlands, or other waters of the state also require a 401 certification. Through this process, Ecology can work with applicants to insure that activities do not degrade state and federal water quality standards. The federal agency is provided a certification from the state that the discharge complies with state and federal water quality standards and natural resource protection requirements of state law. Usually, the federal agency requests this certification on behalf of the applicant. In the case of Corps permit applications, timing of certification is tied to Corps permit process. Public notice for a water quality certification may be piggy-backed with the Corps public notice. Process time varies and there is no fee associated with the certification. Ecology issues the 401 certification after the Corps issues their permit, and Ecology has up to 100 days (depends on whether it is a non-federal applicant or a federal applicant) to issue the 401 certification.

- *Aquatic Use Authorization* - Anybody wishing to use state-owned aquatic lands (including owners of adjacent lands) must get authorization from the Department of Natural Resources (DNR). Long-term ecosystem and economic viability are among DNR's considerations when making decisions regarding state-owned lands. Marinas, docks, and similar land/water connectors are typical authorized activities. Other activities for which authorization is commonly required include shellfish/aquaculture leases, geoduck harvest sales, dredge disposal, easements for bridges and utility crossings (including outfalls), and sand and gravel removal. Information required on the application includes location; proposed use; physical improvements; local, state, and federal regulatory requirements; and a property survey. Application processing time generally ranges from six months to one year. Fees are variable and negotiable.

Local

- *Shoreline Substantial Development Permit/Conditional Use Permit* – A Substantial Development permit is required for any development or activity that is not exempt under local Shoreline Master Programs (SMPs). Conditional Use Permits (CUP) allow greater flexibility in the application of the use regulations in the SMP in a manner consistent with RCW 90.58.020. The SMP also applies to any use or activity that materially interferes with the normal public use of the water or shorelines of the state regardless of cost, for any activity listed as a Conditional Use in the local SMP, and for any activity that requires a variance from the provisions of the SMP. Shorelines are defined as lakes, including reservoirs, of 20 acres or greater; streams with a mean annual flow of 20 cubic feet per second or greater; marine waters; plus an area landward for 200 feet measured on a horizontal plane from the ordinary high water mark; and all associated marshes, bogs, swamps, and river deltas. Floodplains and floodways incorporated into local SMPs are also included. The procedure for obtaining a SSDP/CUP varies as does processing time (a few weeks to several months). Generally, a public hearing is required. The local official will require an affidavit of public notice, a location map, a topographic map, and a site plan. If a shoreline variance or CUP is required, the Ecology must also approve or deny the permit, or approve the permit with conditions. The fees for a SSDP/CUP vary by jurisdiction.