Appendix K

Benefit Cost Analysis

Lead applicant
Iowa Department of Transportation

Partnering agency
Minnesota Department of Transportation

IOWA DEPARTMENT OF TRANSPORTATION

UPPER MIDWEST TRANSPORTATION HUB AT MANLY, IOWA

TIGER DISCRETIONARY GRANTS PROGRAM

ECONOMIC ANALYSIS SUPPLEMENTARY DOCUMENTATION

JUNE 2, 2015

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1. Executive Summary

This TIGER Grant application is for infrastructure construction for the Upper Midwest Transportation Hub (UMTH) Project at Manly, Iowa. This project consists of the construction of infrastructure that will provide an intermodal facility and rail support for transloading highway trailers and shipping containers. The development will serve an approximately 150 mile radius encompassing north central Iowa, southern Minnesota, and a portion of western Wisconsin where little useful intermodal service is currently available.

Manly is currently the home of an approximately 350 acre campus that already serves as a major transportation hub; the long term potential for continued growth of this transportation hub is considerable. The project planned for this TIGER Grant is all contained within the existing transportation campus.

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

1) improving freight rail efficiency and capacity,
2) diverting existing freight from truck to rail,
3) reducing truck miles traveled,
4) reducing highway maintenance costs,
5) reducing transportation costs,
6) reducing congestion costs,
7) reducing accident costs (fatalities and injuries), and
8) job creation.

The overall project is designed to provide an independent, high service and lower cost package of rail, truck and intermodal logistics for Iowa and Minnesota manufacturers, producers and consumers, with the particular portion of the project directly providing lower cost access to domestic and international intermodal service to a large and growing number of shippers/receivers that do not currently have such cost-competitive access. This project will result in reducing the time, distance and related costs for shippers and receivers in the region to access the national and international intermodal network. That will allow existing and potential shippers, receivers and consumers in this region a more equal and competitive access to the world marketplace.

Minnesota DOT, as a partnering agency, has joined with the Iowa Department of Transportation (the lead applicant) in this application because the benefits of the proposed intermodal facility, located approximately 14 miles south of the Iowa/Minnesota border, will be distributed amongst both states as part of a regional solution to limited intermodal transportation options.

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

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternative	Type of Impacts	Population Affected by Impacts	Benefits	Summary of Results ($2014, 7% Discounted, Millions)	Page #
The region served by (UMTH) suffers from a serious lack of nearby intermodal infrastructure and service. There also exists a sever container imbalance situation from too little inbound containers, causing high dray costs. Declining truckload capacity and increasing costs has become a concern. Also, no direct, competitive, time sensitive intermodal service to US Eastern Seaboard, Texas-Mexico and California exists to this region.	The construction of a full-service intermodal facility.	Reduced Highway Maintenance Costs from truck diversion to rail.	Federal and State (various) Governments	Monetized Maintenance Savings.	$133.1	19
		Reduced Transportation Costs from truck diversion to rail.	Goods Shippers	Monetized Shipping Savings.	$118.9	24
		Short-Term Economic Impacts from construction/planning expenditure.	Local Citizens and Businesses	Job years, income etc.	*Pg 24*	25
		Reduction in Highway Congestion from truck diversion to rail	On Road Motorists Using Trucking Routes	Monetized Reduced Congestion Savings.	$83.3	29
		Reduced Emissions from truck diversion to rail.	Iowa	Monetized Reduced Pollution.	$19.9	39
		Reduced Accident Costs from truck diversion to rail.	Motorists/ Railway Travelers Between Fort Stockton and Fort Worth Texas.	Monetized Increased injuries and fatalities.	$426.5	42

The period of analysis used in the estimation of benefits and costs is 24 years, including 2 years of construction and 22 years of operation. The total project capital costs are $16.17M in nominal terms, and are expected to be financed by Federal (TIGER) and private funds from Iowa Northern Railway Company (IANR) and UMTH, LLC according to the distribution shown in Table ES-2 below.

Table ES-2: Summary of Project Costs and Anticipated Funding Sources, 2014$

Funding Source	Capital/Construction	Percent of Total Capital Cost Financed by Source
Federal (TIGER)	$ 7,100,000	43.92%
Private (IANR/UMTH,LLC)	$ 9,065,137	56.08%
TOTAL	**$16,165,137**	**100%**

A summary of the relevant outcomes and partial calculations leading to project evaluation metrics are shown in Table ES-3 (in 2014 dollars). Based on the Benefit Cost Analysis presented in the rest of this document, the project is expected to generate $781.8 million in discounted benefits and $139.0 million in discounted costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $642.3 million and a Benefit/Cost Ratio of 5.62.

Table ES-3: Summary of Pertinent Data, Quantifiable Benefits and Costs

Calendar Year	Project Year	Total Direct Beneficiaries	Total Benefits ($2014)	Total Costs ($2014)	Undiscounted Net Benefits ($2014)	Discounted Net Benefits at 7%
2015	1	Shippers, vehicle operators, rail operators, other users of roads, and local residents	$0	-$1,617,014	-$1,617,014	-$1,617,014
2016	2		$0	-$14,553,124	-$14,553,124	-$13,601,050
2017 (opening)	3		$1,667,397	-$410,000	$1,257,397	$1,098,259
2018	4		$35,314,843	-$6,072,000	$29,242,843	$23,870,871
2019	5		$49,593,730	-$7,888,500	$41,705,230	$31,816,720
2020	6		$55,260,259	-$9,303,930	$45,956,329	$32,766,227
2021	7		$64,069,144	-$11,014,720	$53,054,423	$35,352,402
2022	8		$75,614,546	-$13,062,999	$62,551,547	$38,953,960
2023	9		$84,966,486	-$14,474,878	$70,491,608	$41,026,758
2024	10		$93,463,651	-$16,009,933	$77,453,719	$42,129,691
2025	11		$91,657,572	-$15,973,325	$75,684,248	$38,474,034
2026	12		$93,248,996	-$16,001,033	$77,247,962	$36,699,950
2027	13		$95,092,310	-$15,029,389	$80,062,921	$35,548,894
2028	14		$96,931,664	-$15,058,136	$81,873,528	$33,974,604
2029	15		$98,704,518	-$15,092,093	$83,612,425	$32,426,340
2030	16		$100,560,626	-$15,131,113	$85,429,513	$30,963,587
2031	17		$102,542,857	-$15,175,055	$87,367,802	$29,594,497
2032	18		$104,576,447	-$15,223,785	$89,352,662	$28,286,764
2033	19		$106,587,662	-$15,277,175	$91,310,487	$27,015,478
2034	20		$108,676,562	-$15,335,102	$93,341,461	$25,809,692
2035	21		$110,813,788	-$15,397,449	$95,416,339	$24,657,395
2036	22		$112,973,244	-$15,464,106	$97,509,138	$23,549,733
2037	23		$115,122,163	-$15,534,965	$99,587,198	$22,478,142
2038	24		$117,389,150	-$15,609,926	$101,779,223	$21,470,010
Total			**$1,914,827,614**	**-$309,709,747**	**$1,605,117,867**	**$642,745,945**

A summary of the monetized benefits of the UMTH project are included below in Table ES-4.

Table ES-4: Summary of Monetized Benefits, in Million of 2014$

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Avoided Pavement Maintenance Costs	$133.1	$214.5
Economic Competitiveness	Shipper Savings due to Modal Switch from Truck to Rail and Choice of More Direct Intermodal Routes	$118.9	$189.4
Livability	Reduced Road Congestion due to Modal Switch from Truck to Rail	$83.3	$134.3
Environmental Sustainability	Emission Cost Savings due to Modal Switch from Truck to Rail	$19.9	$35.1
Safety	Accident Cost Savings due to Modal Switch from Truck to Rail	$426.5	$697.6
Total Benefit Estimates		**$781.8**	**$1,270.9**

In addition to the monetized benefits presented in Table ES-4, the project would generate benefits that are difficult to quantify. These benefits are discussed in more details in the main part of this application to provide more context and justification for project needs. A brief description of those benefits is provided below. These benefits would be additive to those reported in Table ES-4 and are acknowledged here in qualitative terms.

- *Induced Regional Benefits to Shippers and Receivers*: it is assumed that a proportion of the lifts in the build scenario will represent 'induced' shipments. That is to say that some volume of the lift forecast is made up of lifts that are not currently moving in the base case (in addition to existing demand). The presence of the intermodal hub at Manly will create new business opportunities through providing access to markets that were previously not cost effective. As an example, this new origin-destination hub will bring new regional opportunities to local commodity producers or processors. The induced component of the lift forecast has been excluded from the cost-benefit analysis to be conservative. As such, it can be said that induced demand will further improve the Benefit Cost Analysis evaluation metrics, as the corresponding benefits will be achieved within the same capital and operating costs.
- *Container imbalance:* Iowa has an imbalance of inbound versus outbound international shipping containers. According to US Census Bureau Data, in 2011 the ratio of the two categories of containers was 1 to 3. This implies a severe shortage of empty containers available to Iowa producers for loading their shipments. Empty containers must be shipped or "drayed" into Iowa to meet demand. This significantly increases the transportation cost. A new, efficient, independent regional intermodal terminal in north central Iowa can draw inbound and outbound container loads from a widespread region including much of Iowa and the southern half of Minnesota alleviating the shortage.
- *Shortage of truck drivers:* The Iowa DOT's Freight Advisory Council has identified driver shortages as one of the major challenges facing truck freight movement in Iowa. There are a number of issues that contribute to the problem, including hours of service

regulations, relatively low salaries that fail to attract enough new drivers, and cultural shifts making the life style of a long-distance truck driver less attractive. Any conversion from long haul trucking to shorter drays for regional commodities will provide opportunities to attract new truck drivers to the profession. The ability to be "off road" for longer periods of time will greatly impact the lifestyle of the trucking community, allowing drivers to be home more often and fully participate in home and family life while earning a living in a rural location where attractive jobs can be scarce.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for Upper Midwest Transportation Hub (UMTH) Project at Manly, Iowa.

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 UMTH 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 Projections. 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. Within this section as well, an Economic Impact Assessment has been conducted to estimate the short-term impacts from the construction of the intermodal facility. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are presented in Section 8. Section 9 provides the outcomes of the sensitivity analysis with respect to variation in key input assumptions. 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.[1]

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.

[1] 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.

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.

4. Project Overview

This TIGER Grant application is for infrastructure construction for the Upper Midwest Transportation Hub (UMTH) Project at Manly, Iowa. The UMTH will add intermodal capabilities to the established rail-served Manly Logistics Park. The UMTH will be located within the Manly Transportation Campus, a 350 acre transportation facility that includes three distinct functional units – the Manly Logistics Park, the Manly Terminal, and the IANR Manly Yard.

The UMTH will be sited within a newly constructed 15,000-foot loop track at the 160-acre Manly Logistics Park. The Park currently has one tenant, Sukup Manufacturing, a metal building fabricator.

The project will develop an intermodal facility capable of handling containers on flat car (COFC) and trailers on flat car (TOFC). The benefits included in this application are predicated on completion of this initial phase. Upon completion, the initial phase of development supporting intermodal operations will attract freight forwarders and shippers needing intermodal services and allows the establishment of rates, routes, and service to get new intermodal business underway. This initial phase of the UMTH will have independent utility.

The TIGER grant will facilitate development of UMTH as a complete, full-service intermodal facility by contributing to the cost of construction. Project construction includes:

- Earthwork
- Construction of a second loop track adjacent to the existing loop track to accommodate added volumes
- Construction of four interior intermodal strip tracks for staging railcars during container/trailer loading and unloading operations
- Track switches and crossovers
- Paving
- Utilities
- Lift equipment for loading containers on railcars and trucks
- Container/chassis storage area
- Security systems and fencing
- Land acquisition (previously optioned)

The region served by (UMTH) suffers from a serious lack of nearby intermodal infrastructure and service. There also exists a severe container imbalance situation from too little inbound containers, causing high dray costs. Declining truckload capacity and increasing costs has become a concern. Also, no direct, competitive, time sensitive intermodal service to US Eastern Seaboard, Texas-Mexico and California exists to this region.

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

1) improving freight rail efficiency and capacity,
2) diverting existing freight from truck to rail,
3) reducing truck miles traveled,
4) reducing highway maintenance costs,
5) reducing transportation costs,
6) reducing congestion costs,
7) reducing accident costs (fatalities and injuries), and
8) job creation.

The overall project is designed to provide an independent, high service and lower cost package of rail, truck and intermodal logistics for Upper Midwest manufacturers, producers and consumers. The project will directly provide lower cost access to domestic and international intermodal service to a large and growing number of shippers/receivers that do not currently have such cost-competitive access. This project will result in reducing the time, distance and related costs for shippers and receivers in the region to access the national and international intermodal network. That will allow existing and potential shippers, receivers and consumers in this region a more equal and competitive access to the world marketplace.

4.1 Base Case, Build Case and Alternative

Base Case (No-Build Case): In the base case, the UMTH project is not undertaken. Shipping is continued via truck and other intermodal facilities farther away.

Build Case: In the build case the UMTH project is undertaken. Trucking traffic and intermodal traffic from less direct routes are diverted to the proposed facility. The benefits of the build case are attributed to the avoidance of truck use as well as use of less direct intermodal routes.

4.2 Project Cost and Schedule

Total costs of the proposed project are estimated at $16.1M. This figure includes all relevant costs: construction and equipment. About 10 percent of total costs, or $1.6M, is expected to be incurred in 2015. The remainder of the costs, or $14.5M, would be incurred in 2016.

4.3 Effects on Long-Term Outcomes

Reduction in Highway 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 highway maintenance cost associated with diverting freight shipments from truck to rail.

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 highway freight to rail can generate cost savings to shippers. The UMTH project allows shippers a greater choice of transportation mode. 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. The UMTH project will also offer some existing intermodal shippers more direct routes and thus also less costly shipping options.

Transportation cost savings are quantified using the calculation of the number of container lifts and shipping costs savings per container. 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.

Shipping costs savings for existing rail users have the potential of spurring dynamic changes in land-use, manufacturing, and industrial re-organization. Research conducted for USDOT/FHWA indicated that reduced shipping costs could enable shifts in mode choice and investments in productivity in the 'medium term'. In addition, these combined savings could increase further based on industrial re-organization, and the shifting of warehousing or just-in-time manufacturing to realize even lower transportation costs.[2] Economists call the difference between the amount people actually pay for something and the amount they would pay for the next most costly alternative, "consumer surplus." Consumer surplus is a monetary quantity that equates to the economic value (EV) of the reduced costs to mode-shifting shippers in this project and is shown in the figure below. The change in consumer surplus is evaluated using

[2] (Citation: NCHRP 586. Rail Freight Solutions to Roadway Congestion—Final Report and Guidebook). These additional costs savings would be realized in the long-run through lower prices for consumers.

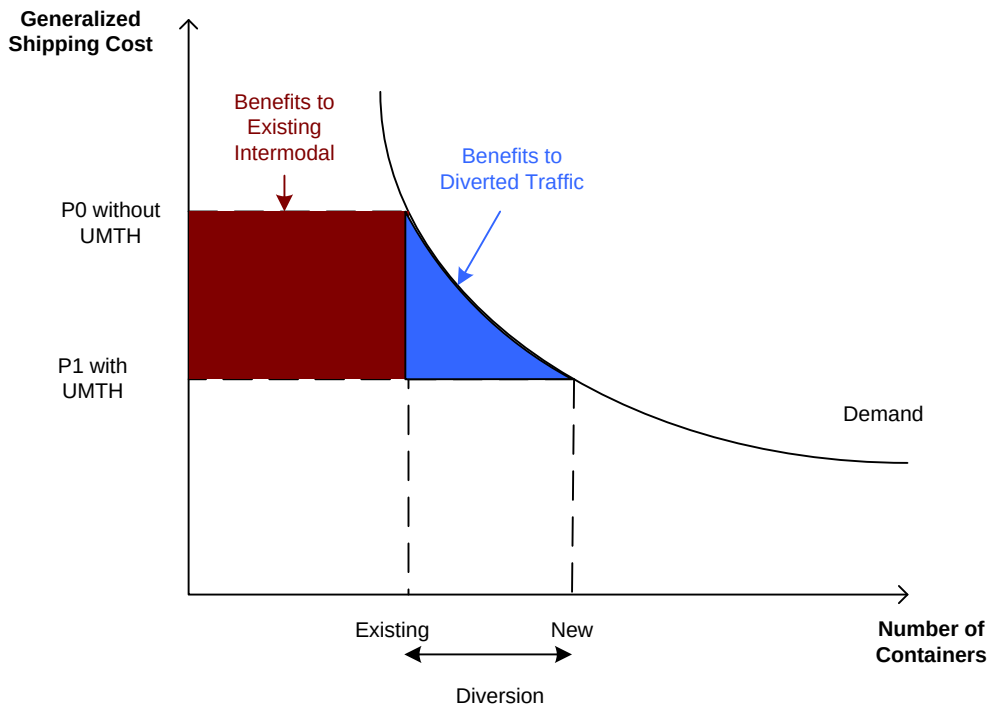
the equation provided below. This equation assumes the "rule-of-half" is being used. The rule of half is a simplification that assumes a linear approximation of the travel demand curve. The rule of half has been used to calculate this benefit category shown diagrammatically in the figure below.

$$\Delta CS = \frac{1}{2}\sum_t (Q_t^0 + Q_t^1)(P_t^0 - P_t^1) \qquad [1]$$

Where:

ΔCS = change in consumer surplus due to rail network improvements
t = time period
Q = number of containers during time period *t*
P = private cost of shipping (shipping rate)
0,1 = index denoting baseline scenario and improvement scenario respectively

Figure 1: Sources of Shipping Benefits



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

The proposed UMTH project will divert freight from road to rail resulting in a reduction in the use of public highways by heavy trucks. This reduces highway traffic volume and thus traffic congestion leading to 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 ton-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 ton-mile and train ton-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 1: Expected Effects on Long-Term Outcomes and Benefit Categories

Impact #	Long-Term Outcomes	Impact Categories	Description	Monetized	Quantified	Qualitative
1	**State of Good Repair**	Avoided Pavement Maintenance Costs	Modal switch from truck to rail will reduce annual pavement O&M costs per ton-mile	√		
2	**Economic Competitiveness**	Shipper Savings due to Modal Switch from Truck to Rail	Modal switch from truck to rail will reduce shipping rate per ton-mile	√		
3		Short-term economic impacts*	Number of jobs expected to be created by the project, and related income		√	
4		Induced Localized Demand	Intermodal terminal will induce additional businesses to ship who would otherwise not			√
5	**Livability**	Reduced Road Congestion due to Modal Switch from Truck to Rail	Modal switch from truck to rail will reduce congestion per truck-mile	√		
6	**Environmental Sustainability**	Emission Cost Savings due to Modal Switch from Truck to Rail	Modal switch from truck to rail will reduce emission rate per ton-mile	√		
7	**Safety**	Accident Cost Savings due to Modal Switch from Truck to Rail	Modal switch from truck to rail will reduce accident risk per ton-mile	√		

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction (2015) and including 22 years of operations after construction completion in 2016. The benefits start accruing in 2017 after construction is completed.

The monetized benefits and costs are estimated in 2014 dollars with future dollars discounted to 2014 and in compliance with TIGER requirements using a 7 percent real rate, and a rate of 3 percent for sensitivity assessment.

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

- Input prices are expressed in 2014 dollars;
- The period of analysis begins in 2015 and ends in 2038. It includes project development and construction years (2015 - 2016) and 22 years of operations (2017 - 2038);
- 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;
- Annual demand ramps up conservatively to account for shifting demand forecasts; and
- Induced lifts have been estimated and subsequently removed from the annual lift diversions forecasts so as to be conservative in estimation of project benefits.

6. Demand Projections

Accurate demand projections are important to ensure the reasonable BCA output results. The magnitudes of the long-term benefits accruing over the Upper Midwest Transportation Hub study period are a function of the number of existing and projected truck and intermodal trips diverted to rail.

6.1 Methodology

The demand projections are based on the number of truck and intermodal trips in the build scenario. One key assumption is the source of the lifts for the intermodal operations. An assumption has been made that 1) existing intermodal moves will be diverted from more distant facilities, like Chicago and 2) there will be a conversion of current truck moves to intermodal as a consequence of the opening of UMTH. A conservative approach has been taken on the truck-miles saved as a consequence of the opening of UMTH, with 1) existing intermodal moves netting a 250 mile savings and 2) conversion from other truck moves netting 750 mile savings (from Origin/Destination sample with rail versus highway mileage to/from Manly, Iowa).[3]

The difference in diversion miles from the base case versus the build case is a function of a weighted average between the distance diverted from existing intermodal moves and the

[3] Based on an analysis of specific origin destination pairs using FAF 3 data that could reasonably be diverted to rail service.

conversion from truck moves. The diverted intermodal moves and conversion from truck to intermodal each have an associated distance and a percentage share of the total lifts. The intermodal lift forecasts at this facility were then adjusted through removal of the estimated proportion of induced traffic in those lift estimates. Both the number of lifts and the estimated proportion of induced traffic vary year to year. The annual lift value is then multiplied by the proportion of lifts that are diverted intermodal moves and the proportion that comes from truck to intermodal by the estimated distance per lift saved from diverted intermodal moves and from truck to intermodal diversions to get the total truck miles diverted to rail.

Growth estimates are based on engineering estimates and discussions with transportation companies. It should be emphasized that the Manly lift forecasts can be considered conservative. To evaluate the robustness of these forecasts, due-diligence was done via using the second generation statewide travel demand model known as iTRAM – Iowa Traffic Analysis Model. This innovative tool was developed using HSIPR (High Speed Intercity Passenger Rail) grant funding. The Iowa DOT's iTRAM is amongst the first in the U.S., to include truck, rail and water commodity movements into a statewide travel demand model. The iTRAM model was utilized to analyze the county by county inbound and outbound movements of freight in the service area. Potential intermodal loads were identified and assigned to intermodal lanes by origin and destination. Because the iTRAM model has multiple data sources all of which are disaggregated to the county level, the amount of potential volume that could be diverted to rail was determined with a high level of specificity.

The projections provided by iTRAM validate that the projections for use and growth at the UMTH are conservative. Projections in earlier planning and grant applications were based solely on the more generalized FAF3 data and discussions with shippers and trucking companies. The much more robust and site specific data that was produced by iTRAM provides a high level of confidence that the UMTH can be a successful intermodal facility.

6.2 Assumptions

Table 2 below lists the key demand inputs used in the benefit-cost assessment of the UMTH project.

Table 2: Demand Input Assumptions

Year of Operation	Manly Lifts: Total	Non-Induced Lifts	Est pct of diverted intermodal moves	Est pct of conversion from truck to intermodal	Est pct of Induced traffic out of total lifts	Avg truck-miles saved per lift-diverted intermodal	Avg truck-miles saved per lift conversion from truck
2017	2,500	2,375	15%	85%	5%	250	750
2018	60,000	51,000	25%	75%	15%	250	750
2019	90,000	72,000	30%	70%	20%	250	750
2020	108,000	81,000	37%	63%	25%	250	750

2021	129,600	93,960	39%	61%	28%	250	750
2022	155,520	110,419	40%	60%	29%	250	750
2023	174,182	121,928	35%	65%	30%	250	750
2024	195,084	131,682	30%	70%	33%	250	750
2025	197,035	128,073	30%	70%	35%	250	750
2026	199,005	129,354	30%	70%	35%	250	750
2027	200,996	130,647	30%	70%	35%	250	750
2028	203,005	131,954	30%	70%	35%	250	750
2029	205,036	133,273	30%	70%	35%	250	750
2030	207,086	134,606	30%	70%	35%	250	750
2031	209,157	135,952	30%	70%	35%	250	750
2032	211,248	137,311	30%	70%	35%	250	750
2033	213,361	138,685	30%	70%	35%	250	750
2034	215,494	140,071	30%	70%	35%	250	750
2035	217,649	141,472	30%	70%	35%	250	750
2036	219,826	142,887	30%	70%	35%	250	750
2037	222,024	144,316	30%	70%	35%	250	750
2038	224,244	145,759	30%	70%	35%	250	750

6.3 Demand Projections

The resulting projections for the truck miles diverted (based on the savings of 250 miles for intermodal moves and 750 miles for truck moves) are shown in the table below.

Table 3: Projections of Truck Miles Saved

Year of Operation	Truck Miles Saved Per Year, by Year
2017	1,603,125
2018	31,875,000
2019	43,200,000
2020	45,765,000
2021	52,147,800
2022	60,730,560
2023	70,108,416
2024	79,009,137
2025	76,843,701
2026	77,612,138
2027	78,388,259
2028	79,172,142
2029	79,963,863

2030	80,763,502
2031	81,571,137
2032	82,386,848
2033	83,210,717
2034	84,042,824
2035	84,883,252
2036	85,732,085
2037	86,589,406
2038	87,455,300

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Table 1 (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

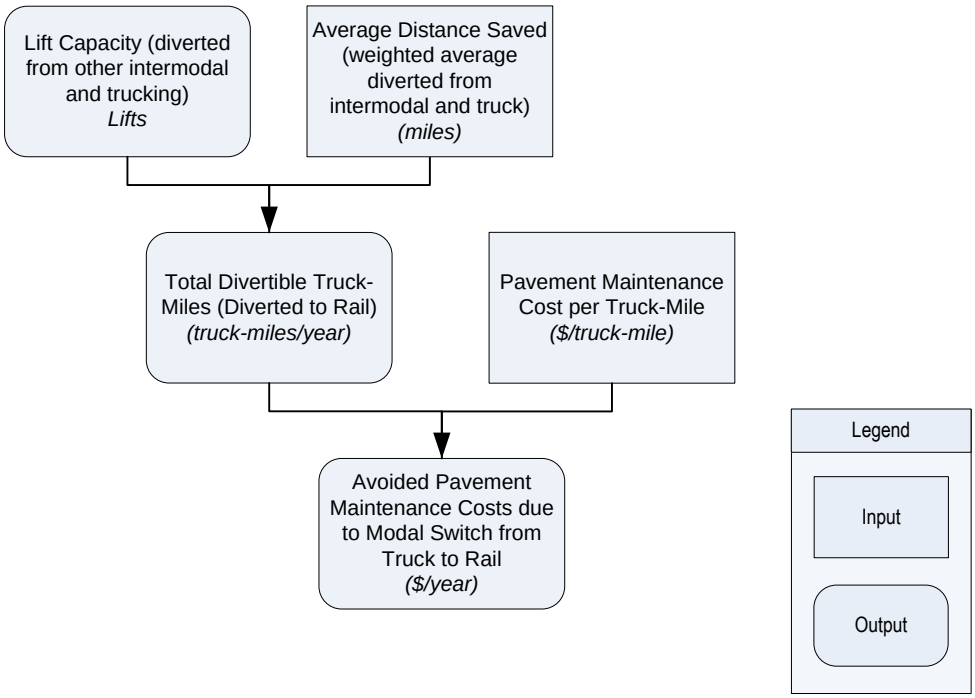
To quantify the benefits associated with maintaining the existing transportation network in a state of good repair, *Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail* is monetized.

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 freight shipments from truck to rail. The total diverted truck miles are applied to highway maintenance cost per truck -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 4: Assumptions used in the Estimation of State-of-Good-Repair Benefits

Input #	Input Name	Units	Value	Source/Comment
1	Total Divertible Truck-miles - 2015	truck-VMT	0	Iowa Northern Railway Company
2	Total Divertible Truck-miles - 2016	truck-VMT	0	
3	Total Divertible Truck-miles - 2017	truck-VMT	1,603,125	
4	Total Divertible Truck-miles - 2018	truck-VMT	31,875,000	
5	Total Divertible Truck-miles - 2019	truck-VMT	43,200,000	
6	Total Divertible Truck-miles - 2020	truck-VMT	45,765,000	
7	Total Divertible Truck-miles - 2021	truck-VMT	52,147,800	
8	Total Divertible Truck-miles - 2022	truck-VMT	60,730,560	
9	Total Divertible Truck-miles - 2023	truck-VMT	70,108,416	
10	Total Divertible Truck-miles - 2024	truck-VMT	79,009,137	
11	Total Divertible Truck-miles - 2025	truck-VMT	76,843,701	
12	Total Divertible Truck-miles - 2026	truck-VMT	77,612,138	

13	Total Divertible Truck-miles - 2027	truck-VMT	78,388,259	
14	Total Divertible Truck-miles - 2028	truck-VMT	79,172,142	
15	Total Divertible Truck-miles - 2029	truck-VMT	79,963,863	
16	Total Divertible Truck-miles - 2030	truck-VMT	80,763,502	
17	Total Divertible Truck-miles - 2031	truck-VMT	81,571,137	
18	Total Divertible Truck-miles - 2032	truck-VMT	82,386,848	
19	Total Divertible Truck-miles - 2033	truck-VMT	83,210,717	
20	Total Divertible Truck-miles - 2034	truck-VMT	84,042,824	
21	Total Divertible Truck-miles - 2035	truck-VMT	84,883,252	
22	Total Divertible Truck-miles - 2036	truck-VMT	85,732,085	
23	Total Divertible Truck-miles - 2037	truck-VMT	86,589,406	
24	Total Divertible Truck-miles - 2038	truck-VMT	87,455,300	
25	Average Tons per Truck	Tons	20	Iowa Northern Railway Company
26	Pavement Maintenance Cost	2014$/Truck Mile	$0.2094	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; Table 13. Assuming 50/50 split of 60,80 kip and 35/65 urban/rural split.

7.1.3 Benefit Estimates

The benefit estimates to reduced pavement maintenance costs are shown in the table below. This benefit category accounts for roughly 17% of the total benefits of this build case.

Table 5: Estimates of State-of-Good-Repair Benefits, Millions of 2014$

	In Project Opening Year, Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Avoided Pavement Maintenance Costs	$0.29	$321.06	$133.08

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, one measure of mobility is presented: *Transportation Cost Savings*.

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 economic impacts of the project. These include short-terms impacts due to construction as well as long-term permanent impacts due to facility operations and additional (external or ancillary) activity attracted to the vicinity of the proposed facility.

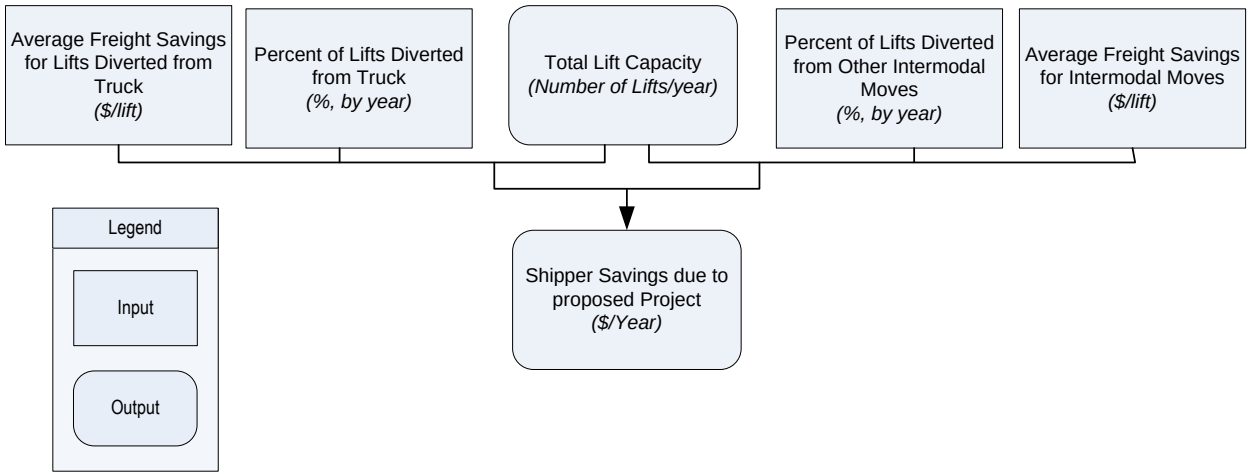
7.2.1 Methodology

Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail and Reduced Transportation Costs from Diverting Existing Intermodal Shipments to More Direct Routes out of UMTH

Rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. As such, diversion of highway freight to rail can generate cost savings to shippers. In addition, the proposed project would offer for some existing intermodal shipments more direct – and thus less costly – shipping routes. In other words, the UMTH facility would reduce shipping costs on a 'per lift' basis, with cost reductions attributed to diverting both existing intermodal and truck-only freight. The category of cost savings relating to the diversion of truck-only freight to rail is attributed to 'new users' of the rail system. As such, it is appropriate to apply the '50% rule' when accounting for this consumer surplus change. Consumer surplus is a monetary quantity that equates to the economic value (EV) of the additional transportation options to users (here shippers of freight) through the new project.

Transportation cost savings are quantified using the calculation of the volume of truck ton-miles avoided and relative shipping rates. Rates were converted into a 'per lift' basis by Iowa Northern Railway Company (IANR). Florilli Logistics, an Iowa based trucking company that handles large volumes of both refrigerated and dry freight within the region and the entire country, compared the assumptions with confidential traffic flow data in-house and confirmed that the assumptions by IANR were reasonable. The benefits in this category are counted as public because the difference in transportation costs between rail intermodal and truckload freight accrue directly to the shipper and receiver lowering the final price consumers pay. The figure below outlines the methodology for quantifying this benefit.

Figure 3: Reduced Transportation Costs S&L



7.2.2 Assumptions

The assumptions used in the estimation of shipping cost reductions are summarized in the table below. Note that input called "Total Lifts (by year)" represents total lifts in UMTH reduced by the percentage of lifts which are expected to represent induced traffic.

Table 6: Assumptions used in the Estimation of Transportation Cost Savings

Input #	Input Name	Units	Value	Source/Comment
1	Total Lifts - 2015	#/year	0	Iowa Northern Railway Company
2	Total Lifts - 2016	#/year	0	
3	Total Lifts - 2017	#/year	2,375	
4	Total Lifts - 2018	#/year	51,000	
5	Total Lifts - 2019	#/year	72,000	
6	Total Lifts - 2020	#/year	81,000	
7	Total Lifts - 2021	#/year	93,960	
8	Total Lifts - 2022	#/year	110,419	
9	Total Lifts - 2023	#/year	121,928	
10	Total Lifts - 2024	#/year	131,682	
11	Total Lifts - 2025	#/year	128,073	
12	Total Lifts - 2026	#/year	129,354	
13	Total Lifts - 2027	#/year	130,647	
14	Total Lifts - 2028	#/year	131,954	
15	Total Lifts - 2029	#/year	133,273	
16	Total Lifts - 2030	#/year	134,606	
17	Total Lifts - 2031	#/year	135,952	
18	Total Lifts - 2032	#/year	137,311	
19	Total Lifts - 2033	#/year	138,685	

20	Total Lifts - 2034	#/year	140,071	
21	Total Lifts - 2035	#/year	141,472	
22	Total Lifts - 2036	#/year	142,887	
23	Total Lifts - 2037	#/year	144,316	
24	Total Lifts - 2038	#/year	145,759	
25	Percentage Diverted of Intermodal Moves - 2015	%	0%	Iowa Northern Railway Company
26	Percentage Diverted of Intermodal Moves - 2016	%	0%	
27	Percentage Diverted of Intermodal Moves - 2017	%	15%	
28	Percentage Diverted of Intermodal Moves - 2018	%	25%	
29	Percentage Diverted of Intermodal Moves - 2019	%	30%	
30	Percentage Diverted of Intermodal Moves - 2020	%	37%	
31	Percentage Diverted of Intermodal Moves - 2021	%	39%	
32	Percentage Diverted of Intermodal Moves - 2022	%	40%	
33	Percentage Diverted of Intermodal Moves - 2023	%	35%	
34	Percentage Diverted of Intermodal Moves - 2024	%	30%	
35	Percentage Diverted of Intermodal Moves - 2025	%	30%	
36	Percentage Diverted of Intermodal Moves - 2026	%	30%	
37	Percentage Diverted of Intermodal Moves - 2027	%	30%	
38	Percentage Diverted of Intermodal Moves - 2028	%	30%	
39	Percentage Diverted of Intermodal Moves - 2029	%	30%	
40	Percentage Diverted of Intermodal Moves - 2030	%	30%	
41	Percentage Diverted of Intermodal Moves - 2031	%	30%	
42	Percentage Diverted of Intermodal Moves - 2032	%	30%	
43	Percentage Diverted of Intermodal Moves - 2033	%	30%	
44	Percentage Diverted of Intermodal Moves - 2034	%	30%	
45	Percentage Diverted of Intermodal Moves - 2035	%	30%	
46	Percentage Diverted of Intermodal Moves - 2036	%	30%	
47	Percentage Diverted of Intermodal Moves - 2037	%	30%	
48	Percentage Diverted of Intermodal Moves - 2038	%	30%	
49	Freight Savings Per Lift: Diverted Intermodal - 2015	$/Lift	$0	Iowa Northern Railway Company
50	Freight Savings Per Lift: Diverted Intermodal - 2016	$/Lift	$0	
51	Freight Savings Per Lift: Diverted Intermodal - 2017	$/Lift	$350	
52	Freight Savings Per Lift: Diverted Intermodal - 2018	$/Lift	$350	
53	Freight Savings Per Lift: Diverted Intermodal - 2019	$/Lift	$350	
54	Freight Savings Per Lift: Diverted Intermodal - 2020	$/Lift	$350	
55	Freight Savings Per Lift: Diverted Intermodal - 2021	$/Lift	$350	
56	Freight Savings Per Lift: Diverted Intermodal - 2022	$/Lift	$350	
57	Freight Savings Per Lift: Diverted Intermodal - 2023	$/Lift	$350	
58	Freight Savings Per Lift: Diverted Intermodal - 2024	$/Lift	$350	
59	Freight Savings Per Lift: Diverted Intermodal - 2025	$/Lift	$350	

60	Freight Savings Per Lift: Diverted Intermodal - 2026	$/Lift	$350	
61	Freight Savings Per Lift: Diverted Intermodal - 2027	$/Lift	$350	
62	Freight Savings Per Lift: Diverted Intermodal - 2028	$/Lift	$350	
63	Freight Savings Per Lift: Diverted Intermodal - 2029	$/Lift	$350	
64	Freight Savings Per Lift: Diverted Intermodal - 2030	$/Lift	$350	
65	Freight Savings Per Lift: Diverted Intermodal - 2031	$/Lift	$350	
66	Freight Savings Per Lift: Diverted Intermodal - 2032	$/Lift	$350	
67	Freight Savings Per Lift: Diverted Intermodal - 2033	$/Lift	$350	
68	Freight Savings Per Lift: Diverted Intermodal - 2034	$/Lift	$350	
69	Freight Savings Per Lift: Diverted Intermodal - 2035	$/Lift	$350	
70	Freight Savings Per Lift: Diverted Intermodal - 2036	$/Lift	$350	
71	Freight Savings Per Lift: Diverted Intermodal - 2037	$/Lift	$350	
72	Freight Savings Per Lift: Diverted Intermodal - 2038	$/Lift	$350	
73	Percentage Diverted From Truck to Intermodal - 2015	%	0%	Iowa Northern Railway Company
74	Percentage Diverted From Truck to Intermodal - 2016	%	0%	
75	Percentage Diverted From Truck to Intermodal - 2017	%	85%	
76	Percentage Diverted From Truck to Intermodal - 2018	%	75%	
77	Percentage Diverted From Truck to Intermodal - 2019	%	70%	
78	Percentage Diverted From Truck to Intermodal - 2020	%	63%	
79	Percentage Diverted From Truck to Intermodal - 2021	%	61%	
80	Percentage Diverted From Truck to Intermodal - 2022	%	60%	
81	Percentage Diverted From Truck to Intermodal - 2023	%	65%	
82	Percentage Diverted From Truck to Intermodal - 2024	%	70%	
83	Percentage Diverted From Truck to Intermodal - 2025	%	70%	
84	Percentage Diverted From Truck to Intermodal - 2026	%	70%	
85	Percentage Diverted From Truck to Intermodal - 2027	%	70%	
86	Percentage Diverted From Truck to Intermodal - 2028	%	70%	
87	Percentage Diverted From Truck to Intermodal - 2029	%	70%	
88	Percentage Diverted From Truck to Intermodal - 2030	%	70%	
89	Percentage Diverted From Truck to Intermodal - 2031	%	70%	
90	Percentage Diverted From Truck to Intermodal - 2032	%	70%	
91	Percentage Diverted From Truck to Intermodal - 2033	%	70%	
92	Percentage Diverted From Truck to Intermodal - 2034	%	70%	
93	Percentage Diverted From Truck to Intermodal - 2035	%	70%	
94	Percentage Diverted From Truck to Intermodal - 2036	%	70%	
95	Percentage Diverted From Truck to Intermodal - 2037	%	70%	
96	Percentage Diverted From Truck to Intermodal - 2038	%	70%	
97	Freight Savings Per Lift: Diverted From Truck - 2015	$/Lift	$0	Iowa Northern Railway Company
98	Freight Savings Per Lift: Diverted From Truck - 2016	$/Lift	$0	
99	Freight Savings Per Lift: Diverted From Truck - 2017	$/Lift	$450	

100	Freight Savings Per Lift: Diverted From Truck - 2018	$/Lift	$450	
101	Freight Savings Per Lift: Diverted From Truck - 2019	$/Lift	$450	
102	Freight Savings Per Lift: Diverted From Truck - 2020	$/Lift	$450	
103	Freight Savings Per Lift: Diverted From Truck - 2021	$/Lift	$450	
104	Freight Savings Per Lift: Diverted From Truck - 2022	$/Lift	$450	
105	Freight Savings Per Lift: Diverted From Truck - 2023	$/Lift	$450	
106	Freight Savings Per Lift: Diverted From Truck - 2024	$/Lift	$450	
107	Freight Savings Per Lift: Diverted From Truck - 2025	$/Lift	$450	
108	Freight Savings Per Lift: Diverted From Truck - 2026	$/Lift	$450	
109	Freight Savings Per Lift: Diverted From Truck - 2027	$/Lift	$450	
110	Freight Savings Per Lift: Diverted From Truck - 2028	$/Lift	$450	
111	Freight Savings Per Lift: Diverted From Truck - 2029	$/Lift	$450	
112	Freight Savings Per Lift: Diverted From Truck - 2030	$/Lift	$450	
113	Freight Savings Per Lift: Diverted From Truck - 2031	$/Lift	$450	
114	Freight Savings Per Lift: Diverted From Truck - 2032	$/Lift	$450	
115	Freight Savings Per Lift: Diverted From Truck - 2033	$/Lift	$450	
116	Freight Savings Per Lift: Diverted From Truck - 2034	$/Lift	$450	
117	Freight Savings Per Lift: Diverted From Truck - 2035	$/Lift	$450	
118	Freight Savings Per Lift: Diverted From Truck - 2036	$/Lift	$450	
119	Freight Savings Per Lift: Diverted From Truck - 2037	$/Lift	$450	
120	Freight Savings Per Lift: Diverted From Truck - 2038	$/Lift	$450	

7.2.3 Benefit Estimates

The table below shows the benefit estimates of transportation cost savings due to the UMTH project. Shipper cost savings from modal switch and shorter intermodal routes accounts for about 15% of the total benefits generated with this project.

Table 7: Estimates of Transportation Cost Savings, Millions of 2014$

	In Project Opening Year, Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Shipper Savings due to Modal Switch from Truck to Rail and Choice of More Direct Intermodal Routes	$0.11	$280.69	$118.95

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 the UMTH 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, construction, procurement and IT integration (capital expenditures) between 2015 and 2016 is used to compute short-term economic impacts.

The project is expected to generate 240.5 job-years during the project development phase. It is also expected to create $19.31 million in value added, including $13.60 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 8: Project Spending and Economic Impacts (Direct, Indirect and Induced) during Project Development Phase

	Spending (Millions of 2014 Dollars)	Direct	Indirect	Induced	Total
Employment*	$13.44	104.5	50.5	85.5	240.5
Labor Income**		$6.20	$3.24	$4.16	$13.60
Value Added**		$6.79	$5.14	$7.38	$19.31

*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 2014 Dollars.*

Another method to estimate job-years from additional spending uses the Council of Economic Advisors' (CEA) methodology as presented in a 2011 analysis[4]. This method assumes that for every $76,923 of government spending, one job-year is created. The following table shows the difference in job-year estimates using the IMPLAN and CEA methodologies.

Note that the estimated employment impacts are lower when using CEA's approach. Specifically, the simplified computation produces a more conservative estimate of 174.7 job-years (including 111.8 direct and indirect job-years and 62.9 induced jobs-years).

Table 9: Project Spending and Job-Year Estimates with IMPLAN and CEA Methodologies

	Spending (Millions of 2014 Dollars)	Direct	Indirect	Induced	Total
IMPLAN *	$13.44	104.5	50.5	85.5	240.5
CEA		111.8		62.9	174.7

[4] 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: * 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.*

The table below presents the short-term increase in employment and labor income resulting from capital expenditures in key industries employing low-income people. 39.7 cumulative job-years (or 16.4 percent of total job-years) are expected to be created in those industries by the end of 2016, bringing in an additional $1.19 million in labor income.

Table 10: Short-Term Impacts in Key Industries Employing Low-Income People

Sectors	Employment (Job-Years)	Labor Income (Millions of 2014 Dollars)
Retail Industries	16.5	$0.54
Services to buildings and dwellings	2.7	$0.07
Other business services	2.5	$0.09
Food services and drinking places	9.3	$0.21
Hotel/accommodation services	1.3	$0.05
Personal care and other personal services	7.4	$0.23
Total	**39.7**	**$1.19**

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 travel time savings of the remaining on-road motorists.

7.3.1 Methodology

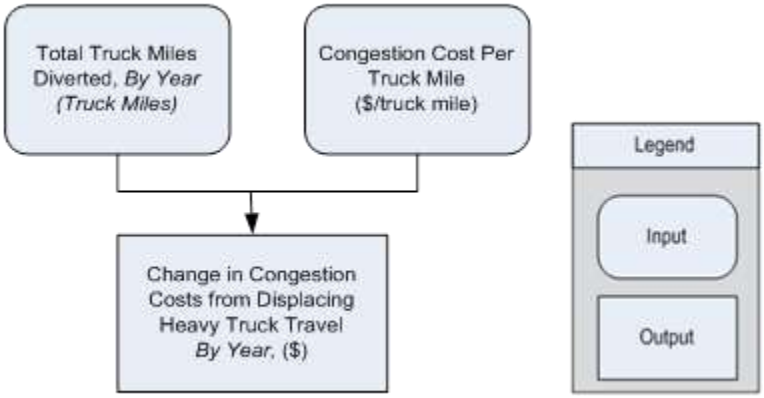
Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail

The proposed UMTH 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.

It should also be noted that increased goods shipment by rail increase traffic on the rail network. Congestion delays do occur on railroads, but costs of delays to trains are internal because one carrier is responsible for all the freight on the rail system. Therefore the cost of congestion is included in the rail rate cost and the external social cost is assumed equal to zero.[5] The figure below outlines the structure and logic model of the benefit calculation.

[5] Transportation Research Board. Paying Our Way: Estimating Marginal Social Costs of Freight Transportation. 1996.

Figure 4: Reduction in Highway Congestion Costs



7.3.2 Assumptions

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

Table 11: Assumptions used in the Estimation of Livability Benefits

Input #	Input Name	Units	Value	Source/Comment
1	Truck Congestion Cost	2014$/mile	$0.13	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000; Table 13. Assuming 50/50 split of 60,80 kip and 35/65 urban/rural split.
2	Rail Congestion Cost	2014$/mile	$0.00	Congestion delays occur on railroads, but costs of delays to trains are internal because one carrier is responsible for all the freight on the rail system. Therefore the cost of congestion is included in the rail rate cost. Transportation Research Board. Paying Our Way: Estimating Marginal Social Costs of Freight Transportation. 1996.
3	Truck Miles Diverted to Rail - 2015	miles/year	0	Iowa Northern Railway Company
4	Truck Miles Diverted to Rail - 2016	miles/year	0	
5	Truck Miles Diverted to Rail - 2017	miles/year	1,603,125	
6	Truck Miles Diverted to Rail - 2018	miles/year	31,875,000	
7	Truck Miles Diverted to Rail - 2019	miles/year	43,200,000	
8	Truck Miles Diverted to Rail - 2020	miles/year	45,765,000	

9	Truck Miles Diverted to Rail - 2021	miles/year	52,147,800	
10	Truck Miles Diverted to Rail - 2022	miles/year	60,730,560	
11	Truck Miles Diverted to Rail - 2023	miles/year	70,108,416	
12	Truck Miles Diverted to Rail - 2024	miles/year	79,009,137	
13	Truck Miles Diverted to Rail - 2025	miles/year	76,843,701	
14	Truck Miles Diverted to Rail - 2026	miles/year	77,612,138	
15	Truck Miles Diverted to Rail - 2027	miles/year	78,388,259	
16	Truck Miles Diverted to Rail - 2028	miles/year	79,172,142	
17	Truck Miles Diverted to Rail - 2029	miles/year	79,963,863	
18	Truck Miles Diverted to Rail - 2030	miles/year	80,763,502	
19	Truck Miles Diverted to Rail - 2031	miles/year	81,571,137	
20	Truck Miles Diverted to Rail - 2032	miles/year	82,386,848	
21	Truck Miles Diverted to Rail - 2033	miles/year	83,210,717	
22	Truck Miles Diverted to Rail - 2034	miles/year	84,042,824	
23	Truck Miles Diverted to Rail - 2035	miles/year	84,883,252	
24	Truck Miles Diverted to Rail - 2036	miles/year	85,732,085	
25	Truck Miles Diverted to Rail - 2037	miles/year	86,589,406	
26	Truck Miles Diverted to Rail - 2038	miles/year	87,455,300	

7.3.3 Benefit Estimates

The table below shows the benefit estimates of road congestion savings due to the UMTH project. Congestion savings from modal switch and shorter intermodal routes accounts for roughly 11% of the total benefits generated with this project.

Table 12: Estimates of Quality of Life Benefits, Millions of 2014$

	In Project Opening Year, Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduced Road Congestion due to Modal Switch from Truck to Rail	$0.18	$201.00	$83.31

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

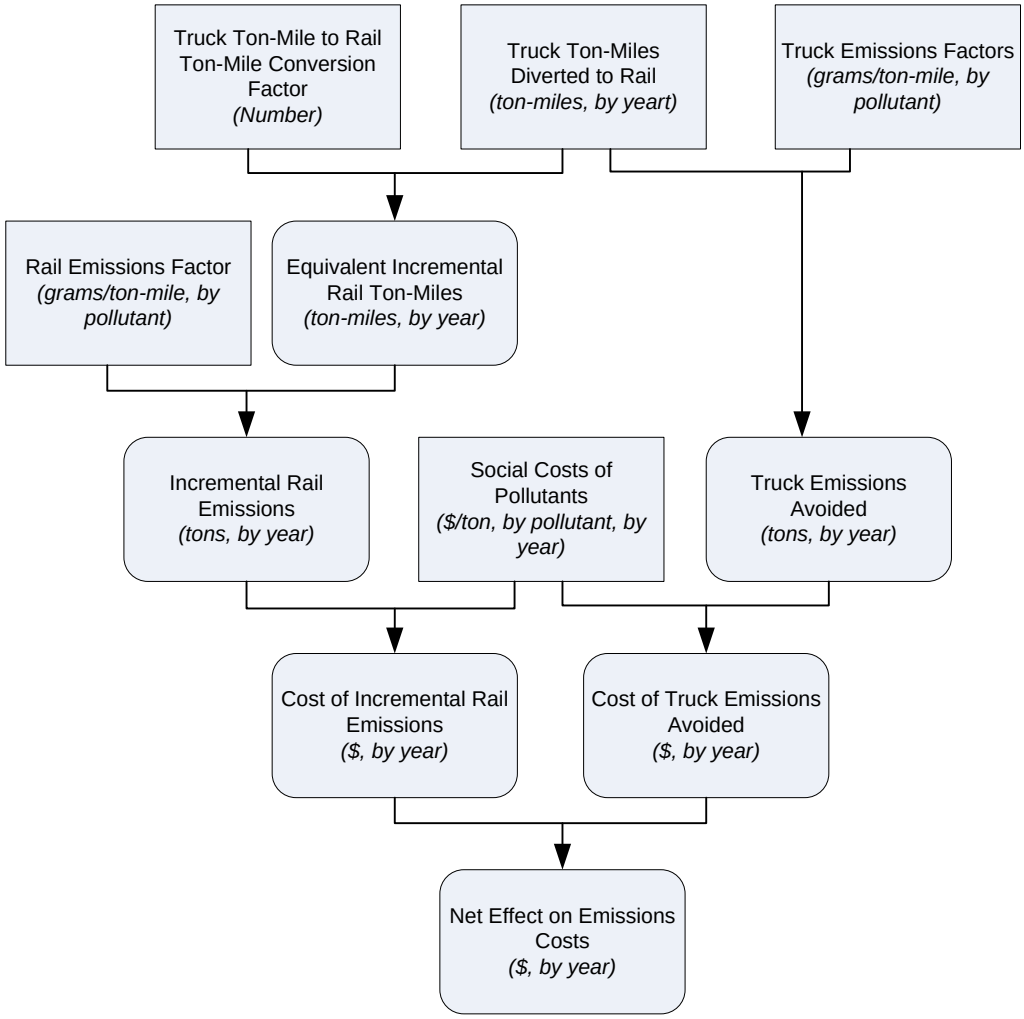
Emission Savings from Diverting Heavy Truck Travel to Rail

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 critical air contaminants (CAC) are calculated on the basis of pollutants generated per ton-mile travelled by truck and train.

Truck ton-miles diverted to rail are estimated by multiplying truck miles diverted (as shown in previous tables) by the average truck load. The estimated truck ton-miles diverted from truck to rail are then multiplied by truck emissions factors (grams of pollutants per truck-ton mile) to calculate the amounts of pollutant emissions avoided.

Truck ton-miles diverted to rail are also multiplied by a truck-mile to rail-mile conversion factor to obtain the equivalent train ton-miles. These are then multiplied by rail emissions factors (grams of pollutants per train ton-mile) to obtain the incremental rail emissions due to diversion of truck shipments. The difference between the two sets of emissions multiplied by the social costs of emissions gives the net impact on emissions. The structure and logic model outlining this calculation is provided in the figure below.

Figure 5: Emission Savings S&L



7.4.2 Assumptions

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

Table 13: Assumptions used in the Estimation of Environmental Sustainability Benefits

Input #	Input Name	Units	Value	Source/Comment
1	Grams of NOx per truck ton-mile - 2015	grams/TM	0.3369	United States Environmental Protection Agency, Motor Vehicle Emission Simulator, 2014.
2	Grams of NOx per truck ton-mile - 2016	grams/TM	0.2991	
3	Grams of NOx per truck ton-mile - 2017	grams/TM	0.2645	
4	Grams of NOx per truck ton-mile - 2018	grams/TM	0.2327	
5	Grams of NOx per truck ton-mile - 2019	grams/TM	0.2052	
6	Grams of NOx per truck	grams/TM	0.1807	

	ton-mile - 2020			
7	Grams of NOx per truck ton-mile - 2021	grams/TM	0.1599	
8	Grams of NOx per truck ton-mile - 2022	grams/TM	0.1422	
9	Grams of NOx per truck ton-mile - 2023	grams/TM	0.1273	
10	Grams of NOx per truck ton-mile - 2024	grams/TM	0.1143	
11	Grams of NOx per truck ton-mile - 2025	grams/TM	0.1031	
12	Grams of NOx per truck ton-mile - 2026	grams/TM	0.0935	
13	Grams of NOx per truck ton-mile - 2027	grams/TM	0.0851	
14	Grams of NOx per truck ton-mile - 2028	grams/TM	0.0778	
15	Grams of NOx per truck ton-mile - 2029	grams/TM	0.0716	
16	Grams of NOx per truck ton-mile - 2030	grams/TM	0.0670	
17	Grams of NOx per truck ton-mile - 2031	grams/TM	0.0633	
18	Grams of NOx per truck ton-mile - 2032	grams/TM	0.0603	
19	Grams of NOx per truck ton-mile - 2033	grams/TM	0.0578	
20	Grams of NOx per truck ton-mile - 2034	grams/TM	0.0563	
21	Grams of NOx per truck ton-mile - 2035	grams/TM	0.0551	
22	Grams of NOx per truck ton-mile - 2036	grams/TM	0.0542	
23	Grams of NOx per truck ton-mile - 2037	grams/TM	0.0534	
24	Grams of NOx per truck ton-mile - 2038	grams/TM	0.0531	
25	Grams of NOx per train ton-mile - 2015	grams/TM	0.2949	United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
26	Grams of NOx per train ton-mile - 2016	grams/TM	0.2726	
27	Grams of NOx per train ton-mile - 2017	grams/TM	0.2530	
28	Grams of NOx per train ton-mile - 2018	grams/TM	0.2361	
29	Grams of NOx per train ton-mile - 2019	grams/TM	0.2219	
30	Grams of NOx per train ton-mile - 2020	grams/TM	0.2101	
31	Grams of NOx per train ton-mile - 2021	grams/TM	0.1966	
32	Grams of NOx per train ton-mile - 2022	grams/TM	0.1833	
33	Grams of NOx per train ton-mile - 2023	grams/TM	0.1705	
34	Grams of NOx per train ton-mile - 2024	grams/TM	0.1580	
35	Grams of NOx per train	grams/TM	0.1458	

	ton-mile - 2025			
36	Grams of NOx per train ton-mile - 2026	grams/TM	0.1339	
37	Grams of NOx per train ton-mile - 2027	grams/TM	0.1243	
38	Grams of NOx per train ton-mile - 2028	grams/TM	0.1149	
39	Grams of NOx per train ton-mile - 2029	grams/TM	0.1058	
40	Grams of NOx per train ton-mile - 2030	grams/TM	0.0969	
41	Grams of NOx per train ton-mile - 2031	grams/TM	0.0883	
42	Grams of NOx per train ton-mile - 2032	grams/TM	0.0817	
43	Grams of NOx per train ton-mile - 2033	grams/TM	0.0752	
44	Grams of NOx per train ton-mile - 2034	grams/TM	0.0689	
45	Grams of NOx per train ton-mile - 2035	grams/TM	0.0628	
46	Grams of NOx per train ton-mile - 2036	grams/TM	0.0585	
47	Grams of NOx per train ton-mile - 2037	grams/TM	0.0544	
48	Grams of NOx per train ton-mile - 2038	grams/TM	0.0503	
49	Grams of CO2 per truck ton-mile - 2015	grams/TM	75.7689	United States Environmental Protection Agency, Motor Vehicle Emission Simulator, 2014.
50	Grams of CO2 per truck ton-mile - 2016	grams/TM	75.2416	
51	Grams of CO2 per truck ton-mile - 2017	grams/TM	74.5183	
52	Grams of CO2 per truck ton-mile - 2018	grams/TM	73.8176	
53	Grams of CO2 per truck ton-mile - 2019	grams/TM	73.1649	
54	Grams of CO2 per truck ton-mile - 2020	grams/TM	72.5576	
55	Grams of CO2 per truck ton-mile - 2021	grams/TM	72.0106	
56	Grams of CO2 per truck ton-mile - 2022	grams/TM	71.5227	
57	Grams of CO2 per truck ton-mile - 2023	grams/TM	71.0910	
58	Grams of CO2 per truck ton-mile - 2024	grams/TM	70.7102	
59	Grams of CO2 per truck ton-mile - 2025	grams/TM	70.3698	
60	Grams of CO2 per truck ton-mile - 2026	grams/TM	70.0670	
61	Grams of CO2 per truck ton-mile - 2027	grams/TM	69.7956	
62	Grams of CO2 per truck ton-mile - 2028	grams/TM	69.5560	
63	Grams of CO2 per truck ton-mile - 2029	grams/TM	69.3543	
64	Grams of CO2 per truck	grams/TM	69.1899	

	ton-mile - 2030			
65	Grams of CO2 per truck ton-mile - 2031	grams/TM	69.0501	
66	Grams of CO2 per truck ton-mile - 2032	grams/TM	68.9295	
67	Grams of CO2 per truck ton-mile - 2033	grams/TM	68.8296	
68	Grams of CO2 per truck ton-mile - 2034	grams/TM	68.7466	
69	Grams of CO2 per truck ton-mile - 2035	grams/TM	68.6765	
70	Grams of CO2 per truck ton-mile - 2036	grams/TM	68.6192	
71	Grams of CO2 per truck ton-mile - 2037	grams/TM	68.5733	
72	Grams of CO2 per truck ton-mile - 2038	grams/TM	68.5369	
73	Grams of CO2 per train ton-mile - 2015	grams/TM	23.3597	United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
74	Grams of CO2 per train ton-mile - 2016	grams/TM	23.0145	
75	Grams of CO2 per train ton-mile - 2017	grams/TM	22.6744	
76	Grams of CO2 per train ton-mile - 2018	grams/TM	22.3393	
77	Grams of CO2 per train ton-mile - 2019	grams/TM	22.0091	
78	Grams of CO2 per train ton-mile - 2020	grams/TM	21.6839	
79	Grams of CO2 per train ton-mile - 2021	grams/TM	21.3634	
80	Grams of CO2 per train ton-mile - 2022	grams/TM	21.0477	
81	Grams of CO2 per train ton-mile - 2023	grams/TM	20.7367	
82	Grams of CO2 per train ton-mile - 2024	grams/TM	20.4302	
83	Grams of CO2 per train ton-mile - 2025	grams/TM	20.1283	
84	Grams of CO2 per train ton-mile - 2026	grams/TM	19.8308	
85	Grams of CO2 per train ton-mile - 2027	grams/TM	19.5378	
86	Grams of CO2 per train ton-mile - 2028	grams/TM	19.2490	
87	Grams of CO2 per train ton-mile - 2029	grams/TM	18.9646	
88	Grams of CO2 per train ton-mile - 2030	grams/TM	18.6843	
89	Grams of CO2 per train ton-mile - 2031	grams/TM	18.4082	
90	Grams of CO2 per train ton-mile - 2032	grams/TM	18.1361	
91	Grams of CO2 per train ton-mile - 2033	grams/TM	17.8681	
92	Grams of CO2 per train ton-mile - 2034	grams/TM	17.6040	
93	Grams of CO2 per train	grams/TM	17.3439	

	ton-mile - 2035			
94	Grams of CO2 per train ton-mile - 2036	grams/TM	17.0876	
95	Grams of CO2 per train ton-mile - 2037	grams/TM	16.8350	
96	Grams of CO2 per train ton-mile - 2038	grams/TM	16.5862	
97	Grams of PM per truck ton-mile - 2015	grams/TM	0.0114	United States Environmental Protection Agency, Motor Vehicle Emission Simulator, 2014.
98	Grams of PM per truck ton-mile - 2016	grams/TM	0.0099	
99	Grams of PM per truck ton-mile - 2017	grams/TM	0.0086	
100	Grams of PM per truck ton-mile - 2018	grams/TM	0.0074	
101	Grams of PM per truck ton-mile - 2019	grams/TM	0.0063	
102	Grams of PM per truck ton-mile - 2020	grams/TM	0.0055	
103	Grams of PM per truck ton-mile - 2021	grams/TM	0.0047	
104	Grams of PM per truck ton-mile - 2022	grams/TM	0.0041	
105	Grams of PM per truck ton-mile - 2023	grams/TM	0.0036	
106	Grams of PM per truck ton-mile - 2024	grams/TM	0.0032	
107	Grams of PM per truck ton-mile - 2025	grams/TM	0.0028	
108	Grams of PM per truck ton-mile - 2026	grams/TM	0.0024	
109	Grams of PM per truck ton-mile - 2027	grams/TM	0.0021	
110	Grams of PM per truck ton-mile - 2028	grams/TM	0.0019	
111	Grams of PM per truck ton-mile - 2029	grams/TM	0.0016	
112	Grams of PM per truck ton-mile - 2030	grams/TM	0.0015	
113	Grams of PM per truck ton-mile - 2031	grams/TM	0.0013	
114	Grams of PM per truck ton-mile - 2032	grams/TM	0.0012	
115	Grams of PM per truck ton-mile - 2033	grams/TM	0.0011	
116	Grams of PM per truck ton-mile - 2034	grams/TM	0.0010	
117	Grams of PM per truck ton-mile - 2035	grams/TM	0.0010	
118	Grams of PM per truck ton-mile - 2036	grams/TM	0.0010	
119	Grams of PM per truck ton-mile - 2037	grams/TM	0.0009	
120	Grams of PM per truck ton-mile - 2038	grams/TM	0.0009	
121	Grams of PM per train ton-mile - 2015	grams/TM	0.0075	United States Environmental Protection
122	Grams of PM per train ton-	grams/TM	0.0068	

	mile - 2016			Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
123	Grams of PM per train ton-mile - 2017	grams/TM	0.0062	
124	Grams of PM per train ton-mile - 2018	grams/TM	0.0057	
125	Grams of PM per train ton-mile - 2019	grams/TM	0.0052	
126	Grams of PM per train ton-mile - 2020	grams/TM	0.0047	
127	Grams of PM per train ton-mile - 2021	grams/TM	0.0045	
128	Grams of PM per train ton-mile - 2022	grams/TM	0.0040	
129	Grams of PM per train ton-mile - 2023	grams/TM	0.0037	
130	Grams of PM per train ton-mile - 2024	grams/TM	0.0033	
131	Grams of PM per train ton-mile - 2025	grams/TM	0.0031	
132	Grams of PM per train ton-mile - 2026	grams/TM	0.0028	
133	Grams of PM per train ton-mile - 2027	grams/TM	0.0026	
134	Grams of PM per train ton-mile - 2028	grams/TM	0.0024	
135	Grams of PM per train ton-mile - 2029	grams/TM	0.0020	
136	Grams of PM per train ton-mile - 2030	grams/TM	0.0018	
137	Grams of PM per train ton-mile - 2031	grams/TM	0.0017	
138	Grams of PM per train ton-mile - 2032	grams/TM	0.0015	
139	Grams of PM per train ton-mile - 2033	grams/TM	0.0014	
140	Grams of PM per train ton-mile - 2034	grams/TM	0.0012	
141	Grams of PM per train ton-mile - 2035	grams/TM	0.0012	
142	Grams of PM per train ton-mile - 2036	grams/TM	0.0010	
143	Grams of PM per train ton-mile - 2037	grams/TM	0.0010	
144	Grams of PM per train ton-mile - 2038	grams/TM	0.0008	
145	Grams of VOC per truck ton-mile - 2015	grams/TM	0.0146	United States Environmental Protection Agency, Motor Vehicle Emission Simulator, 2014.
146	Grams of VOC per truck ton-mile - 2016	grams/TM	0.0128	
147	Grams of VOC per truck ton-mile - 2017	grams/TM	0.0112	
148	Grams of VOC per truck ton-mile - 2018	grams/TM	0.0097	
149	Grams of VOC per truck ton-mile - 2019	grams/TM	0.0084	
150	Grams of VOC per truck ton-mile - 2020	grams/TM	0.0073	
151	Grams of VOC per truck	grams/TM	0.0064	

	ton-mile - 2021			
152	Grams of VOC per truck ton-mile - 2022	grams/TM	0.0056	
153	Grams of VOC per truck ton-mile - 2023	grams/TM	0.0050	
154	Grams of VOC per truck ton-mile - 2024	grams/TM	0.0044	
155	Grams of VOC per truck ton-mile - 2025	grams/TM	0.0039	
156	Grams of VOC per truck ton-mile - 2026	grams/TM	0.0034	
157	Grams of VOC per truck ton-mile - 2027	grams/TM	0.0030	
158	Grams of VOC per truck ton-mile - 2028	grams/TM	0.0027	
159	Grams of VOC per truck ton-mile - 2029	grams/TM	0.0024	
160	Grams of VOC per truck ton-mile - 2030	grams/TM	0.0022	
161	Grams of VOC per truck ton-mile - 2031	grams/TM	0.0020	
162	Grams of VOC per truck ton-mile - 2032	grams/TM	0.0018	
163	Grams of VOC per truck ton-mile - 2033	grams/TM	0.0017	
164	Grams of VOC per truck ton-mile - 2034	grams/TM	0.0016	
165	Grams of VOC per truck ton-mile - 2035	grams/TM	0.0016	
166	Grams of VOC per truck ton-mile - 2036	grams/TM	0.0015	
167	Grams of VOC per truck ton-mile - 2037	grams/TM	0.0015	
168	Grams of VOC per truck ton-mile - 2038	grams/TM	0.0015	
169	Grams of VOC per train ton-mile - 2015	grams/TM	0.0137	United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009.
170	Grams of VOC per train ton-mile - 2016	grams/TM	0.0121	
171	Grams of VOC per train ton-mile - 2017	grams/TM	0.0107	
172	Grams of VOC per train ton-mile - 2018	grams/TM	0.0097	
173	Grams of VOC per train ton-mile - 2019	grams/TM	0.0088	
174	Grams of VOC per train ton-mile - 2020	grams/TM	0.0080	
175	Grams of VOC per train ton-mile - 2021	grams/TM	0.0075	
176	Grams of VOC per train ton-mile - 2022	grams/TM	0.0069	
177	Grams of VOC per train ton-mile - 2023	grams/TM	0.0064	
178	Grams of VOC per train ton-mile - 2024	grams/TM	0.0059	
179	Grams of VOC per train ton-mile - 2025	grams/TM	0.0054	
180	Grams of VOC per train	grams/TM	0.0051	

	ton-mile - 2026			
181	Grams of VOC per train ton-mile - 2027	grams/TM	0.0046	
182	Grams of VOC per train ton-mile - 2028	grams/TM	0.0042	
183	Grams of VOC per train ton-mile - 2029	grams/TM	0.0039	
184	Grams of VOC per train ton-mile - 2030	grams/TM	0.0037	
185	Grams of VOC per train ton-mile - 2031	grams/TM	0.0032	
186	Grams of VOC per train ton-mile - 2032	grams/TM	0.0030	
187	Grams of VOC per train ton-mile - 2033	grams/TM	0.0028	
188	Grams of VOC per train ton-mile - 2034	grams/TM	0.0025	
189	Grams of VOC per train ton-mile - 2035	grams/TM	0.0023	
190	Grams of VOC per train ton-mile - 2036	grams/TM	0.0021	
191	Grams of VOC per train ton-mile - 2037	grams/TM	0.0021	
192	Grams of VOC per train ton-mile - 2038	grams/TM	0.0019	
193	NOx cost per ton	2014$/short ton	$7,262	TIGER Benefit-Cost Analysis Resource Guide, March 27, 2015. Values per metric ton converted to $/short ton
194	CO2 cost per ton - 2015	2014$/short ton	$41.49	TIGER Benefit-Cost Analysis Resource Guide, March 27, 2015. Values per metric ton converted to $/short ton.
195	CO2 cost per ton - 2016	2014$/short ton	$42.41	
196	CO2 cost per ton - 2017	2014$/short ton	$43.33	
197	CO2 cost per ton - 2018	2014$/short ton	$45.17	
198	CO2 cost per ton - 2019	2014$/short ton	$47.02	
199	CO2 cost per ton - 2020	2014$/short ton	$47.94	
200	CO2 cost per ton - 2021	2014$/short ton	$47.94	
201	CO2 cost per ton - 2022	2014$/short ton	$49.78	
202	CO2 cost per ton - 2023	2014$/short ton	$50.70	
203	CO2 cost per ton - 2024	2014$/short ton	$51.63	
204	CO2 cost per ton - 2025	2014$/short ton	$52.55	
205	CO2 cost per ton - 2026	2014$/short ton	$53.47	
206	CO2 cost per ton - 2027	2014$/short ton	$55.31	
207	CO2 cost per ton - 2028	2014$/short ton	$56.24	
208	CO2 cost per ton - 2029	2014$/short ton	$57.16	
209	CO2 cost per ton - 2030	2014$/short ton	$58.08	
210	CO2 cost per ton - 2031	2014$/short ton	$58.08	

211	CO2 cost per ton - 2032	2014$/short ton	$59.92	
212	CO2 cost per ton - 2033	2014$/short ton	$60.85	
213	CO2 cost per ton - 2034	2014$/short ton	$61.77	
214	CO2 cost per ton - 2035	2014$/short ton	$62.69	
215	CO2 cost per ton - 2036	2014$/short ton	$63.61	
216	CO2 cost per ton - 2037	2014$/short ton	$65.45	
217	CO2 cost per ton - 2038	2014$/short ton	$66.38	
218	PM cost per ton	2014$/short ton	$332,237	TIGER Benefit-Cost Analysis Resource Guide, March 27, 2015. Values per metric ton converted to $/short ton
219	VOC cost per ton	2014$/short ton	$1,843	TIGER Benefit-Cost Analysis Resource Guide, March 27, 2015. Values per metric ton converted to $/short ton
220	Truck to Rail Distance Factor	Truck mile/Rail mile	0.8300	National Cooperative Highway Research Program (NCHRP) Report 388, "A Guidebook for Forecasting Freight Transportation Demand", 1997. We assume this figure includes dray distances. This factor is applied to account for relatively longer rail routes for the same origin-destination (O-D) pair.

7.4.3 Benefit Estimates

The table below shows the benefit estimates of emissions savings due to the UMTH project. The greenhouse gas and criteria air contaminant savings account for about 3% of the total benefits generated with this project.

Table 14: Estimates of Environmental Sustainability Benefits, Millions of 2014$

	In Project Opening Year, Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Emission Cost Savings due to Modal Switch from Truck to Rail	$0.04	$56.18	$19.92

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

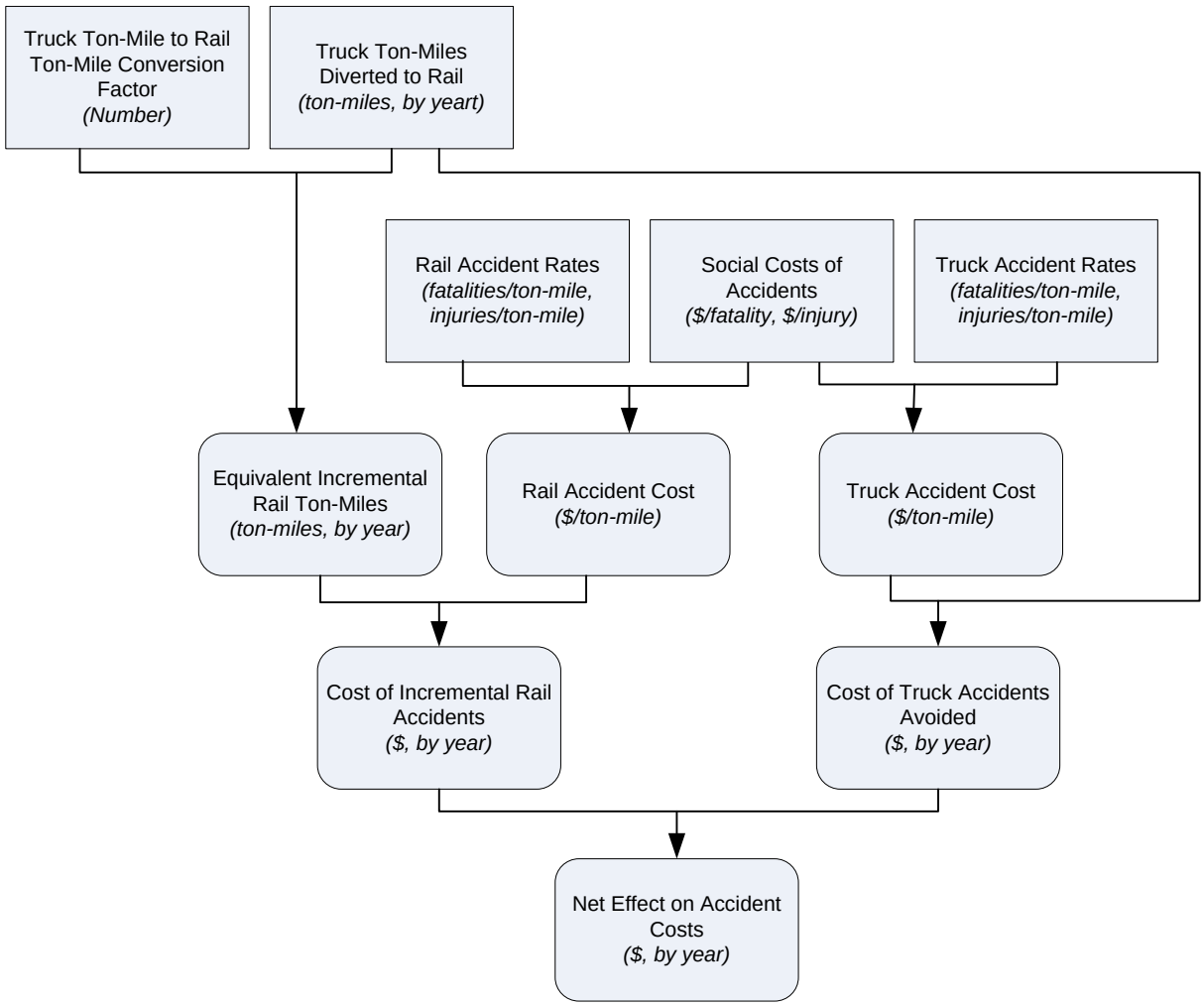
Reduced Accident Costs from Diverting Heavy Truck Travel to Rail

Fatality and injury rates per ton-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 ton-mile and train ton-mile. The accident cost values used here are based on TIGER Benefit-Cost Analysis Guide for accident values and the rates are based on published accident rate analysis for the two modes.[6] Due to the way accident rates are published, the accident cost values are based on the valuation of a fatal accident and an injury accident in which the severity of injury is unknown. Both accident costs are being increased annually by a rate of 1.18% (before discounting) to reflect the forecasts of growth in real incomes and thus growth in social costs of accidents.[7] Truck accident costs avoided are estimated by multiplying truck ton-miles diverted to rail by total accident cost per truck ton-mile. The incremental train ton-miles are estimated by multiplying truck ton-miles diverted by a truck ton-mile to train ton-mile conversion factor. This is then multiplied by the rail accident cost per train ton-mile to obtain the incremental rail accident costs that is partially offsetting truck accident costs avoided. The logic model outlining this calculation is provided in the figure below.

[6] The specific rates used are sourced from a 2011 GAO report: United States Government Accountability Office, "Surface Freight Transportation. A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers", Report to the Subcommittee on Select Revenue Measures, Committee on Ways and Means, House of Representatives, January 2011, Table 4, page 27.

[7] See" Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analysis, Memo dated February28, 2013, page 1.

Figure 6: Reduced Accident Costs S&L



7.5.2 Assumptions

The assumptions used in the estimation of safety benefits are summarized in the table below. Truck ton-miles diverted to rail were estimated in the same way as for other benefit categories.

Table 15: Assumptions used in the Estimation of Safety Benefits

Input #	Input Name	Units	Value	Source/Comment
1	Truck to Rail Distance Factor	Truck mile/Rail mile	0.83	National Cooperative Highway Research Program (NCHRP) Report 388, "A Guidebook for Forecasting Freight Transportation Demand", 1997. We assume this figure includes dray distances. This factor is applied to account for relatively longer rail routes for the same origin-destination (O-D) pair.
2	Fatalities per Billion Ton-Miles Truck	fatalities/Btm	2.54	Surface Freight Transportation. A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers, GAO, January 2011, Table 4.
3	Fatalities per Billion Ton-Miles Rail	fatalities/Btm	0.39	
4	Injuries per Billion Ton-Miles Truck	injuries/Btm	55.98	
5	Injuries per Billion Ton-Miles Rail	injuries/Btm	3.32	
6	Value of a Statistical Life	2014$	$9,552,486	US DOT, Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses. 2015.
7	Average Cost per Accident Injury	2014$	$173,168	US DOT, Based on MAIS Injury Severity Scale and KACBO-AIS Conversion if Injurty Unknown. Department of Transportation Analyses. 2015.
8	Accident Cost - Truck	2014$/per Million truck ton-miles	$34,358	Calculated from inputs above.
9	Accident Cost - Train	2014$/per Million truck ton-miles	$4,351	Calculated from inputs above.
10	Annual Growth in Real Accident Costs	% Annually	1.18%	US DOT, Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses. 2014.

7.5.3 Benefit Estimates

The table below shows the benefit estimates of improved safety due to the UMTH project. The reductions in accidents due to less truck miles account for about 55% of the total benefits generated with this project.

Table 16: Estimates of Safety Benefits, 2014$

	In Project Opening Year, Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Accident Cost Savings due to Modal Switch from Truck to Rail	$0.83	$1,055.89	$426.49

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 (2015-2038). As stated earlier, construction is expected to be completed by the end of 2016. Benefits accrue during the full operation of the project and begin in 2017.

Table 17: Overall Results of the Benefit Cost Analysis, Millions of 2014$*

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$781.75	$1,270.94
Total Discounted Costs	$139.01	$213.44
Net Present Value	$642.75	$1,057.50
Benefit / Cost Ratio	5.62	5.95
Payback Period (years)	1.51	

Considering all monetized benefits and costs, with a 7 percent real discount rate, the $16.17 million of initial capital investment would result in $781.75 million in total benefits, net present value of $642.75 million, and a Benefit/Cost Ratio of 5.62.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $1,057.50 million, for a Benefit/Cost ratio of 5.95.

Table 18: Benefit Estimates by Long-Term Outcome for the Full Project, Millions of 2014$

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Avoided Pavement Maintenance Costs	$133.1	$214.5
Economic Competitiveness	Shipper Savings due to Modal Switch from Truck to Rail and Choice of More Direct Intermodal Routes	$118.9	$189.4
Livability	Reduced Road Congestion due to Modal Switch from Truck to Rail	$83.3	$134.3

Environmental Sustainability	Emission Cost Savings due to Modal Switch from Truck to Rail	$19.9	$35.1
Safety	Accident Cost Savings due to Modal Switch from Truck to Rail	$426.5	$697.6
Total Benefit Estimates		$781.8	$1,270.9

9. BCA Sensitivity/Alternative 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 UMTH at Manly, Iowa, 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 25 percent increase in the capital costs of the project leads to a 6.1 percent reduction in the project NPV. A 25 percent decrease raises the project NPV by 7.2 percent.

The main driver in this particular analysis is the volume of truck to rail diversion. In order to illustrate a substantially wide range of possible outcomes, the annual truck miles diverted was adjusted by 25%. The impact of these values carries through to every impact of the study which is evident by the significant changes in NPV with a 7 percent discount rate (-20.8% and +34.1% respectively). Nonetheless, the B/C ratio remains exceptionally favorable (4.66 and 7.20 respectively). **In summary, this sensitivity analysis provides compelling evidence that that this project will generate significant net benefits and a high return on investment.**

Table 19: Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV (7% discounted)	Change in NPV	New B/C Ratio (7% discounted)
Truck Miles Saved	25% Increase	$861.94	34.1%	7.20
	25% Decrease	$509.14	-20.8%	4.66
Capital Cost Estimate	25% Increase	$681.73	6.1%	5.77

	25% Decrease	$689.34	7.2%	6.10

10. Supplementary Data Tables

This section breaks down all benefits associated with the five long-term outcome criteria (State of Good Repair, Economic Competiveness, Quality of Life, Sustainability, and Safety) in annual form for the UMTH project in Manly, Iowa.

10.1 Annual Estimates of Total Project Benefits and Costs

Calendar Year	Project Year	Total Benefits ($2014)	Total Costs ($2014)	Undiscounted Net Benefits ($2014)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2015	1	$0	-$1,617,014	-$1,617,014	-$1,617,014	-$1,617,014
2016	2	$0	-$14,553,124	-$14,553,124	-$13,601,050	-$14,129,246
2017 (opening)	3	$1,667,397	-$410,000	$1,257,397	$1,098,259	$1,185,218
2018	4	$35,314,843	-$6,072,000	$29,242,843	$23,870,871	$26,761,344
2019	5	$49,593,730	-$7,888,500	$41,705,230	$31,816,720	$37,054,557
2020	6	$55,260,259	-$9,303,930	$45,956,329	$32,766,227	$39,642,333
2021	7	$64,069,144	-$11,014,720	$53,054,423	$35,352,402	$44,432,244
2022	8	$75,614,546	-$13,062,999	$62,551,547	$38,953,960	$50,860,132
2023	9	$84,966,486	-$14,474,878	$70,491,608	$41,026,758	$55,646,727
2024	10	$93,463,651	-$16,009,933	$77,453,719	$42,129,691	$59,361,826
2025	11	$91,657,572	-$15,973,325	$75,684,248	$38,474,034	$56,316,188
2026	12	$93,248,996	-$16,001,033	$77,247,962	$36,699,950	$55,805,571
2027	13	$95,092,310	-$15,029,389	$80,062,921	$35,548,894	$56,154,522
2028	14	$96,931,664	-$15,058,136	$81,873,528	$33,974,604	$55,751,889
2029	15	$98,704,518	-$15,092,093	$83,612,425	$32,426,340	$55,277,663
2030	16	$100,560,626	-$15,131,113	$85,429,513	$30,963,587	$54,833,954
2031	17	$102,542,857	-$15,175,055	$87,367,802	$29,594,497	$54,444,726
2032	18	$104,576,447	-$15,223,785	$89,352,662	$28,286,764	$54,059,830
2033	19	$106,587,662	-$15,277,175	$91,310,487	$27,015,478	$53,635,288
2034	20	$108,676,562	-$15,335,102	$93,341,461	$25,809,692	$53,231,331
2035	21	$110,813,788	-$15,397,449	$95,416,339	$24,657,395	$52,829,713
2036	22	$112,973,244	-$15,464,106	$97,509,138	$23,549,733	$52,415,967
2037	23	$115,122,163	-$15,534,965	$99,587,198	$22,478,142	$51,973,812

2038	24	$117,389,150	-$15,609,926	$101,779,223	$21,470,010	$51,570,693
Total		**$1,914,827,614**	**-$309,709,747**	**$1,605,117,867**	**$642,745,945**	**$1,057,499,265**

10.2 Annual Demand Projections

Calendar Year	Project Year	Truck Miles Saved Per Year
2015	1	0
2016	2	0
2017 (opening)	3	1,603,125
2018	4	31,875,000
2019	5	43,200,000
2020	6	45,765,000
2021	7	52,147,800
2022	8	60,730,560
2023	9	70,108,416
2024	10	79,009,137
2025	11	76,843,701
2026	12	77,612,138
2027	13	78,388,259
2028	14	79,172,142
2029	15	79,963,863
2030	16	80,763,502
2031	17	81,571,137
2032	18	82,386,848
2033	19	83,210,717
2034	20	84,042,824

2035	21	84,883,252
2036	22	85,732,085
2037	23	86,589,406
2038	24	87,455,300

10.3 Benefit Estimates – Undiscounted Values

Calendar Year	Project Year	Avoided Pavement Maintenance Costs	Shipper Savings due to Modal Switch from Truck to Rail and Choice of More Direct Intermodal Routes	Emission Cost Savings due to Modal Switch from Truck to Rail	Accident Cost Savings due to Modal Switch from Truck to Rail	Reduced Road Congestion due to Modal Switch from Truck to Rail
2015	1	$0	$0	$0	$0	$0
2016	2	$0	$0	$0	$0	$0
2017 (opening)	3	$335,735	$124,688	$41,103	$955,681	$210,190
2018	4	$6,675,429	$4,462,500	$771,621	$19,226,070	$4,179,223
2019	5	$9,047,169	$7,560,000	$958,033	$26,364,453	$5,664,076
2020	6	$9,584,345	$10,489,500	$926,620	$28,259,414	$6,000,380
2021	7	$10,921,064	$12,825,540	$904,597	$32,580,696	$6,837,247
2022	8	$12,718,510	$15,458,688	$1,084,064	$38,390,726	$7,962,558
2023	9	$14,682,470	$14,936,141	$1,313,875	$44,841,886	$9,192,115
2024	10	$16,546,505	$13,826,599	$1,600,267	$51,131,167	$10,359,114
2025	11	$16,093,008	$13,447,648	$1,725,113	$50,316,606	$10,075,198
2026	12	$16,253,938	$13,582,124	$1,817,539	$51,419,445	$10,175,950
2027	13	$16,416,478	$13,717,945	$2,133,721	$52,546,456	$10,277,709
2028	14	$16,580,642	$13,855,125	$2,417,241	$53,698,169	$10,380,486
2029	15	$16,746,449	$13,993,676	$2,604,976	$54,875,126	$10,484,291

2030	16	$16,913,913	$14,133,613	$2,846,087	$56,077,879	$10,589,134
2031	17	$17,083,053	$14,274,949	$3,182,837	$57,306,994	$10,695,025
2032	18	$17,253,883	$14,417,698	$3,539,841	$58,563,049	$10,801,976
2033	19	$17,426,422	$14,561,875	$3,842,735	$59,846,634	$10,909,995
2034	20	$17,600,686	$14,707,494	$4,190,935	$61,158,352	$11,019,095
2035	21	$17,776,693	$14,854,569	$4,554,419	$62,498,821	$11,129,286
2036	22	$17,954,460	$15,003,115	$4,906,420	$63,868,670	$11,240,579
2037	23	$18,134,004	$15,153,146	$5,213,484	$65,268,543	$11,352,985
2039	24	$18,315,345	$15,304,677	$5,603,513	$66,699,099	$11,466,515
Total		**$321,060,200**	**$280,691,311**	**$56,179,040**	**$1,055,893,934**	**$201,003,128**

10.4 Benefit Estimates – Discounted Values (at 7 Percent)

Calendar Year	Project Year	Avoided Pavement Maintenance Costs	Shipper Savings due to Modal Switch from Truck to Rail and Choice of More Direct Intermodal Routes	Emission Cost Savings due to Modal Switch from Truck to Rail	Accident Cost Savings due to Modal Switch from Truck to Rail	Reduced Road Congestion due to Modal Switch from Truck to Rail
2015	1	0	0	0	0	0
2016	2	$0	$0	$0	$0	$0
2017 (opening)	3	$293,244	$108,907	$35,901	$834,729	$183,588
2018	4	$5,449,138	$3,642,729	$629,873	$15,694,200	$3,411,490
2019	5	$6,902,042	$5,767,488	$730,879	$20,113,315	$4,321,096
2020	6	$6,833,505	$7,478,869	$660,667	$20,148,572	$4,278,188
2021	7	$7,277,166	$8,546,199	$602,771	$21,709,893	$4,555,947
2022	8	$7,920,449	$9,626,894	$675,101	$23,907,815	$4,958,681
2023	9	$8,545,331	$8,692,970	$764,687	$26,098,386	$5,349,895
2024	10	$9,000,202	$7,520,754	$870,439	$27,811,967	$5,634,672

2025	11	$8,180,869	$6,836,102	$876,960	$25,578,411	$5,121,720
2026	12	$7,722,129	$6,452,769	$863,500	$24,429,008	$4,834,520
2027	13	$7,289,112	$6,090,932	$947,398	$23,331,255	$4,563,426
2028	14	$6,880,377	$5,749,384	$1,003,069	$22,282,831	$4,307,533
2029	15	$6,494,562	$5,426,989	$1,010,255	$21,281,520	$4,065,989
2030	16	$6,130,381	$5,122,672	$1,031,553	$20,325,204	$3,837,989
2031	17	$5,786,621	$4,835,419	$1,078,137	$19,411,862	$3,622,775
2032	18	$5,462,138	$4,564,274	$1,120,623	$18,539,561	$3,419,629
2033	19	$5,155,849	$4,308,334	$1,136,927	$17,706,459	$3,227,874
2034	20	$4,866,736	$4,066,745	$1,158,828	$16,910,794	$3,046,872
2035	21	$4,593,835	$3,838,703	$1,176,948	$16,150,883	$2,876,019
2036	22	$4,336,237	$3,623,449	$1,184,965	$15,425,120	$2,714,747
2037	23	$4,093,084	$3,420,265	$1,176,752	$14,731,970	$2,562,518
2039	24	$3,863,565	$3,228,474	$1,182,044	$14,069,967	$2,418,826
Total		**$133,076,573**	**$118,949,319**	**$19,918,275**	**$426,493,720**	**$83,313,993**