US Army Corps of Engineers®
Seattle District

PORT of GRAYS HARBOR
On Washington's Pacific Coast

Grays Harbor, Washington
Navigation Improvement Project
General Investigation Feasibility Study

DRAFT Limited Reevaluation Report

Appendix A: Economic Analysis

Prepared by:

U.S. Army Corps of Engineers
Seattle District

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Grays Harbor, Washington, Navigation Improvement Project
Grays Harbor County, Washington
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Acronyms

AAEQ	Average Annual Equivalent
BNSF	Burlington Northern Santa Fe Railroad
BLT	Bulk Loader Tool
DDVOC	Deep-draft Operating Cost
FY	Fiscal year
IDC	Interest During Construction
LRR	Limited Reevaluation Report
NED	National Economic Development
MCF	Marine Cargo Forecast
MLLW	Mean Lower Low Water
Port	Port of Grays Harbor
RO RO	Roll on, roll off
sq ft	square feet
UP	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
CAGR	Compound Annual Growth Rate
NIP	Navigation Improvement Project

1 Introduction

*"The **role** of the U. S. Army Corps of Engineers with respect to navigation is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for movement of commerce, national security needs, and recreation. The Corps accomplishes this mission through a combination of capital improvements and the operation and maintenance of existing projects."*(U.S. Army Corps of Engineers 2000)

1.1 Location

The Port of Grays Harbor is located at the mouth of the Chehalis River on the southwestern coastline of Washington (Figure 1), approximately 110 miles south of the entrance to the Strait of Juan de Fuca and 45 miles north of the Columbia River's outfall. The cities of Aberdeen, Hoquiam, Ocean Shores, and Westport are located within the large harbor. Twin jetties secure the mouth of the bay with a deep draft channel over 23 miles long from the Pacific Ocean near Westport inland to Cow Point (near Aberdeen). The two jetties are 17,200 feet and 13,734 feet long (north and south, respectively) and made of large armor rock. The deep draft channel is 1,000 feet wide over the entrance bar and through the entrance channel reach and decreases to 350 feet wide near the Port of Grays Harbor terminals at Cow Point. The channel and jetties were authorized under the River and Harbor Act of 1896, and modified by subsequent acts.

The segment that is being evaluated for deepening is from South Reach inland to Cow Point. This segment of the navigation channel is currently authorized to -38 feet MLLW, but was implemented and is maintained at -36 feet MLLW (Figure 2: Grays Harbor Navigation Channel Reaches) Referenced to other major Northwest Region ports, the port is located approximately 160 nautical miles from the Port of Portland, 280 nautical miles from the Port of Seattle, and 300 nautical miles from the Port of Tacoma (Google Earth Pro 2012).

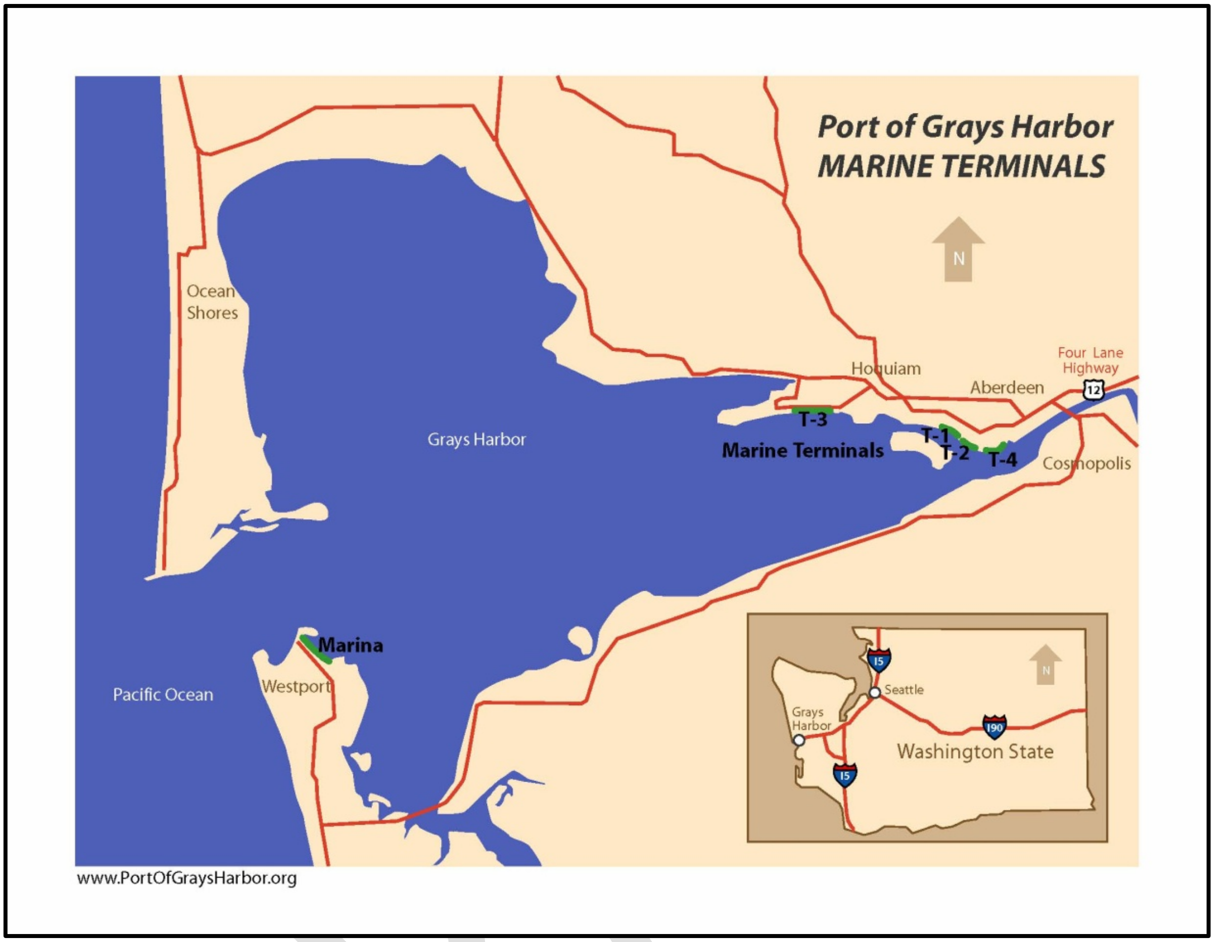


Figure 1: Vicinity Map (Port of Grays Harbor 2013)

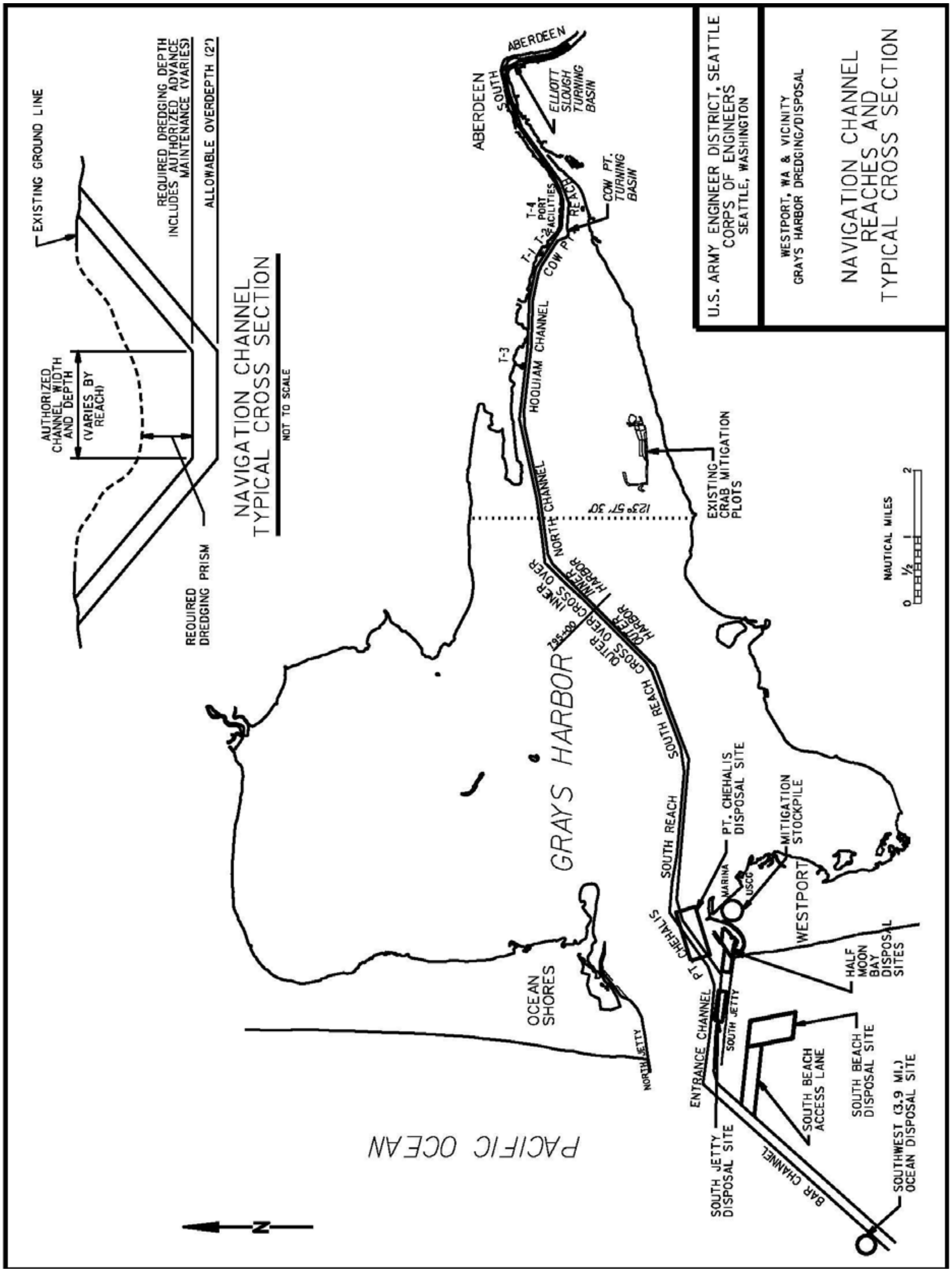


Figure 2: Grays Harbor Navigation Channel Reaches

1.2 Federal Project and Study Authority

This limited reevaluation was initiated at the request of the Port of Grays Harbor (Port) to investigate deepening the Grays Harbor navigation channel, which was not constructed to the authorized depth, based on post-authorization evaluation described below. Congress authorized the NIP in the Water Resources Development Act (WRDA) of 1986, Public Law 99-662. The authorizing legislation is as follows:

PUBLIC LAW 99-662 – NOV 17, 1986

> Section 202 General Cargo and Shallow Harbor Projects
>
> AUTHORIZATION FOR CONSTRUCTION. – The following projects for harbors are authorized to be prosecuted by the Secretary substantially in accordance with the plans and subject to the conditions recommended in the respective reports designated in this subsection, except as otherwise provided in this subsection:
>
> GRAYS HARBOR, WASHINGTON
> The project for navigation, Grays Harbor, Washington: Report of the Chief of Engineers, dated May 4, 1985, at a total cost of $95,700,000, with an estimated first Federal cost of $63,100,000 and an estimated first non-Federal cost of $32,600,000.

The 1986 Navigation Improvement Project authorization provided for deepening the navigation channel to a project depth of -38 feet MLLW. The Corps evaluation presented in the 1989 General Design Memorandum (GDM), Grays Harbor, Washington, Navigation Improvement Project (NIP) resulted in a justified channel depth of -36 feet MLLW from the bar to Cow Point and -32 MLLW feet from Cow Point to Cosmopolis, based on detailed post-authorization engineering, environmental and economic studies[1]. The Corps deepened the channel in 1990, in accordance with the 1989 GDM. This is the current depth of annual maintenance dredging. The project was authorized for a total cost of $95 million, but total initial construction was less than $30 million.

Currently, the channel project depth is -36 feet MLLW up to Aberdeen (just past the Port terminals at Cow Point), and then -32 feet MLLW from there to the last deep-draft dock at Cosmopolis – a distance of about two miles. Based on the shoaling rate in the channel, an additional two feet of dredging occurs for advanced maintenance. Currently, the deep draft channel is dredged either annually or semi-annually depending on volume removed, which averages 1.9 million cubic yards[2] at an average annual cost of roughly $9,000,000[3] with a range of approximately $3-18 million since 1986.

---

[1] The economic analysis in the GDM was based on timber industry and log vessels that, at that time, did not need -38 ft MLLW

[2] This is based on Operations Dredging years from 2000 to 2012.

[3] The annual costs fluctuate and depend heavily on budget availability year to year.

1.3 Purpose and Scope of Limited Reevaluation

Historically, the Port of Grays Harbor, founded in 1911, relied upon renewable resources of the surrounding forest to conduct business. Two decades ago, shifting global demand from U.S. timber to less-costly sources from Russia and New Zealand put the Port of Grays Harbor's future in jeopardy (Millman 2011). This can be attributed in large part to the listing of the Northern spotted owl to the endangered species list in June 1990. The listing prevented the timber industry from clearing lands within a 1.3 mile radius of any spotted owl nest or activity site (Andre and Velasquez 1991). Harvest of timber in the Pacific Northwest was reduced by 80%, decreasing the supply of lumber and increasing prices (Brokaw 1996).

In 2007, to revive the port, Grays Harbor embarked on a redevelopment plan that included diversifying away from timber and focusing on developing new partnerships with manufacturers and exporters. The plan included capital investment of approximately $18 million in rail and rail capacity and an additional $200 million of private investment in port facilities. Due in part to the Port's ambitious redevelopment plan and its touted "one day closer to Asia" than inland spots like Seattle and Tacoma, the Port has seen a steady increase in trade volume over the past decade. The Port of Grays Harbor's diversification of commodities has led to an increased cargo volume from 1.28 million short tons in 2006 to approximately 1.82 million short tons in 2012, representing a 42% increase, and is expected to continue to grow in the near future.

This Limited Reevaluation Report (LRR) documents the analyses undertaken within a limited scope, limited to the economics and environmental effects of deepening alternatives. The purpose of this economic analysis is to estimate the National Economic Development (NED) benefits associated with harbor improvements, specifically channel deepening, that are designed to allow more efficient navigation in Grays Harbor by the existing and future fleet.

At the request of the sponsor the economic evaluation is limited to the legislatively authorized depth of -38 MLLW and as such the recommended plan may or may not coincide with the plan that maximizes the NED benefits but the recommended plan is the plan that maximizes the NED benefits within the aforementioned constraints of limited depth.[4]

The economic analysis was prepared in level of detail commensurate with the complexity of the project. It is not intended for the analyses for Limited Reevaluation Reports (LRR) to be exhaustive, but should provide sufficient data to document the steps used in formulating and identifying the recommended plan.

[4] Generally in deep draft navigation economic analysis the economist would look at a host of depths and not limit the analysis to two depths.

1.4 Problems and Opportunities

The following sections summarize the known problems, opportunities, and objectives identified for the re-evaluation.

1.5 Problem

As a result of the current channel depth of -36 feet MLLW and the narrow tidal windows, deep draft vessels calling at Grays Harbor have to be partially loaded or experience tidal delays due to insufficient channel depth.

1.6 Opportunities

Opportunities of a deeper navigation channel include:

- Vessels could operate more efficiently by being fully loaded or avoiding tidal delays
- Increased efficiencies could result in decreased cost to move commodities through the Port of Grays Harbor, resulting in lower cost of consumer goods
- Vessels carrying more cargo could reach the Port facilities
- U.S. producers could be provided improved access to world markets
- Economic competitiveness of producers would be improved
- Would allow increased beneficial use of dredged materials

1.7 Planning Objectives

The water and related land resource problems and opportunities identified in this study are structured as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions.

The primary objective of federal navigation activities is to contribute to the Nation's economy while protecting the Nation's environmental resources in accordance with existing laws, regulation and executive orders. Navigation channels meet the federal objective by reducing transportation costs and improving the efficiency and safety of the deep-draft navigation system, thereby reducing vessel operating costs, resulting in potential savings to the consumer. The specific planning objective for this study is:

- Reduce navigation transportation costs for the existing and projected future traffic of deep-draft vessels, and improve efficiency and reliability of navigation to and from Grays Harbor over the 50-year period of analysis, as feasible and economically justified, within the parameters of the channel as legislatively authorized.

1.8 Planning Constraints

The following planning constraints represent restrictions that should not be violated. Compliance with environmental policies is addressed in the SEIS (Appendix C).

- The evaluation of alternatives to deepen the navigation channel beyond -36 ft MLLW will not re-evaluate the justification of deepening to -36 ft MLLW.

- The evaluation of alternatives to deepen the navigation channel will be limited to alternatives between -36 ft and the full legislatively authorized depth of -38 ft MLLW.
- Approximately one to two percent of the material to be removed by new channel depth dredging (depending which action alternative is implemented) has been found to be unsuitable for open-water disposal. Therefore, a suitable upland disposal site will be required.

1.9 Alternative Plans

The scope of this feasibility study and thus this Economic Analysis is limited to evaluating the following three alternatives: No Action, deepening the channel to -37 feet MLLW, and deepening the channel to -38 feet MLLW. Note that each of the three alternatives also includes advance maintenance and allowable overdepth[5].

1.9.1 Alternative 1: No Action

Under the No Action Alternative, the Corps would continue channel maintenance as part of the NIP at the current dredging depth of -36 feet MLLW. Under Alternative 1, the Corps would continue the current practice of maintenance dredging of the navigation channel to a depth of −36 feet MLLW and placement of the dredged materials at a variety of open-water placement, beach nourishment, and beneficial use sites. A description of the existing Grays Harbor navigation channel maintenance involving the current dredging process and placement of dredged material is provided in Chapter 2 of the Supplemental Environmental Impact Statement (SEIS) in Appendix C of the LRR. It is important to note that the No Action Alternative does not achieve the objectives described in section 1.6, and is carried forward in this analysis for the sole purpose of comparative evaluation against the action alternatives.

1.9.2 Alternative 2: Deepening Channel to -37 MLLW

Alternative 2 would deepen the navigation channel by one foot, compared to baseline conditions (Alternative 1), to a depth of −37 feet MLLW. Construction dredging of Alternative 2 would occur over an approximate duration of six months for the inner harbor reaches, approximately 1.5 months longer than maintenance dredging under Alternative 1, and would occur within the same seven month dredge window as under

[5] *Advanced Maintenance* is dredging to a specified depth and/or width beyond the authorized channel dimensions in critical and fast-shoaling areas and typically occurs during each annual dredge cycle. Advance maintenance would allow the Corps to avoid frequent re-dredging, and would ensure the reliability and least overall cost of maintaining channels to authorized and implemented dimensions (Corps 2006). To assure channel operational reliability and least overall cost, the Corps would allow an additional two feet to the navigation channel prism and three feet for the Elliot Slough Turning Basin. *Allowable overdepth* is dredging to a permitted depth and/or width outside the required channel prism to allow for inaccuracies in the dredging process. During typical dredging activities, inherent imprecision is known to occur that vary with physical conditions, dredged material characteristics, channel design, and type of dredging equipment used. Due to these variables, and the resulting imprecision associated with the dredging activity; the Corps recognizes that dredging below the congressionally authorized project dimensions would occur. To compensate for these inevitable inaccuracies, the Corps allows its dredging contractor to dredge with a maximum overdepth tolerance of two feet (Corps 1996).

Alternative 1. The duration of dredging for the outer harbor reaches would be approximately one month, the same as under Alternative 1. While the vast majority of the sediments from the inner harbor reaches (over 98%) are suitable for open-water placement, approximately 13,500 cubic yards of sediment that would be dredged during construction of Alternative 2 from the Cow Point 32a subunit are unsuitable for open-water disposal due to toxicity expressed in the sediment larval bioassay. This material would require appropriate upland disposal. Further explanation of channel sediment suitability is provided in the SEIS (Appendix C.)

1.9.3 Alternative 3: Deepening Channel to -38 MLLW

Alternative 3 would deepen the navigation channel by two feet, compared to baseline conditions (Alternative 1), to a depth of −38 feet MLLW. Construction dredging of Alternative 3 would occur over approximately six months for the inner harbor reaches (the same as Alternative 2), approximately 1.5 months longer than maintenance dredging under baseline conditions (Alternative 1), and would occur within the same seven month dredge window as under Alternative 1. The duration of dredging for the outer harbor reaches would be approximately 1 month, the same as under Alternatives 1 and 2. Approximately 22,400 cubic yards of sediment that would be dredged during construction of Alternative 3 from the Cow Point 32a subunit are unsuitable for open-water disposal due to toxicity expressed in the sediment larval bioassay. This material would require appropriate upland disposal. Further explanation of channel sediment suitability is provided in the SEIS (Appendix C.)

1.10 Economic Profile of Project Area

The major population surrounding the project location, assumed to be the majority user of the project area with respect to employment and tax income from operations, is the population of Grays Harbor County, Washington. As such, most of the socioeconomic data is developed using demographic information for the residents of the Aberdeen, Grays Harbor County metropolitan area. The resident population of Grays Harbor County is approximately 73,000, with 57,000 of the resident population of age 18 and over (Bureau 2013). The total number of businesses in Grays Harbor County is approximately 1,747, with the highest percent of industries being in retail trade (15.8%), followed by accommodations and food services (13.2%), health care (12%), and construction (10.4%). Total employment in 2011 for Grays Harbor County was approximately 30,400 (BEA 2011). Per capita personal income from 2011 was approximately $35,000(WAESD 2013), with an estimated 2.5 persons per household (Bureau 2013). The unemployment rate in December 2012 was approximately 12.4%, this approximately 3% higher than the average 9.36% unemployment rate for all counties in the state of Washington (BLS 2013).

1.11 Hinterland Transit Connection

Port of Grays Harbor is connected by numerous avenues of approach. The infrastructures associated with these connections are numerous highways, rail lines, and a regional airport.

1.11.1 Highway

Grays Harbor boasts a four-lane state highway connection (Highway 12) to Interstate 5. Unburdened by daily traffic jams, companies gain efficient and cost-effective highway access. The Port of Grays Harbor, in Aberdeen, is less than 1 hour from Interstate 5, via a four-lane state highway. In addition, I-5 connects to Interstate 90 that provides access to the Midwestern (a major supplier of food and farm product exports) and Central United States.

Figure 4: Washington State Highway Corridor(Port of Grays Harbor 2013)

1.11.2 Rail

Main line rail service to the industrial properties and marine terminals provides direct access to both Class 1 railroads Burlington Northern Santa Fe (BNSF) and Union Pacific (UP), via Rail America's Puget Sound and Pacific short line railroad (Figure 6: Main Line Rail). A rail loop runs through the marine terminal complex providing a continuous rail loop to all three main cargo terminals (Figure 5: Grays Harbor Local Rail). Utilizing this unique state-of-the-art rail infrastructure, unit trains can be continuously loaded or unloaded for movement through the Port's facilities.

Figure 5: Grays Harbor Local Rail Loop (Port of Grays Harbor 2013)

The construction of additional auto tracks, to increase the auto handling capacity at Terminal 4, was complete in 2011. A second rail loop at the harbor will be constructed, providing all shippers with additional import and export handling capacity. An inter-modal 2,800 lineal foot on-dock rail system with direct discharge options and four parallel spurs is available(Harbor 2013)

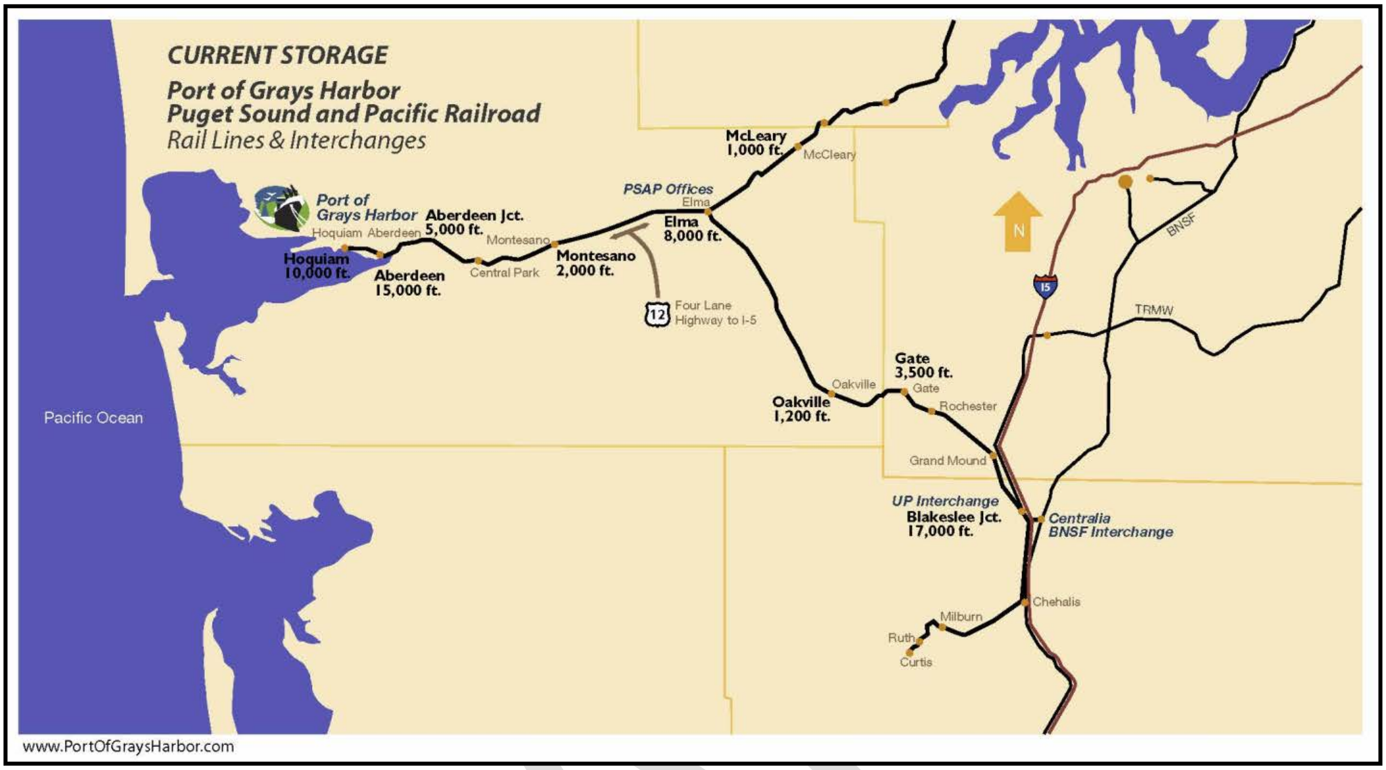


Figure 6: Main Line Rail Service (Port of Grays Harbor 2013)

The local rail system is serviced by a statewide mainline that then splits to connect Washington State to Canada and the midwestern United States (Figure 6: Main Line Rail). Much of the agricultural products that are being shipped through the Port of Grays Harbor is grown and shipped via rail from the midwestern U.S. and is serviced by the major railroad connections (Figure 7: Major Railroad).

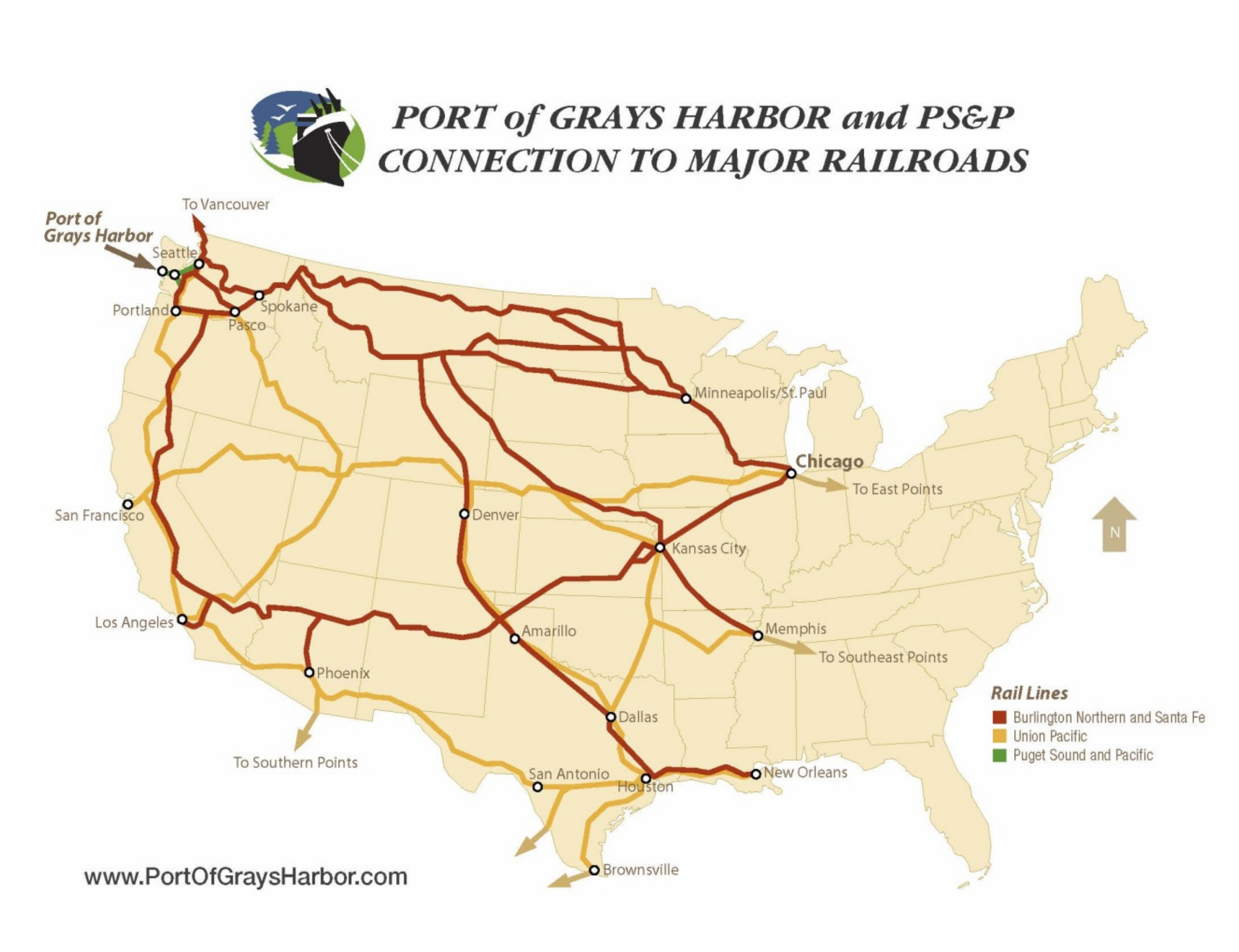


Figure 7: Major Railroad Connections (Port of Grays Harbor 2013)

1.12 Existing Shipping and Receiving Facilities

The Port of Grays Harbor currently offers four marine terminals. The terminals are supported by large, paved, secured cargo yards, the Port's on-dock rail system, and more than 104,000 square feet of on-dock covered storage. In addition, the Port has a rail loop and ladder track system that goes through the entire facility with a rail yard capable of storing 450 rail cars on the marine terminal. The port is positioned centrally between the Pacific Northwest markets of Seattle, Washington and Portland, Oregon. Grays Harbor is connected to its hinterlands by rail and the only four lane coastal highway North of San Francisco (Highway 12)[6].

Terminal 1 was converted in 2009 from a wood chip barge loading facility to a liquid bulk terminal capable of handling Panamax class vessels. It provides liquid bulk commodity shipping access to Port customers Imperium Grays Harbor and Westway Terminal Company. Terminal 2 is a state–of-the-art dry and liquid bulk facility that is served by a

[6] "The inland trade region served by a port is called its hinterland. That hinterland usually consists of a number of cargo hinterlands defined by the inland origins or destinations of specific commodities. Collectively, the cargo hinterlands of actual and potential commerce of the project port define the economic study area."(IWR 2010)

rail loop. Terminal 3 is a 150 acre marine industrial site with a deep water terminal and on-site rail. Terminal 4 is the largest terminal with approximately 1,400 ft long berth capable of handling two vessels. Terminal 4 is also served by the loop track and is equipped with dockside warehousing, paved uplands and on-dock rail service. It serves as the primary roll on roll off (RO/RO) and break-bulk cargo terminal. Table 1 below summarizes and provides additional information on each terminal.

Table 1: Summary of Existing Shipping and Receiving Facilities at Port of Grays Harbor

Terminal	Length (feet)	Depth (feet)	Use(s)
Terminal 1	480	-41 MLLW	Barge & Bulk Liquid
Terminal 2 Liquid Bulk	600	-41 MLLW	Liquid Bulk
Terminal 2 AGP	600	-41 MLLW	Agricultural Processing
Terminal 3	600	-41 MLLW	
Terminal 4	1,400	-41 MLLW	Auto and Ro/Ro[7]
Weyerhaeuser	1,250	N/A	N/A

1.12.1 Terminal 1

[8]Terminal 1 operates as a tanker, barge, and bulk liquid loading facility with adjacent uplands storage area. It provides liquid bulk commodity shipping access to port customers Imperium Grays Harbor and Westway Terminal Company. Berthing depth is -41 feet MLLW, 480 feet long, 50 feet wide, and served by an on-site rail loop (Harbor 2013).


Figure 8: Terminal 1

Imperium Renewables is submitting a permit application in 2013 for the construction of new storage tanks, rail infrastructure and office space. These permits will provide Imperium the opportunity to develop an additional 10.7 acres that are within the Port of Grays Harbor and are adjacent to the existing Imperium biodiesel plant. Imperium anticipates that the products stored on site will vary over the life of the facility, and may include biodiesel, ethanol, U.S. crude oil, jet fuel, gasoline, diesel, vegetable oil, and feed stock (Renewables 2013). These upgrades to facility and infrastructure are expected to take place regardless of the proposed deepening of the existing channel. Thus, this development would be reflected in both the -with and -without project conditions.

[7] Roll-On/Roll-Off Vehicle Based Shipping
[8] Photos for Figure 8-11 taken from http://www.portofgraysharbor.com/terminals/terminals.php

1.12.2 Terminal 2

Terminal 2 operates as a bulk loading facility. Berthing depth is -41 feet MLLW, 600 feet long and 100 feet wide. It includes 75 paved acres, secured cargo yard and near dock warehousing. The facility also includes enclosed conveyers that transport product from the receiving building through a sampler and inline scales into the vessel. The Port, in conjunction with Ag Processing Inc, a grower-owned cooperative in the Midwest, developed the state-of-the-art terminal (Harbor 2013). In 2011, AGP added another dump house, storage silos, shipping bins, and conveying system that connect to the existing ship loader.

Figure 9: Terminal 2

1.12.3 Terminal 3

Terminal 3 is a 150+ acre site with a deep water marine terminal. The Port has installed on-site rail access which is served by the Burlington Northern & Santa Fe (BNSF) and Union Pacific (UP) railroads. It is less than a mile from Bowerman Airport and linked to Interstate 5 by a four-lane state highway. The 600 foot long, 120 foot wide berthing depth is -41 feet MLLW (Harbor 2013).

Figure 10: Terminal 3

Grays Harbor Rail Terminal, LLC is proposing a bulk liquids rail logistics facility at Terminal 3. The facility would be designed to handle liquid bulk, primarily crude oil or light oil. Grays Harbor Rail Terminal is conducting a feasibility study and is expected to be completed, with a high likelihood, in the near term (1-3 years).

1.12.4 Terminal 4

Terminal 4 is the Port's main general cargo terminal. It features over 100,000 square feet of dry, covered warehouse space; a rail loop with on-dock rail access to BNSF and UP railroads, linked to Interstate 5 by a four-lane state highway, 120 acres of paved cargo yard, and twin self-scouring deep-water berths 1,400 feet long, 100 feet wide with water depth at -41 feet (-12.5 meters) MLLW(Harbor 2013). The Port of Grays Harbor provides shippers with more than 100 acres of secured outdoor storage adjacent to two deep-water marine berths. The port is emerging as a leading auto export center in the Pacific Northwest. Pasha Automotive Services, the leasee of Terminal 4, signed a

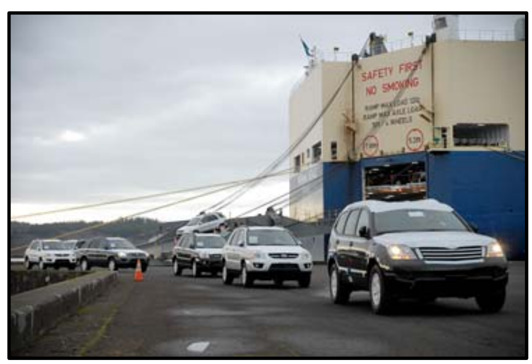


Figure 11: Terminal 4

20 year agreement with the Port of Grays Harbor in in 2009 and as of August 2012 moved over 100,000 Chrysler vehicles through the port (Bruscas 2012).

1.12.5 Weyerhauser Independent Terminal

Although not a major user today or in the near future of the Grays Harbor Navigation Channel, it would be remiss to not mention Weyerhaeuser. There are a few independent terminals for handling log vessels and wood products that are operated by Weyerhaeuser. The log terminal is 1,075 feet in length and the wood products terminal is 1,250 feet in length. Currently this facility is moving little to no major volumes of commodities, and, as such, is not being factored into the economic analysis. The small volume being moved through the independent terminal is not expected to affect the tentatively selected plan for this study. In addition, the locations of these facilities are upriver of the proposed Navigation Improvement Project (NIP) improvements and would not be a major benefactor of said improvements.

2 Multiport Analysis

In 1982, Assistant Secretary of the Army for Civil Works ASA(CW) William Gianelli asked the U.S. Army Corps of Engineers to develop procedures for analyzing deep draft ports, which included data and analysis of competing ports. The basic problem was defined to be the need for a methodology to identify the traffic which could swing from or to the port under study with modest shifts in relative costs (between ports). A multiport analysis approach was developed by the Corps of Engineers and used to evaluate potential benefits due to savings on the land leg and port cost differentials. Combined land leg, port and ocean leg costs were then obtained for the port under study and its competing ports. Finally, the conditions under which some part of the traffic would logically be diverted from one port to another were discerned.

The Economist's role in multiport analysis is to identify relevant competing port trade flows based on analysis of trade routes, commodities, and port facilities. Commodity movements to or from competitive inland hinterlands to or from the same world trade areas are candidates for detailed analysis. Where the commodities are not identical (such as wheat and corn), or the trade routes are distinct (such as exports to different world areas), the opportunities for commodity transfers, based on port deepening alone, are likely to be low as is the case for the Port of Grays Harbor.

Multiport analyses may or may not be needed depending on circumstances. Specifically the Port of Grays Harbor's most likely competing ports are Tacoma and Seattle. In both circumstances, the leading export/import is containerized cargo, whereas at Grays Harbor the leading import/export is break-bulk, liquid bulk, and vehicles. In addition, the Port of Grays Harbor is predominantly export bases, whereas the overwhelming majority of trade at the Port of Tacoma and the Port of Seattle are imports. These among other circumstances surrounding the Port of Grays Harbor lead us to believe that commodity transfers or change of mode between competing ports is not expected to happen. Thus any movement of goods and services from competing ports is expected to be minimal at best and as such a multiport analysis is assumed unwarranted for this project.

3 Existing Conditions

3.1 Tonnage[9]

After the initial steep decline in tonnage in the late 1990s, mostly attributed to the listing of the Northern spotted owl as an endangered species, the Port of Grays Harbor has seen a general increase of tonnage movement (Figure 12: Port of Grays Harbor Historic Tonnage). The revival of the Port, based on a redevelopment plan, is due in large part to the Port's strategy change. This change was to focus on providing goods and services over a broad range of commodities, essentially an exercise in diversification. Figure 13 shows that in 2006 the Port of Grays Harbor moved approximately 1.28 million short tons and by 2012 was moving approximately 1.9 million. This represents a compound annual growth rate (CAGR) of approximately 6.8%. The variance or fluctuations seen in the Port tonnage year over year can be attributed to a multitude of factors. The drop in tonnage in 2009 is directly related to the 2008 financial crisis were world demand of goods and services dropped. In addition, other year's fluctuations in the tonnage moved through the Port of Grays Harbor are due to a host of environmental factors such as commodity (soybean prices), exchange rate fluctuations, and inventory availability.

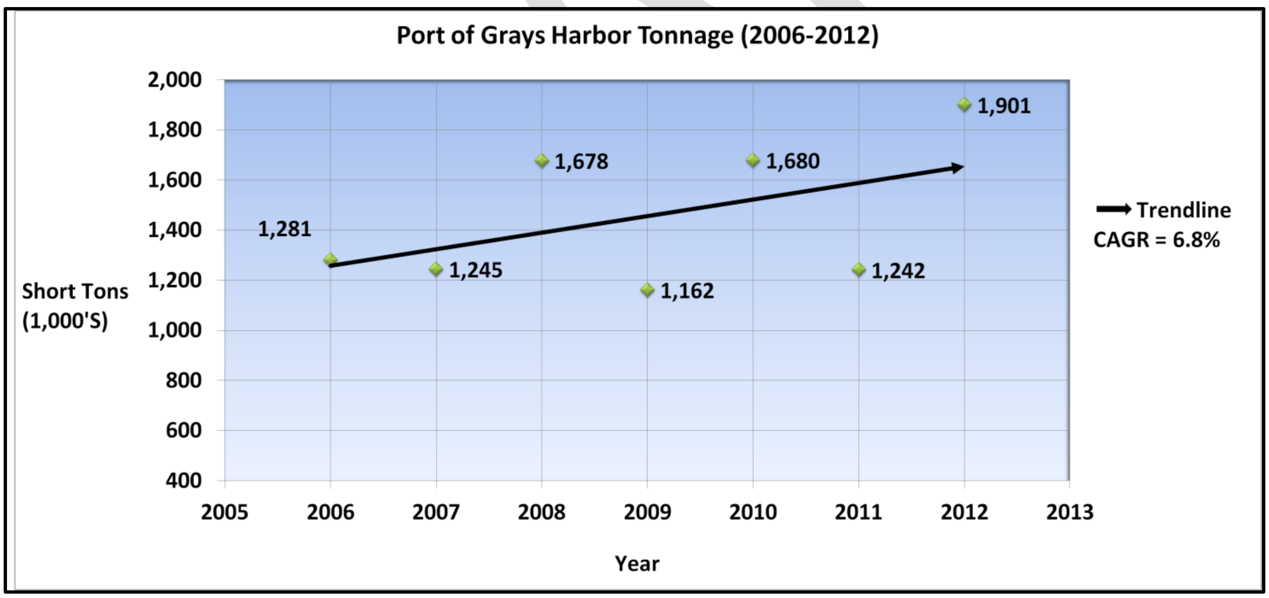


Figure 12: Port of Grays Harbor Historic Tonnage

As of 2012, the latest hard data available, approximately 1.9[10] million short tons was moved through Grays Harbor. Of the 1.9 million tons moved, approximately 96%

[9] All 2012 tonnage data provided by the Port of Grays Harbor Pilot Logs as the Waterborne Commerce Statistics Data Center information was not available at the time of this analysis.

(Figure 13: Historic Import and Export Tonnage by Year) is export based going to places such as China and the Philippines.

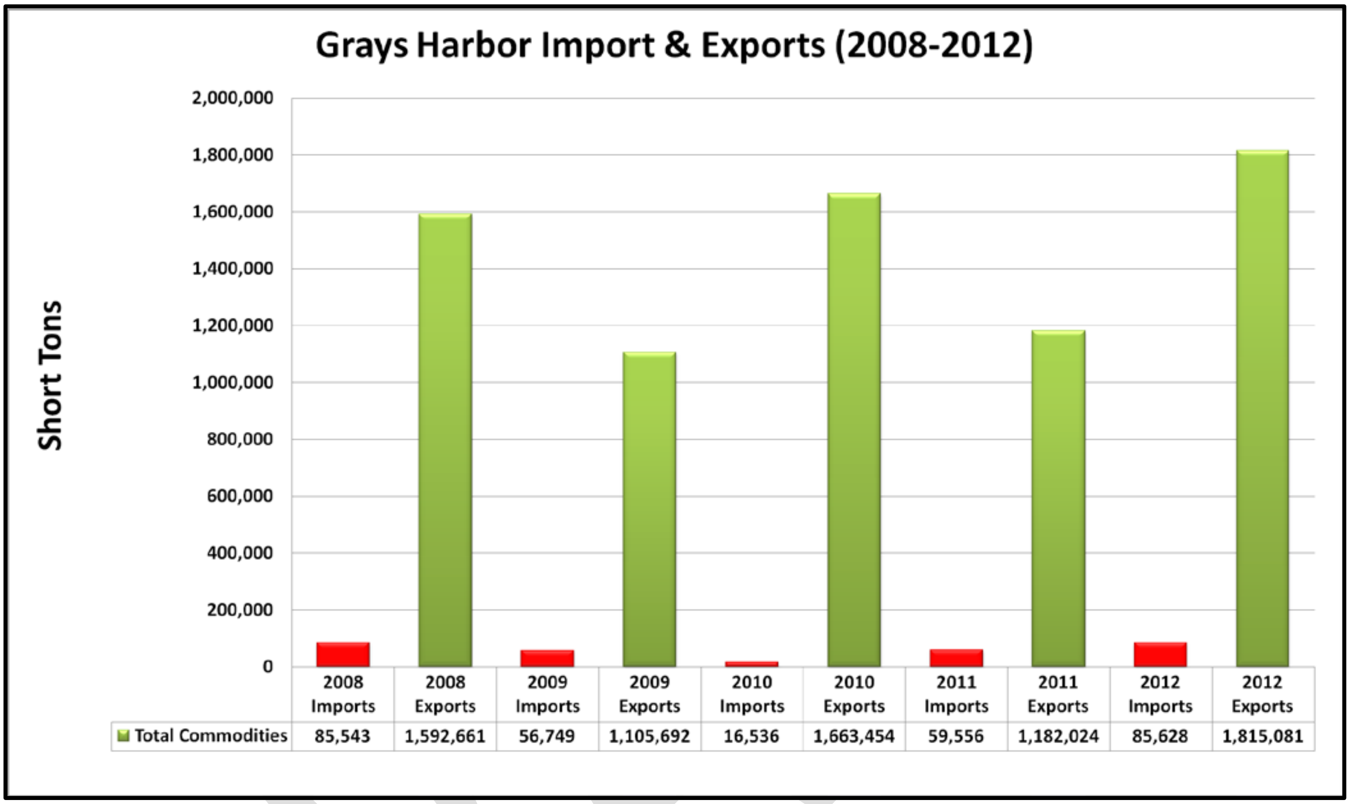


Figure 13: Historic Import and Export Tonnage by Year

3.2 Historic and Existing Commodity Movements

Historically, the Port relied heavily on forest products such as lumber and wood chips to support business activities. The aforementioned strategic change has led to the Port's new main line of businesses, based on pure tonnage moved, of food and farm products, followed by forest products. The category Food and Farm Products' includes things such as soybean, soybean meal, distilled dried grains, and corn (Figure 14: Existing Commodity Breakdown).

[10] Note that the same type of summary values in the tables presented herein may not exactly match each other due to the rounding of values and/ or to values obtained from different sources. These differences are insignificant and as such do not affect the analysis.

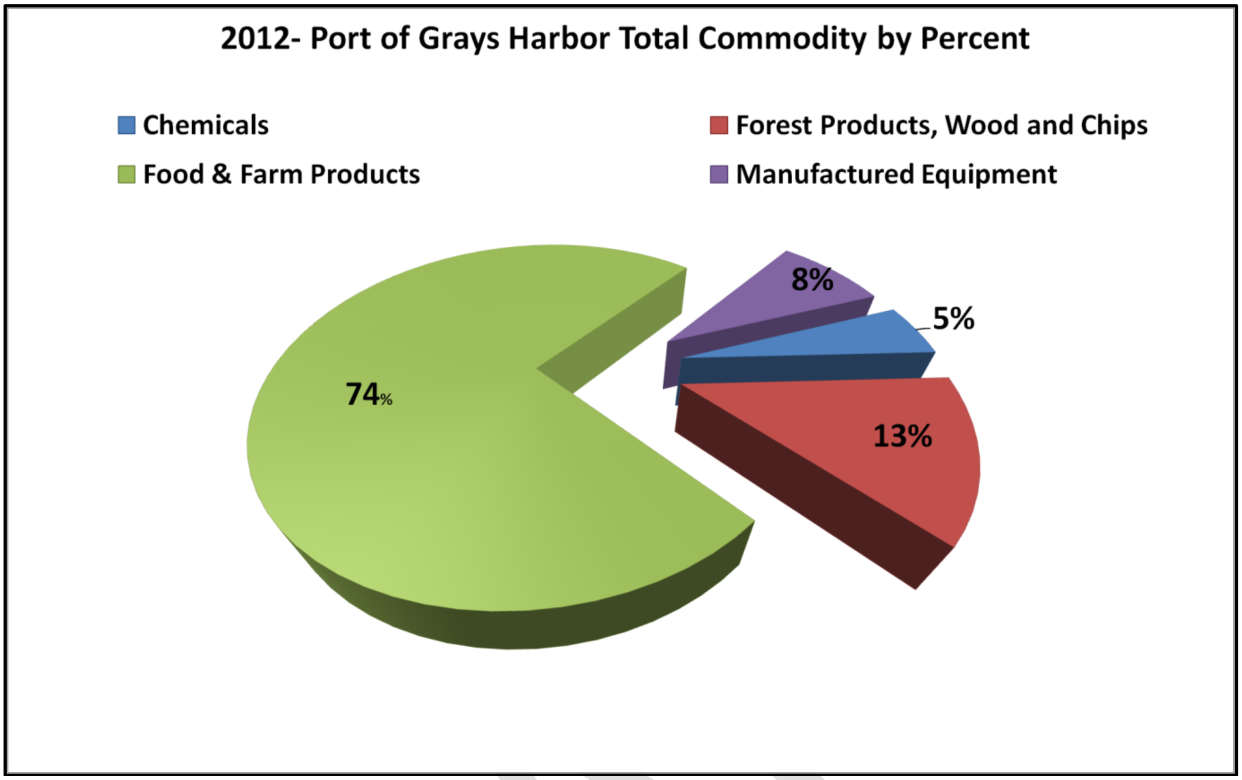


Figure 14: Existing Commodity Breakdown

Table 2 shows the total annual commodity tonnages at the Port for the period 2006 through 2012, and the associated annual growth rate for each year. The compound annual growth rate (CAGR) for the aforementioned periods is approximately 6.8%. This can mostly be attributed to strong demand for soybean and other agricultural products from China and the Philippines. The fluctuations seen in the Port tonnage year over year can be attributed to a multitude of factors. The drop in tonnage in 2009 is directly related to the 2008 financial crisis were world demand of goods and services dropped. Other annual fluctuations in the tonnage moved through the Port of Grays Harbor are due to a host of environmental factors such as commodity (soybean prices), exchange rate fluctuations, a particularly productive harvest (bumper crop), or lack thereof, and abundant foreign supply of similar agricultural products.

Table 2: Grays Harbor Total Annual Cargo

Grays Harbor Total Annual Cargo Short Tons		
Year	Total Tons	Annual Growth Rate (year-to-year)
2006	1,280,578	
2007	1,244,705	-2.8%
2008	1,675,699	34.6%
2009	1,162,441	-30.6%
2010	1,679,991	44.5%
2011	1,241,580	-26.1%
2012	1,900,708	53.1%
Compound Annual Growth Rate (2005-2012)		6.8%

Table 3 summarizes the historic commodities moved through the Port of Grays Harbor and gives a general overview of the amount of each major commodity moved from 2008 through 2012. The table shows a significant increase in both manufactured equipment (vehicles) and food and farm products (soybean) that are moving through the Port.

Table 3: Short Ton by Commodity[11]

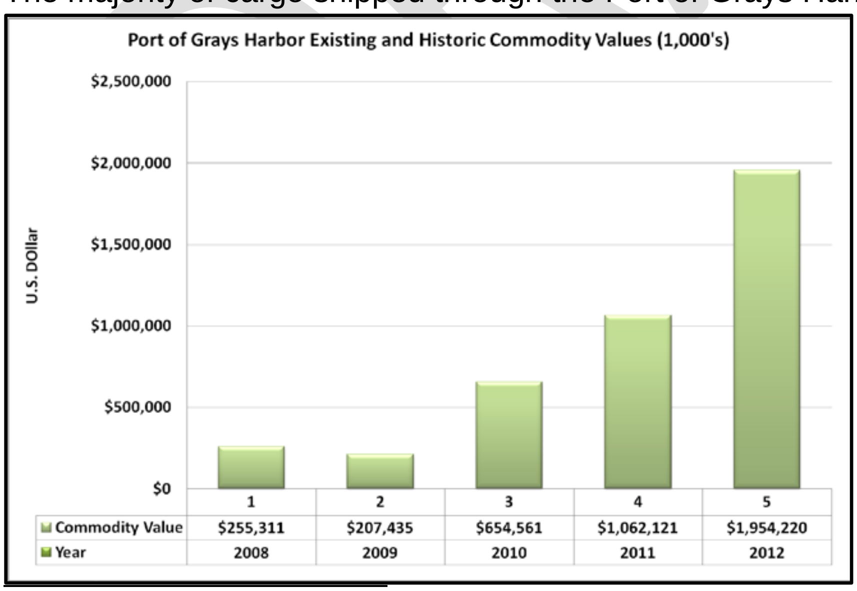
Port of Grays Harbor Historic Short Ton by Commodity					
	2008	2009	2010	2011	2012
Chemicals	90,650	66,793	14,964	131,084	94,082
Forest Products, Wood and Chips	988,223	331,205	530,807	347,887	251,814
Food & Farm Products	595,672	756,825	1,094,985	677,797	1,396,313
Manufactured Equipment	1,154	7,618	32,413	84,811	158,499
Total Commodities	1,678,204	1,162,441	1,679,991	1,241,580	1,900,708

The 2013 cargo volume and vessels calls from January through July are approximately 1.2 million metric tons with 73 vessel calls. The 2013 Port of Grays Harbor projection has the expected tonnage and vessel calls at 2.3 million metric tons and 137 vessel calls.

From a pure dollar perspective, the Port's most valuable export is Manufactured Equipment. This category consists mostly of Jeep, Chrysler, and Dodge vehicles shipped via roll-on roll-off vessels. The change from forest based products to more valuable market commodities, such as vehicles, has led to a drastic increase in the value of commodities moving through the Port. There has been an increase from approximately $255 million in 2008 to nearly $2 Billion in 2012 (Resources, Institute for Water 2013) representing a 665% increase in the value of the goods being shipped.

3.3 Origins and Destinations

The majority of cargo shipped through the Port of Grays Harbor in 2012, principally



[11] Table 3 left out unknown commodities, primary manufactures and oil as they are historically not a substantial volume moved.

Figure 15: Historic Commodity Values

exports, headed to southeast Asian countries with the Philippines', at approximately 59% of total commodities moved, being the prevailing trade partner (Figure 16: Commodity Origin and Destination.) The Philippines is the furthest trade partner away from the Port of Grays Harbor based on average nautical miles traveled by all vessels.

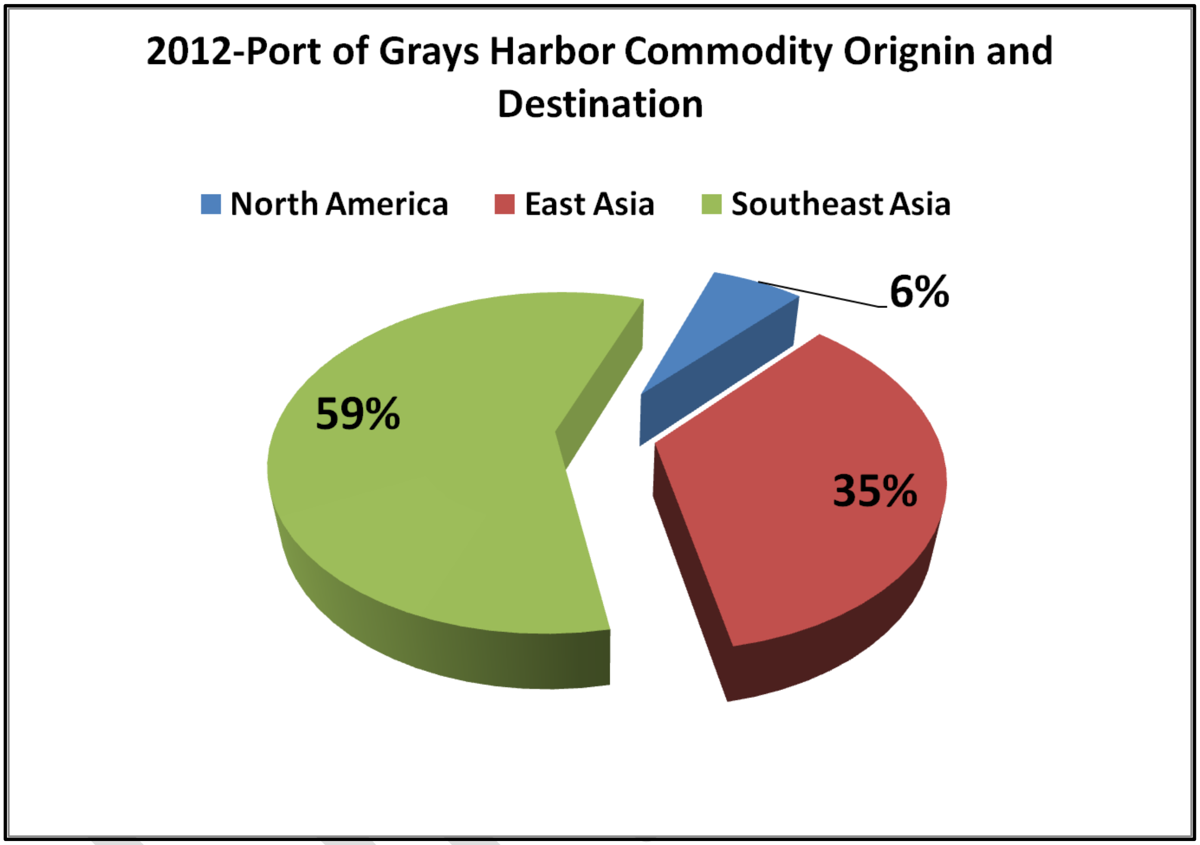


Figure 16: Commodity Origin and Destination

China is the second largest trade partner at approximately 21% of total trade volume by short ton. Agricultural and manufactured equipment (Chrysler, Dodge, Jeep vehicles) is the predominant commodity with respect to the trade relationship between Grays Harbor and China.

Each major trade partner was aggregated into 1 of 3 specific route groups for the simplicity of analysis. The Port of Calls were aggregated based on locations and distances with respect to one another. For example; the East Asia trade group includes countries such as China and Vietnam as they are relatively close to each other and the distance from the Port of Grays Harbor are similar (Table 4: Grays Harbor Port of Call Characteristics). To assign Sea Distance in Harborsym (a Monte Carlo simulation model for deep draft navigation economics) to the route groups the following strategy was applied. The minimum distance traveled to each assigned destination was assigned as the minimum Sea Distance, the maximum distance traveled to each assigned destination was assigned as the maximum Sea Distance in Harborsym, and the average distance of the destinations in each route group was used as the most likely Sea Distance in Harborsym.

Table 4: Grays Harbor Port of Call Characteristics

Grays Harbor Port of Calls				
North America				
Port Name	**Average Nautical Miles**	**Route Group**	**2012 Short Tons**	**% of Sub-total**
United States	443	RtGrp1	70,559	4%
Vancouver Canada	238	RtGrp1	47,238	2%
Lazaro Cardenas, Mex	2,129	RtGrp1	4,423	0%
East Asia				
Port Name	**Average Nautical Miles**	**Route Group**	**2012 Short Tons**	**% of Sub-total**
S. Korea	4,573	RtGrp2	70,066	4%
China	5,030	RtGrp2	392,720	21%
Japan	3,976	RtGrp2	83,425	4%
Vietnam	6,542	RtGrp2	42,825	2%
Russia	4,208	RtGrp2	79,169	4%
Southeast Asia				
Port Name	**Average Nautical Miles**	**Route Group**	**2012 Short Tons**	**% of Sub-total**
Phillipines	5,889	RtGrp3	1,037,923	54%
Indonesia	7,353	RtGrp3	35,666	2%
New Castle, AU	6,617	RtGrp3	44,847	2%
TOTAL			**1,908,861**	**100%**

[12]

3.4 Existing Vessel Fleet

Vessels calling the Port of Grays Harbor were broken down into three main categories; Tanker, Bulker, and Roll On Roll Off (Ro-Ro) because these three vessel types account for most - if not all - of the vessel types calling the Port that would benefit from the proposed channel deepening project. These three categories were further broken down in the HarborSym program to account for the different sizes of each vessel type. For example, Tankers were broken down into Small Tanker, Medium Tanker, and Large Tanker. The specific class and sizes are found in the table Vessel Descriptions and Capacity below.

Figure 17: Vessel Description and Capacity

Vessel Descriptions and Capacity							
Vessel Description	Tanker Small	Tanker Medium	Tanker Large	Bulker Small	Bulker Medium	Bulker Small	Ro-Ro
Dead Weight Tons	4,000-50,000	30,000-70,000	60,000-80,000	1,500-15,000	15,001-58,000	58,001-140,000	1,500-86,000

[12] The distances from and to the Port of Grays Harbor from and to the port of call was determined through the use of seadistances.com (SEA DISTANCE - VOYAGE CALCULATOR 2013).

This allows the simulation program the ability to sort the different Tanker vessels calling the ports into different sizes. The types of vessels and the major rout group associated with each vessel type are broken down by percentage in Table 5 below.

Table 5: Vessel Class by Route Group

Vessel Class Route Group			
Class Name	**North America**	**East Asia**	**Southeast**
Tanker	**0%**	**4.0%**	**2.3%**
Bulke	**95.9%**	**73.0%**	**97.7%**
Ro-Ro	**4.10%**	**22.0%**	**0%**

3.4.1 Tankers

Tankers currently do not play a major role in the commodity movements within the Port of Grays Harbor. This is expected to change in the near (1 year) to intermediate (5 year) future (reference 4.2 Future Commodity Movements) and, as such, will be part of the analysis[13].

The tankers used in 2012 visited from South Korea and the Philippines and accounted for 4%(Grays Harbor Pilot Logs 2013) of East Asia and 2.3% of Southeast Asia's Vessel Class Route Group (Table 5: Vessel Class by Route Group). The commodity associated with these movements is methanol, a liquid bulk item. The average vessel characteristics associated with tankers can be found below.

Table 6: Tanker Characteristics

Tanker Vessel Characteristics (Average)						
Net Short Tons	**Gross Short Tons**	**DeadWt Short Tons**	**Length (ft)**	**Breadth (ft)**	**Depth (ft)**	**Design Draft (ft)**
7,769	**19,794**	**27,600**	**558**	**88**	**51**	**34**

3.4.2 Bulker

Bulker vessels make up the largest portion of all traffic entering the Port by pure tonnage. The overwhelming majority of commodities loaded on bulk vessels are bound for the Philippines and China. The largest bulker has a design draft of approximately 47 feet and is used as a bulk agricultural vessel for exports to China. The average dimensions for bulker type vessels used in 2012 at the Port of Grays Harbor are found in Table 7 below. In 2012 the Port experienced approximately 25 calls from bulker type vessels.

[13] The future tanker fleet that will be calling the Port of Grays Harbor will be moving domestic crude and as such will be required to use domestic vessels in compliance with the Jones Act. These vessels are expected to be of different average characteristics than those displayed in Table 5 above.

Table 7: Bulker Characteristics

Bulker Vessel Characteristics (Average)						
Net Short Tons	Gross Short Tons	DeadWt Short Tons	Length (ft)	Breadth (ft)	Depth (ft)	Design Draft (ft)
17697	32549	53328	624	101	67	39

3.4.3 Roll On-Roll Off[14]

In 2012 the Port of Grays Harbor experienced approximately 20 Ro-Ro vessel callings. These vessels were used to move autos and other manufactured equipment. Most of the export vehicles were shipped to East Asian countries such as China, Japan and Russia. The average characteristics of the Ro-Ro can be found in Figure 15 below.

Table 8: Ro-Ro Characteristics

Ro-Ro Vessel Characteristics (Average)						
Net Short Tons	Gross Short Tons	DeadWt Short Tons	Length (ft)	Breadth (ft)	Depth (ft)	Design Draft (ft)
14,464	47,672	15,024	594	101	101	29

[14] Roll-on/roll-off traffic refers to vessels that are designed to carry wheeled cargo that can be driven directly onto the vessel. Examples of the types of goods loaded on said vessels are automobiles and tractors.

4 Commodity Forecast

The planning horizon for this project is 50-years, with a base year of 2017[15] and a conclusion of 2067. A majority of the commodity forecasts for future conditions was taken from a Washington Public Ports Association (WPPA) and Washington State Department of Transportation (WSDOT) Marine Cargo Forecast (Associates, BST; IHS Global Insight; Mainline Management Inc. 2011). The remaining forecasts (petroleum) were taken from Permits(Hoquiam 2013) and other public and private sources.

The purpose of the "Marine Cargo Forecast," is to assess the expected flow of waterborne cargo through Washington's port system and to evaluate the distribution of cargo through the state's transportation network, including waterways, rail lines, roads, and pipelines.

Since the mid 1980's the WPPA and WSDOT have jointly conducted periodic cargo forecast and performance assessments of the state's marine port transportation system for use in planning tools for the local port community. The review of these reports displays that they have been conservative to close to accurate across all commodity groups (Associates, BST; IHS Global Insight; Mainline Management Inc. 2011).

The forecasts were taken out and applied to the existing conditions (2012) through 2037, at which point the forecasts were held constant from 2037 through 2067. The reason the forecasts were held constant after 2037 is that forecasting tends to become less accurate when attempting to predict future conditions further out in time. The level of uncertainty increases as time elapses and it becomes more difficult to give an accurate estimate past 20 years into the future. In addition, the marine cargo forecasts display a moderate-growth and high-growth forecast growth percentage. The moderate-growth percentage was applied to the commodity growth rates for the Port of Grays Harbor to ensure that conservative projections were used throughout the analysis.

The major categories used in the Marine Cargo Forecast (MCF) were broken down into Containers, Breakbulks, Neobulks, and Dry Bulks. These were further divided into subcategories such as Automobiles for Neobulk and Soybeans for Dry Bulk. The growth projections used and applied were taken from the specific commodity category that corresponds to the commodity being moved at the Port of Grays Harbor. According to the MCF, previous versions of the cargo forecasts have been conservative or close to accurate across all cargo types.

4.1 Caveats of Growth Estimates and Projections

The Marine Cargo Forecast used by WSDOT was developed based on unconstrained limitations in infrastructure. Although the forecasts are unconstrained the use of these forecasts were constrained in that the local infrastructure at the Port of Grays Harbor was taken into account when applying the increases in commodity tonnages and

[15] The base year 2017 is the first year that the project will be fully operational at the NED plan depth.

number of vessels that would be needed to move the increased tonnage over the 50 year period of analysis. The throughput moving through the Port of Grays Harbor was looked at and the limitation of the Port's infrastructure did not reach the maximum capacity.

As with any forecast, growth forecasts have some associated uncertainty and are only used to help make an informed decision for planning purposes. The use of linear forecasts was applied but the true nature of economic markets is anything but linear. The general idea is that in the short run markets act erratic but in the long term the peaks and troughs are less sharp with respect to the extensive time horizon.

The WSDOT Cargo Forecast forecasts to 2030, whereas the forecasts used for the economic analysis took the forecast out to 2037, and then assumed commodity growth levels off because of the difficulty accurately forecasting farther out. This is a small extension of the forecast as the commodity growth percentages ranged from .2% to 3.9% and was done for the ease of analysis with respect to the HarborSym modeling suite. This additional extension in forecast years is not expected to change the outcome of the NED selected plan. The growth estimates are conservative and are relatively accurate based on the idea that the WSDOT Cargo Forecasts have generally been accurate predictions of future growth. In addition, growth is expected to adhere to the forecast in that, with implementation of a deepening project, growth is expected to follow the forecast[16] throughout the project life. There is no indication that new products or additional cargo beyond what has been analyzed to date is expected to present itself, based on the information drawn from regional reports, the niche markets (non containerized cargo) the Port of Grays Harbor is now operating in, and Port feedback,.

4.2 Future Commodity Movements

The Port of Grays Harbor principal trade partners are located in Asia and it is difficult to understate the dependence and trade relationships that exist. China is especially critical to Grays Harbor and China's economy is expected to continue to grow and demand more goods, especially food and finished goods, from the United States. China's GDP growth rate as an annual percentage from 2008-2012 was approximately 7.8% (The World Bank 2013).

Along with China, the Philippines, a principal importer of agricultural and timber products from the Port of Grays Harbor, is expected to see GDP growth of approximately 6% this year, with a similar pace into 2014. This can be attributed to sustained growth in private consumption, a recovery in government spending, and positive net exports (Asian Development Bank 2013).

[16] A major concern at the Corps is for a project to base its benefits on business that is not presently at the project location. This comes from the idea that if the channel is deepened, the business will come. The Port of Grays Harbor has enough current business to justify the project and additional business from outside the periphery of the project is not expected to present itself.

Another key piece to the growth of the volume of commodities moving through the Port of Grays Harbor is the expansive finds of shale oil in the U.S. and Canada. Oil output from the U.S. and Canada is set to raise about 21% from this year to 2018, according to data from the International Energy Agency, largely a result of growing production from fracking and other technologies that access once-inaccessible reserves (Market Watch 2013).

The future commodity growth for the 50-year planning horizon from the base year of 2017 to 2067 is summarized in Table 9 and shown graphically in Figure 18 Port of Grays Harbor Commodity Growth Projections. Note that all commodity projections used the moderate growth forecast derived from the WSDOT Marine Cargo Forecast (Associates, BST; IHS Global Insight; Mainline Management Inc. 2011).

Table 9: Port of Grays Harbor Commodity Moderate Growth Projections (2017-2037)

Port of Grays Harbor Commodity Growth Projections (2017-2067)							
Commodity	2017	2027	2037	2047	2057	2067	CAGR (2017-2037)
Petroleum Moderate	8,467,922	8,638,812	8,813,152	8,813,152	8,813,152	8,813,152	0.2%
Chemicals Moderate	130,726	252,392	487,290	487,290	487,290	487,290	6.8%
Forest Products Moderate	267,290	301,153	339,307	339,307	339,307	339,307	1.2%
Food & Farm Products Moderate	1,445,873	1,550,332	1,662,339	1,662,339	1,662,339	1,662,339	0.7%
Manufactured Equipment Moderate	191,913	281,358	412,492	412,492	412,492	412,492	3.9%
Total Commodities Moderate	10,503,723	11,024,048	11,714,580	11,714,580	11,714,580	11,714,580	0.55%

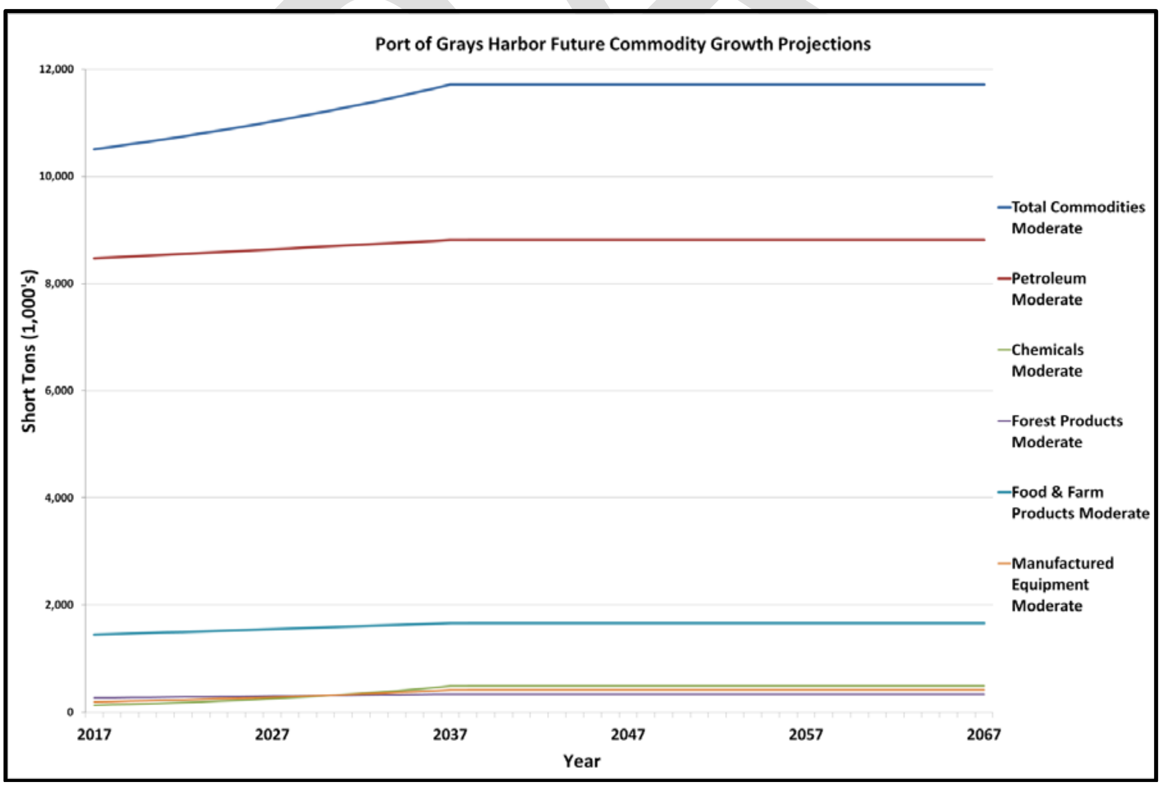


Figure 18: Port of Grays Harbor Commodity Moderate Growth Projections

4.2.1 Petroleum

Oil plays an important role in the U.S. economy, with petroleum accounting for approximately 37% of U.S. primary energy demand in 2010 (Energy Security Leadership Council 2012). America's energy boom has left the middle of the country awash in cheap oil for the first time in decades; the U.S. is experiencing a dramatic and sustained increase in domestic oil production. The key drivers of the oil boom are, in no particular order, high global oil prices, technology advances, and the demand for energy security. U.S. oil production is expected to reach approximately 6 million barrels per day (Figure 19: U.S. Production of Crude) by 2020.

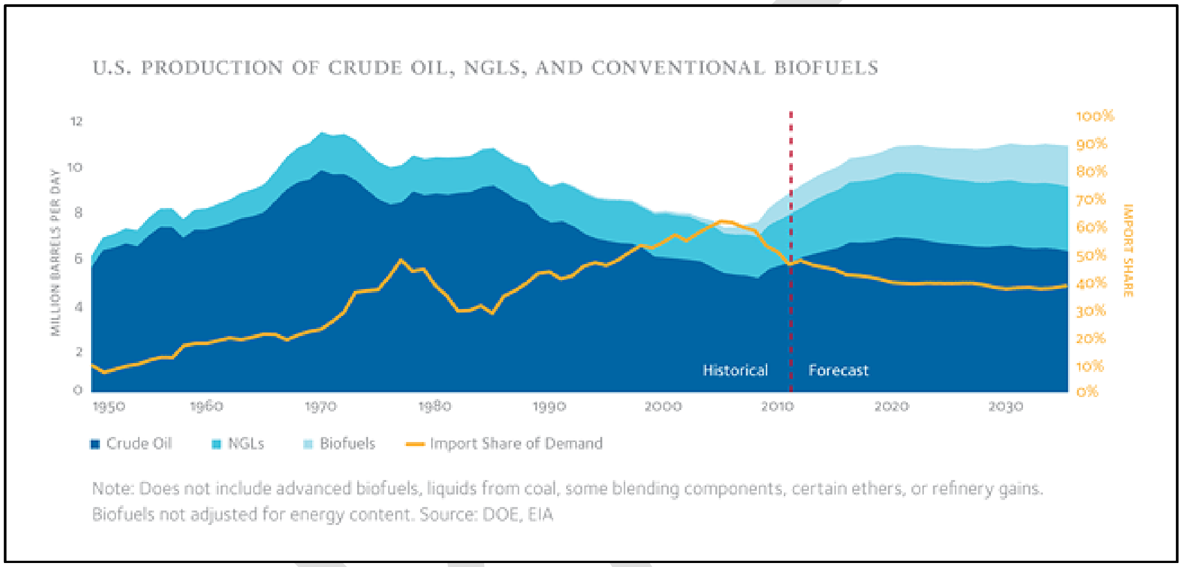


Figure 19: U.S. Production of Crude Oil (Energy Security Leadership Council 2012)

Much of this oil is expected to move via rail due to the fact that trains, although more costly than pipeline, do not require long-term contracts or need to wait for pipelines to be built. In addition, pipes stretch from A to point B, whereas refiners can access nearly any market in the U.S. by rail due to the already extensive infrastructure (Business Week 2013).

The Port of Grays Harbor is expected to move crude by rail (CBR) in the near term (2-5 years). The crude oil would travel to the Port from a variety of locations throughout the U.S. and Canada, the most likely source being crude coming from the Bakken Shale located in North Dakota and Montana in the U.S., and Alberta, Canada.

There are three proposed CBR projects at the Port of Grays Harbor as follows:

1. **Westway Terminals LLC**: Westway has proposed to expand its existing bulk liquid storage terminal at the Port of Grays Harbor to accept, store, and then ship crude oil. The proposal would accept crude oil brought to the facility by rail, store it in large tanks, and then load the crude onto ships that would take it to

U.S. refineries in California or Washington (Earth Justice 2013). Westway proposes four large new storage tanks with the capacity to store a total of 800,000 barrels. Westway estimates that the terminal would receive 9.6 million barrels of oil per year.

2. **U.S. Development Group LLC**: US Development Group is proposing CBR at Terminal 3 that could potentially receive up to 50,000 barrels per day. This would be approximately one 120-car unit train delivery about every two days with approximately 45-60 vessel calls per year (US Development Group 2013). Currently Terminal 3 is underutilized with most cargo movements being forest products such as timber and woodchips. U.S. Development Group has not formally laid out the specifics of the construction or improvements that would take place at Terminal 3 but has provided a preliminary sketch of what is to be expected (Figure 20: Grays Harbor Terminal 3 Proposed Rail Terminals (U.S. Development Group 2013)).

Figure 20: Grays Harbor Terminal 3 Proposed Rail Terminals (U.S. Development Group 2013)

3. **Imperium Terminals Services LLC:** The Imperium group proposed a CBR facility at Terminal 1 with a capacity to receive 78,000 barrels per day. Imperium submitted permit applications for construction of new storage tanks, rail infrastructure and office space. These permits will provide Imperium the

opportunity to develop an additional 10.7 acres that are within the Port of Grays Harbor and are adjacent to the existing Imperium biodiesel plant at Terminal 1(Imperium Renewables 2013).

All three proposals are assumed to move forward by 2014 with a brief ramp up period from 2015 through 2017. Currently, permits have been submitted and a Mitigated Determination of Non-Significance was issued by the City of Hoquiam and the Washington Department of Ecology for the Westway Terminal Company. A Mitigated Determination of Non-Significance was issued and the Shoreline Substantial Development Permit was issued in June of 2013 for the Imperian Terminal Services, LCC. The third proposal by Grays Harbor Rail Terminal (US Development Group) has been granted the Option to Lease Terminal 3 by the Port Commission for an additional 24 months to allow for further analysis and additional time to obtain permits to bring their proposed project to shovel ready status. After 2017 the growth of petroleum exports at the Port are expected to follow the commodity projections from the WSDOT Marine Cargo Forecast of approximately .2% per year. After 2037 the growth projections are to be held constant based on the assumption that as time elapses the projections become less accurate due to uncertainty in what the future conditions may be (Figure 21: Petroleum Forecast).

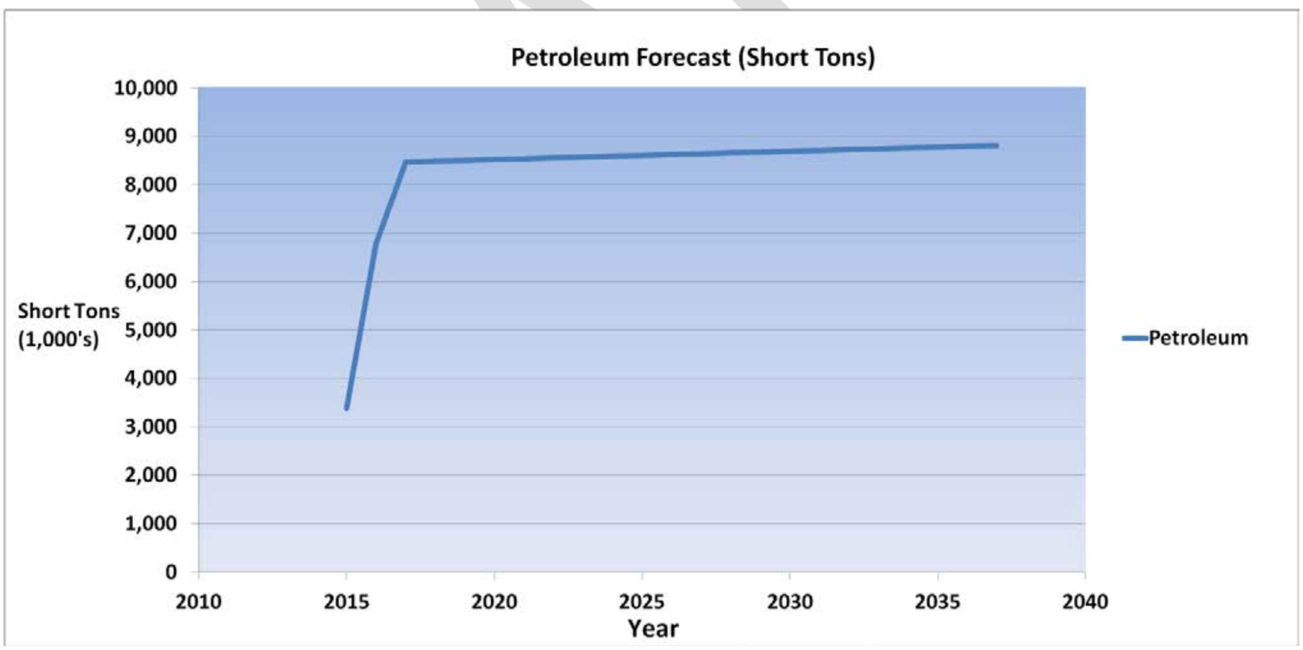


Figure 21: Petroleum Forecast

4.2.2 Soybean

In 2010, soybeans represented the U.S.'s top agricultural export with China and Mexico being the two largest recipients of U.S. soybeans (Nebraska Soybean Board 2012). Pacific Northwest grain and oilseed have shown impressive growth over the past decade, growing from approximately 20 million metric tons in 2000 to 34 million metric tons in 2010 (Associates, BST; IHS Global Insight; Mainline Management Inc. 2011).

In 2012, a record setting 1.69 million metric tons of soybean products were exported through the Port of Grays Harbor to international markets including China, Japan, Philippines, Indonesia, Vietnam and Australia. The increase in export activity in soybean products and other dry agriculture cargos has also been accompanied by increased exports in autos, liquid bulks and forest products (Port of Grays Harbor 2013).

The category Food and Farm Products was used to consolidate grain, oilseed, and soybean into one category. In the base year 2017 the category Food and Farm Products, under the moderate growth assumption, is expected to be approximately 1.4 million short tons and have a CAGR of .7% (Table 10: Port of Grays Harbor Food & Farm Products Growth Forecast). This was taken from the WSDOT Marine Cargo Forecast (Associates, BST; IHS Global Insight; Mainline Management Inc. 2011).

Table 10: Port of Grays Harbor Food & Farm Products Growth Forecast

Port of Grays Harbor Food & Farm Products Growth Forecast							
Commodity	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**	**CAGR**
Food & Farm Products Moderate	**1,445,873**	**1,550,332**	**1,662,339**	**1,662,339**	**1,662,339**	**1,662,339**	**0.70%**

4.2.3 Forest Products

The Port of Grays Harbor relied heavily, up until recently, upon lumber and forest products to sustain business. Two decades ago, shifting global demand from U.S. timber to less-costly sources from Russia and New Zealand put the Port of Grays Harbor's future in jeopardy (Millman 2011). This can be attributed in large part to the listing of the Northern spotted owl to the endangered species list in June 1990. The listing prevented the timber industry from clearing lands within a 1.3 mile radius of any spotted owl nest or activity site (Andre and Velasquez 1991). Harvest of timber in the Pacific Northwest was reduced by 80%, decreasing the supply of lumber and increasing prices (Brokaw 1996).

Once the leading export port for U.S. grown timber, Grays Harbor now leads the U.S. in exports of American grown soybean meal and is the number one seafood landing point in Washington State. While forest products remain an important piece of the Grays Harbor cargo mix, the Port has substantially diversified the products shipped through this Pacific Northwest gateway to include automobiles, biodiesel and other liquid and dry bulk products (Port of Grays Harbor 2013).

The Port of Grays Harbor saw a sharp decrease in the tonnage of forest products moved through the port during the mid 90's and consistently saw a decreasing trend in tonnage. This is attributed to the listing of the spotted owl to the endangered species list but other factors such as the Asian financial crisis, that substantially reduced U.S. exports to Asia, added to the decline in demand for forest products. This trend is expected to turn in favor of higher tonnage and demand is expected to see an improvement due to the Global and U.S. market recovery. The moderate growth forecast for Forest Products is expected to see an increase of approximately CAGR of

1.2% of the next 30 years (Table 11: Port of Grays Harbor Forest Products Growth Projections).

Table 11: Port of Grays Harbor Forest Products Growth Projections

Port of Grays Harbor Forest Products Growth Forecast							
Commodity	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**	**CAGR**
Forest Products	**267,290**	**301,153**	**339,307**	**339,307**	**339,307**	**339,307**	**1.20%**

4.2.4 Manufactured Equipment (Vehicles)

The Port of Grays Harbor has become a major exporter of domestically produced Chrysler and Jeep vehicles. This began with the signing of a 20 year lease agreement with Pasha Automotive Services in 2009, an automotive exporter based in California, and has since increased year over year. Pasha shipped approximately 71,000 Chrysler vehicles in 2012 and is expecting to export approximately 100,000 in 2013(Wilhelm 2013).

The vehicles, along with manufactured heavy equipment, are being exported to Asia (China, Japan, and South Korea). The vehicles arrive by rail and are loaded on Roll-on Roll-off vessels at Terminal 4. According to the WSDOT Marine Cargo Forecast fully assembled autos will exhibit rapid growth with a moderate CAGR of approximately 3.9% and a high CAGR of approximately 4.9% (Table 12: Port of Grays Harbor Manufactured Equipment Growth Projections). The moderate CAGR of 3.9% was used for the economic analysis and was taken out 20 years (2017-2037) at which point the growth was assumed to remain constant due to the uncertainly involved in forecasting far out into the future.

Table 12: Port of Grays Harbor Manufactured Equipment Growth Projections

Port of Grays Harbor Manufactured Equipment Growth Forecast							
Commodity	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**	**CAGR**
Manufactured Equipment	**191,913**	**281,358**	**412,492**	**412,492**	**412,492**	**412,492**	**3.90%**

5 Future With and Without Project Vessel Movements

The increased volume in commodities moved through the Port during the 50-year period of analysis described previously is expected to be enabled by an increase in the number of vessels over the same period. An increase in vessel traffic anticipated over time in any of the three alternatives would not be caused by the deepening action, because channel dimensions are not a present or expected limiting factor on cargo growth, and the vessel traffic increase is expected to occur independent of the deepening because of the growth in commodity volume. The independent commodity growth estimates were mostly derived from the Washington State Marine Cargo forecast(Associates, BST; IHS Global Insight; Mainline Management Inc. 2011). These commodity growth forecasts were applied to the Port of Grays Harbor's existing commodities to get an aggregate tonnage expected to move through the Port during the 50 year life of the project. The total tonnage and commodity types were used to put together a fleet forecast using the Bulk Loader Tool17 to calculate the number of vessels needed to satisfy the commodity demand at the Port (Figure 22: Commodity Tonnage and Vessel Call List Process). The independent commodity growth estimates are expected to be adhered to during the project. That is to say that growth estimates above and beyond what is in the independent commodity estimates or from other sources are not expected to be exceeded. In addition, the total vessels needed to move the specific cargo during the project life is expected to be at its highest during the without project condition (i.e. Alternative 1) and see a decline in the number of vessels needed to move the same amount of cargo due to efficiencies attributed to the implementation of the project (i.e. Alternative 2 or Alternative 3).

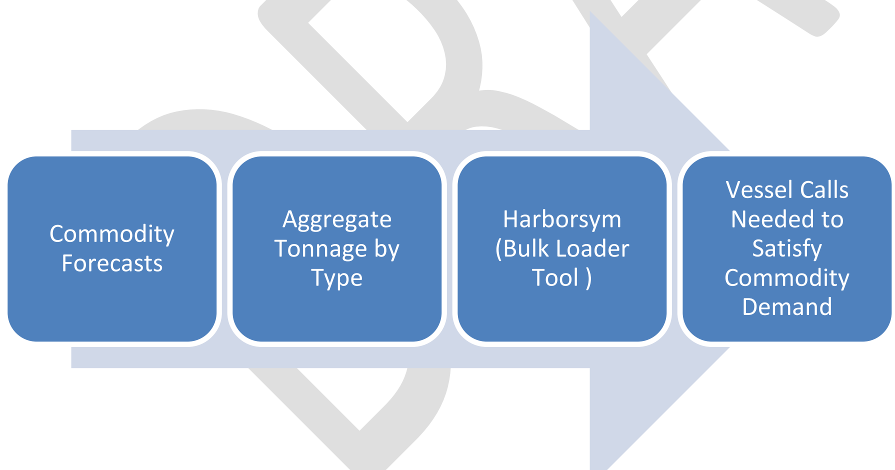


Figure 22: Commodity Tonnage and Vessel Call List Process

The sailing draft distribution for each alternative can be found in Table 13 below.

[17] The Bulk Loader Tool is an integrated module within Harborsym designed to generate synthetic vessel call lists based upon user provided calling statistics. These statistics include information on tonnage, commodity type, and vessel characteristics.

Table 13: Number of Vessels by Draft

Number of Vessels by Draft									
Draft (ft)	Base Without	Base -37MLLW	Base -38MLLW	2027 Without	2027 -37MLLW	2027 -38MLLW	2037 Without	2037 -37MLLW	2037 -38MLLW
4							1		
5								1	
6							1	1	1
7									
8									
9	3	3	3					1	
10	3	3	3	38	39	40	52	51	50
11		0	0				1		
12	5	5	5			1			
13	2	2	2			1			
14		0	0					1	
15	1	1	1	1	1				
16		0	0						
17	1	1	1						
18		0	0						
19	1	1	1	1	1				
20	5	5	5	1	1				1
21	1	1	1						
22	11	11	11						
23	5	5	5	3	3		1		1
24	12	12	12	3	3		10	7	7
25	5	5	5	7	7	7	9	13	10
26	229	208	190	332	332	331	347	346	345
27	9	9	9	3	3	2	5	1	2
28	4	4	4	4	4	6	4	4	6
29	8	8	8	7	7	4	8	6	6
30	5	5	5	3	3	2	3	3	2
31	2	2	2	4	4	3	4	3	3
32			0	11	11	11	20	21	19
33			0	6	6	4	6	4	4
34			0	1	1	3	1	3	3
35	2	2	2			2	1	4	2
36	2	2	2	2	2	8	3	3	9
37	1		0						
38	1	1	1						
39		1	1						

In addition, the future with and without project vessel origin and destination are expected to be the same, and the overall size and type of vessels will remain relatively unchanged[18] regardless of whether a deepening project is implemented.[19]

While the estimated volume of commodities is expected to increase over time, the estimated volume of commodities would be approximately the same in any given year of the 50-year period of analysis between Alternative 1, Alternative 2 and Alternative 3 regardless of whether the channel is deepened. The economic analysis shows that the number of vessels decreases from Alternative 1 to Alternative 2 and from Alternative 2 to Alternative 3 in any given year in the 50-year period of analysis because the vessels

[18] The vessel fleet was held reasonably constant for multiple reasons; Based on information provided by the Port, all reports to date, and commodity tonnage forecast, a need for changes to the existing fleet beyond an increase in numbers would be unnecessary to handle the commodities expected to transit Grays Harbor.

[19] The without project condition is defined as without further deepening – i.e. currently implemented and maintained project of -36 feet MLLW.

can, under the two with-project alternatives, load one or two feet deeper, depending on the alternative considered.

The future with and without project vessel movements were created through the use of the Bulk Loader Tool (BLT) in HarborSym. The total tonnage moved throughout the 50-year analysis for the with and without project conditions used in the modeling were the same. The caveat is that the use of HarborSym (Monte Carlo simulation) there are some minor discrepancies with respect to the exact tonnage between project comparisons once the model has completed all iterations. Relatively speaking the difference was minute and is not expected to affect the plan selection.

The future vessel calls were estimated by applying the forecasted commodity tonnage for each commodity type, developed through the use of regional reports, lease agreements and qualitative data, to a fleet distribution that minimizes total transportation costs. The BLT does this by utilizing the most efficient mix of vessel sizes that take full advantage of increased channel depth in the future with project conditions. Tables 14-16 below summarize estimated vessel traffic, and show the decrease in estimated number of vessels in any given year, when comparing the without project condition and the two with project conditions.

Table 14: Without Project Condition Vessel Calls

Without Project Condition					
		Calls by Project Year			
Vessel Type	**Vessel Type**	**2017**	**2027**	**2037**	**2067**
Tanker	Tanker Medium	217	328	345	345
Bulker	Bulker Small	14	26	26	26
Bulker	Bulker Medium	16	19	19	19
Bulker	Bulker Large	30	16	19	19
RO-RO	RO-RO	41	42	68	68
Total		**318**	**431**	**477**	**477**

Table 15: With Project Condition -37 MLLW

With Project Condition -37 MLLW					
		Calls by Project			
Vessel Type	**Vessel Type**	**2017**	**2027**	**2037**	**2067**
Tanker	Tanker Medium	196	328	343	343
Bulker	Bulker Small	15	23	26	26
Bulker	Bulker Medium	14	19	19	19
Bulker	Bulker Large	32	16	18	18
RO-RO	RO-RO	40	42	68	68
Total		**297**	**428**	**474**	**474**

Table 16: With Project Condition -38 MLLW

With Project Condition -38 MLLW					
		Calls by Project			
Vessel Type	**Vessel Type**	**2017**	**2027**	**2037**	**2067**
Tanker	Tanker Medium	178	328	343	343
Bulker	Bulker Small	15	23	26	26
Bulker	Bulker Medium	14	19	19	19
Bulker	Bulker Large	32	14	15	15
RO-RO	RO-RO	40	41	68	68
Total		**279**	**425**	**471**	**471**

6 National Economic Development Plan Analysis

The base economic benefit of a navigation project is the reduction in the value of resources required to transport commodities. National Economic Development (NED) deep-draft navigation benefits generally fall into 3 major groups:

1. Reduced cost of transportation
2. Shift in origin or destination
3. Increased net return to producers from access to new sources of lower cost materials

For this particular project most of the expected benefits were taken from the cumulative reduction in transportation cost over the 50 year period of analysis. Benefits attributed to transportation cost savings are due to the elimination of vessel calls or reduction in transit times as a result of more efficient vessel loadings, use of alternative mode (land versus water), and/or anticipated net reductions in vessel accident rates between the without and with project conditions.

NED benefits will be assessed for the alternatives identified in the Problems/Opportunities section following the methodology prescribed by Corps Planning Guidance Notebook for deep draft economic analysis (IWR 2010).

Benefits are equal to the difference between without and with project transportation cost. All transportation costs are adjusted to the base year of the project, 2017, and are then converted to Average Annual Equivalent (AAEQ) values using the Fiscal Year (FY) 2012 Federal discount rate of 3.5 percent, assuming a 50-year study period. All project costs and benefits are at 3rd Quarter 2017 price levels. The benefits estimated for the separable elements of each alternative will be compared to its cost to determine its economic justification. The plan that maximizes net benefits (benefits less cost) is the NED Plan. [20].

6.1 Methodology

Transportation cost savings were calculated using the HarborSym model. The USACE Navigation Economic Technologies website (www.corpsnets.us/harborsym/) describes HarborSym as follows:

This model is a planning-level simulation designed to assist in the economic analysis of coastal harbors. With user provided input data, such as the port layout, vessel calls, and transit rules, the model calculates vessel interactions within the harbor. Unproductive wait times result when vessels are forced to delay sailing due to transit restrictions within the channel; HarborSym captures these delays. Using the model, analysts can calculate the cost of these delays and any changes in overall transportation costs

[20] NED analysis generally analyzes a suite of alternatives but for Grays Harbor the analysis was constrained, at the request of the sponsor, to -37 and -38 MLLW. Thus the plan recommended, under the constraints, is the plan that maximized the net benefits and not necessarily what is traditionally thought of as the NED maximizing plan.

resulting from proposed modifications to the channel's physical dimensions or sailing restrictions. Developed as a data driven model, HarborSym allows users to analyze changes without modifying complex computer code. This approach also enables analysts to apply the model to many different ports by altering the network representation of the harbor.

Specific procedures, assumptions and parameters for estimating vessel utilization savings (deepening benefits), vessel operational times savings (delay reduction benefits), and benefits during construction are discussed in the BENEFITS section of this Appendix. In addition, footnotes are placed where applicable to identify sources and any assumptions used throughout the analysis.

6.2 Model Setup and Inputs

The model setup and inputs for Grays Harbor followed a step by step approach that can be summarized as follows:

1. **Setting up Grays Harbor Basic Parameters:** The initial step to using HarborSym to simulate any study is to create a new study in the system and fill in the key parameters such as the port location via longitude and latitude. The exact inputs for Grays Harbor can be found below in figure 23 –Grays Harbor Study Manager.

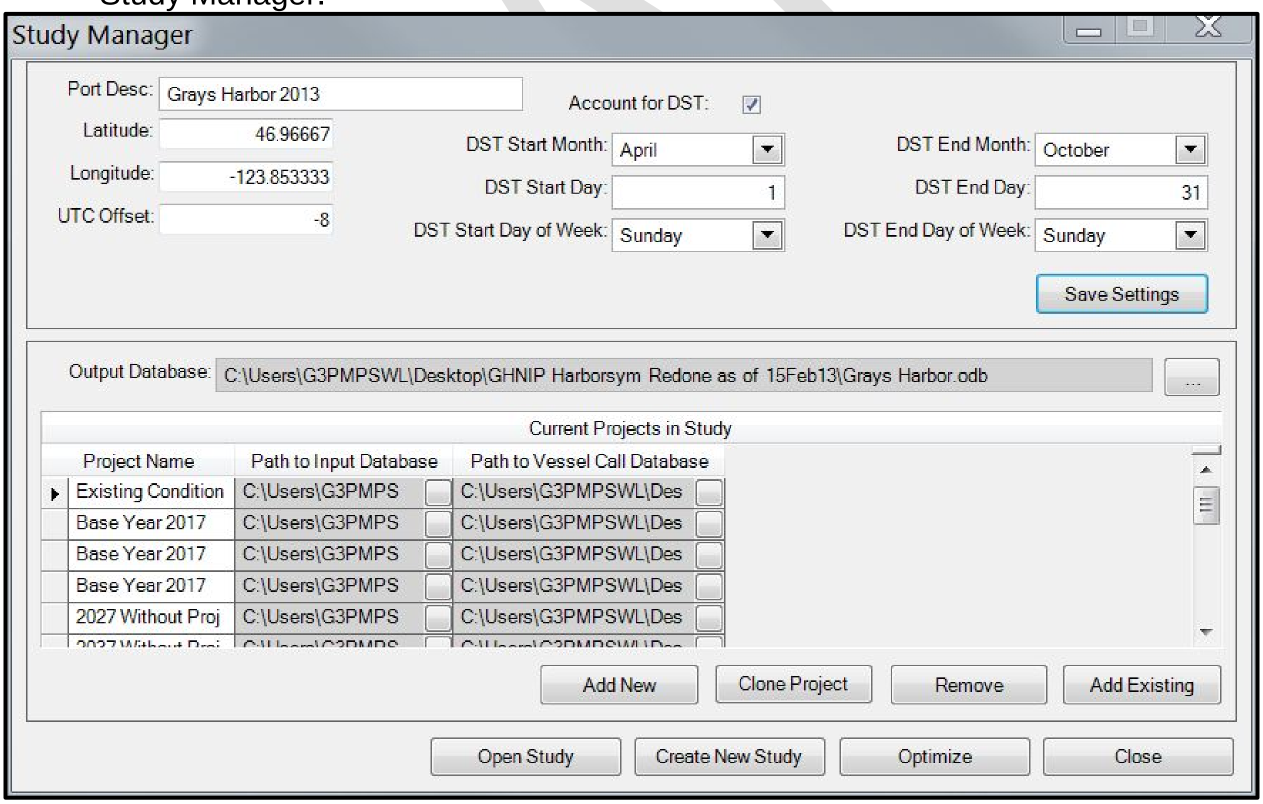


Figure 23: Grays Harbor Study Manager

2. **Building the Grays Harbor Network**: HarborSym is represented by a linked node network and as such each Harbor has a distinct node network. The nodes represent physical characteristics such as turning basins[21], entrances, exits, and terminals at the port (Figure 24: Grays Harbor Network and Nodes). Once these key features are populated into HarborSym the specific characteristics to define the feature are entered.

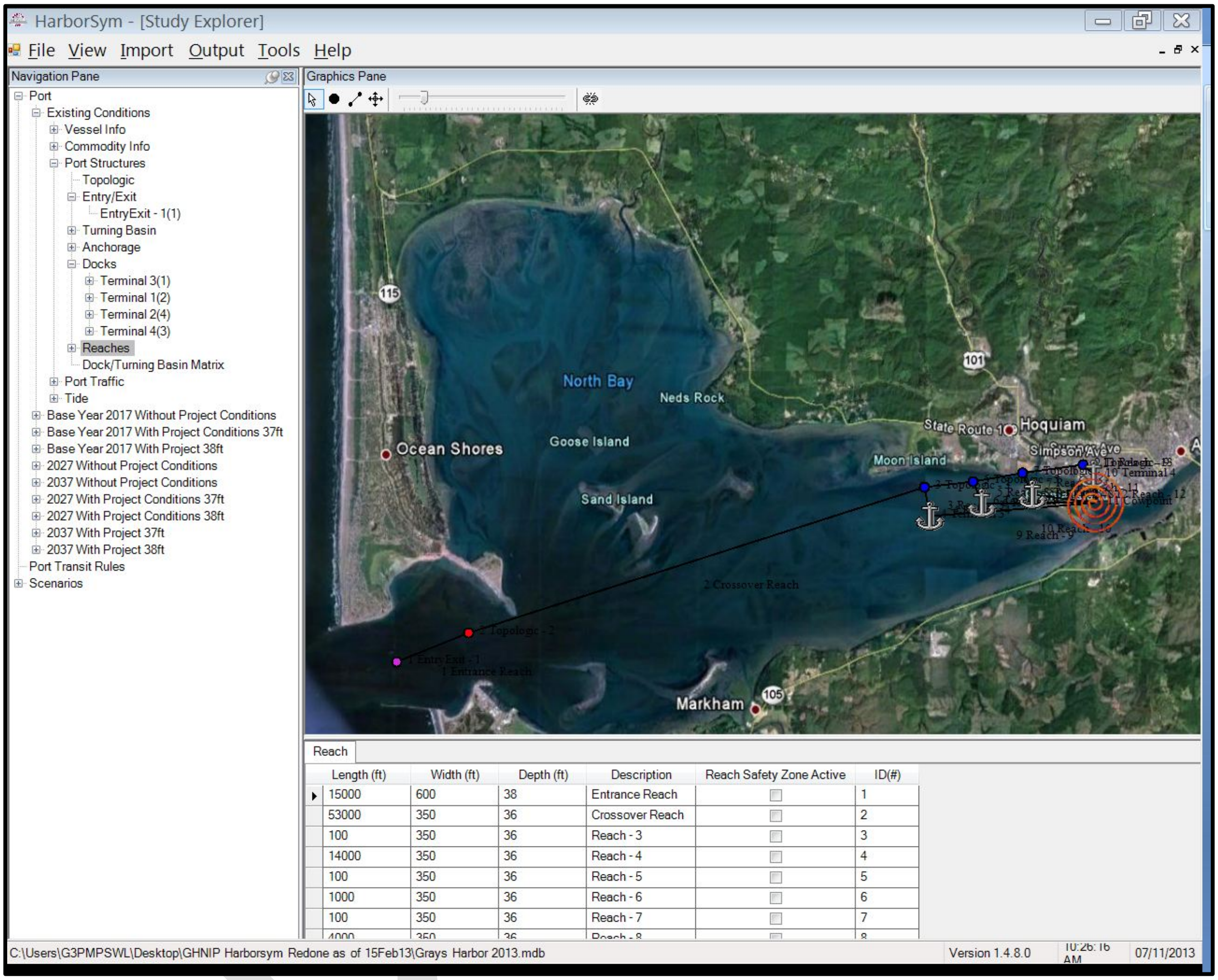


Figure 24: Grays Harbor Network and Nodes

3. **Define Vessel Types and Classes Operating in Grays Harbor**: Harborsym requires that you enter the key vessels operating in the harbor as well as the key characteristics of those vessels (length, beam, design draft, and capacity). Tanker, Bulker, and Ro-Ro[22] are the three main vessel types operating at Grays

[21] There is one turning basin authorized at Grays Harbor and all traffic is expected to utilize this turning basin. Smaller vessels may not use this turning basin but for simplicity in the modeling it is assumed that all vessel entering and exiting the Port of Grays Harbor utilize the single turning basin.
[22] For Ro-Ro vessels one size was utilized to move vehicles throughout the 50 year analysis. The reason is that the Ro-Ro vessels entering Grays Harbor have very similar characteristics and are not expected to have a major deviation in size in the future.

Harbor (Figure 25: Grays Harbor Vessel Types). For specifics of the type of vessels used at Grays Harbor reference section 3.4 Existing Vessel Fleet.

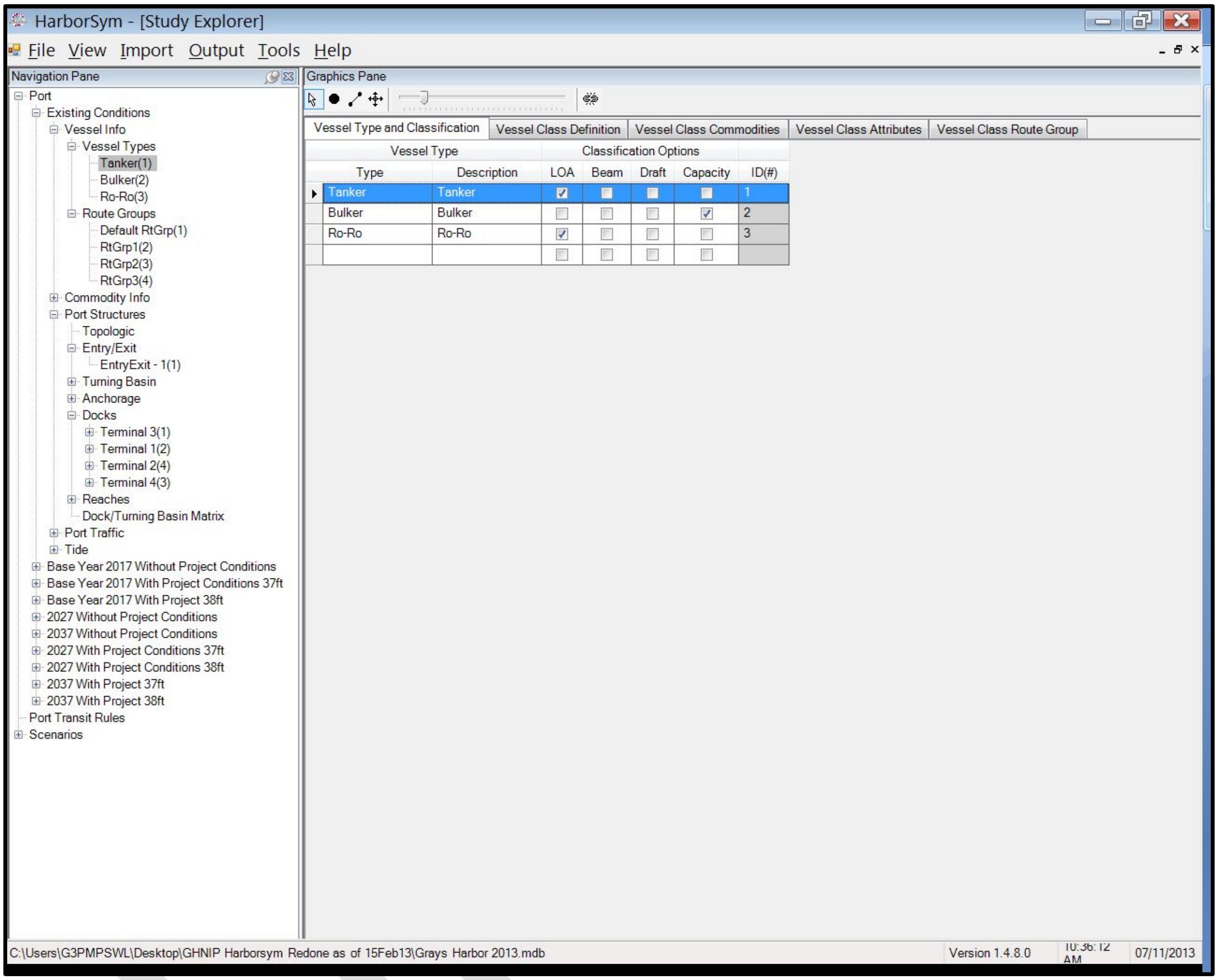


Figure 25: Grays Harbor Vessel Types

4. **Define Route Groups**: The route groups for Grays Harbor are displayed above in the section **Origins and Destination (Section 3.3)**.

5. **Define the Commodities:** Harborsym requires the user to input the commodity categories along with the units of measure and values per unit (Figure 26: Grays Harbor Commodity Categories). More about the commodities being moved through the Port of Grays Harbor can be found previously in Historic and Existing Commodity Movements (Section 3.2) and Future Commodity Movements (Section 4.2).

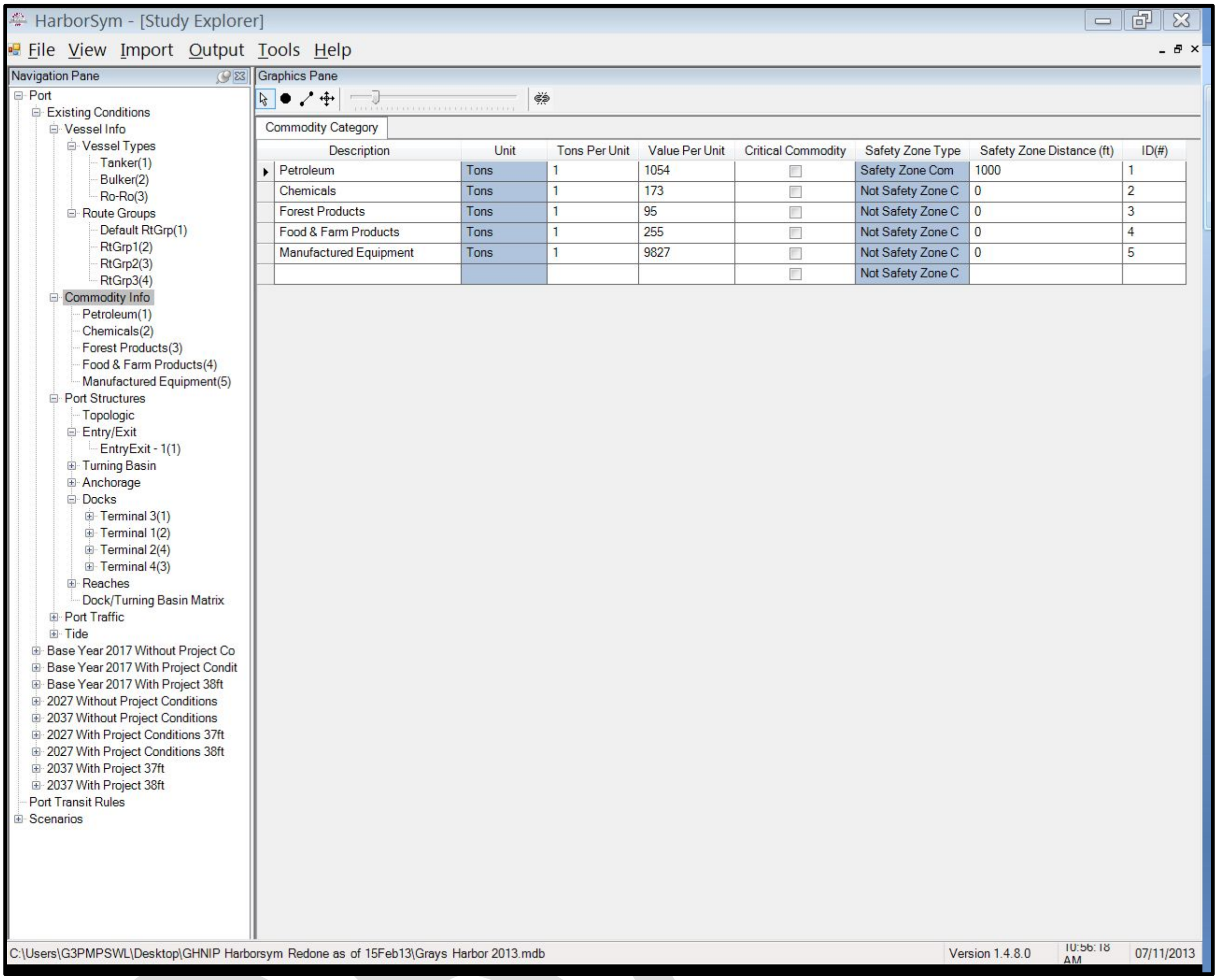


Figure 26: Grays Harbor Commodity Categories

6. **Define Vessel Speeds, and Commodity Transfer Rate:** Vessel speed and docking times were taken from historic information and direct interviews with the Harbor Pilots that operate in Grays Harbor[23]. The transfer rates, found in Table 16 below, for each commodity were derived from Grays Harbor Pilot Logs that show the arrival and departure time. In addition, the Pilot Logs display the tonnage and cargo for each vessel that called in 2012. This data was then input into Harborsym as a key component to deriving total cost of operations at the Port of Grays Harbor.

[23] The time in reaches and at the dock were taken from hard data provided by the Port and the Pilots and as such was not rechecked by the Pilots or Port Authority.

Table 17: Commodity Transfer Rates

Commodity Transfer Rates Terminal 1							
		Loading Rate (Short Tons/Hour)			Unloading Rates (Short Tons/Hour)		
Vessel Type	Commodity	Min	Most likely	Max	Min	Most Likely	Max
Tanker	Petroleum	1000	2000	3000	1000	2000	3000
Tanker	Chemicals	427	540	613	427	540	613
Bulker	Forest Products, Wood & Wood Chips	290	396	603	290	396	603
Bulker	Food & Farm Products	86	360	1222	86	360	1222
Commodity Transfer Rates Terminal 2							
		Loading Rate (Short Tons/Hour)			Unloading Rates (Short Tons/Hour)		
Vessel Type	Commodity	Min	Most likely	Max	Min	Most Likely	Max
Tanker	Petroleum	1000	2000	3000	1000	2000	3000
Tanker	Chemicals	427	540	613	427	540	613
Bulker	Forest Products, Wood & Wood Chips	290	396	603	290	396	603
Bulker	Food & Farm Products	86	360	1222	86	360	1222
Commodity Transfer Rates Terminal 3							
		Loading Rate (Short Tons/Hour)			Unloading Rates (Short Tons/Hour)		
Vessel Type	Commodity	Min	Most likely	Max	Min	Most Likely	Max
Tanker	Petroleum	1000	2000	3000	1000	2000	3000
Tanker	Chemicals	427	540	613	427	540	613
Bulker	Forest Products, Wood & Wood Chips	290	396	603	290	396	603
Bulker	Food & Farm Products	86	360	1222	86	360	1222
Commodity Transfer Rates Terminal 4							
		Loading Rate (Short Tons/Hour)			Unloading Rates (Short Tons/Hour)		
Vessel Type	Commodity	Min	Most likely	Max	Min	Most Likely	Max
Tanker	Petroleum	1000	2000	3000	1000	2000	3000
Tanker	Chemicals	427	540	613	427	540	613
Bulker	Forest Products, Wood & Wood Chips	290	396	603	290	396	603
Bulker	Food & Farm Products	86	360	1222	86	360	1222
Ro-Ro	Manufactured Equip (Cars)	74	792	2440	74	792	2440

7. **Create Historical Call List:** The historic call list for Grays Harbor was taken from the Pilot Logs and Port Vessel Call information provided by the Port for the operating year of 2012. To protect proprietary information associated with the Port and its associated business partnerships the specific call list has been removed from this appendix.

8. **Cloning Project and Simulating Port Traffic**: The historical conditions are used to build the base year, 2017 for Grays Harbor, that is then used as the seed to clone future conditions. The cloning feature of HarborSym is mainly used as a tool to avoid having to repopulate all the data populated in steps 1-7 for each year of analysis. The simulations were 100 iterations with a consistent seed number of 6 for the Monte Carlo simulation. The 100 iterations for each model run are to ensure that the standard deviation is minimized in the model. That is the more iteration run the more the model stabilizes. The main changes made for each future conditions alternative was the adjustment of the depth available for transit along the main channel for each reach[24]. For example, in the -37 MLLW alternatives the depth of the channel for each reach was adjusted from -36 MLLW to -37 MLLW. This was also done for -38 MLLW so as to account for the change in the channel depth.

[24] The only Reach not adjusted for depth was the Entrance Reach as it is naturally deeper and is equal to or greater than the depth of all alternatives under consideration.

9. **Create a Synthetic Vessel Call List in BLT**: The Bulk Loading Tool (BLT) generates the synthetic vessel call list based off of the statistical information derived from the existing vessel call list along with a commodity forecast for each year analyzed and a total number of calls, by vessel class. The BLT was used to create the future call list for each project alternative.

6.2.1 Key Assumptions

With any modeling and or planning projects assumption must be made in order to facilitate the decision making process. The key assumptions that were made for this project are as follows:

- The vessel types (Tanker, Bulker, and Ro-Ro) do a reasonable job of capturing the size and type of vessel utilizing the Port of Grays Harbor.
- Vessel sizes were held reasonably constant during the economic analysis for ease of modeling[25]. This is not expected to change the outcome of the recommended alternative due to the fact that generally as vessel sizes increase so too does the economies to scale. It is reasonable to assume that with larger vessels the analysis would lead to a better case and higher justification for a deeper channel.
- The vessel types and the commodities they move are good approximations for the reality of what commodities each vessel type moves.
- Vessels of similar type and cargo are expected to have similar dock, undock, load, and unload rates.
- Vessels operating in the system do not have mechanical or human failure.
- The vessel route group (East Asia, Asia, and North America) captures most of the traffic utilizing the Port of Grays Harbor.
- Commodities would remain relatively the same throughout the 50-year period of analysis.
- Demand for commodities is expected to grow slightly over the 50-year period of analysis.
- Commodity forecast were held constant after 2037 due to the expectation that predictions become less accurate as time elapses.
- There is not expected to be a shift in destination, mode, or any induced movement of new cargo during the 50-year period of analysis.
- The tonnage transported through Grays Harbor is expected to be similar for future years under either with- or without-project conditions.
- CBR enters the commodity mix around 2015 and the demand for fossil fuels continues to grow.
- The CBR is expected to transit via the Port of Grays Harbor –with or without the project.
- The interest rate of 3.5% used to do the economic analysis would remain the same over the 50-year period of analysis.

[25] Based on Vessel Trends that can be found in the Supplemental Environmental Impact Statement the Port has seen an increase in the overall size of vessels being utilized in the channel.

- The under-keel clearance is 3.5 feet for all vessels utilizing the harbor and is based on expert elicitation.
- The benefits from the project are assumed to not have an economic multiplier effect.
- Modeling in 10 year increments, as oppose to annually, over the 50-year period of analysis and interpolating does a good job of capturing the cost associated with the years in between the modeled years.
- Vessels will wait approximately 1 hour before retrying to enter the harbor or exiting a node to ensure as many vessels as possible can get through and accounted for in the system.
- The maximum time a vessel can wait in the system is approximate 8 hours before being deleted from the system.
- Once a vessel is moving within a leg it has priority over all other vessels that subsequently enter the leg.

6.2.2 Model Limitations

HarborSym is a planning tool developed to analyze deep draft navigation projects by evaluating the impact of various harbor improvements. However, like all planning models, there are limitations. Some key model limitations are:

- HarborSym requires detailed user-provided data and assumptions and relies heavily on the quality of the data available to complete the analysis.
- Cost that are accumulated outside of the actual vessels entering or exiting the harbor such as fixed cost, tug assistance cost, pilot cost, terminal fees, and externalities are not captured by the model.
- Hinterland transportation costs are not included in the model.
- External factors such as weather, emergencies, laws, or policies are not captured in the model.

6.2.3 Vessel Operating Costs

Deep-draft vessel operating cost (DDVOC) are a main component in the evaluation of economic benefits of deep-draft or coastal waterway improvement projects. Since the 1960's the DDVOCs have been developed by the USACE Institute for Water Resources and is published in the form of datasheets (IWR 2010). This helps to ensure consistency, efficiency across the nation. In addition, the provision for DDVOC helps to reduce the burden on USACE District Economist by providing standards for all deep-draft navigation studies without having to defend the development methodology.

The specific tables used to derive the DDVOCs for the Port of Grays Harbor were the Vessel Operating Cost in USACE Economic Guidance Memorandum 11-05 tables dated July of 2011(Army 2011). The HarborSym model requires the hourly domestic and foreign cost at sea and at port as an input. The DDVOC developed by IWR differentiates between domestic and foreign cost at sea or in port for the modeling it was assumed that a vessel cost would be dependent on the most likely type of vessel used and whether the vessel was in transit or at the dock. In addition, the DDVOC displays the cost associated with general characteristics whereas some of the vessels operating in Grays Harbor may or may not match up closely with said general characteristics. Where the vessel characteristics do not match up perfectly, in a few cases, the next closest similar characteristic vessel cost from the DDVOC were used.

6.3 Economic Modeling Results and Plan Selection

The economic modeling was based on the benefits derived from the reduction in overall cost throughout the 50-year period of analysis. The alternative that reasonably maximizes net benefits, per USACE guidance, should be the plan selected to be implemented. The three alternatives previously described in Section 1.7 that were analyzed include:

- Alternative 1: No Action
- Alternative 2: Deepen Channel to -37 MLLW
- Alternative 3: Deepen Channel to -38 MLLW

7 NED Costs

NED costs are defined as opportunity cost and as such may or may not come in many different forms. There are economic costs (explicit) and financial costs (implicit) that may overlap. Financial costs are synonymous with accounting costs or actual expenses. Economic costs can be an exercise in theory on how resources such as land or other national resources could better be used or the value of that which is foregone (opportunity cost).

The relevant costs for project evaluation have been determined by policy to be NED costs. The Planning Guidance Notebook (ER 1105-2-100) states that NED costs are used for the economic analysis of alternative projects and reflect the opportunity cost of direct or indirect resources consumed by project implementation.

The financial costs were provided by the Seattle District Cost Engineering Department and were developed through the Micro-Computer Aided Cost Estimating System (MCACES) 2nd generation (See Attached: Port of Grays Harbor Navigation Improvement Project MII Report).

The annual maintenance at Grays Harbor is approximately $8-10 million for -36 feet MLLW. This dollar amount is expected to change at the alternative depths that were looked at. For comparisons, to derive the benefits, the economic analysis looked at the change in operational costs savings from Alternative 1 (-36 feet MLLW) to Alternative 2 (-37 feet MLLW) and Alternative 3 (-38 feet MLLW). The O&M for the economic analysis for the other alternatives (-37 and -38) are expected to see an incremental change. The incremental cost increase from the current operations (without project) to the -with project (-37, and -38 MLLW) were added to the total project cost. The incremental increase of alternative 2 and 3 are found in the table below (Table 18: Grays Harbor Operation and Maintenance).

Table 18: Grays Harbor Operation and Maintenance

Grays Harbor Incremental Operation and Maintenance		
Alternative	**Volume (Cubic Yards)**	**Total Cost**
Alternative 2 (-37 MLLW)	48,000	$ 218,000
Alternative 3 (-38 MLLW)	107,000	$ 483,000

Additional costs were added to account for the interest during construction (IDC) that would accrue. That is the opportunity cost of not using the funds tied up in the project for other purposes. The FY14 federal interest rate of 3.5% along with a construction period of approximately 8 months was used to derive the IDC. The NED costs for alternative 2 and 3 are found in the tables below.

Table 19: NED Costs Alternative 2 (-37 MLLW)

NED COSTS -37 MLLW	
Estimated Total Project Costs	$ 12,719,000
Interest During Construction	$ 129,000
Operation and Maintenance	$ 218,000
Total	$ 13,066,000

Table 20: NED Costs Alternative 3 (-38 MLLW)

NED COSTS -38 MLLW	
Estimated Total Project Costs	$ 19,703,000
Interest During Construction	$ 199,000
Operation and Maintenance	$ 483,000
Total	$ 20,385,000

8 Benefits

National Economic Development (NED) Benefits are defined as increases in the economic value of the goods and services that result directly from a project. NED benefits are increases in national wealth, regardless of where in the U.S. they occur (IWR 1991).

With respect to navigation, NED benefits are defined as the reduced cost of transportation (see Annual Cost Savings below). Benefits attributed to the Grays Harbor Navigation Improvement Project are mainly transportation cost savings due to the elimination or reduction in transit times, and the use of more efficient vessel loadings.

NED benefits were assessed for the alternatives in this reevaluation following the methodology prescribed by the Corps Planning Guidance Notebook for deep draft economic analysis (IWR 2010).

Benefits are equal to the difference between without (-36 MLLW) and with project transportation cost (-37 and -38 MLLW). All costs are adjusted to the base year of the project, 2017, and are then converted to Average Annual Equivalent (AAEQ) values using the Fiscal Year (FY) 2014 Federal discount rate of 3.5 percent, assuming a 50-year study period. All costs are at 3rd Quarter 2017 price levels. The benefits estimated for the separable elements of each alternative will be compared to its cost to determine its economic justification. The plan that maximizes net benefits (average annual benefits less average annual cost) is the NED Plan. The NED Plan is the Federal recommended plan, and, as is the case with Grays Harbor, equivalent to the locally preferred plan[26]. The annual cost for each alternative along with the corresponding benefit stream can be found in Table 20 below. Modeling was run on the base year (2017) and then at 10 year increments up to 2037 at which point the cost and benefits were held constant. Linear interpolation was used for the benefits and costs for the years that modeling was not run.

Table 21: Annual Transportation Cost and Transportation Cost Savings (Benefit) Stream

Annual Cost and Benefit Stream					
	Alt 1 (No Action)	Alt 2 (-37ft MLLW)		Alternative 3 (-38 MLLW)	
Year	Transit Cost	Transit Cost	Benefits	Transit Cost	Benefits
2017	$ 124,260,105	$ 117,874,845	$ 6,385,260	$ 112,601,294	$ 11,658,811
2018	$ 165,860,966	$ 159,920,150	$ 5,940,817	$ 154,992,304	$ 10,868,662
2019	$ 207,461,828	$ 201,965,454	$ 5,496,374	$ 197,383,314	$ 10,078,514
2020	$ 249,062,689	$ 244,010,759	$ 5,051,930	$ 239,774,324	$ 9,288,365
2021	$ 290,663,551	$ 286,056,063	$ 4,607,487	$ 282,165,334	$ 8,498,217
2022	$ 332,264,412	$ 328,101,368	$ 4,163,044	$ 324,556,344	$ 7,708,068
2023	$ 373,865,273	$ 370,146,673	$ 3,718,601	$ 366,947,354	$ 6,917,919
2024	$ 415,466,135	$ 412,191,977	$ 3,274,158	$ 409,338,364	$ 6,127,771
2025	$ 457,066,996	$ 454,237,282	$ 2,829,714	$ 451,729,374	$ 5,337,622
2026	$ 498,667,858	$ 496,282,586	$ 2,385,271	$ 494,120,384	$ 4,547,474
2027	$ 540,268,719	$ 538,327,891	$ 1,940,828	$ 536,511,394	$ 3,757,325
2028	$ 543,709,060	$ 541,907,950	$ 1,801,110	$ 540,133,287	$ 3,575,774
2029	$ 547,149,401	$ 545,488,008	$ 1,661,393	$ 543,755,179	$ 3,394,222
2030	$ 550,589,742	$ 549,068,067	$ 1,521,675	$ 547,377,072	$ 3,212,671
2031	$ 554,030,083	$ 552,648,126	$ 1,381,958	$ 550,998,964	$ 3,031,119
2032	$ 557,470,425	$ 556,228,185	$ 1,242,240	$ 554,620,857	$ 2,849,568
2033	$ 560,910,766	$ 559,808,243	$ 1,102,522	$ 558,242,749	$ 2,668,017
2034	$ 564,351,107	$ 563,388,302	$ 962,805	$ 561,864,642	$ 2,486,465
2035	$ 567,791,448	$ 566,968,361	$ 823,087	$ 565,486,534	$ 2,304,914
2036	$ 571,231,789	$ 570,548,419	$ 683,370	$ 569,108,427	$ 2,123,362
2037-2057	$ 574,672,130	$ 574,128,478	$ 543,652	$ 572,730,319	$ 1,941,811
Average Annual Benefits			$ 2,205,000		$ 4,552,000

[26] NED analysis generally analyzes a suite of alternatives but for Grays Harbor the analysis was constrained, at the request of the sponsor, to -37 and -38 MLLW. Thus the plan recommended, under the constraints, is the plan that maximized the net benefits and not necessarily what is traditionally thought of as the NED maximizing plan.

8.1.1 Annual Cost Savings

The resulting annual cost savings (benefits) were based on the difference between the without (Alternative 1: No Action) and the –with project (Alternative 2 (-37 feet MLLW) and Alternative 3 (-38 feet MLLW)) cost accrued throughout 50-year period of analysis. Figure 27 displays the expected cost savings associated with the operation of each year from 2017 out to 2067 for alternative 2 and 3.

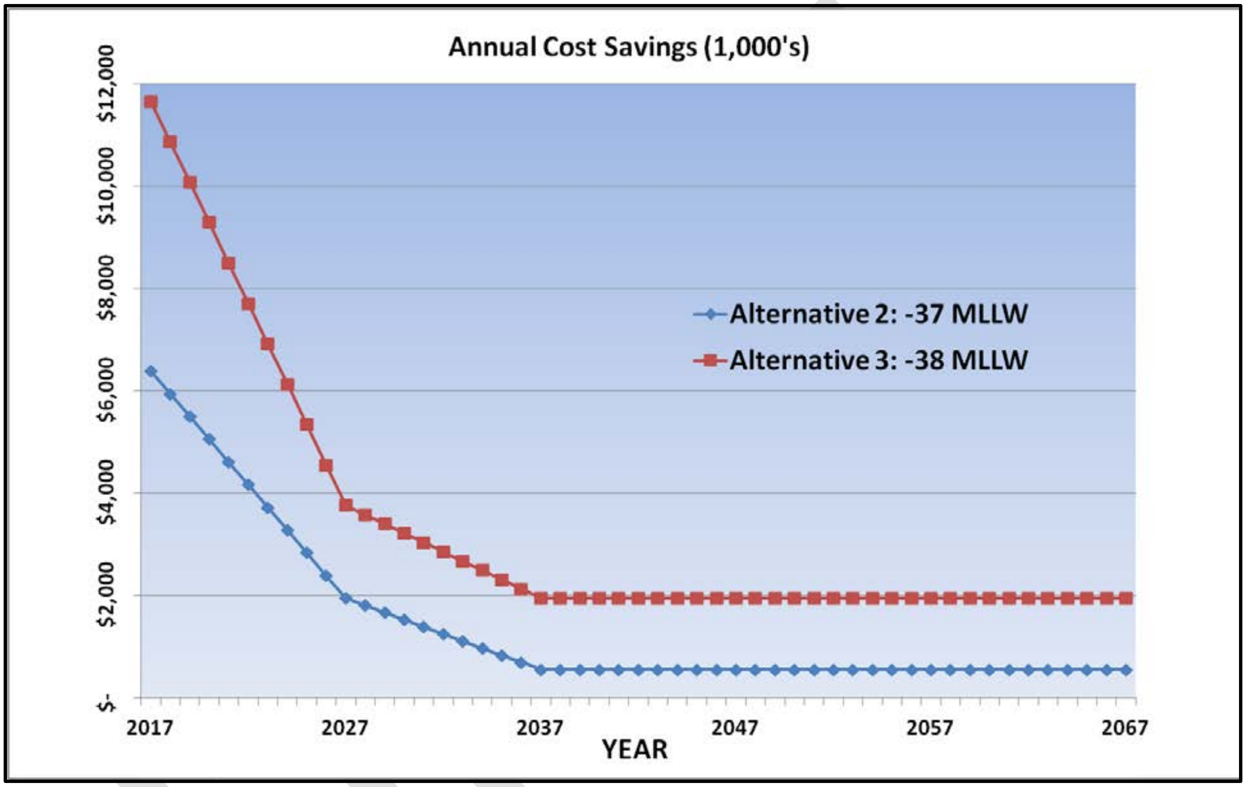


Figure 27: Annual Cost Savings for Alternative 2 and 3

These cost savings, found in table 20, were annualized and taken as a benefit for implementing a project. The outcome is displayed below in Figures 27 and 28.

NED ANALSYSIS -37 MLLW	
Average Annual Benefits	$ 2,154,000
Average Annual Cost	$ 766,000
Net Benefits	$ 1,388,000
Benefit to Cost	2.81

Figure 28: NED Analysis -37 MLLW

NED ANALYSIS -38 MLLW	
Average Annual Benefits	$ 4,470,000
Average Annual Cost	$ 1,331,000
Net Benefits	$ 3,139,000
Benefit to Cost	3.36

Figure 29: NED Analysis -38 MLLW

9 Risk and Uncertainty

9.1.1 Risk-Informed Decision Making

The Risk-Informed Decision Making process described in previous sections provides a general framework that can be incorporated in various economic functions. The general requirement is to identify all assumptions, predicted variables, estimated values and parameter values that are critical to the report recommendation and the value of each critical factor where the recommendations would change or feasibility would be questioned. The specific analyses which are, or may be, required address assumptions such as to traffic projections, rates, vessel operating costs, vessel fleet composition or vessel fleet characteristics.

A risk analysis of the parameters influencing each alternative must be conducted to:

- Identify all critical parameters underlying the justification of each alternative
- Determine the range of conditions under which each alternative is justified.
- Identify potential risks, how it could occur, the likelihood of the risk and consequences

The analyst should distinguish between external and internal parameters. External parameters are those factors which occur independently of project implementation, for example, custom fees. Internal parameters are those factors directly related to project implementation, for example, commodity flows.

Specific areas that might be addressed in a risk analysis are:

- Uncertainty in commodity forecast
- Variation in fleet composition
- Sensitivity of transportation costs to fuel price fluctuations, or other factors
- Global warming impacts on sea levels (See EC 1165-2-211) (PDF Size:457 kb) such as dockside infrastructure, draft and sediment changes, and possibly demand changes
- Southeast Asia’s growing and shifting economy
- Movements towards less foreign oil dependence
- Uncertainty in distribution of domestic shell oil via rail

The key assumptions are described in the section KEY ASSUMPTIONS and the model limitation are listed in the section MODEL LIMITATIONS. To facilitate the risk informed decision making process there were three sensitivity analyses' conducted. The no growth after the base year of 2017 was modeled followed by changing the FY14 discount rate to 7% on the existing analysis to see what, if any, changes in net benefits would occur. In addition, the scenario in which the CBR does not utilize Grays Harbor was modeled to ensure the project would be economically justified regardless of predicted commodity arrivals/flows. Results of the analysis are found in Section 10 below.

10 Sensitivity Analysis

Sensitivity analysis was conducted to help ensure that a risk informed decision was made by determining how changing an independent variable, such as growth rates, will impact a particular dependent variable (vessel operating cost) under a given set of assumptions. For this exercise the no growth after the base year of 2017 was modeled followed by changing the FY14 discount rate to 7% on the existing analysis to see what, if any, changes in net benefits would occur. In addition, the scenario in which the CBR does not utilize Grays Harbor was modeled to ensure the project would be economically justified regardless of predicted commodity arrivals/flows.

10.1.1 No Growth After Base Year

To confirm the sensitivity of our commodity projections a no growth scenario was run. The initial run was based on the 2017 base year and the growth of the commodities entering the Port of Grays Harbor was held constant (zero growth). The findings confirm that the outcome is sensitive to the change in commodity tonnage but the results, with respect to which plan is the selected plan, did not change. In the no growth scenario alternative 3 (-38 MLLW) still maximized net benefits of the three alternatives considered (Figure 31: NED Analysis -38 MLLW (No Growth)).

NED ANALSYSIS -37 MLLW (No Growth)	
Average Annual Benefits	$ 513,000
Average Annual Cost	$ 766,000
NED Benefits	$ (253,000)
Benefit to Cost	0.67

Figure 30: NED Analysis -37 MLLW (No Growth)

NED ANALYSIS -38 MLLW (No Growth)	
Average Annual Benefits	$ 1,389,000
Average Annual Cost	$ 1,331,000
NED Benefits	$ 58,000
Benefit to Cost	1.04

Figure 31: NED Analysis -38 MLLW (No Growth)

10.1.2 Change in Discount Rate

The federal interest rate as prescribed by the U.S. Department of the Treasury, which computes it as the average market yield on interest-bearing marketable securities of the U.S. that have 15 or more years to maturity, changes throughout the years and more than likely will not be the same as assumed in the modeling. The interest rate that was used to derive the benefits and annualize the cost was the current FY14 discount rate of 3.5%.

Interest rates have an inverse relationship to present values. That is increases in expected interest rates result in lower present values because future values are discounted at a high rate to become smaller present values. The reciprocal is also true in that decreases in expected interest rates result in higher present values because future values are discounted at a lower rate.

To ensure an informed decision is made the interest rate used to determine the benefits and annualized the costs was changed from the 3.5% to 7%. This higher number would reduce the present values of future benefits and would give a better idea of what would happen if the cost to borrow capital were to increase. The benefit to cost ratios for both alternative 2 and 3, along with the average annual cost and benefits, changed under both scenarios. However, this change did not show a significant deviation from the previous results when using the FY14 3.5% discount rate. The plan that maximized the net benefits is still alternative 3 (-38 MLLW).

NED ANALSYSIS -37 MLLW (7% Discount Rate)		
Average Annual Benefits	$	2,843,000
Average Annual Cost	$	1,158,000
NED Benefits	$	1,685,000
Benefit to Cost		2.46

Figure 32: NED Analysis -37 MLLW (7% Discount Rate)

NED ANALYSIS -38 MLLW (7% Discount Rate)		
Average Annual Benefits	$	5,585,000
Average Annual Cost	$	1,939,000
NED Benefits	$	3,646,000
Benefit to Cost		2.88

Figure 33: NED Analysis -38 MLLW (7% Discount Rate)

10.1.3 Elimination of CBR

Crude is expected to play a large role in the overall tonnage moved through the Port of Grays Harbor starting around 2015 and continuing throughout the 50 year analysis. One major concern is that CBR, although likely, may not utilize Grays Harbor due to external environmental considerations. If this is the case then we would expect to see a large reduction in the predicted tonnage moved through the Port. The major concern is that the benefits attributed to the reduction in transportation cost are derived from the reduction in the cost to move tonnage and as such the loss of CBR could change the outcome and final decision with respect to the deepening. To account for this concern modeling was done under the assumption that CBR does not utilize Grays Harbor. The results of which are displayed below in figure 32 and 33. With the elimination of CBR the plan with the greatest net benefits is Alternative 3 (-38 MLLW). Thus, the elimination of CBR does have an effect on the benefits but not so much in that a change in the decision to select -38 MLLW as the NED plan is warranted.

NED ANALSYSIS -37 MLLW (No Crude)		
Average Annual Benefits	$	1,904,000
Average Annual Cost	$	766,000
NED Benefits	$	1,138,000
Benefit to Cost		2.49

Figure 34: NED Analysis -37 MLLW (No Crude)

NED ANALYSIS -38 MLLW (No Crude)		
Average Annual Benefits	$	4,433,000
Average Annual Cost	$	1,331,000
NED Benefits	$	3,102,000
Benefit to Cost		3.33

Figure 35: NED Analysis -38 MLLW (No Crude)

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