2014 TIGER Grant Application

Project Title: South Orient Railroad Rehabilitation

Appendix D: Economic Analysis Supplementary Documentation

April 24, 2014

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Section 1: Executive Summary

The South Orient Railroad (SORR) rehabilitation project from Sulphur Junction to Fort Stockton, Texas, is a “shovel-ready” rural freight rail project that will have a significant impact on the region as well as the nation.

The entire SORR is a 391 mile Texas Department of Transportation (TxDOT) owned facility that extends from San Angelo Junction (near Coleman, Texas) through several towns in west Texas, to Presidio at the Texas/Mexico border. The SORR has one of five rail border crossings between Texas and Mexico, and one of eight between the U.S. and Mexico.

The proposed project will upgrade the SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) to FRA Class 2 (25 mph) status. The City of Fort Stockton is located 12.5 miles west of Sulphur Junction. This section of the line is currently FRA Class 1 (10 mph) and requires a significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. If not rehabilitated, the recent and projected increase in traffic will cause rapid deterioration of the line, resulting in a reclassification to Excepted Status[1] becoming inoperable within 5 to 10 years. The rehabilitation is necessary in order to prevent this degradation of the track structure, continue and improve operations, and provide safe and efficient rail service to existing customers. Termination of rail service to the region threatens future transportation network efficiency, freight mobility, and economic growth.

The project will provide significant benefits to the region, state, and nation through:

1) improving freight rail efficiency and capacity;
2) avoiding the diversion of existing freight from rail to truck;
3) avoiding truck miles travelled;
4) avoiding highway maintenance costs;
5) avoiding increased transportation costs;
6) avoiding increased congestion costs;
7) avoiding accident costs (fatalities and injuries); and,
8) job creation.

SORR is the only rail line providing service to the cities and businesses in the region, which includes agricultural interests, steel manufacturers, mining businesses, energy resources, and other miscellaneous customers. The project area encompasses a large oil and gas development region that includes the Cline Shale, the Wolfcamp Shale, and the West Texas (Ouachita) Overthrust Resource Play. The SORR is essential in the transportation of frac sand to Fort Stockton for use in energy resource extraction.

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[1] FRA Excepted Status track class limits train speeds to 10 mph, hazardous material cars to 5 cars per train, and prohibits occupied passenger cars.

The TIGER funding being requested is required to complete the multi-party funding package and enable the project to proceed.

A table summarizing the changes expected from the project (and the associated benefits) is provided below.

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

<table>
<tr><th>Current Status or Baseline & Problems to be Addressed</th><th>Changes to Baseline / Alternative</th><th>Type of Impacts</th><th>Population Affected by Impacts</th><th>Benefits</th><th>Summary of Results ($2013, 7% Discounted)</th></tr>
<tr><td rowspan="6">SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) currently FRA Class 1 and requires significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. This section of the line is expected to become inoperable within 5 to 10 years.</td><td rowspan="6">70 lb. rail will be replaced with 136 lb. standard strength continuously welded rail (CWR). Replace crossties, tie plates, track spikes, weld joints, install compromise joint bars between the CWR and the project ends, and replace track bolts, rail anchors, and ballast. The track shall be constructed to 56.5” gage. Four (4) at-grade highway-rail crossings in the project limits will also be reconstructed (2 with timber surfaces and 2 with precast concrete panel). The railway will be completely rehabilitated, and</td><td>Reduced Highway Maintenance Costs from truck diversion to rail.</td><td>Federal and State (Texas) Governments</td><td>Monetized Maintenance Savings.</td><td>$15,603,013</td></tr>
<tr><td>Reduced Transportation Costs from truck diversion to rail.</td><td>Goods Shippers and Receivers</td><td>Monetized Shipping Savings.</td><td>$20,453,414</td></tr>
<tr><td>Short-Term Economic Impacts from construction/planning expenditure*.</td><td>Local Citizens and Businesses</td><td>Job years, Employment income.</td><td>See Pg. 24</td></tr>
<tr><td>Change in Inventory Costs from truck diversion to rail.</td><td>Goods Shippers and Receivers</td><td>Monetized Increased Inventory Costs.</td><td>-$11,249</td></tr>
<tr><td>Reduction in Highway Congestion from truck diversion to rail</td><td>On Road Motorists Between Fort Stockton and Fort Worth Texas.</td><td>Monetized Reduced Congestion Savings.</td><td>$1,293,926</td></tr>
<tr><td>Reduced Emissions from truck diversion to rail.</td><td>Texas</td><td>Monetized Reduced Pollution.</td><td>$21,092,513</td></tr>
</table>

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternative	Type of Impacts	Population Affected by Impacts	Benefits	Summary of Results ($2013, 7% Discounted)
	upgraded to FRA Class 2 standards; and maintained at this level in perpetuity.	Reduced Accident Costs from truck diversion to rail.	Motorists/Rail way Travellers Between Fort Stockton and Fort Worth Texas.	Monetized Increased injuries and fatalities.	$1,685,208

** Short-Term Economic Impacts from construction/planning expenditure are not included in the benefit-cost analysis and are only included for informational purposes in the Economic Impact Analysis.*

The period of analysis used in the estimation of benefits and costs corresponds to 22 years, including 2 years of construction and 20 years of operation. The total project costs are $15,311,949 million dollars and are expected to be financed by Federal (TIGER), State (TxDOT), local (Fort Stockton Economic Development Corp.) and private (TXPF) funds according to the distribution shown in Table ES-2.

Table ES-2: Summary of Project Costs and Anticipated Funding Sources, 2013$

Funding Source	Capital/Construction	Percent of Total Capital Cost Financed by Source
State (TxDOT)	3.3%	$500,000
Local (Fort Stockton Economic Development Corp.)	1.3%	$200,000
Private (TXPF)	49.2%	$7,527,384
Federal (TIGER)	46.3%	$7,084,565
TOTAL	**100%**	**$15,311,949**

**Numbers rounded to nearest 10th dollar.*

A summary of the capital costs and operation and maintenance (O&M) cost changes by year are shown in Table ES-3 below.

Table ES-3: Cost Summary Table

Calendar Year	Capital Cost (2013$, Undiscounted)	Operations & Maintenance Change* (2013$, Undiscounted)	Total
2014	$0	$0	$0
2015	$14,251,057	$0	$14,251,057
2016	$1,060,891	-$26,191	$1,034,700
2017	$0	-$26,191	-$26,191
2018	$0	-$26,191	-$26,191
2019	$0	-$26,191	-$26,191
2020	$0	-$26,191	-$26,191
2021	$0	$68,000	$68,000
2022	$0	$68,000	$68,000
2023	$0	$68,000	$68,000
2024	$0	$68,000	$68,000
2025	$0	$68,000	$68,000
2026	$0	$68,000	$68,000
2027	$0	$68,000	$68,000
2028	$0	$68,000	$68,000
2029	$0	$68,000	$68,000
2030	$0	$68,000	$68,000
2031	$0	$68,000	$68,000
2032	$0	$68,000	$68,000
2033	$0	$68,000	$68,000
2034	$0	$68,000	$68,000
2035	$0	$68,000	$68,000
2036	$0	$68,000	$68,000
TOTAL	**$15,311,949**	**$889,046**	**$16,200,995**

** Note: This is the incremental Operations and Maintenance (O&M) cost between the Build Case and No-Build Case. In 2014 and 2015 O&M costs remain at the base case level as the project is not yet in operations, thus there is no change in O&M costs. In 2016 the project becomes operational; in years 2016 to 2019, operation and maintenance of the track is less expensive in the Build Case, and thus there is a negative incremental cost; or a reduced O&M amount. In 2020 onwards the No-Build case track becomes inoperable, thus bringing O&M to zero in the No-Build case. The incremental O&M then becomes only the O&M costs of the build scenario as the no-build O&M is zero; i.e. there is an increased O&M amount.*

A summary of the relevant data as well as the annual net benefits used in the Benefit-Cost calculations shown in Table ES-4 (in dollars of 2013). Based on the Benefit-Cost Analysis presented in the remainder of this document, the project is expected to generate $60.1 million in discounted benefits and $14.6 million in discounted costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $45.6 million and a Benefit/Cost Ratio of 4.13 to 1 (See Table 20).

Table ES-4: Summary of Pertinent Data, Quantifiable Benefits and Costs

Calendar Year	Project Year	Reduced Truck Vehicle Miles Travelled (Diverted to Rail)*	Total Benefits ($2013), Undiscounted	Total Costs ($2013), Undiscounted	Undiscounted Net Benefits ($2013)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2014	1	0	$0	$0	$0	$0	$0
2015	2	0	$0	$14,251,057	-$14,251,057	-$13,318,745	-$13,835,978
2016	3	0	$0	$1,034,700	-$1,034,700	-$903,747	-$975,304
2017 (opening)	4	146,228	$926,719	-$26,191	$952,910	$777,859	$872,048
2018	5	180,097	$1,115,316	-$26,191	$1,141,507	$870,850	$1,014,214
2019	6	214,982	$1,304,394	-$26,191	$1,330,585	$948,689	$1,147,774
2020	7	1,233,665	$7,349,399	-$26,191	$7,375,589	$4,914,667	$6,176,940
2021	8	1,270,675	$7,466,536	$68,000	$7,398,536	$4,607,436	$6,015,687
2022	9	1,308,795	$7,556,870	$68,000	$7,488,870	$4,358,591	$5,911,783
2023	10	1,348,059	$7,689,346	$68,000	$7,621,346	$4,145,507	$5,841,127
2024	11	1,388,501	$7,791,135	$68,000	$7,723,135	$3,926,050	$5,746,738
2025	12	1,430,156	$7,958,765	$68,000	$7,890,765	$3,748,846	$5,700,457
2026	13	1,473,061	$8,087,264	$68,000	$8,019,264	$3,560,649	$5,624,551
2027	14	1,517,253	$8,254,184	$68,000	$8,186,184	$3,396,975	$5,574,393
2028	15	1,562,770	$8,427,512	$68,000	$8,359,512	$3,241,963	$5,526,622
2029	16	1,609,653	$8,565,539	$68,000	$8,497,539	$3,079,899	$5,454,247
2030	17	1,657,943	$8,751,897	$68,000	$8,683,897	$2,941,536	$5,411,517
2031	18	1,707,681	$8,990,308	$68,000	$8,922,308	$2,824,574	$5,398,143
2032	19	1,758,912	$9,201,054	$68,000	$9,133,054	$2,702,141	$5,364,707
2033	20	1,811,679	$9,418,056	$68,000	$9,350,056	$2,585,368	$5,332,206
2034	21	1,866,029	$9,641,780	$68,000	$9,573,780	$2,474,047	$5,300,770
2035	22	1,922,010	$9,923,108	$68,000	$9,855,108	$2,380,137	$5,297,606
2036	23	1,979,670	$10,171,468	$68,000	$10,103,468	$2,280,486	$5,272,924
Total		25,408,150	$138,419,184	$16,200,995	$122,218,189	$43,263,293	$77,900,248

**First calculate the number of diverted trucks. Diverted Trucks = (# Build Case Train Carloads less # of No-Build Case train carloads)* number of trucks per carload. Next calculate the number of reduced truck vehicle miles. Reduced Truck Vehicle Miles = Truck Route Miles * Number of Diverted Trucks. For full calculation breakdowns see Section 6 Tables 2 and 3; for annual demand numbers see section 10.2 Annual Demand Projections.*

A summary of the monetized benefits of the SORR rehabilitation project are included below in Table ES-5.

Table ES-5: Benefit Estimates by Long-Term Outcome over the study period, 2013$

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$15,603,013	$25,843,478
Economic Competitiveness*	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$20,453,414	$33,877,263
	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	-$11,249	-$18,631
Quality of Life	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$1,293,926	$2,143,147
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	$21,092,513	$33,971,543
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$1,685,208	$2,791,232
Total Benefit Estimates		**$60,116,825**	**$98,608,031**

*Note: * Excluding the short-term employment impacts of the project*

In addition to the monetized benefits presented in Table ES-5, the project would generate benefits that are difficult to quantify, and thus are not included in the analysis. A brief description of those benefits is provided below.

<u>Safety</u>

- *Hazardous materials movement*: Rail is the safest way to transport hazardous materials. The value of rail as a safer form of hazardous materials has not been monetized. In particular it is expected a major oil and natural gas distributor will be shipping between 15 and 40 carloads of crude oil outbound per day and receiving 15 carloads of sand inbound per day. The SORR rehabilitation is essential in order to support these developments and to prevent this freight from being diverted to trucks. The rehabilitation of the SORR would allow the transportation of these materials by the safest method available.

- *Derailments:* The project area includes 4 roadway/rail at-grade crossings which are in "fair" or "poor" condition. These crossings have substandard rail with deteriorated ties, subgrade and drainage. This causes the track to pump under load, resulting in the possibility of derailments and vehicular accidents. This also causes most drivers to cross the tracks at extremely low speed, which can contribute to vehicular-train accidents.

Section 2: Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the South Orient Railroad Rehabilitation – Sulphur Junction to Fort Stockton project.

Section 3, Methodological Framework, introduces the conceptual framework used in the Benefit-Cost Analysis (BCA). Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the South Orient Rehabilitation project is expected to generate. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projects. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Next, Section 9, BCA Sensitivity Analysis, provides the outcomes of the sensitivity analysis. Additional data tables are provided in Section 10, Supplementary Data Tables, including annual estimates of benefits and costs, as well as intermediate values to assist DOT in its review of the application.[2]

[2] While the models and software themselves do not accompany this appendix, greater detail can be provided, including spreadsheets presenting additional interim calculations and discussions on model mechanics and coding, if requested.

Section 3: Methodological Framework

Benefit-Cost Analysis (BCA) is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

The specific methodology developed for this application was developed using the above BCA principles and is consistent with the TIGER guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to each of the five long-term outcomes identified in the Notice of Funding Availability (NOFA);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the DOT (7 percent, and 3 percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

Section 4: Project Overview

The South Orient Railroad (SORR) rehabilitation project from Sulphur Junction to Fort Stockton, Texas, is a "shovel-ready" rural freight rail project that will have a significant impact on the region as well as the nation.

The entire SORR is a 391 mile TxDOT-owned facility that extends from San Angelo Junction (near Coleman, Texas) through several towns in west Texas, to Presidio at the Texas/Mexico border. The SORR has one of five rail border crossings between Texas and Mexico, and one of eight between the U.S. and Mexico.

The proposed project will upgrade the SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) to FRA Class 2 (25 mph) status. The city of Fort Stockton is located 12.5 miles west of Sulphur Junction. This section of the line is currently FRA Class 1 (10 mph) and requires a significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. If not rehabilitated, the recent and projected increase in traffic will cause rapid deterioration of the line, resulting in a reclassification to Excepted Status[3] becoming inoperable within 5 to 10 years. The rehabilitation is necessary in order to prevent this degradation of the track structure, continue and improve operations, and provide safe and efficient rail service to existing customers. Termination of rail service to the region threatens future transportation network efficiency, freight mobility, and economic growth.

The project will provide significant benefits to the region, state, and nation through:

1) improving freight rail efficiency and capacity;
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7) avoiding accident costs (fatalities and injuries); and,
8) job creation.

SORR is the only rail line providing service to the cities and businesses in the region, which includes agricultural interests, steel manufacturers, mining businesses, energy resources, and other miscellaneous customers. The project area encompasses a large oil and gas development region that includes the Cline Shale, the Wolfcamp Shale, and the West Texas (Ouachita) Overthrust resource play. The SORR is essential in the transportation of frac sand to Fort Stockton for use in mining the shale formations and the Resource Play.
The TIGER funding being requested is required to complete the multi-party funding package and enable the project to proceed. If this funding does not materialize, this section of the

[3] FRA Excepted Status track class limits train speeds to 10 mph, hazardous material cars to 5 cars per train, and prohibits occupied passenger cars.

line is expected to become inoperable within 5 to 10 years, threatening future transportation network efficiency, freight mobility, and economic growth.

4.1: Base Case, Build Case and Alternative

Base Case (No-Build Case): In the base case, the SORR rehabilitation project from Sulphur Junction to Fort Stockton is not undertaken. Given the track condition, it becomes inoperable in year 7 (2020) of the study and all traffic/carloads routing on this segment cease operation. In the base case, the carload tonnage is diverted from the SORR to the UPRR from Fort Worth to Odessa and trucked from Odessa to Fort Stockton once the segment becomes inoperable.

Build Case: In the build case the SORR rehabilitation project from Sulphur Junction to Fort Stockton is undertaken. Carload traffic remains on the railroad (rather than being diverted to trucks). The benefits of the build case are attributed to the avoidance of truck use.

4.2: Project Cost and Schedule[4]

Table 1: Cost Schedule by Quarter, 2013$

Description	2015				2016
	Q1	Q2	Q3	Q4	Q1
% of Total Expenditure	11%	27%	27%	28%	7%
Cost by Quarter	$1,736,783	$4,130,051	$4,146,977	$4,237,246	$1,060,891

Note: Numbers rounded to nearest dollar.

Table 1 shows the breakdown of the project costs by quarter by year. Construction begins in 2015 Q1 and completes by the end of 2016 Q1. Of the total project cost of $15.3 million; $14.3 million will be expended in 2015, and $1.0 million in 2016. For analysis purposes construction years are 2015 and 2016. The project impact analysis period is then analyzed for 20 years from 2017 to 2036.

4.3: Effects on Long-Term Outcomes

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail

An avoidance of heavy trucks on the highway system reduces highway maintenance costs and in particular pavement re-surfacing and maintenance costs. Typically, this benefit is realized in terms of increased cycle times between maintenance work orders. This benefit category captures the reduced maintenance cost associated with diverting goods from truck to rail.

[4] All cost estimates in this section are in millions of 2013 dollars, discounted to 2014 using a 7 percent real discount rate.

Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail

Rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. As such, diversion of intermodal highway freight to rail can generate cost savings to shippers. The SORR rehabilitation allows shippers a greater choice of transportation modes. Furthermore, these improvements increase schedule reliability, one of the key challenges facing a railroad in terms of product delivery. In the absence of such improvements, some shipments would likely be carried by truck at a greater cost to producers.

Transportation cost savings are quantified using the calculation of the volume of truck ton-miles avoided and relative shipping rates.

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail

SORR improvements would give shippers the choice/opportunity of shipping by rail. Generally trucks use the highly developed interstate highway system that provides faster transit times and potentially lower inventory costs. With lower truck shipping times, a modal diversion to rail will increase inventory costs.

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail

The proposed SORR project will divert freight from road to rail resulting in a reduction in the use of public highways by heavy trucks. This represents time savings to the remaining on-road motorists.

Emission Savings from Diverting Heavy Truck Travel to Rail

Freight carried over the rail network imposes less environmental impacts for the same amount of cargo than those imposed by trucks on the highway network. This benefit category estimates the value of the reduced environmental emissions associated with transporting goods on rail as opposed to by truck. The reduced amounts of Nitrogen Oxide (NOx), Carbon Dioxide (CO_2), Particulate Matter (PM), and Volatile Organic Compounds (VOCs) are calculated and monetized.

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail

Fatality and injury rates per mile of freight carried by truck are greater than the fatality and injury rates for an equal volume of cargo when shipped by rail. This benefit captures the different accident rates per truck-mile and train-mile, and the reduced amounts of injuries and fatalities of truck diversion to rail.

The main benefit categories associated with the project are mapped into the five long-term outcome criteria set forth by the DOT in the table below.

Table 2: Expected Effects on Long-Term Outcomes and Benefit Categories

Long-Term Outcomes	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	Maintenance of railroads is less costly per ton-mile than highway maintenance	√		
Economic Competitiveness	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	Railway shipping costs per ton-mile are lower than truck shipping costs.	√		
	Short-term economic impacts*	Number of jobs expected to be created by the project, and related income.		√	
	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	This is a negative impact. Rail shipment time is greater than truck shipment time	√		
Quality of Life	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail	This represents the time savings of the remaining on-road motorists	√		
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	Trains emit fewer pollutants than trucks per ton-mile.	√		
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	Trains have a lower injury and fatality rate per ton-mile travelled than trucks	√		

**Note: This impact is quantified, but is NOT included in the Benefit-Cost Analysis*

Section 5: General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction in 2015 and including 20 years of operations (2017 to 2036) after Construction completion in 2016.

The monetized benefits and costs are estimated in 2013 dollars with future dollars discounted in compliance with TIGER requirements using a 7 percent real discount rate, and sensitivity testing at 3 percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2013 dollars;
- Benefits and costs are discounted to the year 2014;
- The period of analysis begins in 2014 and ends in 2036. It includes project development and construction years (2015 - 2016) and 20 years of operations (2017 - 2036);
- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis; and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full Build alternative (defined in section 4.1 as “Build Case”).

Section 6: Demand Projections

The demand projections are based on the number of carloads that will remain on the rail system in the build scenario. In the build case, carloads grow at 3% annually based on the current 2014 carload value. In addition to the current 2014 carload values, the build case includes volumes from two transload facilities which will be constructed at Sulphur Junction and Fort Stockton respectively. These transload facilities are anticipated to start receiving frac sand in May 2014 and ramp-up to full capacity over the next 3 years. Beyond the ramp-up period, it is forecasted volumes will increase at 3% annually for the reminder of the study period.

In the no build case, carloads are equivalent to the build case amount from 2014 to 2016. Carloads then flatten out at the 2016 value from 2017 to 2019. Traffic/carloads routing this track segment drop to 0 from 2020 (year 7) onwards, as the deteriorating track becomes inoperable.

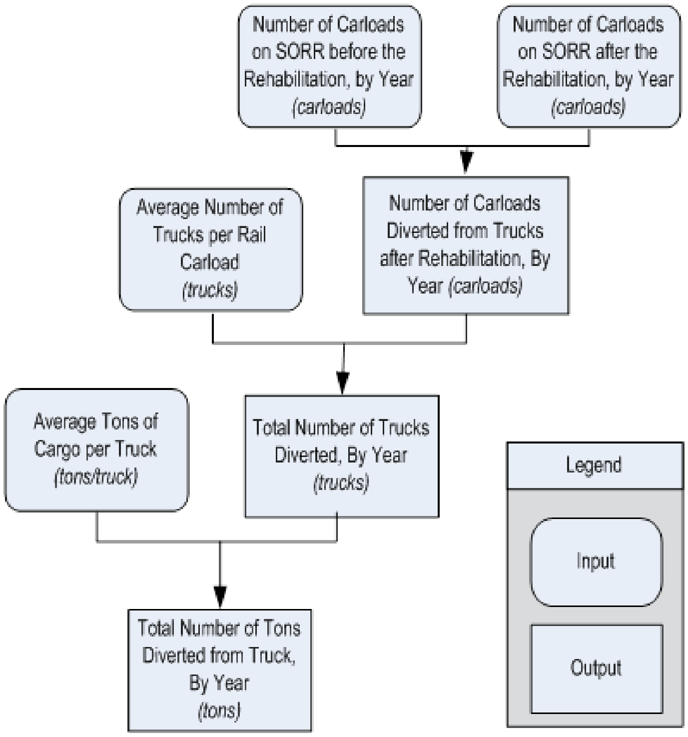
The difference in no-build case carloads and build case carloads is then used to determine the number of diverted (or avoided) on-road trucks. The difference in carloads is multiplied by an average 3.5 trucks/carload to determine the number of avoided trucks. The average number of tons per truck (25 tons/truck) is then multiplied by the number of diverted trucks to determine the number of diverted tons.

In the no-build case, carloads are assumed to divert from Fort Worth, TX to Odessa, TX along the Union Pacific Railroad (UPRR) a distance of 321 miles. From Odessa, TX the carloads are assumed to be transloaded to truck and transported 86 miles to Fort Stockton, TX. The number of diverted truck miles is calculated by multiplying the number of trucks by the truck route mileage of 86 miles. Train miles are calculated as the actual train miles from Fort Worth, TX to Odessa, TX. Truck ton-miles can be calculated by multiplying the truck route (86 miles) by the amount of diverted tons. Train ton-miles can be calculated by multiplying the train route mileage (321 miles) by the amount of diverted tons. Input/assumption sources can be found in Table 3 below. Table 4 provides a summary of the demand projections.

6.1: Methodology

Below in Figure 1 is the structure and logic model of the key demand components on which the studied impacts are based, diverted trucks and diverted tons.

Figure 1: Heavy Truck Diversion to Railroad after Rehabilitation



6.2: Assumptions

Table 3 below lists the key assumptions/inputs used in calculating the: number of train carloads (build case), number of train carloads (no-build case), number of diverted trucks (build case), diverted tons, diverted truck miles, and increased (equivalent) train miles.

Table 3: Assumptions used in the Estimation of Demand

Variable Name	Unit	Value	Source/Comment
Rail Route Mileage - Base Case	Miles	321	Based on one-way rail route miles between Fort Worth and Odessa on the UPRR.
Truck Route Mileage - Base Case	Miles	86	Based on one-way route between Odessa and Fort Stockton by truck.
Rail Route Mileage - Alternative Case	Miles	387	Based on the one-way rail route miles between Fort Worth and Fort Stockton on the FWW and SORR.
Number of Carloads / Train	Carloads	80	TxDOT provided.
Average Tons of Cargo per Truck	Tons/Truck	25	Capacity hauling in pneumatic trucks.
Average Number of Trucks per Rail Carload	Truckloads/ Train carload	3.5	HDR Calculated Average.

6.3: Demand Projections

The resulting projections for the number of train carloads (build case), number of train carloads (no-build case), number of diverted trucks (build case), diverted tons, diverted truck miles, and increased (equivalent) train miles are presented in the table below. Section 10.2 also shows a year by year breakdown of these projections.

Table 4: Demand Projections

Category	Unit	In Project Opening Year (2017)	2025	2036
Number of Train Carloads (Build Case)	# Carloads/year	13,128	16,630	23,019
Number of Train Carloads (No-Build Case)	# Carloads/year	11,427	0	0
Number of Diverted Trucks (Build case)	# Trucks/year	5,951	58,204	80,568
Total Tons of Cargo Diverted	tons	148,778	1,455,101	2,014,200
Total Truck Mileage Diverted - Base Case	truck-miles	146,228	1,430,156	1,979,670
Total Train Mileage Diverted - Base Case	train-miles	6,823	66,727	92,365

Section 7: Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Table 2 (Expected Effects on Long Term Outcomes and Benefit Categories) and provides an overview of the associated methodology, assumptions, and estimates.

7.1: State of Good Repair

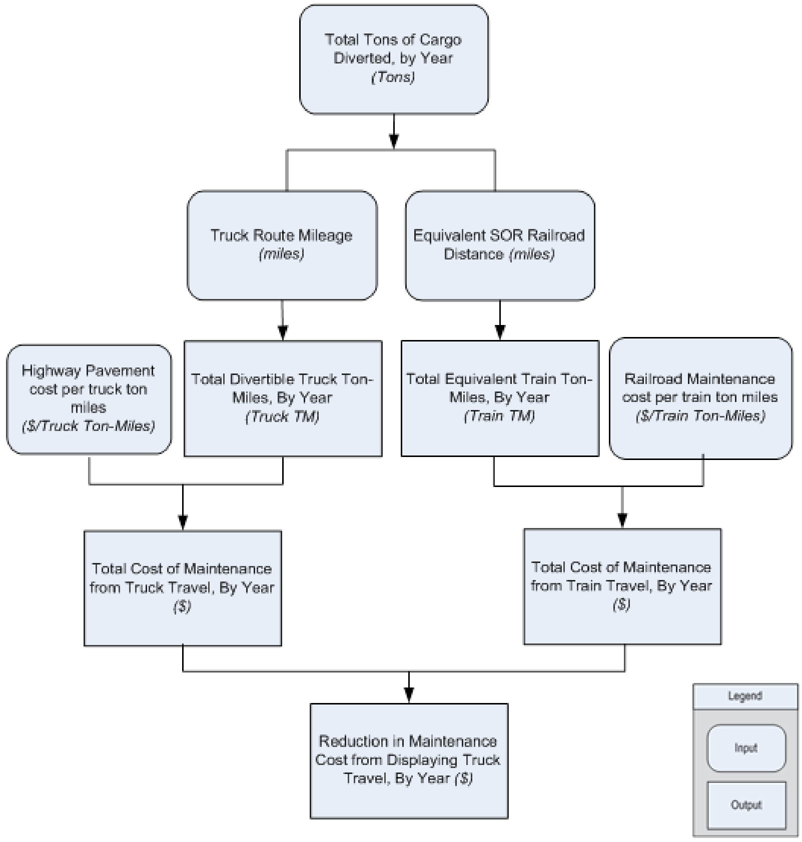
To quantify the benefits associated with maintaining the existing transportation network in a state of good repair, *Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail* is monetized.

7.1.1 Methodology

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail

An avoidance of heavy trucks on the highway system reduces highway maintenance costs and in particular pavement re-surfacing and maintenance costs. Typically, this benefit is realized in terms of increased cycle times between maintenance work orders. This benefit category captures the reduced maintenance cost associated with diverting goods from truck to rail. The total diverted truck ton-miles are applied to highway maintenance cost per truck ton-mile to calculate highway maintenance costs. Figure 2 below provides the structure and logic (S&L) diagram for the calculation.

Figure 2: Reduction in Highway Maintenance S&L



7.1.2 Assumptions

The assumptions used in the estimation of State-of-Good-Repair benefits are summarized in the table below.

Table 5: Assumptions used in the Estimation of State-of-Good-Repair Benefits

Variable Name	Unit	Value	Source
Pavement maintenance cost per truck ton-mile	2013$/ton-mile	$0.01637	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000. Assumes 90 percent rural truck traffic.
Pavement maintenance cost per train ton-mile	2013$/ton-mile	$0	HDR Calculations. Rail maintenance costs are captured in the rail rates and passed on to the shipper.
Truck Route Mileage	Miles	86	Based on one-way route between Odessa and Fort Stockton by truck.

7.1.3 Benefit Estimates

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail is roughly $171 thousand in the opening year (2016) and exceeds $15.6 million in savings (discounted at 7%) over the study period.

Table 6: Estimates of State-of-Good-Repair Benefits, 2013$

	In Project Opening Year (Discounted 7%)	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$170,968	$39,227,760	$15,603,013

7.2: Economic Competitiveness

The proposed project would contribute to enhancing the economic competitiveness of the Nation through improvements in the mobility of goods within and across the study area. In this analysis, two measures of mobility are presented: *Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time)* and out-of-pocket *Transportation Cost Savings*.

Generally trucks use the highly developed interstate highway system that provides faster transit times. With faster transit times than rail, a modal shift towards rail increases inventory costs to shippers and receivers of goods. However, rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. This generates a transportation cost savings to shippers/receivers.

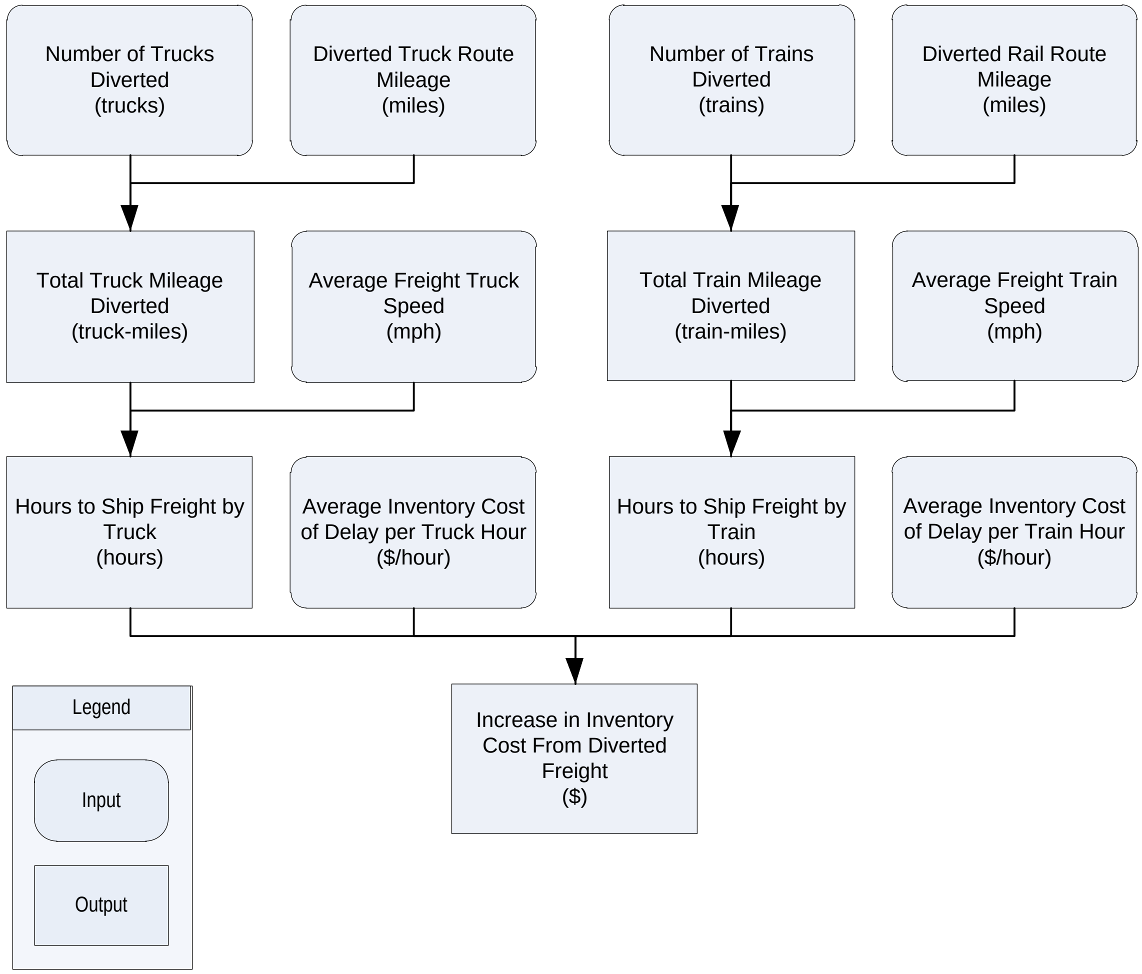
Also presented in this section are estimates of the short-term economic impacts of the project (*7.2.4 Estimation of Short-Term Economic Impacts*), as recommended in the Notice of Funding Availability.

7.2.1 Methodology

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time)

Rail improvements would give shippers the choice/opportunity of shipping by rail. Generally trucks use the highly developed interstate highway system that provides faster transit times and potentially lower inventory costs. With lower truck shipping times, a modal diversion to rail will increase inventory costs. The change in inventory costs due to modal diversion is calculated by applying the time difference in truck and rail shipping to the average inventory cost of transportation time delay per hour. Figure 3 below outlines the model logic used to estimate inventory cost differences.

Figure 3: Change in Inventory Costs S&L

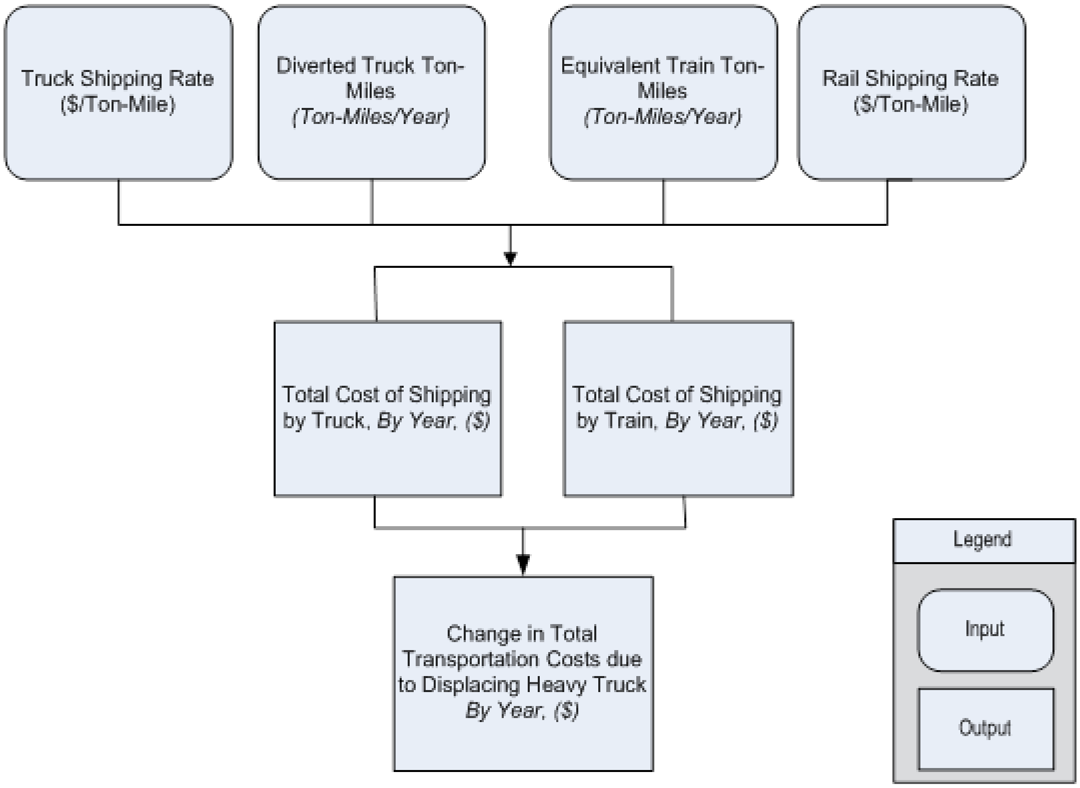


Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail

Rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. As such, diversion of intermodal highway freight to rail can generate cost savings for shippers. The rehabilitation of the SORR will allow shippers another transportation option. Furthermore, these improvements generally improve schedule reliability, one of the key challenges facing a railroad in terms of product delivery. In the absence of such improvements, some shipments would likely be carried by truck at a greater cost to producers.

Transportation cost savings are quantified using the volume of truck ton-miles avoided and relative shipping rates. The benefits in this category are counted as public because the difference in transportation prices between rail intermodal and truckload freight accrue directly to the shipper and receiver lowering the final price consumers pay. Figure 4 below outlines the methodology for quantifying this benefit.[5]

Figure 4: Reduced Transportation Costs S&L



7.2.2 Assumptions

The assumptions used in the estimation of inventory time changes are summarized in the table below.

Table 7: Assumptions used in the Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time) Impacts

Variable Name	Unit	Value	Source
Average Freight Truck Speed	mph	50	Average Truck Speeds in Texas. Federal Highway Administration (FHWA).
Average Freight Train Speed	mph	25	Based on the rehabilitation of the track to FRA Class 2.
Average Inventory Cost of Delay per Truck Hour	2013$/ hour	$0.01 18	HDR Calculation based on an hourly discount rate of .00049%, an average commodity value per ton of $97.36, and an average truck tonnage of 25 tons.
Average Inventory Cost of Delay per Train	2013$/ hour	$3.30 65	HDR Calculation based on an hourly discount rate of .00049%, an average commodity value per ton of

[5] Only 50% of transportation cost savings are included in the analysis to approximate the consumer surplus under the transportation demand curve due to a price reduction.

Variable Name	Unit	Value	Source
Hour			$97.36, and an average train tonnage of 7,000 tons.
Rail Route Mileage - Base Case	miles	321	Based on one-way rail route miles between Fort Worth and Odessa on the UPRR.
Truck Route Mileage - Base Case	miles	86	Based on one-way route between Odessa and Fort Stockton by truck.
Rail Route Mileage - Alternative Case	miles	387	Based on the one-way rail route miles between Fort Worth and Fort Stockton on the FWW and SORR.

The table below provides the inputs used in calculating transportation cost savings.

Table 8: Assumptions used in the Estimation of Out-of-Pocket Transportation Cost Savings

Variable Name	Unit	Value	Source
Average Shipping Rate per ton-Mile, Truck	2013$/truck ton-mile	$0.073	DAT. Average national truck freight rate of $1.82 per mile divided by average truck tonnage of 25 tons.
Average Shipping Rate per ton-Mile, Rail	2013$/rail ton-mile	$0.039	Freight Revenue Per Ton-Mile Adjusted to $2013, BTS. National Transportation Statistics. Table 3-21: Average Freight Revenue Per Ton-Mile.

7.2.3 Benefit Estimates

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail is roughly -$123 in the opening year (2017) and exceeds -$11 thousand (discounted at 7%) over the study period. The numbers are negative, as inventory times are higher for rail. This is a negative impact in the analysis.

Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail is roughly $224 thousand in the opening year (2017) and exceeds $20 million in savings (discounted at 7%) over the study period.

Table 9: Estimates of Inventory Time and Out-of-Pocket Transportation Cost Savings, 2013$

	In Project Opening Year (2017), Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Change in Inventory Costs from Displacing Freight from Rail to Truck	-$123	-$28,280	-$11,249
Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$224,115	$51,422,224	$20,453,414

7.2.4 Estimation of Short-Term Economic Impacts

The Minnesota IMPLAN Group's input-output model has been used to estimate the short-term direct, indirect and induced effects of this project in terms of employment, labor income and value added.

Employment effects represent full-time and part-time jobs created for a full year (unless noted otherwise). Labor income consists of total employee compensation (wage and salary payments, as well as health and life insurance benefits, retirement payments and any other non-cash compensation) and proprietary income (payments received by self-employed individuals as income). Value added represents total business sales (output) minus the cost of purchasing intermediate products and is roughly equivalent to gross regional/domestic product.

Estimated spending on project engineering and construction (capital expenditures) between 2015 and 2016 is used to compute short-term economic impacts.

The project is expected to generate 291.9 job-years during the project development phase. It is also expected to create $22.84 million in value added, including $16.35 million in labor income. A breakdown of short-term impacts by type of effect (direct, indirect and induced) is provided in the table below.

Table 10: Project Spending and Economic Impacts (Direct, Indirect and Induced) during Project Development Phase

	Spending (Millions of 2013 Dollars)*	Direct	Indirect	Induced	Total
Employment*	$15.31	132.6	56.6	102.7	291.9
Labor Income**		$7.81	$3.55	$5.00	$16.35
Value Added**		$8.35	$5.62	$8.87	$22.84

*Note: * Employment impacts from IMPLAN reflect total employment (full time plus part time). On average, the ratio of FTE to total employment is estimated at 90 percent. **Millions of 2013 Dollars.*

Another method to estimate job-years from additional spending uses the Council of Economic Advisors' (CEA) methodology as presented in a 2011 analysis[6]. This method assumes that for every $78,050 of government spending, one job-year is created. The following table shows the difference in job-year estimates using the IMPLAN and CEA methodologies.

[6] Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009; and September 2011 Update.

Note that the estimated employment impacts are lower when using CEA's approach. Specifically, the simplified computation produces a more conservative estimate of 196.2 job-years.

Table 11: Project Spending and Job-Year Estimates with IMPLAN and CEA Methodologies

	Spending (Millions of 2013 Dollars)	Direct	Indirect	Induced	Total
IMPLAN *	$15.31	132.6	56.6	102.7	291.9
CEA		125.6		70.6	196.2

*Note: * Employment impacts from IMPLAN should not be interpreted as full-time equivalent (FTE) as they reflect the mix of full and part time jobs that is typical for each sector.*

A breakdown of short-term economic impacts (using IMPLAN estimates) in terms of employment (job-hours), labor income and value added is provided by quarter in the table below.

Table 12: Project Spending and Short-Term Economic Impacts by Quarter

Period	Spending (Millions of 2013 Dollars)*	Total Job-Hours**	Direct Job-Hours**	Total Labor Income (Millions of 2013 Dollars)	Total Value Added (Millions of 2013 Dollars)
2015 - Q1	$1.68	57,623.3	26,167.3	$1.80	$2.51
2015 - Q2	$4.13	141,439.0	64,228.8	$4.42	$6.17
2015 - Q3	$4.13	141,439.0	64,228.8	$4.42	$6.17
2015 - Q4	$4.29	146,677.4	66,607.6	$4.58	$6.39
2016 - Q1	$1.07	36,669.4	16,651.9	$1.14	$1.60
Total	**$15.31**	**523,848.0**	**237,884.4**	**$16.35**	**$22.84**

*Notes: * includes engineering ($932,000) and construction ($14.38 million); ** assuming average weekly hours of 34.5 (Bureau of Labor Statistics estimate).*

The table below presents the short-term increase in employment and labor income resulting from capital expenditures in key industries employing low-income people. 47.5 cumulative job-years (or 16.3 percent of total job-years) are expected to be created in those industries by the end of 2016, bringing in an additional $1.44 million in labor income.

Table 13: Short-Term Impacts in Key Industries Employing Low-Income People

Sectors	Employment (Job-Years)	Labor Income (Millions of 2013 Dollars)
Retail Industries	19.7	$0.66
Services to buildings and dwellings	3.2	$0.08
Other business services	2.9	$0.10
Food services and drinking places	11.4	$0.26
Hotel/accommodation services	1.6	$0.06
Personal care and other personal Services	8.7	$0.28
Total	**47.5**	**$1.44**

Note: Low-income sectors are identified in BLS, A Profile of the Working Poor, March 2009; BLS, Characteristics of Minimum Wage Workers, March 2009; and Carsey Institute, Issue Brief No. 2, Summer 2008.

7.3: Quality of Life

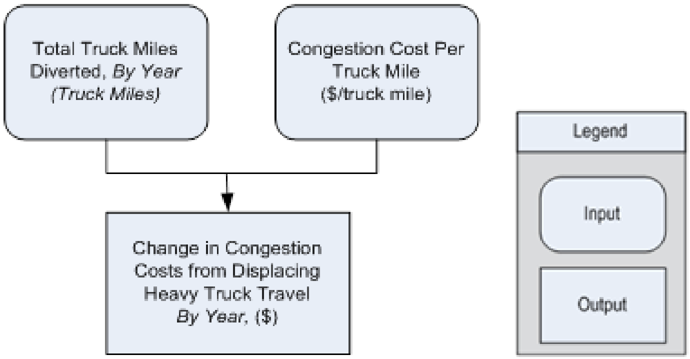
The proposed project would contribute to enhancing livability and quality of life in the study area through the reduction in highway congestion from displacing heavy truck travel to rail. This represents the time savings of the remaining on-road motorists.

7.3.1 Methodology

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail

The proposed SORR project will divert freight from road to rail resulting in a reduction in the use of public highways by heavy trucks. This benefit category estimates the avoided highway congestion costs by applying the total diverted truck miles to a rate of congestion cost per mile. Figure 5 outlines the structure and logic model of the benefit calculation.

Figure 5: Reduction in Highway Congestion Costs



7.3.2 Assumptions

The assumptions used in the estimation of quality of life benefits are summarized in the table below.

Table 14: Assumptions used in the Estimation of Quality of Life Benefits

Variable Name	Unit	Value	Source
Congestion Cost per Truck Mile	2013$/mile	$0.1188	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000. Quoted in: National Highway Traffic Safety Administration, "Corporate Average Fuel Economy for FY 2011 Passenger Cars and Light Trucks", March 2009, Table VIII-5, page VIII-60

7.3.3 Benefit Estimates

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail is roughly $14k in the opening year (2017) and exceeds $1.3 Million in savings (discounted at 7%) over the study period.

Table 15: Estimates of Quality of Life Benefits, 2013$

	In Project Opening Year (2017), Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$14,178	$3,253,079	$1,293,926

7.4: Environmental Sustainability

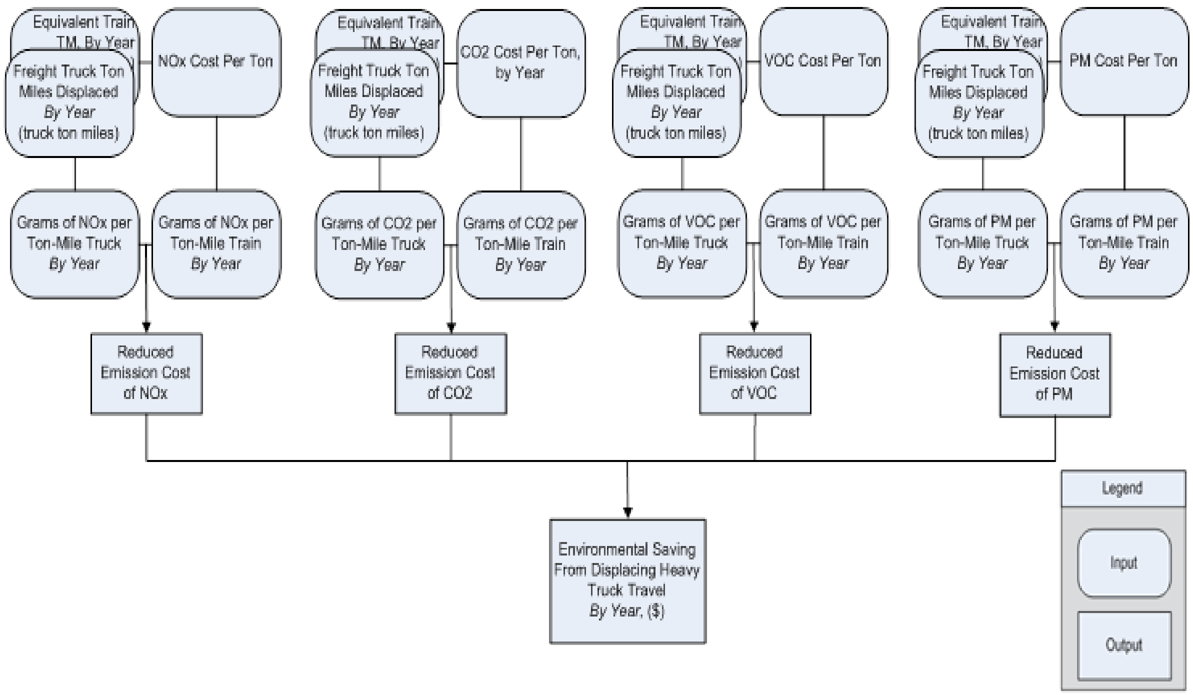
The proposed project would contribute to environmental sustainability through Emission Savings from Diverting Heavy Truck Travel to Rail.

7.4.1 Methodology

Emission Savings from Diverting Heavy Truck Travel to Rail

Freight carried over the rail network imposes less environmental impacts for the same amount of cargo than those imposed by trucks on the highway network. This benefit category estimates the value of the reduced environmental emissions associated with transporting goods on rail as opposed to by truck. The amount of greenhouse gas (GHG) and criteria air contaminants (CAC) are calculated on the basis of pollutants generated per ton-mile travelled by truck and train shipping in the base and alternative cases. The monetized value of environmental savings is then calculated by applying the social cost of emissions to the relative difference in truck versus rail emissions. The structure and logic model outlining this calculation is provided in Figure 6.

Figure 6: Emission Savings S&L



7.4.2 Assumptions

The assumptions used in the estimation of sustainability benefits are summarized in the table below.

Table 16: Assumptions used in the Estimation of Environmental Sustainability Benefits

Variable Name	Unit	Value	Source
Grams of NOx per truck ton-mile - 2013	grams/ TM	0.472	EPA's MOVES model. Calculated grams/gallon emission factors converted to grams/ton-mile by dividing by an average efficiency of 130 freight ton miles per gallon, per the Rocky Mountain Institute, Transformational Trucking Charette. This calculation assumes a current tractor-trailer combination loaded getting 6.5 mpg. No empty backhaul is assumed. Amount decreases annually due to realized

Variable Name	Unit	Value	Source
			efficiencies.
Grams of NOx per train ton-mile - 2013	grams/ TM	0.290	United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009. Gram/gallon values are converted to grams/ton-mile by dividing an average efficiency 480 freight ton miles per gallon. (2009 U.S. average data source in “The Economic Impact of America’s Freight Railroads”, Association of American Railroad (AAR), May 2010. Amount decreases annually due to realized efficiencies.
Grams of CO2 per truck ton-mile - 2013	grams/ TM	102.909	Same source as NOX truck emission rate.
Grams of CO2 per train ton-mile - 2013	grams/ TM	21.267	Same source as NOX train emission rate.
Grams of PM per truck ton-mile - 2013	grams/ TM	0.0182	Same source as NOX truck emission rate.
Grams of PM per train ton-mile - 2013	grams/ TM	0.0079	Same source as NOX train emission rate.
Grams of VOC per truck ton-mile - 2013	grams/ TM	0.043	Same source as NOX truck emission rate.
Grams of VOC per train ton-mile - 2013	grams/ TM	0.0143	Same source as NOX train emission rate.
NOx cost per ton	2013$/ short ton	$7,877	TIGER VI guidelines. Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations
CO2 cost per ton - 2014	2013$/ short ton	$36	TIGER VI guidelines. Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations
PM cost per ton	2013$/ short ton	$360,383	TIGER VI guidelines. Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations

Variable Name	Unit	Value	Source
VOC cost per ton	2013$/ short ton	$1,999	TIGER VI guidelines. Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations

7.4.3 Benefit Estimates

Emission Savings from Diverting Heavy Truck Travel to Rail is roughly $329 thousand in the opening year (2017) and exceeds $21.1 Million in savings (discounted at 7%) over the study period.

Table 17: Estimates of Environmental Sustainability Benefits, 2013$

	In Project Opening Year (Discounted at 7%)	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Emission Savings from Diverting Heavy Truck Travel to Rail	$328,876	$50,479,065	$21,092,513

7.5: Safety

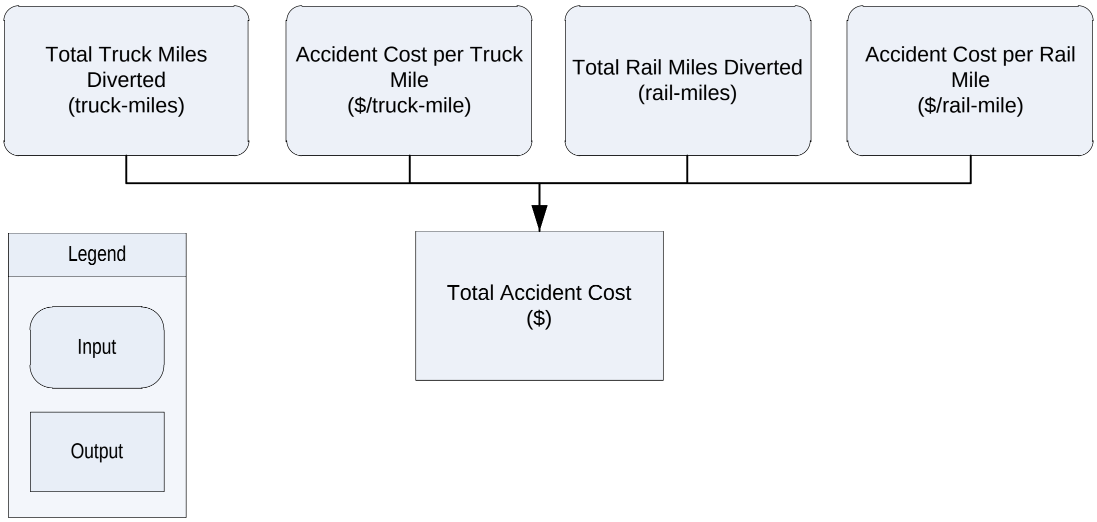
The proposed project would contribute to promoting DOT's safety long-term outcome through a reduction in accident costs (through reduced fatalities and injuries) from diverting heavy truck travel to rail.

7.5.1 Methodology

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail

Fatality and injury rates per mile of freight carried by truck are greater than the fatality and injury rates for an equal volume of cargo when shipped by rail. This benefit captures the different accident rates per truck-mile and train-mile. The accident value used here is recommended by TIGER Guidelines and is based on accident rate data published by the US DOT, Bureau of Transportation Statistics. The logic model outlining this calculation is provided in Figure 7 below.

Figure 7: Reduced Accident Costs S&L



7.5.2 Assumptions

The assumptions used in the estimation of safety benefits are summarized in the table below.

Table 18: Assumptions used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Accident Cost per Truck Mile	2013$/truck miles	$0.23	HDR Calculations based on TIGER Guidelines for Accident Values. US DOT, Bureau of Transportation Statistics for accident data and mileage statistics.
Accident Cost per Train Mile	2013$/train miles	$7.46	HDR Calculations based on TIGER Guidelines for Accident Values. US DOT, Bureau of Transportation Statistics for accident data and mileage statistics.

7.5.3 Benefit Estimates

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail is roughly $18 thousand in the opening year (2017) and roughly $1.7 Million in savings (discounted at 7%) over the study period.

Table 19: Estimates of Safety Benefits, 2013$

	In Project Opening Year. Discounted at 7 Percent	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$18,465	$4,236,805	$1,685,208

Section 8: Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project (2014 through 2036). As stated earlier, construction is expected to be completed by the end of 2016. Benefits accrue during the full operation of the project (2017 through 2036).

*Table 20: Overall Results of the Benefit-Cost Analysis, 2013$**

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$60,116,825	$98,608,031
Total Discounted Costs	$14,557,698	$15,399,370
Net Present Value	$45,559,127	$83,208,662
Benefit / Cost Ratio	4.13	6.40
Internal Rate of Return (%)	24.1%	
Payback Period (years)	5.0	

** Unless Specified Otherwise*
*** Includes incremental O&M costs and construction/capital costs.*

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 24.1 percent. With a 7 percent real discount rate, the $14.6 million investment would result in $45.6 million in total benefits and a Benefit/Cost ratio of approximately 4.13 to 1.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $83.2 million, for a Benefit/Cost ratio of 6.40.

Table 21: Benefit Estimates by Long-Term Outcome over the study period, 2013$

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$15,603,013	$25,843,478
Economic Competitiveness*	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$20,453,414	$33,877,263
	Change in Inventory Costs from Displacing Freight from Rail to Truck	-$11,249	-$18,631
Quality of Life	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$1,293,926	$2,143,147

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	$21,092,513	$33,971,543
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$1,685,208	$2,791,232
Total Benefit Estimates		**$60,116,825**	**$98,608,031**

Section 9: BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections; both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Build Case (as defined in section 4.1) using a 7 percent discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

For example, a 15 percent reduction in Rail and Trucking Shipping Rates leads to a 7.5 percent reduction in the project NPV.

Table 22: Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV (7% discounted)	Change in NPV	New B/C Ratio (7% discounted)
Annual Build Carload Growth (Current Rate: 3%/Year)	1.5% Annual Growth	$37,414,433	-18.6%	3.57
	4.5% Annual Growth	$55,521,802	22.0%	4.81
Rail and Trucking Shipping Rates	Decrease by 15%	$42,641,167	-6.7%	3.93
	Increase by 15%	$48,777,192	6.7%	4.35

Section 10: Supplementary Data Tables

This section provides annual benefit estimates associated with the five long-term outcome criteria (State of Good Repair, Economic Competiveness, Quality of Life, Sustainability, and Safety) for the SORR rehabilitation project from Sulphur Junction to Fort Stockton (Build Case). Supplementary data tables are also provided for some specific benefit categories. For example, tables providing estimates of annual emission reductions (in tons) are provided under Environmental Sustainability.

10.1: Annual Estimates of Total Project Benefits and Costs

Calendar Year	Project Year	Total Benefits ($2013), Undiscounted	Total Costs ($2013), Undiscounted	Undiscounted Net Benefits ($2013)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2014	1	$0	$0	$0	$0	$0
2015	2	$0	$14,251,057	-$14,251,057	-$13,318,745	-$13,835,978
2016	3	$0	$1,034,700	-$1,034,700	-$903,747	-$975,304
2017 (opening)	4	$926,719	-$26,191	$952,910	$777,859	$872,048
2018	5	$1,115,316	-$26,191	$1,141,507	$870,850	$1,014,214
2019	6	$1,304,394	-$26,191	$1,330,585	$948,689	$1,147,774
2020	7	$7,349,399	-$26,191	$7,375,589	$4,914,667	$6,176,940
2021	8	$7,466,536	$68,000	$7,398,536	$4,607,436	$6,015,687
2022	9	$7,556,870	$68,000	$7,488,870	$4,358,591	$5,911,783
2023	10	$7,689,346	$68,000	$7,621,346	$4,145,507	$5,841,127
2024	11	$7,791,135	$68,000	$7,723,135	$3,926,050	$5,746,738
2025	12	$7,958,765	$68,000	$7,890,765	$3,748,846	$5,700,457
2026	13	$8,087,264	$68,000	$8,019,264	$3,560,649	$5,624,551
2027	14	$8,254,184	$68,000	$8,186,184	$3,396,975	$5,574,393
2028	15	$8,427,512	$68,000	$8,359,512	$3,241,963	$5,526,622
2029	16	$8,565,539	$68,000	$8,497,539	$3,079,899	$5,454,247
2030	17	$8,751,897	$68,000	$8,683,897	$2,941,536	$5,411,517
2031	18	$8,990,308	$68,000	$8,922,308	$2,824,574	$5,398,143
2032	19	$9,201,054	$68,000	$9,133,054	$2,702,141	$5,364,707
2033	20	$9,418,056	$68,000	$9,350,056	$2,585,368	$5,332,206
2034	21	$9,641,780	$68,000	$9,573,780	$2,474,047	$5,300,770
2035	22	$9,923,108	$68,000	$9,855,108	$2,380,137	$5,297,606
2036	23	$10,171,468	$68,000	$10,103,468	$2,280,486	$5,272,924
Total		$138,419,184	$16,200,995	$122,218,189	$43,263,293	$77,900,248

10.2: Annual Demand Projections

Calendar Year	Project Year	Train Carloads (Build Case)	Train carloads (No-Build Case)	Diverted Trucks (to rail in build case)*	Diverted Tons (to rail in build case)**	Diverted Truck Miles***	Diverted Train Miles****
2017 (opening)	4	13,128	11,427	5,951	148,778	146,228	6,823
2018	5	13,521	11,427	7,330	183,238	180,097	8,403
2019	6	13,927	11,427	8,749	218,732	214,982	10,030
2020	7	14,345	0	50,207	1,255,183	1,233,665	57,559
2021	8	14,775	0	51,714	1,292,838	1,270,675	59,286
2022	9	15,219	0	53,265	1,331,623	1,308,795	61,064
2023	10	15,675	0	54,863	1,371,572	1,348,059	62,896
2024	11	16,145	0	56,509	1,412,719	1,388,501	64,783
2025	12	16,630	0	58,204	1,455,101	1,430,156	66,727
2026	13	17,129	0	59,950	1,498,754	1,473,061	68,729
2027	14	17,642	0	61,749	1,543,716	1,517,253	70,790
2028	15	18,172	0	63,601	1,590,028	1,562,770	72,914
2029	16	18,717	0	65,509	1,637,729	1,609,653	75,102
2030	17	19,278	0	67,474	1,686,860	1,657,943	77,355
2031	18	19,857	0	69,499	1,737,466	1,707,681	79,675
2032	19	20,452	0	71,584	1,789,590	1,758,912	82,065
2033	20	21,066	0	73,731	1,843,278	1,811,679	84,527
2034	21	21,698	0	75,943	1,898,576	1,866,029	87,063
2035	22	22,349	0	78,221	1,955,534	1,922,010	89,675
2036	23	23,019	0	80,568	2,014,200	1,979,670	92,365

** Diverted Trucks = Difference in Build and No Build Carloads multiplied by the number of trucks per carload (3.5). ** Diverted Tons = Number of Trucks multiplied by the average tonnage per truck.*** Number of Trucks multiplied by the distance travelled. **** Number of trains multiplied by the rail route distance.*

10.3: State of Good Repair: Annual Benefit Estimates

Calendar Year	Project Year	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Discounted 3%
2017 (opening)	4	$209,443	$170,968	$191,670
2018	5	$257,954	$196,792	$229,189
2019	6	$307,921	$219,543	$265,615
2020	7	$1,766,987	$1,177,418	$1,479,824
2021	8	$1,819,997	$1,133,402	$1,479,824
2022	9	$1,874,597	$1,091,032	$1,479,824
2023	10	$1,930,834	$1,050,246	$1,479,824
2024	11	$1,988,759	$1,010,984	$1,479,824
2025	12	$2,048,422	$973,191	$1,479,824
2026	13	$2,109,875	$936,810	$1,479,824
2027	14	$2,173,171	$901,789	$1,479,824
2028	15	$2,238,366	$868,077	$1,479,824
2029	16	$2,305,517	$835,626	$1,479,824
2030	17	$2,374,683	$804,387	$1,479,824
2031	18	$2,445,923	$774,317	$1,479,824
2032	19	$2,519,301	$745,370	$1,479,824
2033	20	$2,594,880	$717,506	$1,479,824
2034	21	$2,672,726	$690,683	$1,479,824
2035	22	$2,752,908	$664,863	$1,479,824
2036	23	$2,835,495	$640,009	$1,479,824
Total		$39,227,760	$15,603,013	$25,843,478

10.4: Economic Competitiveness: Annual Benefit Estimates

Calendar Year	Project Year	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Undiscounted	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Discounted 7%	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Discounted 3%	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Discounted 3%
2017 (opening)	4	$274,551	$224,115	$251,253	-$151	-$123	-$138
2018	5	$338,142	$257,967	$300,435	-$186	-$142	-$165
2019	6	$403,642	$287,791	$348,185	-$222	-$158	-$191
2020	7	$2,316,278	$1,543,434	$1,939,846	-$1,274	-$849	-$1,067
2021	8	$2,385,766	$1,485,735	$1,939,846	-$1,312	-$817	-$1,067
2022	9	$2,457,339	$1,430,194	$1,939,846	-$1,351	-$787	-$1,067
2023	10	$2,531,060	$1,376,729	$1,939,846	-$1,392	-$757	-$1,067
2024	11	$2,606,991	$1,325,262	$1,939,846	-$1,434	-$729	-$1,067
2025	12	$2,685,201	$1,275,720	$1,939,846	-$1,477	-$702	-$1,067
2026	13	$2,765,757	$1,228,029	$1,939,846	-$1,521	-$675	-$1,067
2027	14	$2,848,730	$1,182,122	$1,939,846	-$1,567	-$650	-$1,067
2028	15	$2,934,192	$1,137,930	$1,939,846	-$1,614	-$626	-$1,067
2029	16	$3,022,218	$1,095,391	$1,939,846	-$1,662	-$602	-$1,067
2030	17	$3,112,884	$1,054,442	$1,939,846	-$1,712	-$580	-$1,067
2031	18	$3,206,271	$1,015,023	$1,939,846	-$1,763	-$558	-$1,067
2032	19	$3,302,459	$977,078	$1,939,846	-$1,816	-$537	-$1,067
2033	20	$3,401,533	$940,552	$1,939,846	-$1,871	-$517	-$1,067
2034	21	$3,503,578	$905,391	$1,939,846	-$1,927	-$498	-$1,067
2035	22	$3,608,686	$871,545	$1,939,846	-$1,985	-$479	-$1,067
2036	23	$3,716,946	$838,964	$1,939,846	-$2,044	-$461	-$1,067
Total		$51,422,224	$20,453,414	$33,877,263	-$28,280	-$11,249	-$18,631

10.5: Quality of Life: Annual Benefit Estimates

Calendar Year	Project Year	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Discounted, 3%
2017 (opening)	4	$17,369	$0	$0
2018	5	$21,392	$14,178	$15,895
2019	6	$25,535	$16,320	$19,006
2020	7	$146,533	$18,206	$22,027
2021	8	$150,929	$97,641	$122,719
2022	9	$155,457	$93,991	$122,719
2023	10	$160,120	$90,477	$122,719
2024	11	$164,924	$87,095	$122,719
2025	12	$169,872	$83,839	$122,719
2026	13	$174,968	$80,705	$122,719
2027	14	$180,217	$77,688	$122,719
2028	15	$185,623	$74,784	$122,719
2029	16	$191,192	$71,988	$122,719
2030	17	$196,928	$69,297	$122,719
2031	18	$202,835	$66,706	$122,719
2032	19	$208,921	$64,213	$122,719
2033	20	$215,188	$61,812	$122,719
2034	21	$221,644	$59,501	$122,719
2035	22	$228,293	$57,277	$122,719
2036	23	$235,142	$55,136	$122,719
Total		$3,253,079	$1,240,852	$2,020,429

10.6: Environmental Sustainability: Annual Benefit Estimates

Calendar Year	Project Year	Emission Savings from Diverting Heavy Truck Travel to Rail, Undiscounted	Emission Savings from Diverting Heavy Truck Travel to Rail, Discounted 7%	Emission Savings from Diverting Heavy Truck Travel to Rail, Discounted 3%
2017 (opening)	4	$402,887	$328,876	$368,699
2018	5	$470,154	$358,678	$417,726
2019	6	$534,262	$380,921	$460,859
2020	7	$2,930,031	$1,952,403	$2,453,855
2021	8	$2,914,587	$1,815,058	$2,369,826
2022	9	$2,868,363	$1,669,413	$2,264,312
2023	10	$2,860,183	$1,555,750	$2,192,092
2024	11	$2,817,098	$1,432,070	$2,096,185
2025	12	$2,835,507	$1,347,129	$2,048,430
2026	13	$2,810,308	$1,247,810	$1,971,093
2027	14	$2,818,919	$1,169,751	$1,919,547
2028	15	$2,829,189	$1,097,208	$1,870,427
2029	16	$2,799,266	$1,014,583	$1,796,743
2030	17	$2,812,636	$952,737	$1,752,742
2031	18	$2,872,870	$909,477	$1,738,134
2032	19	$2,900,093	$858,033	$1,703,499
2033	20	$2,928,065	$809,635	$1,669,835
2034	21	$2,957,090	$764,168	$1,637,269
2035	22	$3,037,877	$733,687	$1,633,008
2036	23	$3,079,680	$695,124	$1,607,262
Total		$50,479,065	$21,092,513	$33,971,543

10.7: Safety: Annual Benefit Estimates

Calendar Year	Project Year	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Undiscounted	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Discounted 7%	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Discounted 3%
2017 (opening)	4	$22,621	$18,465	$20,701
2018	5	$27,860	$21,255	$24,754
2019	6	$33,257	$23,712	$28,688
2020	7	$190,844	$127,167	$159,829
2021	8	$196,569	$122,413	$159,829
2022	9	$202,466	$117,837	$159,829
2023	10	$208,540	$113,432	$159,829
2024	11	$214,796	$109,192	$159,829
2025	12	$221,240	$105,110	$159,829
2026	13	$227,878	$101,180	$159,829
2027	14	$234,714	$97,398	$159,829
2028	15	$241,755	$93,757	$159,829
2029	16	$249,008	$90,252	$159,829
2030	17	$256,478	$86,878	$159,829
2031	18	$264,173	$83,630	$159,829
2032	19	$272,098	$80,504	$159,829
2033	20	$280,261	$77,494	$159,829
2034	21	$288,669	$74,597	$159,829
2035	22	$297,329	$71,809	$159,829
2036	23	$306,248	$69,124	$159,829
Total		$4,236,805	$1,685,208	$2,791,232

This report was written on behalf of the Texas Department of Transportation by

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