



**Benefit-cost Analysis Supplementary
Documentation**

Consolidated Rail Infrastructure and Safety
Improvements Program (CRISI) Grants Program
FY20

**Sharp–Tintic Railroad
Connection Project**

Utah Transit Authority

June 19, 2020

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Executive Summary

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 by building approximately 7,400 linear feet of new railroad tracks connecting the Sharp and Tintic Railroad corridors in Springville and Spanish Fork. With the construction of the Sharp-Tintic Connection, a segment of the Tintic Line will be closed. The Sharp-Tintic Rail Connection will enable key public transit and land development objectives and will streamline freight access between the Provo Rail Yard and businesses south of the connection.

The new connection to the Sharp-Tintic Line will enable key public transit and land development objectives while improving local community accessibility and safety. The Project will eliminate six existing at-grade crossings by redirecting train traffic from the Tintic Line to the Sharp Line. The Project is expected to improve safety by reducing potential train/vehicle accidents and to generate benefits through avoiding vehicle idling along the Tintic Line. 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.

This project is also necessary to support a potential future intermodal station in Spanish Fork, Utah, that will link bus routes to the Utah Transit Authority's (UTA) FrontRunner commuter rail and will improve land-development options in both Springville and Spanish Fork, thereby strengthening the cities' economic potential and improving their overall land use pattern.

The proposed Sharp-Tintic Railroad Connection Project concept is presented in Figure ES-1.

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

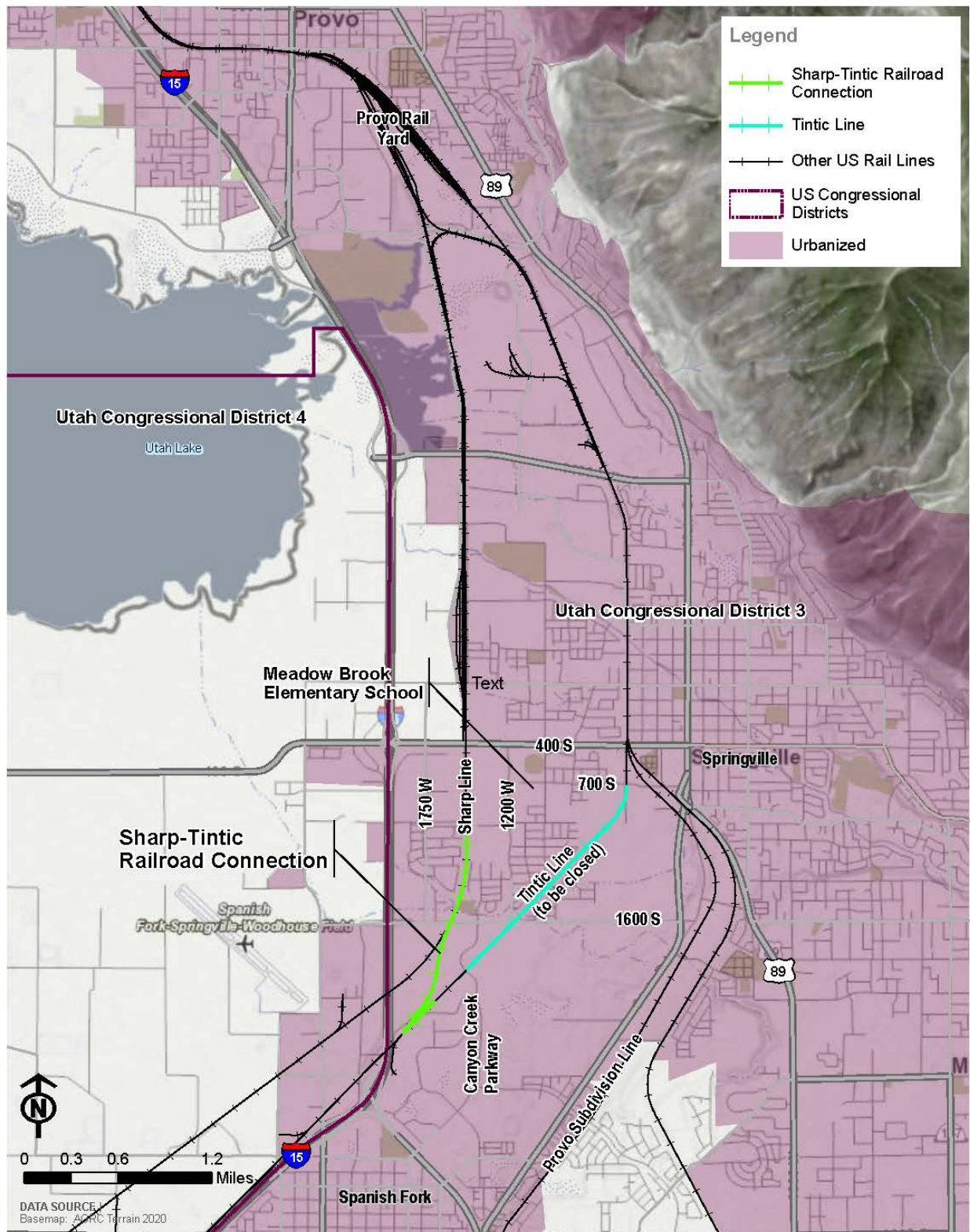


Table ES-1 summarizes the impacts and associated monetary benefits expected from the Sharp-Tintic Railroad Connection Project.

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 (2018\$) Undiscounted | Summary of Results (2018\$) Discounted at 7% |
|--|--|--|---|--|--|--|
| The Tintic Line travels from Interstate 15 (I-15) in Spanish Fork to 400 South in Springville. Currently, thru 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. | 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. | Improved safety and avoided accident costs thru a net reduction in active crossings. | Shippers, motorists, local businesses and residents | Accident cost savings | \$1,842,349 | \$594,754 |
| | | Reduce vehicle delay at crossings. | Shippers, motorists, local businesses and residents | Travel time savings | \$1,075,664 | \$315,050 |
| | | Reduce emissions from idling vehicles delayed at grade crossings. | Local residents and residents across the county | Emissions cost savings | \$2,139 | \$907 |
| | | Reduce out-of-pocket transportation costs from vehicle idling and delay along the grade crossings. | Shippers, motorists, and local businesses | Vehicle operating cost savings | \$150,411 | \$41,560 |
| | | 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 | \$12,010,695 | \$9,162,902 |
| | | Avoided future maintenance once crossings are closed. | Railroad operators and local government | Operation and maintenance (O&M) cost savings | \$720,000 | \$243,107 |
| | | Residual value of infrastructure assets and land. | Local, state, and federal governments | Residual value | \$2,728,179 | \$292,555 |
| | | 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 33 years, including 3 years of construction and project development as well as 30 years of operation. The total project cost is estimated at \$10.32 million in 2020 dollars. For the purpose of the benefit-cost analysis (BCA), costs were de-escalated to 2018 using the gross domestic product (GDP) deflator. The total 2018 (undiscounted) project cost is estimated at \$9.93 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 \$10.65 million in discounted benefits and \$8.42 million in discounted costs, using a 7% real discount rate. Therefore, the Project is expected to generate a net present value of \$2.23 million and a benefit/cost ratio of 1.26.

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 (2018\$)

| 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% |
|---------------|--------------|--|-------------------------|--------------------|---------------------------|---------------------------------|------------------------------|-------------------------------|
| 2020 | 0 | Workers otherwise unemployed (shadow wage benefit); not quantified | \$0 | \$0 | \$0 | \$0 | \$0 | \$0 |
| 2021 | 1 | | \$0 | \$1,361,860 | -\$1,361,860 | \$0 | \$1,272,767 | -\$1,272,767 |
| 2022 | 2 | | \$0 | \$2,766,112 | -\$2,766,112 | \$0 | \$2,416,030 | -\$2,416,030 |
| 2023 | 3 | | \$0 | \$5,798,037 | -\$5,798,037 | \$0 | \$4,732,925 | -\$4,732,925 |
| 2024 | 4 | 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. | \$12,113,728 | \$0 | \$12,113,728 | \$9,241,505 | \$0 | \$9,241,505 |
| 2025 | 5 | | \$104,287 | \$0 | \$104,287 | \$74,356 | \$0 | \$74,356 |
| 2026 | 6 | | \$105,577 | \$0 | \$105,577 | \$70,351 | \$0 | \$70,351 |
| 2027 | 7 | | \$106,897 | \$0 | \$106,897 | \$66,570 | \$0 | \$66,570 |
| 2028 | 8 | | \$108,241 | \$0 | \$108,241 | \$62,997 | \$0 | \$62,997 |
| 2029 | 9 | | \$109,633 | \$0 | \$109,633 | \$59,633 | \$0 | \$59,633 |
| 2030 | 10 | | \$111,117 | \$0 | \$111,117 | \$56,486 | \$0 | \$56,486 |
| 2031 | 11 | | \$112,573 | \$0 | \$112,573 | \$53,483 | \$0 | \$53,483 |
| 2032 | 12 | | \$114,065 | \$0 | \$114,065 | \$50,646 | \$0 | \$50,646 |
| 2033 | 13 | | \$115,629 | \$0 | \$115,629 | \$47,982 | \$0 | \$47,982 |
| 2034 | 14 | | \$117,218 | \$0 | \$117,218 | \$45,459 | \$0 | \$45,459 |
| 2035 | 15 | | \$118,828 | \$0 | \$118,828 | \$43,069 | \$0 | \$43,069 |
| 2036 | 16 | | \$120,483 | \$0 | \$120,483 | \$40,812 | \$0 | \$40,812 |
| 2037 | 17 | | \$122,143 | \$0 | \$122,143 | \$38,667 | \$0 | \$38,667 |
| 2038 | 18 | | \$123,872 | \$0 | \$123,872 | \$36,649 | \$0 | \$36,649 |
| 2039 | 19 | | \$125,653 | \$0 | \$125,653 | \$34,744 | \$0 | \$34,744 |
| 2040 | 20 | | \$127,428 | \$0 | \$127,428 | \$32,930 | \$0 | \$32,930 |
| 2041 | 21 | | \$129,275 | \$0 | \$129,275 | \$31,222 | \$0 | \$31,222 |
| 2042 | 22 | | \$131,213 | \$0 | \$131,213 | \$29,617 | \$0 | \$29,617 |
| 2043 | 23 | | \$133,157 | \$0 | \$133,157 | \$28,089 | \$0 | \$28,089 |
| 2044 | 24 | | \$135,148 | \$0 | \$135,148 | \$26,644 | \$0 | \$26,644 |
| 2045 | 25 | | \$137,222 | \$0 | \$137,222 | \$25,283 | \$0 | \$25,283 |
| 2046 | 26 | | \$139,279 | \$0 | \$139,279 | \$23,983 | \$0 | \$23,983 |
| 2047 | 27 | | \$141,474 | \$0 | \$141,474 | \$22,768 | \$0 | \$22,768 |
| 2048 | 28 | | \$143,693 | \$0 | \$143,693 | \$21,612 | \$0 | \$21,612 |
| 2049 | 29 | | \$145,948 | \$0 | \$145,948 | \$20,515 | \$0 | \$20,515 |
| 2050 | 30 | | \$148,250 | \$0 | \$148,250 | \$19,475 | \$0 | \$19,475 |
| 2051 | 31 | | \$150,622 | \$0 | \$150,622 | \$18,492 | \$0 | \$18,492 |
| 2052 | 32 | | \$153,054 | \$0 | \$153,054 | \$17,562 | \$0 | \$17,562 |
| 2053 | 33 | | \$2,883,725 | \$0 | \$2,883,725 | \$309,235 | \$0 | \$309,235 |
| Total | | | \$18,529,436 | \$9,926,009 | \$8,603,427 | \$10,650,836 | \$8,421,721 | \$2,229,114 |

Table ES-3: Summary of 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 |
|---------------|--------------|-----------------------|---------------------|------------------------|--------------------------------|---------------------|------------------|--------------------|
| 2020 | 0 | \$0 | \$0 | \$0 | \$0 | \$0 | \$0 | \$0 |
| 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 | \$53,514 | \$22,796 | \$152 | \$2,570 | \$12,010,695 | \$24,000 | \$0 |
| 2025 | 5 | \$53,996 | \$23,468 | \$144 | \$2,680 | \$0 | \$24,000 | \$0 |
| 2026 | 6 | \$54,487 | \$24,160 | \$135 | \$2,795 | \$0 | \$24,000 | \$0 |
| 2027 | 7 | \$54,986 | \$24,873 | \$125 | \$2,913 | \$0 | \$24,000 | \$0 |
| 2028 | 8 | \$55,493 | \$25,606 | \$115 | \$3,027 | \$0 | \$24,000 | \$0 |
| 2029 | 9 | \$56,006 | \$26,361 | \$104 | \$3,162 | \$0 | \$24,000 | \$0 |
| 2030 | 10 | \$56,526 | \$27,139 | \$92 | \$3,360 | \$0 | \$24,000 | \$0 |
| 2031 | 11 | \$57,052 | \$27,939 | \$89 | \$3,493 | \$0 | \$24,000 | \$0 |
| 2032 | 12 | \$57,584 | \$28,763 | \$85 | \$3,633 | \$0 | \$24,000 | \$0 |
| 2033 | 13 | \$58,122 | \$29,612 | \$81 | \$3,813 | \$0 | \$24,000 | \$0 |
| 2034 | 14 | \$58,667 | \$30,485 | \$77 | \$3,989 | \$0 | \$24,000 | \$0 |
| 2035 | 15 | \$59,217 | \$31,384 | \$73 | \$4,155 | \$0 | \$24,000 | \$0 |
| 2036 | 16 | \$59,773 | \$32,310 | \$67 | \$4,333 | \$0 | \$24,000 | \$0 |
| 2037 | 17 | \$60,335 | \$33,263 | \$61 | \$4,484 | \$0 | \$24,000 | \$0 |
| 2038 | 18 | \$60,902 | \$34,244 | \$55 | \$4,671 | \$0 | \$24,000 | \$0 |
| 2039 | 19 | \$61,476 | \$35,254 | \$49 | \$4,875 | \$0 | \$24,000 | \$0 |
| 2040 | 20 | \$62,055 | \$36,294 | \$41 | \$5,037 | \$0 | \$24,000 | \$0 |
| 2041 | 21 | \$62,640 | \$37,364 | \$42 | \$5,228 | \$0 | \$24,000 | \$0 |
| 2042 | 22 | \$63,232 | \$38,466 | \$43 | \$5,473 | \$0 | \$24,000 | \$0 |
| 2043 | 23 | \$63,829 | \$39,601 | \$43 | \$5,684 | \$0 | \$24,000 | \$0 |
| 2044 | 24 | \$64,432 | \$40,769 | \$44 | \$5,904 | \$0 | \$24,000 | \$0 |
| 2045 | 25 | \$65,041 | \$41,971 | \$44 | \$6,166 | \$0 | \$24,000 | \$0 |
| 2046 | 26 | \$65,656 | \$43,209 | \$45 | \$6,370 | \$0 | \$24,000 | \$0 |
| 2047 | 27 | \$66,277 | \$44,484 | \$45 | \$6,669 | \$0 | \$24,000 | \$0 |
| 2048 | 28 | \$66,904 | \$45,796 | \$46 | \$6,948 | \$0 | \$24,000 | \$0 |
| 2049 | 29 | \$67,538 | \$47,146 | \$46 | \$7,218 | \$0 | \$24,000 | \$0 |
| 2050 | 30 | \$68,178 | \$48,537 | \$47 | \$7,489 | \$0 | \$24,000 | \$0 |
| 2051 | 31 | \$68,824 | \$49,968 | \$48 | \$7,782 | \$0 | \$24,000 | \$0 |
| 2052 | 32 | \$69,476 | \$51,442 | \$49 | \$8,086 | \$0 | \$24,000 | \$0 |
| 2053 | 33 | \$70,135 | \$52,959 | \$51 | \$8,402 | \$0 | \$24,000 | \$2,728,179 |
| Total | | \$1,842,349 | \$1,075,664 | \$2,139 | \$150,411 | \$12,010,695 | \$720,000 | \$2,728,179 |

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) |
|---------------|--------------|--------------------|------------------|-----------------------|---|--|--------------------------------------|--|
| 2020 | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 | 0 | 0 |
| 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 | 0.003 | 0.061 | 0.300 | 1,422 | 839 | 225 | 31 |
| 2025 | 5 | 0.004 | 0.061 | 0.303 | 1,464 | 864 | 231 | 31 |
| 2026 | 6 | 0.004 | 0.062 | 0.306 | 1,508 | 889 | 238 | 32 |
| 2027 | 7 | 0.004 | 0.063 | 0.309 | 1,552 | 915 | 245 | 33 |
| 2028 | 8 | 0.004 | 0.063 | 0.312 | 1,598 | 942 | 253 | 34 |
| 2029 | 9 | 0.004 | 0.064 | 0.315 | 1,645 | 970 | 260 | 35 |
| 2030 | 10 | 0.004 | 0.064 | 0.318 | 1,693 | 999 | 268 | 36 |
| 2031 | 11 | 0.004 | 0.065 | 0.321 | 1,743 | 1,028 | 276 | 37 |
| 2032 | 12 | 0.004 | 0.066 | 0.324 | 1,795 | 1,059 | 284 | 39 |
| 2033 | 13 | 0.004 | 0.066 | 0.327 | 1,848 | 1,090 | 292 | 40 |
| 2034 | 14 | 0.004 | 0.067 | 0.331 | 1,902 | 1,122 | 301 | 41 |
| 2035 | 15 | 0.004 | 0.068 | 0.334 | 1,958 | 1,155 | 309 | 42 |
| 2036 | 16 | 0.004 | 0.068 | 0.337 | 2,016 | 1,189 | 319 | 43 |
| 2037 | 17 | 0.004 | 0.069 | 0.340 | 2,076 | 1,224 | 328 | 45 |
| 2038 | 18 | 0.004 | 0.070 | 0.343 | 2,137 | 1,260 | 338 | 46 |
| 2039 | 19 | 0.004 | 0.070 | 0.347 | 2,200 | 1,297 | 348 | 47 |
| 2040 | 20 | 0.004 | 0.071 | 0.350 | 2,265 | 1,336 | 358 | 49 |
| 2041 | 21 | 0.004 | 0.072 | 0.353 | 2,331 | 1,375 | 368 | 50 |
| 2042 | 22 | 0.004 | 0.072 | 0.357 | 2,400 | 1,416 | 379 | 52 |
| 2043 | 23 | 0.004 | 0.073 | 0.360 | 2,471 | 1,457 | 391 | 53 |
| 2044 | 24 | 0.004 | 0.074 | 0.364 | 2,544 | 1,500 | 402 | 55 |
| 2045 | 25 | 0.004 | 0.074 | 0.367 | 2,619 | 1,545 | 414 | 56 |
| 2046 | 26 | 0.004 | 0.075 | 0.371 | 2,696 | 1,590 | 426 | 58 |
| 2047 | 27 | 0.004 | 0.076 | 0.374 | 2,776 | 1,637 | 439 | 60 |
| 2048 | 28 | 0.004 | 0.077 | 0.378 | 2,858 | 1,685 | 452 | 61 |
| 2049 | 29 | 0.004 | 0.077 | 0.381 | 2,942 | 1,735 | 465 | 63 |
| 2050 | 30 | 0.004 | 0.078 | 0.385 | 3,029 | 1,786 | 479 | 65 |
| 2051 | 31 | 0.004 | 0.079 | 0.389 | 3,118 | 1,839 | 493 | 67 |
| 2052 | 32 | 0.004 | 0.080 | 0.392 | 3,210 | 1,893 | 507 | 69 |
| 2053 | 33 | 0.005 | 0.080 | 0.396 | 3,305 | 1,949 | 522 | 71 |
| Total | | 0.119 | 2.104 | 10.384 | 67,120 | 39,588 | 10,608 | 1,440 |

1 Introduction

This document provides detailed technical information regarding the economic analyses conducted in support of the Federal Railroad Administration's (FRA) fiscal year 2020 (FY20) CRISI Grant Application for the Sharp-Tintic Railroad Connection Project (the Project).

- **Section 2, Methodological Framework:** Introduces the conceptual framework used in the benefit-cost analysis (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 net present value (NPV), its benefit-cost ratio (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 U.S. Department of Transportation (USDOT) in its review of the application.¹

¹ Although the models and software themselves do not accompany this technical appendix, they are provided separately as part of the 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*, January 2020

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 six 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, thru 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 thru train movements.

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

- **2** daily thru trains on the Tintic track;
- **6** daily thru trains on the Sharp track north of the project area;
- **8** daily thru trains on the Tintic track north of the project area;
- Thru train length of **1,000** feet;
- Thru train traffic assumed to remain constant with 0% growth; and,
- **2,347** acres of mixed-use land within 500 feet of the industrial lead, currently valued at a blended average of **\$102,366** per acre 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 six 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 thru trains on the Sharp-Tintic Connection track;
- **8** daily thru trains on the Sharp track north of the project area;
- **6** daily thru trains on the Tintic track north of the project area;
- Thru train length of **1,000** feet (same as the base case);
- **6** at-grade crossing closed;
- 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

The Sharp-Tintic Railroad Connection Project leverages non-Federal funding to provide optimal project cost delivery. Table 1 summarizes the Project's capital expenditure components, with project delivery estimated for 2023. Table 2 lists the capital cost by component.

Table 1: Cost Summary Table

| Capital Expenditures | 2018 Dollars |
|----------------------|--------------------|
| 2020 | - |
| 2021 | \$1,361,860 |
| 2022 | \$2,766,112 |
| 2023 | \$5,798,037 |
| Total | \$9,926,009 |

Table 2: Capital Cost by Component

| Capital Expenditures | 2018 Dollars | Percentage of Project Costs |
|--------------------------|--------------------|-----------------------------|
| P.E. | \$995,651 | 10.0% |
| Right of Way | \$950,437 | 9.6% |
| Utilities | \$96,198 | 1.0% |
| Construction | \$7,110,965 | 71.6% |
| C.E. | \$497,344 | 5.0% |
| Change Order Contingency | \$121,497 | 1.2% |
| UDOT Oversight | \$153,917 | 1.6% |
| Total | \$9,926,009 | |

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 2018 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 2018 dollars.
- The period of analysis begins in 2020 and ends in 2053. It includes 3 years for project development and construction (2021 – 2023) and 30 full years of operations (2024 – 2053).
- A constant 7% real discount rate is assumed throughout the period of analysis. A 3% real discount rate is used for the sensitivity analysis.

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 thru train traffic in the corridor and the average daily vehicle count (annual average daily traffic, or AADT) at the active crossings.

5.1 Methodology

Daily thru train volumes are forecasted based on current daily thru train volumes and assumed to remain constant for the duration of the study since no changes in operations are anticipated. The current thru train volumes were obtained from FRA's Grade Crossing Inventory for the impacted crossings along the Tintic and Sharp tracks.

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.

Table 4: Assumptions used in the Estimation of Demand

| Variable Name | Unit | Value | Source |
|---|----------------------|---------|---|
| General Corridor Assumptions | | | |
| Current Thru Train Volumes | trains/day | 2 | Based on FRA's Grade Crossing Inventory for the impacted crossings on the Tintic line. |
| Thru Train Growth | % | 0% | Assume no growth based on current service. |
| Average Thru Train Length | feet | 1,000 | Assumption. |
| Lead and Lag Time | minutes | 0.5 | Assumption. |
| Rail Train Data | | | |
| Tintic Rail Train Data | | | Based on FRA's Grade Crossing Inventory for the impacted crossings on the Tintic Line. |
| Thru Trains | Thru trains/day | 2.0 | |
| Thru 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. |
| Thru Trains | Thru trains/day | 6.0 | |
| Thru 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. |
| Thru Trains | Thru trains/day | 8.0 | |
| Thru 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 | % | 3.0% | 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% | |

| Variable Name | Unit | Value | Source |
|-----------------------------|--------------|---------|---|
| Bus | bus/day | 0 | |
| 950 West | | | |
| Crossing ID | ID | 968062Y | FRA's Grade Crossing Inventory. |
| 2010 AADT | vehicles/day | 550 | |
| AADT Growth Rate | % | 3.0% | 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 | % | 3.0% | 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 | % | 3.0% | 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 | |
| Private | | | |
| Crossing ID | ID | 254402J | FRA's Grade Crossing Inventory. |
| 2010 AADT | vehicles/day | 130 | |
| AADT Growth Rate | % | 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 | % | 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 | % | 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 | % | 3% | Calculated from the AADT and projected AADT in the area provided by UDOT. |
| Passenger Vehicles | % | 90.0% | FRA's Grade Crossing Inventory. |

| Variable Name | Unit | Value | Source |
|--------------------|--------------|---------|---|
| 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 | % | 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 | % | 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 | % | 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 | |
| 400 North | | | |
| Crossing ID | ID | 254731H | FRA's Grade Crossing Inventory. |
| 2010 AADT | vehicles/day | 1,600 | |
| AADT Growth Rate | % | 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 thru 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 – Thru Train

| Demand | Unit | 2020 | 2024 | 2030 | 2035 | 2040 | 2045 | 2051 |
|--|-------------|------|------|------|------|------|------|------|
| No Build | | | | | | | | |
| Tintic Thru Train | trains/day | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Sharp-Tintic Thru Trains | trains/day | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sharp Tracks North of the Project Thru Trains | trains/day | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Tintic Tracks North of the Project Thru Trains | trains/year | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Build | | | | | | | | |
| Tintic Thru Train | trains/day | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sharp-Tintic Thru Trains | trains/day | 0 | 2 | 2 | 2 | 2 | 2 | 2 |
| Sharp Tracks North of the Project Thru Trains | trains/day | 6 | 8 | 8 | 8 | 8 | 8 | 8 |
| Tintic Tracks North of the Project Thru Trains | trains/year | 8 | 6 | 6 | 6 | 6 | 6 | 6 |

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 |
| | 2053 | 1,920 | 1,920 | 13,611 | 1,920 | 860 | 13,611 | 691 | 1,815 | 2,967 | 36,645 | 2,967 | 5,584 |
| 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 |
| | 2053 | 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 |

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 grade crossings. The Project would also redirect some train traffic 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 | 2018\$/fatal crash | \$10,636,600 | USDOT, BCA Guidance 2020. |
| Injury Crash | 2018\$/injury crash | \$250,600 | USDOT, BCA Guidance 2020. |
| Average Cost per Property Damage Only (PDO) Accident | 2018\$/PDO accident | \$4,400 | USDOT, BCA Guidance 2020. |
| Annual Growth in Real Accident Costs | % | 0 | USDOT, BCA Guidance 2020. |

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 \$0.59 million.

Table 8: Estimates of Accident Cost Savings, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|-----------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| Accident Cost Savings | \$53,514 | \$1,842,349 | \$594,754 |

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, 2020 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 | 2018\$/hour | \$15.20 | USDOT, 2020 BCA, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis. |
| Value of Time for Truck Driver | 2018\$/hour | \$29.50 | |
| Value of Time for Bus Driver | 2018\$/hour | \$31.00 | |

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 \$0.32 million. See Sections 9.5 and 9.6 for additional information.

Table 10: Estimates of Travel Time Savings, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|---------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| Travel Time Savings | \$22,796 | \$1,075,664 | \$315,050 |

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), volatile organic carbons (VOC), particulate matter (PM), 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

| Pollutant | Unit | Year | Value | Source |
|------------------------------------|------------------|-----------|-----------|---|
| Carbon Dioxide (CO ₂) | 2018\$/short ton | 2020 | \$0.91 | USDOT, BCA Guidance January 2020; The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks (July 2018). Prices assumed constant past 2050 to account for benefits conservatively. |
| | | 2021 | \$0.91 | |
| | | 2022 | \$0.91 | |
| | | 2023 | \$0.91 | |
| | | 2024 | \$0.91 | |
| | | 2025 | \$0.91 | |
| | | 2026 | \$0.91 | |
| | | 2027 | \$0.91 | |
| | | 2028 | \$0.91 | |
| | | 2029 | \$0.91 | |
| | | 2030 | \$0.91 | |
| | | 2031 | \$1.09 | |
| | | 2032 | \$1.27 | |
| | | 2033 | \$1.45 | |
| | | 2034 | \$1.63 | |
| | | 2035 | \$1.81 | |
| | | 2036 | \$1.81 | |
| | | 2037 | \$1.81 | |
| | | 2038 | \$1.81 | |
| | | 2039 | \$1.81 | |
| | | 2040 | \$1.81 | |
| | | 2041 | \$1.81 | |
| | | 2042 | \$1.81 | |
| | | 2043 | \$1.81 | |
| | | 2044 | \$1.81 | |
| | | 2045 | \$1.81 | |
| | | 2046 | \$1.81 | |
| | | 2047 | \$1.81 | |
| | | 2048 | \$1.81 | |
| | | 2049 | \$1.81 | |
| | | 2050 | \$1.81 | |
| | | 2051 | \$1.81 | |
| | | 2052 | \$1.81 | |
| | | 2053 | \$1.81 | |
| Nitrogen Oxides (NO _x) | 2018\$/short ton | 2020-2053 | \$8,600 | US DOT, BCA Guidance January 2020; The Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars and Light Trucks Preliminary Regulatory Impact Analysis (October 2018)". |
| Volatile Organic Compounds (VOC) | 2018\$/short ton | 2020-2053 | \$2,100 | |
| Particulate Matter (PM) | 2018\$/short ton | 2020-2053 | \$387,300 | |
| Sulfur Dioxide (SO ₂) | 2018\$/short ton | 2020-2053 | \$50,100 | |

Table 12: Vehicle Emissions

| Emissions per Gallon of Fuel Burned - Trucks (grams/ton-miles) | | | | | | Source/Comment |
|--|-----------------|-------|-------|-----------------|-----------------|---|
| Year | NO _x | VOC | PM | SO ₂ | CO ₂ | |
| 2020 | 2.181 | 1.027 | 0.057 | 0.015 | 2307 | 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. |
| 2021 | 1.987 | 0.933 | 0.055 | 0.015 | 2274 | |
| 2022 | 1.792 | 0.838 | 0.053 | 0.015 | 2241 | |
| 2023 | 1.597 | 0.744 | 0.051 | 0.015 | 2207 | |
| 2024 | 1.403 | 0.650 | 0.049 | 0.014 | 2174 | |
| 2025 | 1.208 | 0.555 | 0.047 | 0.014 | 2141 | |
| 2026 | 1.014 | 0.461 | 0.046 | 0.014 | 2107 | |
| 2027 | 0.819 | 0.367 | 0.044 | 0.014 | 2074 | |
| 2028 | 0.625 | 0.272 | 0.042 | 0.014 | 2040 | |
| 2029 | 0.430 | 0.178 | 0.040 | 0.013 | 2007 | |
| 2030 | 0.235 | 0.084 | 0.038 | 0.013 | 1974 | |
| 2031 | 0.216 | 0.077 | 0.037 | 0.013 | 1935 | |
| 2032 | 0.196 | 0.071 | 0.036 | 0.013 | 1897 | |
| 2033 | 0.176 | 0.065 | 0.034 | 0.012 | 1858 | |
| 2034 | 0.156 | 0.058 | 0.033 | 0.012 | 1819 | |
| 2035 | 0.136 | 0.052 | 0.032 | 0.012 | 1781 | |
| 2036 | 0.117 | 0.046 | 0.031 | 0.012 | 1742 | |
| 2037 | 0.097 | 0.039 | 0.029 | 0.011 | 1704 | |
| 2038 | 0.077 | 0.033 | 0.028 | 0.011 | 1665 | |
| 2039 | 0.057 | 0.027 | 0.027 | 0.011 | 1627 | |
| 2040 | 0.037 | 0.020 | 0.025 | 0.011 | 1588 | |
| 2041 | 0.035 | 0.020 | 0.025 | 0.010 | 1562 | |
| 2042 | 0.032 | 0.019 | 0.024 | 0.010 | 1537 | |
| 2043 | 0.029 | 0.018 | 0.023 | 0.010 | 1511 | |
| 2044 | 0.026 | 0.017 | 0.022 | 0.010 | 1485 | |
| 2045 | 0.024 | 0.016 | 0.021 | 0.010 | 1459 | |
| 2046 | 0.021 | 0.016 | 0.020 | 0.010 | 1434 | |
| 2047 | 0.018 | 0.015 | 0.019 | 0.009 | 1408 | |
| 2048 | 0.016 | 0.014 | 0.018 | 0.009 | 1382 | |
| 2049 | 0.013 | 0.013 | 0.017 | 0.009 | 1356 | |
| 2050 | 0.010 | 0.013 | 0.016 | 0.009 | 1330 | |
| 2051 | 0.010 | 0.013 | 0.016 | 0.009 | 1330 | |
| 2052 | 0.010 | 0.013 | 0.016 | 0.009 | 1330 | |
| 2053 | 0.010 | 0.013 | 0.016 | 0.009 | 1330 | |

Table 13: Truck Emissions

| Emissions per Gallon of Fuel Burned - Trucks (grams/ton-miles) | | | | | | Source/Comment |
|--|-----------------|-------|-------|-----------------|-----------------|--|
| Year | NO _x | VOC | PM | SO ₂ | CO ₂ | |
| 2020 | 78.110 | 7.953 | 2.877 | 0.086 | 9911 | MOVES Average Annual Emissions Factors for Light Commercial Trucks (grams/veh-miles) assuming an average speed of 2.5 mph to reflect idling conditions. Model run in May 2020. |
| 2021 | 73.377 | 7.508 | 2.690 | 0.086 | 9884 | |
| 2022 | 68.643 | 7.062 | 2.502 | 0.085 | 9857 | |
| 2023 | 63.910 | 6.617 | 2.315 | 0.085 | 9830 | |
| 2024 | 59.177 | 6.172 | 2.128 | 0.084 | 9803 | |
| 2025 | 54.444 | 5.726 | 1.941 | 0.084 | 9775 | |
| 2026 | 49.710 | 5.281 | 1.753 | 0.084 | 9748 | |
| 2027 | 44.977 | 4.836 | 1.566 | 0.083 | 9721 | |
| 2028 | 40.244 | 4.390 | 1.379 | 0.083 | 9694 | |
| 2029 | 35.511 | 3.945 | 1.192 | 0.082 | 9667 | |
| 2030 | 30.778 | 3.500 | 1.004 | 0.082 | 9640 | |
| 2031 | 28.716 | 3.216 | 0.916 | 0.081 | 9613 | |
| 2032 | 26.654 | 2.932 | 0.827 | 0.081 | 9585 | |
| 2033 | 24.592 | 2.648 | 0.739 | 0.081 | 9557 | |
| 2034 | 22.530 | 2.364 | 0.650 | 0.080 | 9529 | |
| 2035 | 20.468 | 2.081 | 0.562 | 0.080 | 9501 | |
| 2036 | 18.406 | 1.797 | 0.473 | 0.080 | 9473 | |
| 2037 | 16.344 | 1.513 | 0.385 | 0.079 | 9445 | |
| 2038 | 14.282 | 1.229 | 0.296 | 0.079 | 9418 | |
| 2039 | 12.220 | 0.945 | 0.208 | 0.078 | 9390 | |
| 2040 | 10.158 | 0.662 | 0.119 | 0.078 | 9362 | |
| 2041 | 10.119 | 0.661 | 0.119 | 0.078 | 9346 | |
| 2042 | 10.080 | 0.661 | 0.119 | 0.078 | 9330 | |
| 2043 | 10.041 | 0.661 | 0.119 | 0.078 | 9315 | |
| 2044 | 10.001 | 0.660 | 0.119 | 0.078 | 9299 | |
| 2045 | 9.962 | 0.660 | 0.119 | 0.077 | 9283 | |
| 2046 | 9.923 | 0.660 | 0.119 | 0.077 | 9267 | |
| 2047 | 9.884 | 0.659 | 0.118 | 0.077 | 9252 | |
| 2048 | 9.844 | 0.659 | 0.118 | 0.077 | 9236 | |
| 2049 | 9.805 | 0.659 | 0.118 | 0.077 | 9220 | |
| 2050 | 9.766 | 0.658 | 0.118 | 0.077 | 9204 | |
| 2051 | 9.766 | 0.658 | 0.118 | 0.077 | 9204 | |
| 2052 | 9.766 | 0.658 | 0.118 | 0.077 | 9204 | |
| 2053 | 9.766 | 0.658 | 0.118 | 0.077 | 9204 | |

Table 14: Bus Emissions

| Emissions per Gallon of Fuel Burned - Trucks (grams/ton-miles) | | | | | | Source/Comment |
|--|-----------------|-------|-------|-----------------|-----------------|---|
| Year | NO _x | VOC | PM | SO ₂ | CO ₂ | |
| 2020 | 18.730 | 0.325 | 0.027 | 2.566 | 3342 | HDR Calculations based on Bus Emissions reported in California Air Resources Board, EMFAC 2014. |
| 2021 | 17.890 | 0.307 | 0.026 | 2.430 | 3321 | |
| 2022 | 17.050 | 0.289 | 0.026 | 2.294 | 3299 | |
| 2023 | 16.210 | 0.271 | 0.026 | 2.158 | 3278 | |
| 2024 | 15.370 | 0.253 | 0.026 | 2.021 | 3256 | |
| 2025 | 14.531 | 0.234 | 0.026 | 1.885 | 3235 | |
| 2026 | 13.691 | 0.216 | 0.026 | 1.749 | 3214 | |
| 2027 | 12.851 | 0.198 | 0.025 | 1.613 | 3192 | |
| 2028 | 12.011 | 0.180 | 0.025 | 1.477 | 3171 | |
| 2029 | 11.171 | 0.162 | 0.025 | 1.340 | 3149 | |
| 2030 | 10.331 | 0.144 | 0.025 | 1.204 | 3128 | |
| 2031 | 9.491 | 0.126 | 0.025 | 1.068 | 3107 | |
| 2032 | 8.651 | 0.108 | 0.025 | 0.932 | 3085 | |
| 2033 | 7.812 | 0.089 | 0.024 | 0.796 | 3064 | |
| 2034 | 6.972 | 0.071 | 0.024 | 0.659 | 3042 | |
| 2035 | 6.132 | 0.053 | 0.024 | 0.523 | 3021 | |
| 2036 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2037 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2038 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2039 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2040 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2041 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2042 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2043 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2044 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2045 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2046 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2047 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2048 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2049 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2050 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2051 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2052 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |
| 2053 | 5.292 | 0.035 | 0.024 | 0.387 | 3000 | |

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 \$907 dollars. See Sections 9.7 and 9.8 for additional information.

Table 15: Estimates of Emission Cost Savings, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|------------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| Emissions Cost Savings | \$152 | \$2,139 | \$907 |

6.4 Vehicle Operating Costs

6.4.1 Methodology

The reduction in vehicle idling time is directly correlated to eliminating the six active 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 | 2018\$/quart | - | \$10.58 | Average Oil Price Sourced From HERS Model and Inflated to 2018\$ by Motor Oil CPI (BLS CUUR0000SS47021). |
| Cost of Motor Oil - Trucks | 2018\$/quart | - | \$4.23 | |
| Cost of Motor Oil - Bus | 2018\$/quart | - | \$10.58 | |
| Gasoline Retail Price | 2018\$/gallon | 2020 | \$2.07 | US EIA Annual Energy Outlook 2020, net of Federal & State Taxes. |
| | | 2021 | \$2.07 | |
| | | 2022 | \$2.08 | |
| | | 2023 | \$2.07 | |
| | | 2024 | \$2.04 | |
| | | 2025 | \$2.07 | |
| | | 2026 | \$2.10 | |
| | | 2027 | \$2.13 | |
| | | 2028 | \$2.15 | |
| | | 2029 | \$2.19 | |
| | | 2030 | \$2.28 | |
| | | 2031 | \$2.30 | |
| | | 2032 | \$2.32 | |
| | | 2033 | \$2.38 | |
| | | 2034 | \$2.42 | |
| | | 2035 | \$2.46 | |
| | | 2036 | \$2.49 | |
| | | 2037 | \$2.51 | |
| | | 2038 | \$2.54 | |
| | | 2039 | \$2.58 | |
| | | 2040 | \$2.60 | |
| | | 2041 | \$2.62 | |
| | | 2042 | \$2.67 | |
| | | 2043 | \$2.70 | |
| | | 2044 | \$2.72 | |
| | | 2045 | \$2.77 | |
| | | 2046 | \$2.78 | |
| | | 2047 | \$2.83 | |
| | | 2048 | \$2.87 | |
| | | 2049 | \$2.91 | |
| | | 2050 | \$2.93 | |
| | | 2051 | \$2.96 | |
| | | 2052 and onwards | \$2.99 | |
| Diesel Retail Price | 2018\$/gallon | 2020 | \$2.31 | US EIA Annual Energy Outlook 2020, net of Federal & State Taxes. |
| | | 2021 | \$2.33 | |
| | | 2022 | \$2.37 | |
| | | 2023 | \$2.40 | |
| | | 2024 | \$2.46 | |
| | | 2025 | \$2.48 | |
| | | 2026 | \$2.54 | |
| | | 2027 | \$2.55 | |
| | | 2028 | \$2.60 | |
| | | 2029 | \$2.64 | |
| | | 2030 | \$2.71 | |
| | | 2031 | \$2.75 | |
| | | 2032 | \$2.77 | |

| Variable Name | Unit | Year | Value | Source |
|---------------|------|------------------|--------|--------|
| | | 2033 | \$2.83 | |
| | | 2034 | \$2.86 | |
| | | 2035 | \$2.90 | |
| | | 2036 | \$2.93 | |
| | | 2037 | \$2.96 | |
| | | 2038 | \$2.99 | |
| | | 2039 | \$3.03 | |
| | | 2040 | \$3.03 | |
| | | 2041 | \$3.06 | |
| | | 2042 | \$3.11 | |
| | | 2043 | \$3.14 | |
| | | 2044 | \$3.17 | |
| | | 2045 | \$3.22 | |
| | | 2046 | \$3.23 | |
| | | 2047 | \$3.26 | |
| | | 2048 | \$3.30 | |
| | | 2049 | \$3.33 | |
| | | 2050 | \$3.35 | |
| | | 2051 | \$3.38 | |
| | | 2052 and onwards | \$3.42 | |

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 \$41,560. See Sections 9.9 and 9.10 for more information.

Table 17: Estimates of Vehicle Operating Costs, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|--------------------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| Vehicle Operating Cost Savings | \$2,570 | \$150,411 | \$41,560 |

6.5 Land Value Increases

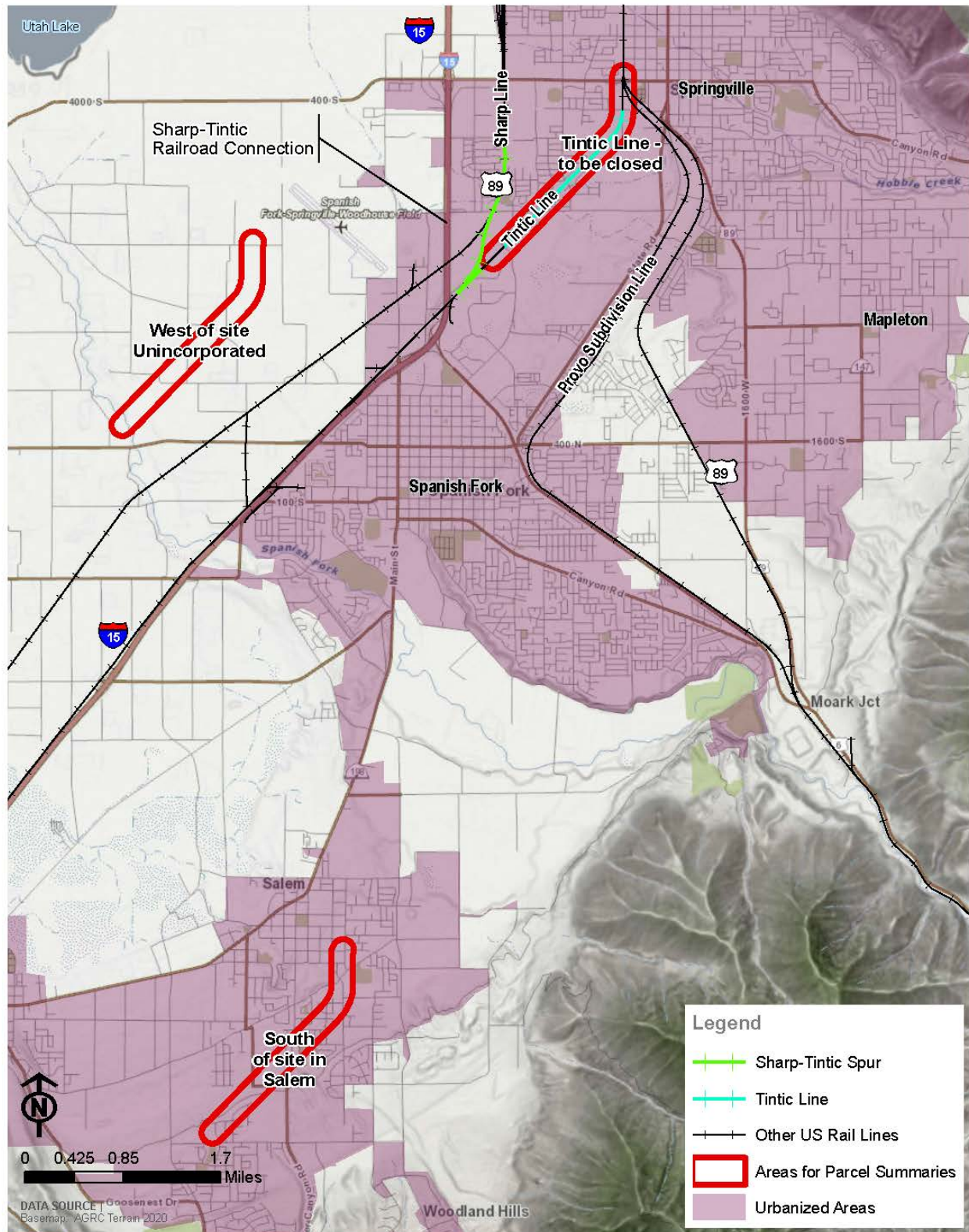
6.5.1 Methodology

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



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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 | 2018\$ | - | \$102,366 | Data from Utah County GIS Data - Tax Parcels. Extracted August 31, 2018. |
| 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 | 2018\$ | - | \$5,118 | Calculated based on data from Utah County GIS Data - Tax Parcel. Extracted August 31, 2018. |
| Total Acreage | acres | - | 2,346.6 | Data from Utah County GIS Data - Tax Parcels. Extracted August 31, 2018. |
| Total One-time Benefit | 2018\$ | 2024 | \$12,010,695 | 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 \$9.16 million. See Section 9.11 for additional information.

Table 19: Estimates of Land Value Increase, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|---------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| Land Value Increase | \$12,010,695 | \$12,010,695 | \$9,162,902 |

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 | 2018\$/year | \$4,000 | Detailed bottom up cost estimate as performed by HDR including maintenance related to gates, roadway surface, testing, signage, and marking. |
| O&M Cost Savings - 950 West | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 1600 South | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 400 West | 2018\$/year | \$4,000 | |
| O&M Cost Savings - Private | 2018\$/year | \$4,000 | |
| O&M Cost Savings - Canyon Creek Parkway | 2018\$/year | \$4,000 | |
| O&M Cost Savings - Colorado Avenue | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 900 South | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 1000 North | 2018\$/year | \$4,000 | |
| O&M Cost Savings - West Center | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 2000 South | 2018\$/year | \$4,000 | |
| O&M Cost Savings - 400 North | 2018\$/year | \$4,000 | |

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 \$0.24 million. See Section 9.12 for additional information.

Table 21: Estimates of O&M Cost Savings, 2018 Dollars

| | In Project Opening Year | Over the Project Lifecycle | |
|------------------|-------------------------|----------------------------|-------------------------|
| | | In Constant Dollars | Discounted at 7 Percent |
| O&M Cost Savings | \$24,000 | \$720,000 | \$243,107 |

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.

Table 22: Assumptions Used in the Estimation of Residual Value

| Variable Name | Unit | Value | Source |
|------------------------------------|--------|-------------|--|
| Years of Benefits | years | 30 | Based on maximum benefit years for BCA from 2018 USDOT BCA Guidance. |
| 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 | HDR Calculations based on Consultations with Utah DOT. |
| Capital Cost of New Tracks | 2018\$ | \$7,110,965 | Project Cost Estimate. |
| Capital Cost of ROW Land Purchases | 2018\$ | \$950,437 | |

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 \$0.29 million. See Section 9.13 for additional information.

Table 23: Estimates of Residual Value, 2018 Dollars

| | Over the Project Lifecycle | |
|----------------|----------------------------|-------------------------|
| | In Constant Dollars | Discounted at 7 Percent |
| Residual Value | \$2,728,179 | \$292,555 |

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 six 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 2023, with 2024 being the Project opening year. 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 \$10.65 million at a 7% discount factor over the project lifecycle.

Table 24: Overall Results of the Benefit-cost Analysis, 2018 Dollars*

| Benefit or Impact Categories | 7% Discount Rate | 3% Discount Rate |
|--------------------------------|---------------------|---------------------|
| Accident Cost Savings | \$594,754 | \$1,079,171 |
| Travel Time Savings | \$315,050 | \$603,299 |
| Emissions Cost Savings | \$907 | \$1,419 |
| Vehicle Operating Cost Savings | \$41,560 | \$82,275 |
| Land Value Increase | \$9,162,902 | \$10,671,347 |
| O&M Costs Savings | \$243,107 | \$430,492 |
| Residual Value | \$292,555 | \$1,028,595 |
| Total Benefit Estimates | \$10,650,836 | \$13,896,598 |

**Values in 2018 dollars unless specified otherwise*

Considering all monetized benefits and costs, the estimated internal rate of return of the Project is 17.2 percent. With a 7% real discount rate, the \$8.4 million investment would result in \$10.7 million in total benefits for a net present value (NPV) of \$2.23 million and a benefit/cost ratio (BCR) of 1.26.

With a 3% real discount rate, the NPV of the Project would increase to \$4.7 million, for a BCR of 1.50 (Table 25).

Table 25: Benefit Estimates for the Full Build Alternative

| Project Evaluation Metric | 7% Discount Rate | 3% Discount Rate |
|-----------------------------|------------------|------------------|
| Total Discounted Benefits | \$10.7 M | \$13.9 M |
| Total Discounted Costs | \$8.4 M | \$9.2 M |
| Net Present Value | \$2.23 M | \$4.7 M |
| Benefit/Cost Ratio | 1.26 | 1.50 |
| Internal Rate of Return (%) | 17.2% | |
| Payback Period (years) | 0.82 | |

**Values in 2018 dollars unless specified otherwise*

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 |
|---------------------------------|--|--|----------------------------|---------------|---------------|
| \$2.23 M | AADT Growth | 0% AADT Growth | \$1.92 M | -13.9% | 1.23 |
| | Lead Lag Time | 20 seconds | \$2.18 M | -2.3% | 1.26 |
| | Variation in Average Thru Train Length | 500 ft. | \$1.99 M | -10.9% | 1.24 |
| | | 1,250 ft. | \$2.40 M | +7.8% | 1.29 |
| | Construction Costs | +25% Increase in Construction Costs | \$0.12 M | -94.5% | 1.01 |
| | Land Value Increase | Land values of comparable nearby areas | \$54.39 M | +2340.0% | 7.46 |

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 2,340 percent. The Project would generate an NPV of \$54.39 million and a BCR of 7.46.

Although the assumptions regarding the land values of comparable nearby areas were the main variable of interest to be tested, additional changes to the AADT growth, lead lag time, average thru train length, and the potential for increased construction costs were also considered. From the additional tests, an increase of 25 percent of the construction costs is expected to have the most significant impact, decreasing the NPV by 94.5 percent.

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 (2018\$) | Total Capital Costs (2018\$) | Undiscounted Net Benefits (2018\$) | Discounted Net Benefits at 7% | Discounted Net Benefits at 3% |
|---------------|--------------|----------------------------|---------------------------------|---------------------------------------|----------------------------------|----------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$1,361,860 | -\$1,361,860 | -\$1,272,767 | -\$1,322,195 |
| 2022 | 2 | \$0 | \$2,766,112 | -\$2,766,112 | -\$2,416,030 | -\$2,607,326 |
| 2023 | 3 | \$0 | \$5,798,037 | -\$5,798,037 | -\$4,732,925 | -\$5,306,025 |
| 2024 | 4 | \$12,113,728 | \$0 | \$12,113,728 | \$9,241,505 | \$10,762,890 |
| 2025 | 5 | \$104,287 | \$0 | \$104,287 | \$74,356 | \$89,959 |
| 2026 | 6 | \$105,577 | \$0 | \$105,577 | \$70,351 | \$88,419 |
| 2027 | 7 | \$106,897 | \$0 | \$106,897 | \$66,570 | \$86,917 |
| 2028 | 8 | \$108,241 | \$0 | \$108,241 | \$62,997 | \$85,447 |
| 2029 | 9 | \$109,633 | \$0 | \$109,633 | \$59,633 | \$84,025 |
| 2030 | 10 | \$111,117 | \$0 | \$111,117 | \$56,486 | \$82,681 |
| 2031 | 11 | \$112,573 | \$0 | \$112,573 | \$53,483 | \$81,325 |
| 2032 | 12 | \$114,065 | \$0 | \$114,065 | \$50,646 | \$80,003 |
| 2033 | 13 | \$115,629 | \$0 | \$115,629 | \$47,982 | \$78,738 |
| 2034 | 14 | \$117,218 | \$0 | \$117,218 | \$45,459 | \$77,495 |
| 2035 | 15 | \$118,828 | \$0 | \$118,828 | \$43,069 | \$76,271 |
| 2036 | 16 | \$120,483 | \$0 | \$120,483 | \$40,812 | \$75,081 |
| 2037 | 17 | \$122,143 | \$0 | \$122,143 | \$38,667 | \$73,899 |
| 2038 | 18 | \$123,872 | \$0 | \$123,872 | \$36,649 | \$72,762 |
| 2039 | 19 | \$125,653 | \$0 | \$125,653 | \$34,744 | \$71,658 |
| 2040 | 20 | \$127,428 | \$0 | \$127,428 | \$32,930 | \$70,554 |
| 2041 | 21 | \$129,275 | \$0 | \$129,275 | \$31,222 | \$69,492 |
| 2042 | 22 | \$131,213 | \$0 | \$131,213 | \$29,617 | \$68,479 |
| 2043 | 23 | \$133,157 | \$0 | \$133,157 | \$28,089 | \$67,470 |
| 2044 | 24 | \$135,148 | \$0 | \$135,148 | \$26,644 | \$66,484 |
| 2045 | 25 | \$137,222 | \$0 | \$137,222 | \$25,283 | \$65,538 |
| 2046 | 26 | \$139,279 | \$0 | \$139,279 | \$23,983 | \$64,583 |
| 2047 | 27 | \$141,474 | \$0 | \$141,474 | \$22,768 | \$63,690 |
| 2048 | 28 | \$143,693 | \$0 | \$143,693 | \$21,612 | \$62,805 |
| 2049 | 29 | \$145,948 | \$0 | \$145,948 | \$20,515 | \$61,933 |
| 2050 | 30 | \$148,250 | \$0 | \$148,250 | \$19,475 | \$61,077 |
| 2051 | 31 | \$150,622 | \$0 | \$150,622 | \$18,492 | \$60,247 |
| 2052 | 32 | \$153,054 | \$0 | \$153,054 | \$17,562 | \$59,436 |
| 2053 | 33 | \$2,883,725 | \$0 | \$2,883,725 | \$309,235 | \$1,087,240 |
| Total | | \$18,529,436 | \$9,926,009 | \$8,603,427 | \$2,229,114 | \$4,661,053 |

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 |
|---------------|--------------|-------------------|-------------------|--------------------|-------------------|------------------|----------------------|------------------|-------------------|-------------------|--------------------|-------------------|-------------------|
| 2020 | 0 | 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 |
| 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 |
| Total | | 15,352,679 | 15,352,679 | 108,864,454 | 15,352,679 | 6,878,436 | 108,864,454 | 5,530,580 | 14,515,261 | 23,726,868 | 293,096,606 | 23,726,868 | 44,662,340 |

9.3 Accident Cost Savings: Pertinent Quantifiable Impacts

| Calendar Year | Project Year | Fatalities Avoided | Injuries Avoided | PDO-Accidents Avoided |
|---------------|--------------|--------------------|------------------|-----------------------|
| 2020 | 0 | 0.000 | 0.000 | 0.000 |
| 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 | 0.003 | 0.061 | 0.300 |
| 2025 | 5 | 0.004 | 0.061 | 0.303 |
| 2026 | 6 | 0.004 | 0.062 | 0.306 |
| 2027 | 7 | 0.004 | 0.063 | 0.309 |
| 2028 | 8 | 0.004 | 0.063 | 0.312 |
| 2029 | 9 | 0.004 | 0.064 | 0.315 |
| 2030 | 10 | 0.004 | 0.064 | 0.318 |
| 2031 | 11 | 0.004 | 0.065 | 0.321 |
| 2032 | 12 | 0.004 | 0.066 | 0.324 |
| 2033 | 13 | 0.004 | 0.066 | 0.327 |
| 2034 | 14 | 0.004 | 0.067 | 0.331 |
| 2035 | 15 | 0.004 | 0.068 | 0.334 |
| 2036 | 16 | 0.004 | 0.068 | 0.337 |
| 2037 | 17 | 0.004 | 0.069 | 0.340 |
| 2038 | 18 | 0.004 | 0.070 | 0.343 |
| 2039 | 19 | 0.004 | 0.070 | 0.347 |
| 2040 | 20 | 0.004 | 0.071 | 0.350 |
| 2041 | 21 | 0.004 | 0.072 | 0.353 |
| 2042 | 22 | 0.004 | 0.072 | 0.357 |
| 2043 | 23 | 0.004 | 0.073 | 0.360 |
| 2044 | 24 | 0.004 | 0.074 | 0.364 |
| 2045 | 25 | 0.004 | 0.074 | 0.367 |
| 2046 | 26 | 0.004 | 0.075 | 0.371 |
| 2047 | 27 | 0.004 | 0.076 | 0.374 |
| 2048 | 28 | 0.004 | 0.077 | 0.378 |
| 2049 | 29 | 0.004 | 0.077 | 0.381 |
| 2050 | 30 | 0.004 | 0.078 | 0.385 |
| 2051 | 31 | 0.004 | 0.079 | 0.389 |
| 2052 | 32 | 0.004 | 0.080 | 0.392 |
| 2053 | 33 | 0.005 | 0.080 | 0.396 |
| Total | | 0.119 | 2.104 | 10.384 |

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% |
|---------------|--------------|-----------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$53,514 | \$40,826 | \$47,547 |
| 2025 | 5 | \$53,996 | \$38,498 | \$46,577 |
| 2026 | 6 | \$54,487 | \$36,307 | \$45,632 |
| 2027 | 7 | \$54,986 | \$34,243 | \$44,709 |
| 2028 | 8 | \$55,493 | \$32,297 | \$43,806 |
| 2029 | 9 | \$56,006 | \$30,463 | \$42,924 |
| 2030 | 10 | \$56,526 | \$28,735 | \$42,060 |
| 2031 | 11 | \$57,052 | \$27,105 | \$41,215 |
| 2032 | 12 | \$57,584 | \$25,568 | \$40,388 |
| 2033 | 13 | \$58,122 | \$24,119 | \$39,578 |
| 2034 | 14 | \$58,667 | \$22,752 | \$38,786 |
| 2035 | 15 | \$59,217 | \$21,463 | \$38,009 |
| 2036 | 16 | \$59,773 | \$20,247 | \$37,248 |
| 2037 | 17 | \$60,335 | \$19,100 | \$36,503 |
| 2038 | 18 | \$60,902 | \$18,019 | \$35,774 |
| 2039 | 19 | \$61,476 | \$16,999 | \$35,059 |
| 2040 | 20 | \$62,055 | \$16,036 | \$34,358 |
| 2041 | 21 | \$62,640 | \$15,128 | \$33,672 |
| 2042 | 22 | \$63,232 | \$14,272 | \$33,000 |
| 2043 | 23 | \$63,829 | \$13,464 | \$32,341 |
| 2044 | 24 | \$64,432 | \$12,702 | \$31,696 |
| 2045 | 25 | \$65,041 | \$11,984 | \$31,064 |
| 2046 | 26 | \$65,656 | \$11,306 | \$30,444 |
| 2047 | 27 | \$66,277 | \$10,666 | \$29,837 |
| 2048 | 28 | \$66,904 | \$10,063 | \$29,242 |
| 2049 | 29 | \$67,538 | \$9,493 | \$28,659 |
| 2050 | 30 | \$68,178 | \$8,956 | \$28,088 |
| 2051 | 31 | \$68,824 | \$8,450 | \$27,529 |
| 2052 | 32 | \$69,476 | \$7,972 | \$26,980 |
| 2053 | 33 | \$70,135 | \$7,521 | \$26,443 |
| Total | | \$1,842,349 | \$594,754 | \$1,079,171 |

9.5 Travel Time Savings: Pertinent Quantifiable Impacts

| Calendar Year | Project Year | Avoided Person Hours of Travel Time | Avoided Vehicle Hours of Travel Time |
|---------------|--------------|-------------------------------------|--------------------------------------|
| 2020 | 0 | 0 | 0 |
| 2021 | 1 | 0 | 0 |
| 2022 | 2 | 0 | 0 |
| 2023 | 3 | 0 | 0 |
| 2024 | 4 | 1,422 | 885 |
| 2025 | 5 | 1,464 | 911 |
| 2026 | 6 | 1,508 | 938 |
| 2027 | 7 | 1,552 | 965 |
| 2028 | 8 | 1,598 | 994 |
| 2029 | 9 | 1,645 | 1,023 |
| 2030 | 10 | 1,693 | 1,053 |
| 2031 | 11 | 1,743 | 1,084 |
| 2032 | 12 | 1,795 | 1,116 |
| 2033 | 13 | 1,848 | 1,149 |
| 2034 | 14 | 1,902 | 1,183 |
| 2035 | 15 | 1,958 | 1,218 |
| 2036 | 16 | 2,016 | 1,254 |
| 2037 | 17 | 2,076 | 1,291 |
| 2038 | 18 | 2,137 | 1,329 |
| 2039 | 19 | 2,200 | 1,368 |
| 2040 | 20 | 2,265 | 1,408 |
| 2041 | 21 | 2,331 | 1,450 |
| 2042 | 22 | 2,400 | 1,493 |
| 2043 | 23 | 2,471 | 1,537 |
| 2044 | 24 | 2,544 | 1,582 |
| 2045 | 25 | 2,619 | 1,629 |
| 2046 | 26 | 2,696 | 1,677 |
| 2047 | 27 | 2,776 | 1,726 |
| 2048 | 28 | 2,858 | 1,777 |
| 2049 | 29 | 2,942 | 1,830 |
| 2050 | 30 | 3,029 | 1,884 |
| 2051 | 31 | 3,118 | 1,939 |
| 2052 | 32 | 3,210 | 1,996 |
| 2053 | 33 | 3,305 | 2,055 |
| Total | | 67,120 | 41,744 |

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% |
|---------------|--------------|---------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$22,796 | \$17,391 | \$20,254 |
| 2025 | 5 | \$23,468 | \$16,732 | \$20,244 |
| 2026 | 6 | \$24,160 | \$16,099 | \$20,234 |
| 2027 | 7 | \$24,873 | \$15,489 | \$20,224 |
| 2028 | 8 | \$25,606 | \$14,903 | \$20,214 |
| 2029 | 9 | \$26,361 | \$14,339 | \$20,204 |
| 2030 | 10 | \$27,139 | \$13,796 | \$20,194 |
| 2031 | 11 | \$27,939 | \$13,274 | \$20,184 |
| 2032 | 12 | \$28,763 | \$12,771 | \$20,174 |
| 2033 | 13 | \$29,612 | \$12,288 | \$20,164 |
| 2034 | 14 | \$30,485 | \$11,823 | \$20,154 |
| 2035 | 15 | \$31,384 | \$11,375 | \$20,144 |
| 2036 | 16 | \$32,310 | \$10,945 | \$20,135 |
| 2037 | 17 | \$33,263 | \$10,530 | \$20,125 |
| 2038 | 18 | \$34,244 | \$10,132 | \$20,115 |
| 2039 | 19 | \$35,254 | \$9,748 | \$20,105 |
| 2040 | 20 | \$36,294 | \$9,379 | \$20,095 |
| 2041 | 21 | \$37,364 | \$9,024 | \$20,085 |
| 2042 | 22 | \$38,466 | \$8,682 | \$20,075 |
| 2043 | 23 | \$39,601 | \$8,354 | \$20,065 |
| 2044 | 24 | \$40,769 | \$8,037 | \$20,056 |
| 2045 | 25 | \$41,971 | \$7,733 | \$20,046 |
| 2046 | 26 | \$43,209 | \$7,440 | \$20,036 |
| 2047 | 27 | \$44,484 | \$7,159 | \$20,026 |
| 2048 | 28 | \$45,796 | \$6,888 | \$20,016 |
| 2049 | 29 | \$47,146 | \$6,627 | \$20,006 |
| 2050 | 30 | \$48,537 | \$6,376 | \$19,996 |
| 2051 | 31 | \$49,968 | \$6,135 | \$19,987 |
| 2052 | 32 | \$51,442 | \$5,903 | \$19,977 |
| 2053 | 33 | \$52,959 | \$5,679 | \$19,967 |
| Total | | \$1,075,664 | \$315,050 | \$603,299 |

9.7 Emission Cost Savings: Pertinent Quantifiable Impacts

| Calendar Year | Project Year | CO ₂ Emissions Avoided | NO _x Emissions Avoided | VOC Emissions Avoided | PM Emissions Avoided | SO ₂ Emissions Avoided |
|---------------|--------------|-----------------------------------|-----------------------------------|-----------------------|----------------------|-----------------------------------|
| 2020 | 0 | 0.00 | 0.00 | 0.0000 | 0.0000 | 0.0000 |
| 2021 | 1 | 0.00 | 0.00 | 0.0000 | 0.0000 | 0.0000 |
| 2022 | 2 | 0.00 | 0.00 | 0.0000 | 0.0000 | 0.0000 |
| 2023 | 3 | 0.00 | 0.00 | 0.0000 | 0.0000 | 0.0000 |
| 2024 | 4 | 2.80 | 0.01 | 0.0011 | 0.0002 | 0.0000 |
| 2025 | 5 | 2.85 | 0.01 | 0.0010 | 0.0002 | 0.0000 |
| 2026 | 6 | 2.90 | 0.01 | 0.0009 | 0.0002 | 0.0000 |
| 2027 | 7 | 2.95 | 0.01 | 0.0008 | 0.0002 | 0.0000 |
| 2028 | 8 | 3.00 | 0.00 | 0.0007 | 0.0002 | 0.0000 |
| 2029 | 9 | 3.05 | 0.00 | 0.0006 | 0.0002 | 0.0000 |
| 2030 | 10 | 3.10 | 0.00 | 0.0005 | 0.0001 | 0.0000 |
| 2031 | 11 | 3.15 | 0.00 | 0.0004 | 0.0001 | 0.0000 |
| 2032 | 12 | 3.20 | 0.00 | 0.0004 | 0.0001 | 0.0000 |
| 2033 | 13 | 3.25 | 0.00 | 0.0004 | 0.0001 | 0.0000 |
| 2034 | 14 | 3.29 | 0.00 | 0.0004 | 0.0001 | 0.0000 |
| 2035 | 15 | 3.34 | 0.00 | 0.0003 | 0.0001 | 0.0000 |
| 2036 | 16 | 3.39 | 0.00 | 0.0003 | 0.0001 | 0.0000 |
| 2037 | 17 | 3.43 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| 2038 | 18 | 3.48 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| 2039 | 19 | 3.52 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| 2040 | 20 | 3.57 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2041 | 21 | 3.64 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2042 | 22 | 3.70 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2043 | 23 | 3.77 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2044 | 24 | 3.84 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2045 | 25 | 3.91 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2046 | 26 | 3.97 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2047 | 27 | 4.04 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2048 | 28 | 4.12 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2049 | 29 | 4.19 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2050 | 30 | 4.26 | 0.00 | 0.0001 | 0.0001 | 0.0000 |
| 2051 | 31 | 4.38 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| 2052 | 32 | 4.51 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| 2053 | 33 | 4.65 | 0.00 | 0.0002 | 0.0001 | 0.0000 |
| Total | | 107.2 | 0.084 | 0.010 | 0.003 | 0.001 |

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% |
|---------------|--------------|------------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$152 | \$116 | \$135 |
| 2025 | 5 | \$144 | \$103 | \$124 |
| 2026 | 6 | \$135 | \$90 | \$113 |
| 2027 | 7 | \$125 | \$78 | \$102 |
| 2028 | 8 | \$115 | \$67 | \$91 |
| 2029 | 9 | \$104 | \$57 | \$80 |
| 2030 | 10 | \$92 | \$47 | \$69 |
| 2031 | 11 | \$89 | \$42 | \$64 |
| 2032 | 12 | \$85 | \$38 | \$60 |
| 2033 | 13 | \$81 | \$34 | \$55 |
| 2034 | 14 | \$77 | \$30 | \$51 |
| 2035 | 15 | \$73 | \$26 | \$47 |
| 2036 | 16 | \$67 | \$23 | \$42 |
| 2037 | 17 | \$61 | \$19 | \$37 |
| 2038 | 18 | \$55 | \$16 | \$32 |
| 2039 | 19 | \$49 | \$13 | \$28 |
| 2040 | 20 | \$41 | \$11 | \$23 |
| 2041 | 21 | \$42 | \$10 | \$23 |
| 2042 | 22 | \$43 | \$10 | \$22 |
| 2043 | 23 | \$43 | \$9 | \$22 |
| 2044 | 24 | \$44 | \$9 | \$21 |
| 2045 | 25 | \$44 | \$8 | \$21 |
| 2046 | 26 | \$45 | \$8 | \$21 |
| 2047 | 27 | \$45 | \$7 | \$20 |
| 2048 | 28 | \$46 | \$7 | \$20 |
| 2049 | 29 | \$46 | \$6 | \$20 |
| 2050 | 30 | \$47 | \$6 | \$19 |
| 2051 | 31 | \$48 | \$6 | \$19 |
| 2052 | 32 | \$49 | \$6 | \$19 |
| 2053 | 33 | \$51 | \$5 | \$19 |
| Total | | \$2,139 | \$907 | \$1,419 |

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) |
|---------------|--------------|--|--------------------------------------|--|
| 2020 | 0 | 0 | 0 | 0 |
| 2021 | 1 | 0 | 0 | 0 |
| 2022 | 2 | 0 | 0 | 0 |
| 2023 | 3 | 0 | 0 | 0 |
| 2024 | 4 | 839 | 225 | 31 |
| 2025 | 5 | 864 | 231 | 31 |
| 2026 | 6 | 889 | 238 | 32 |
| 2027 | 7 | 915 | 245 | 33 |
| 2028 | 8 | 942 | 253 | 34 |
| 2029 | 9 | 970 | 260 | 35 |
| 2030 | 10 | 999 | 268 | 36 |
| 2031 | 11 | 1,028 | 276 | 37 |
| 2032 | 12 | 1,059 | 284 | 39 |
| 2033 | 13 | 1,090 | 292 | 40 |
| 2034 | 14 | 1,122 | 301 | 41 |
| 2035 | 15 | 1,155 | 309 | 42 |
| 2036 | 16 | 1,189 | 319 | 43 |
| 2037 | 17 | 1,224 | 328 | 45 |
| 2038 | 18 | 1,260 | 338 | 46 |
| 2039 | 19 | 1,297 | 348 | 47 |
| 2040 | 20 | 1,336 | 358 | 49 |
| 2041 | 21 | 1,375 | 368 | 50 |
| 2042 | 22 | 1,416 | 379 | 52 |
| 2043 | 23 | 1,457 | 391 | 53 |
| 2044 | 24 | 1,500 | 402 | 55 |
| 2045 | 25 | 1,545 | 414 | 56 |
| 2046 | 26 | 1,590 | 426 | 58 |
| 2047 | 27 | 1,637 | 439 | 60 |
| 2048 | 28 | 1,685 | 452 | 61 |
| 2049 | 29 | 1,735 | 465 | 63 |
| 2050 | 30 | 1,786 | 479 | 65 |
| 2051 | 31 | 1,839 | 493 | 67 |
| 2052 | 32 | 1,893 | 507 | 69 |
| 2053 | 33 | 1,949 | 522 | 71 |
| Total | | 39,588 | 10,608 | 1,440 |

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% |
|---------------|--------------|--------------------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$2,570 | \$1,961 | \$2,284 |
| 2025 | 5 | \$2,680 | \$1,911 | \$2,312 |
| 2026 | 6 | \$2,795 | \$1,863 | \$2,341 |
| 2027 | 7 | \$2,913 | \$1,814 | \$2,369 |
| 2028 | 8 | \$3,027 | \$1,762 | \$2,390 |
| 2029 | 9 | \$3,162 | \$1,720 | \$2,424 |
| 2030 | 10 | \$3,360 | \$1,708 | \$2,500 |
| 2031 | 11 | \$3,493 | \$1,659 | \$2,523 |
| 2032 | 12 | \$3,633 | \$1,613 | \$2,548 |
| 2033 | 13 | \$3,813 | \$1,582 | \$2,597 |
| 2034 | 14 | \$3,989 | \$1,547 | \$2,637 |
| 2035 | 15 | \$4,155 | \$1,506 | \$2,667 |
| 2036 | 16 | \$4,333 | \$1,468 | \$2,700 |
| 2037 | 17 | \$4,484 | \$1,420 | \$2,713 |
| 2038 | 18 | \$4,671 | \$1,382 | \$2,744 |
| 2039 | 19 | \$4,875 | \$1,348 | \$2,780 |
| 2040 | 20 | \$5,037 | \$1,302 | \$2,789 |
| 2041 | 21 | \$5,228 | \$1,263 | \$2,810 |
| 2042 | 22 | \$5,473 | \$1,235 | \$2,856 |
| 2043 | 23 | \$5,684 | \$1,199 | \$2,880 |
| 2044 | 24 | \$5,904 | \$1,164 | \$2,905 |
| 2045 | 25 | \$6,166 | \$1,136 | \$2,945 |
| 2046 | 26 | \$6,370 | \$1,097 | \$2,954 |
| 2047 | 27 | \$6,669 | \$1,073 | \$3,002 |
| 2048 | 28 | \$6,948 | \$1,045 | \$3,037 |
| 2049 | 29 | \$7,218 | \$1,015 | \$3,063 |
| 2050 | 30 | \$7,489 | \$984 | \$3,085 |
| 2051 | 31 | \$7,782 | \$955 | \$3,113 |
| 2052 | 32 | \$8,086 | \$928 | \$3,140 |
| 2053 | 33 | \$8,402 | \$901 | \$3,168 |
| Total | 0 | \$150,411 | \$41,560 | \$82,275 |

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% |
|---------------|--------------|---------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$12,010,695 | \$9,162,902 | \$10,671,347 |
| 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 |
| Total | | \$12,010,695 | \$9,162,902 | \$10,671,347 |

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% |
|---------------|--------------|-------------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 2021 | 1 | \$0 | \$0 | \$0 |
| 2022 | 2 | \$0 | \$0 | \$0 |
| 2023 | 3 | \$0 | \$0 | \$0 |
| 2024 | 4 | \$24,000 | \$18,309 | \$21,324 |
| 2025 | 5 | \$24,000 | \$17,112 | \$20,703 |
| 2026 | 6 | \$24,000 | \$15,992 | \$20,100 |
| 2027 | 7 | \$24,000 | \$14,946 | \$19,514 |
| 2028 | 8 | \$24,000 | \$13,968 | \$18,946 |
| 2029 | 9 | \$24,000 | \$13,054 | \$18,394 |
| 2030 | 10 | \$24,000 | \$12,200 | \$17,858 |
| 2031 | 11 | \$24,000 | \$11,402 | \$17,338 |
| 2032 | 12 | \$24,000 | \$10,656 | \$16,833 |
| 2033 | 13 | \$24,000 | \$9,959 | \$16,343 |
| 2034 | 14 | \$24,000 | \$9,308 | \$15,867 |
| 2035 | 15 | \$24,000 | \$8,699 | \$15,405 |
| 2036 | 16 | \$24,000 | \$8,130 | \$14,956 |
| 2037 | 17 | \$24,000 | \$7,598 | \$14,520 |
| 2038 | 18 | \$24,000 | \$7,101 | \$14,097 |
| 2039 | 19 | \$24,000 | \$6,636 | \$13,687 |
| 2040 | 20 | \$24,000 | \$6,202 | \$13,288 |
| 2041 | 21 | \$24,000 | \$5,796 | \$12,901 |
| 2042 | 22 | \$24,000 | \$5,417 | \$12,525 |
| 2043 | 23 | \$24,000 | \$5,063 | \$12,161 |
| 2044 | 24 | \$24,000 | \$4,732 | \$11,806 |
| 2045 | 25 | \$24,000 | \$4,422 | \$11,463 |
| 2046 | 26 | \$24,000 | \$4,133 | \$11,129 |
| 2047 | 27 | \$24,000 | \$3,862 | \$10,805 |
| 2048 | 28 | \$24,000 | \$3,610 | \$10,490 |
| 2049 | 29 | \$24,000 | \$3,374 | \$10,184 |
| 2050 | 30 | \$24,000 | \$3,153 | \$9,888 |
| 2051 | 31 | \$24,000 | \$2,947 | \$9,600 |
| 2052 | 32 | \$24,000 | \$2,754 | \$9,320 |
| 2053 | 33 | \$24,000 | \$2,574 | \$9,049 |
| Total | | \$720,000 | \$243,107 | \$430,492 |

9.13 Residual Value: Annual Benefits Estimates

| Calendar Year | Project Year | Residual Value | Total Discounted Benefits at 7% | Total Discounted Benefits at 3% |
|---------------|--------------|----------------|---------------------------------|---------------------------------|
| 2020 | 0 | \$0 | \$0 | \$0 |
| 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 | \$2,728,179 | \$292,555 | \$1,028,595 |