

Benefit-cost Analysis Supplementary Documentation

2021 Consolidated Rail Infrastructure and Safety Improvements Program (CRISI) Grants Program

Sharp–Tintic Railroad Connection Project

Utah Transit Authority

November 2021

Contents

Executive Summary	1
1 Introduction	8
2 Methodological Framework	9
3 Project Overview	10
3.1 Base Case and Alternative Case	10
3.2 Project Cost and Schedule	11
3.3 Benefit Outcomes	12
4 General Assumptions	12
5 Demand Projections	13
5.1 Methodology	13
5.2 Assumptions	13
5.3 Demand Projections	17
6 Estimation of Economic Benefits	18
6.1 Accident Cost Savings	18
6.2 Travel Time Savings	19
6.3 Emission Cost Savings	20
6.4 Vehicle Operating Costs	25
6.5 Land Value Increases	28
6.6 O&M Cost Savings	31
6.7 Residual Value	31
6.8 Qualitative Benefits	32
7 Summary of Findings and Benefit-Cost Outcomes	33
8 Benefit-Cost Sensitivity Analysis	34
8.1 Variation in Key Inputs and Assumptions	34
9 Supplementary Data Tables	35
9.1 Annual Estimates of Total Project Benefits and Costs	36
9.2 Annual Demand Projections	37
9.3 Accident Cost Savings: Pertinent Quantifiable Impacts	38
9.4 Accident Cost Savings: Annual Benefit Estimates	39
9.5 Travel Time Savings: Pertinent Quantifiable Impacts	40
9.6 Travel Time Savings: Annual Benefit Estimates	41
9.7 Emission Cost Savings: Pertinent Quantifiable Impacts	42
9.8 Emission Cost Savings: Annual Benefit Estimates	43
9.9 Vehicle Operating Costs: Pertinent Quantifiable Impacts	44
9.10 Vehicle Operating Costs: Annual Benefit Estimates	45
9.11 Land Value Increases: Annual Benefit Estimates	46
9.12 O&M Cost Savings: Annual Benefit Estimates	47
9.13 Residual Value: Annual Benefits Estimates	48

Tables

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits	3
Table ES-2: Summary of Total Project Benefits and Costs (2019\$)	5
Table ES-3: Summary of Project Benefits by Benefit Type.....	6
Table ES-4: Summary of Pertinent Quantifiable Data.....	7
Table 1: Cost Summary Table.....	11
Table 2: Capital Cost by Component	12
Table 3: Expected Effects on Benefit Categories.....	12
Table 4: Assumptions used in the Estimation of Demand.....	14
Table 5: Demand Projections – Through Train	17
Table 6: Demand Projections - AADT	17
Table 7: Assumptions Used in the Estimation of Accident Cost Savings.....	18
Table 8: Estimates of Accident Cost Savings, 2019 Dollars	18
Table 9: Assumptions used in the Travel Time Savings Benefits	19
Table 10: Estimates of Travel Time Savings, 2019 Dollars	19
Table 11: Emission Cost	21
Table 12: Vehicle Emissions	22
Table 13: Truck Emissions.....	23
Table 14: Bus Emissions.....	24
Table 15: Estimates of Emission Cost Savings, 2019 Dollars	25
Table 16: Assumptions used in the Estimation of Vehicle Operating Costs	25
Table 17: Estimates of Vehicle Operating Costs, 2019 Dollars	27
Table 18: Assumptions Used in the Estimation of Land Value Increases.....	30
Table 19: Estimates of Land Value Increase, 2019 Dollars	30
Table 20: Assumptions Used in the Estimation of O&M Cost Savings	31
Table 21: Estimates of O&M Cost Savings, 2019 Dollars.....	31
Table 22: Assumptions Used in the Estimation of Residual Value	32
Table 23: Estimates of Residual Value, 2019 Dollars	32
Table 24: Overall Results of the Benefit-cost Analysis, 2019 Dollars*	33
Table 25: Benefit Estimates for the Full Build Alternative	33
Table 26: Quantitative Assessment of Sensitivity, Summary (Discounted at 7%)	34

Figures

Figure ES-1: Sharp-Tintic Railroad Connection Project Concept	2
Figure 1: Comparable Regions for Land Value Increase Assessment	29

Executive Summary

The Utah Transit Authority (UTA) (as grant applicant) and Utah Department of Transportation (UDOT), in partnership with Union Pacific Railroad (UPRR), the Mountainland Association of Governments (MAG), and cities of Springville and Spanish Fork, Utah, are submitting this application for a Consolidated Rail Infrastructure and Safety Improvements (CRISI) Program grant for the Sharp-Tintic Railroad Connection (Project).

CRISI grant funding is being sought to refine design and construct 1.4 miles of new railroad tracks connecting the Sharp and Tintic Railroad corridors within the cities of Springville and Spanish Fork, while closing and future re-purposing of seven at-grade rail crossings.

Completion of this Project will:

- Improve safety by closing grade-crossings that lack crossing gates, arms, lights, and other modern safety infrastructure;
- Re-route Union Pacific freight trains from the Tintic Railroad Line to the Sharp Railroad Line, bypassing and retiring the current route through Springville residential areas, resulting in:
 - The City of Springville's ability to reclaim access to the land currently used for Tintic Railroad crossings.
 - The elimination of the rail barrier obstructing access to two existing and one future public school(s).
- Enable a future project for a grade-separated crossing to be constructed over the Sharp Railroad Line eliminating the at-grade crossing at the same location. The proximity of the existing Springville 1600 South Tintic railroad crossing to Sharp crossing makes it impractical to build a second grade-separated crossing over the Tintic line.
- Provide a route for future expansion of the UTA FrontRunner commuter rail service to southern Utah County. Through future southward expansion of FrontRunner, the Project will create the potential to introduce new mobility options in the County and decrease the amount of single occupancy vehicles on the surrounding road network.

Over a 30-year period of operation, the Project is projected to result in \$17.33 million in discounted benefits. The total Project cost is \$15.64 Million with a resulting benefit-cost ratio of 1.38. A detailed benefit-cost spreadsheet is uploaded to FRA.

The Project is presented on the next page in Figure ES-1.

Figure ES-1: Sharp-Tintic Railroad Connection Project Concept

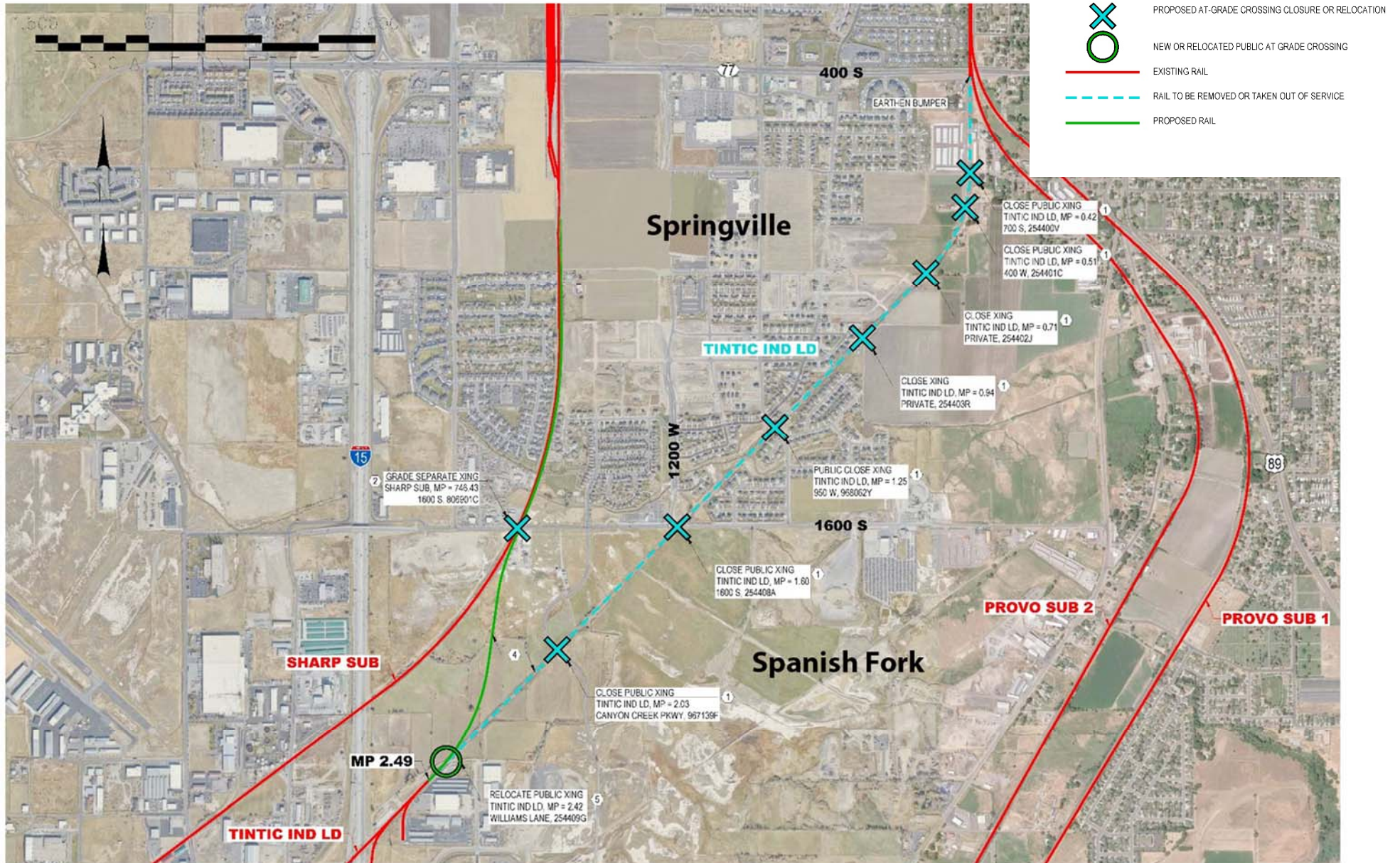


Table ES-1 summarizes the impacts and associated monetary benefits expected from the Sharp-Tintic Railroad Connection Project.

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

Current Status or Baseline and Problems to be Addressed	Changes to Baseline/ Alternative	Type of Impacts	Population Affected by Impacts	Economic Benefits	Summary of Results (2019\$) Undiscounted	Summary of Results (2019\$) Discounted at 7%
<p>The Tintic Line travels from Interstate 15 (I-15) in Spanish Fork to 400 South in Springville. Currently, through train traffic along the Tintic Line passes through six active at-grade crossings, which generates delays for local motorists and potential safety concerns for residents.</p>	<p>The Project will construct new leads diverting train traffic to the Sharp Line. While the new connection results in increase traffic in the Sharp Line, the Project will receive notable benefits closing six at-grade crossings along the Tintic Line. This will significantly reduce delays and potential safety concerns for both motorists and local residents. In addition, the Project will support improved freight operations and future transit operations.</p>	Improved safety and avoided accident costs through a net reduction in active crossings.	Shippers, motorists, local businesses and residents	Accident cost savings	\$2,312,423	\$729,807
		Reduce vehicle delay at crossings.	Shippers, motorists, local businesses and residents	Travel time savings	\$21,212,498	\$5,894,793
		Reduce emissions from idling vehicles delayed at grade crossings.	Local residents and residents across the county	Emissions cost savings	\$172,967	\$54,756
		Reduce out-of-pocket transportation costs from vehicle idling and delay along the grade crossings.	Shippers, motorists, and local businesses	Vehicle operating cost savings	\$2,501,627	\$657,183
		Increase the land value of properties due to the removal of a segment of the Tintic Line.	Local businesses, residents, and government	Land value increase	\$12,248,164	\$9,344,066
		Avoided future maintenance once crossings are closed.	Railroad operators and local government	Operation and maintenance (O&M) cost savings	\$734,235	\$247,914
		Residual value of infrastructure assets and land.	Local, state, and federal governments	Residual value	\$3,620,160	\$388,207
		The removal of a segment of the Tintic Line will reduce noise levels, improve air quality, and support the promotion of public transportation.	Local residents	Quality of life	N/A	N/A

The period of analysis used in the estimation of benefits and costs is 34 years, including 4 years of project development and construction followed by 30 years of operation. The total project cost is estimated at \$15.64 million in year of expenditure (YOE) dollars. For the purpose of the benefit-cost analysis (BCA), costs were deflated to 2019 using the gross domestic product (GDP) deflator. The total 2019 (undiscounted) project cost is estimated at \$14.80 million.

Table ES-2, Table ES-3, and Table ES-4 provide various summaries of the relevant data and calculations used to derive the benefits and costs of the Project. Based on the analysis presented in this document, the Project is expected to generate \$17.32 million in discounted benefits against \$12.53 million in discounted costs, using a 7% real discount rate. Therefore, the Project is expected to generate a net present value (NPV) of \$4.79 million and a benefit-cost ratio (BCR) of 1.38.

In addition to the monetized benefits presented in Table ES-2 and Table ES-3, the Project would generate benefits that are difficult to monetize. Specifically, removing a segment of the Tintic Line is expected to improve the quality of life through reduced noise levels, and improve air quality through reduced vehicle idling at the grade crossings. In addition, there are redevelopment plans to open up the area to alternative uses, while promoting the use of public transportation through the future intermodal transportation hub. The Project will also provide a safe walking route for children to a local elementary school and reduce the length of bus routes.

Table ES-2: Summary of Total Project Benefits and Costs (2019\$)

Calendar Year	Project Year	Direct Beneficiaries	Total Economic Benefits	Total Costs	Undiscounted Net Benefits	Discounted Total Benefits at 7%	Discounted Total Costs at 7%	Discounted Net Benefits at 7%
2021	1	Workers otherwise unemployed (shadow wage benefit); not quantified	\$0	\$442,825	-\$442,825	\$0	\$442,825	-\$442,825
2022	2		\$0	\$1,962,150	-\$1,962,150	\$0	\$1,833,785	-\$1,833,785
2023	3		\$0	\$2,275,820	-\$2,275,820	\$0	\$1,987,790	-\$1,987,790
2024	4		\$0	\$10,122,708	-\$10,122,708	\$0	\$8,263,145	-\$8,263,145
2025	5	Federal and State governments, pedestrians, cyclists, motorists, local residents and businesses, trucking companies, property owners along the project corridor, and other residents across the country.	\$12,751,804	\$0	\$12,751,804	\$9,728,290	\$0	\$9,728,290
2026	6		\$521,548	\$0	\$521,548	\$371,856	\$0	\$371,856
2027	7		\$540,132	\$0	\$540,132	\$359,913	\$0	\$359,913
2028	8		\$559,335	\$0	\$559,335	\$348,326	\$0	\$348,326
2029	9		\$579,509	\$0	\$579,509	\$337,280	\$0	\$337,280
2030	10		\$601,282	\$0	\$601,282	\$327,058	\$0	\$327,058
2031	11		\$623,116	\$0	\$623,116	\$316,761	\$0	\$316,761
2032	12		\$645,846	\$0	\$645,846	\$306,837	\$0	\$306,837
2033	13		\$669,998	\$0	\$669,998	\$297,487	\$0	\$297,487
2034	14		\$694,996	\$0	\$694,996	\$288,398	\$0	\$288,398
2035	15		\$720,715	\$0	\$720,715	\$279,506	\$0	\$279,506
2036	16		\$747,565	\$0	\$747,565	\$270,952	\$0	\$270,952
2037	17		\$774,978	\$0	\$774,978	\$262,512	\$0	\$262,512
2038	18		\$803,941	\$0	\$803,941	\$254,507	\$0	\$254,507
2039	19		\$834,228	\$0	\$834,228	\$246,818	\$0	\$246,818
2040	20		\$864,969	\$0	\$864,969	\$239,171	\$0	\$239,171
2041	21		\$897,563	\$0	\$897,563	\$231,947	\$0	\$231,947
2042	22		\$932,268	\$0	\$932,268	\$225,155	\$0	\$225,155
2043	23		\$967,657	\$0	\$967,657	\$218,413	\$0	\$218,413
2044	24		\$1,004,492	\$0	\$1,004,492	\$211,894	\$0	\$211,894
2045	25		\$1,043,371	\$0	\$1,043,371	\$205,697	\$0	\$205,697
2046	26		\$1,082,711	\$0	\$1,082,711	\$199,489	\$0	\$199,489
2047	27		\$1,125,107	\$0	\$1,125,107	\$193,738	\$0	\$193,738
2048	28		\$1,168,720	\$0	\$1,168,720	\$188,083	\$0	\$188,083
2049	29		\$1,213,850	\$0	\$1,213,850	\$182,566	\$0	\$182,566
2050	30		\$1,260,596	\$0	\$1,260,596	\$177,193	\$0	\$177,193
2051	31		\$1,309,476	\$0	\$1,309,476	\$172,022	\$0	\$172,022
2052	32		\$1,360,357	\$0	\$1,360,357	\$167,015	\$0	\$167,015
2053	33		\$1,413,323	\$0	\$1,413,323	\$162,166	\$0	\$162,166
2054	34		\$5,088,622	\$0	\$5,088,622	\$545,677	\$0	\$545,677
Total			\$42,802,075	\$14,803,504	\$27,998,571	\$17,316,726	\$12,527,545	\$4,789,181

Table ES-3: Summary of Undiscounted Project Benefits by Benefit Type

Calendar Year	Project Year	Accident Cost Savings	Travel Time Savings	Emissions Cost Savings	Vehicle Operating Cost Savings	Land Value Increase	O&M Cost Savings	Residual Value
2021	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2022	2	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2023	3	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2024	4	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2025	5	\$62,562	\$375,617	\$5,458	\$35,528	\$12,248,164	\$24,475	\$0
2026	6	\$63,416	\$390,797	\$5,407	\$37,453	\$0	\$24,475	\$0
2027	7	\$64,287	\$406,590	\$5,341	\$39,439	\$0	\$24,475	\$0
2028	8	\$65,175	\$423,022	\$5,243	\$41,421	\$0	\$24,475	\$0
2029	9	\$66,079	\$440,118	\$5,118	\$43,720	\$0	\$24,475	\$0
2030	10	\$66,998	\$457,904	\$4,969	\$46,937	\$0	\$24,475	\$0
2031	11	\$67,932	\$476,410	\$4,991	\$49,308	\$0	\$24,475	\$0
2032	12	\$68,881	\$495,663	\$5,007	\$51,821	\$0	\$24,475	\$0
2033	13	\$69,846	\$515,694	\$5,014	\$54,970	\$0	\$24,475	\$0
2034	14	\$70,825	\$536,535	\$5,057	\$58,104	\$0	\$24,475	\$0
2035	15	\$71,819	\$558,218	\$5,046	\$61,157	\$0	\$24,475	\$0
2036	16	\$72,828	\$580,778	\$5,025	\$64,460	\$0	\$24,475	\$0
2037	17	\$73,853	\$604,249	\$4,993	\$67,409	\$0	\$24,475	\$0
2038	18	\$74,893	\$628,669	\$4,949	\$70,955	\$0	\$24,475	\$0
2039	19	\$75,948	\$654,076	\$4,892	\$74,838	\$0	\$24,475	\$0
2040	20	\$77,020	\$680,509	\$4,820	\$78,145	\$0	\$24,475	\$0
2041	21	\$78,107	\$708,011	\$5,007	\$81,964	\$0	\$24,475	\$0
2042	22	\$79,210	\$736,624	\$5,255	\$86,704	\$0	\$24,475	\$0
2043	23	\$80,330	\$766,393	\$5,455	\$91,004	\$0	\$24,475	\$0
2044	24	\$81,466	\$797,366	\$5,662	\$95,523	\$0	\$24,475	\$0
2045	25	\$82,619	\$829,590	\$5,875	\$100,813	\$0	\$24,475	\$0
2046	26	\$83,789	\$863,116	\$6,095	\$105,236	\$0	\$24,475	\$0
2047	27	\$84,976	\$897,998	\$6,321	\$111,337	\$0	\$24,475	\$0
2048	28	\$86,181	\$934,289	\$6,555	\$117,221	\$0	\$24,475	\$0
2049	29	\$87,403	\$972,047	\$6,862	\$123,064	\$0	\$24,475	\$0
2050	30	\$88,643	\$1,011,330	\$7,111	\$129,038	\$0	\$24,475	\$0
2051	31	\$89,901	\$1,052,201	\$7,398	\$135,500	\$0	\$24,475	\$0
2052	32	\$91,177	\$1,094,724	\$7,697	\$142,283	\$0	\$24,475	\$0
2053	33	\$92,472	\$1,138,966	\$8,009	\$149,402	\$0	\$24,475	\$0
2054	34	\$93,786	\$1,184,995	\$8,332	\$156,873	\$0	\$24,475	\$3,620,160
Total		\$2,312,423	\$21,212,498	\$172,967	\$2,501,627	\$12,248,164	\$734,235	\$3,620,160

Table ES-4: Summary of Pertinent Quantifiable Data

Calendar Year	Project Year	Fatalities Avoided	Injuries Avoided	PDO-Accidents Avoided	Avoided Person Hours of Travel Time(Hours)	Avoided Gasoline Consumption (Gallons)	Avoided Diesel Consumption (Gallons)	Avoided Motor Oil Consumption (Quarts)
2021	1	0.000	0.000	0.000	0	0	0	0
2022	2	0.000	0.000	0.000	0	0	0	0
2023	3	0.000	0.000	0.000	0	0	0	0
2024	4	0.000	0.000	0.000	0	0	0	0
2025	5	0.004	0.063	0.310	20,149	11,192	2,984	432
2026	6	0.004	0.064	0.314	20,963	11,644	3,104	450
2027	7	0.004	0.064	0.318	21,811	12,115	3,230	468
2028	8	0.004	0.065	0.323	22,692	12,605	3,360	487
2029	9	0.004	0.066	0.327	23,609	13,114	3,496	506
2030	10	0.004	0.067	0.331	24,563	13,644	3,637	527
2031	11	0.004	0.068	0.336	25,556	14,195	3,784	548
2032	12	0.004	0.069	0.341	26,589	14,769	3,937	570
2033	13	0.004	0.070	0.345	27,663	15,366	4,096	593
2034	14	0.004	0.071	0.350	28,781	15,987	4,262	617
2035	15	0.004	0.072	0.355	29,944	16,633	4,434	642
2036	16	0.004	0.073	0.360	31,154	17,305	4,613	668
2037	17	0.004	0.074	0.365	32,413	18,004	4,800	695
2038	18	0.004	0.075	0.370	33,723	18,732	4,994	723
2039	19	0.004	0.076	0.375	35,086	19,489	5,195	753
2040	20	0.004	0.077	0.380	36,504	20,277	5,405	783
2041	21	0.004	0.078	0.385	37,979	21,096	5,624	815
2042	22	0.005	0.079	0.390	39,514	21,949	5,851	848
2043	23	0.005	0.080	0.396	41,111	22,836	6,087	882
2044	24	0.005	0.081	0.401	42,773	23,759	6,333	918
2045	25	0.005	0.082	0.407	44,501	24,719	6,589	955
2046	26	0.005	0.084	0.412	46,300	25,718	6,856	993
2047	27	0.005	0.085	0.418	48,171	26,757	7,133	1,033
2048	28	0.005	0.086	0.424	50,118	27,838	7,421	1,075
2049	29	0.005	0.087	0.429	52,143	28,964	7,721	1,119
2050	30	0.005	0.088	0.435	54,250	30,134	8,033	1,164
2051	31	0.005	0.089	0.441	56,443	31,352	8,358	1,211
2052	32	0.005	0.091	0.447	58,724	32,619	8,695	1,260
2053	33	0.005	0.092	0.453	61,097	33,937	9,047	1,311
2054	34	0.005	0.093	0.460	63,566	35,309	9,412	1,364
Total		0.133	2.309	11.396	1,137,892	632,056	168,491	24,412

1 Introduction

This document provides detailed technical information regarding the benefit-cost analysis (BCA) conducted in support of the Federal Railroad Administration's (FRA) fiscal year (FY) 2021 Consolidated Rail Infrastructure and Safety Improvements (CRISI) program grant application for the Sharp-Tintic Railroad Connection Project (the Project).

This BCA was originally prepared for UTA by HDR, Inc., for inclusion in a FY 2020 CRISI grant application. The analysis has since been updated by UTA for the FY 2021 CRISI program. Revisions include an updated project cost estimate and delivery schedule, and updated BCA parameters based on United States Department of Transportation (USDOT) BCA guidelines published in February 2021.

- **Section 2, Methodological Framework:** Introduces the conceptual framework used in the BCA.
- **Section 3, 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 Sharp-Tintic Railroad Connection Project is expected to generate.
- **Section 4, General Assumptions:** Discusses the general assumptions used in the estimation of project costs and benefits.
- **Section 5, Demand Projections:** Provides estimates of travel demand and traffic volumes.
- **Section 6, Estimation of Economic Benefits:** Details the specific data elements and assumptions used to address the goals of the Project to comply with CRISI program requirements.
- **Section 7, Summary of Findings and Benefit-Cost Outcomes:** Provides estimates of the NPV, BCR, and other evaluation metrics.
- **Section 8, Benefit-cost Sensitivity Analysis:** Provides the outcome of the sensitivity analysis that evaluates the different assumptions made in the analysis and the impact that the variability of those assumptions could have on the overall results.
- **Section 9, Supplementary Data Tables:** Includes a breakdown of all benefits associated with the outcomes for the Project, including annual estimates of benefits and costs, as well as intermediate values to assist the USDOT in its review of the application. The BCA model spreadsheets will also be provided as part of the grant application.

2 Methodological Framework

The BCA conducted for this project includes monetized benefits and costs measured using USDOT guidance, as well as the quantitative and qualitative merits of the Project. A BCA provides estimates of the benefits that are expected to accrue over a specified period and compares them to the anticipated costs. Costs include both the resources required to develop the Project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the Project on both users and non-users of the facility, valued in monetary terms.²

Although the BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.³

The specific methodology used for this application was developed using the BCA guidance developed by USDOT and is consistent with the CRISI program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the Base Case (No-Build) and Alternative Case (Build) scenarios;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of safety benefits and reductions in air pollutant 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 USDOT (7%); and,
- Conducting a sensitivity analysis to assess the impacts of changes in key assumptions.

² USDOT, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, February 2021

³ *Ibid.*

3 Project Overview

The Sharp-Tintic Railroad Connection Project (the Project) will improve freight rail operations in Springville and Spanish Fork, Utah, by streamlining routes, increasing safety by reducing the number of at-grade crossings, and improving overall freight operations through a fast-growing metropolitan corridor. This will be achieved through closing a segment of the Tintic track, which currently runs from Interstate 15 (I-15) in Spanish Fork to 400 South in Springville, and constructing a new line that connects Tintic at I-15 to Sharp at 1600 South.

The Project will close a segment of the Tintic Line, which will result in the closure of seven at-grade crossings. In addition, it looks to redirect some train traffic from the Tintic Line to the Sharp Line. The Sharp-Tintic Rail Connection will streamline freight connections between the Provo Rail Yard and Tintic customers located south of Spanish Fork by providing a shorter distance traveled and fewer at-grade crossings.

The Project is expected to improve safety by reducing potential train/vehicle accidents and to generate benefits through avoiding vehicle idling along the Tintic Railroad. These benefits are projected to increase as both redevelopment and planning around the local area are expected to increase vehicle traffic. The Project is also expected to have a significant impact on land values adjacent to the tracks. Specifically, land values for parcels within 500 feet of the tracks are expected to experience a 5 percent price uplift.

The new tracks will make an interconnection from the Sharp Railroad line to the Tintic Railroad line for the potential use of Utah Transit Authority's (UTA) FrontRunner commuter rail and will improve land-development options in Springville and Spanish Fork, thereby strengthening the cities' economic potential and improving their overall land use pattern.

3.1 Base Case and Alternative Case

3.1.1 Base Case

The Base Case for the Sharp-Tintic Railroad Connection Project is defined as the No Build scenario. In the Base Case, through trains will continue to operate along the Tintic Line. This will result in continued risk of train/vehicle accidents occurring along the at-grade crossings as well as traffic delays from through train movements.

The key assumptions used to define the Base Case (No Build Scenario) are as follows:

- **2** daily through trains on the Tintic track;
- **6** daily through trains on the Sharp track north of the project area;
- **8** daily through trains on the Tintic track north of the project area;
- Through train length of **3,960** feet (three-quarters of one mile);
- Through train traffic assumed to grow at 1.1% per year; and,
- **2,347** acres of mixed-use land within 500 feet of the industrial lead, currently valued at a blended average of **\$104,390** per acre (2019 dollars) based on Utah County assessed values.

3.1.2 Alternative Case

The Alternative Case is defined as the Build scenario. In the Alternative Case, a segment of the Tintic Line is closed and at-grade crossing rails are removed. This would eliminate seven at-grade crossings and the social cost associated with each of the grade crossings. The removal of the rail line is also expected to increase the land value of parcels located within 500 feet of the track.

Specifically, the new infrastructure and improved process described in the project overview section above will result in the following changes to key inputs and assumptions:

- **2** daily through trains on the Sharp-Tintic Connection track;
- **8** daily through trains on the Sharp track north of the project area;
- **6** daily through trains on the Tintic track north of the project area;
- Through train length of **3,960** feet (same as the base case);
- Through train traffic assumed to grow at 1.1% per year (same as the base case);
- **6** at-grade crossing closed. While the Project will remove seven crossings, one has already been blocked and is therefore not included in this analysis;
- Removal of tracks is expected to increase land value within 500 feet of the Tintic track; and,
- **2,347** acres of mixed-use land within 500 feet of the industrial lead will experience a 5 percent price uplift.

3.2 Project Cost and Schedule

Table 1 summarizes the Project’s capital expenditure components, with project delivery estimated for early in the second half of 2024. Cost is shown in both YOE dollars and adjusted to constant 2019 dollars for use in the BCA. These costs include expenditures prior to the anticipated CRISI grant obligation date. Table 2 shows cost by component in 2019 dollars.

Table 1: Cost Summary Table

Capital Expenditures	YOE Dollars	2019 Dollars
2021	\$452,645	\$442,825
2022	\$2,045,576	\$1,962,150
2023	\$2,427,553	\$2,275,820
2024	\$11,057,881	\$10,122,708
Total	\$15,983,656	\$14,803,504

Table 2: Capital Cost by Component

Capital Expenditures	2019 Dollars	Percentage of Project Costs
Engineering and Environmental Permitting	\$1,244,253	8.4%
Right of Way	\$1,820,135	12.3%
Utilities	\$465,461	3.1%
Construction	\$7,200,100	48.6%
C.E.	\$641,990	4.3%
Contingency	\$2,959,389	20.0%
UPRR Coordination	\$283,306	1.9%
Agency Coordination	\$188,870	1.3%
Total	\$14,803,504	

3.3 Benefit Outcomes

The main benefit categories associated with the Project are summarized in Table 3.

Table 3: Expected Effects on Benefit Categories

Benefit or Impact Category	Description	Monetized	Qualitative
Accident cost savings	Improved safety and avoided accident costs through a net reduction in active crossings.	Yes	-
Travel time savings	Reduce vehicle delay at crossings.	Yes	-
Emissions cost savings	Reduce emissions from idling vehicles delayed at grade crossings.	Yes	-
Vehicle operating cost savings	Reduce out-of-pocket transportation costs from vehicle idling and delay along the grade crossings.	Yes	-
Land value increase	Increase the land value of properties due to the removal of a segment of the Tintic Line.	Yes	-
O&M cost savings	Avoided future maintenance once crossings are closed.	Yes	-
Residual value	Residual value of infrastructure assets and land.	Yes	-
Quality of life	The removal of a segment of the Tintic Line will reduce noise levels, improve air quality, and support the promotion of public transportation.	-	Yes

4 General Assumptions

The BCA measures benefits against costs throughout a period of analysis starting with project development and including 30 years of operations.

The monetized benefits and costs are estimated in 2019 dollars with future dollars discounted in compliance with CRISI requirements using a 7% real rate, and sensitivity testing at 3%.

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

- Input prices are expressed in 2019 dollars.
- The period of analysis begins in 2021 and ends in 2054. It includes 4 years for project development and construction (2021 – 2024) and 30 full years of operations (2025 – 2054). As the project schedule currently estimates completion in the second half of

2024, no benefits were quantified for 2024 to be conservative in the event of minor schedule delays.

- A constant 7% real discount rate is assumed throughout the period of analysis. For sensitivity analysis, the BCA was also calculated using a 3% discount rate.

5 Demand Projections

Accurate demand projections are important to ensure reasonable BCA output results. The magnitudes of the long-term benefits accruing over the Sharp-Tintic Railroad Connection Project study period are a function of through train traffic in the corridor and the average dailyvehicle count (annual average daily traffic, or AADT) at the active crossings.

5.1 Methodology

Daily through train volumes are forecasted based on current daily through train volumes. The current through train volumes were obtained from FRA's Grade Crossing Inventory for the impacted crossings along the Tintic and Sharp tracks. Train traffic is assumed to grow at 1.1% per year from the base year, based on the statewide rail traffic forecast.¹

For daily vehicle traffic at each of the active crossings, average vehicle counts were obtained from FRA's Grade Crossing Inventory and projected using the growth in vehicle counts.

5.2 Assumptions

General assumptions used for the entire corridor in the estimation of demand inputs for the Sharp-Tintic Railroad Connection Project are provided in Table 4.

¹ Utah Freight Plan. 2017. Available online at <https://www.udot.utah.gov/main/uconowner.gf?n=23980801691013244>

Table 4: Assumptions used in the Estimation of Demand

Variable Name	Unit	Value	Source
General Corridor Assumptions			
Current Through Train Volumes	trains/day	2	Based on FRA's Grade Crossing Inventory for the impacted crossings on the Tintic line.
Through Train Growth Rate	%/year	1.1%	Utah Freight Plan (2017)
Average Through Train Length	feet	3,960	Field observation
Lead and Lag Time	minutes	0.5	Assumption.
Train Data			
Tintic Rail Train Data			Based on FRA's Grade Crossing Inventory for the impacted crossings on the Tintic Line.
Through Trains	Thru trains/day	2.0	
Through Trains per Day during Daylight	Thru trains/daylight	1.0	
Sharp Tracks (North of the Project Area)			Based on FRA's Grade Crossing Inventory for Sharp Tracks North of Tintic Line to Provo Rail Yard.
Through Trains	Thru trains/day	6.0	
Through Trains per Day during Daylight	Thru trains/daylight	2.0	
Tintic Tracks (North of the Project Area)			Based on FRA's Grade Crossing Inventory for North of Tintic Line to Provo Rail Yard.
Through Trains	Thru trains/day	8.0	
Through Trains per Day during Daylight	Thru trains/daylight	4.0	
700 South			
Crossing ID	ID	254400V	FRA's Grade Crossing Inventory.
2017 AADT	vehicles/day	550	
AADT Growth Rate	%/year	2.9%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	99.5%	FRA's Grade Crossing Inventory.
Trucks	%	0.5%	
Bus	bus/day	0	
950 West			
Crossing ID	ID	968062Y	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	550	
AADT Growth Rate	%/year	2.9%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	100.0%	FRA's Grade Crossing Inventory.
Trucks	%	0.0%	
Bus	bus/day	0.0%	
1600 South			
Crossing ID	ID	254408A	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	3,900	
AADT Growth Rate	%/year	2.9%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	89%	FRA's Grade Crossing Inventory.
Trucks	%	10%	
Bus	bus/day	42	
400 West			
Crossing ID	ID	254401C	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	550	
AADT Growth Rate	%/year	2.9%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	95%	FRA's Grade Crossing Inventory.
Trucks	%	5%	
Bus	bus/day	0	

Variable Name	Unit	Value	Source
Private			
Crossing ID	ID	254402J	FRA's Grade Crossing Inventory.
1988 AADT	vehicles/day	130	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	99.5%	FRA's Grade Crossing Inventory.
Trucks	%	0.5%	
Bus	bus/day	0	
Canyon Creek Parkway			
Crossing ID	ID	967139F	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	3,900	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	90.0%	FRA's Grade Crossing Inventory.
Trucks	%	10.0%	
Bus	bus/day	0	
Colorado Avenue			
Crossing ID	ID	975187R	FRA's Grade Crossing Inventory.
2018 AADT	vehicles/day	250	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	99.8%	FRA's Grade Crossing Inventory.
Trucks	%	0.2%	
Bus	bus/day	0	
900 South			
Crossing ID	ID	806921N	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	520	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	90.0%	FRA's Grade Crossing Inventory.
Trucks	%	10.0%	
Bus	bus/day	0	
1000 North			
Crossing ID	ID	806913W	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	850	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	90.0%	FRA's Grade Crossing Inventory.
Trucks	%	10.0%	
Bus	bus/day	0	
West Center			
Crossing ID	ID	254733W	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	10,500	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	90.0%	FRA's Grade Crossing Inventory.
Trucks	%	10.0%	
Bus	bus/day	0	
2000 South			
Crossing ID	ID	254729G	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	850	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	80.0%	FRA's Grade Crossing Inventory.
Trucks	%	20.0%	
Bus	bus/day	0	

Variable Name	Unit	Value	Source
400 North			
Crossing ID	ID	254731H	FRA's Grade Crossing Inventory.
2010 AADT	vehicles/day	1,600	
AADT Growth Rate	%/year	3%	Calculated from the AADT and projected AADT in the area provided by UDOT.
Passenger Vehicles	%	99.5%	FRA's Grade Crossing Inventory.
Trucks	%	0.5%	
Bus	bus/day	0	

5.3 Demand Projections

The resulting projections for through train traffic are presented in Table 5, while the AADT projections by active crossing are presented in Table 6. Detailed demand projections are provided in Section 9.2.

Table 5: Demand Projections – Through Trains

Demand	Unit	2020	2025	2030	2035	2040	2045	2050	2055
No Build									
Tintic Through Trains	trains/day	2	2	2	2	2	3	3	3
Sharp-Tintic Through Trains	trains/day	0	0	0	0	0	0	0	0
Sharp Tracks North of the Project Through Trains	trains/day	6	6	7	7	7	8	8	9
Tintic Tracks North of the Project Through Trains	trains/year	8	8	9	9	10	10	11	12
Build									
Tintic Through Trains	trains/day	2	0	0	0	0	0	0	0
Sharp-Tintic Through Trains	trains/day	0	2	2	2	2	3	3	3
Sharp Tracks North of the Project Through Trains	trains/day	6	8	9	9	10	10	11	12
Tintic Tracks North of the Project Through Trains	trains/year	8	6	7	7	7	8	8	9

Table 6: Demand Projections - AADT

Category	Year	700 South	950 West	1600 South	400 West	Private	Canyon Creek Parkway	Colorado Avenue	900 South	1000 North	West Center	2000 South	400 North
Average Daily Vehicle Traffic	2020	736	736	5,216	736	330	5,216	265	695	1,137	14,042	1,137	2,140
	2025	851	851	6,031	851	381	6,031	306	804	1,315	16,239	1,315	2,474
	2030	984	984	6,975	984	441	6,975	354	930	1,520	18,779	1,520	2,862
	2035	1,138	1,138	8,066	1,138	510	8,066	410	1,075	1,758	21,716	1,758	3,309
	2040	1,315	1,315	9,328	1,315	589	9,328	474	1,244	2,033	25,113	2,033	3,827
	2045	1,521	1,521	10,787	1,521	682	10,787	548	1,438	2,351	29,042	2,351	4,425
	2050	1,759	1,759	12,474	1,759	788	12,474	634	1,663	2,719	33,585	2,719	5,118
	2055	2,034	2,034	14,426	2,034	911	14,426	733	1,923	3,144	38,839	3,144	5,918
Annual Vehicle Traffic	2020	268,469	268,469	1,903,689	268,469	120,282	1,903,689	96,712	253,825	414,907	5,125,317	414,907	781,001
	2025	310,466	310,466	2,201,483	310,466	139,097	2,201,483	111,841	293,531	479,810	5,927,069	479,810	903,172
	2030	359,032	359,032	2,545,860	359,032	160,856	2,545,860	129,336	339,448	554,867	6,854,240	554,867	1,044,456
	2035	415,195	415,195	2,944,109	415,195	186,019	2,944,109	149,568	392,548	641,665	7,926,447	641,665	1,207,840
	2040	480,144	480,144	3,404,655	480,144	215,118	3,404,655	172,965	453,954	742,040	9,166,380	742,040	1,396,782
	2045	555,253	555,253	3,937,245	555,253	248,769	3,937,245	200,022	524,966	858,118	10,600,275	858,118	1,615,280
	2050	642,111	642,111	4,553,148	642,111	287,684	4,553,148	231,311	607,086	992,353	12,258,474	992,353	1,867,958
	2055	742,556	742,556	5,265,396	742,556	332,686	5,265,396	267,495	702,053	1,147,586	14,176,065	1,147,586	2,160,162

6 Estimation of Economic Benefits

This section describes the measurement approach used for each benefit or impact category identified in Table ES-1 and provides an overview of the associated methodology, assumptions, and estimates.

6.1 Accident Cost Savings

Accident costs and impacts on life, limb, and property are a significant component of costs to both road and rail users. Safety is a key economic factor in transportation efficiency, while outside the economic context, safety is often the object of public concern and a leading social issue.

The Project would contribute to promoting FRA’s goal of transportation safety through accident reductions due to closing six active (and one blocked) grade crossings. The Project would also redirect some traintraffic from the Tintic Line to the Sharp Line until the Provo Rail Yard. This would eliminate the potential for train/vehicle encounters at the specified grade crossings.

6.1.1 Methodology

Estimating accident cost savings requires data regarding the characteristics of the grade crossings and the costs of injuries and fatalities to monetize the impacts. Expected accidents at the various grade crossings were derived using FRA’s collision prediction formulae.

6.1.2 Assumptions

The assumptions used in the estimation of accident cost savings are summarized in Table 7.

Table 7: Assumptions Used in the Estimation of Accident Cost Savings

Variable Name	Unit	Value	Source
Fatal Crash	2019\$/fatal crash	\$12,071,000	USDOT, BCA Guidance 2021.
Injury Crash	2019\$/injury crash	\$284,100	USDOT, BCA Guidance 2021.
Average Cost per Property Damage Only (PDO) Accident	2019\$/PDO accident	\$4,500	USDOT, BCA Guidance 2021.
Annual Growth in Real Accident Costs	%	0	USDOT, BCA Guidance 2021.

6.1.3 Benefit Estimates

Table 8 shows the estimates of accident cost savings. With a 7% discount rate applied to the benefits, the estimated present value is \$0.73 million.

Table 8: Estimates of Accident Cost Savings, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
Accident Cost Savings	\$62,562	\$2,312,423	\$729,807

6.2 Travel Time Savings

6.2.1 Methodology

Travel time savings will be generated for motorists (automobiles and trucks) at the active at-grade crossings. Reduced crossing blockage times will lead to decreased travel time costs for automobile drivers and passengers as well as truck drivers.

Travel time savings in hours between the Base and Alternative Cases were estimated based on daily traffic of both trains and vehicles at the crossing, as well as train length and speeds. For vehicles, the AADT forecasts are derived based on current and projected AADT. The expected crossing time delay is derived by applying the probability of delay, which is a function of train frequency, speed, length, and lead and lag time.

The value of time by vehicle type, as well as occupancy assumptions for both automobiles and trucks, are available in the USDOT Benefit-Cost Analysis Guidance. The estimate for travel time savings is simply the project of hours of delay, vehicle occupancy, and respective value of time.

6.2.2 Assumptions

The assumptions used in the travel time savings benefits are summarized in Table 9.

Table 9: Assumptions used in the Travel Time Savings Benefits

Variable Name	Unit	Value	Source
Auto Occupancy	persons	1.67	USDOT, 2021 BCA Guidance and 2017 National Household Travel Survey.
Truck Occupancy	persons	1.00	
Bus Drivers per Bus	persons	1.00	Assumed to be the same as Truck Occupancy.
Value of Time for Automobile Driver and Passenger	2019\$/hour	\$17.90	USDOT, 2021 BCA, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.
Value of Time for Truck Driver	2019\$/hour	\$30.80	
Value of Time for Bus Driver	2019\$/hour	\$31.70	

6.2.3 Benefit Estimates

Table 10 shows the estimates from travel time savings. With a 7% discount rate, the estimated present value of benefits over the project lifecycle is \$5.89 million. See Sections 9.5 and 9.6 for additional information.

Table 10: Estimates of Travel Time Savings, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
Travel Time Savings	\$375,617	\$21,212,498	\$5,894,793

6.3 Emission Cost Savings

The Project would contribute to environmental sustainability benefits through a net reduction in emissions due to idling. Environmental costs are increasingly considered as an important component in the evaluation of transportation projects, and the main environmental impacts of vehicle use and exhaust emissions can impose wide-ranging social costs on people, material, and vegetation. The adverse effects of pollution depend not only on the quantity of pollution produced but also on the types of pollutants emitted and the conditions into which the pollution is released.

6.3.1 Methodology

The change in vehicle delay time along the study region is used to estimate the total fuel consumption while idling. The total estimated vehicle delay times are multiplied by the appropriate emission factors for tons of carbon dioxide (CO₂), nitrogen oxides (NO_x), fine particulate matter (PM_{2.5}), and sulfur dioxide (SO₂) per hour of idling by vehicle type. Each pollutant is then multiplied by its monetary value to arrive at the total emission cost impact due to delays at grade crossings.

6.3.2 Assumptions

The assumptions used in the estimation of emission cost savings are summarized in Table 11 through Table 14.

Table 11: Emission Cost

Emission Cost per Metric Ton (2019 Dollars)					
Year	NO _x	SO ₂	PM _{2.5}	CO ₂	Source/Comment
2020	\$15,700	\$40,400	\$729,300	\$50	USDOT, BCA Guidance February 2021. Costs assumed constant past 2050 to account for benefits conservatively.
2021	\$15,900	\$41,300	\$742,300	\$52	
2022	\$16,100	\$42,100	\$755,500	\$53	
2023	\$16,400	\$43,000	\$769,000	\$54	
2024	\$16,600	\$43,900	\$782,700	\$55	
2025	\$16,800	\$44,900	\$796,600	\$56	
2026	\$17,000	\$45,500	\$807,500	\$57	
2027	\$17,300	\$46,200	\$818,600	\$58	
2028	\$17,500	\$46,900	\$829,800	\$59	
2029	\$17,700	\$47,600	\$841,200	\$60	
2030	\$18,000	\$48,200	\$852,700	\$61	
2031	\$18,000	\$48,200	\$852,700	\$62	
2032	\$18,000	\$48,200	\$852,700	\$63	
2033	\$18,000	\$48,200	\$852,700	\$64	
2034	\$18,000	\$48,200	\$852,700	\$66	
2035	\$18,000	\$48,200	\$852,700	\$67	
2036	\$18,000	\$48,200	\$852,700	\$68	
2037	\$18,000	\$48,200	\$852,700	\$69	
2038	\$18,000	\$48,200	\$852,700	\$70	
2039	\$18,000	\$48,200	\$852,700	\$71	
2040	\$18,000	\$48,200	\$852,700	\$72	
2041	\$18,000	\$48,200	\$852,700	\$73	
2042	\$18,000	\$48,200	\$852,700	\$75	
2043	\$18,000	\$48,200	\$852,700	\$76	
2044	\$18,000	\$48,200	\$852,700	\$77	
2045	\$18,000	\$48,200	\$852,700	\$78	
2046	\$18,000	\$48,200	\$852,700	\$79	
2047	\$18,000	\$48,200	\$852,700	\$80	
2048	\$18,000	\$48,200	\$852,700	\$81	
2049	\$18,000	\$48,200	\$852,700	\$83	
2050	\$18,000	\$48,200	\$852,700	\$84	
2051	\$18,000	\$48,200	\$852,700	\$84	
2052	\$18,000	\$48,200	\$852,700	\$84	
2053	\$18,000	\$48,200	\$852,700	\$84	
2054	\$18,000	\$48,200	\$852,700	\$84	
2055	\$18,000	\$48,200	\$852,700	\$84	

Table 12: Automobile Emissions

Idling Emissions – Autos (grams/hour)					Source/Comment
Year	NO _x	SO ₂	PM _{2.5}	CO ₂	
2021	1.987	0.015	0.055	2,274	MOVES Average Annual Emissions Factors for Passenger Vehicles (grams/veh-miles) assuming an average speed of 2.5 mph to reflect idling conditions. Model run in May 2020.
2022	1.792	0.015	0.053	2,241	
2023	1.597	0.015	0.051	2,207	
2024	1.403	0.014	0.049	2,174	
2025	1.208	0.014	0.047	2,141	
2026	1.014	0.014	0.046	2,107	
2027	0.819	0.014	0.044	2,074	
2028	0.625	0.014	0.042	2,040	
2029	0.430	0.013	0.040	2,007	
2030	0.235	0.013	0.038	1,974	
2031	0.216	0.013	0.037	1,935	
2032	0.196	0.013	0.036	1,897	
2033	0.176	0.012	0.034	1,858	
2034	0.156	0.012	0.033	1,819	
2035	0.136	0.012	0.032	1,781	
2036	0.117	0.012	0.031	1,742	
2037	0.097	0.011	0.029	1,704	
2038	0.077	0.011	0.028	1,665	
2039	0.057	0.011	0.027	1,627	
2040	0.037	0.011	0.025	1,588	
2041	0.035	0.010	0.025	1,562	
2042	0.032	0.010	0.024	1,537	
2043	0.029	0.010	0.023	1,511	
2044	0.026	0.010	0.022	1,485	
2045	0.024	0.010	0.021	1,459	
2046	0.021	0.010	0.020	1,434	
2047	0.018	0.009	0.019	1,408	
2048	0.016	0.009	0.018	1,382	
2049	0.013	0.009	0.017	1,356	
2050	0.010	0.009	0.016	1,330	
2051	0.010	0.009	0.016	1,330	
2052	0.010	0.009	0.016	1,330	
2053	0.010	0.009	0.016	1,330	
2054	0.010	0.009	0.016	1,330	

Table 13: Truck Emissions

Idling Emissions – Trucks (grams/hour)					
Year	NO _x	SO ₂	PM _{2.5}	CO ₂	Source/Comment
2021	73.377	0.086	2.690	9,884	MOVES Average Annual Emissions Factors for Passenger Vehicles (grams/veh-miles) assuming an average speed of 2.5 mph to reflect idling conditions. Model run in May 2020.
2022	68.643	0.085	2.502	9,857	
2023	63.910	0.085	2.315	9,830	
2024	59.177	0.084	2.128	9,803	
2025	54.444	0.084	1.941	9,775	
2026	49.710	0.084	1.753	9,748	
2027	44.977	0.083	1.566	9,721	
2028	40.244	0.083	1.379	9,694	
2029	35.511	0.082	1.192	9,667	
2030	30.778	0.082	1.004	9,640	
2031	28.716	0.081	0.916	9,613	
2032	26.654	0.081	0.827	9,585	
2033	24.592	0.081	0.739	9,557	
2034	22.530	0.080	0.650	9,529	
2035	20.468	0.080	0.562	9,501	
2036	18.406	0.080	0.473	9,473	
2037	16.344	0.079	0.385	9,445	
2038	14.282	0.079	0.296	9,418	
2039	12.220	0.078	0.208	9,390	
2040	10.158	0.078	0.119	9,362	
2041	10.119	0.078	0.119	9,346	
2042	10.080	0.078	0.119	9,330	
2043	10.041	0.078	0.119	9,315	
2044	10.001	0.078	0.119	9,299	
2045	9.962	0.077	0.119	9,283	
2046	9.923	0.077	0.119	9,267	
2047	9.884	0.077	0.118	9,252	
2048	9.844	0.077	0.118	9,236	
2049	9.805	0.077	0.118	9,220	
2050	9.766	0.077	0.118	9,204	
2051	9.766	0.077	0.118	9,204	
2052	9.766	0.077	0.118	9,204	
2053	9.766	0.077	0.118	9,204	
2054	9.766	0.077	0.118	9,204	

Table 14: Bus Emissions

Idling Emissions – Buses (grams/hour)					
Year	NO _x	SO ₂	PM _{2.5}	CO ₂	Source/Comment
2021	17.890	2.430	0.026	3,321	MOVES Average Annual Emissions Factors for Passenger Vehicles (grams/veh-miles) assuming an average speed of 2.5 mph to reflect idling conditions. Model run in May 2020.
2022	17.050	2.294	0.026	3,299	
2023	16.210	2.158	0.026	3,278	
2024	15.370	2.021	0.026	3,256	
2025	14.531	1.885	0.026	3,235	
2026	13.691	1.749	0.026	3,214	
2027	12.851	1.613	0.025	3,192	
2028	12.011	1.477	0.025	3,171	
2029	11.171	1.340	0.025	3,149	
2030	10.331	1.204	0.025	3,128	
2031	9.491	1.068	0.025	3,107	
2032	8.651	0.932	0.025	3,085	
2033	7.812	0.796	0.024	3,064	
2034	6.972	0.659	0.024	3,042	
2035	6.132	0.523	0.024	3,021	
2036	5.292	0.387	0.024	3,000	
2037	5.292	0.387	0.024	3,000	
2038	5.292	0.387	0.024	3,000	
2039	5.292	0.387	0.024	3,000	
2040	5.292	0.387	0.024	3,000	
2041	5.292	0.387	0.024	3,000	
2042	5.292	0.387	0.024	3,000	
2043	5.292	0.387	0.024	3,000	
2044	5.292	0.387	0.024	3,000	
2045	5.292	0.387	0.024	3,000	
2046	5.292	0.387	0.024	3,000	
2047	5.292	0.387	0.024	3,000	
2048	5.292	0.387	0.024	3,000	
2049	5.292	0.387	0.024	3,000	
2050	5.292	0.387	0.024	3,000	
2051	5.292	0.387	0.024	3,000	
2052	5.292	0.387	0.024	3,000	
2053	5.292	0.387	0.024	3,000	
2054	5.292	0.387	0.024	3,000	

6.3.3 Benefit Estimates

Table 15 shows the environmental benefit estimates from reducing vehicle delay times. With a 7% discount rate, the estimated present value of benefits over the project life cycle is \$55 thousand. See Sections 9.7 and 9.8 for additional information.

Table 15: Estimates of Emission Cost Savings, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
Emissions Cost Savings	\$5,458	\$172,967	\$54,756

6.4 Vehicle Operating Costs

6.4.1 Methodology

The reduction in vehicle idling time is directly correlated to eliminating the six active (and one-blocked) at-grade crossings and redirecting train traffic to less traveled crossings along the Sharp Line. The reduction in vehicle idling time will translate to lower net vehicle operating costs from reduced fuel and motor oil consumption from idling. The change in vehicle delay is multiplied by the fuel and motor oil consumption rate to obtain annual estimates of fuel and motor oil consumption from idling time. This, multiplied by the respective cost per unit of fuel and motor oil, provides an estimate of the change in vehicle operating costs.

6.4.2 Assumptions

The assumptions used in the estimation of vehicle operating costs are summarized in Table 16.

Table 16: Assumptions used in the Estimation of Vehicle Operating Costs

Variable Name	Unit	Year	Value	Source
Gasoline Burned at Idle - Autos	gallons/hour	-	0.358	USDOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Average of gasoline passenger vehicles.
Diesel Fuel Burned at Idle - Trucks	gallons/hour	-	0.840	USDOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Medium Trucks.
Diesel Fuel Burned at Idle - Bus	gallons/hour	-	0.970	USDOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Transit Bus.
Motor Oil Consumption at Idle - Autos	quarts/hour	-	0.035	Based on USDOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles and assuming that "One hour of
Motor Oil Consumption at Idle - Trucks	quarts/hour	-	0.035	

Variable Name	Unit	Year	Value	Source
Motor Oil Consumption at Idle - Bus	quarts/hour	-	0.035	idle time is equal to approximately 25 miles of driving" (Ford Motor Company, 2011).
Cost of Motor Oil - Autos	2019\$/quart	-	\$10.72	Average Oil Price Sourced From HERS Model and Inflated to 2019\$ by Motor Oil CPI (BLS CUUR0000SS47021).
Cost of Motor Oil - Trucks	2019\$/quart	-	\$4.29	
Cost of Motor Oil - Bus	2019\$/quart	-	\$10.72	
Gasoline Retail Price	2019\$/gallon	2021	\$2.11	US EIA Annual Energy Outlook 2020, net of Federal & State Taxes.
		2022	\$2.11	
		2023	\$2.11	
		2024	\$2.08	
		2025	\$2.11	
		2026	\$2.14	
		2027	\$2.17	
		2028	\$2.19	
		2029	\$2.23	
		2030	\$2.31	
		2031	\$2.34	
		2032	\$2.36	
		2033	\$2.42	
		2034	\$2.47	
		2035	\$2.50	
		2036	\$2.54	
		2037	\$2.55	
		2038	\$2.58	
		2039	\$2.63	
		2040	\$2.64	
		2041	\$2.67	
		2042	\$2.72	
		2043	\$2.74	
2044	\$2.77			
2045	\$2.81			
2046	\$2.83			
2047	\$2.88			
2048	\$2.92			
2049	\$2.96			
2050	\$2.98			
2051	\$3.01			
2052	\$3.04			
2053				
2054	\$3.08			
Diesel Retail Price	2019\$/gallon	2021	\$2.37	US EIA Annual Energy Outlook 2020, net of Federal & State Taxes.
		2022	\$2.42	
		2023	\$2.44	
		2024	\$2.50	
		2025	\$2.52	
		2026	\$2.58	
		2027	\$2.60	
		2028	\$2.65	
		2029	\$2.68	
		2030	\$2.75	
		2031	\$2.79	
2032	\$2.82			
2033	\$2.88			

Variable Name	Unit	Year	Value	Source
		2034	\$2.91	
		2035	\$2.95	
		2036	\$2.98	
		2037	\$3.01	
		2038	\$3.05	
		2039	\$3.08	
		2040	\$3.08	
		2041	\$3.11	
		2042	\$3.17	
		2043	\$3.19	
		2044	\$3.22	
		2045	\$3.28	
		2046	\$3.28	
		2047	\$3.32	
		2048	\$3.36	
		2049	\$3.38	
		2050	\$3.41	
		2051	\$3.44	
		2052	\$3.48	
		2053	\$3.51	
		2054	\$3.54	

6.4.3 Benefit Estimates

Table 17 shows the benefit estimates of reduced vehicle operating costs. With a 7% discount rate applied to the benefits, the estimated present value is \$0.66 million. See Sections 9.9 and 9.10 for more information.

Table 17: Estimates of Vehicle Operating Costs, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
Vehicle Operating Cost Savings	\$35,528	\$2,501,627	\$657,183

6.5 Land Value Increases

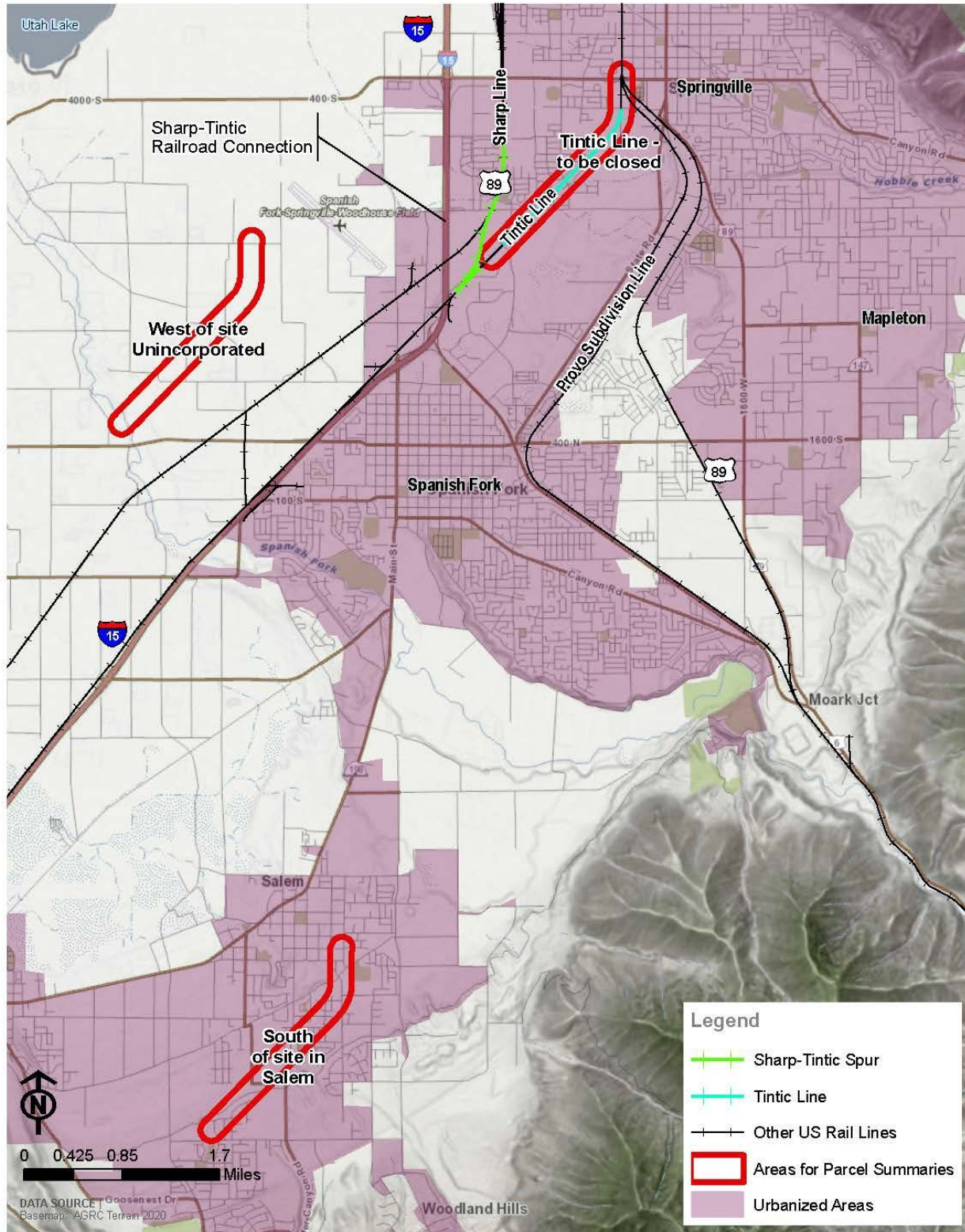
6.5.1 Methodology

For the estimation of land value increase from the removal of the tracks on the Tintic Line, two methodologies were evaluated. The first methodology derived the land value increase using the current land values within 500 feet of the Tintic Line and the land values of comparable nearby areas of Unincorporated and Salem, as shown in Figure 1. This methodology resulted in enormous benefits and is tested in the results sensitivity section of the report.

The second methodology evaluated to estimate the land value increase from the removal of the track on the Tintic Line is derived using the current land values within 500 feet of the Tintic tracks and a 5 percent property price appreciation. This methodology resulted in more conservative benefits. Therefore, the second methodology was selected for the analysis.

Land values for these areas were obtained from the Tax Parcels GIS data provided by Utah County. The land value increase includes only the estimated increase in land value for land parcels within 500 feet of the current Tintic Line. Additional projected land value appreciation associated with the future redevelopment of the local region was not included. The increase in land value, due to the removal of the tracks on the Tintic Line, is treated as a one-time impact realized once the project construction is completed.

Figure 1: Comparable Regions for Land Value Increase Assessment



**SHARP-TINTIC RAILROAD
CONNECTION PROJECT**
UTAH COUNTY, UTAH
FRA CRISI GRANT APPLICATION

6.5.2 Assumptions

The assumptions used in the estimation of land value increases are summarized in Table 18.

Table 18: Assumptions Used in the Estimation of Land Value Increases

Variable Name	Unit	Date	Value	Source
Current Price per Acre	2019\$	-	\$104,390	Data from Utah County GIS Data - Tax Parcels. Extracted August 31, 2018. Inflated to 2019\$
Property Price Appreciation	%	-	5%	Various case studies have shown price appreciation in adjacent properties of railroad tracks in the range of 2-10%.
Incremental Price Uplift	2019\$	-	\$5,219	Calculated.
Total Acreage	acres	-	2,346.6	Data from Utah County GIS Data - Tax Parcels. Extracted August 31, 2018.
Total One-time Benefit	2019\$	2025	\$12,248,164	Calculated comparing average land value for nearby comparable regions. Data from Utah County GIS Data - Tax Parcels.

6.5.3 Benefit Estimates

Table 19 shows the benefit estimates of land value increase. With a 7% discount rate, the estimated present value of benefits over the project lifecycle is approximately \$9.34 million. See Section 9.11 for additional information.

Table 19: Estimates of Land Value Increase, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
Land Value Increase	\$12,248,164	\$12,248,164	\$9,344,066

6.6 O&M Cost Savings

6.6.1 Methodology

While O&M costs are incurred at each crossing, the net reduction of at-grade crossings is expected to generate O&M cost savings. These savings are applied over the 30 years of operation assessed in this study.

6.6.2 Assumptions

The assumptions used in the estimation of O&M cost savings are summarized in Table 20.

Table 20: Assumptions Used in the Estimation of O&M Cost Savings

Variable Name	Unit	Value	Source
O&M Cost Savings - 700 South	2019\$/year	\$4,079	Detailed bottom up cost estimate as performed by HDR including maintenance related to gates, roadway surface, testing, signage, and marking. Inflated from 2018\$ to 2019\$.
O&M Cost Savings - 950 West	2019\$/year	\$4,079	
O&M Cost Savings - 1600 South	2019\$/year	\$4,079	
O&M Cost Savings - 400 West	2019\$/year	\$4,079	
O&M Cost Savings - Private	2019\$/year	\$4,079	
O&M Cost Savings - Canyon Creek Parkway	2019\$/year	\$4,079	
O&M Cost Savings - Colorado Avenue	2019\$/year	\$4,079	
O&M Cost Savings - 900 South	2019\$/year	\$4,079	
O&M Cost Savings - 1000 North	2019\$/year	\$4,079	
O&M Cost Savings - West Center	2019\$/year	\$4,079	
O&M Cost Savings - 2000 South	2019\$/year	\$4,079	
O&M Cost Savings - 400 North	2019\$/year	\$4,079	

6.6.3 Benefit Estimates

Table 21 shows the benefit estimates of the O&M cost savings. With a 7% discount rate, the estimated present value of benefits over the project lifecycle is approximately \$0.25 million. See Section 9.12 for additional information.

Table 21: Estimates of O&M Cost Savings, 2019 Dollars

	In Project Opening Year	Over the Analysis Period	
		Undiscounted	Discounted at 7 Percent
O&M Cost Savings	\$24,475	\$734,235	\$247,914

6.7 Residual Value

6.7.1 Methodology

Residual value for the new track was estimated assuming a 40-year useful asset service life with straight-line depreciation over the 30 years of operations.

Because land values are not expected to depreciate with time, the residual value for the purchased right-of-way is the capital spent on acquiring the right-of-way for the Project.

6.7.2 Assumptions

The assumptions used to estimate the residual value are summarized in Table 22. Residual value for new track construction is based on the useful life of the asset, while ROW land purchases retain their full value as residual value (before discounting).

Table 22: Assumptions Used in the Estimation of Residual Value

Variable Name	Unit	Value	Source
Years of Benefits	years	30	BCA analysis period.
Useful Life of New Tracks	year	40	Assumption of 40 years for relatively light use of new track based on industry experience. Expected tie replacement, ballast lifts, and surface maintenance starting within 25 years, but excluded on an incremental basis as compared to existing infrastructure.
Service Life Remaining (years)	years	10	Difference between useful life and analysis period.
Capital Cost of New Tracks	2019\$	\$7,200,100	Project Cost Estimate.
Capital Cost of ROW Land Purchases	2019\$	\$1,820,135	

6.7.3 Benefit Estimates

Table 23 shows the benefit estimates of the residual value. With a 7% discount rate, the estimated present value of benefits over the project lifecycle is approximately \$0.39 million. See Section 9.13 for additional information.

Table 23: Estimates of Residual Value, 2019 Dollars

	Over the Analysis Period	
	Undiscounted	Discounted at 7 Percent
Residual Value	\$3,620,160	\$388,207

6.8 Qualitative Benefits

6.8.1 Improved Quality of Life

The closing of the Tintic segment is expected to improve the quality of life by reducing noise levels and improving the air quality through reduced vehicle idling at the grade crossings. In addition, the redevelopment plans are expected to open up the area to alternative uses. The closing of the seven at-grade crossings will improve local community accessibility and safety in the neighborhood and its access to an elementary school.

7 Summary of Findings and Benefit-Cost Outcomes

Table 24 and Table 25 summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the Project (33 years). As stated earlier, construction is expected to be completed by 2024, with 2025 being the Project opening year for BCA purposes. Benefits accrue during the full operation of the Project.

Table 24 compiles the values of monetized benefits based on the assumptions presented above. The Project is estimated to produce benefits valued at \$17.32 million at a 7% discount factor over the project lifecycle.

Table 24: Overall Results of the Benefit-cost Analysis, 2019 Dollars

Benefit or Impact Categories	7% Discount Rate	3% Discount Rate
Accident Cost Savings	\$729,807	\$1,340,739
Travel Time Savings	\$5,894,793	\$11,628,089
Emissions Cost Savings	\$54,756	\$100,071
Vehicle Operating Cost Savings	\$657,183	\$1,339,164
Land Value Increase	\$9,344,066	\$10,882,335
O&M Costs Savings	\$247,914	\$439,004
Residual Value	\$388,207	\$1,364,895
Total Benefit Estimates	\$17,316,726	\$27,094,296

Considering all monetized benefits and costs, the estimated internal rate of return of the Project is 12.0 percent. With a 7% real discount rate, the \$12.53 million investment would result in a NPV of \$4.79 million and a BCR of 1.38.

With a 3% real discount rate, the NPV of the Project would increase to \$13.34 million, for a BCR of 1.97 (Table 25).

Table 25: Benefit Estimates for the Full Build Alternative

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	\$17.32 M	\$27.09 M
Total Discounted Costs	\$12.53 M	\$13.76 M
Net Present Value	\$4.79 M	\$13.34 M
Benefit/Cost Ratio	1.38	1.97
Internal Rate of Return (%)	13.1%	
Payback Period (years)	4.74	

8 Benefit-Cost Sensitivity Analysis

8.1 Variation in Key Inputs and Assumptions

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 Sharp-Tintic Railroad Connection Project using a 7% discount rate are summarized in Table 26. The table provides the percentage changes in project NPV associated with variations in variables or parameters, as indicated in the column headers.

Table 26: Quantitative Assessment of Sensitivity, Summary (Discounted at 7%)

Original NPV (discounted at 7%)	Parameters	Change in Parameter Value	New NPV (discounted at 7%)	Change in NPV	New B/C Ratio
\$4.79 M	AADT Growth	0% AADT Growth	\$1.06 M	-77.9%	1.08
	Lead Lag Time	20 seconds	\$4.65 M	-3.0%	1.37
	Variation in Average Through Train Length	2,640 ft.	\$1.22 M	-74.6%	1.10
		5,280 ft.	\$9.74 M	+103.3%	1.78
	Capital Costs	+25% Increase in Capital Costs	\$1.75 M	-63.4%	1.14
Land Value Increase	Land values of comparable nearby areas	\$57.98 M	+1110.7%	5.63	

By adjusting the assumptions to consider the land values of comparable nearby areas as an alternative method to calculate the land value increase, the BCA indicates that this would increase the NPV by 1,111%. The Project would generate an NPV of \$57.98 million and a BCR of 5.63.

Although the assumption regarding the land values of comparable nearby areas was the main variable of interest to be tested, additional changes to the AADT growth, lead lag time, average through train length, and the potential for increased capital costs were also considered. From the additional tests, reduced train lengths and increased capital costs had the most significant impacts, decreasing the NPV by 74.6% and 63.4%, respectively. In both scenarios, the NPV remains positive and the BCR exceeds 1.0, indicating that project benefits still exceed costs.

9 Supplementary Data Tables

This section reports on all economic benefits associated with the Sharp-Tintic Railroad Connection Project. Results are reported by year and benefit type. Supplementary data tables are also provided for some specific benefit categories.

9.1 Annual Estimates of Total Project Benefits and Costs

Calendar Year	Project Year	Total Benefits (2019\$)	Total Capital Costs (2019\$)	Undiscounted Net Benefits (2019\$)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2021	1	\$0	\$442,825	-\$442,825	-\$442,825	-\$442,825
2022	2	\$0	\$1,962,150	-\$1,962,150	-\$1,833,785	-\$1,905,000
2023	3	\$0	\$2,275,820	-\$2,275,820	-\$1,987,790	-\$2,145,179
2024	4	\$0	\$10,122,708	-\$10,122,708	-\$8,263,145	-\$9,263,712
2025	5	\$12,751,804	\$0	\$12,751,804	\$9,728,290	\$11,329,812
2026	6	\$521,548	\$0	\$521,548	\$371,856	\$449,892
2027	7	\$540,132	\$0	\$540,132	\$359,913	\$452,352
2028	8	\$559,335	\$0	\$559,335	\$348,326	\$454,791
2029	9	\$579,509	\$0	\$579,509	\$337,280	\$457,470
2030	10	\$601,282	\$0	\$601,282	\$327,058	\$460,833
2031	11	\$623,116	\$0	\$623,116	\$316,761	\$463,657
2032	12	\$645,846	\$0	\$645,846	\$306,837	\$466,573
2033	13	\$669,998	\$0	\$669,998	\$297,487	\$469,923
2034	14	\$694,996	\$0	\$694,996	\$288,398	\$473,258
2035	15	\$720,715	\$0	\$720,715	\$279,506	\$476,478
2036	16	\$747,565	\$0	\$747,565	\$270,952	\$479,834
2037	17	\$774,978	\$0	\$774,978	\$262,512	\$482,941
2038	18	\$803,941	\$0	\$803,941	\$254,507	\$486,397
2039	19	\$834,228	\$0	\$834,228	\$246,818	\$490,021
2040	20	\$864,969	\$0	\$864,969	\$239,171	\$493,280
2041	21	\$897,563	\$0	\$897,563	\$231,947	\$496,959
2042	22	\$932,268	\$0	\$932,268	\$225,155	\$501,140
2043	23	\$967,657	\$0	\$967,657	\$218,413	\$505,013
2044	24	\$1,004,492	\$0	\$1,004,492	\$211,894	\$508,968
2045	25	\$1,043,371	\$0	\$1,043,371	\$205,697	\$513,270
2046	26	\$1,082,711	\$0	\$1,082,711	\$199,489	\$517,109
2047	27	\$1,125,107	\$0	\$1,125,107	\$193,738	\$521,706
2048	28	\$1,168,720	\$0	\$1,168,720	\$188,083	\$526,145
2049	29	\$1,213,850	\$0	\$1,213,850	\$182,566	\$530,545
2050	30	\$1,260,596	\$0	\$1,260,596	\$177,193	\$534,930
2051	31	\$1,309,476	\$0	\$1,309,476	\$172,022	\$539,487
2052	32	\$1,360,357	\$0	\$1,360,357	\$167,015	\$544,125
2053	33	\$1,413,323	\$0	\$1,413,323	\$162,166	\$548,846
2054	34	\$5,088,622	\$0	\$5,088,622	\$545,677	\$1,918,544
Total		\$42,802,075	\$14,803,504	\$27,998,571	\$4,789,181	\$13,337,580

9.2 Annual Demand Projections

Calendar Year	Project Year	700 South	950 West	1600 South	400 West	Private	Canyon Creek Parkway	Colorado Avenue	900 South	1000 North	West Center	2000 South	400 North
2021	1	276,387	276,387	1,959,837	276,387	123,829	1,959,837	99,564	261,312	427,144	5,276,484	427,144	804,036
2022	2	284,539	284,539	2,017,640	284,539	127,482	2,017,640	102,501	269,019	439,742	5,432,109	439,742	827,750
2023	3	292,931	292,931	2,077,149	292,931	131,242	2,077,149	105,524	276,953	452,712	5,592,324	452,712	852,164
2024	4	301,571	301,571	2,138,412	301,571	135,112	2,138,412	108,637	285,122	466,064	5,757,264	466,064	877,297
2025	5	310,466	310,466	2,201,483	310,466	139,097	2,201,483	111,841	293,531	479,810	5,927,069	479,810	903,172
2026	6	319,622	319,622	2,266,414	319,622	143,200	2,266,414	115,139	302,188	493,962	6,101,883	493,962	929,811
2027	7	329,049	329,049	2,333,259	329,049	147,423	2,333,259	118,535	311,101	508,531	6,281,852	508,531	957,235
2028	8	338,754	338,754	2,402,077	338,754	151,772	2,402,077	122,031	320,277	523,530	6,467,130	523,530	985,467
2029	9	348,746	348,746	2,472,924	348,746	156,248	2,472,924	125,631	329,723	538,971	6,657,872	538,971	1,014,533
2030	10	359,032	359,032	2,545,860	359,032	160,856	2,545,860	129,336	339,448	554,867	6,854,240	554,867	1,044,456
2031	11	369,621	369,621	2,620,948	369,621	165,601	2,620,948	133,151	349,460	571,232	7,056,399	571,232	1,075,261
2032	12	380,523	380,523	2,698,251	380,523	170,485	2,698,251	137,078	359,767	588,080	7,264,521	588,080	1,106,975
2033	13	391,746	391,746	2,777,833	391,746	175,513	2,777,833	141,121	370,378	605,425	7,478,782	605,425	1,139,624
2034	14	403,300	403,300	2,859,763	403,300	180,690	2,859,763	145,283	381,302	623,282	7,699,362	623,282	1,173,236
2035	15	415,195	415,195	2,944,109	415,195	186,019	2,944,109	149,568	392,548	641,665	7,926,447	641,665	1,207,840
2036	16	427,441	427,441	3,030,943	427,441	191,506	3,030,943	153,979	404,126	660,590	8,160,231	660,590	1,243,464
2037	17	440,048	440,048	3,120,338	440,048	197,154	3,120,338	158,521	416,045	680,074	8,400,909	680,074	1,280,139
2038	18	453,026	453,026	3,212,369	453,026	202,969	3,212,369	163,196	428,316	700,132	8,648,686	700,132	1,317,895
2039	19	466,388	466,388	3,307,115	466,388	208,955	3,307,115	168,010	440,949	720,781	8,903,771	720,781	1,356,765
2040	20	480,144	480,144	3,404,655	480,144	215,118	3,404,655	172,965	453,954	742,040	9,166,380	742,040	1,396,782
2041	21	494,305	494,305	3,505,073	494,305	221,463	3,505,073	178,066	467,343	763,926	9,436,734	763,926	1,437,979
2042	22	508,884	508,884	3,608,452	508,884	227,995	3,608,452	183,318	481,127	786,457	9,715,062	786,457	1,480,390
2043	23	523,893	523,893	3,714,880	523,893	234,719	3,714,880	188,725	495,317	809,653	10,001,599	809,653	1,524,053
2044	24	539,345	539,345	3,824,447	539,345	241,642	3,824,447	194,291	509,926	833,533	10,296,587	833,533	1,569,004
2045	25	555,253	555,253	3,937,245	555,253	248,769	3,937,245	200,022	524,966	858,118	10,600,275	858,118	1,615,280
2046	26	571,629	571,629	4,053,371	571,629	256,106	4,053,371	205,921	540,449	883,427	10,912,921	883,427	1,662,921
2047	27	588,489	588,489	4,172,921	588,489	263,660	4,172,921	211,995	556,389	909,483	11,234,787	909,483	1,711,968
2048	28	605,846	605,846	4,295,998	605,846	271,436	4,295,998	218,247	572,800	936,307	11,566,147	936,307	1,762,461
2049	29	623,715	623,715	4,422,704	623,715	279,442	4,422,704	224,684	589,694	963,923	11,907,280	963,923	1,814,443
2050	30	642,111	642,111	4,553,148	642,111	287,684	4,553,148	231,311	607,086	992,353	12,258,474	992,353	1,867,958
2051	31	661,049	661,049	4,687,439	661,049	296,169	4,687,439	238,133	624,992	1,021,621	12,620,027	1,021,621	1,923,052
2052	32	680,546	680,546	4,825,690	680,546	304,904	4,825,690	245,157	643,425	1,051,753	12,992,243	1,051,753	1,979,770
2053	33	700,618	700,618	4,968,020	700,618	313,897	4,968,020	252,388	662,403	1,082,774	13,375,437	1,082,774	2,038,162
2054	34	721,282	721,282	5,114,547	721,282	323,155	5,114,547	259,831	681,940	1,114,709	13,769,934	1,114,709	2,098,276
Total		15,805,493	15,805,493	112,075,311	15,805,493	7,081,309	112,075,311	5,693,699	14,943,375	24,426,670	301,741,223	24,426,670	45,979,615

9.3 Accident Cost Savings: Pertinent Quantifiable Impacts

Calendar Year	Project Year	Fatalities Avoided	Injuries Avoided	PDO-Accidents Avoided
2021	1	0.000	0.000	0.000
2022	2	0.000	0.000	0.000
2023	3	0.000	0.000	0.000
2024	4	0.000	0.000	0.000
2025	5	0.004	0.063	0.310
2026	6	0.004	0.064	0.314
2027	7	0.004	0.064	0.318
2028	8	0.004	0.065	0.323
2029	9	0.004	0.066	0.327
2030	10	0.004	0.067	0.331
2031	11	0.004	0.068	0.336
2032	12	0.004	0.069	0.341
2033	13	0.004	0.070	0.345
2034	14	0.004	0.071	0.350
2035	15	0.004	0.072	0.355
2036	16	0.004	0.073	0.360
2037	17	0.004	0.074	0.365
2038	18	0.004	0.075	0.370
2039	19	0.004	0.076	0.375
2040	20	0.004	0.077	0.380
2041	21	0.004	0.078	0.385
2042	22	0.005	0.079	0.390
2043	23	0.005	0.080	0.396
2044	24	0.005	0.081	0.401
2045	25	0.005	0.082	0.407
2046	26	0.005	0.084	0.412
2047	27	0.005	0.085	0.418
2048	28	0.005	0.086	0.424
2049	29	0.005	0.087	0.429
2050	30	0.005	0.088	0.435
2051	31	0.005	0.089	0.441
2052	32	0.005	0.091	0.447
2053	33	0.005	0.092	0.453
2054	34	0.005	0.093	0.460
Total		0.133	2.309	11.396

9.4 Accident Cost Savings: Annual Benefit Estimates

Calendar Year	Project Year	Accident Cost Savings	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$62,562	\$47,728	\$55,586
2026	6	\$63,416	\$45,215	\$54,703
2027	7	\$64,287	\$42,837	\$53,840
2028	8	\$65,175	\$40,588	\$52,993
2029	9	\$66,079	\$38,459	\$52,163
2030	10	\$66,998	\$36,442	\$51,348
2031	11	\$67,932	\$34,533	\$50,548
2032	12	\$68,881	\$32,725	\$49,761
2033	13	\$69,846	\$31,012	\$48,988
2034	14	\$70,825	\$29,390	\$48,228
2035	15	\$71,819	\$27,853	\$47,481
2036	16	\$72,828	\$26,396	\$46,746
2037	17	\$73,853	\$25,017	\$46,023
2038	18	\$74,893	\$23,709	\$45,311
2039	19	\$75,948	\$22,470	\$44,612
2040	20	\$77,020	\$21,297	\$43,923
2041	21	\$78,107	\$20,184	\$43,246
2042	22	\$79,210	\$19,130	\$42,579
2043	23	\$80,330	\$18,132	\$41,924
2044	24	\$81,466	\$17,185	\$41,278
2045	25	\$82,619	\$16,288	\$40,643
2046	26	\$83,789	\$15,438	\$40,018
2047	27	\$84,976	\$14,632	\$39,403
2048	28	\$86,181	\$13,869	\$38,798
2049	29	\$87,403	\$13,146	\$38,202
2050	30	\$88,643	\$12,460	\$37,615
2051	31	\$89,901	\$11,810	\$37,038
2052	32	\$91,177	\$11,194	\$36,470
2053	33	\$92,472	\$10,610	\$35,910
2054	34	\$93,786	\$10,057	\$35,360
Total		\$2,312,423	\$729,807	\$1,340,739

9.5 Travel Time Savings: Pertinent Quantifiable Impacts

Calendar Year	Project Year	Avoided Person Hours of Travel Time	Avoided Vehicle Hours of Travel Time
2021	1	0	0
2022	2	0	0
2023	3	0	0
2024	4	0	0
2025	5	20,149	12,530
2026	6	20,963	13,036
2027	7	21,811	13,563
2028	8	22,692	14,111
2029	9	23,609	14,681
2030	10	24,563	15,274
2031	11	25,556	15,892
2032	12	26,589	16,534
2033	13	27,663	17,202
2034	14	28,781	17,897
2035	15	29,944	18,621
2036	16	31,154	19,373
2037	17	32,413	20,156
2038	18	33,723	20,971
2039	19	35,086	21,818
2040	20	36,504	22,700
2041	21	37,979	23,617
2042	22	39,514	24,572
2043	23	41,111	25,565
2044	24	42,773	26,598
2045	25	44,501	27,673
2046	26	46,300	28,791
2047	27	48,171	29,955
2048	28	50,118	31,165
2049	29	52,143	32,425
2050	30	54,250	33,735
2051	31	56,443	35,099
2052	32	58,724	36,517
2053	33	61,097	37,993
2054	34	63,566	39,528
Total		1,137,892	707,592

9.6 Travel Time Savings: Annual Benefit Estimates

Calendar Year	Project Year	Travel Time Savings	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$375,617	\$286,556	\$333,731
2026	6	\$390,797	\$278,633	\$337,105
2027	7	\$406,590	\$270,928	\$340,513
2028	8	\$423,022	\$263,437	\$343,955
2029	9	\$440,118	\$256,152	\$347,433
2030	10	\$457,904	\$249,070	\$350,945
2031	11	\$476,410	\$242,183	\$354,494
2032	12	\$495,663	\$235,486	\$358,077
2033	13	\$515,694	\$228,974	\$361,698
2034	14	\$536,535	\$222,643	\$365,354
2035	15	\$558,218	\$216,487	\$369,048
2036	16	\$580,778	\$210,501	\$372,779
2037	17	\$604,249	\$204,680	\$376,548
2038	18	\$628,669	\$199,020	\$380,355
2039	19	\$654,076	\$193,517	\$384,200
2040	20	\$680,509	\$188,166	\$388,085
2041	21	\$708,011	\$182,963	\$392,008
2042	22	\$736,624	\$177,904	\$395,971
2043	23	\$766,393	\$172,985	\$399,975
2044	24	\$797,366	\$168,202	\$404,019
2045	25	\$829,590	\$163,551	\$408,103
2046	26	\$863,116	\$159,028	\$412,229
2047	27	\$897,998	\$154,631	\$416,397
2048	28	\$934,289	\$150,355	\$420,607
2049	29	\$972,047	\$146,198	\$424,859
2050	30	\$1,011,330	\$142,155	\$429,154
2051	31	\$1,052,201	\$138,225	\$433,493
2052	32	\$1,094,724	\$134,403	\$437,876
2053	33	\$1,138,966	\$130,686	\$442,303
2054	34	\$1,184,995	\$127,073	\$446,774
Total		\$21,212,498	\$5,894,793	\$11,628,089

9.7 Emission Cost Savings: Pertinent Quantifiable Impacts

Calendar Year	Project Year	Metric Tons of Emissions Avoided			
		NO _x Emissions Avoided	SO ₂ Emissions Avoided	PM _{2.5} Emissions Avoided	CO ₂ Emissions Avoided
2021	1	0.00	0.0000	0.0000	0.00
2022	2	0.00	0.0000	0.0000	0.00
2023	3	0.00	0.0000	0.0000	0.00
2024	4	0.00	0.0000	0.0000	0.00
2025	5	0.08	0.0003	0.0027	35.50
2026	6	0.07	0.0003	0.0026	36.51
2027	7	0.07	0.0003	0.0025	37.54
2028	8	0.06	0.0003	0.0023	38.60
2029	9	0.05	0.0003	0.0021	39.67
2030	10	0.05	0.0003	0.0019	40.78
2031	11	0.04	0.0003	0.0018	41.83
2032	12	0.04	0.0003	0.0018	42.90
2033	13	0.04	0.0003	0.0017	43.99
2034	14	0.04	0.0003	0.0016	45.09
2035	15	0.04	0.0004	0.0015	46.21
2036	16	0.03	0.0004	0.0014	47.35
2037	17	0.03	0.0004	0.0012	48.51
2038	18	0.03	0.0004	0.0011	49.69
2039	19	0.03	0.0004	0.0009	50.88
2040	20	0.02	0.0004	0.0008	52.08
2041	21	0.02	0.0004	0.0008	53.60
2042	22	0.02	0.0004	0.0008	55.16
2043	23	0.02	0.0004	0.0008	56.75
2044	24	0.02	0.0004	0.0008	58.38
2045	25	0.03	0.0005	0.0008	60.06
2046	26	0.03	0.0005	0.0008	61.77
2047	27	0.03	0.0005	0.0008	63.52
2048	28	0.03	0.0005	0.0009	65.32
2049	29	0.03	0.0005	0.0009	67.15
2050	30	0.03	0.0005	0.0009	69.03
2051	31	0.03	0.0006	0.0009	71.82
2052	32	0.03	0.0006	0.0009	74.72
2053	33	0.03	0.0006	0.0010	77.74
2054	34	0.04	0.0006	0.0010	80.88
Total		1.117	0.013	0.040	1,613.0

9.8 Emission Cost Savings: Annual Benefit Estimates

Calendar Year	Project Year	Emissions Cost Savings	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$5,458	\$4,164	\$4,849
2026	6	\$5,407	\$3,855	\$4,664
2027	7	\$5,341	\$3,559	\$4,473
2028	8	\$5,243	\$3,265	\$4,263
2029	9	\$5,118	\$2,979	\$4,041
2030	10	\$4,969	\$2,703	\$3,808
2031	11	\$4,991	\$2,537	\$3,714
2032	12	\$5,007	\$2,379	\$3,617
2033	13	\$5,014	\$2,226	\$3,516
2034	14	\$5,057	\$2,098	\$3,443
2035	15	\$5,046	\$1,957	\$3,336
2036	16	\$5,025	\$1,821	\$3,225
2037	17	\$4,993	\$1,691	\$3,112
2038	18	\$4,949	\$1,567	\$2,994
2039	19	\$4,892	\$1,447	\$2,874
2040	20	\$4,820	\$1,333	\$2,749
2041	21	\$5,007	\$1,294	\$2,772
2042	22	\$5,255	\$1,269	\$2,825
2043	23	\$5,455	\$1,231	\$2,847
2044	24	\$5,662	\$1,194	\$2,869
2045	25	\$5,875	\$1,158	\$2,890
2046	26	\$6,095	\$1,123	\$2,911
2047	27	\$6,321	\$1,089	\$2,931
2048	28	\$6,555	\$1,055	\$2,951
2049	29	\$6,862	\$1,032	\$2,999
2050	30	\$7,111	\$1,000	\$3,018
2051	31	\$7,398	\$972	\$3,048
2052	32	\$7,697	\$945	\$3,079
2053	33	\$8,009	\$919	\$3,110
2054	34	\$8,332	\$894	\$3,141
Total		\$172,967	\$54,756	\$100,071

9.9 Vehicle Operating Costs: Pertinent Quantifiable Impacts

Calendar Year	Project Year	Avoided Gasoline Consumption (gallons)	Avoided Diesel Consumption (gallons)	Avoided Motor Oil Consumption (quarts)
2021	1	0	0	0
2022	2	0	0	0
2023	3	0	0	0
2024	4	0	0	0
2025	5	11,192	2,984	432
2026	6	11,644	3,104	450
2027	7	12,115	3,230	468
2028	8	12,605	3,360	487
2029	9	13,114	3,496	506
2030	10	13,644	3,637	527
2031	11	14,195	3,784	548
2032	12	14,769	3,937	570
2033	13	15,366	4,096	593
2034	14	15,987	4,262	617
2035	15	16,633	4,434	642
2036	16	17,305	4,613	668
2037	17	18,004	4,800	695
2038	18	18,732	4,994	723
2039	19	19,489	5,195	753
2040	20	20,277	5,405	783
2041	21	21,096	5,624	815
2042	22	21,949	5,851	848
2043	23	22,836	6,087	882
2044	24	23,759	6,333	918
2045	25	24,719	6,589	955
2046	26	25,718	6,856	993
2047	27	26,757	7,133	1,033
2048	28	27,838	7,421	1,075
2049	29	28,964	7,721	1,119
2050	30	30,134	8,033	1,164
2051	31	31,352	8,358	1,211
2052	32	32,619	8,695	1,260
2053	33	33,937	9,047	1,311
2054	34	35,309	9,412	1,364
Total		632,056	168,491	24,412

9.10 Vehicle Operating Costs: Annual Benefit Estimates

Calendar Year	Project Year	Vehicle Operating Cost Savings	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$35,528	\$27,104	\$31,567
2026	6	\$37,453	\$26,704	\$32,307
2027	7	\$39,439	\$26,280	\$33,029
2028	8	\$41,421	\$25,795	\$33,679
2029	9	\$43,720	\$25,445	\$34,513
2030	10	\$46,937	\$25,531	\$35,973
2031	11	\$49,308	\$25,066	\$36,690
2032	12	\$51,821	\$24,620	\$37,436
2033	13	\$54,970	\$24,407	\$38,555
2034	14	\$58,104	\$24,111	\$39,566
2035	15	\$61,157	\$23,718	\$40,432
2036	16	\$64,460	\$23,363	\$41,374
2037	17	\$67,409	\$22,834	\$42,007
2038	18	\$70,955	\$22,463	\$42,929
2039	19	\$74,838	\$22,142	\$43,959
2040	20	\$78,145	\$21,608	\$44,565
2041	21	\$81,964	\$21,181	\$45,382
2042	22	\$86,704	\$20,940	\$46,608
2043	23	\$91,004	\$20,541	\$47,494
2044	24	\$95,523	\$20,150	\$48,401
2045	25	\$100,813	\$19,875	\$49,593
2046	26	\$105,236	\$19,390	\$50,261
2047	27	\$111,337	\$19,172	\$51,626
2048	28	\$117,221	\$18,864	\$52,772
2049	29	\$123,064	\$18,509	\$53,788
2050	30	\$129,038	\$18,138	\$54,757
2051	31	\$135,500	\$17,800	\$55,824
2052	32	\$142,283	\$17,469	\$56,911
2053	33	\$149,402	\$17,143	\$58,018
2054	34	\$156,873	\$16,822	\$59,145
Total		\$2,501,627	\$657,183	\$1,339,164

9.11 Land Value Increases: Annual Benefit Estimates

Calendar Year	Project Year	Land Value Increase	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$12,248,164	\$9,344,066	\$10,882,335
2026	6	\$0	\$0	\$0
2027	7	\$0	\$0	\$0
2028	8	\$0	\$0	\$0
2029	9	\$0	\$0	\$0
2030	10	\$0	\$0	\$0
2031	11	\$0	\$0	\$0
2032	12	\$0	\$0	\$0
2033	13	\$0	\$0	\$0
2034	14	\$0	\$0	\$0
2035	15	\$0	\$0	\$0
2036	16	\$0	\$0	\$0
2037	17	\$0	\$0	\$0
2038	18	\$0	\$0	\$0
2039	19	\$0	\$0	\$0
2040	20	\$0	\$0	\$0
2041	21	\$0	\$0	\$0
2042	22	\$0	\$0	\$0
2043	23	\$0	\$0	\$0
2044	24	\$0	\$0	\$0
2045	25	\$0	\$0	\$0
2046	26	\$0	\$0	\$0
2047	27	\$0	\$0	\$0
2048	28	\$0	\$0	\$0
2049	29	\$0	\$0	\$0
2050	30	\$0	\$0	\$0
2051	31	\$0	\$0	\$0
2052	32	\$0	\$0	\$0
2053	33	\$0	\$0	\$0
2054	34	\$0	\$0	\$0
Total		\$12,248,164	\$9,344,066	\$10,882,335

9.12 O&M Cost Savings: Annual Benefit Estimates

Calendar Year	Project Year	O&M Costs Savings	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$24,475	\$18,671	\$21,745
2026	6	\$24,475	\$17,450	\$21,112
2027	7	\$24,475	\$16,308	\$20,497
2028	8	\$24,475	\$15,241	\$19,900
2029	9	\$24,475	\$14,244	\$19,320
2030	10	\$24,475	\$13,313	\$18,758
2031	11	\$24,475	\$12,442	\$18,211
2032	12	\$24,475	\$11,628	\$17,681
2033	13	\$24,475	\$10,867	\$17,166
2034	14	\$24,475	\$10,156	\$16,666
2035	15	\$24,475	\$9,492	\$16,181
2036	16	\$24,475	\$8,871	\$15,709
2037	17	\$24,475	\$8,290	\$15,252
2038	18	\$24,475	\$7,748	\$14,807
2039	19	\$24,475	\$7,241	\$14,376
2040	20	\$24,475	\$6,767	\$13,957
2041	21	\$24,475	\$6,325	\$13,551
2042	22	\$24,475	\$5,911	\$13,156
2043	23	\$24,475	\$5,524	\$12,773
2044	24	\$24,475	\$5,163	\$12,401
2045	25	\$24,475	\$4,825	\$12,040
2046	26	\$24,475	\$4,509	\$11,689
2047	27	\$24,475	\$4,214	\$11,349
2048	28	\$24,475	\$3,939	\$11,018
2049	29	\$24,475	\$3,681	\$10,697
2050	30	\$24,475	\$3,440	\$10,386
2051	31	\$24,475	\$3,215	\$10,083
2052	32	\$24,475	\$3,005	\$9,789
2053	33	\$24,475	\$2,808	\$9,504
2054	34	\$24,475	\$2,625	\$9,228
Total		\$734,235	\$247,914	\$439,004

9.13 Residual Value: Annual Benefits Estimates

Calendar Year	Project Year	Residual Value	Total Discounted Benefits at 7%	Total Discounted Benefits at 3%
2021	1	\$0	\$0	\$0
2022	2	\$0	\$0	\$0
2023	3	\$0	\$0	\$0
2024	4	\$0	\$0	\$0
2025	5	\$0	\$0	\$0
2026	6	\$0	\$0	\$0
2027	7	\$0	\$0	\$0
2028	8	\$0	\$0	\$0
2029	9	\$0	\$0	\$0
2030	10	\$0	\$0	\$0
2031	11	\$0	\$0	\$0
2032	12	\$0	\$0	\$0
2033	13	\$0	\$0	\$0
2034	14	\$0	\$0	\$0
2035	15	\$0	\$0	\$0
2036	16	\$0	\$0	\$0
2037	17	\$0	\$0	\$0
2038	18	\$0	\$0	\$0
2039	19	\$0	\$0	\$0
2040	20	\$0	\$0	\$0
2041	21	\$0	\$0	\$0
2042	22	\$0	\$0	\$0
2043	23	\$0	\$0	\$0
2044	24	\$0	\$0	\$0
2045	25	\$0	\$0	\$0
2046	26	\$0	\$0	\$0
2047	27	\$0	\$0	\$0
2048	28	\$0	\$0	\$0
2049	29	\$0	\$0	\$0
2050	30	\$0	\$0	\$0
2051	31	\$0	\$0	\$0
2052	32	\$0	\$0	\$0
2053	33	\$0	\$0	\$0
2054	34	\$3,620,160	\$388,207	\$1,364,895