PhilaPort

THE PORT OF PHILADELPHIA

Regional Port, Global Impact

2020 Port Infrastructure Development Program Grant Application

SOUTHPORT BERTH DEVELOPMENT AND PORT EXPANSION,

Port of Philadelphia, PA

May 18, 2020

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

Contains Confidential Business Information (CBI)

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EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for the **Southport Berth Development and Port Expansion** project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the Port Infrastructure Development Program. The analysis was conducted in accordance with the benefit-cost methodology outlined by U.S. DOT in the 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. The period of analysis corresponds to 31 years and includes 4 years for project completion including design work in 2021 and construction ending in 2024. After construction an analysis period of 27 years with benefits commencing after operations begin in 2025.

The project provides much needed berth capacity to the Port of Philadelphia (PhilaPort) and significantly improves the efficiency of roll on/roll off (Ro/Ro) cargo handling at the port. Ro/Ro cargo are automobiles and other vehicles that are driven onto and off of vessels. The greatest quantified benefits result from 1) reduced automobile handling in the port, 2) reduced inland truck mileage due to Ro/Ro cargoes being delivered more efficiently from the Port of Philadelphia, 3) reduced inland truck mileage from containers being delivered more efficiently from the Port of Philadelphia, 4) more efficient vessel operations. With the construction of a new berth at Southport, PhilaPort will be able to make much more efficient use of the Southport vehicle processing center (VPC) and associated vehicle storage areas. Seventy-one percent of cargo would proceed directly from ship to the new storage areas and VPC without passing over public roadways. The current operation is much less efficient, and the port's tenant reports that the company must spend at least $250,000 per month moving vehicles across public streets to the port's VPC at 98 Annex. This cost will grow with additional volumes of vehicles handled under current conditions. With the new terminal, this cost would be greatly reduced. Depreciation on autos and fuel costs will also be reduced as a result of the new more efficient operation. Vessel operations would be more efficient than at the primary berth where vessels would otherwise be handled, Pier 122.

Without the **Southport Berth Development and Port Expansion**, it will be impossible for PhilaPort to meet projected demand. During construction of the Southport VPC and storage area, vehicles were diverted to Brunswick, GA. If the Southport berth is not built, a similar situation would likely occur in the short-term, so that the port's largest customer inefficiently diverts vehicles to Brunswick, GA. In the longer term, the most likely scenario is that the increasing Ro/Ro cargo bound for Philadelphia would be handled by the Port of Baltimore instead of Georgia. PhilaPort's hinterland for Ro/Ro is the greater Northeast, including the area from Virginia to Maine. Were PhilaPort's market to be handled from Baltimore, this would add truck miles, since Baltimore is toward the southern end of the Northeast market area. In order to meet this demand, additional truck vehicle miles travelled will be generated as truckloads of vehicles are brought to the Northeast from Baltimore. This will not only generate additional costs for shippers, but will also generate additional risk of highway accidents, wear and tear on roadways, and truck emissions.

By consolidating Ro/Ro operations in the Southport terminal area and reducing the need for vehicles to pass between Packer Avenue Marine Terminal and 98 Annex, the project will also free up valuable space for the port to handle more containers, allowing the container handling capacity to increase by over 44,000 containers per year. Growth in container traffic at the port has been dramatic, increasing from less than 300,000 TEUs between 2007 and 2012 to nearly 600,000 twenty-foot equivalent units (TEUs) in 2019. PhilaPort plays an important role in providing container service to the Philadelphia region. A recently completed analysis of a Port Import/Export Reporting Service (PIERS) report using 2018 data found that only 16 percent of the import/export container traffic to/from the 21-county region around Philadelphia was handled by the Port of Philadelphia. Most of the rest was handled by the ports of New York/New Jersey, Baltimore, or the Port of Virginia. Increasing container capacity at PhilaPort enables the port to serve its immediate hinterland and reduces truck mileage to/from these other ports.

The new **Southport Berth Development and Port Expansion** project will also result in reduced vessel dwell times. Because Ro/Ro cargos will be offloaded more efficiently between the Southport berth and the new Southport storage yard and VPC, vessels will need to spend less time at port at lower cost to the vessel owners. Furthermore, without the Southport berth, most Ro/Ro vessels would need to use Pier 122 which is inefficient because it is a "finger pier" so that vessels require additional time to be backed into the pier with the aid of tugboats. This will be a continual source of inefficiency. Each of these factors will cause vessels to spend unnecessary time at PhilaPort at a significant cost to owners. Furthermore, ocean vessels emit air pollution and would sit idle for longer periods in PhilaPort or the Delaware River. A map of the terminal area is included as Figure ES-1.

Figure ES-1: PhilaPort's Ro/Ro Facilities

Costs

The capital cost for the **Southport Berth Development and Port Expansion** project is expected to be $76.3 million in undiscounted 2018 dollars, with construction ending in 2024. Costs have been deescalated using the U.S. Congressional Budget Office (CBO) forecast GDP Price Index.[1] At a seven percent real discount rate, these costs are $56.9 million. Operations and maintenance costs are projected to average $447,840 per year in the long term, which is associated with maintenance dredging. Another recurring cost will be replacement of fenders, which is estimated to cost $750,000 and must be replaced every 10 years. Over the entire 27-year post-construction analysis period operating and maintenance costs accumulate to $13.6 million in undiscounted 2018 dollars, or $3.7 million when discounted at 7 percent. Per U.S. DOT Guidance, operations and maintenance costs have been included in the numerator of the benefit/cost ratio calculation as an offset to benefits.

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[1] January 2020 supplement to CBO's *The Budget and Economic Outlook: 2020 to 2030, www.cbo.gov/publication/56020.*

The Southport berth is expected to have a service life of 50 years. At the end of the 27-year analysis period, the terminal retains 46 percent of its value or $35.1 million in residual value. Discounted at 7 percent, the residual value is $4.0 million. Per U.S. DOT, the residual value is included in the numerator of the benefit/cost ratio calculation. Project costs are summarized in Table ES-1.

Table ES-1: Project Costs in Millions of 2018 Dollars

Funding Source	Capital Costs	Operating and Maintenance Costs	Residual Value
Undiscounted	$76.3	$13.6	$35.1
Discounted	$56.9	$4.2	$4.0

Source: PhilaPort, WSP Analysis

Benefits

In 2018 dollars, the **Southport Berth Development and Port Expansion** project is expected to generate $131.1 million in discounted benefits using a 7 percent discount rate. Most of these benefits result from improved vehicle handling at the PhilaPort and the reduction of truck vehicle miles travelled. This leads to an overall project Net Present Value of $74.2 million and a Benefit Cost Ratio (BCR) of 2.30. The overall project benefit matrix can be seen in Table ES-2.

Table ES-2: Project Impacts and Benefits Summary, Monetary Values in Millions of 2018 Dollars

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impact	Population Affected by Impact	Economic Benefit	Results (at 7% discount rate)	Page in BCA
Ro/Ro vehicles travel significant distances over public roadways to processing center	New berth located adjacent to terminal and processing center minimizes handling costs	Reduction in vehicle handling costs	Port tenant and port tenant's customers	Reduced operating expense	$38.0	p. 12
Without the project, vehicles will need to be trucked further to meet Northeast market demand and containers will need to be trucked from more distant ports to the Philadelphia area	Capacity is added to PhilaPort to meet local demand	Reduction in truck miles	Vehicle and container shippers in the Philadelphia region	Reduced shipping costs	$60.4	p. 12
Without the project, vessels spend unnecessary time at berth, waiting for berth, maneuvering, more dredging at Pier 122, extra tugboats	More efficient vehicle handling and vessel handling reduces vessel operating time, less dredging at Pier 122, few tugboats	Reduction in vessel hours of operating time, less dredging, less use of tugboats	Vessel owners, the port	Reduced operating expense	$15.0	p. 15

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impact	Population Affected by Impact	Economic Benefit	Results (at 7% discount rate)	Page in BCA
Operations at the port are such that vehicles are driven unnecessarily far to VPC	A berth at the terminal combined with new VPC will reduce distances vehicles are driven	Reduction in automobile miles	PhilaPort Ro/Ro tenants and their customers	Reduced operating cost of vehicles, reduced fuel usage	$0.4	p. 17
Without the project, autos and trucks must be driven unnecessary miles on public roadways	Project will result in reduced truck and auto miles	Reduction in truck, auto miles	Society at large, travelers on roadways in the Northeast	Reduced injuries, fatalities, property damage only accidents	$9.0	p. 18
Without the project, autos and trucks must be driven unnecessary miles on public roadways	Project will result in reduced truck and auto miles	Reduction in truck, auto miles	Society at large, roadway owners	Reduced pavement damage	$4.3	p. 19
Without the project, autos and trucks must be driven unnecessary miles on public roadways	Project will result in reduced truck and auto miles	Reduction in truck, auto miles	Society at large	Reduced emissions	$1.5	p. 19
Without the project, vessels would be delayed unnecessarily, creating additional emissions	Vessel dwell, delay, and maneuvering are reduced which in turn reduces emissions	Reduction in vessel hours of operating time	Society at large	Reduced emissions	$2.6	p. 19

Source: WSP

The overall Project impacts can be seen in Table ES-3, which shows the magnitude of change and direction of the various impact categories.

Table ES-3: Project Impacts, Cumulative 2025-2051

Category	Unit	Quantity	Direction
Automobile handling cost	$2018	$117,696,630	▼
Truck shipping cost	$2018	$237,388,653	▼
Truck Vehicle-Miles Traveled	VMT	136,744,616	▼
Auto Vehicle-Miles Traveled	VMT	2,894,465	▼
Vessel Operating Hours	Hours	57,644	▼
Fatalities	#	2.5	▼
Injuries	#	61.3	▼
Property Damage Only (PDO)	#	163.4	▼
NO_X Emissions	tons	574.8	▼
PM^{10}	tons	18.1	▼
SO_X	tons	2.3	▼
VOC	tons	51.3	▼

Source: WSP, 2020

1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the **Southport Berth Development and Port Expansion** project for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the 2020 Port Infrastructure Development Program. The following section describes the BCA framework, evaluation metrics, and report contents.

1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or “No Build” Case, which is compared to the “Build” Case, where the grant request is awarded, and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project life-cycle. The value of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the January 2020 BCA Guidance for Discretionary Grant Programs. This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case as well as under the Build Case;
- Estimating benefits and costs during project construction and operation, as well as for 27 years of operations beyond the Project completion when benefits accrue;
- Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2018 dollars. In instances where cost estimates and benefit valuations are expressed in historical dollar years, using an appropriate Gross Domestic Product Implicit Price Deflator (GDP/IPD) to adjust the values;
- Discounting future benefits and costs with a real discount rate of 7 percent consistent with U.S. DOT guidance;

1.2 REPORT CONTENTS

- Section 2 provides a general overview of the project, the general assumptions behind the BCA.
- Section 3 describes the details of the demand assumptions, benefits, and costs.
- Section 4 summarizes the results and provides a sensitivity analysis.

2 PROJECT OVERVIEW

2.1 DESCRIPTION

The $85.0 million (in year of expenditure dollars) development of a new marine terminal wharf at Southport will consist of the following major components:

- Design and construction of a 1,056-foot long and 115-foot wide berth
- Landside improvements and site access modifications to the wharf
- Dredging to approximately – 36-ft Mean Lower Low Water (MLLW) operational depth and proper disposal of dredged material in a Confined Disposal Facility (CDF)
- Revetment and bulkhead rock and stonework

Of the $85.0 million in capital costs, $4.0 million are for final design work, while $81.0 million are for construction.

2.2 GENERAL ASSUMPTIONS

Costs include environmental, engineering, and design work scheduled to begin in 2021. Costs for professional services and construction are expected to continue through 2024. The project is forecast to become operational in 2025.

For project costs and benefits, dollar figures in this analysis are expressed in constant 2018 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values in other (historical) years, these costs were adjusted to 2018 using the U.S. Bureau of Economic Analysis Implicit Price Deflators for Gross Domestic Product per U.S. DOT guidance for discretionary grant programs.

A real discount rate of 7.0 percent was used, consistent with U.S. DOT guidance and OMB Circular A-4. Costs and benefits are discounted to 2019.

2.3 BASE CASE AND NO BUILD CASE

The BCA compares the benefits and costs that would accrue under a Build or No Build (Base Case) scenario. Under the Build scenario included in this BCA, the **Southport Berth Development and Port Expansion** project is constructed, including dredging. The resulting capacity is added to PhilaPort, bringing total Ro/Ro capacity at PhilaPort to 528,000 vehicles, and expanding container-handling capacity by more than 45,000 containers per year.

Under the No Build scenario, the **Southport Berth Development and Port Expansion** project is not built, and the associated capacity is not added to PhilaPort. Under this scenario, volumes at the port increase until port's berth capacity is met at 282,000 vehicles per year. PhilaPort's largest customer, Hyundai Glovis Co., Ltd indicates that the company has previously shipped vehicles destined for the Mid-Atlantic through the Port of Brunswick, GA due to lack of storage capacity at PhilaPort, which has been inefficient and has required longer truck moves than if these vehicles were handled through PhilaPort. While the customer's immediate issues are addressed through completion of the vehicle storage area at Southport, it is likely that similar issues will arise if the project is not completed. Under the No Build scenario, vehicles that would otherwise be handled at PhilaPort are instead diverted to Brunswick, GA. To be reasonable, it is assumed that after five years, the customer makes alternate arrangements due to continually increasing gas and labor expenses.

PhilaPort's primary hinterland is the greater Northeast. PhilaPort customers believe that the Port of NY/NJ is too land-constrained to add capacity if PhilaPort should be unable to meet demand, and that this capacity would instead be added to the Port of Baltimore. However, Baltimore is farther from most of the markets that PhilaPort serves. Under the No Build scenario, after PhilaPort's customer ceases to ship vehicles from Brunswick, GA after five years, PhilaPort traffic is then diverted to the Port of Baltimore, which adds truck miles because Baltimore is on average farther from PhilaPort's core markets in the Northeast.

As a result of the project, 71 percent of vehicles are processed through the Southport Marine Terminal and the Southport VPC. In the No Build scenario, 72 percent of vehicles are processed at the Southport VPC, but are handled at Pier 122 instead of the Southport Marine Terminal. Table 1 displays total vehicles by the marine terminal at which they are unloaded and VPC where they are driven.

Table 1: Build and No Build Demand Forecasts by Marine Terminal and Vehicle Processing Center

Year	Build			No Build	
	PAMT to 98 Annex VPC	Pier 122 Terminal to 98 Annex VPC	Southport Terminal to Southport VPC	PAMT to 98 Annex VPC	Pier 122 Terminal to Southport VPC
2025	17,400	40,600	248,839	64,803	166,636
2026	19,401	45,269	261,281	68,043	174,968
2027	21,632	50,475	274,345	71,445	183,716
2028	24,120	56,280	288,062	75,017	192,902
2029	26,894	62,752	302,465	78,768	202,547
2030	29,986	69,968	317,588	78,960	203,040
2031	33,435	78,014	333,468	78,960	203,040
2032	37,280	86,986	350,141	78,960	203,040
2033	41,567	96,990	367,648	78,960	203,040
2034	45,625	106,458	376,699	78,960	203,040
2035 - 2051	45,625	106,458	376,699	78,960	203,040

Source: PhilaPort and WSP analysis

As a result of the project, there is less need for movements between 98 Annex and Packer Avenue Marine Terminal, which frees up areas of 98 Annex close to the Packer Avenue Marine Terminal for container operations. Ten acres can be repurposed to support Packer Avenue Marine Terminal container operations, thus freeing additional space at Packer Avenue Marine Terminal. This area can be used for container and chassis storage. PhilaPort estimates that each acre enables the processing of 7,500 TEUs per year. Each container is approximately equivalent to 1.65 TEUs, so the area saved would be 7,500 TEUs x 10 acres ÷ 1.65 TEU's per container = 45,455 additional container capacity.

2.4 PROJECT COSTS

2.4.1 *CAPITAL COSTS*

Capital costs include those costs associated with constructing the **Southport Berth Development and Port Expansion** project.

Table 2: Project Schedule and Costs, Millions of 2018 Dollars

Variable	Unit	Value
Construction Start	Year	2021
Construction End	Year	2024
Construction Duration	Years	4 years
Project Opening	Year	2025
Capital Cost – Construction	$ M	$3.8
Capital Cost – Professional Services	$ M	$72.5

Source: WSP

Engineering estimates presented in this grant application have included an escalation factor. It is assumed that this adjustment is to account for real and nominal price changes, and that as a result of this adjustment, engineering cost estimates are equal to year of expenditure dollars. For the purposes of the BCA, all costs, including construction, design, and permitting, have been adjusted from the engineering estimates to constant $2018 using the U.S. Congressional Budget Office (CBO) forecast GDP Price Index. This has had the effect of de-escalating engineering estimates to remove the impacts of nominal inflation as shown in Table 3.

Table 3: Adjustment to Capital Costs to Convert to $2018 Using Forecast GDP/IPD

Year	Capital Costs in Year of Expenditure $'s	2018 GDP/IPD	Forecast GDP/IPD	Adjustment to $2018	Capital Cost in $2018
2018		110.4	110.4	1.00	$0
2019		110.4	112.4	0.98	$0
2020		110.4	114.6	0.96	$0
2021	4,046,933	110.4	117.0	0.94	$3,818,314
2022	9,360,000	110.4	119.5	0.92	$8,647,406
2023	22,525,721	110.4	122.0	0.90	$20,382,929
2024	49,050,000	110.4	124.5	0.89	$43,478,025
Total	**$84,982,654**				**$76,326,674**

2.4.2 *OPERATIONS AND MAINTENANCE COSTS*

The project includes dredging the area in front of the Southport berth to provide 36-foot depth. However, over the years, the area will require maintenance dredging as silt accumulates in the dredged area. The cost of maintenance dredging is based on actual costs of maintenance dredging for the Packer Avenue Marine Terminal between 2011 and 2018, indexed to $2018. Because the area to be dredged is one third that of the Packer Avenue Marine Terminal, the cost of maintenance dredging at the Southport Marine Terminal was estimated to be one third that of dredging at Packer Avenue Marine Terminal. The total undiscounted cost is $447,840 per year. Per U.S. DOT

BCA Guidance, operations and maintenance costs appear in the numerator of the benefit/cost ratio as an offset to benefits.

Considering the 30-year window for the wharf, the only maintenance that should be expected would be the fender system. The wharf is being built for a useful life of 50 years, but fenders are much like tires and brakes on a car. They need to be replaced several times over the life of the asset. The quantity of use plays into the frequency of the replacement. Given forecast usage, it is estimated that the fenders would need to be replaced every 10 years. The estimated cost is $750,000 and would occur twice during the benefit analysis period.

2.4.3 *RESIDUAL VALUE*

The project is estimated to have a 50-year service life. Assuming straight-line depreciation, the Southport berth will still retain 46 percent of its original value at the end of the 27-year analysis period. Undiscounted residual value equals $35.1 million. Discounted at 7 percent from the close of the project analysis period, the residual value is $4.0 million. The residual value is included in the numerator of the BCR per U.S. DOT Guidance.

2.5 PROJECT BENEFITS

The **Southport Berth Development and Port Expansion** will generate benefits in a number of ways:

1) Reduced operational costs: Currently, autos unloaded from vessels at PhilaPort must be driven over public streets to the VPC at 98 Annex or the VPC at Southport. The port's tenant incurs at least $250,000 in additional costs per month as a result of transferring vehicles in this manner. With the development of a Southport berth located next to the Southport storage area and VPC, much of this cost can be avoided.
2) Reduced truck mileage, risk of highway accidents, pavement damage and truck emissions: Cargo volumes at PhilaPort have grown dramatically in recent years. Ro/Ro cargo is expected to continue to grow, outstripping PhilaPort's capacity by 2025. Without the project, Ro/Ro cargoes would shift to other ports, at first to Brunswick, GA, and then to Baltimore. These ports are farther from markets served by PhilaPort. Shifting Ro/Ro cargoes to these ports would increase truck mileage and costs. By reducing truck mileage, the project also reduces the risk of highway accidents, damage to pavement, and truck emissions.
3) Increased container storage capacity: The project will free capacity in the area of 98 Annex next to PAMT to support container operations, including empty container/chassis storage, moving these activities away from the PAMT. This will increase full container storage capacity at PAMT and allow the port to process more containers. Enabling this capacity at PhilaPort will reduce inland truck mileage as more of the import/export demand can flow through PhilaPort rather than through the ports of Baltimore, NY/NJ, or Virginia.
4) Reduced vessel delays and berth time at PhilaPort: Because autos can be unloaded faster, vessels need spend less time at PhilaPort berths. Pier 122 is a "finger pier" where vessels must be backed into this pier by a relatively inefficient process. Each vessel at Pier 122 requires an additional tugboat, which incurs an extra expense of $3,000 per vessel. Vessel owners will benefit from a more efficient berthing process at Southport. Maintenance dredging at Pier 122 can also be reduced as the PhilaPort is less dependent on Pier 122 for Ro/Ro cargoes. These reductions in vessel delays will also result in emissions reductions as ships no longer need to remain as long at port or outside of the port using auxiliary power.
5) Reduced auto mileage, risk of accidents, pavement damage and auto emissions: Less automobiles would need to be driven between vessels and VPCs, since the Southport berth, storage area and VPC will be adjacent to each other. This will save fuel and vehicle operating costs, as well as roadway damage, risk of crashes, and emissions.

3 BENEFIT-COST ANALYSIS DATA AND ASSUMPTIONS

3.1 DEMAND PROJECTIONS

PhilaPort's Ro/Ro cargos grew by 290 percent between 2010 and 2019 with the port handling 199,085 vehicles in 2019. The port expects market growth to increase to 528,782 by 2035, the capacity of the port with the new Southport berth. Growth would include additional demand associated with existing operations, new export opportunities brought to the port by rail, and new customers that have continued to expressed interest in using the Southport terminal and berth. These projections are in part based on past growth rates and in part based on port staff communications with existing and potential customers. The resulting demand projections are presented in Table 4 for 2025 (the first year of operation) onward.

Table 4: Build and No Build Vehicle Forecasts

Year	No Build	Build		
		Existing and New Customers	Export	Total Demand
2025	231,439	289,439	17,400	306,839
2026	243,011	307,681	18,270	325,951
2027	255,161	327,268	19,184	346,452
2028	267,919	348,319	20,143	368,461
2029	281,315	370,961	21,150	392,110
2030	282,000	395,336	22,207	417,543
2031	282,000	421,599	23,318	444,917
2032	282,000	449,924	24,484	474,407
2033	282,000	480,497	25,708	506,205
2034 - 2051	282,000	501,789	26,993	528,782

Source: PhilaPort and WSP analysis

In the Build scenario, the Southport Marine Terminal handles 71 percent of the Ro/Ro volume, while Pier 122 handles 20 percent and PAMT handles 9 percent from 2034 onward. All autos handled by the Southport Marine Terminal are processed at the Southport VPC. All vehicles arriving at Pier 122 are processed at Southport VPC, while vehicles arriving at PAMT are processed at the existing VPC at 98 Annex.

In the No Build scenario, PhilaPort is only capable of handling 282,000 vehicles per year. Of these, 72 percent or 203,040 are unloaded at Pier 122 and processed at the Southport VPC, while the other 78,960 or 28 percent are unloaded at the PAMT and processed at 98 Annex. The remaining market demand, which PhilaPort is unable to meet, reaches 219,789 vehicles per year by 2034 and remains at this level for the remainder of the analysis period.

According to one of PhilaPort's largest customers, Hyundai Glovis Co, Ltd, the company redirected vehicles bound for PhilaPort through the Port of Brunswick, GA in 2018 due to capacity constraints. Although a considerably longer truck journey is required to ship these vehicles through Brunswick, GA, the company was forced to do so because PhilaPort was unable to accommodate these vehicles as a result of the construction of the Southport storage area and VPC. Were PhilaPort to be unable to accommodate vehicles due to lack of marine terminal capacity, a similar situation would likely occur. However, this customer would only be willing to endure this inconvenience for a finite amount of time before seeking different arrangements, estimated to be five years. At the end of those five years, PhilaPort would still be unable to meet demand. According to a port customer, the primary Ro/Ro market area for PhilaPort is the greater Northeast. According to the same customer, if PhilaPort were not able to meet demand, Ro/Ro cargoes would likely shift to the Port of Baltimore. Although the Port of NY/NJ serves the same market, it lacks enough land to expand significantly. Some of the customers would be closer to Baltimore, while some would be closer to Philadelphia, but the customer believes that on average a longer truck haul would be required to serve PhilaPort's existing market from Baltimore. Some key markets that could be accessed within a day from Philadelphia would be beyond truckers' hours of service for a single day, significantly adding costs.

As mentioned previously, the growth of container traffic at PhilaPort has been remarkable. In part due to a previous INFRA grant, PhilaPort is expanding its capacity to handle 969,286 TEUs or 587,446 containers assuming 1.65 TEUs per container. However, given current growth, this demand may be exceeded in the not too distant future. Table 5 displays the estimated container traffic, capacity, volumes enable by the project.

Table 5: Forecast Container Demand, Capacity, Additional Container Traffic Enabled by Project

Year	Container Demand	Container Capacity	Added Container Traffic from Project
2018	340,060	587,446	0
2019	352,000	587,446	0
2020	357,742	587,446	0
2021	370,411	587,446	0
2022	386,910	587,446	0
2023	424,694	587,446	0
2024	451,680	587,446	0
2025	467,488	587,446	0
2026	483,850	587,446	0
2027	518,967	587,446	0
2028	537,131	587,446	0
2029	568,052	587,446	0
2030	587,933	587,446	487
2031	608,511	587,446	21,065
2032 - 2051	632,901	587,446	45,455

Source: PhilaPort and WSP analysis

3.2 ECONOMIC COMPETITIVENESS

This project would contribute to increasing the economic competitiveness of the Nation through improvements in the mobility of people and goods in the study area. The project will reduce the cost of transporting automobiles through several different ways:

- More efficient offloading vehicles at PhilaPort
- Reduced truck mileage
- Reduced operating costs of vessels at berth, maneuvering or waiting for a berth
- Reduced use of tugboats

— Reduced maintenance dredging at Pier 122
— Reduced automobile operating costs.

These benefits will accrue to port customers, port tenants, buyers of automobiles in the Philadelphia area.

Table 6: Economic Competitiveness Estimation of Benefits, 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Lower automobile handling cost	$4,831,621	$3,219,513	$117,696,630	$38,004,791
Lower cost of truck shipping	$319,679	$213,016	$237,388,653	$60,435,820
Lower vessel operating cost due to lower dwell, delays, and handling	$1,337,839	$891,459	$37,708,629	$12,434,638
Reduced maintenance dredging of Pier 122	$300,000	$199,903	$8,100,000	$2,563,907
Lower automobile fuel and operating cost due to fewer miles driven in port	$58,063	$38,690	$1,015,226	$367,069

Source: WSP analysis

3.2.1 *LOWER AUTOMOBILE HANDLING COSTS*

Currently, autos handled at PhilaPort must travel unnecessarily long distances over public roadways to access VPCs. This creates cost in terms of the hiring of police to direct traffic, extra staffing of drivers to move vehicles from vessels to vehicle processing centers, van drivers to drive these individuals back to the ships. The port's largest tenant reports that the company incurs at least an extra $250,000 per month as a result of this operation, likely more. With the **the Southport Berth Development and Port Expansion** project, costs would be greatly reduced, since vehicles can be unloaded from ships almost directly to the VPC. If PhilaPort were to increase volumes from an estimated 169,848 vehicles in 2018 to 282,000 as is assumed in the No Build scenario, the $3 million ($250,000/month x 12 months) in annual costs increase proportionately. In the Build scenario, this cost would be reduced by 71 percent, since the 71 percent of vehicles would move directly between the Southport berth and the Southport storage area and VPC.

3.2.2 *AVOIDED TRUCKING COST*

If PhilaPort is unable to expand Ro/Ro capacity, it will not be able to meet forecast demand. Volumes handled at the port have grown rapidly in recent years and are expected to continue to grow rapidly. As the port reaches capacity, port operational performance may decline, but beyond a point, shippers will take their cargos elsewhere. As mentioned previously, the port's largest Ro/Ro customer has indicated that the company had to ship vehicles through Brunswick, GA, and if PhilaPort cannot meet demand in the future, this is a likely short-term outcome. The company reports that it pays a $43 per vehicle premium ($2018) to ship these vehicles through Brunswick, GA.

Long-term, the company would likely make alternate arrangements, but PhilaPort would still not be able to meet market demand. PhilaPort's primary market area is the Northeast. Traffic that PhilaPort cannot handle would shift to the Port of Baltimore, which is farther from many of PhilaPort's primary markets. Reviewing the relative position of Baltimore and Philadelphia and weighting Northeast states by population, it is estimated that the weighted average additional mileage from Baltimore would be about 36 miles. Long-term, the costs of additional trucking are estimated to be $1.736 per mile. This is based on the U.S. DOT Guidance on the vehicle operating cost of commercial trucks ($0.96), plus the average cost of driver wages and benefits from the American Transportation Research Institute's estimated operating cost of trucking ($0.596 and $0.180, respectively).[2]

Avoided trucking cost for the first five years of the project is estimated by multiplying the number of vehicles PhilaPort would otherwise be unable to handle by $43 per vehicle. Associated vehicle miles traveled (VMT) are estimated to be $43/vehicle x 8 vehicles per truck ÷ $1.736/truck VMT = 198 miles per diverted truck. Avoided truck vehicle miles travelled beyond the first five years are estimated to be diverted vehicles ÷ 8 vehicles per truck x 36 miles x 100 percent empty return ratio. Avoided truck costs are truck VMT x $1.736/mile.

Table 7: Summary of Avoided Trucking Cost for Ro/Ro Shipments

Year	Demand	No Build Unfulfilled Demand	Truck Vehicle Miles Traveled	Undiscounted Benefit
2025	289,439	7,439	184,147	$319,679
2026	307,681	25,681	635,724	$1,103,617
2027	327,268	45,268	1,120,613	$1,945,384
2028	348,319	66,319	1,641,713	$2,850,013
2029	370,961	88,961	2,202,211	$3,823,038
2030	395,336	113,336	1,017,187	$1,765,836
2031	421,599	139,599	1,252,905	$2,175,042
2032	449,924	167,924	1,507,114	$2,616,350
2033	480,497	198,497	1,781,511	$3,092,703
2034 - 2051	501,789	219,789	1,972,606	$3,424,444

Source: PhilaPort, WSP analysis

As mentioned previously, PhilaPort's container volumes have grown dramatically in recent years from below 300,000 TEUs in 2007 – 2012 to nearly 600,000 TEUs in 2019. By the time the project is expected to be completed, PhilaPort will have sufficient capacity to handle 969,286 TEUs per year. However, because container volumes are growing rapidly, it is expected that demand will exceed the 969,286 TEUs in 2030. The project will enable PhilaPort to handle an additional 75,000 TEUs or 45,455 containers.

An analysis of PIERS data by PhilaPort marketing staff found that 16 percent of container traffic headed to or from the 21 counties around Philadelphia were handled by PhilaPort in 2018. This suggested a significant demand for container handling capacity in the Philadelphia region, which has been borne out by rapid increases in the number of containers handled at the port.[3]

[2] American Transportation Research Institute, *An Analysis of the Operating Costs of Trucking: 2019 Update,* November 2019, https://atri-online.org/wp-content/uploads/2019/11/ATRI-Operational-Costs-of-Trucking-2019-1.pdf.

[3] PhilaPort's share of container volumes for the 21 counties has increased. A previous analysis performed with 2015 data found that PhilaPort's share was only 13 percent.

Table 8: 2018 County Container Units for 21 counties

DESTINATION COUNTY	TOTAL	US NORTHEAST PORT OF ORIGIN				
		PHILADELPHIA	NY/NJ	BALTIMORE	VIRGINIA	TOTAL NON-PHILADELPHIA
Atlantic	1,383	498	865	0	34	727
Berks	18,645	1,629	12,377	1,417	1,573	12,746
Bucks	10,125	703	7,726	211	1,410	9,916
Burlington	23,543	3,432	9,143	648	130	10,777
Camden	4,038	275	3,665	360	140	3,701
Cape May	9,159	4,179	700	11	0	374
Chester	12,500	9,232	2,766	1,980	6,346	11,780
Cumberland	12,084	356	10,808	3,615	1,600	10,188
Delaware	8,373	498	7,855	975	1,367	9,346
Gloucester	5,482	126	4,632	37	317	7,338
Kent	5,003	1,170	2,740	120	103	649
Lancaster	3,054	18	3,029	2,478	951	7,041
Lebanon	3,691	1,045	653	125	88	1,270
Lehigh	8,811	1,949	6,773	359	975	8,624
Montgomery	16,753	785	13,661	1,694	2,162	15,798
New Castle	11,469	173	11,177	215	373	2,056
Northampton	4,385	33	4,032	73	22	8,276
Philadelphia	18,313	1,786	16,154	1,113	3,520	22,001
Salem	3,440	14	784	12	129	651
Schuylkill	10,558	1,818	5,512	162	11	7,847
Sussex	3,836	581	750	974	1,387	3,657
VOLUME BOUND FOR PHILADELPHIA REGION	**194,645**	**30,300**	**125,803**	**16,581**	**22,636**	**154,763**
PCT BY PORT OF ORIGIN	**100%**	**16%**	**65%**	**9%**	**13%**	**87%**

Source: PhilaPort analysis of PIERS data

If PhilaPort is unable to meet demand due to capacity constraints, it is likely that this freight will revert back to these other more distant ports. The same PIERS analysis found that if freight handled by these other ports were instead handled by PhilaPort, average trucking hauls would be 96.6 miles less. The 96.6 miles per container was multiplied by the containers that PhilaPort would be unable to accommodate without the project to derive avoided vehicle miles traveled. These were then multiplied by $1.736 per mile to estimate avoided trucking costs. Table 9 displays the estimation of container truck costs avoided.

Table 9: Summary of Avoided Truck Cost for Container Shipments

Year	Demand	Current Capacity	Added Capacity	Truck Mileage Avoided	Truck VMT Avoided	Undiscounted Truck Cost Avoided
2025	467,488	587,446	0	96.6	0	$0
2026	483,850	587,446	0	96.6	0	$0
2027	518,967	587,446	0	96.6	0	$0
2028	537,131	587,446	0	96.6	0	$0
2029	568,052	587,446	0	96.6	0	$0
2030	587,933	587,446	487	96.6	47,076	$81,724
2031	608,511	587,446	21,065	96.6	2,034,756	$3,532,337
2032 - 2051	632,901	587,446	45,455	96.6	4,390,638	$7,622,147

Source: PhilaPort, WSP analysis

3.2.3 *AVOIDED VESSEL OPERATING COSTS*

Without the **Southport Berth Development and Port Expansion** project:

- Crews will require a longer period of time to load and unload vessels. Vessel owners will need to pay additional vessel operating costs as the vessels wait at berth. The difference in vessel unloading times is estimated in Table 10. As can be seen, unloading of vessels between Southport berth and transporting the cargo to the Southport storage area or VPC would be twice as fast as unloading between PAMT and 98 Annex or Pier 122 and Southport today. The unload times of Table 10 are based on 2,500 vehicles per call. Under the No Build scenario, it is unknown the unload time of the vessels that PhilaPort is unable to accommodate. Therefore, the unloading times of the Build scenario have been adjusted to include only the same number of vehicles handled as the No Build scenario.
- PhilaPort will need to make greater use of Pier 122. For vessels to berth at Pier 122 requires more handling because it is a “finger pier” and vessels must be backed into the pier. This additional time is estimated to be one hour per vessel.

Table 10: Comparison of Time to Unload Vessel (Includes only Driving/Van Time)

	PAMT to 98 Annex	P122 to 98 Annex	P122 to Southport	Southport
Vessel Time (hrs)	20.8	50	41.7	10.4

Source: PhilaPort and WSP analysis

Ship operating costs per hour have been estimated using the U.S. Army Corps of Engineers Economic Guidance for Deep Draft Vessels, 2002, indexed to $2018.[4] Costs are those of a 20,000 deadweight tonne foreign flag general cargo vessel at port. Vessel operating cost per hour is estimated to equal $717.

[4] The U.S. Army Corps of Engineers has produced more updated estimates of vessel operating costs, but recent estimates are proprietary.

Table 11: Vessel Operating Hours Avoided and Savings

Year	Faster Unloading	Avoided Berthing Time at Pier 122	Total Vessel Time Savings	Total Savings in $2018
2025	1,754	70	1,824	$1,306,741
2026	1,901	72	1,972	$1,413,409
2027	2,055	74	2,129	$1,525,608
2028	2,218	76	2,294	$1,643,643
2029	1,760	70	1,830	$1,310,979
2030	1,731	67	1,798	$1,288,247
2031	1,693	63	1,755	$1,257,682
2032	1,653	58	1,711	$1,225,945
2033	1,612	57	1,669	$1,196,169
2034 - 2051	1,564	53	1,617	$1,158,457

Source: PhilaPort and WSP analysis

3.2.4 *AVOIDED TUGBOAT COSTS*

Building the Southport Marine Terminal will allow PhilaPort's customers to avoid unnecessary tugboat costs. Because Pier 122 is a finger pier, it requires an extra tugboat per vessel, which would not be required by vessels visiting Southport. Discussions with PhilaPort and its customers suggests that the cost is somewhere between $2,000 and $4,000 per vessel. For the purposes of this BCA, the cost is assumed to be $3,000 per vessel. Benefits are shown in Table 12.

Table 12: Vessel Operating Hours Avoided and Savings

Year	Avoided Berthing at Pier 122	Total Savings in $2018
2025	70	$209,320
2026	72	$215,828
2027	74	$222,206
2028	76	$228,395
2029	70	$209,693
2030	67	$199,608
2031	63	$187,538
2032	58	$174,081
2033	57	$172,302
2034 - 2051	53	$159,390

Source: PhilaPort and WSP analysis

3.2.5 *AVOIDED PIER 122 MAINTENANCE DREDGING COSTS*

Under the No Build scenario, 72 percent of PhilaPort's Ro/Ro freight would be handled by Pier 122. Under the Build scenario, PhilaPort's dependence on Pier 122 would not be as high. While maintenance dredging will still be necessary for Pier 122, it is not anticipated to be as high in the Build scenario. An analysis of PhilaPort maintenance dredging between 2011 and 2018 suggests that maintenance dredging for Pier 122 has averaged about $900,000 per year. The project could reduce the required maintenance dredging by $300,000 per year.

3.2.6 *AVOIDED AUTOMOBILE OPERATING AND FUEL COSTS*

The $250,000 per month handling cost above included the external costs of moving automobiles, but the existing operation also introduces costs to vehicles including fuel and maintenance. By driving vehicles an unnecessarily long distance between the marine terminal and VPC, current operations impose wear and tear on vehicles, reducing the number of miles until they will require maintenance. With **the Southport Berth Development and Port Expansion** project, this vehicle operating cost will be minimized.

Vehicle miles travelled between marine terminals and VPCs under the Build and No Build scenarios were compared. Mileages were multiplied by the vehicles shown in Table 4. Mileage for each marine terminal – VPC pair were estimated to be:

- PAMT – 98 Annex VPC: 0.5 miles
- Pier 122 Marine Terminal – Southport VPC: 1.0 miles
- Pier 122 Marine Terminal – 98 Annex VPC: 1.5 miles
- Southport Marine Terminal – Southport VPC: 0 miles

Build scenario mileage was only compared to that mileage in the No Build scenario that would remain at PhilaPort. This would include the first 282,000 vehicles in the Build scenario, since it is unknown how far vehicles diverting to other ports in the No Build scenario must be driven between vessels and VPCs at these other ports. Therefore, vehicle miles in the Build scenario were reduced to a level as if only 282,000 vehicles were being handled, since these additional vehicles were unaccounted for in the No Build scenario. Vehicle operating expense was $0.41 per VMT per U.S. DOT 2020 BCA guidance.

Table 13: Automotive VMT Savings and Vehicle Operating Benefits

Year	VMT Savings	Vehicle Operating and Maintenance
2025	141,617	$58,063
2026	144,966	$59,436
2027	148,053	$60,702
2028	150,815	$61,834
2029	135,038	$55,365
2030	125,376	$51,404
2031	113,996	$46,738
2032	101,308	$41,536
2033	87,160	$35,736
2034 - 2051	73,769	$30,245

Source: WSP analysis

3.3 SAFETY

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in property-damage-only crash costs resulting from the project. Reduction in auto processing VMTs yield benefits, but the reduction of truck VMTs are a much larger source of benefits. Safety benefits impact the general traveling public.

Table 14: Safety Estimation of Benefits, 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Reduced truck crash fatalities	$31,644	$21,086	$23,498,195	$5,982,311
Reduced truck crash injuries	$14,002	$9,330	$10,397,787	$2,647,131
Reduced truck property damage only crashes	$968	$645	$719,003	$183,048
Reduced auto crash fatalities	$15,535	$10,352	$271,636	$98,214
Reduced auto crash injuries	$15,806	$10,532	$276,373	$99,926
Reduced auto property damage only crashes	Not quantified	Not quantified	Not quantified	Not quantified

Source: WSP analysis and Table 13 sources

The analysis assumes constant accident rates for the "Build" and "No Build" scenarios. As a result, any changes in the number of accidents will be a result of changes in VMT, not of structural changes to the safety conditions on the roadway network. The assumptions used in the estimation of safety benefits are presented in Table 15. The rate of accidents per VMT was multiplied by the VMT reduction and then multiplied by the value per avoided fatality, injury, or property damage only accident. National statistics for truck accidents were considered more appropriate than Pennsylvania statistics, since much of the truck VMT would be outside of the state.

Table 15: Safety Benefits Assumptions and Sources

Variable	Unit	Value	Source
Truck fatalities per 100 million VMT	#/100M VMT	1.79	Federal Motor Carrier Safety Administration, *Large Truck and Bus Crash Facts 2016*
Truck injuries per 100 million VMT	#/100M VMT	43.7	Federal Motor Carrier Safety Administration, *Large Truck and Bus Crash Facts 2016*
Truck property damage only accidents per VMT	#/100M VMT	119.5	Federal Motor Carrier Safety Administration, *Large Truck and Bus Crash Facts 2016*
Automobile fatalities	#/100M VMT	1.14	Pennsylvania Department of Transportation, *2017 Pennsylvania Crash Facts and Statistics*
Automobile serious injuries per 100 million VMT	#/100M VMT	4.25	Pennsylvania Department of Transportation, *2017 Pennsylvania Crash Facts and Statistics*
Automobile minor injuries per 100 million VMT	#/100M VMT	27.37	Pennsylvania Department of Transportation, *2017 Pennsylvania Crash Facts and Statistics*
Automobile possible injuries per 100 million VMT	#/100M VMT	22.74	Pennsylvania Department of Transportation, *2017 Pennsylvania Crash Facts and Statistics*
Automobile injury severity unknown per 100 million VMT	#/100M VMT	26.65	Pennsylvania Department of Transportation, *2017 Pennsylvania Crash Facts and Statistics*
Value of fatality avoided	$2018	$9,600,000	U.S. DOT 2018 BCA Guidance, indexed to $2018
Value of a serious injury avoided	$2018	$1,008,000	U.S. DOT 2018 BCA Guidance, indexed to $2018
Value of injury accident avoided, severity unknown	$2018	$174,000	U.S. DOT 2018 BCA Guidance, indexed to $2018
Value of minor injury avoided	$2018	$28,800	U.S. DOT 2018 BCA Guidance, indexed to $2018
Value of possible injury avoided	$2018	$63,900	U.S. DOT 2018 BCA Guidance, indexed to $2018
Value of property damage only accident avoided	$2018	$4,300	U.S. DOT 2018 BCA Guidance, indexed to $2018

3.4 STATE OF GOOD REPAIR

The state of good repair benefits assessed in this analysis include maintenance and repair savings, deferral of replacement cost savings, as well as reduced VMT which leads to less road and pavement damage. State of good repair impacts government entities, toll authorities, and taxpayers that pay to improve roadways. Roadway maintenance savings have been quantified for both automobile and truck VMT. Savings associated with automobile VMT reductions are minimal and have been excluded from this analysis.

The source of pavement impacts is the FHWA *Addendum to the 1997 Federal Highway Cost Allocation Study Final Report*, May 2000, indexed to $2018. This study provides different values for avoided pavement damage depending upon the weight of truck and whether roadways are urban or rural. The average gross weight per truck was assumed to be 60,000 pounds. For the truck diversion analysis, the region is primarily urban. An analysis was performed which used Interstate 95 as a proxy for urban/rural mileage for regional truck moves. This analysis suggested that about 85 percent of the mileage in the area around Philadelphia and between Baltimore and Philadelphia would be urban and 15 percent rural. Weighting a value of $0.146 per VMT for urban roadway sections and $0.046 per VMT for rural roadway sections yields a weighted value of $0.131 per mile. For movements that would otherwise divert to Brunswick, GA during the first five years of the analysis period, the ratio of urban to rural highways is assumed to be reversed, so 85 percent rural and 15 percent urban. Weighted pavement damage is $0.061 per mile.

Table 16: State of Good Repair Estimation of Benefits, 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Avoided truck pavement damage	$11,204	$7,466	$17,488,554	$4,332,575.92

3.5 ENVIRONMENTAL SUSTAINABILITY

This project will create environmental and sustainability benefits relating to reduction in air pollution associated with decreased automobile and commercial truck travel. Five forms of emissions were identified, measured and monetized, including: nitrous oxide, particulate matter, sulfur dioxide, volatile organic compounds, and carbon dioxide. Emissions of vessels at harbor were also quantified. Because vessel emission factors are only available for particulate matter, volatile organic compounds and nitrous oxides, only these pollutants were quantified for vessel emissions.

For vehicle emissions, the emission rate or factor in grams per VMT is multiplied by VMT savings. The resulting savings in grams are converted to metric tons and then multiplied by the value per metric ton of avoided emissions. For vessel emissions, estimated fuel consumption per hour while the vessel is at port is multiplied by vessel hour savings. For trucks, emissions were estimated assuming average speeds of a long-distance haul. For vehicle fuel emissions, vehicles were assumed to be travelling below 15 miles per hour between vessel, location of first rest, and vehicle processing center. The resulting metric tonnage of fuel consumed is multiplied by kilograms of emissions per metric ton of fuel. Kilograms of emissions are converted to metric tons and then multiplied by the value of emissions reduction per metric ton.

Table 17: Environmental Sustainability Estimation of Benefits, 2018 Dollars

Benefit	Project Opening Year		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Truck VOC emission savings	$230	$153	$126,001	$34,655
Truck NOx emission savings	$6,995	$4,661	$3,095,004	$851,236
Truck SOx emission savings	$166	$110	$122,495	$33,691
Truck PM emission savings	$8,799	$5,863	$2,032,761	$559,082
Auto VOC emission savings	$126	$84	$808	$401
Auto NOx emission savings	$10,754	$7,166	$76,100	$37,806
Auto SOx emission savings	$182	$121	$3,061	$1,521
Auto PM emission savings	$4,973	$3,314	$31,755	$15,776
Vessel NOx emission savings	$89,973	$59,953	$2,273,572	$747,857
Vessel VOC emission savings	$598	$398	$15,101	$4,967
Vessel PM emission savings	$226,908	$151,198	$5,733,844	$1,886,062

Source: WSP analysis

The assumptions used in the estimation of environmental sustainability benefits are presented in Table 18. Truck emissions factors rely on an analysis using the U.S. EPA MOVES model. Auto emissions factors rely on an analysis using the California Air Resources Board EMFAC model. Vessel emissions are based on a paper by Techne Consulting, Inc.[5] Vessel fuel consumption rate is based upon U.S. Army Corps of Engineers estimate for vehicles at port on auxiliary power.

The value per ton of reducing emissions are from U.S. DOT 2020 guidance.

Table 18: Environmental Sustainability Benefits Assumptions and Sources

Variable	Unit	Value	Source
Truck VOC emission factor 2023	g/VMT	0.61	EPA Moves 2016
Truck NOx emission factor 2023	g/VMT	4.86	EPA Moves 2016
Truck SOx emission factor 2023	g/VMT	0.02	EPA Moves 2016
Truck PM10 emission factor 2023	g/VMT	0.175	EPA Moves 2016
Truck VOC emission factor 2047	g/VMT	0.39	EPA Moves 2016
Truck NOx emission factor 2047	g/VMT	2.23	EPA Moves 2016
Truck SOx emission factor 2047	g/VMT	0.02	EPA Moves 2016
Truck PM10 emission factor 2047	g/VMT	0.03	EPA Moves 2016
Auto NOx emission factor 2023	g/VMT	9.44	CARB EMFAC 2017
Auto PM10 emission factor 2023	g/VMT	0.10	CARB EMFAC 2017
Auto SOx emission factor 2023	g/VMT	0.02	CARB EMFAC 2017
Auto VOC emission factor 2023	g/VMT	0.45	CARB EMFAC 2017
Auto NOx emission factor 2047	g/VMT	0.39	CARB EMFAC 2017
Auto PM10 emission factor 2047	g/VMT	0.003	CARB EMFAC 2017
Auto SOx emission factor 2047	g/VMT	0.02	CARB EMFAC 2017
Auto VOC emission factor 2047	g/VMT	0.04	CARB EMFAC 2017

[5] Carlo Trozzi, Techne Consulting, Inc., "Emission Estimate Methodology for Maritime Navigation," https://www3.epa.gov/ttnchie1/conference/ei19/session10/trozzi.pdf.

Variable	Unit	Value	Source
Vessel fuel consumption rate	MT/Hr	0.083	USACE Economic Guidance
Vessel NOx emission factor	Kg/MT	62.5	Carlo Trozzi, Techne Consulting, Inc.
Vessel VOC emission factor	Kg/MT	1.7	Carlo Trozzi, Techne Consulting, Inc.
Vessel PM emission factor	Kg/MT	3.5	Carlo Trozzi, Techne Consulting, Inc.
Cost per ton of NOX	$2018	$9,473	2018 U.S. DOT Guidance
Cost per ton of PM10	$2018	$426,611	2018 U.S. DOT Guidance
Cost per ton of SOX	$2018	$55,185	2018 U.S. DOT Guidance
Cost per ton of VOC	$2018	$2,313	2018 U.S. DOT Guidance

4 SUMMARY OF RESULTS

4.1 EVALUATION MEASURES

The BCA converts potential gains (benefits) and losses (costs) from **the Southport Berth Development and Port Expansion** project into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCA:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- BCR: The evaluation also estimates the BCR; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.
- Internal Rate of Return (IRR): The IRR is the discount rate which makes the NPV from the Project equal to zero. In other words, it is the discount rate at which the Project breaks even. Generally, the greater the IRR, the more desirable the Project.
- Payback Period: The payback period refers to the period of time required to recover the funds expended on a Project. When calculating the payback period, the time value of money (discounting) is not taken into account.

4.2 BCA RESULTS

Table 19 presents the evaluation results for the Southport Berth Development and Port Expansion project. Results are presented in undiscounted, discounted at 7 percent as prescribed by the U.S. DOT. All benefits and costs were estimated in constant 2018 dollars over an evaluation period extending 27 years beyond system completion in 2024.

Table 19: Benefit Cost Analysis Results, Millions of 2018 Dollars

BCA Metric	Project Lifecycle	
	Undiscounted	Discounted (7%)
Total Benefits	$489.6	$131.1
Total Costs	$76.3	$56.9
Net Present Value (NPV)	$413.3	$74.2
Benefit Cost Ratio (BCR)	6.4	2.30
Internal Rate of Return (IRR)	15.0%	
Payback Period (Years)	8	

Source: WSP analysis

The project creates $489.6 million in undiscounted benefits over the 27-year project analysis period. When discounted to 2019 at 7 percent, benefits are $131.1 million. Undiscounted costs are $76.3 million. The ratio of benefits over costs at a 7 percent is 2.30. The net present value (discounted benefits minus discounted costs) is

$74.2 million. The project has an internal rate of return of 15.0 percent. The project pays for itself in eight years from going into service.

The benefits over the project lifecycle are presented in the Table 20 by U.S. DOT long-term outcome category.

Table 20: Benefits by Long-Term Outcome, Millions of 2018 Dollars

Long-Term Outcome	Project Lifecycle	
	Undiscounted	Discounted (7%)
Economic Competitiveness	$401.9	$113.8
Safety	$35.2	$9.0
State of Good Repair	$17.5	$4.3
Environmental Sustainability	$13.5	$4.2
Additional O&M	-$13.6	-$4.2
Residual Value	$35.1	$4.0

Source: WSP analysis

4.3 SENSITIVITY TESTING

A sensitivity analysis is used to help identify which variables have the greatest impact on the BCA results. This analysis can be used to estimate how changes to key variables from their preferred value affect the final results and how sensitive the final results are to these changes. This sensitivity testing investigates key assumptions of the BCA and assesses impact of changes to those assumptions.

— The project is assumed to add overall capacity to PhilaPort by consolidating Ro/Ro operations in Southport and reducing the need for automobiles to travel between Packer Avenue Marine Terminal and 98 Annex or Pier 122 and Southport. The project will not only increase Ro/Ro berth capacity, but also container capacity. If the projects impacts were limited to Ro/Ro cargoes, the net present value would fall to $27.5 million. The new benefit/cost ratio would be 1.48.

— Many of the benefits of the project related to additional capacity that the project provides. The project enables PhilaPort to continue to serve markets for which it is most efficiently situated. If capacity was not available, freight would move to other ports and travel farther to markets served. Benefit assumptions rely on demand forecasts, which estimate the point at which PhilaPort without the project would not be able to meet demand. If the assumed growth rate is reduced to three percent for both container and Ro/Ro traffic, the net present value declines to $31.2 million and the benefit/cost ratio becomes 1.55. If growth rates are further reduced to two percent, the net present value declines to $7.1 million with a benefit/cost ratio of 1.12.

Table 21 summarizes the key variables which have been tested for sensitivity and the results of this analysis.

Table 21: Benefit Cost Analysis Sensitivity Analysis

Sensitivity Variable	New BCR	New NPV (Million $2018)
Project has no impact on container capacity	1.48	$27.5
Truck diversion estimates to be based on a growth rate of 3 percent per year	1.55	$31.2
Truck diversion estimates to be based on a growth rate of 2 percent per year	1.12	$7.1

Source: WSP analysis