Regional Sediment Management at the Mouth of the Columbia River, Oregon and Washington

FINAL REPORT

Independent Technical Review of the Proposal for a Washington Littoral Drift Restoration (Benson Beach) Regional Sediment Management Demonstration

By

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For

U.S. Army Engineer District, Portland

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1 Purpose and Scope

The purpose of this report is to present the results of an Independent Technical Review (ITR) of the Washington Littoral Drift Restoration (Benson Beach) Demonstration alternatives. This work included a rigorous evaluation of technical documents prepared by the U.S. Army Corps of Engineers (USACE), Portland District and those prepared by Pacific International Engineering (PIE), on behalf of the Southwest Washington Coastal Communities (SWCC). The scope and purpose of the ITR has been to identify, explain, and comment upon assumptions that underlie economic, engineering, and environmental analyses, as well as to evaluate the soundness of models and planning methods. This ITR was conducted by Moffatt & Nichol (M&N) during May and June 2006.

1.1 Background

The mouth of the Columbia River (MCR) is the terminus for one of the largest rivers on the West Coast of North America. The MCR is a regionally critical coastal inlet supporting international trade and commerce, the ocean gateway to and from the Columbia – Snake River navigation system, within the ecologically sensitive Pacific Northwest. The federal deep-draft entrance channel at the MCR extends from River Mile (RM) -3 to RM 3 on the Columbia River. The MCR channel is 2,640 feet wide and the northerly 2,000 feet is authorized to a depth of –55 feet mean lower low water (MLLW), with the southern 640 feet authorized to - 48 feet MLLW. Maintenance dredging at the MCR is performed by hopper dredges operating during the relatively calmer months of summer, and the channel is dredged up to 5 feet deeper than the authorized depth to provide project depths for a longer period between dredging operations (fall–spring). Due to the large volume of dredging and short operating season, two hopper dredges are needed to maintain the MCR (one government-owned and one private industry dredge). The contract dredge is hired by competitive bid.

An average of 4-5 million cubic yards (mcy) of sand is dredged annually at MCR. The hopper dredges place the sand in ocean dredged material disposal sites (ODMDS) and a Section 404 site adjacent to the North Jetty. The Shallow Water Site (SWS) and the North Jetty (404) sites are used to the maximum extent possible, in order to: (1) keep sediment in the littoral system; and (2) help to protect the North Jetty from potential undermining. However, use of the SWS and the North Jetty site is limited to avoid the possibility of adverse wave amplification and the associated impacts to navigation safety. Dredged material not placed at either the SWS or the North Jetty site is placed at the Deep Water Site (DWS), located 6 miles offshore, beyond the active littoral zone.

1.1.1 Littoral Drift Placement of Dredged Material

During 1885-1917, MCR jetty construction facilitated the discharge of 300-500 mcy of sediment from the estuary to the ocean/nearshore regions north and south of MCR. Before construction of the North Jetty, the subareal sand spit on which Fort Canby State Park (now known as Cape Disappointment) is founded did not exist. However, immediately following completion of the MCR North Jetty in 1917, the sand spit accreted rapidly. Since 1917, this surplus of sand has been dispersed by waves and currents onshore, offshore, and to points north and south. At the present time, the surplus of sand is beginning to run its course and is turning to deficit.

Benson Beach lies along the 7,500 foot long ocean shore of Cape Disappointment State Park immediately north of MCR in Pacific County, Washington. Benson Beach (and most of Cape Disappointment State Park) is in part protected and wholly retained by the MCR North Jetty. The sand spit on which Benson Beach is founded has been eroding since 1940, with the rate of erosion accelerating in the past decade. In recent years, state and local interests have requested that the USACE place sand dredged from the MCR Federal navigation channel directly onto Benson Beach to offset beach erosion and supply sand to the littoral system of the Long Beach peninsula.

1.1.2 Dredge Pump-Ashore to Benson Beach

As requested by the U.S. Congress, the USACE, Portland District has undertaken efforts to examine options for placing dredged material on Benson Beach. To evaluate the impacts of this activity, the USACE conducted an on-site pilot study during July 2002, whereby a limited quantity of dredged material (sand) was to be placed on Benson Beach using a hopper dredge. Pacific County obtained the permit and environmental clearances that were used for the placement activity. Monitoring activities were undertaken to assess operational, environmental, and economic effects of dredged material placement.

The USACE had originally estimated that placing even a minimal volume (25,000 cubic yards) of dredged material on Benson Beach would require $200,000 to $1 million. Due to the small scale of the Benson Beach pilot study and limited funding, the placement of dredged material on Benson Beach had to be undertaken within the framework of normal MCR maintenance dredging operations. For the 2002 pilot study, the contract for MCR dredging was structured to include an optional bid item for placing dredged material on Benson Beach. Three bids were received. The overall low bid (awarded) had the Benson Beach option for 25,000 cy placement costing $673,000.

Strong local support for the Benson Beach pilot study resulted in a $575,000 contribution to the congressional appropriation (of $200,000), which made the pilot study possible. Local funding originated from Lower Columbia River Ports, Pacific County/ Washington State Coastal Communities, and Washington State. During 16-19 July 2002, 43,727 cubic yards (equivalent to 4,400 dump truck loads or 1% of the annual maintenance dredging at MCR) of sand was placed on Benson Beach, by a contract hopper dredge, at a cost of $775,000.

Based on present economics and unit costs observed during the July 2002 hopper dredge “pump-ashore” activity, the USACE was unable to recommend the use of Benson Beach as an alternative for primary open water dredged material disposal at MCR. However, opportunities of decreasing cost should be explored to determine if other methods to place dredged material on Benson Beach could be more economical. For example, conducting a larger-scale hopper dredge “pump-ashore” activity (200,000 – 400,000 cy) at Benson Beach (and performing subsequent monitoring) would provide additional data to better evaluate the fate of dredged material placed on the beach, the yearly carrying capacity of the beach, related environmental impacts, and the costs associated with this type of disposal activity. Unit costs of such an activity could be significantly less than those realized during the July 2002 operation due to the increased economy of scale and achieved "learning curve." Regardless of the disposal method used, the above information would be very useful, and perhaps necessary, for planning and evaluating a large-scale (500,000 cy to 1 mcy) dredged material disposal operation at Benson Beach.

The USACE also concluded that other disposal alternatives should be evaluated that benefit the littoral sediment budget, but that do not carry a high mobilization/demobilization (mob/demob) or recurring cost. Such considerations must recognize that 1) hopper dredges cannot be replaced at MCR as they are the only means in which to perform the Operations and Maintenance (O&M) mission in an open coast inlet on the Pacific Northwest; 2) the cost of mobilizing a third hopper dredge if required to complete the yearly MCR dredging can range from $600,000 to $1,500,000 depending upon the location of the contract dredge; and 3) the ultimate capacity of Benson Beach to accept dredged material (as a disposal site) is limited to about 700,000 cy per year and 12 million cy total (additional dredged material placement would either accumulate to excessive elevations, or the material would cause the beach to extend offshore where sand would be easily transported around the North Jetty and back into the MCR channel).

1.1.3 Sump Excavation, Filling and Re-Handling to Benson Beach

Another alternative that is being investigated, and strongly supported by the Southwest Washington Coastal Communities (SWCC), is a demonstration project using a "sump re-handling" approach to pump sand over the north jetty at the MCR in association with the annual dredging program. The demonstration project proposed for implementation is intended to provide information on sump re-handling operations to assess the feasibility of placing much larger volumes of sand into the littoral system at Benson Beach. The demonstration project would involve removal of approximately 500,000 cy of sand from the sump and placing the material in the inter-tidal zone at Benson Beach. The actual volume of material to be re-handled will depend on available funds and the construction bids received. The following paragraphs describe the sump re-handling concept as proposed.

A sump zone has been defined by considering navigation and operations, aquatic species and habitats, and sump and jetty stability. The identified sump zone and a potential sump location are shown in Figure 1. The potential sump footprint measures 3,000 feet by 600 feet; the depth of the sump will be limited by the choice of dredging equipment and the desired volume of material from a given footprint, and is expected to be less than -75 feet MLLW. It is anticipated that the sump will have side slopes of approximately 5:1 (horiz:ver) As depicted, the sump could accommodate up to 1 million cubic yards of dredged material. Obtaining environmental clearances for a zone larger than the actual sump will allow the dredging operators flexibility in approach, promoting efficiency and reducing costs. One restriction that will be placed on the sump construction within the zone is that it must form a contiguous area (i.e., the sump cannot be composed of several separate excavations).

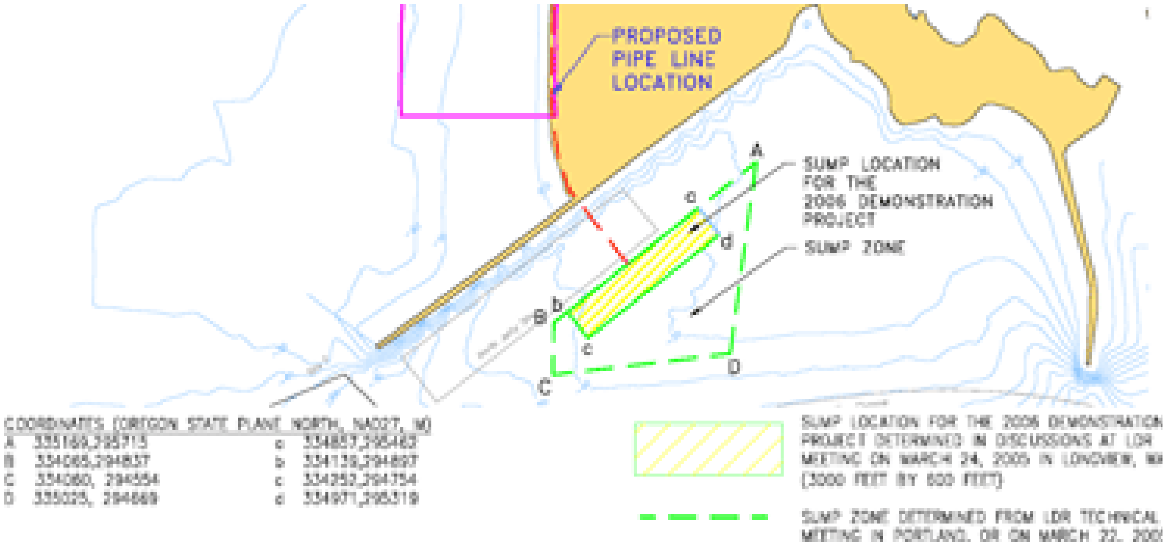

Figure 1 – Sump Zone and Potential Sump Location

A pipeline dredge would be deployed to dredge sand from the sump area and the dredged material would be pumped through a 16- to 30- inch diameter pipeline over the top of the North Jetty onto Benson Beach. The area for placement of sand on Benson Beach extends from approximately 1,500 feet north of the North Jetty to a point approximately 4,500 feet north of the jetty. It is likely that the material would be placed in "strips" measuring approximately 150 feet by 2,000 feet. The strips will be placed by beginning at the southern end and moving to the north by incrementally extending the pipeline. The process would then be repeated until all the material is placed. The preferred pipeline route extends along the edge of the upper beach scarp, or the seaward edge of the vegetation in areas where there is no scarp, to the point of deposition. The pipeline will likely be buried in at least some locations to mitigate safety risks to beach users. Some re-working of the placed material with earth-moving equipment will be required. The constructed profile will be relatively flat with a front slope on the order of 20:1 (horiz:vert) from approximately +14 to -10 feet MLLW. Conceptual illustrations of the sand placement are shown in Figure 2 and Figure 3.

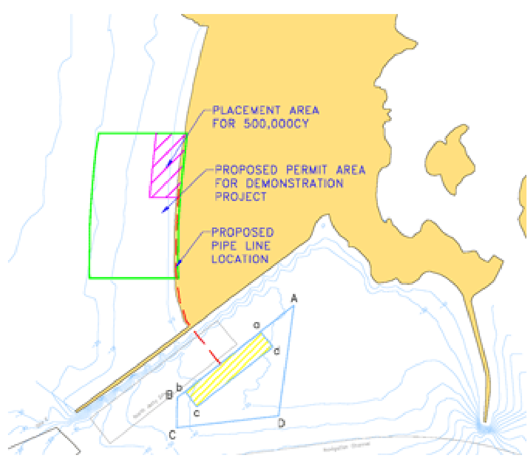

Figure 2 – Plan View of Benson Beach Placement Area

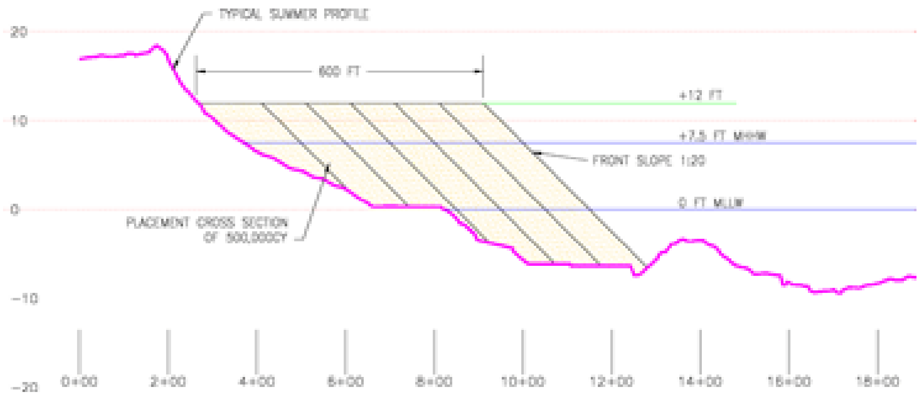

Figure 3 – Typical Section of Benson Beach Placement Area

Refilling of the sump would be achieved by bottom dumping from hopper dredges. This refilling will be performed either concurrently with or following the excavation of the sump. The dredging contract would specify that the sump must be refilled prior to the end of the dredging season.

The project would be conducted concurrently with Portland District dredging and disposal operations at the MCR, which typically occur between June and September. The timeframe for excavating the sump and placing the material would likely range from the environmental work window for the Benson Beach area and sump location of July 15 to September 15 (salmonids and crab migration), depending on the equipment used and weather and wave conditions encountered during operations. During periods of bad weather, the pipeline dredge may need to be withdrawn from the sump area to the more sheltered area in the northeast corner south of the North Jetty or to a location east of Jetty A. It is likely that the pipeline dredge would be anchored to the seabed in the sump area using an anchoring system (commonly referred to as a Christmas tree). The most common method for positioning and holding a pipeline dredge on station is a spud system which is judged to be impractical under ocean exposure conditions.

Baseline data has been collected on site to allow project performance to be assessed. An ARGUS camera system has been installed in the North Head Lighthouse by Northwest Research Associates under contract with USACE to collect baseline data in the area north of the North Jetty. Measurements of waves, currents, and suspended sediments were obtained in the proposed sump and placement areas by Pacific International Engineering (PIE) over a number of years and by the USACE under contract in 2005 using an array of instruments across the MCR Channel, with two positions in the area south of the North Jetty. Measurement locations were chosen to characterize physical processes in the sump area and on Benson Beach. The measurements were intended to determine hydrodynamic conditions forcing movement of sediment in these areas and allow validation of models for dispersal of sediment from the placement area and potential for sediment movement in the sump area. Numerical sediment transport models have also been applied to evaluate the short-term and long-term dispersal patterns and fate of sediment placed on Benson Beach.

1.2 Independent Technical Review Plan

The ITR is intended to identify, explain, and comment upon assumptions that underlie economic, engineering, and environmental analyses, as well as to evaluate the soundness of models and planning methods. The remainder of this section lists the documents that were reviewed, the charge to the reviewers and the specific tasks to be undertaken by the reviewers.

1.3 List of Reviewed Documents

Moffatt & Nichol has reviewed the following documents, among others, provided by the Portland District, U.S. Army Corps of Engineers and/or Pacific International Engineering:

Reference 1. *Evaluation of Alternative Dredged Material Disposal Methods for Maintenance Dredging at the Mouth of the Columbia River, OR and WA,* A Progress Report to Congress – Appropriations Committee, prepared by Portland District, U.S. Army Corps of Engineers, September 2002.

Reference 2. *Maintenance Dredging at the Mouth of the Columbia River, OR and WA - A Proposal for the Phase II – Evaluation of Alternative Dredged Material Disposal Methods for Placement of Dredged Material on Benson Beach*, prepared by Portland District, U.S. Army Corps of Engineers, September 2004.

Reference 3. *Dredging Operations and Sand Placement Alternatives, Southwest Washington Littoral Drift Restoration Project, Mouth of the Columbia River, North Jetty*, prepared by Pacific International Engineering, May 2005.

Reference 4. *Littoral Drift Re-Handling Sump: Evaluation of Geotechnical and Structural Effects on the North Jetty- Version 2.0*, prepared by Pacific International Engineering, May 2006.

Reference 5. *Vibracores at the Mouth of the Columbia River - Final Report*, prepared by Washington Department of Ecology, June 2005.

Reference 6. Particle Tracking Method Modeling Animations, Pacific International Engineering, 2006.

Reference 7. *Safety Analysis of Pipeline Operation at MCR*, prepared by Operations Division, Waterways Contracts Team Leader, Portland District, U.S. Army Corps of Engineers.

Reference 8. *Technical Memorandum*, prepared by Pacific International Engineering, June 2006

In addition to detailed review of technical documents, M&N observed the MCR site and conducted in-depth informational meetings with key staff from the USACE Portland District, Pacific International Engineering, and the South Washington Coastal Communities.

1.4 Charge to Reviewers

Moffatt & Nichol (M&N) was requested to evaluate and address the following questions in conducting their review of relevant documents including those identified above. M&N was to provide any improvements, publications or literature that supported response to the questions.

- Question 1: *Are the methods and procedures set forth in the documents adequate to demonstrate that there will not be adverse impacts to the North Jetty or the shoal area on which the North Jetty is built as a result of operating the sump?*
- Question 2: *Are the methods and procedures set forth in the documents adequate to demonstrate the operational feasibility of operating a direct pump-ashore operation from a hopper dredge and operating a pipeline dredge to construct a sump including the safe operation of a pipeline dredge in the sump location?*
- Question 3: *Are the methods and procedures set forth in the documents adequate to demonstrate that there will not be adverse impacts to the Benson Beach area as a result of the pipeline operation and that the purpose of the demonstration – to disperse material to the littoral drift met? Please provide any improvements, publications or literature that supports your response.*
- Question 4: *Waves from the northwest occur frequently during the summer and many storms affecting MCR result from waves approaching MCR from the northwest. Have the documents fully investigated wave-related effects upon sump operation and sump-related impacts for northwest waves?*
- Question 5: *According to the documents, it appears that the pump-ashore alternative is a more cost effective, both in terms of total cost and cost per cubic yard, than the sump/pipeline alternative if the scale of dredged material placement (on Benson Beach) is less than 500,000-700,000 cy/yr. Similarly, it appears that the sump alternative is a more cost effective in terms of cost/cubic yard than the pump-ashore alternative if the scale of dredged material placement (on Benson Beach) is to be greater than 700,000 cy/yr. The sump-pipeline alternative assumes that a finite area along Benson Beach can disperse more material than 500,000-700,000 cy/yr? Do the documents verify this dispersal rate? If the environmental window for placing dredged material on Benson Beach is constrained to begin no earlier than July 15 along the Benson Beach area (applies to both alternatives) and ends September 15 in the sump location, what would be the maximum yearly capacity for each alternative?*
- Question 6: *Do the documents contain adequate procedures and factors to decide whether to modify or stop use of the sump in the event that conditions during operation of the sump present a threat to public health or the environment?*
- Question 7: *Have metrics been defined for assessing project performance at the re-handling area (sump or pump-ashore hopper dredged), at the point of initial placement on Benson Beach, and dispersal after placement?*
- Question 8: *Have the documents described a monitoring plan that measures the response of the project and related impacts based on the above metrics?*

- Question 9: *Do the documents identify and characterize the uncertainties related to the methods and procedures used, and are the potential implications of such uncertainties clearly explained?*
- Question 10: *Have the documents described the short-term and long-term objectives of the Washington Littoral Drift Restoration Demonstration? Are these goals consistent with the constraints at MCR (the potential need to balance sediment management both north and south of MCR)?*
- Question 11: *Do the documents address the potential consequences of maximizing placement of MCR dredged material on Benson Beach, with respect to: Effects on the overall MCR sediment budget, capacity of Benson Beach to disperse placed material, capacity of Benson Beach to accumulate placed dredged material, and intended transport direction at location of placement?*
- Question 12: *Are the documents detailed enough to be consistently followed and understood by technical staff, dredge operators, and the public?*

1.5 Report Organization

Section 2 discusses the in-depth findings of the Independent Technical Review, organized according to the twelve questions posed in the preceding section. Section 3 provides the overall summary and conclusions of the ITR.

2 Findings of Independent Technical Review

This section summarizes the findings of the Independent Technical Review. For purposes of orientation and reference, Figures 4 and 5 illustrate features of the MCR Regional Sediment Management Demonstration, including placement sites and the North Jetty. The figures illustrate the shallow water site (SWS) and the North Jetty site (NJ) for MCR dredged material placement. Figure 5 also shows the deep water site (DWS.)

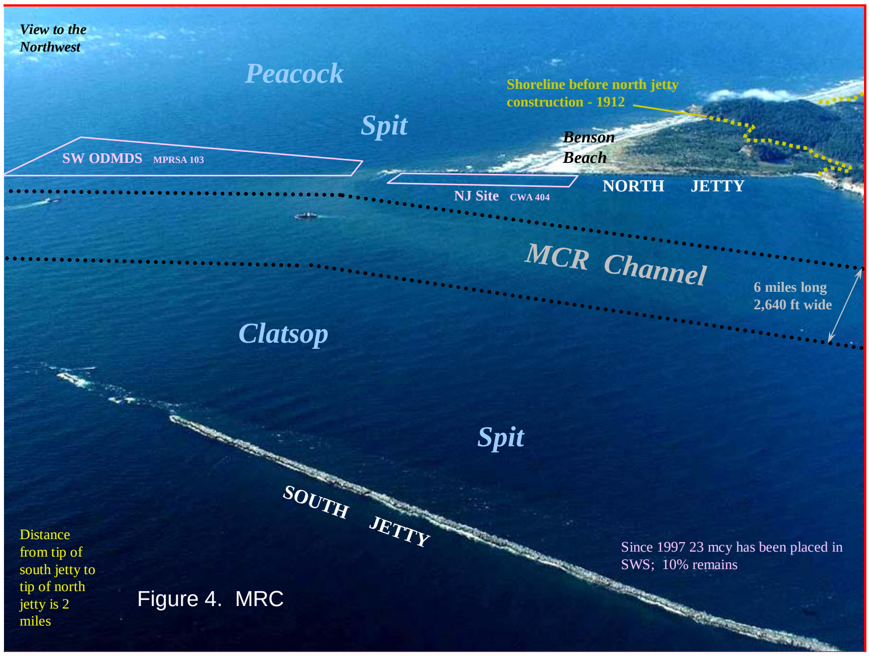

Figure 4 – MCR Overview

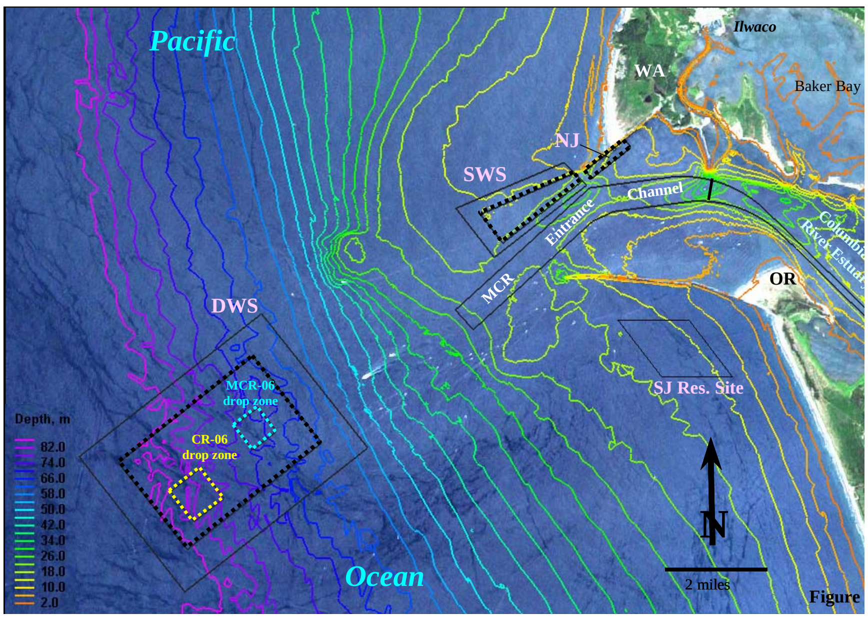

Figure 5 – MCR Dredged Material Placement Sites

2.1 Response to Question 1

Question 1: Are the methods and procedures set forth in the documents adequate to demonstrate that there will not be adverse impacts to the North Jetty or the shoal area on which the North Jetty is built as a result of operating the sump?

The sump alternative considers the excavation of a 3,000 foot by 600 foot pit located 1,500 feet south of the North Jetty from which as much as 500,000 cubic yards of sediment would be removed with a cutter suction pipeline-type dredge. We understand that the location of the pit was selected by Pacific International Engineering (PIE) and other parties after taking into account concerns raised by USACE regarding the potential for undermining the North Jetty and to allow adequate depth for the safe hopper dredge operation. The proposed sump would deepen the existing bottom elevations, which range from -34 to -44 feet Mean Tide Level (MTL), to -46 ft MTL. This means that the pit will be 2 to 12 feet deep relative to the existing surrounding depths.

Bathymetric surveys taken just south of the North Jetty over time unequivocally show that the area has been subject to erosion over time. Figure 6 summarizes results presented by Moritz et al (2003)[1] and shows that the area in the vicinity of the proposed sump eroded

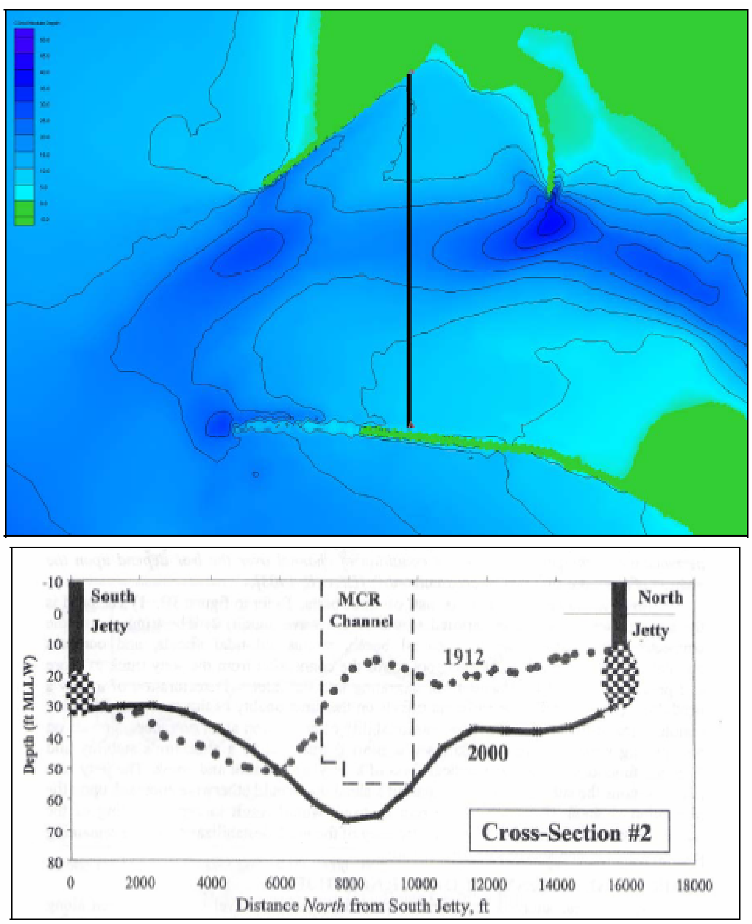

Figure 6 – Erosion South of North Jetty Near Proposed Sump Site

[1] Moritz, H.R., Moritz, H.P., Hayes, J., Sumerell, H., "Holistic Framework For Assessing the Functional Integrity of Navigation Structures at the Mouth of the Columbia River," ASCE, Coastal Structures '03, 2003.

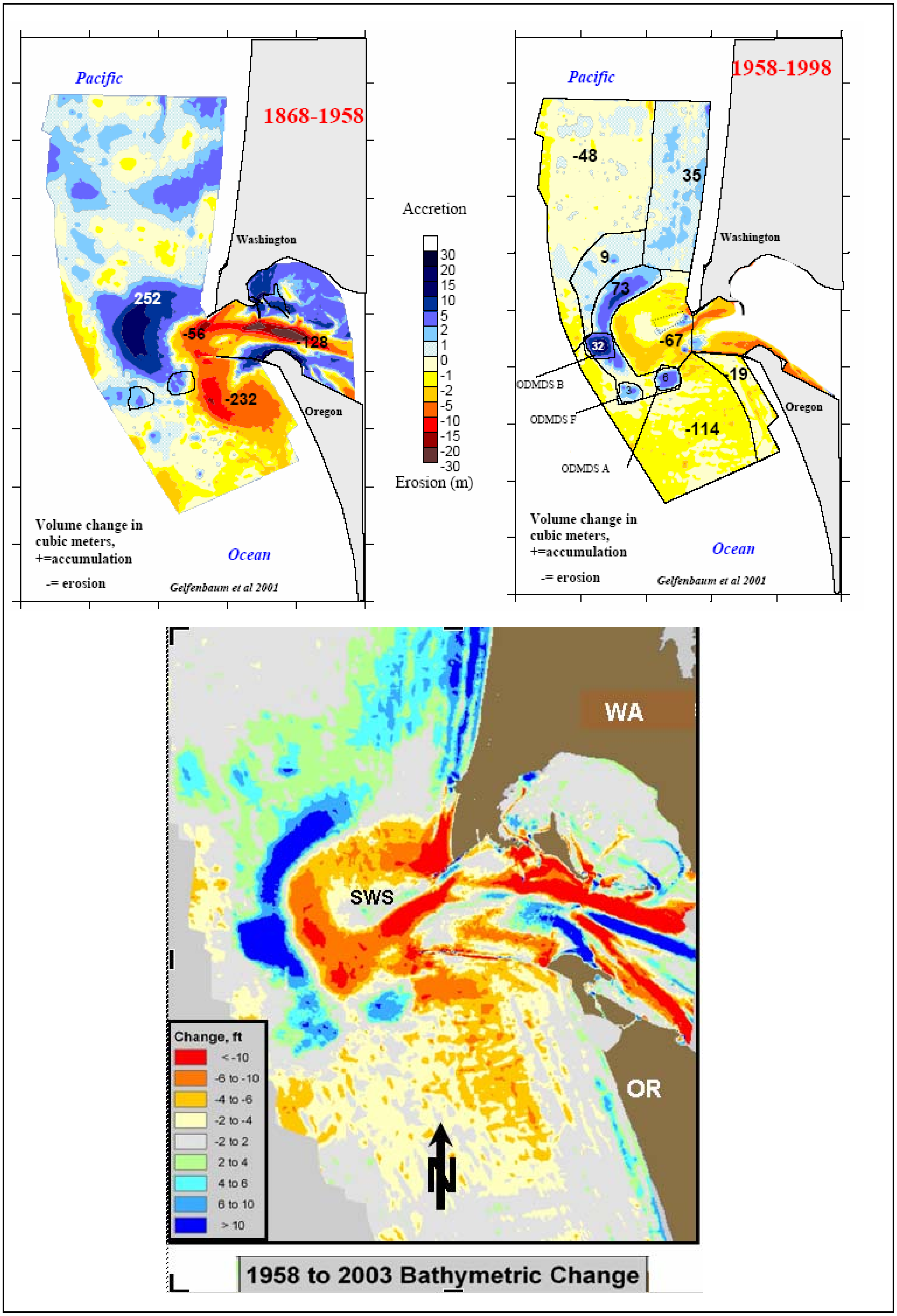

Figure 7 – Bathymetric Changes for MCR Shows Erosion South of North Jetty Near Proposed Sump Site

vertically on the order 20 feet between 1912 and 2000. Figure 7 illustrates bathymetric changes for two periods (1868-1958 and 1958-1998) and demonstrates the continued tendency for sediments to erode south of the North Jetty. Similarly, USACE officials indicate that that sediment placed at the North Jetty placement site erodes at a rate on the order of 300,000 cy/yr. Furthermore, tidal flow models (Figures 8 through 10) show that there is tendency for ebb flows to train against the south side of the North Jetty. The reader will note that there is not a similar tendency for flow training along the South Jetty. Figure 8 presents the PIE model results for peak ebb flow; similar results are presented in Figures 9 and 10 for USACE models. In fact, the purpose of Jetty A construction was to redirect ebb flows away from the south side of the North Jetty. Jetty A has indeed reduced, but has not eliminated, the tendency for flow training along the western reaches of the south side of the North Jetty. Furthermore, Moritz et al (2003) has documented the historic damage to the south side of the North Jetty owing to the scouring of sands. It should be noted that Reference 8 (PIE, June 2006), provided subsequent to draft report, includes an analysis of bathymetric surveys for the period August 1997 through July 2003. These data, which cover an eastern portion of the sump area, indicate as much as three feet of erosion in the central and southern portions of the sump area and areas of up to two feet of accretion along the northwest edge of the sump area adjacent to the NJ placement site. The latter accretional changes could be associated with placement of material at the NJ site. Nonetheless, these data support concerns that the sump is prone to long-term erosion. Accordingly, it can be concluded that the sump area is vulnerable to erosion. Great care must be exercised, therefore, in order to avoid any potential damage to the North Jetty. This fundamental has guided the ITR team as it has considered the efficacy and feasibility of the proposed sump construction.

The proposed side slope for the sump is 5:1 (horizontal:vertical) as noted above. This value is a reasonable assumption for a new excavation cut in sand. It is not a value, however, that is easily predicted in the absence of actual site experience. The actual slope will be the product of hydrodynamic/geotechnical conditions and construction method. More than likely, the slope would be constructed by as vertical a cut as practicable with a cutter suction pipeline dredge. The slope would subsequently adjust under hydrodynamic/geotechnical conditions to an equilibrium slope. The actual slope attained before sump filling is best determined by experience. In the absence of direct experience or predictive methodology, it is necessary to estimate on the basis of existing slopes in the area which appear to be considerably flatter than 5:1 (see Figure 6.) Thus, there is concern that the actual slope could be flatter than the estimated 5:1 although it is recognized that the intent is to fill the sump before slope equilibration occurs.

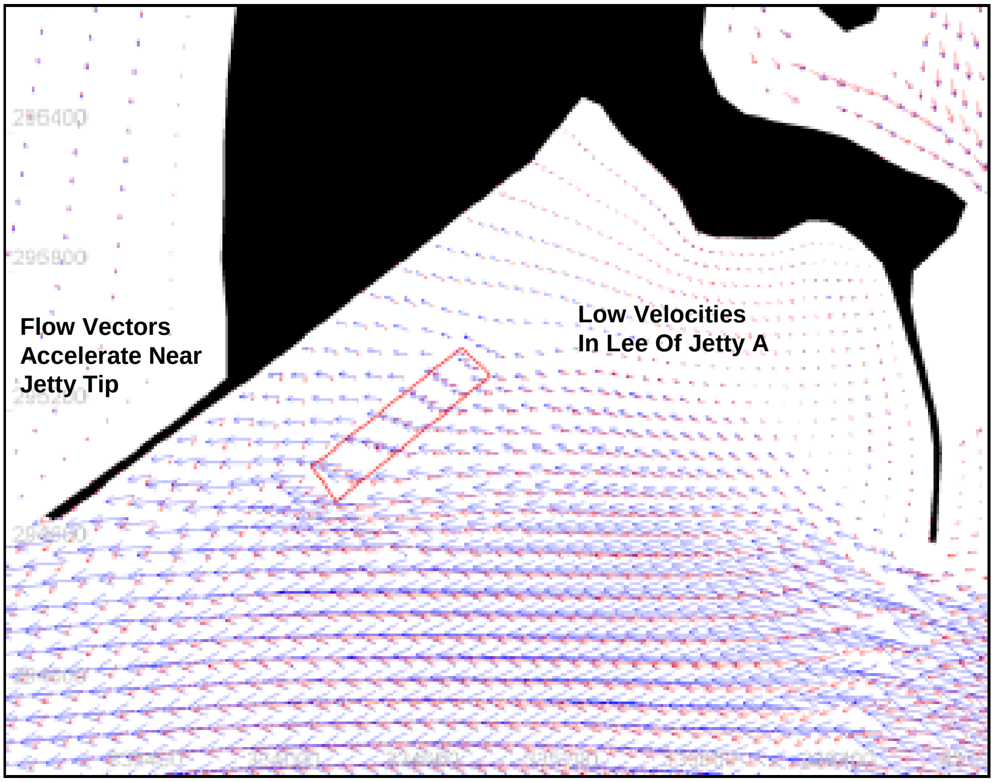

Figure 8 – Current Vectors Tend to train or Accelerate Against Southern Side of North Jetty – (PIE Model)

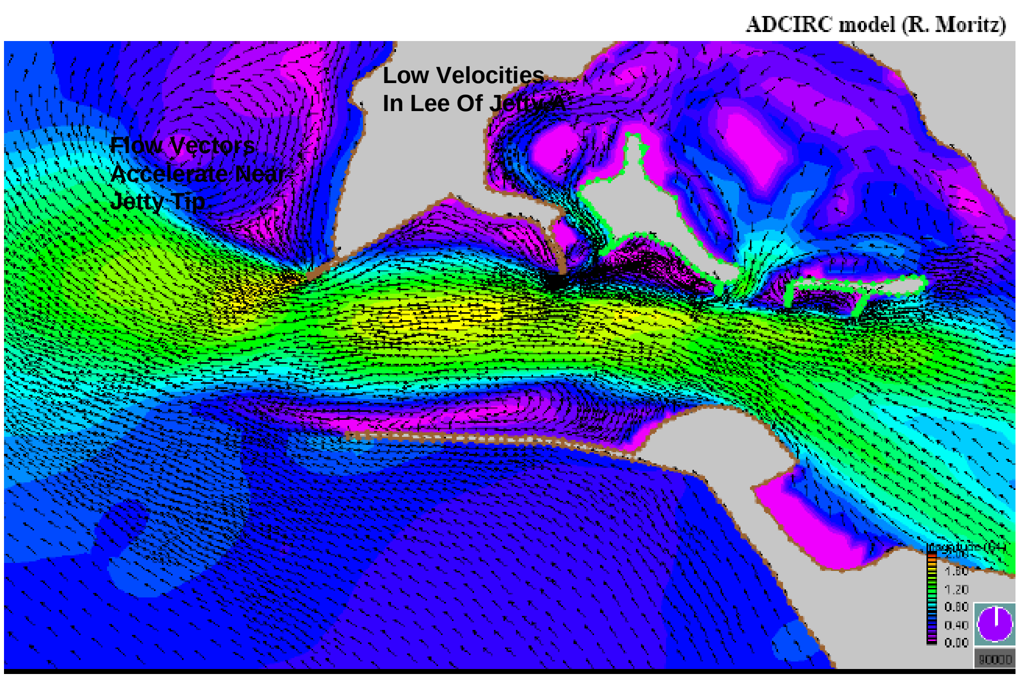

Figure 9 – Current Vectors Tend to Train or Accelerate Against Southern Side of North Jetty (USACE ADCIRC Model)

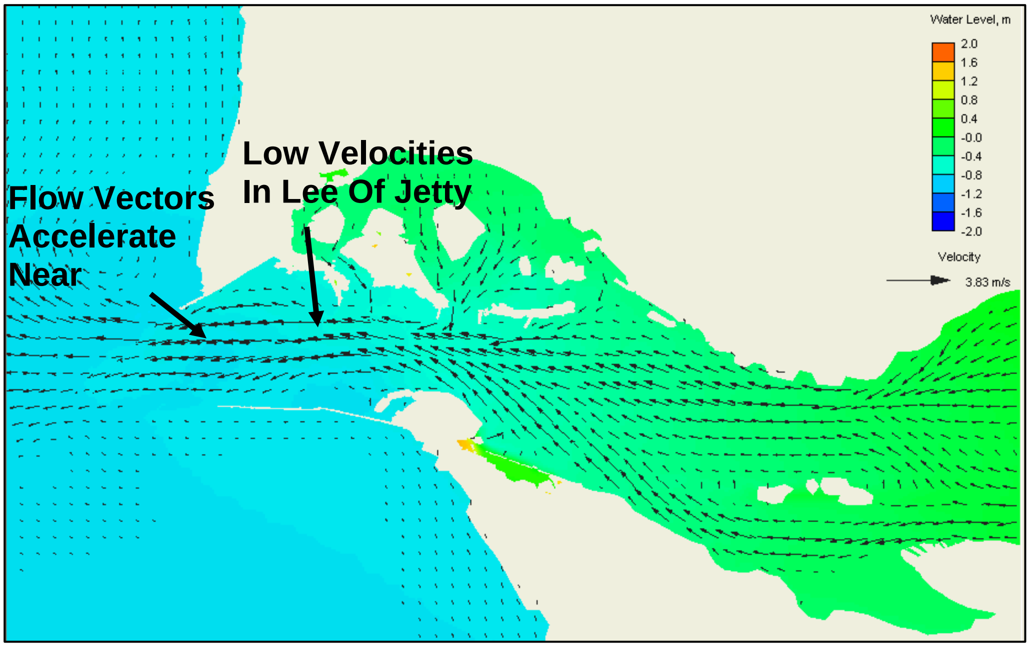

Figure 10 – Current Vectors Tend to Train or Accelerate Against Southern Side of North Jetty (USACE ADCIRC Model)

The MCR is a very dynamic environment. Significant changes to the morphology south of the jetty (e.g. sump construction) have, at the very least, the potential to re-direct flows and cause a permanent set of this powerful river further towards the North Jetty inasmuch as the flows already have a natural tendency to train against the jetty. The proposed sump operation advanced by PIE ameliorates the risk of damage to the North Jetty with the following logic and features:

1. The sump is located 1,500 feet away from the jetty.
2. The sump will be re-filled at the end of each dredging season.
3. Numerical modeling results show that the sump does not significantly change wave/tidal flow conditions in/around the sump.
4. Potential sediment transport modeling suggests that sediments will tend to deposit within, rather than erode from, the sump.
5. The sump results in local increases wave heights, but the increased waves are smaller than the winter waves that frequently reach the south side of the North Jetty.

The above items are addressed below.

We agree that Item 1 (sump location 1,500 feet south of the jetty) and Item 2 (sump refilling) help to ameliorate the risk of the channel migrating towards the North Jetty. Questions remain, however. First, we note in Figure 11 that flood flow velocities at the bottom of the excavated sump are predicted to be same as those without the sump. This means that flood flow is attracted towards the sump area. If flood flow in the vicinity of the sump remained constant with dredging, then sump flood flow velocities would be smaller owing to the increase in depth with sump excavation. For example, take the average depths before and after sump excavation as -34 feet and -46 feet MTL, respectively. Applying basic concepts of the flow continuity principle, one would expect the depth averaged velocities within the sump to be 34/46 = .74 or 75% of the existing velocities. Ebb flow velocities are lower than existing as shown in Figure 12, but are not as low as 74% as shown in Figure 52 of PIE (2006). While this is not a major concern, the potential for the sump to attract flood flow could give rise to unanticipated morphological changes. As planned, the sump would be filled at the end of each summer dredging season. We are concerned, however, that there is risk that under unusual conditions, it might not be possible to fill the sump.

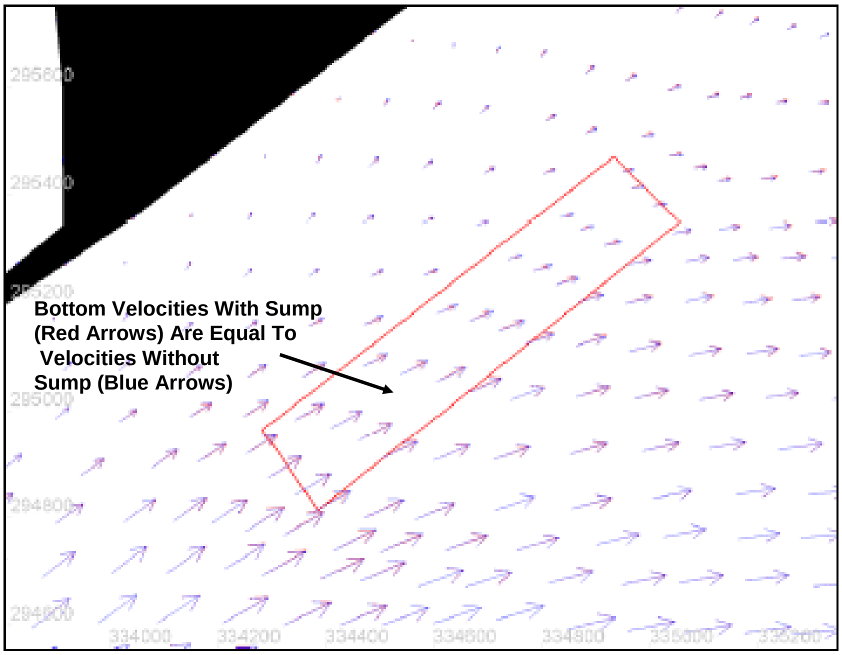

Figure 11 – Flood Current Vectors are Similar With and Without the Sump

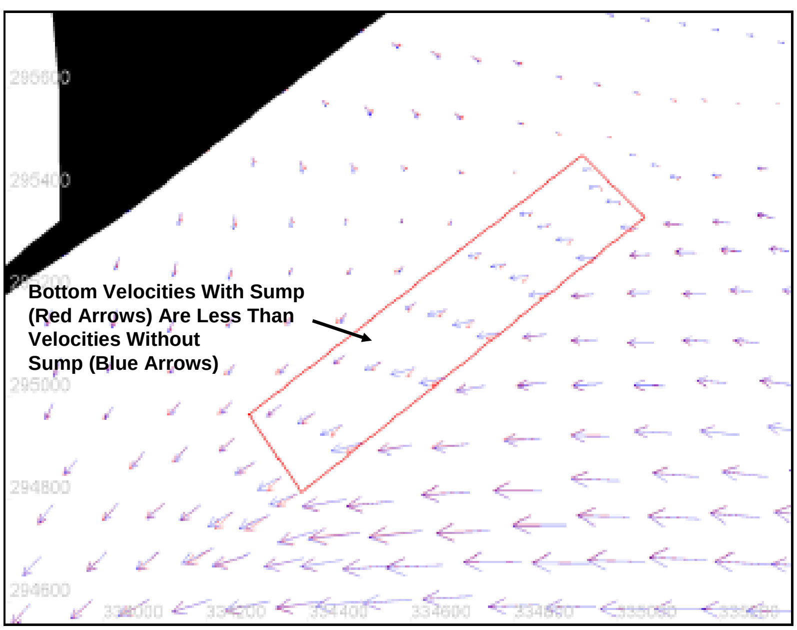

Figure 12 – Ebb Current Vectors For Excavated Sump Area Are Lower

The concern here is operational. Is there not a possibility that a dredging contractor could fail to fill the sump in the available time? What if contracted dredge was damaged or broke down owing to the failure of some major engine part? What about a labor strike or a long period of inclement weather, or simply a failure to perform on the part of the contractor? Could not a potential lawsuit impact the ability to fill the sump? Filling of the sump should conceivably cover this risk. However, we are concerned that if performed in perpetuity, there is a potential scenario in which the sump is not filled and would have to remain open for the roughly nine-month period from September through June. Under such a scenario, would the sump grow larger as a result of waves and flows during the non-summer months? Would the sump amplify the winter waves that reach the North Jetty resulting in structural damage to same? Could the sump migrate towards the jetty in response to the flow regime which tends to train against the North Jetty? Would the sides of the sump adjust to a much flatter equilibrium slope than envisaged? M&N is concerned about this risk and suggests further field data collection and modeling work (preferably with morphological modeling technology) to further investigate these scenarios.

Filling the sump sounds like a relatively simple operation with a hopper dredge. This may be the case. We remain concerned, however. One issue surrounds the fate of material placed in the sump. Material placed during strong currents or waves may not settle in the sump area. This is a common complication for bottom dump hopper dredges. As a result, it may be necessary to dredge and place a larger amount of material than simply the volume of the excavated sump area in order to fill the sump. This issue should be addressed in cost analysis. Navigation into and through the sump area with a hopper dredge may also be problematic or impossible under certain weather conditions especially if a pipeline dredge (on anchor wires) is working in the sump area at the same time. This could result in operational inefficiencies and production downtime.

Further with respect to filling the sump, it is mentioned that it may be difficult to fill the sump to a uniform depth and surface. Bottom dumped dredged material generally falls into discrete piles. The filled surface of the sump may, therefore, resemble a checker-board pattern of discrete piles of sediment. In order to achieve a uniform surface of the sump that is (at least) flush with the surrounding area, it may be necessary to over-fill the sump and allow waves and currents to plane-off the surface. This could be especially true around the edges of the sump area where it may be difficult to place sediment with accuracy. Again, this would require a larger fill volume than simply that associated with the excavated volume of the sump. Also, sand placed in the sump will likely settle over time. This would also require overfilling of the sump. Failure to fully fill the sump could lead to erosion or re-working of the sump morphology over the winter months with potentially undesirable consequences as regards the North Jetty.

A final issue with regard to filling the sump stems from concerns about suspended sediment concentrations in the Columbia River near the sump. Clearly, bottom sediments in the area are sands. On the other hand, suspended sediment concentrations are relatively high (100 mg/L or greater) in the vicinity of the sump. It may not be a significant risk, but some silts and/or mud could settle in the sump which would be both unsuitable for beach nourishment and could give rise to settlement of material placed in the sump.

PIE have performed “potential” sediment transport analysis of the site location and have concluded that sediments will settle within the sump area, as illustrated in Figure 13. Both

PIE and M&N fully appreciate the complexities of, and vagaries associated with, sediment transport modeling and we commend PIE for their efforts. We note, however, that the numerical modeling performed to date has not been calibrated nor verified with actual bed changes in the vicinity of the sump. Accordingly, we do not dispute the trend identified by PIE for sediment to deposit in the sump. We do, on the other hand, conclude that the "potential" sediment transport modeling results have not been developed to the extent that they can be used to quantify short or long-term morphological changes in the vicinity of the sump. This is not meant as a criticism as further quantification is a difficult and time-consuming exercise.

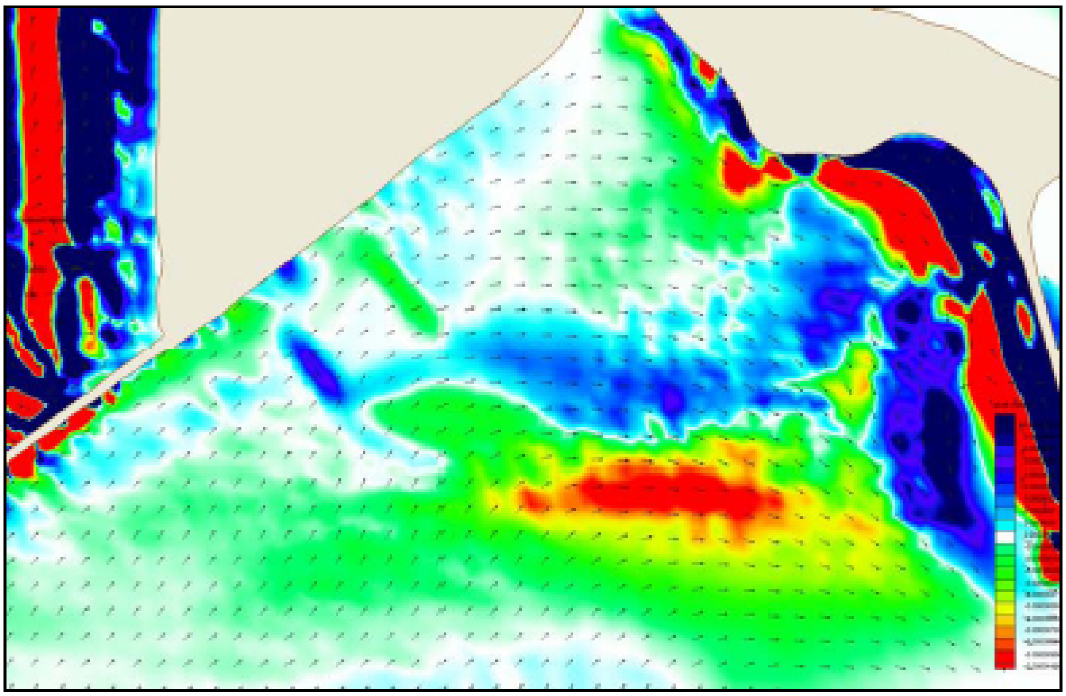

Figure 13 – Model of Potential Sediment Transport

Figures 14 through 16 from PIE (Reference 4) summarize typical results for the increase in wave heights near the North Jetty and show that a 5 meter offshore wave increases approximately 0.5 m near the jetty. A similar plot developed by the USACE is shown in Figure 17. The differences in results for these two cases (i.e., Figure 15 and 17) stem from the differences in modeling technology and model setup. The fact that there are significant differences in the plots simply serves to point out that the uncertainties inherent in the numerical modeling of waves, especially within tidal inlets protected by jetties such as MCR. Again, we do not criticize any one result but weigh the information available to us and surmise that estimates of wave climate at sump and jetty are approximations and would benefit significantly from additional field measurements directly at the sump location coupled with additional modeling.

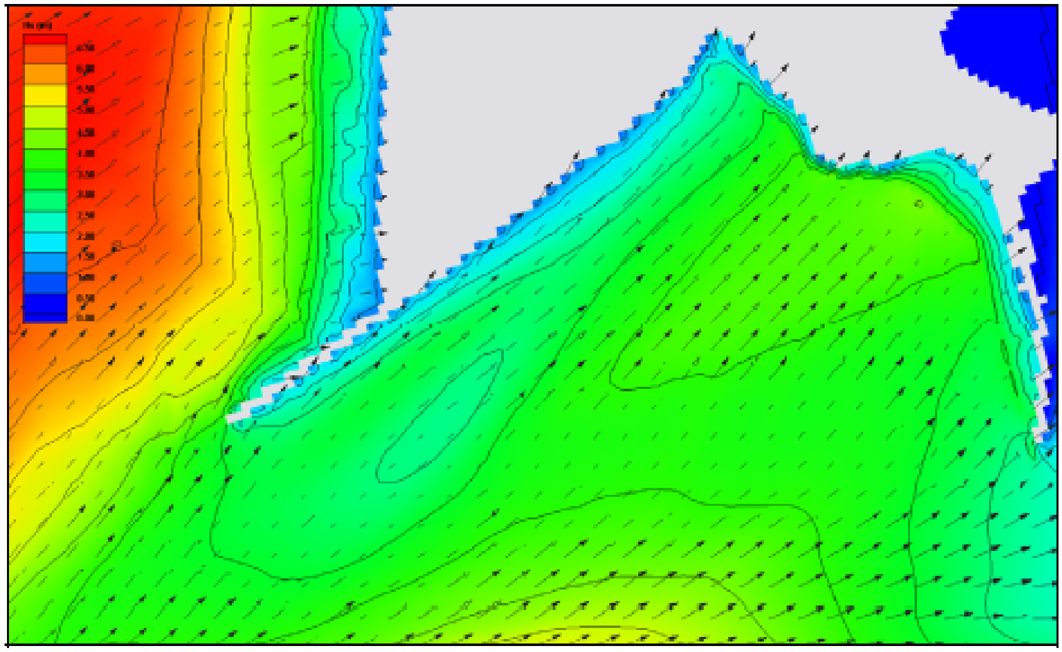

Figure 20 Close-up view of H_s=5 m T=12 sec waves from Az 230 deg

Figure 14 – Wave Field Near North Jetty – Without Sump (PIE)

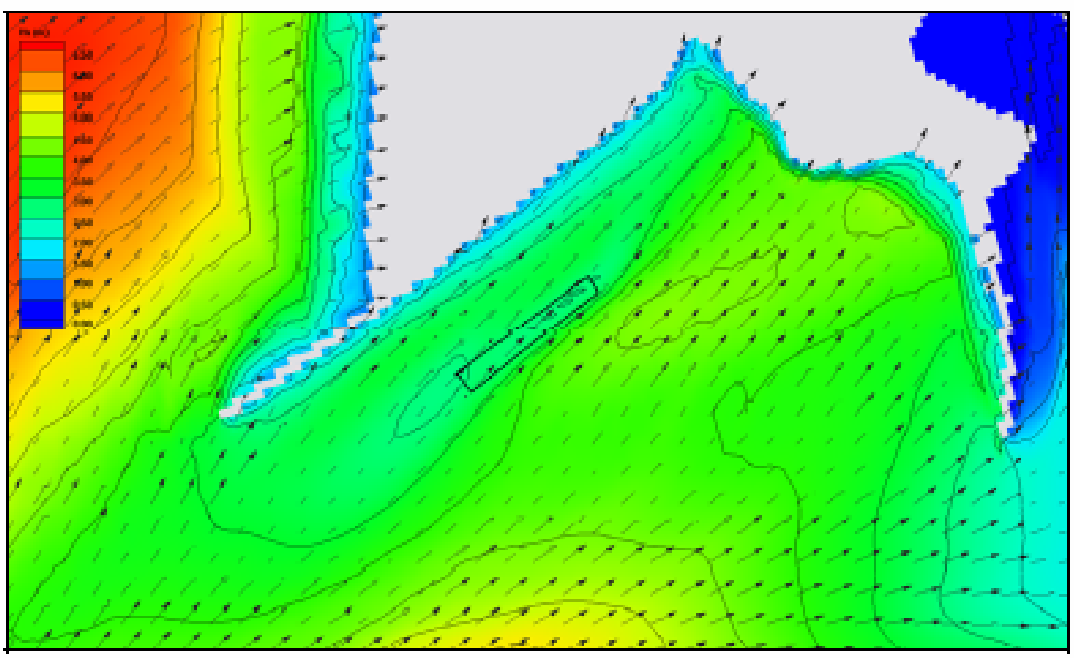

Figure 26 H_s =5 m T_p =12 sec HWS Az 220 with 0.5 million cu yd sump

Figure 15 – Wave Field Near North Jetty – With Sump (PIE)

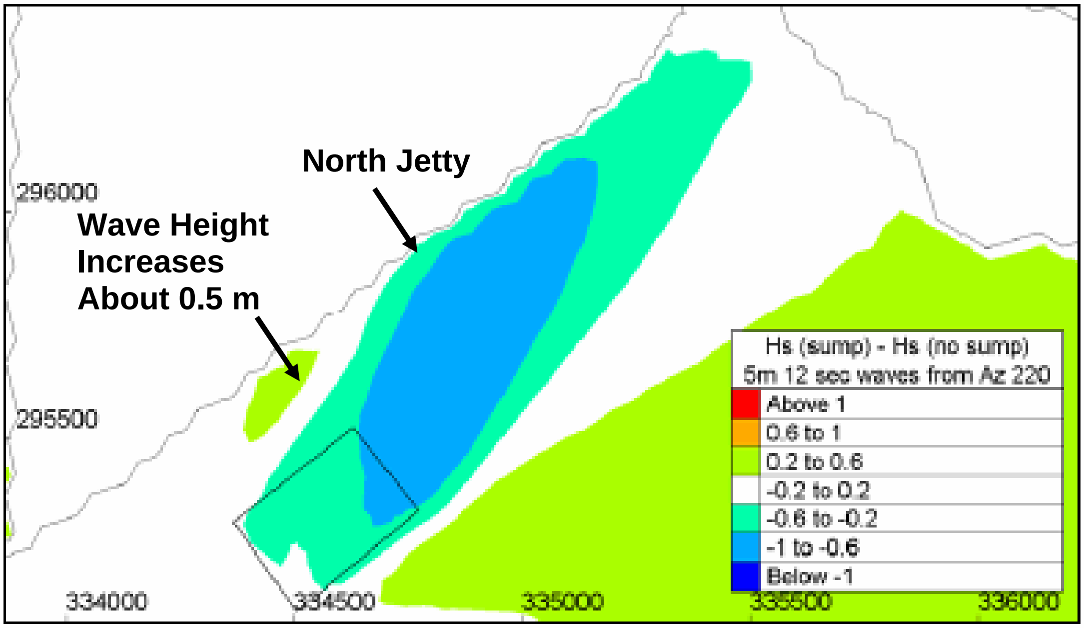

Figure 16 – Wave Height Differences With Sump (PIE)

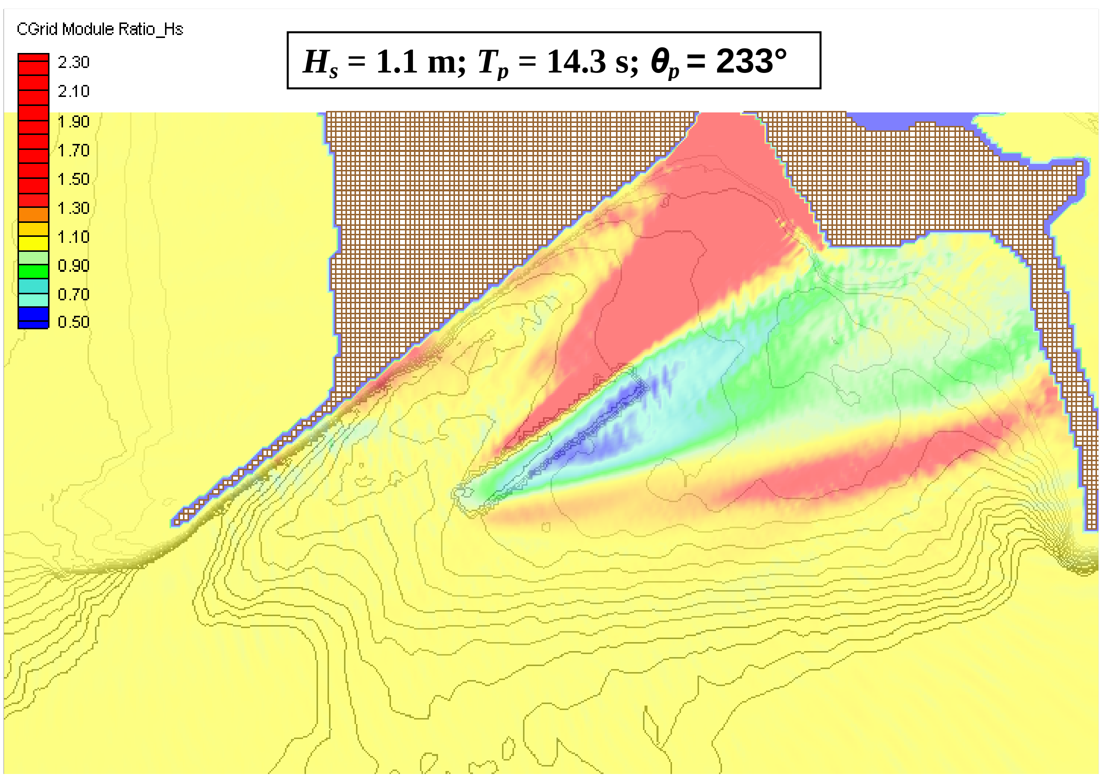

Figure 17 – Wave Heights Surrounding Sump (USACE)

Figure 18 through 20 summarize measured wave statistics in the vicinity of the proposed sump area. Figure 18 shows the location of wave measurement locations for a 2003 measurement campaign with Station 2 being the closest to the proposed sump area. Figure 19 summarizes wave measurements taken at Station 2 during the summer of 2003 and shows that a wave height of 1 m was exceeded about 30 percent of the time. Figure 20, based on PIE numerical modeling efforts for the sump location, shows that the same 1 m wave height is exceeded about 15 percent of the time. It should be noted that the two stations are not at the exact same location; Station 2 is about 600 feet south of the sump area. Nonetheless, there are clear differences in the two estimates with significant consequences as regards the feasibility of using a pipeline dredge at the sump location. As previously stated, additional wave measurements should taken directly at the sump location in order to fully establish wave conditions for use in planning future dredging operations.

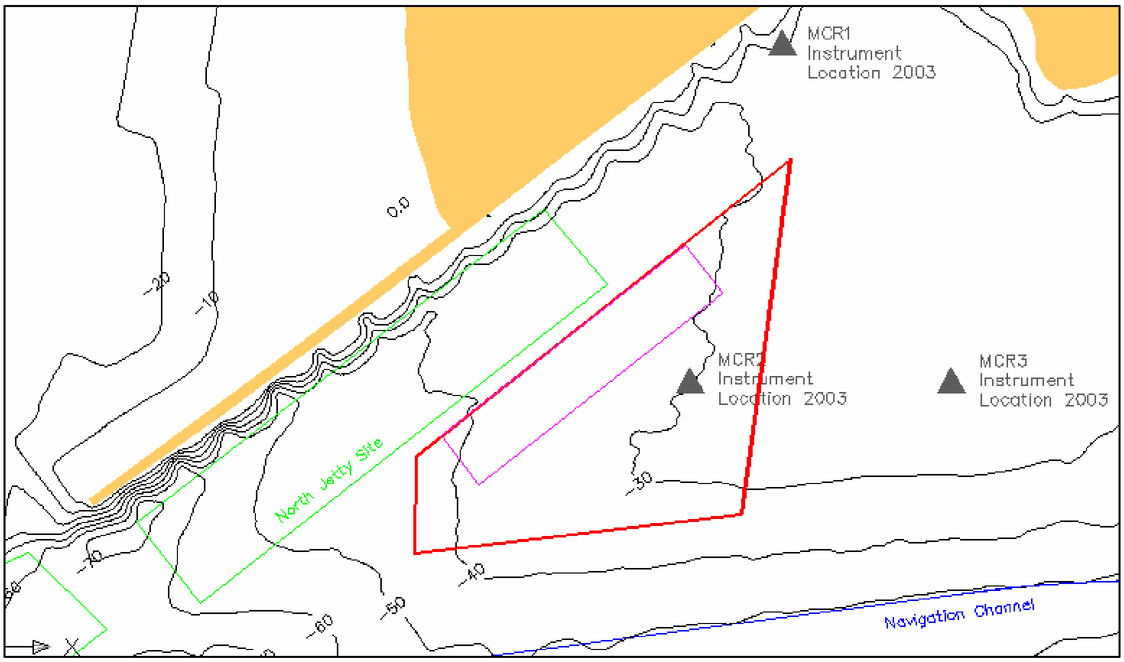

Figure 18 – Wave Heights Surrounding Sump (USACE)

It should be noted that PIE analyses indicate that there is good correlation between computed and measured wave conditions at Station 2. To wit, model results tend to slightly overpredict measurements for the comparison periods provided in the PIE report (i.e., 7 thru 17 September, 2003 and 26 August, 2003.) It is not clear from the existing PIE reports, however, that this trend was true for the entire measurement period from 15 July through September 15, 2003. Furthermore, there appears from Figure 19 to be a considerable difference in wave statistics from year to year. Specifically, a 0.5 m wave height at Station 1 was exceeded 25% of the time in 2000 and only 15% of the time in 2002. In short, the wave climate can change from year to year.

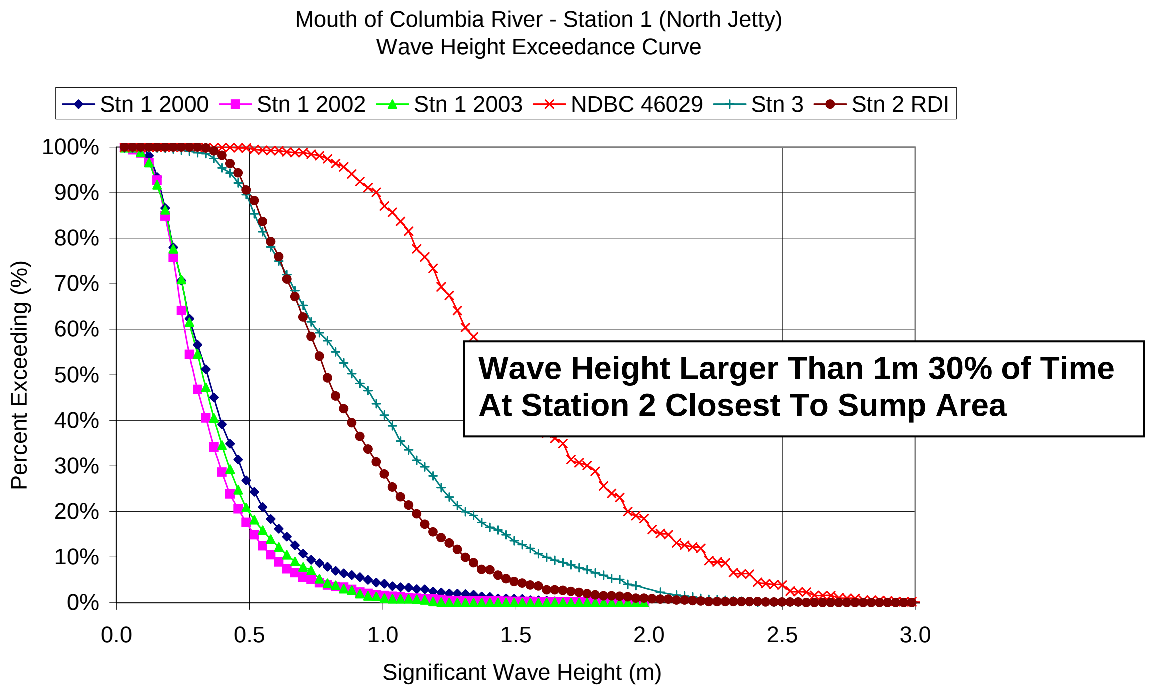

Figure 19 – Wave Heights Surrounding Sump (USACE)

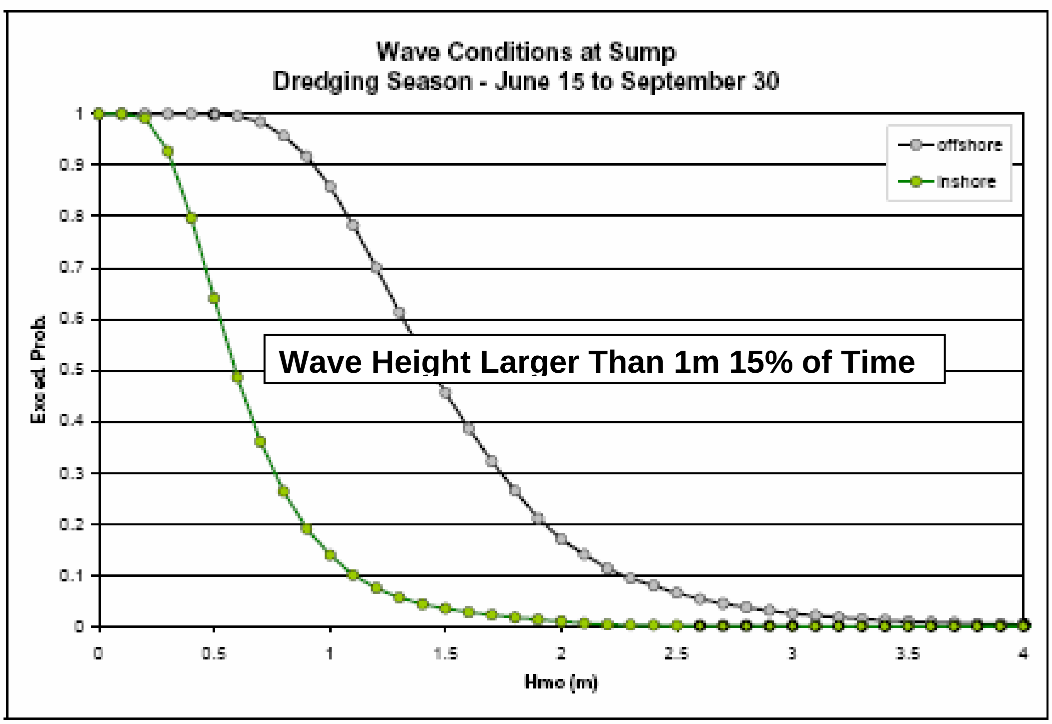

Figure 20 – Modeled Wave Heights Predicted For Sump Area (PIE)

Figure 21 presents example wave measurements obtained by the USACE for August 29, 2005. This plot shows: (1) that the offshore and nearshore wave heights are the same; and (2) that problematic wave heights can build quickly in a matter of 6 hours or so. Although detailed comparisons are not available, the first point is inconsistent with Figure 14 which shows (for reasonably comparable wave direction and period) that waves in the vicinity of the recording station are less than the offshore wave height. The second point is relevant to dredging operations inasmuch as it suggests that rapid deterioration of local wave conditions may not allow sufficient time for a dredge to exit the sump area prior to experiencing excessive wave heights for safe working.

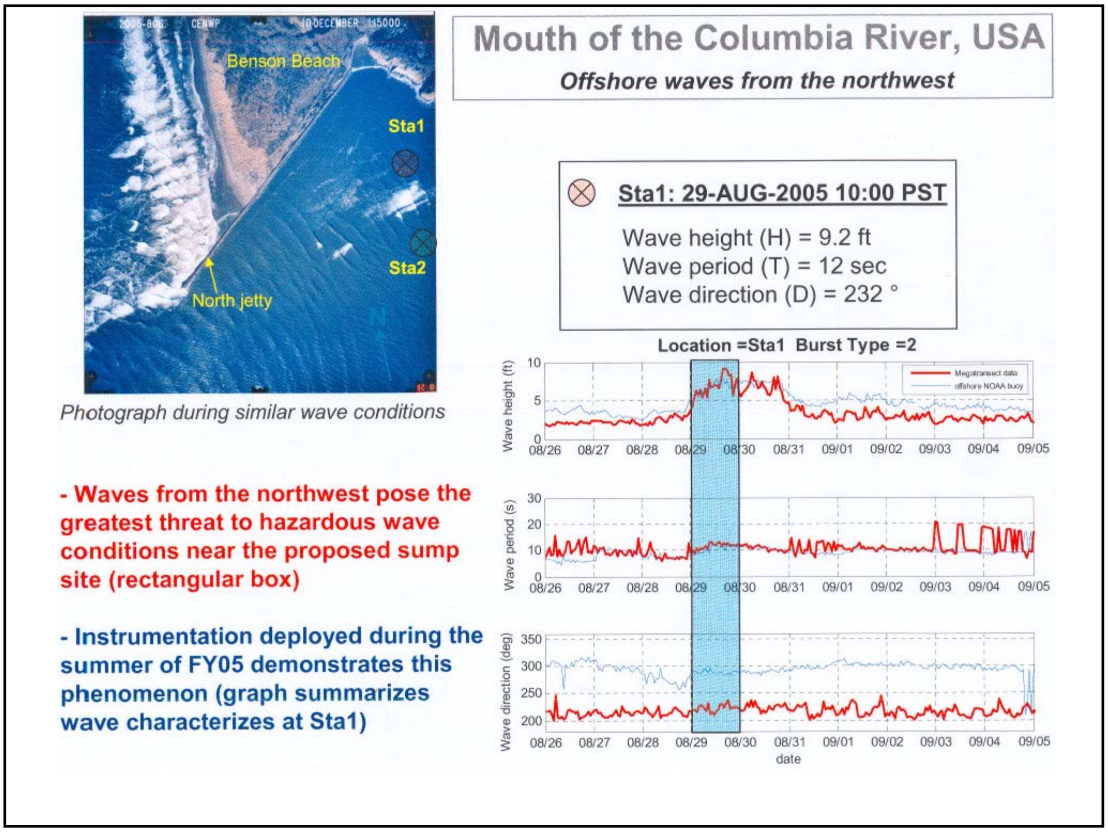

Figure 21 – 2005 Wave Measurements 29 August, 2005 (USACE)

In order to overcome/avoid the considerable uncertainties associated with the predicted wave climate at the sump location, we recommend that long-term wave measurements be taken in connection with any dredging operations to put sand on Benson Beach (whether under the “pipeline dredge-sump (PDS)” or “hopper dredge pump-ashore (HDPA)” scenarios). These long term measurements would be used to unambiguously document wave conditions experienced at the site for construction contracting purposes as well as for the purposes of further calibrating/verifying wave models for the site. Presently, no measurements are directly available for the site.

In summary, we are concerned that the sump poses risk to the North Jetty. These risks may or may not be deeply threatening to the structure, but neither have they been quantified to the degree practicable using either modeling technology or direct wave measurements. Further, much can be gained by further experience at the site. In this regard, we recommend that additional trials of the HDPA option (Figure 22) be implemented in order to better understand the feasibility of putting sand on Benson Beach from the MCR. The principle advantage of the HDPA approach relative to the PDS is that construction of the sump and any attendant risk issues can be avoided or postponed until further experience is gained at the site. The HDPA operation is envisaged as the first in a potentially two-step process, the PDS operation being the second phase. The HDPA operations would explicitly address questions regarding the benefits and feasibility of putting large volumes of sand on Benson Beach at relatively low cost. If successful, steps would be taken to undertake a PDS second step. We recommend the HDPA be conducted for a minimum of three successive seasons. **Furthermore, the HDPA accomplishes the same mission as the proposed PDS, namely, it puts sand directly on Benson Beach**. The advantage of this approach, which does not eliminate PDS as an eventual alternative, is that it incrementally builds on previous hopper dredging experience at the site including the 2002 HDPA trial. Risks associated with a sump, and unprecedented pipeline dredging activities are eliminated until further studies and measurements can be completed. PIE have expressed that one of the advantages of the PDS option is that large volumes of sediment (up to 4 Mcy) could be placed on Benson Beach with such a scheme. In contrast, the USACE have estimated that the volume that can be placed using the HDPA alternative is limited to about 700,000 cy unless an additional hopper dredge is mobilized. This issue is addressed further under question 5. It suffices to say here that we estimate that the maximum volume that could be placed with a 30-inch cutter suction dredge is about 1.1 Mcy rather than 4 Mcy. The PDS option (which is significantly more costly/risky than the HDPA scheme) requires the mobilization of 2 hoppers and one cutter dredge. If a third hopper dredge were mobilized, then the 1.1 Mcy volume could be achieved with the HDPA scheme. Furthermore, it would be inadvisable to place 4 Mcy on Benson Beach even if it were possible because: (1) Benson Beach would likely be unable to absorb that much sediment, (2) it would be inappropriate to place of all sediment to the north of the MCR; it would more appropriate to place sediments on both sides to the inlet in order to restore littoral drift, (3) it remains necessary to place sediments at the rapidly eroding SJ and SWS locations in order to maintain the integrity of the North Jetty.

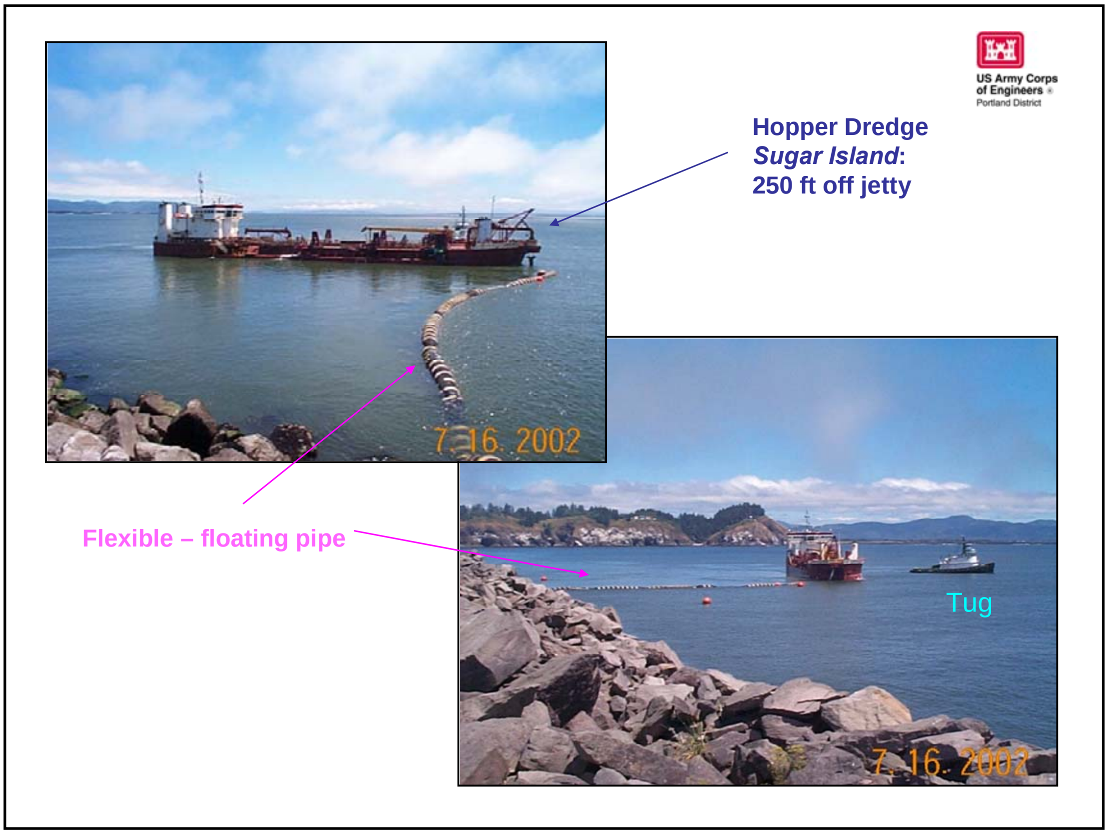

Figure 22 – Hopper Dredge/Pump Ashore Methodology

2.2 Response to Question 2

Question 2: Are the methods and procedures set forth in the documents adequate to demonstrate the operational feasibility of operating a direct pump-ashore operation from a hopper dredge and operating a pipeline dredge to construct a sump including the safe operation of a pipeline dredge in the sump location?

As stated in our response to Question 1, M&N is concerned that there is an absence of long-term measurements of wave conditions at the sump location. Further to this issue, we are concerned that the wave conditions will be too rough to allow safe operation of a pipeline dredge without significant periods of downtime. We know of no comparable case in the U.S. where a pipeline dredge has operated in as severe a wave climate as that at the MCR. We recognize that PIE has argued that the safe working wave height for a pipeline dredge is 1.5 meters and that by their estimate this wave height would only be exceeded about 3 % of the time during the summer months of operation. We do not necessarily agree with the maximum working wave height of 1.5 meters at this location. Nor are we convinced that the estimates of wave conditions at the sump are accurate in the absence of extended wave measurements that can be compared to those derived from numerical models as described above. Limited model calibration and verification, combined with significant variability in results between models and measurements at various locations, raises concerns regarding the reliability of the percent of time that the suggested maximum wave height threshold is exceeded.

Bray[2] provides recommendations for limiting wave heights for a 6-8 second period wave for efficient operations (EO) and those corresponding to dangerous and/or very inefficient operations (DOVI) for both small and large cutter suction pipeline dredges. The EO and DOVI limits for a small pipeline dredge are 0.2 and 0.5 meters; a large pipeline dredge 1 and 2 m. Given the fact that many of the waves reaching the sump location have periods longer than 6 seconds, we take a 1m wave height as the limit for EO or DOVI for a large dredge for discussion purposes. As stated in connection with Question 1, this wave could be exceeded some 15 to 30 percent of the time in the vicinity of the proposed sump. As stated in connection with Question 1, this wave could be exceeded some 15 to 30 percent of the time in the vicinity of the proposed sump. Some key issues include:

- The 1m threshold is considered a maximum condition that can be sustained, and the contractor would typically disengage for a safe haven well before this condition is reached.

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[2] Bray, R.N., Bates, A.D. and Land, J.M., "Dredging: A Handbook For Engineers" 2nd Edition, Arnold, 1997.

- A key reason why we have concerns about the appropriateness of the 1 meter threshold is the difficulty in wave forecasting within the MCR. The complex interaction of waves, wind and high-velocity, multi-directional tidal currents limit the reliability of wave height forecasting. In the recent field data collection within the MCR conducted by the USACE in the summer of 2005, recorded wave measurements indicated that wave conditions can amplify in a matter of a few hours (see Figure 21).

- It is difficult to uniquely define the maximum allowable wave height for a pipeline dredge. It depends heavily, for example, on the size and geometry of the dredge. The allowable wave height is typically larger for a larger dredge. The allowable wave height may be larger for a dredge moored on wires than for one moored on spud piles. Further, the allowable wave height for swell (longer period waves) is normally much lower than the allowable wave height for sea (shorter period waves.) Similarly, the allowable wave height in beam seas is lower than for head seas.

- Excessive wave conditions even during a single mishap (e.g., pipeline dredge does not disconnect prior to rough weather) could significantly threaten dredging equipment and personnel. This will be of particular concern to contractors given the fact the dredge will be very close to the North Jetty. Should the dredge or other support plant break loose, there would be very little time to react before the dredge was in danger of landing on the rock jetty.

The two best means for establishing allowable wave heights are, in order of preference, experience with a given dredge at a specific site or numerical modeling of the moored dredge behavior. Neither means is presently available.

With regard to the present work, no quantitative attempt has been made to establish safe operational wave height limits appropriate for the MCR and, as previously mentioned, we remain concerned that the more data collection and analysis is required to quantify wave conditions at the site.

A pipeline dredge has never worked at the MCR, and they have limited application at any open ocean locations on the west coast of the U.S. Reference 3 (PIE 2005) suggests that there is precedent for the PDS-type operation at Channel Island Harbor/Port Hueneme and Ventura Harbors in Southern California. We do not think the operational conditions are comparable. The coast of California, south of Point Conception, exhibits a relatively benign operational wave climate compared to the coast of Oregon and Washington. Both of the referenced Southern California harbors are within the northern portion of the Southern California Bight and therefore sheltered from extra-tropical swell from the west and northwest. Furthermore, the harbors are sheltered by the Channel Islands which act to mollify south and southwest swell at those sites (see Figure 23). More importantly, the pipeline dredging at both sites is performed behind a protective, shore-parallel offshore breakwater. In contrast, the MCR site is fully exposed to relatively large waves from the SW quadrant and exposed to diffracted waves from the NW quadrant and has no similar protective breakwater behind which to operate.

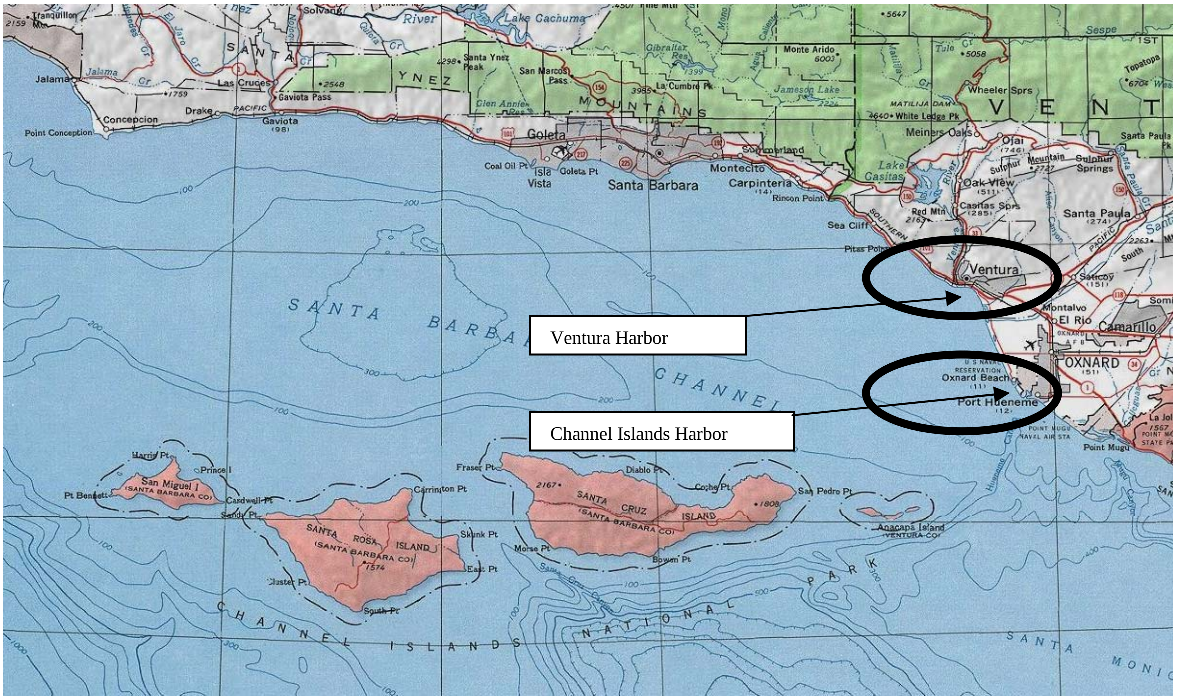

Figure 23 – Southern California Bight

Ventura Harbor

Channel Islands

A primary concern here is that a pipeline dredge will be exposed to significant periods of downtime. Downtime, in fact, is not simply the percent of time that waves exceed a given wave height for several reasons. It takes time for a pipeline dredge to cease operations and disconnect from the floating pipeline. Our best estimate is that it could take four hours to disconnect and six hours to reconnect. It could, however, take longer. An event may also damage or destroy the pipeline resulting in even longer delays. The latter action is most threatening to personnel and requires that the dredge disconnect during calmer conditions than those that limit the actual dredging operation. Normally, a dredging contractor would rely on weather forecasts to determine ahead of rough weather to disconnect or not. If the weather is threatening enough, disconnection would ensue and the dredge would be moved to calmer water. In this case, that would mean moving further upstream in the Columbia River perhaps to a point landward of Jetty A. This move would have to consider wave conditions between the sump and Jetty A which are often rougher than those experienced at the sump owing to loss of shadow from the North Jetty and areas of wave focusing to the east and south of the sump area. Moreover, there will be times of "false alarm" when the actual waves are not as severe as those forecast ahead of time. In short, the actual downtime experienced at the site will likely exceed those indicated by actual wave conditions at the site and especially those based on the existing approximations of wave conditions at the site based on limited wave measurements and numerical modeling technology. In this regard, we are not convinced that the methods and procedures set forth in the existing reports are adequate to accurately demonstrate that it is feasible to conduct sufficient pipeline dredging activities at the sump location to place 500,000 or more cubic yards of material on Benson Beach.

Reference 8 (PIE, June 2006) includes a relatively detailed downtime analysis in response to questions raised by the ITR team. PIE used their wave transformation model and offshore wave conditions to develop time histories of wave conditions for the period 15 July thru 15 September for the years from 1996 to 2005. PIE examined several wave height criteria for cessation or demobilization of pipeline dredging (i.e., 3, 4, and 5 feet) and recommencement or remobilization of dredging (i.e., 1.5, 2 and 3 feet.) They assumed no time for demobilization and 3 hours for re-mobilization. As stated above, we do not think that these periods for de- and re-mobilization are long enough. Further, we think the 3 foot wave height criterion is most appropriate as mentioned above (i.e. approximately 1 m.) The corresponding downtime for that cessation criterion is 34%. This value would increase, perhaps significantly, using our criteria for de- and re-mobilization. Also, safe allowance should be made for cases where little time exists between consecutive periods of excessive wave events. In reality, the contractor would not go back to the site unless forecasts predicted a reasonably extended period of good weather.

The downtime analysis computes the earliest (August 24) and latest (September 11) completion dates for pumping 500,000 cy of material on Benson Beach based on actual wave data. The concern here is that there has to be enough remaining time to re-fill the sump. Another factor here pertains to whether hopper dredge sump re-filling can occur at the same time that a pipeline dredge is excavating the sump. The need to perform sump excavation and re-filling sequentially rather than in parallel makes the PDS option more problematic. If the hopper tries to dump in the pit while a cutter is working on anchors in the relatively small and dynamic area, the efficiency of both dredges will be negatively impacted. There will also be measurement and payment issues to consider for the cutter work if the dumping and re-handling are concurrent. If the hopper were to follow the cutter, the hopper would have to be scheduled to start the refilling well after the cutter is planned to complete the pit or risk delays to the hopper dredge as it waits for the cutter to finish. Scheduling the hopper late in the season, heightens the risk of rough weather or mechanical delays hindering the ability of the hopper to ensure the pit gets refilled within one season.

Some further comments regarding operation safety of a potential PDS operation in the MCR are warranted. Discussions with USACE Portland District dredging operations staff further indicate limited opportunities for a safe haven in inclement weather for the pipeline dredge. They cite Baker Bay as the only likely option. However, difficult navigation access and currents limit the viability of this opportunity.

It is not the purpose of the above paragraphs to dismiss the pipeline dredge as an eventual alternative. Rather, we recommend (as mentioned above) that additional experience be gained with the HDPA alternative as an intermediate action. The goal of the HDPA operation would be to determine if such an approach could result in placement of 500,000-700,000 cy of sand on Benson Beach for three successive seasons. The HDPA operation has the advantage of being able to operate in heavier seas. Further, if the seas are too rough then the hopper dredge can disconnect from the pump ashore pipeline and continue dredging elsewhere in the MCR area. This approach would reduce downtime to a minimum and greatly minimize the economic effect of such downtime. Furthermore, placement of a wave gage at the sump area for several years would allow for direct determination of the wave climate for use in planning additional HDPA or PDS operations. Three seasons of actual experience would go a long way towards better assessing the feasibility of operating a pipeline dredge at the sump location.

2.3 Response to Question 3

Question 3: Are the methods and procedures set forth in the documents adequate to demonstrate that there will not be adverse impacts to the Benson Beach area as a result of the pipeline operation and that the purpose of the demonstration – to disperse material to the littoral drift met? Please provide and improvements, publications or literature that supports your response.

M&N was briefed by PIE on the Particle Tracking Model (PTM) during a presentation at the Portland District on June 7, 2006. We were shown animations of the PTM for several dredge material placement sites including: *Site 1* placement at the Shallow Water Site (SWS), *Site 2* and *Site 3* placement at two locations on Benson Beach (one nearer to and one further from the North Jetty), and *Site 4* placement immediately offshore of Benson Beach in a water depth on the order of 30 feet. As we understand it, the PTM was driven by the wave/current hydrodynamic models documented in Reference 4 (PIE 2006). The referenced models were calibrated/verified with field measurements, however, none of these data were taken directly at any of the placement sites evaluated in the PTM. In this sense, the hydrodynamic models and the associated PTM may be “under” calibrated. Furthermore, PTM technology may or may not be an accurate representation of sandy sediment behavior owing to the fact that the particles used in the model may not behave like sandy sediments. Additionally, the reader should note that accurate modeling of sediment transport is difficult. Normally, a successful model can approximate the geometrical changes to the area bathymetry over time. We are not aware of any efforts to compare the PTM results to actual historical bathymetry changes anywhere in the PTM domain. Nonetheless, we found the PTM animations to be of qualitative use as described below.

Particles placed at *Site 1* (SWS) tended to move toward the north of the placement site both towards the edges of the ebb tidal delta as well as onshore towards Benson Beach. The results mimicked the bypassing pathways advanced by both the USACE (Figure 24) and that shown by USGS (Figure 25) for the northern ebb tidal delta area. While the relative proportions of sediment transported towards shore and toward the edges of the ebb tidal delta are in question, the qualitative behavior appeared to be consistent with arguments that sediments placed at the SWS remain in the littoral system (Moritz 2003)[3].

The SWS has been used since 1973 and as of 2005, 71 million cubic yards have been placed at the site. According to the Portland District, 23 million cubic yards have been placed at the SWS since 1997 with only 2.3 million cubic yards remaining. The inference is that sediment placed at the SWS is dispersed by waves and currents over Peacock Spit as suggested above by Figures 24 and 25. USACE field measurement and modeling work continue in order to document the processes that disperse sediment placed at the SWS. The USACE and Moritz et al (2003) argue that placement of material at the SWS emulates the process by which sediment moved historically from Peacock Spit to Benson Beach. Further study of this pathway should help to document the efficacy of SWS placement in feeding Benson Beach vis-à-vis nearshore placement and beach nourishment. Finally, it is important to note that there is a need to continue to place sediment at the SWS regardless of the current proposals to put sand on Benson Beach. This owes to the concern that Peacock Spit is eroding (see Figure 7.) If left un-nourished, the erosion could undermine the North Jetty. Hence, there must be a careful balance of the sediment placed on Benson Beach and the SWS.

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[3] Moritz, H.R., Moritz, H.P, Hays, J.R., Sumerall, H.R., "100-Years of Shoal Evolution at the Mouth of the Columbia River: Impacts on Channel, Structures, and Shorelines," ASCE, Coastal Sediments '03, 2003.

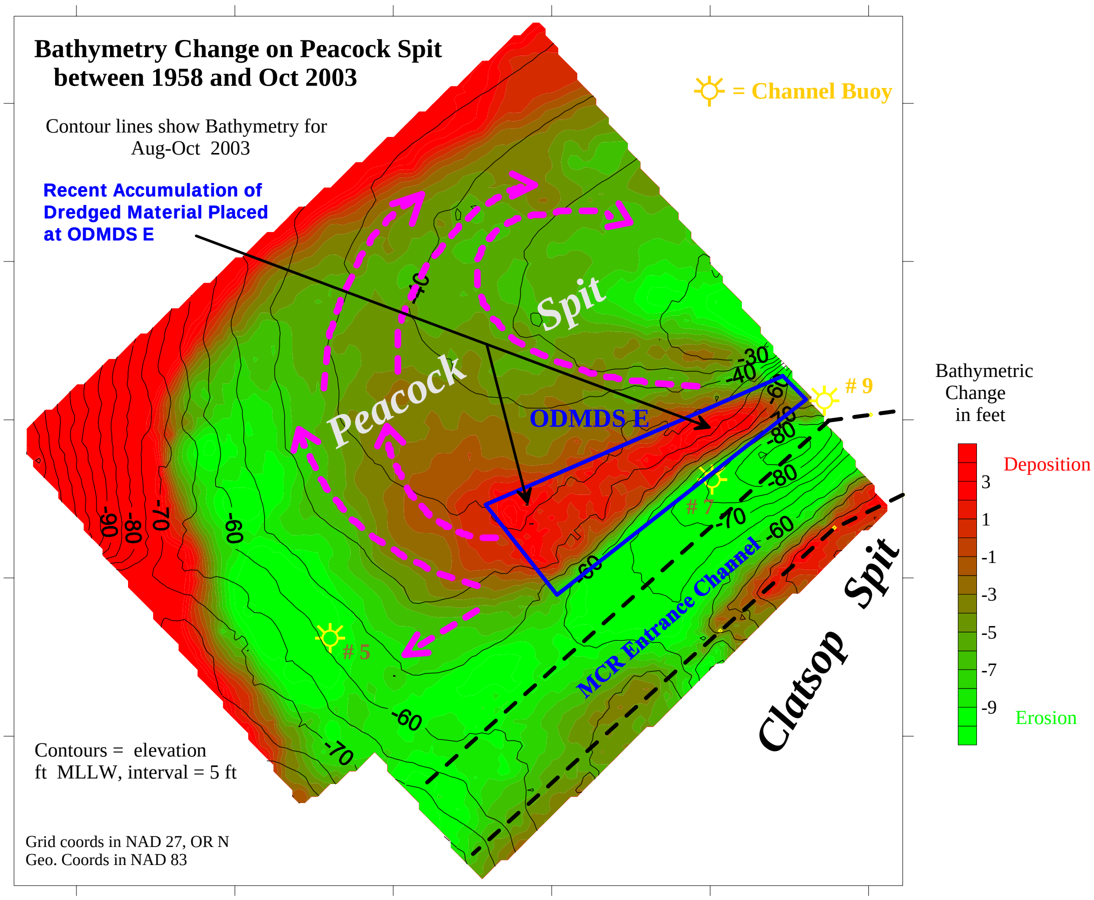

Figure 24 – Bottom Changes and Sediment Movement Over Peacock Spit (USACE)

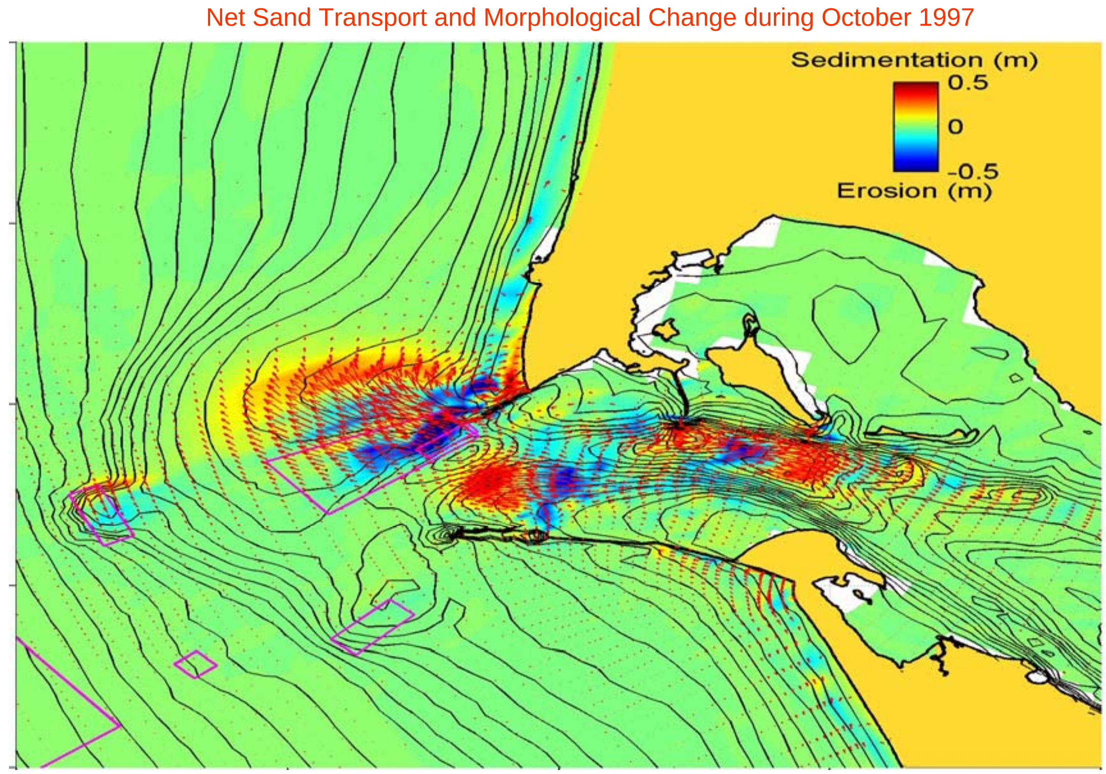

Figure 25 – Bottom Changes and Sediment Movement Over Peacock Spit (USGS)

The results for placement Sites 2 and 3 are also qualitatively consistent with logical expectations. Specifically, the results suggest that sediment placed within 2,000 feet of the North Jetty tend to move south towards the North Jetty; sediments placed beyond 2000 feet move to the north along Benson Beach.

The results for near-shore placement at Site 4 are less conclusive inasmuch as the PTM does not simulate the physics of onshore/offshore sediment movement. For example, the model does not simulate the onshore movement that occurs when a beach is exposed to lower height, swell waves.

More work is needed (both in terms of numerical modeling and field measurements) in order to determine the fate of sediment placed at various locations along Benson Beach. In this regard, moving ahead with a HDPA operation involving 500,000 cy or more would offer an excellent opportunity to monitor the sediment fate. Field measurements and modeling efforts should be conducted in connection with such placement of sand.

Finally, it is noted that PIE suggests that the proposed beach will be placed with a 20:1 slope extending from approximately +14 to -10 feet MLLW, see Figure 3. While it may be entirely possible to accomplish this construction template, it is quite likely that the material will be reworked and flattened by waves. It will be important to document the evolution of this fill and determine any effect it may have on adjacent shorelines.

2.4 Response to Question 4

Question 4: Waves from the northwest occur frequently during the summer and many storms affecting MCR are based on waves approaching MCR from the northwest. Have the documents fully investigated wave-related effects upon sump operation and sump-related impacts for northwest waves?

M&N has reviewed numerical wave model results in Reference 4 (PIE 2006), along with similar results prepared by the USACE and compared the results to actual measurements of waves at both offshore and nearshore locations. While our comparisons were limited owing to time constraints and the availability modeling/measurement details, we are concerned that some of the model results underestimate wave heights in the areas near the proposed sump.

As previously mentioned, Figure 21 shows wave measurements taken offshore and at a station south of the proposed sump. Whereas the PIE model results for this wave condition (see Figure 14) suggest that the nearshore waves would be lower than offshore waves, the measurements show that the nearshore waves are approximately the same height as the offshore wave. Accordingly and as stated above, we are concerned that the wave models require more calibration against additional wave measurements in order to assure that the models accurately reproduce nearshore waves for a full range of offshore wave conditions. Such activities could continue while the suggested HDPA trials are carried out.

2.5 Response to Question 5

Question 5: According to the documents, it appears that the pump-ashore alternative is a more cost effective, total cost and cost/cubic yard, than the sump/pipeline alternative if the scale of dredged material placement (on Benson Beach) is less than 500,000-700,000 cy/yr. Similarly, it appears that the sump alternative is a more cost effective, cost/cubic yard than the pump-ashore alternative if the scale of dredged material placement (on Benson Beach) is to be greater than 700,000 cy/yr. The sump-pipeline alternative assumes that a finite area along Benson Beach can disperse more material than 500,000-700,000 cy/yr? Do the documents verify this dispersal rate? If the environmental window for placing dredged material on Benson Beach is constrained to begin no earlier than July 15 along the Benson Beach area (applies to both alternatives) and ends September 15 in the sump location, what would be the maximum yearly capacity for each alternative?

Although the variation in estimated incremental cost between the USACE (2002) and PIE reports is substantial, there appears to be agreement that the pump-ashore option is more cost effective. Reference 3 (PIE 2005) calculates an incremental cost of pump-ashore as low as $1.00 / cy. Reference 1 (USACE 2002) calculates an incremental cost to the pump-ashore of roughly $5.00/cy. The more recently prepared government estimate of the incremental cost associated with HDPA placement of 500,000 cy on Benson Beach was not included in the documents reviewed for this study. That 2005 prepared government estimate was recently provided and is summarized below with a comparison to M&N estimated numbers for the HDPA option. M&N did not attempt to estimate the cutter-sump option.

The cutter sump option is estimated by PIE to be $5.50 per cy. The USACE 2007 government estimate of the incremental cost associated with the cutter sump options is $7.87 including mob, escalation & contingency as shown below.

USACE 2007 Government Estimate (prepared Aug 05' to Oct 05')

			Mark-ups							
Option 1- Hopper Pump-off	Quantity	**Contract Unit Price**	4% on CC Misc Owner	8% on CC SIOH	4.2% on subtotal Escalation	25% on subtotal Contingency	**Project Unit Price**	Project Cost Extension	Unit Price Comparable to M&N Bid Estimate	M&N Bid Estimate
Hopper Pump-off	500,000	**$5.13**	$0.21	$0.41	$0.24	$1.50	**$7.48**	$3,740,047	$6.68	$4.45
Hopper Nearby Bottom Dump	500,000	**-$1.51**	-$0.06	-$0.12	-$0.07	-$0.44	**-$2.21**	-$1,102,743	-$1.97	-$1.20
Incremental Unit Price	500,000	**$3.62**	$0.14	$0.29	$0.17	$1.05	**$5.27**	$2,637,304	$4.71	$3.24
Incremental Mob		**$0.34**	$0.01	$0.03	$0.02	$0.10	**$0.50**	$248,115	$221,532	$500,000
									Overall Incremental on 500k cys	
Total Incremental Price	500,000	**$3.96**	$0.16	$0.32	$0.19	$1.15	**$5.77**	$2,885,419	$5.15	$4.24
			Mark-ups							
Option 2- Cutter-Sump	Quantity	**Unit Price**	4% on CC Misc Owner	8% on CC SIOH	4.2% on subtotal Escalation	25% on subtotal Contingency	**Project Unit Price**	Project Cost Extension	Unit Price Comparable to M&N Bid Estimate	M&N Bid Estimate
Hopper Dump in Pit	500,000	**$1.90**	$0.08	$0.15	$0.09	$0.56	**$2.78**	$1,387,618	$2.48	No Estimate, uncertain availability, production & feasibility
Hopper Nearby Bottom Dump	500,000	**-$1.51**	-$0.06	-$0.12	-$0.07	-$0.44	**-$2.21**	-$1,102,743	-$1.97	
Incremental Hopper Bottom Dump	500,000	**$0.39**	$0.02	$0.03	$0.02	$0.11	**$0.57**	$284,875	$0.51	
Cutter Rehandle from pit	500,000	**$4.25**	$0.17	$0.34	$0.20	$1.24	**$6.20**	$3,100,410	$5.54	
Incremental Unit Price	500,000	**$4.64**	$0.19	$0.37	$0.22	$1.35	**$6.77**	$3,385,285	$6.05	
Incremental Mob		**$1.40**	$0.06	$0.11	$0.07	$0.41	**$2.04**	$1,020,866	$911,487	
									Overall Incremental on 500k cys	
Total Incremental Price	500,000	**$6.04**	$0.24	$0.48	$0.28	$1.76	**$8.81**	$4,406,151	$7.87	

The Reference 1 USACE 2002 analysis, which arrives at a roughly $5.00 incremental unit price for the hopper pump-off option, is based primarily on the Benson Beach option bid results from 2002. The following issues are relevant:

- The 2002 bids were a small optional quantity within a much larger bid. Small quantity items do not have significant impact on the bidders overall bid success so their pricing is much more subjective than items that make up a large percentage of the total bid. This means that low quantity optional bid items are often not very predictive of future large quantity pricing. This is evidenced by the wide variation in Benson Beach incremental bid prices. The Benson Beach incremental bid varied by 60% while total bid maximum variation was only 14%.

- The approach of using 2002 as bid prices does not take advantage of the actual production experience gained during the 2002 work.

- An estimate based on an understanding of anticipated production and daily cost will be more accurate. There is ample information available on daily cost and production history of the likely construction tools, dredging the same channel, and pumping out in the same location.

- The graph in Figure 26 presents a similar analysis as in Reference 1 (USACE 2002) but shows all bids. The Great Lakes Dredge and Dock (GL) line is the one used as the high line with an average and low offset, but not widely enough to cover the other bids received. Approximations of the USACE mid and low projections are shown dashed. Given the bandwidth, this analysis is not conclusive. By the USACE numbers, the incremental beach fill cost for the expected quantity is anywhere from approximately $3.5 to $6.00. The as-bid variation was wider from $2 to $7 per cy, demonstrating how inconclusive basing a cost estimate on a small quantity optional bid can be.

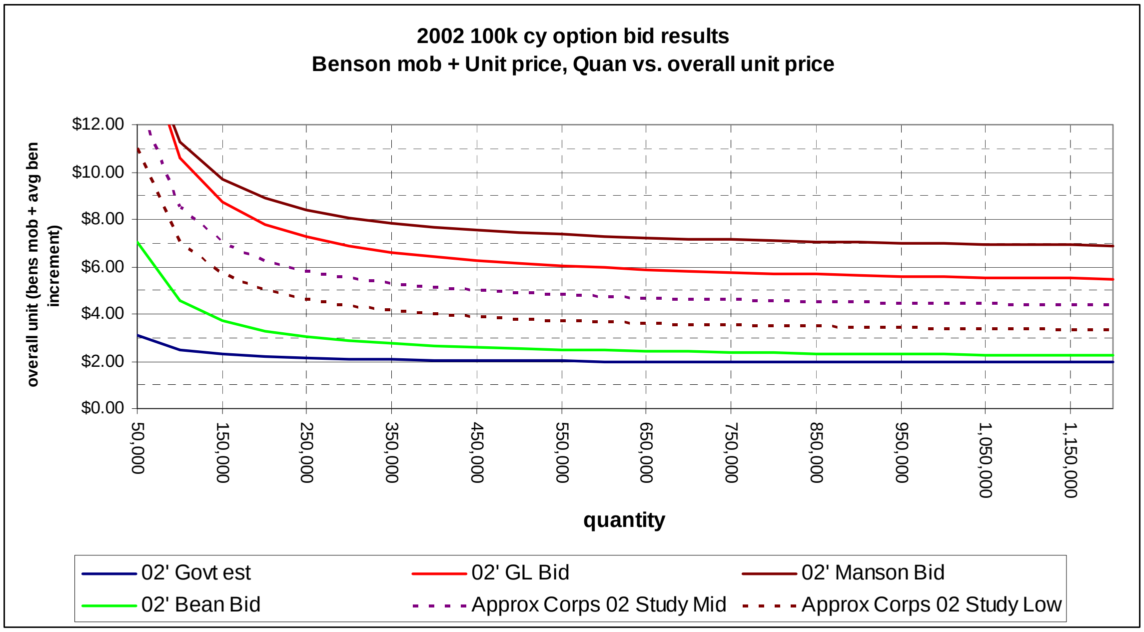

Figure 26 – 2002 Dredge Bid Analysis

Reference 3 (PIE 2005) presents hopper pump-off costs based on regressions from production and price history. Our own analysis of the incremental price is based varying only the components of the overall cycle that are impacted by the disposal operation change and should therefore be more accurate in determining cost. We are also concerned about the PIE pricing of the cutter-sump options as the availability of suitable cutter-suction pipeline dredges on the West Coast is quite limited. Combining the requirement for an ocean-capable cutter suction pipeline dredge to an already limited hopper dredge bidding field makes accurate predictions of the pricing of the cutter work nearly impossible.

Table 1 below shows the results of the M&N analysis. The incremental cost of Benson Beach pump off is roughly $3.24 as compared to Area E and $1.95 /cy as compared to the Deep Water site (not including a $500k Benson Beach Mobilization).

M&N Estimate Summary					7/15/2006
Evaluation of Incremental Price to Benson Beach via Hopper Pump-out					JGM
1	**Base Mob**	$1,500,000			
2	**Unit Prices**		Alternative Disposal Sites		
			Option A	Option B	
	Disposal Sites	E/NJ	Deep Water	Benson Beach	Totals
	Cys	950,000	700,000		1,650,000
	Load Size	2,300	2,300	2,300	
	Pump	51	51	51	
	Turn	1	1	1	
	Sail to dump	16	75	22	
	Connect	0	0	15	
	Discharge	6	6	90	
	Disconnect	0	0	15	
	Sail to cut	15	50	21	
	Total Cycle	88	182	214	
	T.E.	88%	88%	80%	
	Loads per day	14.4	7.0	5.4	
	cys/day	33,198	16,013	12,368	
	days	28.6	43.7	56.6	
	Daily Revenue	$40,000	$40,000	$55,000	
	Unit Price	$1.20	$2.50	$4.45	
	Extension	$1,144,659	$1,748,582	$3,112,945	
	Incremental Beach Mob			$500,000	
	Total MCR Maint Option A (DWS)				$4,393,241
	Total MCR Maint Option B (Benson Beach)				$6,257,604
3	**Incremental Benson Prices (M&N)**				
		As compared to DWS			
			Increemental Unit	**$1.95**	
			Incremental Mob	$500,000	
			Quantity (cys)	700,000	
			Incremental Cost	$1,864,363	
			Incremental Unit including Mob	**$2.66**	
		As compared to E/NJ			
			Increemental Unit	**$3.24**	
			Incremental Mob	$500,000	
			Quantity (cys)	700,000	
			Incremental Cost	$2,769,512	
			Incremental Unit including Mob	**$3.96**	

Table 1 – M&N Dredge Cost Analysis

Note the resulting days of contractor dredge occupation at MCR are higher than the Reference 1 (USACE 2002) stated limit of 60 in either disposal scenario, but given the average 4.2 mil cys/year, the closure of Site F and the limit of 50 government dredge days (assuming 51k cys/day x 50 days = 2.55 mil cys Essayons), there may not be an option to exceed the 60-day contractor duration without requiring larger dredges that have been used in the past. To require larger, higher capacity contract dredges would further limit an already small field of potential equipment available to bid on the project.

The M&N estimated incremental price shown above for hopper pump-off is $3.24/cy without mobilization. This is higher than the PIE estimate of $1.00/cy and lower then the comparable USACE estimate of $4.71/cy (not including mobilization).

It should be noted that the USACE estimates (in both reference 1 and the 2007 government estimate) compare Benson Beach costs to nearby bottom dump (E or NJ), while the PIE compares the Benson cost to the Deep Water Site. The M&N analysis generates an incremental price as compared to each of these two possible base cases. In the case of the DWS, the M&N incremental unit prices are $1.95 and $2.66 without and with mobilization respectively. Given the limited capacity of areas E and NJ, it is likely that any material delivered to Benson in 2007 and beyond would be diverted from the Deep Water site, making a comparison to DWS more appropriate than area E or NJ.

There is certainly no guarantee a cutter-suction dredge in the cutter-sump option could deliver more quantity to Benson Beach in one season than the hopper pump off option. The reason is the cutter suction placement on Benson Beach would have to halt early enough in the season to ensure the hoppers can re-fill the sump within the weather window. Moreover, the cutter-suction is expected to have very limited operating time at this site due to the site conditions. In fact, we are not sure a contractor would accept the risk of placing a cutter-suction dredge at this site due to the wave climate, current conditions and proximity to the jetty. Even if they would, we would expect the costs to be prohibitive. Unlike the hoppers, which could bottom dump in periods of inclement weather, the cutter suction dredge will be idle, or worse yet trying to move on and off the site as the weather changes. The cost of this idle time will be built into the cutter-suction dredge unit price. Contractors with many years of experience in this area explain that the wave conditions at this site can go from acceptable to unacceptable simply based on the tide stage, with peak ebb tide being the most difficult time. A hopper dredge could select which loads in the course of a day to pump off but a cutter suction dredge (given the extensive set-up and demob time) could obviously not “play the tides” in selected it’s operating windows. It is not unusual for ocean operated cutter suction dredges to break anchor wires or have floating pipeline come apart in rough weather. While working in offshore beach replenishment work, the consequences of such an event are minimal as equipment is chased down by tugs or at worst, goes aground on the soft bottom slope of the beach. While just a few hundred feet from a rock jetty, the consequences for a cutter suction dredge would obviously be much more dire. It is true that hopper dredges have the same issue but hopper dredges are self propelled vessels and always have their main engines running during pump-out. Any issues with the mooring system, while risky, are much less likely to lead to a dredge smashing into the jetty with the resulting fuel spill and personnel risk.

Production rates and costs associated with cutter-suction dredging are difficult to quantify owing to (1) the lack of reliable wave climate and systematic downtime analysis for pipeline operations; (2) the lack of bidding history for pipeline dredges at MCR or comparable sites; (3) the lack of precedence for pipeline dredging in such rough location on the U.S. West coast; (4) the unquantifiable weather-related production risks associated with operating a cutter-suction dredge at this site; and (5) the safety concerns related to the operation of a cutter-suction dredge at this site.

Despite the above statements, we have attempted to estimate the maximum volume that could be placed on Benson Beach in a single season. The following assumptions were made: (1) a 30" dredge comparable to the HR Morris, (2) production rate of 30,000 cy/day based on free flowing, deep cut sand pumped less than 10,000 feet, (3) re-fill of the sump does not commence until the cutter work is complete, (4) the re-filling is made by a contractor hopper dredge at a rate of 33,000 cy/day, and (5) the cutter dredge experiences 35% downtime (an optimistic value that we do not recommend but used here for comparison purposes.) The resulting monthly production rate for the cutter-suction dredge is 590,000 cy. Balancing the available time for cutter and hopper dredging, results in a maximum volume of 1.18 MCY on Benson Beach. The cutter and hopper times are 2 months and 1 month, respectively. This value exceeds the maximum value of 700,000 cy associated with the use to two hopper dredges under the HDPA option, but is much lower than 4 MCY volumes that PIE have associated with a PDS alternative. In short, one can achieve similar maximum volumes on the order of 1.1 MCY for both options so long as a third hopper dredge is mobilized.

We have spoken to representatives of all the major cutter-suction dredge operators in the nation (Manson, GLD&D, Weeks and Bean-Stuyvesant). All are in agreement that given the site conditions, a hopper pump-out is a much more practical alternative to a cutter-suction dredge digging a sump in the given location. Additionally, each of the contractors consulted expressed serious concerns regarding safe operation of a cutter-suction dredge at the MCR owing to difficult wave and current conditions. These views are consonant with those expressed in this report.

In summary,

- The HDPA option can place 500,000 cy of sand on Benson Beach at total estimated incremental cost (relative to the SWS) of $2.9 M per annum (per USACE cost estimate, which is more conservative than M&N estimate) for a fair weather year. This can be accomplished with the typical 2 hopper dredges and avoids digging the sump, exposing the North Jetty to attendant potential damage from scour/waves, risking cutter dredge equipment and personnel, and mobilizing a third dredge. Mobilizing a third hopper dredge can result in placement of more than 1 MCY at a lower cost per cy than the PDS.

- The PDS option can place 500,000 cy of sand on Benson Beach at a total estimated cost (per USACE) of $4.4 M per annum for a fair weather year. This option requires the mobilization of 3 dredges but has the potential to place up to 1.1 MCY on the beach (albeit at proportionately greater cost than $4.4 M/yr). This option involves much more risk than the PSA in terms of digging the sump (with attendant risk to the North Jetty), and exposing the cutter dredge, equipment, and crew to damage/injury.

- Inasmuch as the same volume of sand can be put on Benson Beach at much lower risk/cost using the HDPA scheme vis-à-vis the PDS option, we see no advantage to the latter.

The issue of sediment dispersal posed above for Question 5 is addressed under Question 7.

2.6 Response to Question 6

Question 6: Do the documents contain adequate procedures and factors to decide whether to modify or stop use of the sump in the event that conditions during operation of the sump present a threat to public health or the environment?

This question is addressed in our response to Question 2. M&N recommends that a detailed downtime analysis of proposed sump operations be conducted once additional wave data are available for the sump location. These data can be collected while the HDPA alternative is being tested over several dredging seasons. The downtime simulations would have to consider all of the relevant factors associated with a PDS operation including dredge mooring analysis, wave conditions, operational procedures, and means for evacuating the dredge to safer waters. Such analyses are common for petroleum terminals (both pier-type and single or multi-buoy mooring types) and are used by the oil companies to quantify anticipated downtime.

2.7 Response to Question 7

Question 7: Have metrics been defined for assessing project performance; at the re-handling area (sump or pump-ashore hopper dredged), at the point of initial placement on Benson Beach, and dispersal after placement.

Specific metrics have not yet been developed for assessing the project performance. We would suggest that the minimum metrics would involve the following:

For the sump re-handling area, an appropriate metric would be the expected/actual downtime analysis either the HDPA or PDS operations. The analysis should include detailed wave measurements at the sump site as well as predictions of the downtime impacts associated with sump-related modifications to the wave environment using a more fully calibrated/verified numerical model. Results in Reference 4 (PIE 2006) illustrate the potential for wave amplification on the sump boundaries (see Figures 15 thru 17.)

For the initial placement area, important metrics include the volume and location of all material placed on the beach. Appropriate field measurements should include topographic and hydrographic surveys. The Argus camera system also provides an excellent opportunity to quantify initial placement as well as subsequent dispersal.

A critical metric for the overall demonstration project is the volume of sand restored into the littoral system. Tracking the fate of the initial placement through a detailed monitoring program must be a cornerstone of the littoral drift restoration. Morphological models can use this data for calibration and verification purposes.

2.8 Response to Question 8

Question 8: Have the documents described a monitoring plan that measures the response of the project and related impacts based on the above metrics?

The documents reviewed do not address monitoring plans in detail. However, understanding of their importance has been made clear. Reference 2 (USACE 2004) states the following, with which we fully concur:

> *If there is to be additional dredged material placed at Benson Beach, monitoring actions should be adequately funded "up front" for tracking of the movement of placed sand and include monitoring during the fall, winter and spring seasons. Before a large pump-ashore operation is contemplated…more information is needed concerning the fate of dredged sediment placed within the inter-tidal area of the beach. Biological monitoring of the beach and nearshore should be conducted, especially if a large quantity of sand is to be placed…*
>
> *Predictions of dredged material behavior when placed within the inter-tidal area of Benson Beach cannot be made due to the complexities of waves, currents and sediment transport within the surf zone…Field measurements of dredged material behavior, when placed on Benson Beach, are the only way to reliably verify the beneficial effects of dredged material placement.*

Reference 4 (PIE 2006) suggests the following elements of detailed monitoring plan to be developed:

- *Monitor the sump during construction and operation, and observe any tendency for migration toward North Jetty.*
- *Plan to take mitigation action to fill sump if migration toward North Jetty occurs.*
- *Evaluate performance of sump and effects on surrounding area for application beyond the scope of the demonstration project.*

Monitoring should, at a minimum, include wave measurements, current measurements, measurement of dredged volumes, periodic beach profile surveys, aerial photographs, dredging operation logs, and Argus photographic monitoring of beach movements.

2.9 Response to Question 9

Question 9: Do the documents identify and characterize the uncertainties related to the methods and procedures used, and are the potential implications of such uncertainties clearly explained?

An explicit assessment of the above uncertainties has not yet been addressed. This pertains to modeling efforts, field measurements, anticipated dredging operations, potential morphological developments of the sump, exposure of the North Jetty to waves, the long-term trend for lowering of the bottom south of the North Jetty, and fate of sand placed on Benson Beach.

2.10 Response to Question 10

Question 10: Have the documents described the short-term and long-term objectives of the Washington Littoral Drift Restoration Demonstration? Are these goals consistent with the constraints at MCR (the potential need to balance sediment management both north and south of MCR)?

The following is taken from Reference 4 (PIE 2006):

> *The Littoral Drift Restoration (LDR) Project is a long-term strategy for disposal of dredged sediment at the MCR. The purpose of the project is to restore significant quantities of sediment directly to the littoral drift on the Washington Coast to the north of MCR. The objective of the project is to place dredged sediment directly into the intertidal zone on Benson Beach on the north side of the North Jetty....*
>
> *Pacific County and the Coastal Communities of Southwest Washington, through their consultants Pacific International Engineering (PI Engineering), identified the technical feasibility of pumping sediment from a hopper dredge across the North Jetty onto Benson Beach through a trial placement in 2002.*
>
> *The LDR Project is consistent with the origin, objectives, and intent of the USACE Regional Sediment Management (RSM) program (e.g., Martin, 2002). The concept of RSM originated with the notion of coordinating coastal dredging activities for the purpose of retaining sand in the littoral zone in order to foster more balanced, natural system processes, and reduced project costs. The project under development is intended to promote sustainability principles through an approach that considers competing demands for sediment resources, accommodates multiple objectives, and adopts a long term perspective to develop, demonstrate, and implement a dredging and placement program and achieve acceptable cost efficiencies.*

The above paragraphs espouse LDR, an appropriate and responsible goal to place sand dredged from the MCR directly onto Benson Beach in order to keep sediment in the littoral system. LDR as stated above does not address placement of sediment on the Oregon side of the MCR. M&N agrees with the goal of putting as much sand directly on the beaches of both Washington and Oregon as practicable. Additional analyses should be prepared to better support a rational for determining the equitable fractions placed north and south of the MCR. Several factors influence the need to place sand directly on the beaches and determine the appropriate volume of sand placed including:

- Placement costs and cost sharing roles compared to the status quo placement practices;
- The ability of receiving beaches to accommodate sand volumes while assuring that sediment is transported alongshore to the north and south so as to restore littoral drift; and

- The extent to which sediment already moves from the various placement existing sites to the surf zones of Washington and Oregon.

It is more expensive to put sand directly on the beach than place it in existing MCR placement sites. The USACE is Congressionally charged to place sediments at the least cost, environmentally acceptable sites. At this point in time, the additional costs associated with placing sand directly on the Benson Beach are borne by special funding arrangements.

Moving forward, a number of critical issues should be addressed in order to further rationalize decision-making:

- More work needs to be done to determine the efficacy of placing sediments at the SWS to feed the Washington Coast, and in near-shore placement for the Oregon Coast. The work should include additional field measurements and numerical modeling. Given the USACE's charter to place sediment in a cost-effective and environmentally acceptable manner, it will be important to quantify to the extent practicable the amount of sediment that reaches Washington from the SWS. This volume will influence decisions regarding the volume placed directly on the beach, irrespective of the funding mechanism.

- Sediment placed on Benson Beach (e.g., 500,000 cy from a HDPA operation) should be thoroughly monitored and modeled in order to determine if the sediment volume: (1) can be accommodated without excessive offshore losses; (2) can be accommodated without excessive losses associated with southern transport back to the MCR; and (3) will move towards the north to feed State of Washington beaches. Additional volumes could be placed in subsequent years, within the limit of available funding, in order to determine the volumetric "dose" of sand that can be absorbed by the Benson Beach littoral system.

- A detailed assessment should be made to determine the amount of sand that should be placed north and south of the MCR. It is certainly inequitable to place all of the sediment dredged from the MCR to one side or the other. This determination will identify the maximum volumes that should be expected by Washington and Oregon.

2.11 Response to Question 11

Question 11: Do the documents address the potential consequences of maximizing placement of MCR dredged material on Benson Beach, with respect to: Effects on the overall MCR sediment budget, capacity of Benson Beach to disperse placed material, capacity of Benson Beach to accumulate placed dredged material, intended transport direction at location of placement?

The documents focus on the placement of dredged sand directly onto Benson Beach. Discussions with PIE indicate that one of the reasons that compel them to advance the pipeline dredge-sump alternative is because it would be possible to place as much as 4,000,000 cy on Benson Beach with a pipeline dredge. Achieving this same volume with a hopper dredge scheme would be more difficult. In this regard, the documents focus on getting sand on Benson Beach. They do not address the overall MCR sediment budget or the ability of Benson Beach to accommodate such a range of sand volumes in a relatively short time window. The overall MCR sediment budget is of concern. There are strong arguments for continuing to place sediments dredged from the navigation channel within the MCR littoral complex in order to keep the ebb-tidal bar in relative equilibrium. Putting all 4,000,000 cubic yards of the sand dredged on Benson Beach, for example, may result in a destabilization of the ebb-bar with potentially dire consequences for the North Jetty system and natural processes. Suggestions for addressing these issues are provided above in connection with Question 10.

There is also a public access issue associated with the volume of sand place on Benson Beach. Reference 2 (USACE 2004) states that Cape Disappointment State Park is the second most visited state park in Washington. Impacts to public access must be considered as part of the NEPA process. In Southern California, RSM-related beach fill activities are restricted to non-summer months, due in part to consideration of impacts to public access. Non-summer beach fill operations are not feasible at the MCR due to severity of operational conditions. Any large scale beach fill operation must consider the duration and extent of access impacts. Impacts will result from both pump ashore operation as well as the subsequent earth-moving operations to more effectively place the material along the beach.

2.12 Response to Question 12

Question 12: Are the documents detailed enough to be consistently followed and understood by technical staff, dredge operators, and the public?

The ITR team found the reviewed documents to be of a high quality, consistent, and understandable. Some are relatively technical in nature and may, as a result, be more difficult for a layperson to follow. This is an observation, not a criticism.

3 Summary and Conclusions

Moffatt & Nichol (M&N) has conducted an independent technical review (ITR) of issues surrounding the proposed scheme to place sediments from the mouth of the Columbia River (MCR) on Benson Beach. The scheme involves excavation of a sump (excavated pit south of the North Jetty) using a cutter suction pipeline dredge with placement of excavated sediment on Benson Beach. This scheme has been devised by the Southwest Washington Coastal Communities (SWCC) as a means for littoral drift restoration (LDR) to shorelines north of the MCR. SWCC and their consultants (i.e., PIE) prefer placing sand on the beach to the USACE practice of placing sediments at the existing shallow water site (SWS.) The USACE maintain that a portion of the sediment placed at the SWS reaches Benson Beach. The USACE further argue that placing sand directly on the beach constitutes a costly alternative to SWS, or nearshore placement, both of which keep sediment in the littoral system and act to feed sediment to areas north of the MCR. Nearshore placement, it should be noted, is not a current practice owing to various environmental issues.

The following conclusions are relevant to this ITR.

- LDR is an appropriate and responsible goal for sediment management at coastal inlets. Every effort should be taken to place sediment directly on the beach, or at least well-within the littoral zone, so long as such placement can be paid for in an appropriate manner consistent with the normal statutory responsibilities[4] of the USACE to place dredged sediment in the least cost, environmentally acceptable, manner. Further, the volume of sediment placed on the beach in this case should consider the balance of sediment appropriate for the adjacent coasts of Oregon and Washington as well as the volumes that should be placed at the SWS to maintain Peacock Spit and the North Jetty.

- To the best of M&N's knowledge from review of existing reports, the work conducted to date on behalf of the SWCC by Pacific International Engineering (PIE) appears to be of good quality and has served to inform stakeholders to LDR issues. This work has included numerical modeling and field measurement efforts dating to 2002 and earlier. USACE and the United States Geological Survey (USGS) have also contributed high quality modeling, field measurements, and other scientific analysis.

- Despite the commendable work done to date by all parties in connection with dredged material management and LDR issues at the MCR, M&N is concerned that significant uncertainties remain including: (1) the vulnerability of the North Jetty to the construction of a sump particularly under a scenario where the sump is not re-filled by the end of the summer dredging season owing to unforeseen operational vagaries, exigencies, or breakdowns in dredging operations; (2) the long-term morphological evolution of the bathymetry south of the North Jetty; (3) the wave climate anticipated at the sump location; and (4) the feasibility of using

[4] Code of Federal Regulations, Part 334.7, 335.5

a pipeline dredge to accomplish the work in the potentially problematic wave climate at the sump location.

- The Pipeline Dredge-Sump (PDS) alternative has some promise for application at the MCR. Owing to the remaining uncertainties listed above, however, the ITR team recommends that additional tests of the hopper dredge pump ashore (HDPA) scheme be continued for at least three successive summer seasons. The HDPA scheme is less risky and more conducive to poor weather than the PDS scheme. For example, when waves become intolerably large, a hopper dredge can cease pump-ashore operations and continue dredging the MCR and placing sediment at current placement sites. This way, dredging downtime and its associated economic effects are minimized to the greatest extent possible. The HDPA operation is envisaged as the first of a two-step process to place 500,000 cy of sand on Benson Beach and would serve to answer key questions regarding the feasibility of such an operation. Performance criterion (e.g., cost-effectiveness, ability of Benson Beach to absorb sand, acceptable downtime, etc.) should be established and agreed to by stakeholders to fully evaluate HDPA efficacy. With several years of HDPA experience and new wave data taken directly at the sump/pump-out location, better-informed decisions can be made regarding implementing the phase 2, PDS option.

- In connection with the recommended HDPA activities, the ITR team strongly recommends that scientific and engineering efforts continue. The efforts should include: (1) wave data collection at the sump area for the proposed three seasons of HDPA activities; (2) further modeling/measurements of waves, currents, sediment transport, and morphological evolution of the MCR including the area to the south of the North Jetty and the SWS; (3) further modeling/measurements of the Benson Beach including fate and dispersal of sediment placed on the beach; (4) assessment of the relative distributions of sediment that could be placed on the adjacent shorelines of both Washington and Oregon and (5) detailed monitoring and evaluation of dredging operations, downtime, and correlation of both to actual wave conditions. The combination of the HDPA activities and further scientific/engineering efforts is a positive means for making progress in dredged material management and LDR of interest to stakeholders including the States of Washington and Oregon as well as Federal Agencies including the USACE.

- The recommended HDPA operations are a logical extension of the scientific, engineering and construction activities performed to date. The risks associated with the HDPA are significantly less than those associated with PDS alternative owing to the fact that hopper dredges have worked the MCR for years whereas a pipeline dredges have never worked the MCR. Uncertainties associated with wave climate, sump development/performance, suitability of pipeline dredge for application to the MCR are all circumvented by HDPA implementation. Furthermore, the HDPA costs are significantly lower than the PDS costs to achieve the same results.

- The HDPA alternative accomplishes the same goals as the PDS alternative: it puts sandy sediment from the MCR directly on the beach. This is agreeable to the various stakeholders. PIE argues that one of the principle advantages of the PDS scheme is that it could place as much as 4 MCY/yr on Benson Beach. We have estimated, however, that the PDS volume is limited to about 1.1 MCY/yr based on existing dredging windows and typical 30 inch dredge. The reader should note that the PDS involves a total of 3 dredges (i.e., 2 hoppers and 1 cutter). We have also estimated that a similar volume could be placed with 3 hoppers while only 700,000 cy could be placed with 2 hoppers. With regard to costs, we estimate that 500,000 cy could be placed on Benson Beach with the HDPA scheme at an estimated incremental cost of about $2.9M per year. The same incremental cost for the PDS option is estimated at $4.4M per year. In short, the hopper dredge scheme is significantly more economical for the same volume. At this point we do not see the advantages of the PDS option in terms of total volumes ranging from 500,000 to 1.1 Mcy. Rather, we see several significant risks and disadvantages of the PDS option relative to the PDS option. This is not say that the PDS should be eliminated but should be further evaluated over the next 3 years as more experience is gained. Furthermore and as has been stated, it is inadvisable to place volumes on the order of 4Mcy on Benson Beach. A better approach would balance the volume of sediment placed: (1) north and south of the MCR, (2) at the SJ site, and (3) the SWS.

- Upon completion of the recommended three years of HDPA operations, much more will be known about the sump area wave climate, the ability to place certain volumes of sediment on the beach, the fate of sediments placed on the beach, and the impact (if any) to the ebb tidal shoal areas of the MCR. At this time the issue of the HDPA and PDS alternatives should be revisited to determine if the latter is economically/environmentally feasible based on a better understanding of: (1) the performance of the HDPA operation; (2) the actual wave climate; (3) studies of the downtime that could hamper PDS; and (4) issues surrounding the sediment budget of the MCR and appropriate distribution/placement of sediments therein.

- Funding sources for placing sand on Benson Beach have been intermittent and associated with specific Congressional initiatives. To place 500,000 cy sand on Benson Beach in perpetuity will require annual funding on the order of $2.9M to $4.4M; larger volumes will require proportionately larger funds. Accordingly, it will be necessary to identify and implement a long-term funding arrangement for placing sand on the beach. An attractive option would be to pursue Section 933 of the Water Resources Development Act of 1986 which allows for a 50/50 Federal/Local share of the incremental cost to place sand on the beach vis-à-vis the least cost, environmentally acceptable, option. This, or a similar funding mechanism, should be evaluated in order to develop a perennial program for placing sediments on Benson Beach rather than one-off approaches.