Benefit – Cost Analysis

2016 TIGER Grant Application
Funding Opportunity #: DTOS59-16-RA-TIGER8

Applicant: Philadelphia Regional Port Authority

Packer Avenue Marine Terminal Berth and Crane Rail Enhancement Project

Executive Summary- Benefit Cost Analysis

A Benefit Cost Analysis was conducted for the ***Packer Avenue Marine Terminal Berth and Crane Rail Enhancement Project***, where the net present values of the benefits are compared against the values of the project. The anticipated total cost for the project is $39,000,000. The proposed project net benefits have an economic value of $450,270,663 prior to the application of the discount rates.

Below is a table indicating the net benefits of the project associated with the grant selection criteria net benefit value (before discount).

Table 1 Overall Benefit Cost Analysis for Primary Grant Criteria

	Grant Selection Criteria	Net benefits (before Discount)
Emissions Reductions/Greenhouse Gas Reductions	Sustainability, Livability	$ 31,312,437
Freight Efficiency Improvements (PAMT Expense Reductions)	State of Good Repair, Economic Competitiveness,	$ 19,981,095
Freight Efficiency Improvements (reduced supply chain costs)	Economic Competitiveness	$ 326,393,834
Reduced Pavement and Property Damage	State of Good Repair, Economic Competitiveness	$ 26,103,112
Safety (Value of Statistical Life and Injuries)	Safety	$ 46,480,185
Total		**$ 450,270,663**

Benefit cost ratios have been estimated on an annual basis for 34 years, beginning in 2017 and ending in 2050. Applying discount rates of 3% and 7% lead to a Net Present Value of $336,348,985 and $66,123,436 with respective BC ratios of 3.1 and 9.3. An excel worksheet to support the BCA calculation and a PDF of the worksheets has been included with the grant submission and can be accessed at the following link http://www.philaport.com/grants-packer/.

	7%	3%
Total Benefits Discounted	$ 97,089,945	$ 377,094,592
Total Costs Discounted	$ (30,966,508)	$ (40,745,607)
NPV	$ 66,123,436	$ 336,348,985
BCR	**3.1**	**9.3**

Assumptions

- The project start date is January 2017 for the Berth crane rail support upgrades and terminal electrical capacity enhancements. The Hyundai cranes are anticipated to be retrofitted with electric drives by January 2021. The total useful life of the berth infrastructure upgrades and the crane drive retrofit is anticipated to be 30 years.

- Benefits achieved from this project are primarily arrived at from the electric retrofit of the Hyundai cranes which reduces operating expenses, downtime and reduced air emissions. from reduced crane emissions. Additionally, the extended life cycle of the crane and the new 2 post panama cranes proposed would reduce miles from additional shippers using port of Philadelphia due to lower inland costs.

- For purposes of the Benefits Cost Analysis capital expenses are to be incurred during the projected four year implementation period beginning in 2017.

- A crane maintenance expense of $100,000 is projected in the first year of the project's completion and increased 3% each year thereafter.

Methodology

The value of the benefits resulting from the proposed projects is made up of four principal categories arising from the difference in performance between the electric powered cranes and the diesel powered cranes, and the economic factors in the efficient movement of freight as it relates to the wharf enhancements of the Packer Avenue Marine Terminal (PAMT). We believe that the implementation of the project will have the following benefits:

(1) Monetized the value of the reduced level of emissions and greenhouse gases from reduction in crane emissions as well as vehicles miles traveled;

(2) Increase in freight efficiency resulting from lower operating costs and reliability for the electric cranes; and

(3) Freight efficiency improvements resulting from reduced supply chain costs in the event that the project is undertaken.

(4) Safety benefits in the form of reduced fatalities, injuries and property damage due to decreased truck vehicles miles from cargo moving to the Port of Philadelphia.

Overview Attachments

Attachment 1 provides an overview of the undiscounted project benefits and capital and operating expense.

Attachment 2 is a worksheet of the projected cost benefit analysis at 3% and 7% discount rates.

Attachment 3 is a worksheet that shows container volumes and crane hours at PAMT for the life of the project period.

Emissions/Greenhouse Gas Reductions

The annual emissions reductions resulting from the electrification program were estimated using the emission estimates in EPA's AP-42 Chapter 3.4 (Table 3.4-1). These calculations were developed as a section of the Container Crane Conversion Analysis Report –Packer Avenue Marine Terminal prepared by CMI. This document is provided as an Attachment of the application. The emissions quantity is calculated by utilizing the 2013 benchmark emissions reductions (TPY) and adjusting by the increase (or decrease) in crane hours per year based upon actual volumes in 2015.

The annual value of the emissions reductions is estimated based on the "Emissions Damage Costs" identified in the as suggested by the TIGER grant guidance. Diesel and electricity prices were projected utilizing Energy Information Administration sources and are escalated by the crane use growth rate. Below are the 2016 emissions quantity and value of emissions benefit. The total benefit of reduced emissions is $31,312,698 over the life of the project. **Attachment 4** of this document is a worksheet that calculates the benefit over the life of the project for emissions as a result of reduction vehicles miles traveled (VMT) and crane emissions due to the electric drive retrofit. Reductions in emissions and greenhouse gases specifically address the primary grant selection criteria of ***sustainability*** and ***livability***.

Table 2 Emission Type and Related Project Benefits (Undiscounted)

Emission Type	2013 emission quantity (TPY)	2015 Value of Emissions Benefit ($/metric ton)	Total Projected Benefits of Reduced Emissions
Greenhouse Gas Emissions (CO_2)	2,319.43	$ 39	$15,354,533
Nitrogen Oxide (NO_x)	28.47	$8,014	$4,601,270
Voluntary Organic Compound (VIC)	3.01	$2,034	$132,239
Particulate Matter (PM)	1.43	$366,659	$11,127,551
Sulfur dioxide (SO_x)	0.0006	$47,352	$97,106
Total Expense Reduction	**$31,312,698**		
Primary Selection Criteria Addressed	**Sustainability, Livability**		

Freight Efficiency Improvements (PAMT Expense Reductions)

The electrification of the cranes results in several operational improvements that reduce costs. Maintenance and repair of electric powered cranes is less demanding than for diesel powered cranes. It is estimated that an annual savings of $480,000 in maintenance and repair will be realized as a result of this project.

As a result of reduced maintenance time, as well as improved reliability, it is also estimated that there will be a reduction in crane downtime. Downtime results in significant increased costs in idle labor, equipment and vessel fuel consumption. It has been estimated that an annual reduction of 63 hours of crane downtime leads to a cost savings of more than $474,871 in the supply chain.

Electric powered cranes also are more energy efficient than diesel powered cranes. Based upon 2015 crane usage the two Hyundai cranes used a total of 153,361 gallons of diesel. At an average cost of $3.12/gallon the total fuel cost per year was $479,141. Electric usage for the modified cranes is estimated at 1.634 Million KWH per year at 2015 usage levels. At $0.069 per KWH the expected equivalent annual cost for electricity after the crane conversion is $112,774. Therefore utilizing 2015 as a benchmark the conversions would provide a cost savings of $ 366,367. Additionally, an intangible but an important benefit derived would be the reduction in a reliance on foreign fuels to power critical infrastructure. Reductions in replacing diesel drives with electric specifically address the primary grant selection criteria of ***state of good repair*** and ***economic competiveness.***

Attachment 5 of this Analysis provides supporting information for the maintenance expense, crane down time and utility cost savings.

Table 3 PAMT Terminal Expense Reduction Project Benefits (Undiscounted)

Terminal Expense Reductions	**2015 Expense**	**Total Projected Benefits**
Maintenance	$480,000	$6,780,491
Crane Down time	$474,871	$6,708,043
Cost saving of electricity versus Diesel	$366,367	$6,492,561
Total Expense Reduction	**$19,981,095**	
Primary Selection Criteria Addressed	**State of Good Repair, Economic Competitiveness**	

Freight Efficiency Improvements (reduced supply chain costs)

The structural improvements to the terminal crane rail are required in order to increase the container handling capability of the Packer Avenue Marine Terminal. If the improvements are made it is projected that local hinterland shipper will move cargo volumes currently being handled at other North Atlantic Ports to Philadelphia. Hinterland shippers will be compelled to make his port change to take advantage of logistical savings due to being in closer proximity to the load or discharge port.

The Philadelphia hinterland is defined as those shipper locations that have a logistical cost savings having their containers on vessels being handled at Philadelphia's Packer Avenue Marine Terminal. Utilizing 2014 PIERS (Port Import Export Reporting System) data we have forecasted that an estimated 235,675 container units move via the North Atlantic Port range (Norfolk to New York) destined to the Philadelphia hinterland. In calendar year 2014 the Port of Philadelphia handled 34,156 (15%) of the Philadelphia hinterland market.

Utilizing actual shipper activity and trucking rates we have developed a trucking analysis to identify the cost differential between a container unit being handled at a North Atlantic Port and Philadelphia. The average inland logistic costs would be reduced $264 and have a decrease in miles travelled of more than 91 miles. An example is illustrated in **Table 4** for a shipper currently moving containers between Media, Pennsylvania via the Port of New York/New Jersey. As the table illustrates 90 truck miles are reduced with an inland cost savings of $300. In 2014 there were 6,499 container units handled via the port of New York/New Jersey with and origin/destination in Delaware County- Media, PA.

An excel worksheet entitled "2014_hinterland analysis" provides further detail on this analysis has been provided for review.

Table 4 Example of Logistics and Mileage Savings

Port	Mileage to/from Port to Shipper	Inland (trucking) cost to/from Port to Shipper
Philadelphia	24	$450
New York/New Jersey	114	$750
Differential	**90**	**$300**

Attachment 6 details the analysis showing the benefit of the reduction in supply chain costs as a result of cargo being moved over Philadelphia versus other ports in the North Atlantic Range. The initial benefit is taken in year 2021 utilizing the difference from the year prior due to the Crane rail infrastructure and Hyundai improvements. In essence capacity would be met in 2020 so hinterland levels are benchmark and the benefit is calculated based upon the increase in container units. A conservative trucking differential of $200 is utilized

(compared to the average overall differential of $260). Applying a conservative growth rate of 1.5% for overall hinterland growth and a 0.75% per year container market share to the Philadelphia hinterland handled via the port of Philadelphia increases from 15.3% in 2014 to 41.5% in 2050.

Increasing supply chain cost benefits address the primary grant selection criteria of ***economic competiveness.***

Table 5 identifies the overall miles and cost savings from this benefit.

Table 5 Supply Chain Cost Savings and Benefits (Undiscounted)

	Reduced Miles	Cost Savings
Reduced Supply Chain Costs	**148,509,194**	**$326,393,834**
Primary Selection Criteria Addressed	**Economic Competitiveness**	

Value of Statically Life Fatalities, Injuries Pavement and Property Damage

As the above Table outlines we forecast the potential reduction of 148,509,194 miles due to additional cargo moving over the Port of Philadelphia over the life of the Project. There are several cost savings and consequences avoided when these miles are eliminated from the highway system, summarized in table 6.

We used the fatality rate of 1.4 fatalities per 100 million truck VMT using data from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS) data. The product of this rate with the annual VMT savings gives the annual fatalities averted, which multiplied by the value of statistical life of $9.4M gives the total value of fatalities prevented. Based on these inputs, 2.1 fatalities are projected to be avoided through 2050, equal to $19.7M in undiscounted savings.

For injuries, we used the injury rate of 38.8 injuries per 100 million truck VMT using data from the Federal Motor Carrier Safety Administration (FMCSA). Similar to calculating fatalities averted above, the product of this injury rate and the annual VMT savings gives the number of generic injuries averted per year. This figure was converted to a MAIS scale as per USDOT recommendation, leading to 58 injuries averted in total. We multiplied the value of each injury type with the number of occurrences prevented, to give the total value injuries prevented through 2050 of $26.7M in undiscounted 2015 dollars.

Property damage averted was quantified using a property damage rate of 94.3 instances per 100 million truck VMT from the same FMCSA database used above. Using the annual VMT saved and the USDOT recommended value per property damage, we estimated a total of 140 prevented property damage instances, equaling about $559K in undiscounted 2015 dollars.

Reduced trucking VMT should also have an impact on reducing pavement damage over time. Assuming a 80 kip combination truck on rural highways, we used the Federal Highway Administration's (FHWA) estimate of $.172 per mile and the annual VMT saved to calculate the total value of reduced pavement damage of $25.5M through 2050 in undiscounted 2050 dollars.

Attachment 7 calculates the benefits of reduced fatalities and injuries resulting from shipper miles avoided.

Attachment 8 outlines the consequences avoided Pavement and Property damage in the event that these projected units are handle on vessels that call PAMT.

The Table below outlines these benefits.

Table 6 Fatalities, Injuries and Damage Savings (Undiscounted)

	Injuries	Fatalities	Pavement Damage	Property Damage
Avoided costs	**$26,741,534**	**$19,738,651**	**$25,543,581**	**$559,531**
Incidents Avoided	**58**	**2.1**		**140**
Primary Selection Criteria Addressed	**Safety**		**State of Good Repair, Economic Competiveness**	