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PORTSMOUTH HARBOR AND PISCATAQUA RIVER
PORTSMOUTH, NEW HAMPSHIRE

NAVIGATION IMPROVEMENT PROJECT
FEASIBILITY STUDY

ECONOMIC APPENDIX

APPENDIX C

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Methodology

The purpose of this assessment is to evaluate the benefit of navigation improvement in the Piscataqua River and Portsmouth Harbor. Benefit classification is from the National Economic Development Account (NED). Regional economic benefit is not developed in this evaluation. Benefit and cost are made comparable by conversion to average annual equivalents. An interest rate of 3-1/2% as specified in the Federal Register is to be used by Federal agencies in the formulation and evaluation of water and land resource plans for the period 1 October 2013 to 30 September 2014. All cost and benefit are stated at the FY 2014 price level. The project economic life is considered to be 50 years. The analysis of cost and benefit follows standard U.S. Army Corps of Engineers procedures. The reference document used in the benefit estimation process is ER 1105-2-100, 22 April 2000, Appendix E, Section II, Navigation, E-10, NED Benefit Evaluation Procedures: Transportation, Deep-Draft Navigation.

A plan is considered to be economically feasible if annualized benefit divided by annualized cost is greater than or equal to one. Net benefit, or plan benefit minus plan cost, must be greater than or equal to zero. This report includes an analysis of alternatives and the identification of the plan with the largest net benefit that is labeled the NED plan.

Area Description

The Piscataqua River forms a portion of the state boundary between Maine and New Hampshire. Portsmouth Harbor, located at the mouth of the river, is about 45 miles northeast of Boston Harbor, Massachusetts. The existing Federal project includes a 35-foot deep channel, generally 400 feet wide, extending from deep water in Portsmouth Harbor to a point approximately 6.2 miles upstream. The existing project as modified by WRDA86 also includes: widening the bends at several locations; a 1,000 foot emergency maneuvering area between the Memorial and Maine-New Hampshire lift bridges; channel widening upstream of the Maine-New Hampshire Bridge; a 950-foot wide turning basin upstream of Boiling Rock; and an 800-foot wide turning basin at the head of the project.

Commodity Forecasts

<u>Commodity Flows at Portsmouth Harbor, New Hampshire:</u>

Portsmouth is the only major commercial port in New Hampshire, shipping and receiving approximately 3,047,000 tons of waterborne commerce in 2011. Petroleum products comprise the majority of commodities shipped and received at Portsmouth Harbor, accounting for 62% of all commodities since 1991. In recent years dry bulk products have shown a significant increase at Portsmouth Harbor. Table C-1 shows the commodity distribution in 2011.

The freight which make up the majority of all commodities at Portsmouth Harbor are depicted in the commodity flows table presented on page 5. The four most prominent commodities at Portsmouth Harbor are coal, distillate fuel oil, gypsum and non-metal minerals. Table C-2 shows the percentage annual change in commodity flows at Portsmouth Harbor since 1991.

The final page is a statistical summary of output. The dependent variable 'Y' represents total annual tonnage at Portsmouth Harbor and the independent variable 'X' represents the year. Through the statistical data derived from these variables the following equation was created:

$$Y=-205903.5+105.1x$$

This equation can be used to predict the commodity flows at Portsmouth Harbor in years to come. Therefore, in 2010 it can be expected that Portsmouth Harbor will ship and receive approximately 5,347,500 tons of waterborne commerce. In 2015 Portsmouth Harbor will ship and receive 5,873,000 tons, in 2030 7,449,900 tons and in 2060 Portsmouth Harbor can be expected to have total consignments exceeding 10,602,500 tons.

For purposes of this analysis the 2011 commodity tonnage will be held constant through the study period.

Table C-1
Freight Traffic by Commodity
2011

Commodity	Tons (thousands)
Total, All Commodities	3,047
Coal	309
Petroleum Products	1,407
Crude Materials	1,298
All Other Commodites	34

Table C-2 Total Tonnage by Year 1991 to 2011 Portsmouth Harbor		
Percent Annual Increase of Commodities at Portsmouth Harbor		
Year	Tons (thousands)	Percent Change
2011	3,047	2.80%
2010	2,964	-17.28%
2009	3,583	-6.52%
2008	3,833	-4.79%
2007	4,026	-16.52%
2006	4,823	-8.20%
2005	5,254	9.57%
2004	4,795	-3.54%
2003	4,971	21.01%
2002	4,108	-7.62%
2001	4,447	-0.34%
2000	4,462	-2.06%
1999	4,556	8.63%
1998	4,194	6.07%
1997	3,954	6.63%
1996	3,708	-5.26%
1995	3,914	12.50%
1994	3,479	-5.77%
1993	3,692	-1.23%
1992	3,738	5.68%
1991	3,537	

Table C-3
Vessel Trips by Draft
2011

	Upbound	Downbound
	Foreign	
Total	121	121
38	1	
36	19	
35	31	
34	8	2
33	1	3
32	3	2
31	2	3
30	4	12
29	3	4
28	2	9
27	2	8
26		5
25	7	12
24	5	9
23	5	6
22	4	12
21	3	13
20	4	4
<20	17	17
	Domestic	
Total	54	30
25	1	
24	2	
23	1	
22	1	1
21	18	
20	2	1
<20	29	28

Fleet Forecasts

The fleet currently calling on the upper Piscataqua River in Portsmouth Harbor ranges is length from 420 feet to 747 feet, with most vessels in the 20,000 to 50,000 DWT range. There are currently about 80 vessel visits a year with many shipments originating in the Mediterranean, Northern Europe and North Africa. Fleet trips by sailing draft and flag are shown in Table C-3.

Data published by MARAD (US Department of Transportation, Maritime Administration) for 2006 indicate that there are 474 LNG carries in the world fleet with a capacity of 24,495, 441 deadweight (metric) tons. The bulker fleet contains 6,464 vessels with a deadweight capacity of 370,785,388 metric tons. These are the main types of vessels utilizing the upper turning basin.

For the fleet distribution used in this analysis about 36 % of the fleet has vessels lengths greater than 500 feet in the without project condition. The fleet size is estimated to be 78 vessels all using the turning basin. The fleet distribution by vessel length is shown in Table C-3(b). All these vessel calls are at the two benefiting terminals and all utilize the turning basin. It is anticipated that transition to larger will occur upon completion of the project with benefit accruing in year 1 of the study period.

Table C-3(b)
Fleet Distribution by Vessel Length
Upper Turning Basin Fleet
Piscataqua River
Portsmouth, N H

	Alternative Turning Basin Widths											
Vessel	800 '			1020 '			1120 '			1200 '		
Length	Domestic	Foreign	Total	Domestic	Foreign	Total	Domestic	Foreign	Total	Domestic	Foreign	Total
<= 500 '	28	22	50	28	22	50	28	22	50	28	22	50
501' - 599'	0	9	9	0	0	0	0	0	0	0	0	0
600' - 699'	0	12	12	0	14	14	0	0	0	0	0	0
700' - 800'	0	7	7	0	5	5	0	17	17	0	15	15
> 800'	0	0	0	0	0	0	0	0	0	0	0	0
Total	28	50	78	28	41	69	28	39	67	28	37	65

Improvement Plans

The plans under consideration would widen the upper turning basin from the existing 800 feet to 1020 feet, 1120 feet and 1200 feet. A wider turning basin would allow shippers to utilize larger vessels, improve the safety of turning by reducing the probability of grounding, and lower the cost of turning by reducing the number of tugs needed for assistance in turning vessels.

Piscataqua River Improvement Benefit

Vessels utilizing the upper turning basin off load their cargo at two upstream berths. The two berths are owned by Sprague and a third berth owned by the Department of Defense (DOD) is currently not in use. Sprague Energy owns both the Sprague River Road terminal, which it operates, and the Avery Lane Terminal. Sea-3 has an easement to access and operate the Avery Lane Terminal for its propane pipeline which connects its gas tanks on Sea-3 property with the dock. That easement was originally granted to Sea-3's predecessor, Dorchester Enterprises, and grants a right of way to the terminal as well as over the terminal itself. That easement itself does not have a stated termination date but is instead tied to the terms and conditions of a Dock Agreement which memorializes the two companies (Sprague and Sea-3) shared responsibilities for dock maintenance and operation. The Dock Agreement's termination date is 2079, beyond the 50-year project life, but may be terminated sooner upon the expiration of the useful life of the dock or if any occurrence or event requires a capital improvement of $500,000.00 or more. However, Sea-3 has an Option to Purchase the dock if either of those events come to pass. Sea-3's Option to Purchase is also triggered by Sprague attempting to sell or lease the dock to another entity or if 51% of the Sprague's stock is transferred. The grantee in the easement (Sea-3) has an ownership interest in the property to the extent the Dock Agreement remains in effect. Sea-3 imports liquefied propane gas (LPG). The other shippers using the Sprague facility are Pike Industries (asphalt), Georgia Pacific (gypsum), BCS (caustic soda), Morton (road salt), Baker Commodities (tallow), and Dragon (cement). The products from both of these terminals are destined for local markets. The terminals estimate that most of the tonnage is destined to locations within a 100-mile radius of the port to northern Massachusetts and southern New Hampshire and Maine.

There are three types of benefit evaluated in this study. The first type would be a reduction in transportation cost associated with the economies of scale of utilizing larger vessels and less time in port. The second type would be a reduction in damages as a result of grounding when turning. The third type would be an efficiency achieved in the turning operation as a result to utilizing fewer tug boats to assist in the turn.

Reduction in Transportation Cost

Shippers trade-off the risk of grounding from using larger ships with the gain in economies of scale from using these larger ships. The risk of grounding, and thus damages to vessels, increases with the length of the vessel. However, transportation cost declines with the use of larger ships. In the without project condition shippers are more or less in a state of equilibrium. They have no incentive to increase their utilization of larger ships, as the potential damage from doing so would exceed the reduction in transportation cost from doing so. They have no incentive to utilize smaller ships, as the increase in transportation cost from doing so would exceed the expected grounding damage from the use of these vessels. Widening the turning basin from 800 feet to the proposed widths of 1020, 1120, and 1200 feet would encourage shippers to schedule relatively more of the larger ships. A new equilibrium would likely be established in the with project condition where both the expected damage from groundings and the transportation cost would be lower than in the old equilibrium. Both Sea-3 and the users of the Sprague facility indicate that a greater percentage of their tonnage would be carried on larger ships if the turning basin were widened. These ships are currently in use now at Portsmouth Harbor and it is expected that they would be used more intensively with a wider turning basin.

Shippers were queried as to their type of product, volume of product, vessel size distribution (with and without widening of the turning basin), origin/destination of their shipments, and distribution of shipments by flag (foreign or US). From this basic information transportation costs for both the without and with project condition were developed.

Cost saving is estimated by determining the transportation cost with widening of the turning basin with the transportation cost without widening. Cost saving is the difference between the without and with project transportation cost. This cost is calculated for users of each berth and then aggregated. Arithmetically, the transportation cost is the product of the round-trip distance from origin to destination and the hours per mile, the cost per hour and the number of vessel trips. The number of vessel trips is derived by dividing the total tonnage imported in a vessel size category by the tonnage capacity of the vessel. Separate transportation cost was developed for each vessel size in both the without and with project conditions. Hourly vessel operating cost is developed by the Institute for Water Resources (IWR) every few years. The latest estimates for FY 2011 were used in the analysis. IWR develops cost by flag, type and size of vessel. Transportation cost is summed over the number of trips and then put on a per ton basis by dividing by the total tonnage imported by each shipper. The differential cost per ton is then multiplied by total tonnage imported to determine cost savings for each shipper. The reduction in transportation cost between the without project condition and the with project condition is a project benefit. Savings are put on a per ton basis to allow for calculation with tonnage growth. However, no growth is assumed in this evaluation. The primary trade routes are Northern Europe, the Mediterranean and Northern Africa.

It is anticipated that the shippers utilizing vessels in the without project condition that have a ratio of length to existing turning basin width (800’) greater than two-thirds will shift to larger vessels in the with project conditions. This implies vessels that are greater than 533’ in length will be replaced by larger vessels in the with project conditions. This anticipated shift is shown in Table C-3(b) on Page C-5. As the channel depth is not changing there is no anticipated change in operating drafts. The larger vessels will still be light loaded to transiting the channel. Due air draft restrictions under bridges vessels longer than 800 feet could not be employed.

Transportation costs are estimated for Sprague for the width of the existing turning basin and the three improved widths. These costs are shown in Table C-4 and the transportation costs savings estimated for each improved width are shown in Table C-5.

Table C- 4
Transportation Cost
Sprague
Piscataqua River
Portsmouth NH
($000)

Turn Basin Width	At Sea Cost	In Port Cost	Tidal Delay	Transportation Cost
800	$5,470.7	$928.1	$0.1	$6,398.9
1020	$4,749.8	$709.2	$0.1	$5,459.0
1120	$4,444.3	$701.9	$0.1	$5,146.3
1200	$4,139.3	$704.6	$0.2	$4,844.0

Table C-5
Benefit
Sprague
Piscataqua River
Portsmouth NH
($000)

Turn Basin Width	Transportation Cost Savings			
	At Sea	In Port	Tidal Delay	Total
1020	$720.9	$218.9	$0.0	$939.9
1120	$1,026.4	$226.1	$0.0	$1,252.6
1200	$1,331.4	$223.5	$0.0	$1,554.8

Similar transportation costs and estimated savings are shown for Sea-3 in Table C-6 and Table C-7.

Table C-6 Transportation Cost Sea-3 Piscataqua River Portsmouth NH ($000)				
Turn Basin Width	At Sea Cost	In Port Cost	Tidal Delay	Transportation Cost
800	$4,660.4	$613.0	$7.0	$5,280.4
1020	$3,710.0	$414.8	$5.7	$4,130.5
1120	$3,842.5	$407.0	$6.0	$4,255.5
1200	$3,558.5	$396.6	$6.6	$3,961.7

Table C-7 Benefit Sea-3 Piscataqua River Portsmouth NH ($000)				
Turn Basin Width	Transportation Cost Savings			
	At Sea	In Port	Tidal Delay	Total
1020	$950.5	$198.3	$1.2	$1,149.9
1120	$817.9	$206.0	$1.0	$1,024.9
1200	$1,102.0	$216.4	$0.3	$1,318.7

The combined transportation cost savings, or benefits, for both terminals are displayed in Table C-8.

Table C-8 Benefit Piscataqua River Portsmouth NH ($000)				
Turn Basin Width	Transportation Cost Savings			
	At Sea	In Port	Tidal Delay	Total
1020	$1,671.4	$417.1	$1.2	$2,089.8
1120	$1,844.4	$432.1	$1.0	$2,277.5
1200	$2,433.4	$439.9	$0.3	$2,873.6

For the alternative that would provide a turning basin width of 1020 feet, at sea transportation costs savings would be an estimated $1,671,400 annually due to the economies of scale of utilizing larger ships. In port cost savings are estimated at $417,100 based on each vessel spending on average 24 fewer hours in-port due to the removal of the requirement of daylight for vessel turning. There would be some minor reductions in tidal delay due to fewer vessel trips in the with project conditions given that operating drafts are not expected to change in the with project conditions. Benefits are not smoothly increasing with turning basin width improvements as for some alternatives higher vessel operating associated with larger vessels is not completely offset by the reduction in number of trips. Total transportation cost savings for a turning basin width of 1020 feet are estimated at $2,089,800.

Reduction in Grounding Damages

Of the five groundings, the most costly incident occurred in 1985 where the vessel grounding resulted in damage to the propeller, propeller shaft, and stern tube. Damage to the vessel, towing charges, penalties, and vessel service loss were estimated to be $8,000,000. That loss in the 2014 price level is estimated to be $15,600,000. One other incident resulted in damage to the bulbous bow of the ship of an estimated $250,000 or $313,000 in the 2014 price level. No damage was reported from the other three groundings. The number of groundings and associated damages were obtained from the Portsmouth Pilots.

There were five groundings in the 28 years between 1985 and 2012. With approximately 40 turnings a year for ships greater 500 feet in length for 28 years, the probability of grounding is 0.00446 (5 divided by 1120). The turnings represent all vessels greater than 500 feet in length using the upper turning basin. The average damage for a grounding is $3,182,600. The annual cumulative probability of a grounding for 28 turns is 0.12. Multiplying the cumulative probability of annually grounding by the average damage per grounding yields the expected without project annual damage of $374,800. Widening the turning basin is expected to reduce the probability of grounding by at least 75 percent resulting in a with project expected grounding damages shown in Table C-9. With a turning basin of 1020 feet the expected damage of grounding would be $66,800 resulting in damages reduced, or a benefit, of $307,900.

The estimated benefit for reduction in grounding damages is shown in Table C-9.

Table C-9 Grounding Damages Piscataqua River Portsmouth, NH						
Turning Basin Width feet	Number of Turns	Grounding Probability Per Turn Turns	Annual Cumulative Grounding Probability	Average Damage Per Grounding ($000)	Expected Annual Damage ($000)	Expected Annual Benefit ($000)
800	28	0.00446	0.11775	3,182.6	374.8	
1020	19	0.00112	0.02099	3,182.6	66.8	307.9
1120	17	0.00112	0.01880	3,182.6	59.8	314.9
1200	15	0.00112	0.01661	3,182.6	52.9	321.9

Reduction in Turning Cost

In the without project condition three tugs are required to turn larger vessels in the upper turning basin. These larger vessels are greater than 700 feet in length and also loaded vessels greater 600 feet in length. In the with project condition this requirement can be reduced to two tugs. Three hours are required to turn a vessel. The hourly tug cost is estimated to be $666 based on information provided by the terminals. The product of the number of tugs (3), the hourly tug cost, the time required to turn a vessel (3 hours), and the number of annual turnings (19 larger vessels and 62 smaller vessels) results in a without project cost of $349,700. With the project the number of tugs will decrease by one yielding a turning cost of $275,700 and a benefit of $74,000 for the alternative that provides a width of 1020 feet. Due to the economies of scale of using larger vessels, the number of vessel trips is estimated to decline in the with project conditions. The number of tugs required for turning vessels in both with and without project conditions and hourly tug cost was obtained from the Portsmouth Pilots. The derivation of estimated turning costs and benefits are shown in Table C-10. It is not anticipated that turning time will decrease in the with project conditions. However, time in port is likely to decrease as turns will be made on less restrictive conditions. This anticipated cost savings was not estimated.

Table C-10 Turning Costs Piscataqua River Portsmouth, NH										
Turning Basin Width (feet)	Tug Rate ($/hr)	Turning Time (hours)	No. of Tugs	No. of Turns	Turning Cost ($000)	No. of Tugs	No. of Turns	Turning Cost ($000)	Total Turning Cost ($000)	Turning Benefit ($000)
800	666	3	3	19	113.9	2.0	59.0	235.8	349.7	
1020	666	3	2	19	75.9	2.0	50.0	199.8	275.7	74.0
1120	666	3	2	19	75.9	2.0	48.0	191.8	267.7	82.0
1200	666	3	2	19	75.9	2.0	48.0	191.8	267.7	82.0

Project benefit for transportation cost saving, reduction in damages to vessels, and operation efficiencies are summarized in Table C-11. The total annual benefit for a turning basin width of 1020 feet is $2,471,700.

Table C-11 Project Annual Benefit Piscataqua River Portsmouth, N.H. ($000)							
	Turning Basin Width, feet				Annual Benefit		
	800	1020	1120	1200	1020	1120	1200
Transportation Cost							
Sea-3	5,280.4	4,130.5	4,255.5	3,961.7	1,149.9	1,024.9	1,318.7
Sprague	6,398.9	5,459.0	5,146.3	4,844.0	939.9	1,252.6	1,554.8
Total	11,679.3	9,589.5	9,401.8	8,805.7	2,089.8	2,277.5	2,873.6
Vessel Damages	374.8	66.8	59.8	52.9	307.9	314.9	321.9
Turning Cost	113.9	75.9	75.9	75.9	74.0	82.0	90.0
Total	12,167.9	9,732.2	9,537.6	8,934.5	2,471.7	2,674.4	3,285.5