Appendix C: Cost Benefit Methodology in Evaluation of Project Costs and Benefits

Overview of the Benefit-Cost Analysis

This section presents the methodology, assumptions, and results for the benefit-cost analysis (BCA) of the Port of Corpus Christi Nueces River Rail Yard project. It is based on the U.S. Department of Transportation's (USDOT's) guidance for benefit-cost analysis of TIGER III Discretionary Grants.

Results from a benefit-cost analysis include:

- Net Present Value (NPV) - defined as the difference between present value benefits and costs;
- Benefit/Cost Ratio (BCR) - defined as the ratio of present value of benefits to costs.

A worthy project will have a NPV greater than zero and a BCR greater than one. The BCR indicates the return on investment as a percentage above the breakeven point. The NPV reflects the total value of a project to society.

The Port of Corpus Christi Project Overview

The Port of Corpus Christi is requesting $10 million dollars from the TIGER III Discretionary Grant program to complete a capacity improvement project which will greatly improve the rail infrastructure and transportation network in and out of the Port of Corpus Christi. The project has support from the three Class I railroads, including Union Pacific, Burlington Northern Santa Fe, and Kansas City Southern railroads, that serve this region. The primary scope of work is to construct approximately 27,000 feet of new rail capacity within the Nueces River Rail Yard. The rail yard is located along the Fulton Corridor between Mile Post 1 and 2 (just east of the Viola Turning Basin). This interchange yard is best suited to serve POCC's north side rail customers. It can easily serve the south side rail facilities as well because it is less than ¼ mile from the Viola loop, which connects to the UP mainline track as it enters the south side of the inner harbor. The yard will consists of a 8,000 foot unit train siding capable of storing a full 110 car unit train and will be adjacent to five parallel ladder tracks ranging in length from 3,380 feet (52 cars) to 4,370 feet (67 cars) for a total yard capacity of 18,800 feet and 290 total rail cars. A 16-foot wide service road runs south of the yard and widened lanes between every other track will allow better access for car inspections and air tests. In addition, a 750-foot service track will be constructed on the south side service road for locomotives awaiting outbound trains. Estimated cost for full build out is $21.5M. These improvements in rail capacity will reduce costs associated with the shipping of goods in these areas allowing for rail to capture a fraction of the

truck market. This diversion from trucks to rail will provide a wide range of public benefits, which are detailed further below.

Estimation of Diversion from Trucks

The planned improvements are expected to divert raw materials and finished goods from trucks to rail. As such an analysis measuring the amount of cargo that would be subject to this diversion was performed. This analysis consisted of an assessment of current commodities processed through the Port of Corpus Christi, an estimate as to the types of commodities and volume of cargo could potentially be diverted. The assessment of potential divertible cargo yields approximately 1 million tons of cargo that could potentially be diverted from truck to rail each year. To put this number into context, the Port of Corpus Christi processed approximately 84 million tons of cargo in 2010.

General Assumptions

- 24 Tons per Bulk and Carload Truck was used to convert number of trucks to tonnage that could be diverted
- First Year of Diversion is assumed to be 2014, when the rail yard improvements will be completed
- Market capture for Port of Corpus Christi: 10% of divertible trucks for each market will shift to rail in the initial year of benefits (2014) continually increasing 1% a year
- Diversion ramp-up is based on the assumption that full market capture will be achieved at a 25% diversion rate

Port of Corpus Christi Project Benefits

Various benefits are expected from the rail yard improvements at the Port of Corpus Christi. Those benefits and the methodology used to quantify the benefits of each category are detailed below. The benefits were quantified in accordance with the TIGER application guidelines to complete a formal Benefit-Cost Analysis (BCA).

State of Good Repair

Pavement Maintenance Cost Savings

As part of the freight cargo being shipped by rail rather than truck, the number of trucks that traverse the roadways will dramatically be reduced. Over the course of the planning horizon, 290,000 trucks will be removed from the highways. This reduction will directly reduce the impact that trucks have on the condition of the roadway pavement as trucks cause a great amount of stress.

The cost of pavement maintenance is estimated per truck mile and is multiplied by the total number of reduced truck miles traveled for an annual cost savings in pavement maintenance due to diversion. Estimates used to monetize benefits are based on FHWA's Federal Cost Allocation Study from 1997.[1]

Methodology

- Pavement maintenance costs for different truck loads (60 kip, 80 kip) and locations (urban / rural) are based on FHWA Highway Cost Allocation Study (2000) (Table 13) as shown in **Table 1**
- Assume diverted truck loads are split 10%/90% for 60 kip and 80 kip loads respectively, and diverted miles are 35 percent urban / 65 percent rural
- Inflate values using CPI from 2000 to 2011 dollars (1.32 factor) to determine the value: $0.275 per mile
- Determine the proportion of the truck route that is diverted and compute weighted average of pavement damage across all truck miles

Table 1: Results from Highway Cost Allocation Study

Cents per Mile Vehicle Class/Highway Class	Pavement	Congestion	Noise
Urban			
60 kip 5-axle Comb/Urban Interstate	10.5	18.39	2.75
80 kip 5-axle Comb/Urban Interstate	40.9	20.06	3.04
Rural			
60 kip 5-axle Comb/Rural Interstate	3.3	1.88	0.17
80 kip 5-axle Comb/Rural Interstate	12.7	2.23	0.19

Source: Reproduced in part from Addendum to the 1997 Federal Highway Cost Allocation Study Final Report; U.S. Department of Transportation Federal Highway Administration, May 2000, Table 13.

Economic Competitiveness

Shipping Cost Savings for Existing Rail

Due to the rail yard improvement project increasing the efficiency of rail freight movements in and out of the port, existing rail shippers will enjoy a lower generalized shipping cost. This per mile cost savings is applied to the existing background rail traffic that is currently processed at the port. A conservative generalized cost savings of 1% was used for the analysis. Any additional savings will only add to the overall benefit of the project.

[1] Citation: Addendum to the 1997 Federal Highway Cost Allocation Study - Final Report. U.S. Department of Transportation Federal Highway Administration. May 2000

Methodology

- Determine current traffic on rail without rail yard improvements
- Apply assumed level of generalized cost savings of about 1% to existing rail rate ($0.034 / ton-mile) because truck and rail service is assumed to be competitive
- Freight cost savings per ton-mile (1% * $0.034 = $0.0003 per ton-mile) is applied to all existing background ton-miles

Shipping Cost Savings – New rail users

Due to market competiveness between the rail and trucking industry, the total cost savings per mile of the rail industry will improve the competitiveness of rail compared to truck. Due to the reduction in rail shipping costs, cargo movements currently being shipped by the trucking industry will be diverted to the rail industry. The current amount of cargo that is processed by the port that is deemed divertible from truck to rail is approximately 1 million tons. Last year in 2010, the Port of Corpus Christi processed approximately 84 million tons of cargo. The anticipated levels of diversion to rail will be 10 percent of divertible freight in the initial year ramping up one percent a year to a cap diversion of 25 percent. The diversions were identified from selected existing commodities and markets.

Methodology

- Expected shipping cost savings of 1% or $0.0003 per ton-mile
- Add difference between shipping rate of trucking and rail
- Apply 50% of actual savings (as area under demand curve) for diverted benefits
- Multiply by estimated diversion of 10% ramping up to 25% of cargo ton-miles diverted to generate savings of new rail shipping

Livability

There are several benefits that the rail yard improvement project will yield due to the reduction in the number of trucks on the highway. Two of the benefits include reduced highway congestion and noise reduction.

Congestion Cost Savings

Congestion on the highways will improve due to cargo now being carried by the rail industry and therefore reducing the number of trucks.

The category of congestion cost savings is based on values for urban and rural conditions in the study areas. These benefits are applied per truck mile that is diverted from truck to the rail

industry. The basis for monetization of this benefit category, for removing one truck mile, is based on the 1997 FHWA Cost Allocation Study [2]

Methodology

- Apply same methodology for congestion costs for trucks as discussed above for pavement maintenance
- Computed value of congestion costs per mile is $0.11 per truck mile

Noise Savings

Noise savings is quantified similarly to that of congestion cost savings. By removing trucks from the highway, neighborhoods and communities adjacent to highways experience lower noise. The reduction of noise reduces the potential need for the construction of sound walls along highways to dampen noise. The basis for monetization of this benefit category, for removing one truck mile, is based on the 1997 FHWA Cost Allocation Study[3].

Methodology

- Apply same methodology for noise costs for trucks as discussed above for pavement maintenance
- Computed value of noise costs per mile is $0.015 per truck mile

Sustainability

A public benefit of reduced emissions will be generated from the diversion of cargo tonnage from the trucking industry to the rail industry. Furthermore, diversion from truck to rail reduces the amount of fuel needed to ship the same amount of cargo tonnage.

Environmental Cost Reduction

This category is quantified by subtracting the cost of pollution produced by the increase in movement of cargo by rail from the cost of pollution prevented from the eliminated number of trucks.

The assessment includes the major pollutants for which reasonably solid data inputs are available, including both Criteria Air Contaminants (CAC) and Greenhouse Gases (GhG): Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), Particulate Matter, Carbon Monoxide (CO) and Carbon Dioxide (CO2).

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[2] Citation: Addendum to the 1997 Federal Highway Cost Allocation Study - Final Report. U.S. Department of Transportation Federal Highway Administration. May 2000

[3] Citation: Addendum to the 1997 Federal Highway Cost Allocation Study - Final Report. U.S. Department of Transportation Federal Highway Administration. May 2000

Emission rates for rail are based on recent EPA analyses and rates for trucking are based on research performed by the Texas Transportation Institute. The volume difference of emissions saved is then combined with unit emission costs to arrive at total emission cost savings. Monetization values for various emissions elements has been provided by TIGER Guidance.

Methodology

- Determine forecasts of vehicle emission rates per ton-mile for trucks and rail
- Apply emission rate forecasts for trucks and rail to reduction in truck ton-mile and increase in rail ton-mile, respectively
- Apply valuation of emissions to total emission for trucks and rail
- Determine forecast of emissions and compute net emissions value

Fuel Consumption Savings

The amount of fuel used to move the same amount of cargo tonnage will be reduced to the tonnage being shipped via the rail industry instead of the trucking industry. Based on an average shipment load of 24 tons per truck, a gallon of fuel is required to carry 155 ton-miles of freight. On the other hand, rail freight operates at an average of 410 ton-miles per gallon. The estimated level of diversion will save about 6 million gallons of fuel consumption over the planning horizon.

Safety

Accident Cost Savings

From accident statistics obtained from the National Highway Traffic Safety Administration and the Federal Railroad Administration, rail is a safer mode of travel than the trucking industry.

The methodology used in estimating the accident cost savings is by taking the difference in accidents avoided through the reduction in truck traffic[4] and increased train mileage for freight. Accident cost per truck ton-mile has been estimated to be $0.0048, while accident cost per train ton-mile is $0.0008. These were calculated on the basis of accident data obtained from the National Highway Statistics and the Federal Railroad Administration.

TIGER Guidance has established monetary values for deaths which were used in this analysis. The analysis was conservative and only looked at fatality accidents, the inclusion of injuries will only show the project as being even more beneficial.

[4] http://www-nrd.nhtsa.dot.gov/Pubs/811002.PDF

Methodology

- Using historical data on roadway accidents from Traffic Safety Facts FARS/GES Annual Reports
- Using historical data on rail accidents from the Federal Railroad Administration
- Applied difference in cost per ton mile to number of cargo ton-miles diverted

Model Inputs

See **Table 4** for the values used in quantifying benefits. Some values used in the model were obtained from the TIGER Guidance or are standard values in the transportation industry.

Port of Corpus Christi Costs

The total construction costs associated with the rail yard improvement were used within the BCA. The cost figures were discounted at the same rate as the benefits.

Overview of the Cost Benefit Analysis Results

The impact of the Nueces River Rail Yard project will reduce truck traffic and will result in several benefits. The benefits include pavement maintenance savings, reduced shipping costs, congestion cost savings, noise savings, environmental cost reduction, and improved safety on the highways.

The following tables present the results of the cost benefit analysis for the Port of Corpus Christi Improvements Project. At the 7 percent discount rate the project is expected to generate **$30.7 million** in discounted benefits compared to a discounted cost of **$21.5 million**. As a result, the benefit/cost ratio for the project is estimated to be **1.4** with a net present value of **$9.2 million**.

Table 2: Summary of Results

	Total	
Project Impacts		
Gallons of Fuel Avoided (Millions)	**6**	
Number of Trucks Diverted	**290,041**	
Reduced Truck Miles on Highways (Millions)	**68**	
Reduced CO2 Emissions (Tons)	**57,135**	
Reduced CO Emissions (Tons)	**101**	
Reduced VOC Emissions (Tons)	**20**	
Reduced NOx Emissions (Tons)	**781**	
Reduced PM Emissions (Tons)	**20**	
	Discount Rate	
Monetized Benefits	**7%**	**3%**
Shipper Costs Savings associated with Existing Rail Traffic (Millions, $)	**$3.9**	**$6.9**
Shipper Costs Savings associated with Truck Diversion (Millions, $)	**$12.8**	**$23.2**
Pavement Maintenance Savings (Millions, $)	**$6.1**	**$11.1**
Accident Cost Savings, (Millions, $)	**$2.1**	**$3.7**
Congestion Savings (Millions, $)	**$2.5**	**$4.4**
Emission Savings (Millions, $)	**$3.0**	**$5.6**
Noise Savings (Millions, $)	**$0.3**	**$0.6**
Benefit Cost Analysis Results		
Total Discounted Benefits (Millions, $)	**$30.7**	**$55.5**
Total Discounted Costs (Millions, $)	**$21.5**	**$21.5**
Net Present Value (Millions, $)	**$9.2**	**$34.0**
Benefit - Cost Ratio	**1.4**	**2.6**

Table 3: Discounted Project Benefits, By Year, 7 Percent Discount Rate

Year	Shipper Savings Existing	Shipper Savings New	Pavement Maintenance Savings	Congestion Savings	Noise Savings	Emissions Savings	Accident Savings	Total
2012	$0	$0	$0	$0	$0	$0	$0	**$0**
2013	$0	$0	$0	$0	$0	$0	$0	**$0**
2014	$219,675	$546,397	$261,340	$104,928	$14,709	$106,717	$88,304	**$1,342,071**
2015	$211,463	$561,717	$268,668	$107,869	$15,122	$112,197	$90,780	**$1,367,816**
2016	$203,558	$572,693	$273,918	$109,977	$15,417	$118,480	$92,554	**$1,386,598**
2017	$195,948	$579,830	$277,331	$111,348	$15,609	$122,826	$93,707	**$1,396,599**
2018	$188,623	$583,581	$279,125	$112,068	$15,710	$126,270	$94,313	**$1,399,692**
2019	$181,572	$584,360	$279,498	$112,218	$15,731	$128,853	$94,439	**$1,396,672**
2020	$174,784	$582,540	$278,627	$111,868	$15,682	$130,633	$94,145	**$1,388,280**
2021	$168,250	$578,457	$276,674	$111,084	$15,572	$131,105	$93,485	**$1,374,628**
2022	$161,960	$572,414	$273,784	$109,924	$15,410	$132,153	$92,509	**$1,358,155**
2023	$155,906	$564,687	$270,088	$108,440	$15,202	$131,765	$91,260	**$1,337,348**
2024	$150,078	$555,521	$265,704	$106,680	$14,955	$132,013	$89,779	**$1,314,729**
2025	$144,467	$545,138	$260,738	$104,686	$14,675	$130,933	$88,101	**$1,288,737**
2026	$139,067	$533,735	$255,284	$102,496	$14,368	$129,562	$86,258	**$1,260,770**
2027	$133,868	$521,491	$249,428	$100,145	$14,039	$127,733	$84,279	**$1,230,983**
2028	$128,863	$508,565	$243,245	$97,663	$13,691	$125,700	$82,190	**$1,199,918**
2029	$124,046	$495,099	$236,804	$95,076	$13,328	$124,368	$80,014	**$1,168,736**
2030	$119,409	$462,709	$221,312	$88,857	$12,456	$117,288	$74,779	**$1,096,810**
2031	$114,945	$432,438	$206,834	$83,043	$11,641	$109,852	$69,887	**$1,028,641**
2032	$110,648	$404,148	$193,303	$77,611	$10,880	$103,445	$65,315	**$965,349**
2033	$106,512	$377,708	$180,657	$72,533	$10,168	$97,419	$61,042	**$906,039**
2034	$102,530	$352,998	$168,838	$67,788	$9,503	$91,752	$57,049	**$850,458**
2035	$98,697	$329,905	$157,793	$63,353	$8,881	$85,831	$53,316	**$797,777**
2036	$95,007	$308,323	$147,470	$59,209	$8,300	$80,724	$49,828	**$748,861**
2037	$91,456	$288,152	$137,822	$55,335	$7,757	$75,407	$46,569	**$702,498**
2038	$88,037	$269,301	$128,806	$51,715	$7,250	$70,936	$43,522	**$659,567**
2039	$84,746	$251,683	$120,379	$48,332	$6,775	$66,282	$40,675	**$618,873**
2040	$81,578	$235,218	$112,504	$45,170	$6,332	$62,267	$38,014	**$581,083**
2041	$78,528	$219,830	$105,144	$42,215	$5,918	$58,011	$35,527	**$545,172**
Sum	**$3,854,222**	**$12,818,637**	**$6,131,121**	**$2,461,633**	**$345,083**	**$3,030,522**	**$2,071,640**	

Table 4: Model Inputs

Input Name	Unit		Input Value	Source/Comment
Initial Cost	$		$21,500,000	POCC
Divertible Number of Trucks	# of trucks		47,368	POCC
Divertible Tonnage from Trucks	tons		1,136,832	Calculation
Existing Tonnage processed at POCC	tons		84,822,000	POCC
Existing POCC Background Rail Traffic	rail cars		40,000	POCC
Estimated increase in Background Rail Traffic	%		3%	POCC
Discount Rate - Option 1	%		7%	TIGER Guidelines
Discount Rate - Option 2	%		3%	TIGER Guidelines
Study Base Year	year		2012	
First Year of Benefits	year		2014	Year of Rail Yard Completion
Initial Diversion Rate from Trucks to Rail - In First Year of Benefits	%		10%	Assumed
Yearly Diversion Rate Increase	%		1%	Assumed
Max Diversion Rate from Trucks to Rail	%		25%	Assumed
Average distance travelled by Rail Car or Truck	miles		233	POCC
Intermodal Cargo as % of Total Cargo	%		15%	POCC - 2010 Cargo Report
Bulk/Manifest Cargo as % of Total Cargo	%		85%	POCC - 2010 Cargo Report
Average Cargo weight per Intermodal Train Car	tons/car		35	Industry Average
Average Cargo weight per Bulk/Manifest Train Car	tons/car		88	Industry Average
Average Cargo weight per Bulk/Manifest Truck	tons/truck		24	Industry Average
Average Cargo weight per Intermodal Truck	tons/truck		17.5	Industry Average
Of Truck Diverted - Percent of Trucks 60 Kip Loads	%		10%	Assumed
Of Truck Diverted - Percent of Trucks 80 Kip Loads	%		90%	Assumed
Of Truck Miles Diverted - Percent of miles Urban	%		35%	Assumed
Of Truck Miles Diverted - Percent of miles Rural	%		65%	Assumed
Pavement Maintenance Cost per truck mile	$/truck mile		0.275	Derived from 1997 Federal Highway Cost Allocation Study - Table 13

Congestion Cost per truck mile	$/truck mile		0.110	Derived from 1997 Federal Highway Cost Allocation Study - Table 13
Noise Cost per truck mile	$/truck mile		0.015	Derived from 1997 Federal Highway Cost Allocation Study - Table 13
Shipping Cost Rate - Truck Rate	$/ton-mile		0.0842	Per "EXTERNAL COSTS OF INTERCITY TRUCK FREIGHT TRANSPORTATION" published by the Transportation Research Part A, by D.J. Forkenbrock, 1999. This value is cited as the general freight carrier rate.
Shipping Cost Rate - Rail Rate	$/ton-mile		0.034	American Association of Railroads
Shipping Cost Savings - Generalized Cost Savings from Truck to Rail	$/ton-mile		0.0253	Calculation
Shipper Cost Savings - Generalized Cost Savings for Existing Rail	%		1%	Assumed
Shipper Cost Savings - Generalized Cost Savings for Existing Rail	$/ton-mile		0.0003	Calculation
# of rail cars per train	rail cars/train		100	Industry Average
Truck Fuel Consumption	ton-miles/gallon		155	"A MODAL COMPARISON OF DOMESTIC FREIGHT TRANSPORTATION EFFECTS ON THE GENERAL PUBLIC" published by the Texas Transportation Institute, Dec. 2007. This value is cited as a national average for truck freight hauling.
Train Fuel Consumption	ton-miles/gallon		410	EPA420-R-08-001a - May 2008
Accident Cost per Vehicle Mile Traveled	$/ton-mile		0.0048	Derived from data obtained from the National Highway Traffic Safety Administration
Accident Cost per Train Mile Traveled	$/ton-mile		0.0008	Derived from data obtained from the Federal Railroad Administration
Nox Cost per ton	$/ton		$4,000.00	TIGER Guidelines

Annual Increase in CO2 Damage	%		2.40%	TIGER Guidelines - "CORPORATE AVERAGE FUEL ECONOMY FOR MY2011 PASSENGER CARS AND LIGHT TRUCKS", March 2009, Page VIII-60, Table VIII-5
CO2 Cost per ton - 2012	$/ton		$33.00	TIGER Guidelines - "CORPORATE AVERAGE FUEL ECONOMY FOR MY2011 PASSENGER CARS AND LIGHT TRUCKS", March 2009, Page VIII-60, Table VIII-5
PM Cost per ton - 2012	$/ton		$168,000.00	TIGER Guidelines
VOC Cost per ton - 2012	$/ton		$1,700.00	TIGER Guidelines
CO Cost per ton - 2012	$/ton		$1,000.00	Industry Average