Executive Summary

The mouth of the Columbia River (MCR) jetty system is in a state of structural decay. Continued deterioration, ongoing storm activity and the continued loss of sand shoal material—the foundation of each of the three MCR jetties—has positioned the jetty system for a series of frequent, costly emergency repairs. Consequently, significant modifications and repairs to the MCR jetties are necessary for the continued safe entry of ships into the Columbia River navigation channel. Functioning jetties at the MCR support the following:

- $20 billion in international trade
- 42 million tons of cargo
- 3,500 Cargo Vessel crossings per year
- 1,400 crossings requiring more 30-foot draft or greater
- More than 40,000 jobs dependent on this trade

According to the Center for Economic Development and Research, the Columbia/Snake River navigation system is the number one export gateway for the Nation's wheat and barley exports. It is also the number one export gateway for west coast wood and mineral bulk exports and number one for automobile imports. Marine traffic passing the entrance of the Columbia River has increased by 34% from 32 million tons in 2003 to 42 million tons in 2010. All of this translates into significant benefits for not only the Pacific Northwest, but also for the national economy. The Columbia River comprises the M-84 Corridor for the Marine Highway Program. It is noted by the US Department of Transportation as a truck bottleneck resulting in up to 750,000 truck delay hours and an area of major rail congestion. The marine highway serves to reduce the congestion

The primary function of the MCR project is to maintain the navigation channel for deep draft shipping. The secondary function evaluated in the structure rehabilitation effort is to significantly extend the life and reliability of the jetties in order to ensure the primary function.

The MCR jetty system consists of three rubble-mound jetties, with a total originally authorized length of 10.2 miles, constructed from 1885-1939 on massive tidal shoals to secure consistent navigation through the coastal inlet. The inlet morphology has been changing ever since. After decades of storm activity, the tidal shoals of each jetty's foundation have been modified due to erosion.

An analysis was completed that evaluated the causes and problems associated with the current structural instability of the MCR jetty system. This analysis resulted in a recommendation to improve structural reliability, to extend functional life, and most significantly, to maintain deep-draft navigation. Each of the three jetties was analyzed independently in order to define the scope of this major rehabilitation effort. The evaluation report outlines the coastal processes affecting jetty reliability, summarizes the sequence of events leading to the present condition of the jetties, and describes their structural condition. A risk-based, life-cycle analysis was used to examine jetty performance (past and future) and develop jetty modification alternatives through a phased strategy for jetty repair.

Beaches on the ocean sides of the North and South jetties, formed originally as a result of jetty construction, have been receding and thus exposing previously protected jetty sections to storm waves at the beach line. In the absence of specific and immediate repair actions, the jetties and sand shoals upon which they rest will further deteriorate, increasing the likelihood of a jetty breach and immediate impact

to the navigation channel and commercial deep draft access to the Columbia River port facilities. Recent interim jetty repairs have addressed some of the immediate critical needs. For example, in 2007 approximately $19M was expended on repairs to the South Jetty. Additional jetty repairs will be necessary to address critical near- and long-term maintenance needs and to reduce the potential need for emergency repairs and/or emergency dredging and the impacts that result to navigation.

Development of this report applied the recent *Lessons Learned* resulting from Hurricanes Katrina and Rita. They are as follows:

Point 1 – Employ Integrated, Comprehensive and Systems-Based Approach
Point 2 – Employ Risk-Based Concepts in Planning, Design, Construction, Operations and Maintenance
Point 3 – Continuously Reassess and Update Policy for Program Development, Planning Guidance, Design and Construction Standards
Point 4 – Dynamic Independent Review
Point 5 – Employ Adaptive Planning and Engineering Systems
Point 6 – Focus on Sustainability
Point 7 – Review and Inspect Completed Works
Point 8 – Assess and Modify Organizational Behavior
Point 9 – Effectively Communicate Risk
Point 10 – Establish Public Involvement Risk Reduction Strategies
Point 11 – Manage and Enhance Technical Expertise and Professionalism
Point 12 – Invest in Research

The major rehabilitation approach for the MCR jetty system is focused on defining the larger processes affecting the jetty system and then describing the jetty system degradation and reliability over time. Frequency and consequences of future jetty repairs, as well as potential impacts to dredging and navigation, were evaluated using a planning model.

Initially, the base condition involved a "fix-as-fails" approach where each jetty was allowed to degrade to as low as 20 percent of the originally authorized cross section and therefore breaches were forecasted. An Independent External Peer Review (IEPR) comment stated that this was an unrealistic assumption. Upon further consideration, the Portland District changed the base condition to reflect the most likely future jetty maintenance strategy of interim repair.

Due to the level of construction and the high mobilization costs, the revised base condition described in this report does not include any jetty head re-construction. Only the trunk and the root of the jetty are maintained, and the jetty head is allowed to recede landward. The base condition is identified as an interim repair approach because the upper portion of the cross section is allowed to be damaged to approximately 35 percent of the remaining cross-section above -5 MLLW prior to repair actions being taken. In this way, the jetty is maintained close to the margin of functional loss without breaching.

The South Jetty dune augmentation at the root of the South Jetty is part of the base condition and will be implemented regardless of the outcome of the MCR Jetties Major Rehabilitation project. Within a broad assessment it was determined that consequences of a breach would be high enough to warrant preventive measures now, independent of any jetty repair activity. In addition, the FY 11 *Major Maintenance Report* (MMR) actions are part of the *Major Rehabilitation Report* (MRR) base condition: North Jetty lagoon fill between stations (STA) 20 to 60; and North Jetty critical repairs between STA 86 to 99.

In this report, the MRR, three basic with-project implementation alternatives were developed and considered for the MCR jetties: scheduled repair, immediate rehabilitation, and scheduled rehabilitation. Alternatives for each jetty were considered to occur either through scheduled, predetermined time and place, or on a monitor-and-repair basis for locations where a stochastic model predicted jetty repair or breach locations or both.

For the North and South jetties, the repair alternative included repair combined with and without engineering features (head capping and spur groins). For the repair alternative, stone placement is generally limited to the above-water jetty sections and remains within the limits of the existing jetty and relic stone structures.

Rehabilitation alternatives generally incorporated engineering components necessary to increase the reliability of the current structure and jetty system, and could include features that extend beyond the current footprint of existing jetty and relic stone structures and include both above- and below-water fill. Engineering features were incorporated as common components in all rehabilitation alternatives and included head capping, and adding spur groins. Rehabilitation strategies were evaluated as both immediate and scheduled. Scheduled rehabilitation included construction at specific locations along a jetty during specific times in order to optimize the federal investment. For example, based on modeling results, construction on Jetty A will be completed years before work concludes on the South Jetty.

A common set of descriptive life-cycle statistics were used to assess the performance for each jetty within a historical and future context. The statistics used to assess historical performance included jetty repair aspects, life-cycle repair cost, jetty geometry (crest profile, cross-section, head location), and jetty reliability. The statistics used to assess future jetty performance and compare alternatives included:

- Average annual cost (AAC)
    - Initial construction cost
    - Repair costs and their timing
- Reliability or the probability of a project feature to perform satisfactorily
- Constructability and access
- Potential impacts to larger inlet system
- Environmental effects of jetty rehabilitation, repair, or function loss
- Jetty lengths were evaluated based on AAC and functional reliability of their performance, the jetties will not be re-constructed to their authorized length at this time.

Alternatives were formulated based on jetty cross-section resilience, maintenance options, and construction scheduling. Estimates of future life-cycle outcomes were made for a range of maintenance strategies and rehabilitation alternatives. Selection of a least cost plan to manage the future life-cycle of each jetty was based on the optimization of the above metric considerations.

The metric used to portray future life-cycle cost is expressed in terms of average annual cost, which is based on a 50-year period beginning with the on-line year of alternative implementation.

Based on the tonnages produced by the Stochastic Risk-Based life-cycle simulation (SRB) model, head capping and spur groins are not part of the least cost—National Economic Development (NED)—plan for

any of the three jetties. However, this does not preclude the addition of either of these engineering features in the future. If biennial photogrammetric surveys and best adaptive management practices indicate the necessity of head stabilization or spur groins or both, such actions will be reconsidered. Furthermore, during the detailed design report (DDR) phase alternatives to optimize head stabilization will be assessed.

Beyond the initial rehabilitation period, the jetties will be aggressively monitored and maintained. The future costs have been estimated as a series of predicted repairs continuing for the next 50 years. Although the predicted repairs for the entire 50 year life-cycle was utilized to select the most economical plan, only the initial rehabilitation period consisting of the first seven years are itemized below.

For all three jetties, the NED plan was selected and their benefit to cost ratios (BCR) are listed below:

- **North Jetty** (BCR: 1.09) – Scheduled repair with head stabilization at or near STA 101, (less extensive than the previously proposed capping). These repairs will be conducted after the base condition maintenance repairs to stations 86-99 and lagoon fill to stop erosion of the jetty root. It does not include spur groin construction.

- **South Jetty** (BCR: 1.00) – Base condition (interim repairs) allowing head recession. It does not include spur groin construction. Dune augmentation near the jetty root will be implemented in FY 13 as a separate action and not included in the cost estimate. Although the base condition is the NED plan, the interim repair, hold head alternative is very close in AAC, differing by 0.9 percent. When conditions are appropriate (i.e., repairs of the South Jetty allow for a haul road to be established to the end of the jetty approximately FY 2019), head stabilization could be re-evaluated—using parameters such as least cost, environmental acceptability and engineering feasibility.

- **Jetty A** (BCR: 1.42) – scheduled repair and head stabilization at approximately STA 89. It does not include spur groin construction. The modeling performed to assess the project alternatives assumes that Jetty A is in place and fully functioning. This is because Jetty A, as originally constructed, protects the North Jetty and helps to train the Columbia River main stem. In addition, Jetty A is believed to play an important function for the Columbia River plume. The plume is an important food source for the 13 Columbia River salmonid evolutionarily significant units (ESUs) listed under the Endangered Species Act (ESA).

The project has a combined BCR of 1.1 for the system (all three jetties).

The initial construction schedule is projected to be from 2014 through 2020. Based on the 100% federally fully funded, feasibility level design in 2012 dollars, project first cost at an effective price level of 01 October 2012 is $238,547,000 and a total project cost fully funded of $257,201,000**.** Total project costs fully funded are estimated as follows per jetty: North Jetty at $79,797,000; South Jetty at $146,884,000; and Jetty A at $30,520,000.

The scheduled jetty repairs plan will reduce ongoing erosion to the surrounding shoals. Stabilizing the North Jetty and Jetty A lengths will have positive effects on the adjacent shorelines as well as the configuration and evolution of the ebb tidal shoal. Scheduled repairs will also help to stabilize both the above and below water morphology at the project.

Chapter 1 of this report provides a general introduction to the MCR jetties system and surrounding area, including:

- The purpose and importance of the jetty system;
- A detailed history of the construction, past repairs, and morphologic changes;
- The technical, as well as budget challenges; and
- A description of the current conditions.

Chapter 2 provides the economic rationale for the federal interest, a summary of how costs are calculated, and the benefit-to-cost ratios of the various repair/rehabilitation alternatives.

Chapter 3 provides the engineering basis for the development and analysis of the alternatives. This chapter includes:

- A characterization of the wave climate and morphologic processes at the MCR;
- The current issues/risks of deterioration or failure for each of the jetties and associated consequences;
- A characterization of the design of each jetty and the relevant performance modes;
- The description of the methodology and model used for assessing the reliability and life-cycle performance of the jetties, including alternatives;
- A summary of how the model was calibrated using historical and hindcast data; and
- A description of each of the repair/rehabilitation alternatives, including the model analysis results related to projected future long-term maintenance actions and reliability.

Chapter 4 builds upon the previous two chapters to provide a comparison of the alternatives based on initial and life-cycle costs, reliability, and environmental considerations. Based on these comparisons, a recommended plan for each jetty is given.

Chapter 5 summarizes the anticipated environmental effects of the proposed rehabilitation of the MCR jetty system, and the coordination undertaken related to environmental compliance issues. The associated EA provides a full evaluation of the project and associated environmental compliance considerations. Additional discussion and pertinent correspondence is included in Appendix D, *Environmental Documentation.* Any citations in this chapter can be found in the References section of the EA. The discussion is pulled directly from the EA which evaluates the effects of the Major Rehabilitation actions, the Major Maintenance Report actions, and South Jetty dune augmentation actions.

Chapter 6 provides an overview of the construction methods (both land-based and water-based) and estimated production rates and schedule for the recommended plan. The associated cost estimates are provided.

Chapter 7 is the recommendation signed by the USACE District Commander.

The first six appendices provide further technical details of the information summarized in Chapters 3 and 4 of the report. Appendices C, D, E, F, and G provide detailed information related to the economic, environmental, and programmatic discussions of Chapters 2, 5, and 6. Appendix H is a summary of key project events and provides an audit trail for all report reviews.