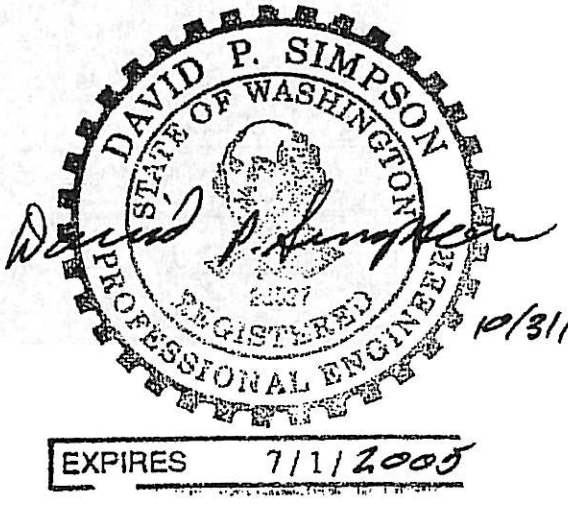
Technical Memorandum

Bank Protection at Pancake Point and Welcome Slough, Puget Island

Prepared for:

Wahkiakum County

Prepared by:



David P. Simpson
Coast & Harbor Engineering, LLC

October 31, 2003

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Bank Protection at Pancake Point and Welcome Slough, Puget Island

Wahkiakum County
Puget Island Erosion Control District

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1 Introduction

The beach width along the Columbia River side of Puget Island has been narrowing for many years. Erosion has become critical at some locations, particularly at certain pile dikes. Progressive and episodic bankline loss at pile dikes 40.51 (near Welcome Slough) and 43.55 (at Pancake Point) is threatening property and structures. Figure 1 shows the project locations with respect to Puget Island and the Columbia River.

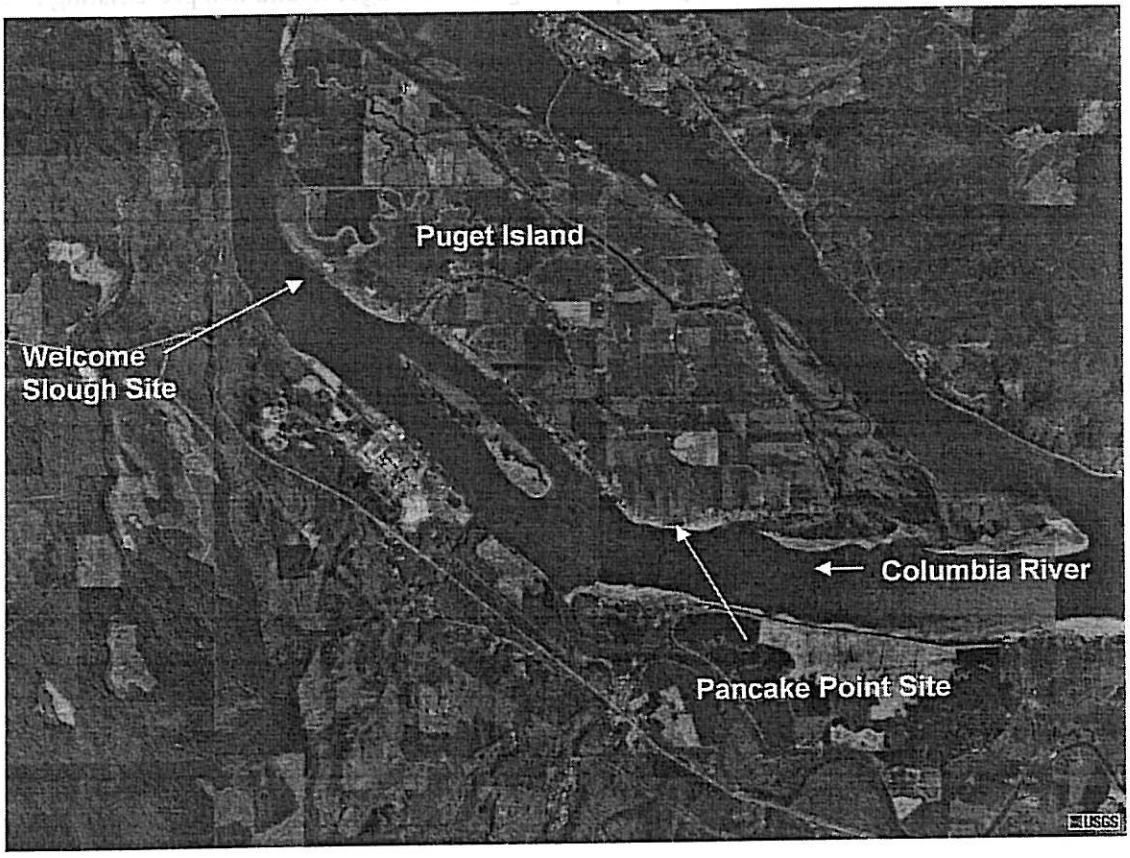


Figure 1 Puget Island and the study site locations

The Puget Island Erosion Control District contracted with Coast & Harbor Engineering for the following tasks:

- Review data pertinent to these specific erosion problems
- Perform preliminary engineering analysis of processes and solutions erosion problems
- Document and coordinate with the Erosion Control District and Corps of Engineers the findings and conclusions of the study.

The purpose of this engineering assessment is to develop bank protection alternatives, identify a feasible alternative, and provide information that will assist the Erosion Control District in selecting the path toward implementing a solution. This technical memorandum is the final documentation of the study. It presents summaries of engineering analysis, initial permitting information, and conceptual solutions.

2 Project Background

The erosion sites studied in the current investigation are on Puget Island in the Wauna and Driscoll Ranges of the Columbia River Federal Navigation Project, which is managed by the Portland District of the U.S. Army Corps of Engineers. Puget Island is a pre-existing mid-channel bar of the river that was levied and developed for agricultural and residential use. Pile dikes were installed along Puget Island as part of the navigation project to train the flow in a manner to minimize maintenance dredging of the shipping channel and to provide protected areas for disposal of dredged material. Disposal of dredged sand on Puget Island banks was a common practice for many years, but ceased at most locations in the mid 1980's. The Pancake Point erosion site is designated as Disposal Site W-43.8 in the Portland District Maintenance Disposal Plan. The Welcome Slough study site is downstream adjacent to disposal site W-40.9.

Both sites of most critical erosion are on the downstream side of pile dikes. Figures 2 and 3 are photographs of the Welcome Slough and Pancake Point erosion sites, respectively. Shoreline loss due to erosion at least at shallow depth is evident at the pile dike landward end at the two locations. A concave bend in the bankline centered where the pile dike connects to land, present at the two sites, is a common feature observed in association with pile dikes on the lower Columbia River. Sudden slumping of a section of the bankline into the river has been reported just downstream of the pile dike at both study sites. A loss of several feet of bank was experienced suddenly on April 27, 2002 at Pancake Point. This mode of loss suggests slope instability due to oversteepening as a failure mechanism, and erosion at depth adjacent to the bank is a factor in the bankline loss.

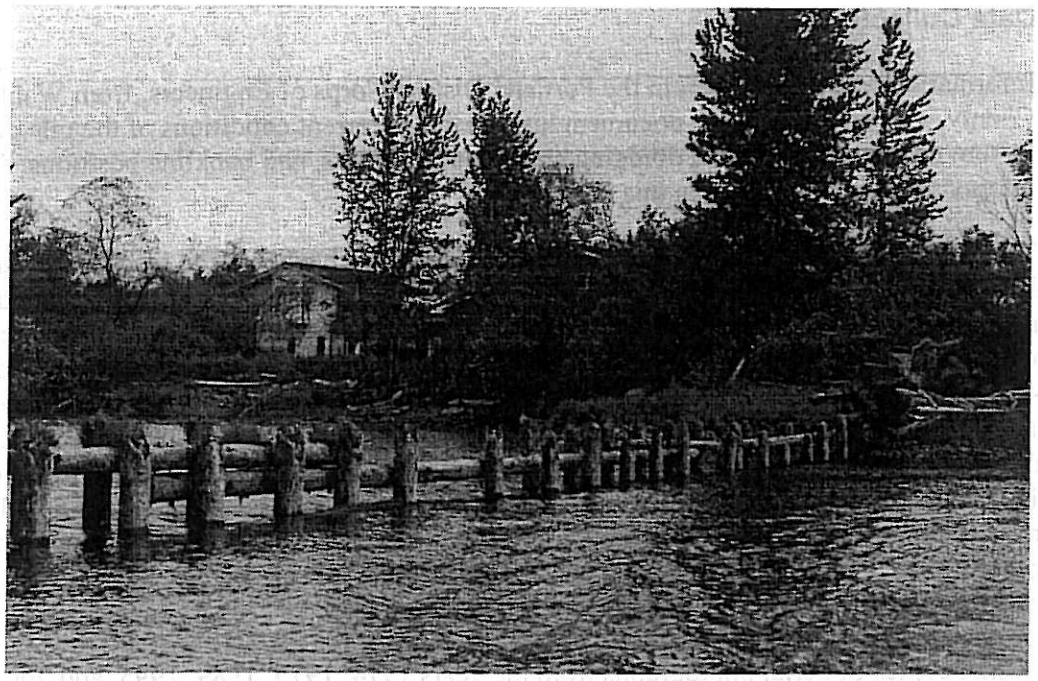


Figure 2 Bank erosion downstream of pile dike 40.51 (Welcome Slough)

Figure 3 Bank erosion downstream of pile dike 43.55 (Pancake Point)

3 Data Collection

Information was collected from the Portland District Corps of Engineers, from Wahkiakum County, and from the site to document historical and current conditions of the pile dike, bottom and bank elevations, dredging and disposal actions, and bankline positions. The information is summarized in this section.

The authorized depth of the Columbia River navigation channel in the reaches containing Puget Island changed from 25 feet to 30, 35, and 40 feet in the years 1912, 1935, and 1962, respectively. Dredged sand was commonly placed on the bankline and in upland locations where it was an economical means of disposal. Disposal has never occurred at pile dike 40.51, but the upstream site W-42.5 received 477,000 cu yd over a period from 1976 to 1988. Disposal at Pancake Point has not occurred since January 1984, when 133,000 cu yd of sand was placed there. Previously 757,000 cu yd of sand was disposed in the period from 1970 to 1975 at the Pancake Point site. Disposal at most bankline locations is now heavily restricted through application of the Endangered Species Act. The shoaling rate in the navigation channel has diminished over the years and now a hopper dredge operates there more efficiently than does a pipeline dredge.

Digital copies of aerial photographs from the years 1974, 1979, 1989, 1995, and 2001 were purchased from the Corps of Engineers to compare bankline position. Photographs from 1967 and 1973 were scanned from Wahkiakum County files. The photographs are shown in Appendix A. The 1974 photograph was selected as a base and photographs from later years were overlain for bankline comparison. The comparisons show that the bankline advanced between 1974 and 1979, and then continued to recede in the succeeding photographs.

Dredging and disposal information was provided by the Portland District Corps of Engineers. The available data show that the 1970s was the period of greatest rate of sand placement at Pancake Point and upstream of Welcome Slough. The bankline retreat observed in the photographs evidently results from the processes that erode sand from the bank combined with the lack of replenishment through placement of dredged sand. The rate of bankline retreat varies according to location and to time period. Maximum retreat rates estimated from the photographs are in the range of 20 ft per year in the period 1979 to 1989 at Pancake Point.

The location and orientation of pile dikes were determined during engineering studies sometimes by detailed physical modeling and many times, because of the great number of these structures, by experience and engineering judgment. USACE (1987) states that the maximum scour created by pile dikes usually occurs when the dike is perpendicular to the flow and that other inclinations result in smaller scour depth. Pile dikes 40.51 (length 150 feet) and 43.55 (length 500 feet) were constructed before 1967. The shoreward extension of Pile Dike 43.55 was added between 1967 and 1973. The two pile dikes were inspected as part of a large study to evaluate all pile dikes in the lower Columbia River. The evaluation is reported in a Value Engineering Study Report (USACE 1987). In that study the evaluation of both pile dikes 40.51 and 43.55 was to "maintain as is." An inspection report by Portland District dated 15 March 2001 listed both the pile dikes in the category of needing no repairs.

Bottom depths in the vicinity of the problem areas are not well documented. Cross line surveys have not covered the areas subject to erosion. A swath survey close to the pile dike 43.55 was completed in 2002, and is shown in Figure 4. Cross sections spaced at 25 feet increments downstream of the dike are shown in Figure 5. A sequence of 4 bottom profiles is shown in Figure 6.

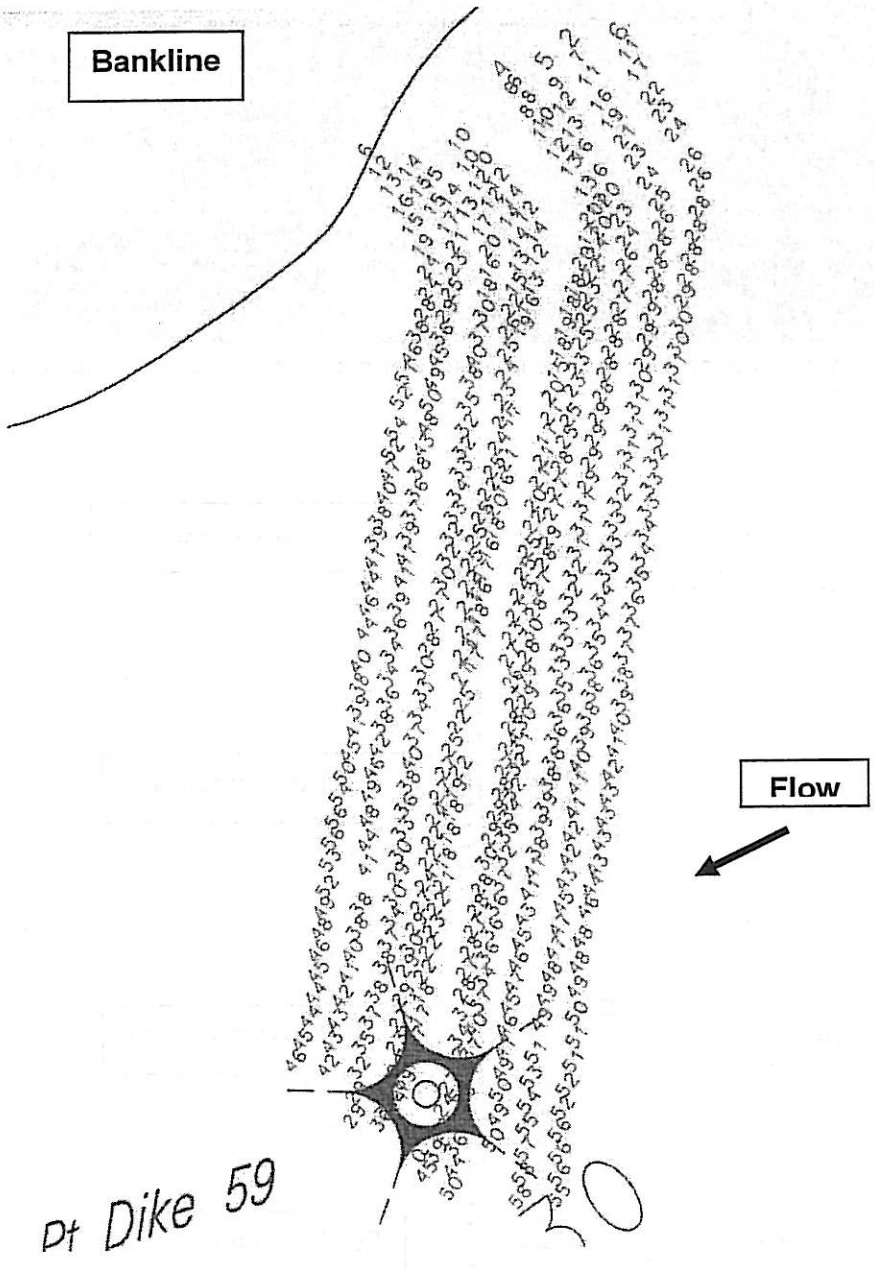


Figure 4 Hydrographic survey at pile dike at Pancake Point

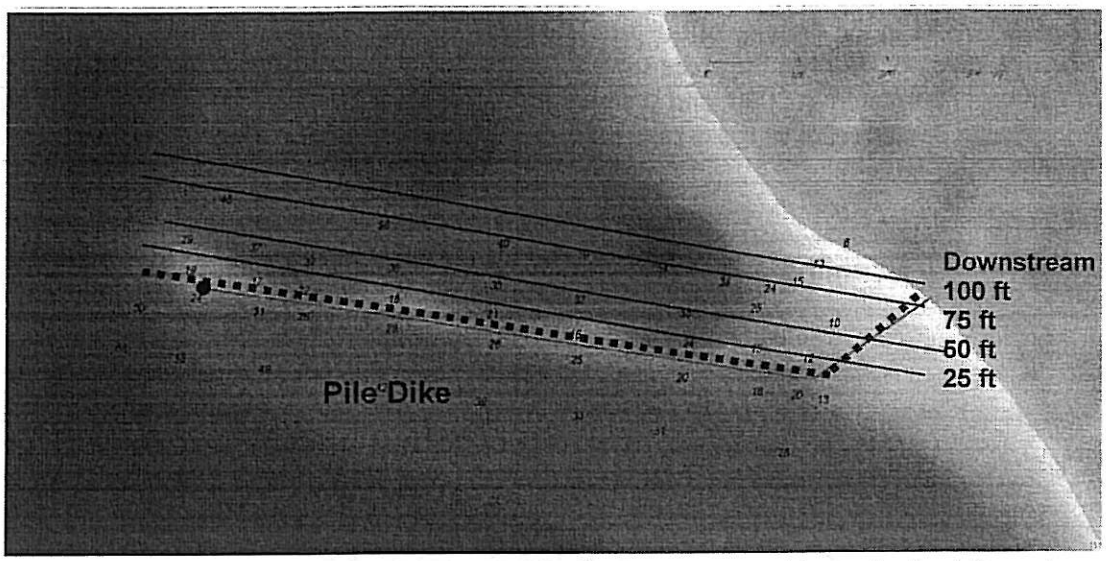


Figure 5 Location of cross sections used for bottom topographic analysis at Pancake Point

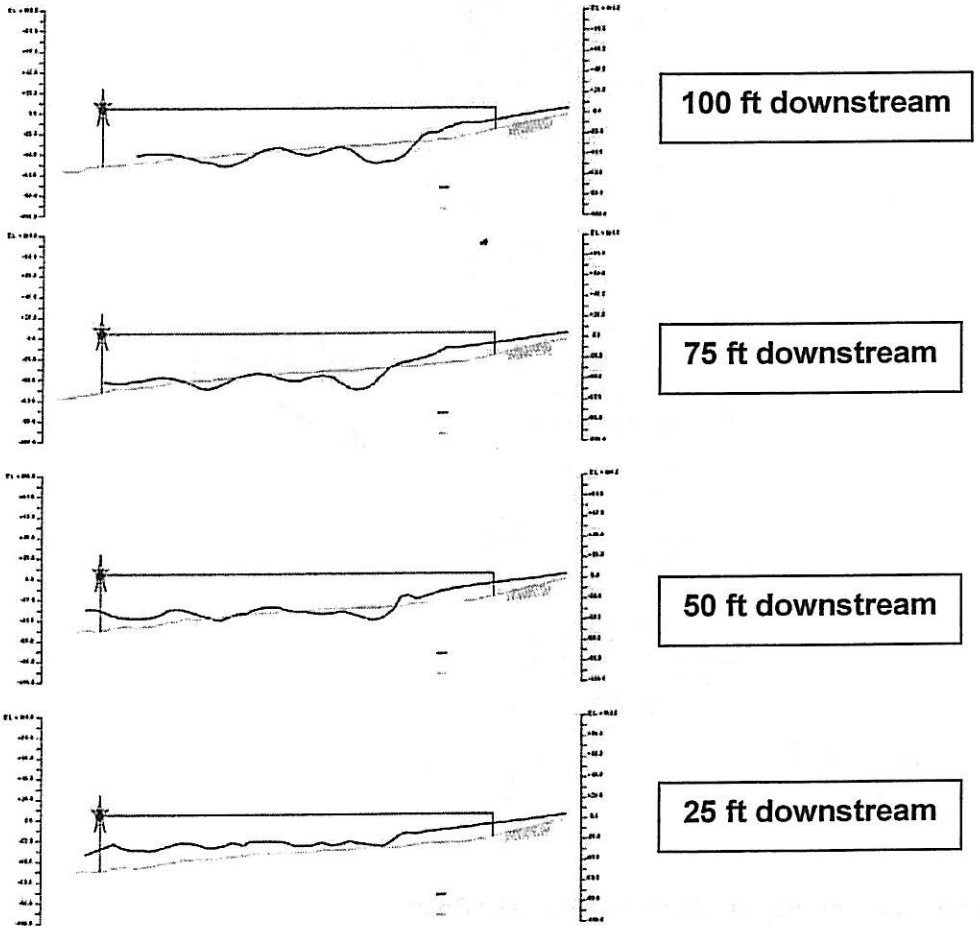


Figure 6 Bottom profiles at successive distances downstream from pile dike at Pancake Point

An informal measurement of depth was made in May 2003 using an acoustic depth sounder mounted on a small boat and positions at which depths were recorded were visually estimated from reference points. The pattern of bottom profiles shows that a scour hole exists downstream of the pile dike and is within 100 feet of the bank at Pancake Point. A diagram interpreting the combined depth information is shown in Figure 7.

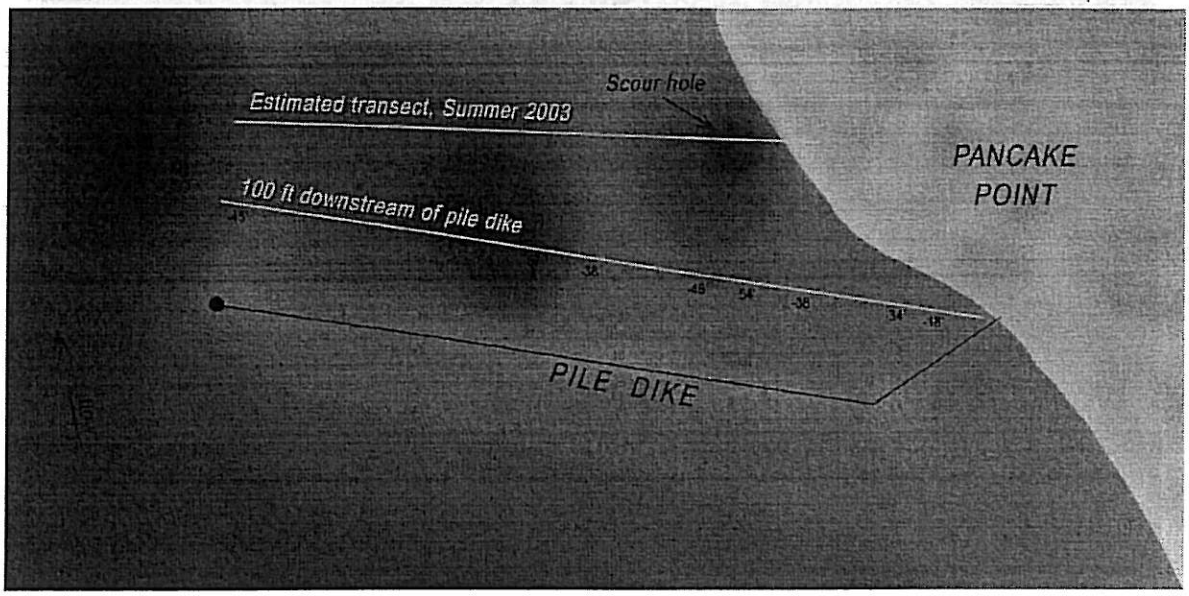


Figure 7 Interpretation of scour hole locations based on depth information

4 Erosion Assessment

Causes of erosion at the study sites were inferred through understanding of general hydraulic principles. Examination of bottom scour patterns at pile dikes shown in a study at Sauvie Island (river miles 99 + 05 and 99 + 30) (USACE 1986) and the informal survey at Pancake Point in May 2003 showed that scour holes typically develop in the lee of the tip of the pile dike. The location of the scour hole coincides with the area of flow separation and eddy formation, due to the interaction of the flow and the structure. At Pancake Point a large eddy is observed moving clockwise in the lee of the pile dike, and coincides with the location of relatively great depths close to the bank. The depths are inferred to be caused by non-uniform flow patterns set up through interference by the pile dike structure with the river flow near the bank.

As a demonstration of possible effects of a pile dike on flow patterns, a generalized model of river flows was developed for two cases. One case represents a portion of the Wauna and Driscoll Ranges before pile dikes were constructed at Pancake Point. The second case represents the same location and river discharge with pile dikes in place. Model results of a 200,000-c.f.s. discharge and a dike having low porosity are shown in Figures 8 and 9. Comparison of the figures indicates that the pile dike at Pancake Point is capable of flow interference of the type that could create an eddy turning in the observed direction. Although the pile dike near Welcome Slough was not modeled with the generalized hydraulic model, cause-and-effect relationship of the presence of the pile dike and lack of

sand placement with development of a deep scour hole near the bank is likewise inferred at this location.

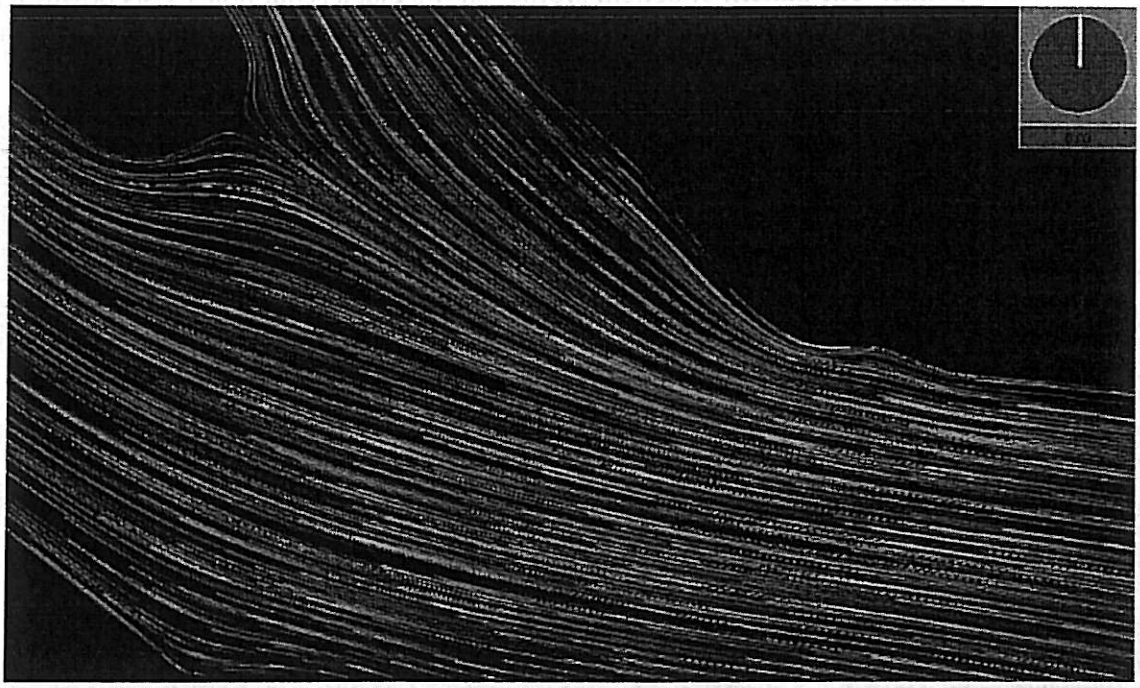


Figure 8 Flow pattern in approximated Wauna Reach without pile dikes

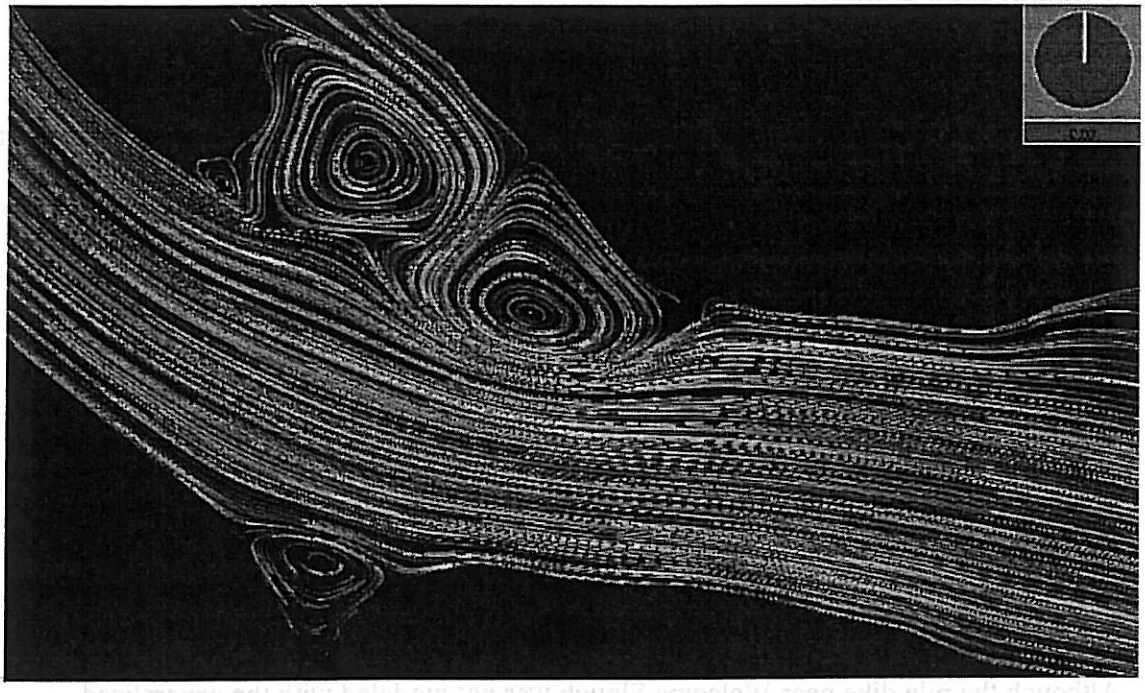


Figure 9 Flow pattern in approximated Wauna Reach with pile dikes represented

Although depth information is informal, collected with a depth sounder on a boat and with approximated positions, the bottom profile perpendicular to the bank developed from this information shows the slope is steeper than can be maintained by sandy bank material. The underlying, original material is known to be clayey and is somewhat erosion resistant. The steep near-bank slope downstream from both pile dikes is concluded to result from erosion into the original clayey material. Bank material that existed before pile dike construction has evidently been eroded by the local current and sediment transport regime. The particular local current and transport regime results from installing the pile dikes and the present practice of managing disposal of dredged sediment.

5 Permitting

Solutions to the threat of continued loss of bankline were developed which respond to needs for engineering feasibility, speed of implementation, cost, ease of permitting, and Corps of Engineers concerns regarding movement of placed sand by the current into the navigation channel. For any alternative solution to receive environmental permits the design must conform to normal requirements for protection of aquatic resources and those of the Endangered Species Act. Initial contact with NOAA Fisheries and Washington Department of Fish and Wildlife (WDFW) has provided the understanding that the most harmful situation for migrating fish is to be in deep water near a steep bank. That type of environment is judged to currently exist at the erosion sites and should be avoided in the design of a solution. Rock revetment is viewed as a solution that is least-favorable for natural resources. Sand placed at and above the shoreline can be formed by waves, wakes, and currents into a flat sloping beach. Small fish are at risk of being stranded on the sandy beach by the wake of passing deep-draft ships. Incorporation of bioengineering concepts in the erosion control design is preferred by the agencies.

Information regarding permitting issues of the alternative solutions obtained from resource agencies is summarized in Appendix B.

6 Conceptual Solutions

Concepts considered for possible solutions in this study are no action, rock revetment, unconfined sand fill, and partially confined sand fill. Based on previous rapid bankline losses and the erosion mechanism concluded above, the no action alternative would result in continued future bankline loss at these locations. If the previous rapid slumping of bankline material is repeated, it is expected to endanger the house located just landward of the scarp at both erosion sites.

6.1 Alternative 1 - Rock Revetment

Rock revetment has been a standard design for responding to bank erosion problems and a large volume of design guidance exists. Based on experience with revetment performance, revetment was proposed as a feasible solution from an engineering standpoint. Dimensions of a rock revetment were developed using the approximated

near-bank profile, tapering the revetment to a minimal cross section at the ends 300 feet upstream and 300 feet downstream from the center of the scour hole at Pancake Point. A similar concept was applied at the Welcome Slough site, assuming the revetment extended from 150 feet upstream to 150 feet downstream of the center of the scour hole. Because the erosion process is considered to be active at depths to 50 feet at these locations, the revetment extended from the bottom of the scour hole to just above the high water elevation at a slope of 2 horizontal to 1 vertical. The cross section of this concept is illustrated in Figure 10. Revetment performance is well documented at other locations.

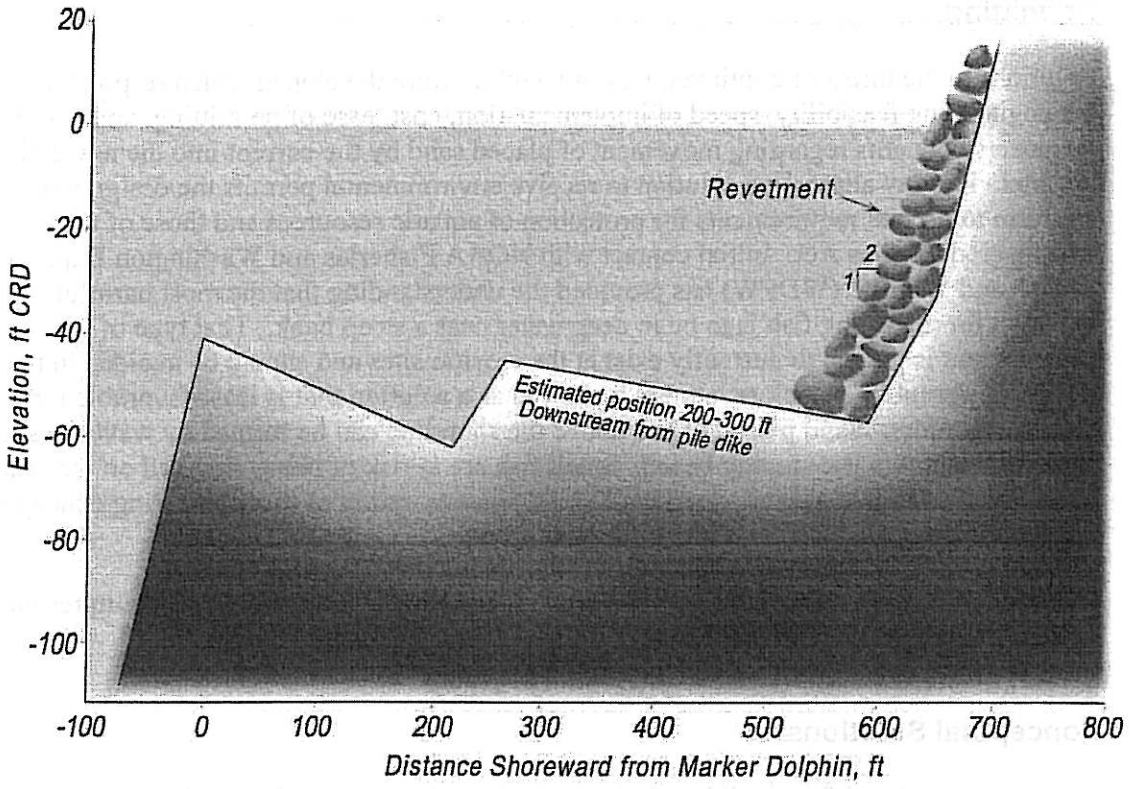


Figure 10 Conceptual illustration of revetment applied at scour hole

6.2 Alternative 2 - Unconfined Sand Fill

Placing dredged sand in the scour holes to the elevation of approximately 5 feet below the water surface would buttress the slope and reduce the potential for slope failure. Sand placement would be at a rate slow enough to prevent destabilizing the critical slopes. The top elevation of the fill if kept below the water surface would not present the stranding risk for fish. Placed sand is considered to be a solution requiring occasional maintenance by adding more sand. The top elevation of the fill would be -5 feet at the bank, with a 10 horizontal to 1 vertical slope toward the

channel on the fill crest. The initial placed volume would have a side slope of 5 horizontal to 1 vertical to accommodate slope stability requirements and present less danger to migrating juvenile salmon. The crest of the fill was assumed to be 50 feet wide, to provide for longevity of the fill. The cross section of this alternative concept is illustrated in Figure 11. Because the fill is not confined the process that created the scour hole is assumed to continue to remove the placed sand. The transport pathway of the eroded sand was not determined in this study, but deposition in the ferry access channel and in the main navigation channel are possible fates of some of the sand eroded from the placement areas.

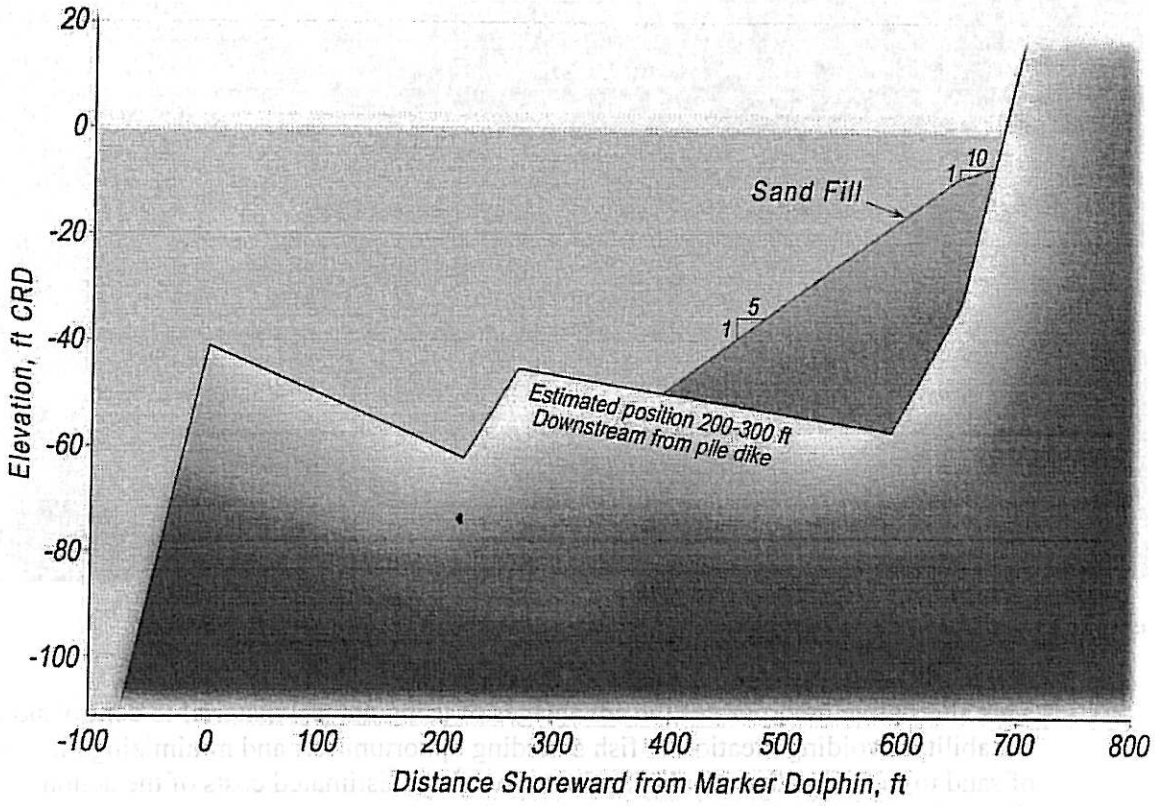


Figure 11 Conceptual Illustration of unconfined sand fill at scour hole

6.3 Alternative 3 - Partially Confined Sand Fill

A final alternative considered incorporates the benefits of the placed sand and is expected to extend the life of the fill. This alternative incorporates a submerged sand retention structure on the shallow bottom at the downstream edge of the scour hole and oriented perpendicular to the bank at Pancake Point. More bottom information at the Welcome Slough site will better define the design of the sand retention structure. The structure would act as an underwater groin and would have only enough vertical

relief to contain the sand or to interfere with the eddy flow if further study determines that the eddy extends to that location. The initial sand placement dimensions for this alternative are the same as for the unconfined sand fill, but the fill life is expected to be longer because of the retention structure. The structure itself could be constructed from rock or rock combined with sand-filled geotextile containers. The crest elevation would not exceed -5 feet and would slope toward the channel center and intersect the bottom about 250 feet from the bank. It would have a trapezoidal shape in cross section and would have side slopes about 7 horizontal to 1 vertical to facilitate flow transition past the structure that would not induce scour itself. This concept is illustrated in Figure 12.

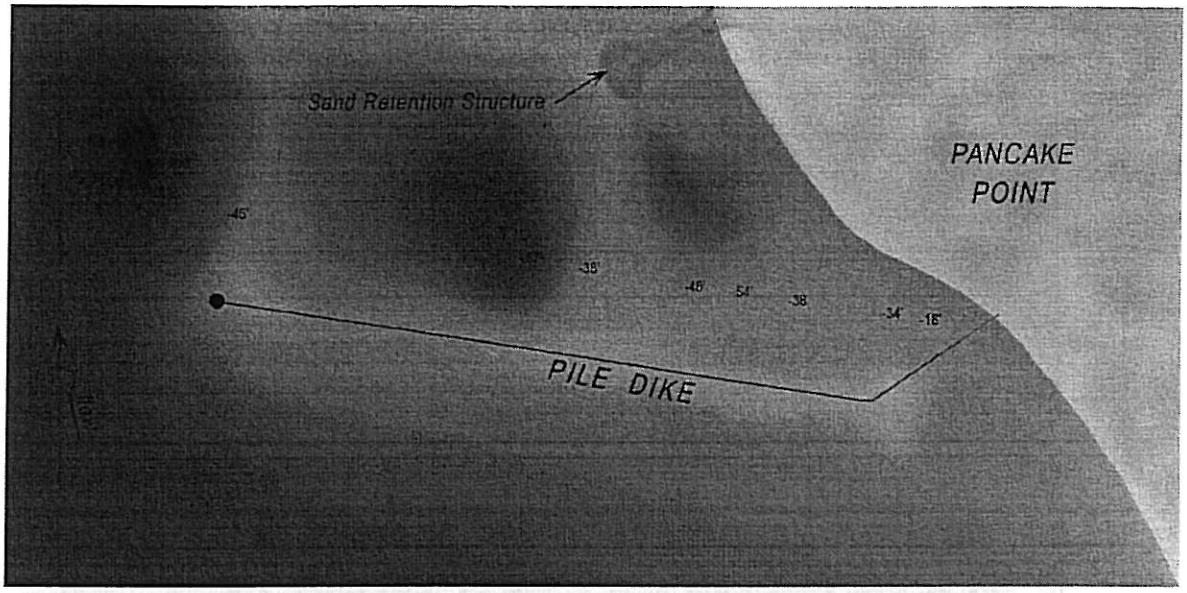


Figure 12 Conceptual illustration of confined sand fill at scour hole

This alternative incorporates the advantages of using natural material to control slope instability, avoiding creation of fish stranding opportunities, and minimizing the loss of sand to locations that would require redredging. Estimated costs of the action alternatives are listed in Table 1 with the estimated permitting costs and time to obtain permitting.

Table 1 Time and Cost Conceptual Estimates for Implementing Alternative Solutions

Alternative	Construction Cost	Maintenance Cycle, yrs	Permit Cost	Permitting Duration
1	$5 million	25	$60,000	12 – 18 months
2	$500,000	5	$40,000	9 – 12 months
3	$650,000	20	$40,000	9 – 12 months

7 Recommended Solution

The partially confined sand fill concept optimally meets the stated criteria of providing bank stability, has lower initial construction cost, requires least maintenance, has minimal impact on deposition in navigation channels, and has highest likelihood of being permitted, compared to the other alternatives presented here. The partially confined sand fill is recommended as the concept design with which to proceed to preliminary engineering. In the preliminary engineering phase, with more detailed information gained about the site, refinements can be made to the fill size, downstream groin location, length, and height. More investigation of hydraulics is recommended to specify the existing transport path and how structural modifications would alter the transport of the placed sand.

8 Action Plan

Three options exist for proceeding with implementing the selected erosion control solution. Two include various levels of participation with the Corps of Engineers and one option is for the Erosion Control District to direct the project. The advantages and disadvantages are discussed below.

8.1 Option 1: Corps of Engineers Section 111 Authority

The Portland District Corps of Engineers has begun the process of a Section 111 project to respond to the erosion problem at the two sites. The authority is contained in Section 111 of the River and Harbor Act of 1968 (Public Law 90-483). Portland District is nearing completion of the Initial Appraisal phase, which will determine if economic benefits of the project appear to justify an engineering solution. If so, a more detailed analysis would be undertaken. The solution that is the basis of the Initial Appraisal is a rock revetment to protect the eroding upper bank area at Pancake Point, and a rock revetment for the full depth of the eroding bank at Welcome Slough. At the Initial Appraisal stage the ability to obtain environmental permits for the solution is not investigated. The pace of completing the project is determined by the timetable for the steps specified by the Continuing Authorities Program. The expected steps in the process and durations are:

Phase	Estimated Duration
Initial Appraisal	6 months
Cost Share Agreement with Local Sponsor	3 – 6 months
Detailed Project Study (includes environmental studies and permitting)	1 – 2 years
Obtain funding for Plans and Specifications	3 – 6 months
Final Design	1 – 3 months
Advertise, review bids, notice to proceed	2 – 4 months
Construct	1 month.

Because the navigation project in this reach is 100% federally funded, there would be no cost-sharing by the Erosional Control District for work accomplished under Section 111 authority.

8.2 Option 2: Corps of Engineers Operations and Maintenance Authority

The Portland District Corps of Engineers has authority to dredge sediment from the navigation channel and dispose it in a least-cost, environmentally acceptable manner. The Pancake Point erosion site is a designated disposal site but to place material there, even according to the recommended design, is expected to require clearances from regulatory agencies because of the importance of the bank habitat to species listed as threatened or endangered and the length of time since the last disposal there. The erosion site near Welcome Slough is not a designated disposal site and would require the full set of permitting documents that are usual for placing in-water fill. The Corps of Engineers is expected to analyze the potential for sand placed near the bank to result in increased maintenance of the navigation channel. The cost difference between the least-cost method of dredging and dredged material disposal, and the dredging and disposal for constructing the erosion control project at the two sites would be calculated. The Erosion Control District would agree to reimburse the Corps of Engineers the amount of that cost differential. The expected phases and durations are:

Phase	Estimated Duration
Analysis by Corps of Engineers of dredging and disposal	2 – 4 months
Cost Share Agreement with Local Sponsor	3 – 6 months
Environmental studies and permitting	9 – 12 months
Final Design	1 – 3 months
Advertise, review bids, notice to proceed	2 – 4 months
Construct	1 month

8.3 Option 3—Puget Island Erosion Control District Management of Project

The Puget Island Erosion Control District or Wahkiakum County can manage the process and implement the solution with assistance from specialists. This option would require funding by the Erosion Control District or funding provided to it by outside sources (for example, grants). Consultants would likely be contracted by Wahkiakum County to accomplish the specialized engineering and permitting tasks. Once funding is obtained the expected phases and durations are:

Phase	Estimated Duration
Preliminary engineering	2 – 3 months
Environmental studies and permitting	9– 12 months
Final Design	1 month
Advertise, review bids, notice to proceed	1 month
Construct	1 month

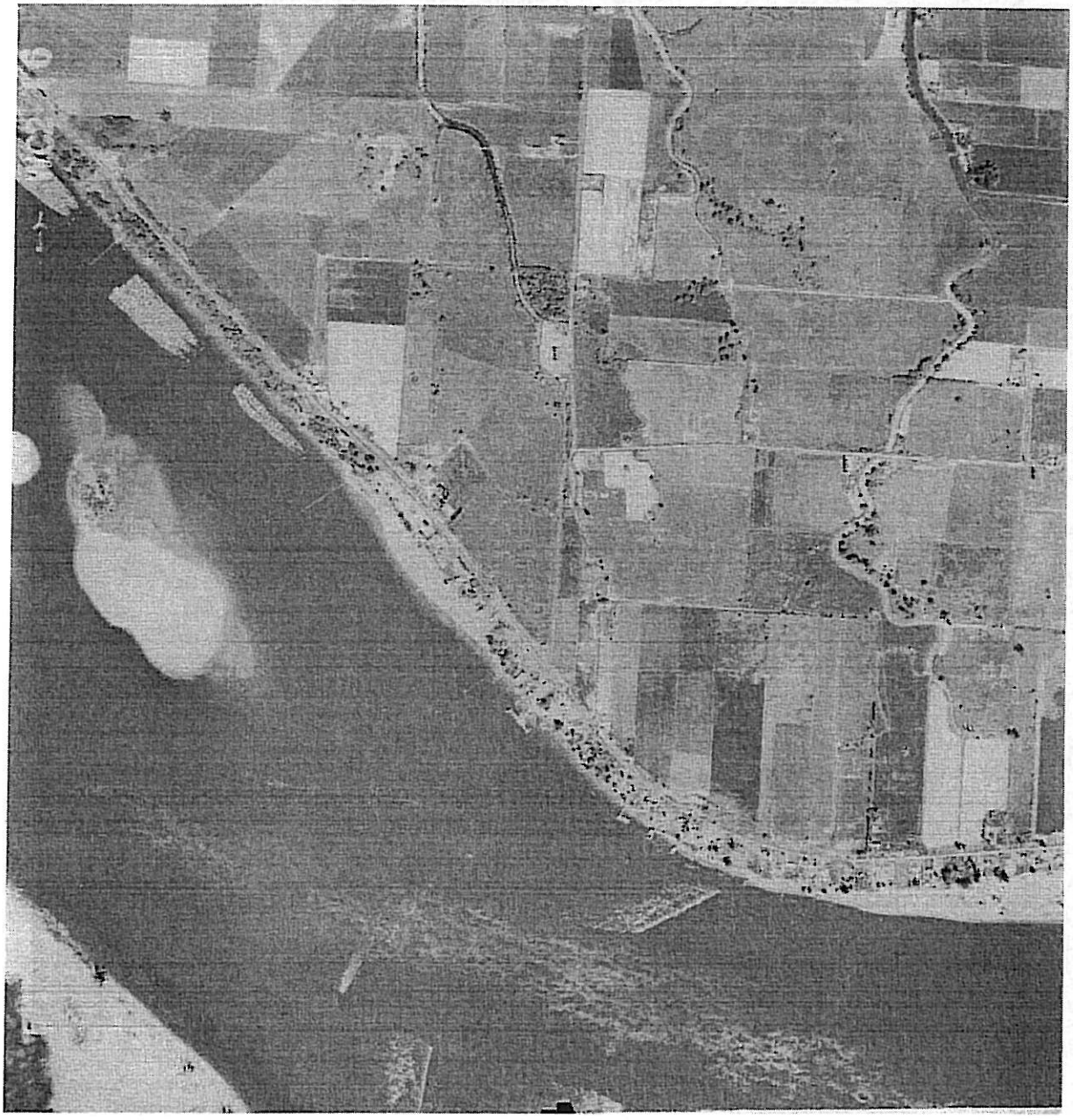
9 References

USACE 1986. Investigation of Bank Erosion at Sauvie Island, OR. US Army Corps of Engineers, Portland District Planning Division Technical Report, September1986.

USACE 1987. Value Engineering Study Report Columbia River Pile Dike Maintenance Phase 1. US Army Corps of Engineers, Portland District, November 1987.

APPENDIX A

Aerial Photographs
Showing Pile Dikes 40.51 and 43.55

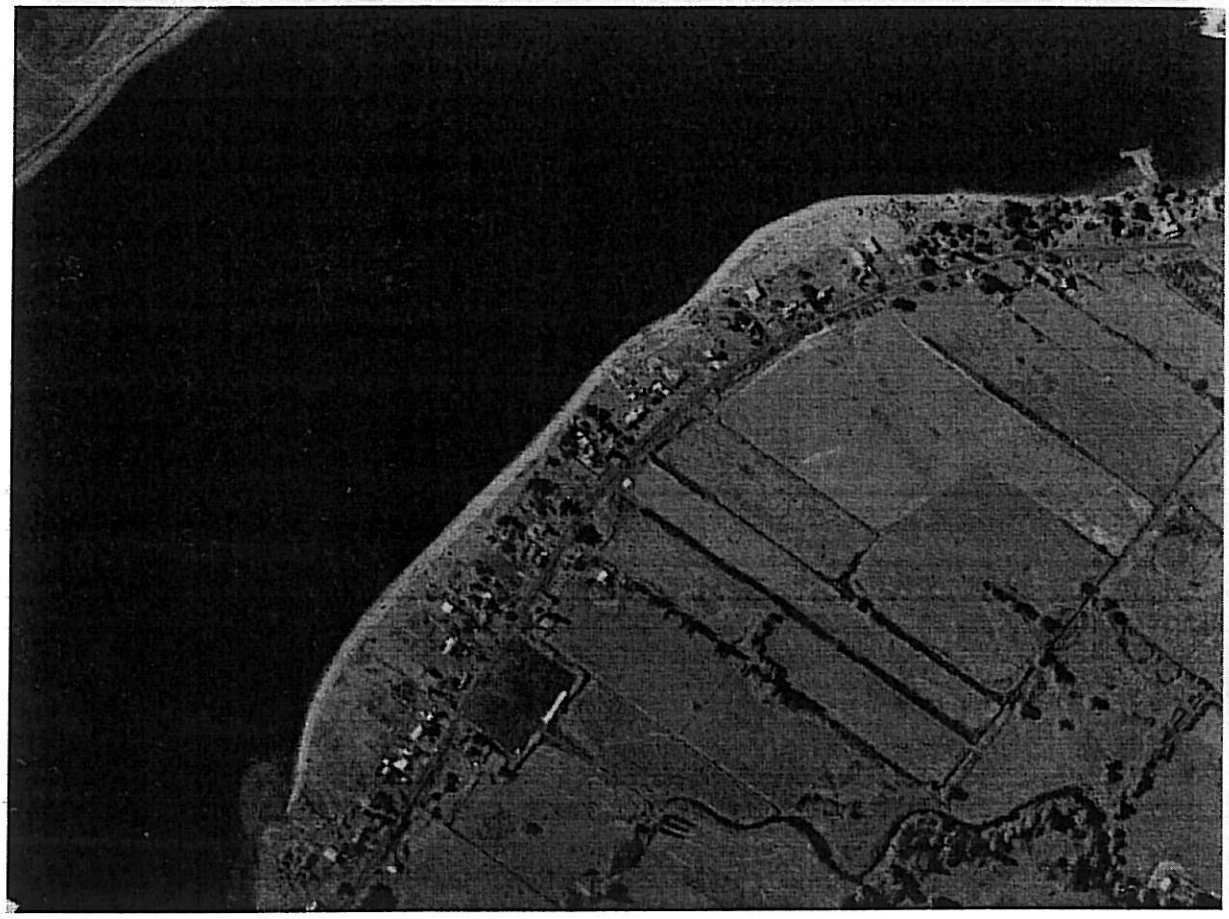


Pancake Point 1969

Pancake Point 1973

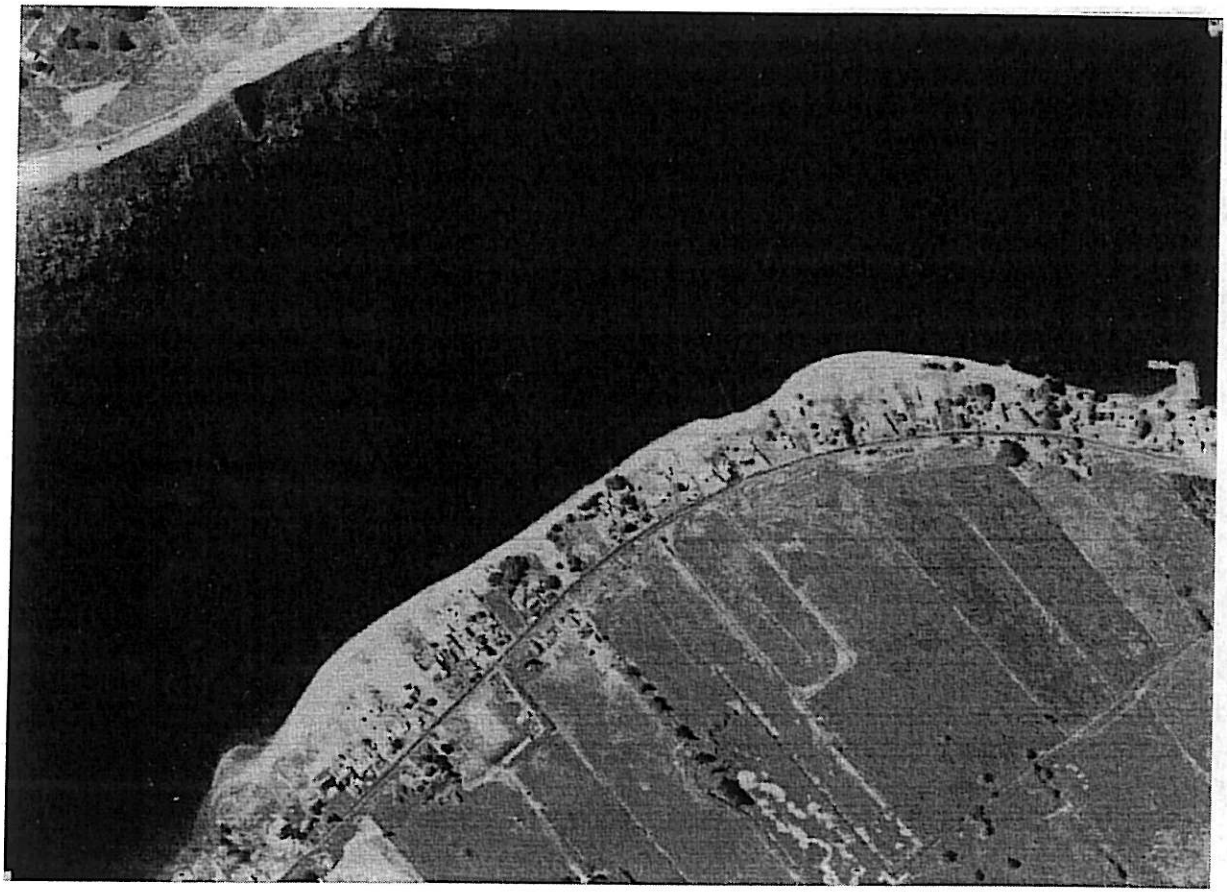
Pancake Point 1974

Pancake Point 1979



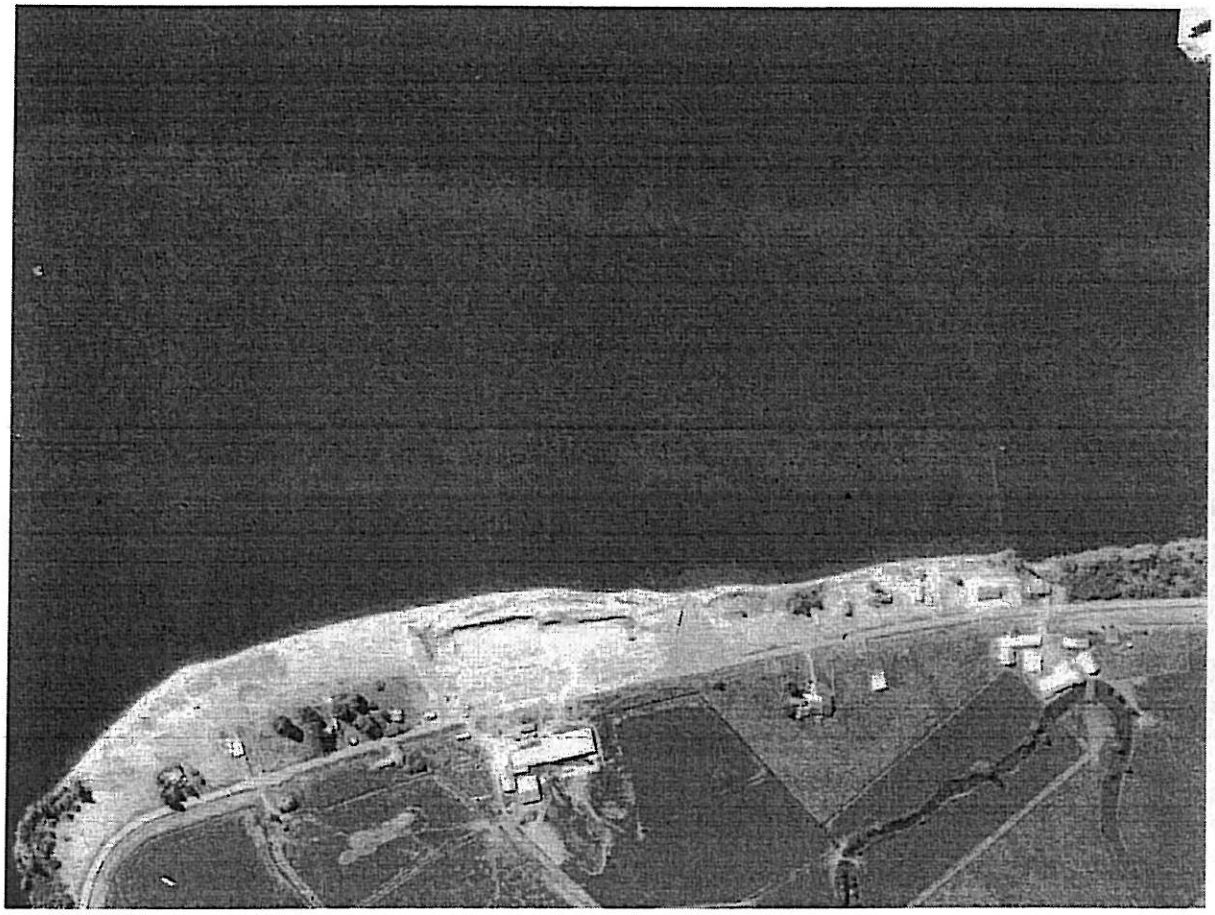
Pancake Point 1989

Pancake Point 1995

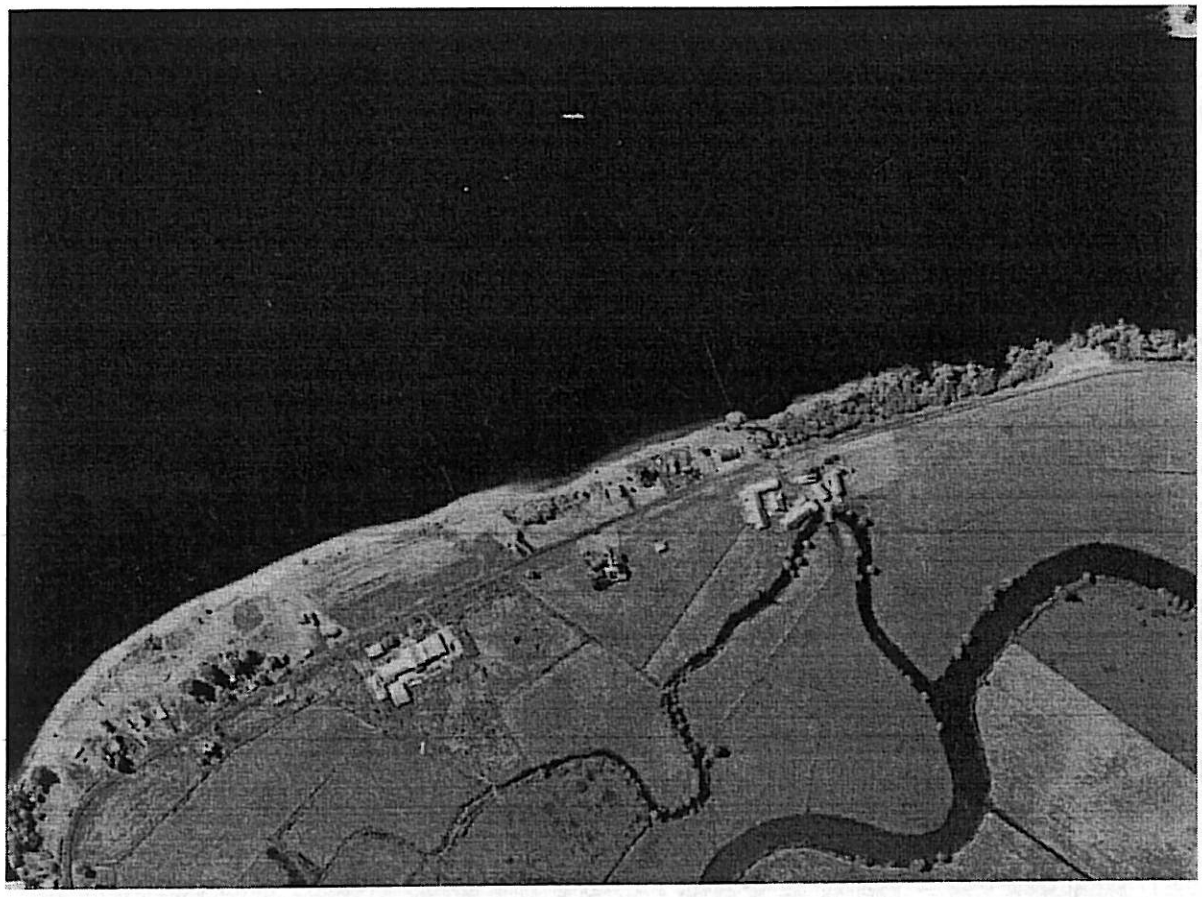


Pancake Point 2001

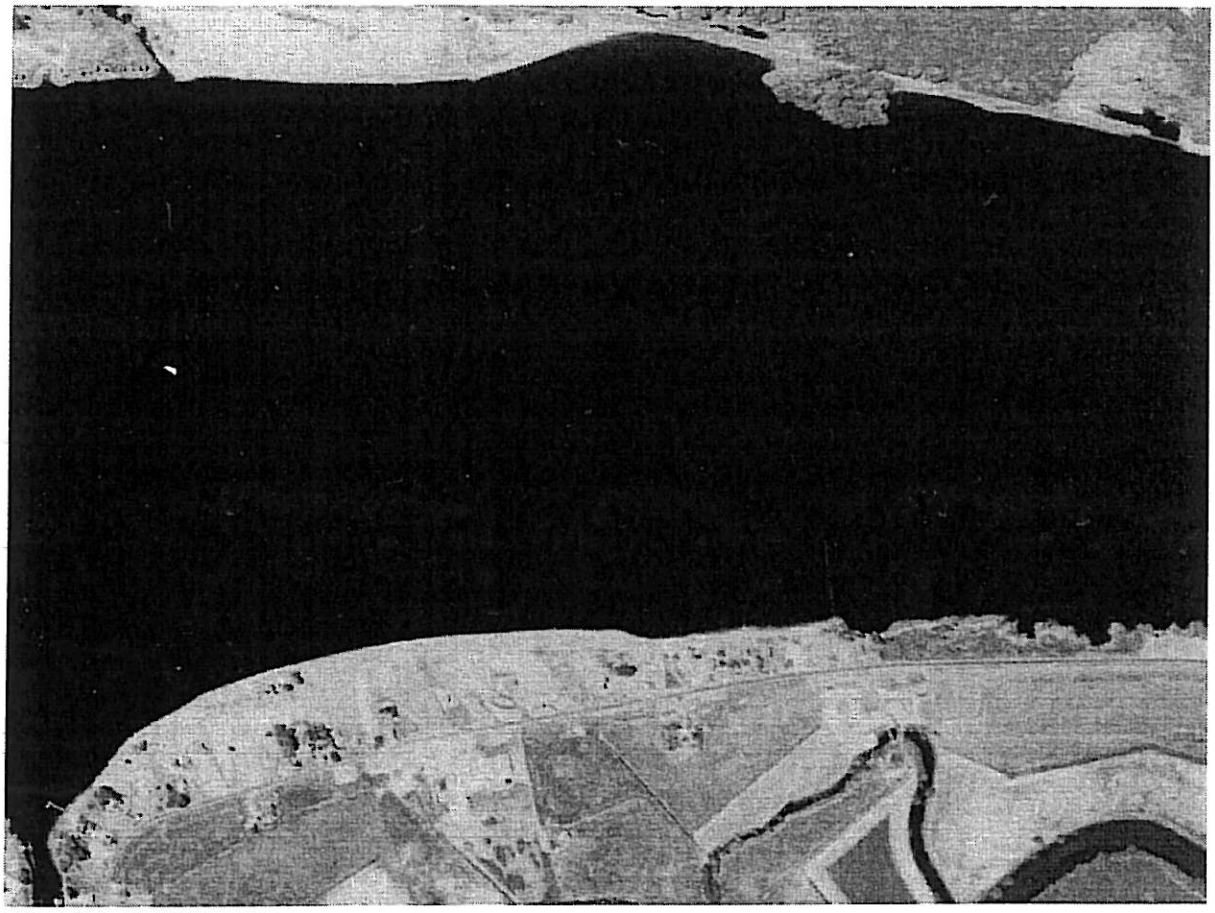
Welcome Slough 1974



Welcome Slough 1979



Welcome Slough 1989



Welcome Slough 2001

APPENDIX B

Permitting Information for Alternative Solutions

Permitting Information for Alternative Solutions to Bank Erosion at Puget Island

Introduction:

Following is permitting information gathered through September 12, 2003 and is an edited version of a report by Carl Kassebaum under subcontract with Coast & Harbor Engineering. Information is based on experience, from discussion with consultants with Columbia River experience, and the following telephone interviews:

- Washington Department of Fish and Wildlife (WDFW)
- Environmental Resources, Corps of Engineers
- Waterways Maintenance, Corps of Engineers
- NOAA Fisheries

Findings:

The agencies have issued very few permits recently for fill projects in the Columbia River. Everyone blames the Endangered Species Act (ESA) fish listings as the cause for the limited number of permits. The agencies, particularly NOAA Fisheries and U.S. Fish and Wildlife Service (USFWS), have been very conservative and protective of listed species.

The following permits and regulatory processes, as a minimum, will be required:

- Corps of Engineers Section 10/404 Permit, including ESA Section 7 Consultation concurrence from the NOAA Fisheries and USFWS
- Washington Department of Ecology (WDOE) 401 Water Quality Certification
- Washington Department of Fish and Wildlife (WDFW) Hydraulic Project Approval (HPA)
- Wahkiakum County Shoreline Substantial Development Permit
- SEPA Finding of No Significant Impact (FONSI)

The most difficult and inclusive of these permits is the Corps Section 10/404 permit. This permit requires:

- Demonstration of the project need and justification
- Project purpose statement including its justification
- Alternative analysis, including the determination of the practicable alternative with the least adverse environmental impact yet still satisfies the project purpose. (Note: A practicable alternative means "available and capable of being done after taking into

consideration cost, existing technology, and logistics in light of overall project purposes." The 404(b)(1) regulations allow for screening of non-practicable alternatives from detailed evaluation.)

- Select the least impacting practicable alternative.
- Undertake detailed environmental impact analyses
- Identify needed compensatory mitigation to offset adverse environmental impacts

A first review supports the probable straightforward analyses of the project purpose and need evaluations.

Regarding alternatives, we initially identified three basic alternatives for evaluation:

1. Rock riprap protection
2. Unconfined sand fill
3. Confined submerged bench

Interviews indicated that there was concern that the erosion is occurring for properties that are on the outside perimeter of the flood control dike around the island. The resource agency viewpoint, based on this, is to look for non-fill alternatives first, including:

1. Move the affected homeowners and allow erosion to continue
2. Protect shorelines via bioengineering and vegetation
3. Evaluate/modify existing flow control actions such as the pile dikes to modify flow/erosion regimes. Strong caution about just changing the location of erosion impact accompanied this recommendation.
4. I also heard from one source that they would like to see all the properties addressed comprehensively rather than piecemeal to define eventual solutions.

Rock Riprap Fill Concerns:

The agencies universally consider the rock riprap fill alternative to be the least favorable alternative. Compensatory mitigation would be required for this alternative.

Unconfined Sand Fill Concerns:

- The probable need to undertake separate permitting analysis for every separate maintenance cycle following first material placement
- Probable need for off-site mitigation for the original as well as the subsequent maintenance cycles
- The Corps indicated that there is a lack of good nearby source of sand in the navigation channel for regular scheduled placement. (Note: The navigation channel sedimentation pattern, at and near the Pancake Point area, is characterized by spotty sand wave or

intermittent shoaling. Consequently, the Corps uses a hopper dredge rather than hydraulic dredge in this area. The hopper dredge has a bottom dump design and cannot deliver the dredged sediments to the shoreline. Because of the spotty deposition, the frequency of dredging is inconsistent and volume of material is relatively small.)

- Adverse impacts associated with unconfined disposal and perceived associated impacts on the fishery

Confined Submerged Bench Concerns:

- The agencies were interested but generally did not have a good understanding of the basic concepts of the alternative. We need to present pictures and descriptions of what is proposed.
- The agencies are concerned over the loss of habitat associated with the fill. Analysis and comparison of existing and post project habitat characteristics will be required.
- Several agencies expressed concern that compensatory mitigation would be required for fill impacts. However, the agencies appear to be open to discussions allowing for the project itself to be its own mitigation by building the mitigation on top of the bench.

Following are some highlights of individual conversations:

WDFW

Highlighted the need to complete the following analyses prior to completing analyses of the above potential alternatives:

- Identify what the ability is to move the homeowner (i.e., purchase the property, move the homeowner, and allow the erosion to continue.) I suspect that this is not possible. However, we need to provide the rationale and reasons why this is not possible as part of the permit submittals.
- Bioengineering. This usually means placing logs and root balls in key locations to dampen the river energy; thereby, protecting the property. Often a sub goal of bioengineering is to create vegetated areas adjacent the shore. These systems are usually functional and workable in relatively shallow water environments. I suspect that these may not be technically feasible where there is deep-water erosion occurring.

The following is a brief summary of WDFW observations:

- PREFERRED HABITAT FOR SALMON - The juvenile salmonids preferred habitat is adjacent to shore with shallows sloping to deeper water. The juveniles use this area to escape predators (i.e., bigger fish predators and birds by staying in natural turbidity adjacent to shore). Adults also tend to use shallower water (i.e., upper five or so feet) to avoid their predators (i.e., seals and sea lions that are thick in the area during winter and spring). The adults maneuver to try to keep these predators above them rather than below. Generally, the most dangerous areas for both juveniles and adults are water areas adjacent to very steep or vertical slopes.

- STURGEON – Sturgeon tend to use deeper holes where there is minimal energy depositional areas. These areas tend to be stabile and have mussels and other organisms growing on the bottom. Sturgeons tend to feed at night in shallow flat areas. High-energy (erosion holes) areas usually are not good sturgeon habitat.
- ROCK RIPRAP – This is the least desired alternative. It adversely affects fish habitat and mitigation to offset adverse impacts is usually required.
- UNCONFINED SAND FILL – Fish stranding will generally not occur on sand fill slopes at or steeper than 7:1. Slopes flatter than 10:1 are a big concern for fish stranding. A big problem with unconfined sand fill is that the sand needs replacing on a regular basis and this usually entails a separate permitting effort for each subsequent maintenance event. Project specifics would determine the need for additional mitigation including potential mitigation for each subsequent maintenance event.
- CONFINED SUBMERGED BENCH – A big concern is with the potential to change or alter the energy environment causing problems elsewhere downstream. However, if modeling and design analyses can resolve these concerns, then this holds very interesting possibilities to create good habitat. Some of these habitats may include salt marsh, shallow water habitat, place large woody debris on the fill surface, etc. In addition, the design will likely self mitigate and eliminate the need for additional separate mitigation.

Environmental Resources, Corps of Engineers

Studies have been undertaken on the river regarding fish stranding. Following are some key points:

- The Corps does not have any approved disposal sites on Puget Island.
- The 5-year review and plan for the Corps navigation program is ongoing. They are now defining proposed disposal sites that will go through Section 7 Consultation with the Services (NOAA Fisheries and USFWS). If a Puget Island disposal site is identified, then it could become part of this program for the ESA Section 7 Biological Assessment review by the Services.

Area Habitat Biologist, WDFW

Following are some key points made by a habitat biologist responsible for this region of the Columbia River:

- Bioengineering is his first choice.
- He is generally opposed to land reclaiming (i.e., placement of fill material to create new lands lost via erosion)
- If fill alternatives are permitted, demonstration that bioengineering would not work is required.
- Rock riprap is least desirable.

- His understanding is that NOAA Fisheries designate shallow water in the Columbia River 20 feet or less depth of water.
- The confined submerged bench alternative intrigues him; however, he needs additional information to understand it. He especially needs to see information on how this design would be self-mitigating.
- Martin would like to see all properties addressed comprehensively, rather than piecemeal. His concern is that by fixing the first problem, there could be unintended impacts on other properties downstream unless addressed comprehensively.

Waterways Maintenance, Corps of Engineers

Corps Maintenance dredging on the Columbia River made the following points:

- No beach nourishment is currently ongoing on the river
- Shallow water depth is considered to be 20 feet or less
- Essentially most of the sandy beaches along the river were result of historical dredged material disposal.
- Material rehandling is a big concern. Corps does not want to place material simply to have it eroded downstream in the channel; thereby, requiring subsequent redredging.
- The Corps only does limited dredging near Puget Island. Dredging at or near Pancake Point is by hopper dredge because of spotty sand wave or intermittent shoaling patterns, and relatively low volume of material. Use of the dredge Oregon (hydraulic 30" pipeline dredge) and needed to place material on the shore, is not generally used in this area. Reliance on sand material supplied by the Corps in this region would be questionable.
- Last shoreline placement of material on Puget Island by the Corps of Engineers dredging operation from the Pancake Point area occurred in either 1983 or 1987.
- The Corps undertakes significant dredging at point W-38.7. The last placement of this material on shore took place in 1997. Apparently, there was significant erosion and re-deposition back into the channel that then needed additional dredging.

Regulatory Branch Corps of Engineers

The Corps is responsible for Section 10/404 permit review at this area of the Columbia River. Following are some key points.

- The Washington Department of Natural Resources (WDNR) owns many of the eroding shorelines. A lease from WDNR is required to place fill material.
- He suggested we investigate the Corps of Engineers Section 206 and 1135 processes for potential funding and study support.

- He suggested we investigate getting support from commercial shipping interests, including Ports, for "good-will" funding and study support associated from wake erosion impact from barge and ship traffic.
- He sees opportunity to develop a combination of solutions for differing properties and locations that could be coordinated to result in a net overall habitat enhancement for the listed fish species.
- Fill here would probably require individual Corps permit rather than Nationwide Permit 13, because of its size and impacts. However, there is substantial flexibility on NWP #13, except for the Section 7 ESA consultation processes.
- Formal ESA consultation is probable.
- Emergency procedures are difficult, but not impossible, to trigger. The NW Division Commander makes the decision personally. Dave sent me the emergency procedure guidelines and I have transmitted them to Dave Simpson.
- The Services and WDFW often allow a mid to late summer construction window when the work can be done largely in the dry when river levels are down. Normal work windows are November 1 through February 28 to avoid juvenile conflicts.

Fish friendly structures that create habitat and stabilize the bank from additional erosion are encouraged.

NOAA Fisheries

NOAA Fisheries team leader responsible for the Puget Island area of the Columbia River in Lacey, Washington. Concerns include:

- The erosion is occurring for properties outside of the flood control dike around the island.
- Bioengineering options are attractive.
- Rock riprap fill is the least attractive.
- He would need to see the design and impact analyses of the confined submerged bench alternative. His first perceptions are that it would have a negative impact on habitat but would have to see actual site conditions.
- If fill is proposed, formal Section 7 ESA consultation will likely be required.
- He encourages detailed analyses looking at costs, biological impacts, engineering, etc to identify solutions.