2016 Montana Rail Grade Separation Study

Final Report

May 2016

Prepared for:

Montana Department of Transportation

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Executive Summary

The Montana Department of Transportation (MDT) commissioned an update to the 2003 Montana Rail Grade Separation Study to address changed conditions and assess highway-rail crossing needs across the state. Since publication of the 2003 Study some Montana communities have experienced growth in population, roadway traffic, and train traffic, contributing to vehicle delays at at-grade railroad crossings. Both safety and delay issues at railroad crossings continue to be an important statewide and individual community concern.

The purpose of the 2016 Montana Rail Grade Separation Study was to use a data-driven evaluation process to identify a list of at-grade and grade-separated railroad crossings where potential feasible improvements may be considered. The evaluation process included a two-tiered screening and selection process to identify a final list of 10 at-grade and 12 grade-separated crossings. A data-based methodology was used to identify these locations from a total of more than 5,200 at-grade crossings and more than 400 grade-separated crossings throughout the state. For each of the final 10 at-grade crossings, potential grade-separated alternatives were identified and conceptual plans, planning-level cost estimates and benefit-cost analyses (BCA) developed. Potential improvements were also identified for selected grade-separated crossings.

Based on results of the evaluation process, three cities (Billings, Bozeman, and Helena) had multiple crossings considered for feasibility of grade separation. Additional evaluation will be necessary to determine which crossing or crossings would be viable, cost effective, and provide the greatest benefit for each city. If a crossing enhancement is implemented at one location, a re-evaluation of crossing needs may be necessary for the impacted community.

No funding sources have been identified to support recommended improvement projects identified by this study. However, the study presents detailed descriptions of rail crossing needs and constraints which may aid in developing future transportation plans.

Crossing Screening Methodology

A screening methodology was developed to determine 25 at-grade and 25 grade-separated rail crossing locations to carry forward in this planning study. The screening methodology involved an initial screening and a data-based analysis as described below.

1. **Initial Screening**: This step began with all statewide rail crossings from the Federal Rail Administration (FRA) database, MDT public at-grade crossings database, and MDT Bridge Management System (BMS). The process resulted in 941 at-grade crossings after removing private, closed, and pedestrian crossings, as well as crossings with zero train movements. 73 grade-separated crossings remained after removing vehicle overpasses (i.e., vehicle bridges over the railroad) and private and pedestrian crossings.

2. **Detailed Screening**: This step evaluated and scored the 941 at-grade and 73 grade-separated crossings using a set of objective screening criteria unique to each crossing type. The at-grade crossings were screened using the average annual daily traffic (AADT) and average daily train traffic (ADTT) at the crossing, resulting in 25 selected crossing locations for further analysis. The grade-separated crossings were screened

based on AADT and minimum vertical clearance criteria and a combined composite score was calculated resulting in a list of 25 current grade-separated crossing locations for further analysis.

The overall evaluation process describing the screening and selection methodology is illustrated in Figure ES-1 on the following page. Additional selection processes used to determine the final 10 at-grade and 12 grade-separated crossings are described in the following sections.

At-Grade Rail Crossing Selection Process and Results

The 25 at-grade crossing locations were narrowed to 10 crossings using a mix of qualitative and quantitative analyses. The qualitative analysis considered a holistic approach, which combined and/or eliminated crossings due to proximity to existing grade separations, proximity to another crossing determined to be more suitable for a grade separation, mobility objectives, or improvements already planned and programmed. The at-grade quantitative analysis included three weighted criteria as shown in ES-1.

Table ES-1. At-Grade Crossing Evaluation Criteria

Criteria		Description/Purpose	Weight
1	**Montana Department of Transportation (MDT) Priority Index**	The MDT Priority Index is a formula used to compute the hazard potential of each public crossing based on train traffic, vehicular traffic, and other existing physical conditions of the crossing. The metric is used to prioritize public highway-rail crossings based on need of safety improvements.	60%
2	**Roadway Functional Classification**	Functional classification of the roadway groups highways by the character of service they provide. Higher functionally classified roads generally have higher capacity and mobility significance. The functional classification is directly tied to the Federal-Aid Highway System and to eligibility for federal transportation funding, and was therefore considered an important criterion to include in the evaluation.	30%
3	**Average Train Speed**	This criterion represents an average speed based on the posted train speed and timetable speeds for specific movements (passenger trains, freight trains and switching trains). Higher train speeds can increase accident probability and severity and create additional safety concerns.	10%
		Total	100%

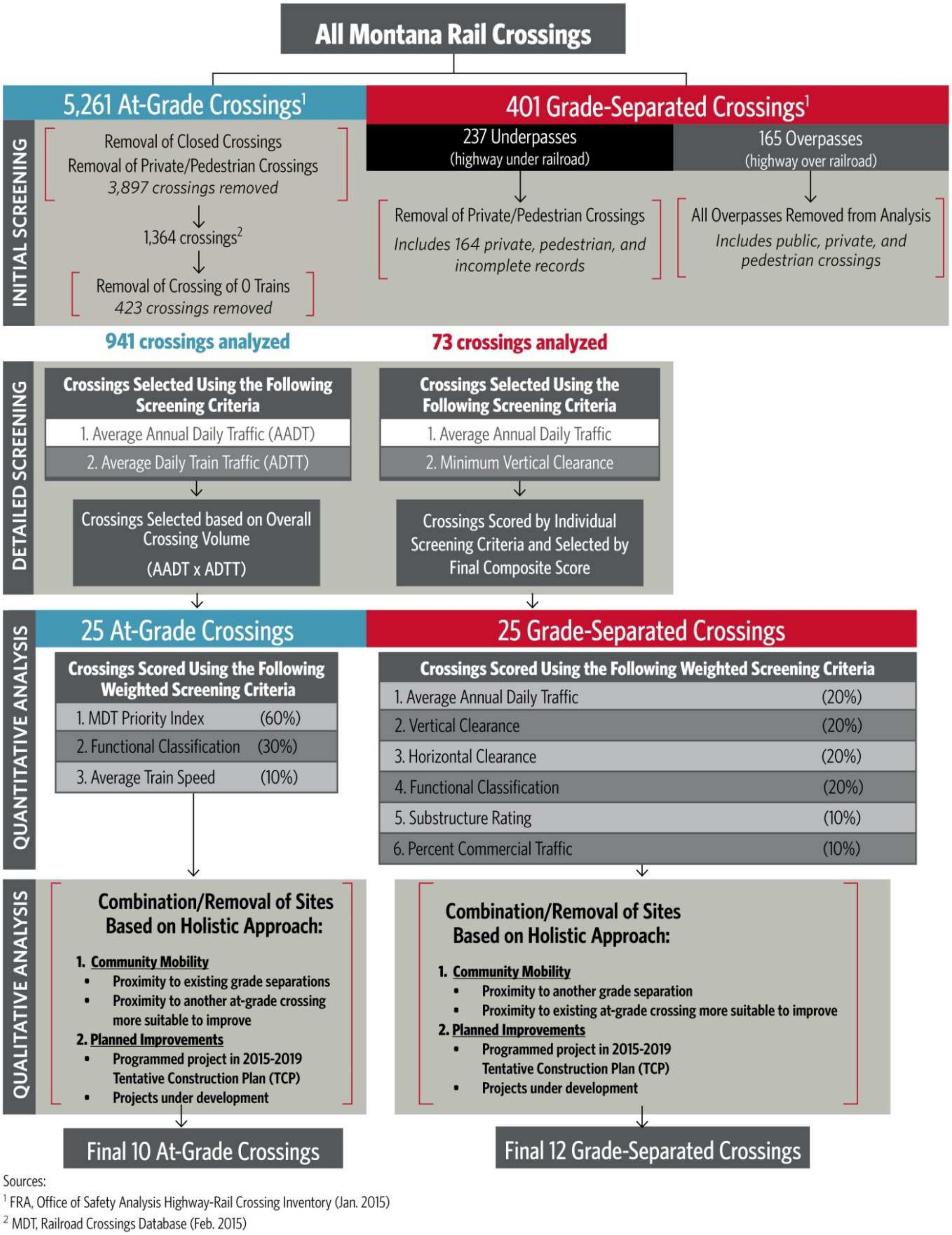

Figure ES-1. Rail Crossing Evaluation Process

The top crossings identified through the evaluation process were field reviewed to examine the detailed feasibility of constructing a grade separation at the crossing location. During this process, seven at-grade crossings (listed below) were determined infeasible to grade separate based on site conditions and potential impacts to surrounding buildings, infrastructure, residences, and street connectivity.

1. Broadway Street, Belgrade
2. Pratten Street, Columbus
3. Makawasha Avenue, Crow Agency
4. Madison Street/Greenough Drive, Missoula
5. Valley Center Road, Gallatin County
6. 5th Street, Livingston
7. Broadway Street, Manhattan

The final result of the evaluation process included the identification of 10 at-grade crossing locations for which practical grade separation concepts were developed, including conceptual plans, cost estimates, and BCA.

Table ES-2 presents the final 10 at-grade crossings organized alphabetically by city, including the identified feasible grade separation improvement option and benefit-cost ratio.

Table ES-2. Final At-Grade Crossing Locations and Improvements

City	Location	Feasible Grade Separation Solution	Benefit-Cost Ratio[1]
Belgrade	Jackrabbit Lane	Underpass	0.22
Billings	27th Street	Partial Overpass Partial Underpass	1.05 (overpass) 0.56 (underpass)
Billings	Moore Lane	Underpass	0.16
Bozeman	Griffin Drive	Underpass	0.15
Bozeman	Rouse Avenue	Underpass	0.13
Helena	Benton Avenue	Overpass Underpass	0.12 (overpass) 0.11 (underpass)
Helena	Carter Drive	Underpass	0.09
Helena	Montana Avenue	Underpass	0.45
Huntley	Northern Avenue	Overpass	0.13
Laurel	S 72nd Street W	Overpass	0.08

[1] Undiscounted benefit-cost ratio results. Refer to Appendix C for more information.

Grade-Separated Rail Crossing Selection Process and Results

The 25 existing grade-separated crossing locations were narrowed to 12 crossings using both qualitative and quantitative analyses. The qualitative analysis considered a holistic approach, which combined and/or eliminated crossings due to proximity to another grade separation, proximity to an at-grade crossing determined to be more suitable for grade separation, mobility objectives, or improvements already planned and programmed. The quantitative analysis criteria included AADT and vertical clearance, which were used in the screening process described above, as well as four additional criteria shown in Table ES-3.

Table ES-3. Grade-Separated Crossing Evaluation Criteria

Criteria		Description/Purpose	Weight
1	**Average Annual Daily Traffic (AADT)**	AADT was evaluated for each crossing. Higher traffic volumes are indicative of the overall importance of the crossing within the roadway network. Higher traffic volumes are also representative of higher potential for collisions between vehicles and/or usage by commercial vehicles.	20%
2	**Vertical Clearance**	This criterion represents the minimum vertical clearance from the roadway (travel lanes only) to the underside of the superstructure. Sub-standard vertical clearances represent a safety concern as well as restrictions for commercial vehicles.	20%
3	**Horizontal Clearance**	The horizontal clearance was evaluated using the minimum right lateral clearance distance underneath the structure. The lateral clearance is measured from the right edge of the roadway (excluding shoulders) to the nearest substructure unit (pier, abutment, etc.), to a rigid barrier (concrete bridge rail, etc.), or to the toe of slope steeper than 1:3 ratio. The measurement is the minimum distance available for both directions of travel.	20%
4	**Roadway Functional Classification**	Functional classification of the roadway groups highways by the character of service they provide. Higher functionally classified roads generally have higher capacity and mobility significance. The functional classification is directly tied to the Federal-Aid Highway System and to eligibility for federal transportation funding, and was therefore considered an important criterion to include in the evaluation.	20%
5	**Substructure Rating**	The substructure rating for underpasses was obtained from the MDT Bridge Management System. This metric is based on the National Bridge Inventory rating system and represents the overall condition of the substructure structural elements. Values range from 0 to 9, with 0 representing a failed condition and 9 representing excellent condition.	10%
6	**Percent Commercial Traffic**	The number of commercial trucks as a percentage of total AADT was examined for each crossing and used in the evaluation.	10%
		Total	100%

Composite scores for each of the 25 grade-separated railroad crossing were developed based on the quantitative analysis previously described. The list was then reviewed and, based on the qualitative assessment, several crossings were removed from further consideration. Sites with projects already programmed for construction were also removed. Table ES-4 lists alphabetically by city the final 12 grade-separated rail crossings, including the AADT and vertical clearances.

Table ES-4. Final Grade-Separated Crossings

City	Location	Average Annual Daily Traffic [1]	Vertical Clearance[2] (feet)
Big Timber	U.S. Highway 191	1,550	13.66
Butte	Harrison Avenue	14,110	13.91
East Glacier	Montana Highway 49	890	12.70
Glasgow	6^{th} Street S	8,020	12.75
Great Falls	1^{st} Avenue N	17,620	14.60
Great Falls	6^{th} Street N	3,050	12.99
Kalispell	U.S. Highway 2	22,630	14.58
Malta	U.S. Highway 191	3,860	13.94
Miles City	Main Street	9,840	12.11

City	Location	Average Annual Daily Traffic [1]	Vertical Clearance[2] (feet)
Missoula	Orange Street	16,150	13.48
Missoula	N Van Buren Street	15,980	15.00
Wolf Point	S 3rd Avenue	6,550	14.33

Sources:
[1] Montana Department of Transportation Montana Traffic Data Web Mapping Service (July 2015)
[2] Montana Department of Transportation Bridge Management System Database (July 2015)

The final list of grade-separated crossings and a general questionnaire were distributed to each of MDT's five District Administrators based on crossing location. The questionnaire was structured to request additional information about local conditions such as frequency and reasons for crossing closures, detour distances, pedestrian and bus access, and identified plans for improvement. Based on the responses from this survey, the District Administrators did not provide many additional suggestions to either the list of grade-separated locations or the types of improvement projects that could benefit each crossing location.

Five grade-separated crossings were identified by the Rail Grade Separation Study Project Team, MDT Planning personnel, and MDT District Administrators as locations of interest due to limitations in vertical or horizontal clearance and/or geometric roadway issues. These crossings (listed below) were examined in greater detail to identify potential improvements to safety and traffic operations. Section 5.2 presents detailed information on the recommended improvements for each location.

1. Orange Street, Missoula
2. Henderson Street, Helena
3. South 3rd Avenue, Wolf Point
4. 13th Street, Billings
5. 21st Street, Billings

Conclusions and Next Steps

Potential improvements were identified for crossings located on National Highway System (NHS) Non-Interstate, Primary, Secondary, Urban, and off-system routes. Implementation of any of the improvement options will depend on funding availability which varies based upon the crossing location and the agency responsible. Funding has not been identified to implement improvement options analyzed in this study. Future project development and implementation will require identifying and securing funding and, for federally funded projects, following MDT processes for project nomination and development, including a public involvement process and environmental documentation.

This study is a planning-level assessment of existing at-grade and grade-separated crossings throughout the state of Montana. The findings and recommendations provided by this study were developed based on field reviews of existing site conditions and review of publicly available transportation databases. The recommendations are preliminary and are intended to offer a range of potential mitigation strategies for the identified railroad crossings. Where applicable, recommendations were intended to align with local plans. Community priorities change over time, however, and any project advanced through this study would involve local participation and potentially additional evaluations. In addition, more detailed, site specific data, which could include traffic studies, topographical and cadastral surveys, coordination and agreement on railroad requirements, and environmental investigations would be required should a project be selected and advanced at any of the locations identified by this study. Strategies to mitigate potential impacts would be further developed during project development activities.

Summary of Report Sections

This report is organized into six sections.

- Section 1 presents an introduction and overview of the study, including the purpose, approach, and public outreach processes.
- Section 2 describes the rail crossing screening process used to determine the 25 at-grade crossings and 25 grade-separated crossings.
- Section 3 describes the rail crossing selection process which evaluated the 25 at-grade and 25 grade-separated crossings in detail through a combined quantitative and qualitative analysis to determine the final 10 at-grade crossings and 12 grade-separated crossings to be carried forward.
- Section 4 includes an in-depth analysis of the final 10 at-grade crossings, including grade separation conceptual plans, cost estimates, and BCA results.
- Section 5 addresses existing grade-separated crossings and presents potential recommendations to selected crossings.
- Section 6 presents conclusions and next steps, including a brief funding discussion.

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Glossary

At-grade

A junction or intersection of two or more roadways or railroads crossing each other at the same level.

Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) is a systematic process for calculating and comparing the monetized value of the benefits and costs of a project to determine the soundness of the investment.

Grade Separation

A method of aligning a junction (typically using a bridge) of two or more roadways or railroads at different heights so they will not disrupt traffic flow on the intersecting route.

Overpass

A bridge, road, or railroad (or similar structure) that crosses over another road or railroad.

Shoofly Track

A temporary railroad track or bypass used as a detour around a construction zone such as a bridge replacement.

Spur Track

A short, usually dead-end section of track used to access a facility or loading/unloading ramp. It also can be used to temporarily store equipment.

Underpass

A location where a road or railroad crosses beneath another road or railroad.

Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
ADA	Americans with Disabilities Act
ADTT	Average Daily Train Traffic
AREMA	American Railway Engineering and Maintenance-of-Way Association
BCA	benefit-cost analysis
BMS	Bridge Management System
BNSF	BNSF Railway
DOT	U.S. Department of Transportation
FRA	Federal Rail Administration
MDT	Montana Department of Transportation
MEPA	Montana Environmental Policy Act
mph	miles per hour
MRL	Montana Rail Link
MSE	mechanically stabilized earth
NEPA	National Environmental Policy Act
NHS	National Highway System
NRHP	National Register of Historic Places
O&M	Operations and Maintenance
PROWAG	Public Right-of-Way Accessibility Guidelines
UPRR	Union Pacific Railroad

1 Introduction

The Montana Department of Transportation (MDT) commissioned an update to the 2003 Montana Rail Grade Separation Study to address changed conditions and assess highway-rail crossing needs across the state. Since publication of the 2003 Study some Montana communities have experienced growth in population, roadway traffic, and train traffic, contributing to vehicle delays at at-grade railroad crossings. Both safety and delay issues at railroad crossings continue to be an important statewide and individual community concern.

A data-based crossing evaluation process was designed and used to identify a final list of 10 at-grade and 12 grade-separated crossings from a total of 5,261 at-grade and 401 grade-separated locations throughout the state. For each of the final 10 at-grade crossings selected grade-separated alternatives were identified and planning-level cost estimates and benefit-cost analyses (BCA) were developed. Potential improvements were identified for selected grade-separated crossings.

This study included a review of at-grade and grade-separated railroad crossings throughout the state. Based on results from the evaluation process, three cities (Billings, Bozeman, and Helena) had multiple crossings considered for feasibility of grade separation. Additional evaluation will be necessary to determine which crossing or crossings would be viable, cost effective, and provide the greatest benefit for each city. If a crossing enhancement is implemented at one location, a re-evaluation of crossing needs may be necessary for the impacted community.

No funding sources have been identified to support the recommended improvement projects identified by this study. Currently MDT does not anticipate availability of additional funds allocated to potential improvements. However, the study presents detailed descriptions of rail crossing needs and constraints that may aid in developing future transportation plans.

1.1 Study Purpose

The purpose of the 2016 Montana Rail Grade Separation Study was to use a data-driven selection process to develop a list of at-grade and grade-separated railroad crossings and to identify potential feasible improvements to those crossings. A primary focus of this study was to identify feasible grade separation concepts at selected at-grade crossings. For each final at-grade crossing location, a benefit-cost analysis (BCA) was developed to assist transportation decision makers in allocating highway-rail grade crossing funding.

The Study's primary objectives included:

- Examining both at-grade and grade-separated railroad crossings, with emphasis on crossings with high train and vehicular volumes
- Designing and using a multi-criteria approach to separately evaluate at-grade crossings and grade-separated crossings
- Developing lists of crossing locations for both at-grade and grade-separated crossings where potential improvement options may be considered

- Determining the feasibility of potential improvements
- Conducting preliminary engineering for feasible at-grade crossing locations, including identification of potential impacts and mitigation
- Developing planning-level cost estimates and BCAs to assist in guiding future investments
- Identifying ways proposed railroad crossing improvements could provide the greatest benefit to safety, freight and passenger mobility, and vehicle traffic operations

1.2 Study Approach

The study's approach was developed and implemented using a series of tasks to identify and select at-grade and grade-separated rail crossings and to determine feasible improvement solutions for the identified locations across the state. The study tasks are summarized in the following sections.

1.2.1 Study Process

1.2.1.1 RAIL CROSSING SCREENING

This task included a screening process whereby statewide databases of 5,261 at-grade and 401 grade-separated locations throughout the state were used to identify 25 at-grade and 25 grade-separated crossings to move forward for further analyses. The screening process used separate evaluation criteria to determine at-grade and grade-separated crossings and is described in detail in Section 2.

1.2.1.2 RAIL CROSSING EVALUATION PROCESS

The rail crossing evaluation process began with the 25 at-grade and 25 grade-separated crossings previously identified and narrowed the list to 10 at-grade crossings and 12 grade-separated crossings. The crossings were holistically analyzed to determine overall community mobility, proximity to existing grade separations, and general traffic patterns. This analysis included identifying crossings already programmed for planned improvements in MDT's Tentative Construction Plan in order to justify combination and/or removal of crossings from the respective lists. For example, if one of the 25 at-grade crossings was located within a short distance from an existing grade separation, the crossing was removed from further consideration (e.g., lower degree of need compared to at-grade crossings in communities without an existing grade separation). The rail crossing evaluation process is described in detail in Section 3.

The final at-grade crossing list determined the crossings to be advanced for preliminary engineering review including development of conceptual grade separation improvements. For the final grade-separated crossings, site visits, conceptual plans and cost estimates were considered out of scope of the study.

1.2.1.3 AT-GRADE CROSSING SITE VISITS AND ANALYSES

The next task included conducting on-site field reviews of the top at-grade crossings to determine the feasibility of constructing grade separation solutions at the crossing location. Field reviews included a detailed documentation of the railroad crossing location and adjacent vicinity, roadway conditions, and the surrounding built environment and resulted in the removal of several at-grade crossings due to infeasibility of separation solutions. As part of the site analyses, an underpass versus overpass evaluation was conducted based on existing physical characteristics to determine the most feasible crossing improvement. The result of the evaluation process was identification of the final 10 at-grade crossing locations for which grade separation concepts were developed, including conceptual plans, cost estimates, and BCAs. More detailed information about this process and the proposed grade separation improvements are provided in Section 4.

1.2.1.4 BENEFIT-COST ANALYSES

For each of the final 10 at-grade crossings a BCA was performed using planning-level costs and federal methodology. The BCA provides a total monetized value of benefits and costs of each project over a 20-year period to determine the payback ratio of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions) and pavement maintenance. Results for each at-grade crossing are presented in Section 4. Appendix C presents the full BCA approach and results.

1.2.1.5 IDENTIFICATION OF GRADE-SEPARATED CROSSING IMPROVEMENTS

The study process included identification of selected grade-separated crossings and determining potential crossing improvements that could be made to improve safety and traffic at these locations. Recommended improvements were developed for 5 selected grade-separated crossings. These 5 crossings were included on the list of 25 grade-separated crossings and identified by the Project Team, MDT Planning personnel, and MDT District Administrators as locations of interest due to limitations in vertical or horizontal clearance or geometric roadway issues. Section 5.2 provides information on grade-separated crossing improvements.

1.2.2 Statewide Rail Crossings

Figure 1-1 provides an overview of Montana’s highway and railroad system, including the State’s public at-grade and grade-separated (highway underpasses) railroad crossing locations and illustrates the geographic distribution and overall volume of crossings examined in this study.

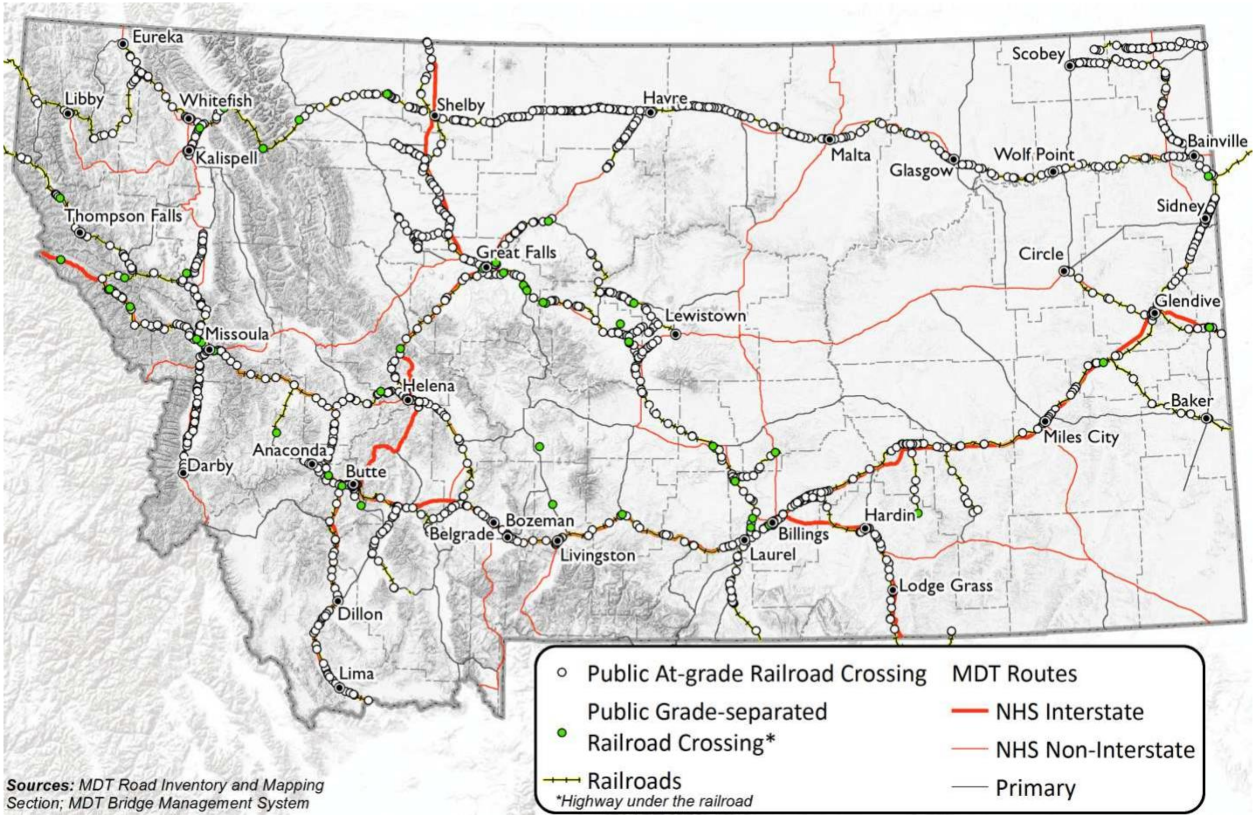

Figure 1-1. Statewide Public At-grade and Grade-separated Railroad Crossings

1.2.3 Montana Railroad Operators

Railroad freight operators in North America are classified based on operating revenues. Railroads are classified as Class I, Class II, or Class III and the exact revenue criteria for each classification has varied over time. Montana's rail system includes railroads operating under each classification and includes the following main operators (Figure 1-2):

Class I Railroads
- BNSF Railway (BNSF)
- Union Pacific Railroad (UPRR)

Class II Railroads
- Montana Rail Link (MRL)
- Dakota, Missouri Valley & Western Railroad

Class III Railroads
- Central Montana Rail, Inc.
- Mission Mountain Railroad
- Butte, Anaconda & Pacific Railway
- Signal Peak Energy
- Alder Gulch Short Line Railroad

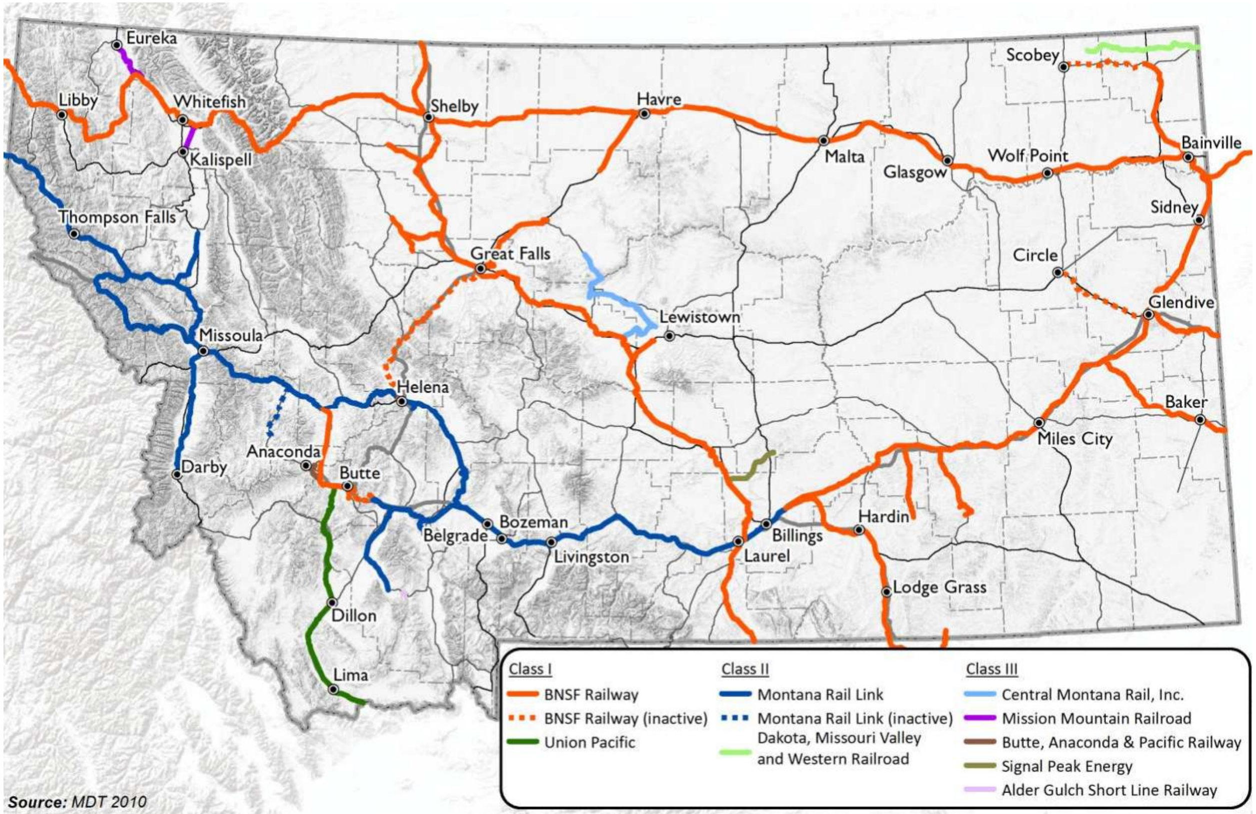

Figure 1-2. Montana Railroad Operators

1.3 Public Outreach

A project website was developed to support public and stakeholder outreach opportunities throughout the study process. The website can be accessed by searching for Rail Grade Separation Study at the following link: http://www.mdt.mt.gov/. The project website includes an overview of the study, frequently asked questions, and links to relevant studies. Members of the public were provided an opportunity to participate in this study by joining the mailing list to receive notifications of study updates. Additionally, online comment forms for submission were provided through use of the website.

The public was encouraged to review the draft report and provide written comments. The draft report was published to the project website and a 30-day public review period extended from April 11, 2016 to May 10, 2016. The Project Team received comments and provided responses as appropriate during the comment period. The project website provides a link to the final report.

1.4 Summary of Report Sections

Section 2 below describes the rail crossing screening process used to determine the 25 at-grade crossings and 25 grade-separated crossings advanced in the study. Section 3 describes the rail crossing selection process which evaluated the crossings in detail through a combined quantitative and qualitative analysis to determine the final crossings to be carried forward. Section 4 includes an in-depth analysis of the final 10 at-grade crossings, including grade separation conceptual plans, cost estimates and BCA results. Section 5 addresses existing grade-separated crossings and provides recommendations for select locations. Finally, Section 6 provides conclusions and next steps, including a brief funding discussion.

2 Rail Crossing Screening

An initial rail crossing screening process was conducted to identify specific crossings to advance in the study. The purpose of the screening process was to develop and apply an evaluation methodology to statewide rail crossings to determine 25 at-grade and 25 grade-separated crossings to be more closely evaluated.

2.1 Screening Methodology

The overall methodology included an initial screening of statewide crossing databases followed by a more detailed screening and independent analysis of both at-grade and grade-separated crossings, as described below.

The overall methodology shown in Figure 2-1 presents the procedural steps applied to screen the crossings. Separate screening processes were employed for the two different crossing types, at-grade and grade-separated. Available information from the Federal Rail Administration (FRA), Office of Safety Analysis Highway-Rail Crossing Inventory (January 2015), MDT crossing inventory database (February 2015), and the MDT Bridge Management System (BMS) (February 2015) were used to identify the total number of at-grade and grade-separated rail crossings. The procedural steps shown in Figure 2-1 were used to identify the 25 crossings of each type from the total of 5,261 at-grade and 401 grade-separated crossings contained in the FRA database. Detailed descriptions of each procedural step are presented in the screening methodology sections below.

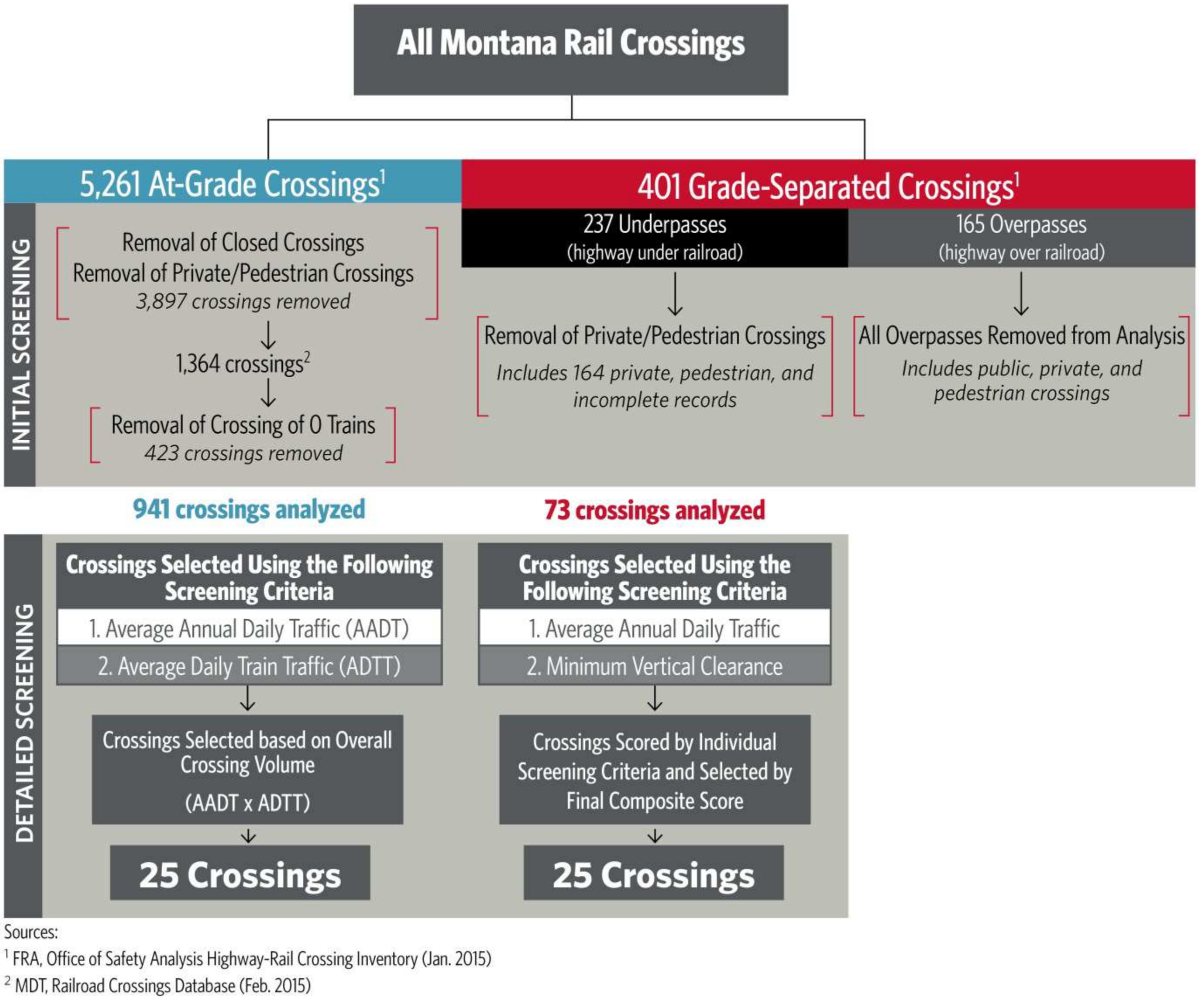

Figure 2-1. Crossing Screening Process

2.2 Initial Screening of Statewide Rail Crossings

Separate initial screening processes were employed for the two different crossing types, as described in the following sections.

2.2.1 At-Grade Crossings

The initial screening of at-grade railroad crossings began with the FRA Office of Safety Analysis Highway-Rail Crossing Inventory[1] for the state of Montana, which was downloaded in January 2015. This database included information for 5,261 public and private at-grade crossings. This initial screening removed all closed crossings (i.e., crossings either out of service, track disconnected, or track removed). The list of crossings was further narrowed by removing all private and pedestrian crossings. These crossings were removed because this study is focused on public roads and assessment of highway-rail crossing improvements for safety and mobility of vehicular traffic. Next, the MDT public at-grade crossings database (February 2015) was obtained for the remaining 1,364 crossings. MDT conducts scheduled on-site crossing

[1] FRA Highway-Rail Crossing Inventory by State. Accessed Jan. 26, 2015. Accessed at http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/downloaddbf.aspx.

inventories of all public at-grade crossings to accurately collect site conditions. This information is entered into MDT's database which is the primary data source for prioritizing highway-rail safety projects for the state. The system also feeds information to the FRA national crossing database. Railroads submit railroad specific information to both the FRA and MDT databases. By joining both MDT's and FRA's data sets a comprehensive list of all active, public, at-grade highway-rail crossings for Montana was compiled. The next step was to identify and exclude those crossings with zero train movements per day. This process removed 423 additional crossings. The result of the initial screening yielded 941 active, public at-grade crossings experiencing one or more trains per day.

2.2.2 Grade-Separated Crossings

The evaluation of grade-separated crossings began with 401 crossings from the FRA database. The initial screening involved removing highway overpasses, resulting in a new total of 236 crossings. The decision was made to evaluate only highway-rail underpasses (i.e., highway traveling underneath the railroad) for the following reasons:

1. Underpass structures are generally those carrying vehicular traffic beneath another mode of transportation. Underpasses were evaluated in this process to identify potential concerns unique to this type of structure: drainage, height/width restrictions, Americans with Disabilities Act (ADA) access, ownership (railroad vs MDT), etc.
2. Overpasses generally do not present restrictions related to vehicular traffic and commercial trucks based on their physical characteristics carrying traffic over another mode of transportation.
3. Highway-rail overpasses are inspected and maintained by the MDT Bridge Bureau. Improvements to overpasses are made based on prioritized needs identified in the BMS, which includes factors such as National Bridge Inventory rating, structure deficiencies, etc., and likely would not have an impact on the mobility of traffic crossing the railroad.

The next step included removing all private grade-separated crossings, resulting in a reduction from 236 to 103 public underpasses. Pedestrian underpasses were also removed since this study is focused on improvements for the safety and mobility of vehicular traffic. This process resulted in 94 crossings remaining.

The FRA database was further reduced to remove incomplete records lacking street location information, which resulted in a total of 62 usable records for public grade-separated crossings. Next, the MDT BMS database was obtained, which provided comprehensive information for 72 public highway-rail underpasses, including location, structure condition, and vertical clearance. The BMS database was joined to the FRA database, providing a final dataset containing 72 grade-separated crossings. One additional underpass of local significance—21st Street, Billings—was not included in the BMS and was added to the list of grade-separated crossings. The final list of grade-separated crossings included 73 public underpasses.

2.3 Detailed Screening

2.3.1 At-Grade Crossings

Following the initial screening process, a detailed screening of the at-grade crossings was conducted using the two criteria below, which are defined in Table 2-1.

1. Average Annual Daily Traffic (AADT)
2. Average Daily Train Traffic (ADTT)

Table 2-1. At-Grade Screening Evaluation Criteria and Definitions

Criteria	Description
Average Annual Daily Traffic (AADT)	This criterion represents the volume of daily activity at the crossing as measured by vehicular volumes. Vehicular volumes are measured by AADT values of the intersecting roadway at that crossing. AADT values were obtained from the Montana Department of Transportation Montana Traffic Data web mapping service (July 2015).
Average Daily Train Traffic (ADTT)	This criterion represents the volume of daily activity at the crossing as measured by train volumes. Train volumes are measured by the total number of passenger, freight, and switching trains at the crossing per day. Daily train counts were obtained from the Federal Rail Administration database (Jan. 2015).

AADT and ADTT were considered critical inputs in the initial screening evaluation to provide priority to crossings experiencing the greatest overall volumes of vehicles and trains.

AADT and train volumes were multiplied together to obtain a total crossing value for each crossing. The values were ordered numerically from high to low, which provided the final list of at-grade crossings to be carried forward. The formula used can be expressed in the following terms:

$R = AADT * AATT$

where;
R = total crossing value
AADT = average annual daily traffic
AATT = average daily train traffic

2.3.2 Grade-Separated Crossings

Following the initial screening of grade-separated crossings, a detailed screening was conducted based on the following criteria:

1. AADT
2. Minimum Vertical Clearance

These factors provided quantifiable measures to evaluate the 73 grade-separated crossings. The criteria are defined in Table 2-2.

Table 2-2. Grade-Separated Screening Evaluation Criteria and Definitions

Criteria	Description
Average Annual Daily Traffic (AADT)	This criterion represents the current AADT values of the roadway at that crossing. AADT values were obtained through the Montana Department of Transportation Montana Traffic Data web mapping service (July 2015).
Minimum Vertical Clearance	This criterion represents the minimum vertical clearance from the roadway (travel lanes only) or railroad track beneath the structure to the underside of the bridge. Vertical clearance was obtained from the Montana Department of Transportation BMS (July 2015).

AADT was determined an important criterion for grade-separated crossings as it represents the amount of vehicular travel use at the crossing. The minimum vertical clearance criterion was determined to be important due to mobility restrictions caused by lower clearance structures and potential for over-height vehicles to strike bridge structures.

The grade-separated crossings were ranked independently by the two criteria above and rank values were combined. AADT was ordered from high to low with the crossings with higher AADT volumes receiving a lower rank score. The minimum vertical clearance criterion was used by ranking in ascending order (i.e., lowest vertical clearance to highest vertical clearance) each crossing. A composite score for each crossing was then obtained by combining the scores for both criteria. The grade-separated crossings were then listed in ascending order by their composite scores to determine the 25 grade-separated crossings. The composite score was expressed in the following terms:

$$R = C1 + C2$$

where;
R = composite score
C1 = rank score from Criterion 1, AADT
C2 = rank score from Criterion 2, Minimum Vertical Clearance

2.4 Screening Results

Based on the methods previously described above, the 25 at-grade and 25 grade-separated crossings were determined from the overall crossings analyzed. Table 2-3 and Table 2-4 present the 25 at-grade and 25 grade-separated crossings, respectively, to be carried forward in the analysis and are organized alphabetically by city.

Table 2-3. 25 At-Grade Crossings

Crossing ID	City	Location
060090P	Belgrade	Jackrabbit Lane
060085T	Belgrade	Broadway
087491T	Billings	27^{th} Street
087383W	Billings	Moore Lane
087492A	Billings	28th Street (Broadway)
060055B	Bozeman	Rouse Avenue

Crossing ID	City	Location
060073Y	Bozeman	Griffin Drive
060076U	Bozeman	Valley Center Road
059909U	Columbus	Pratten Street
104062M	Crow Agency	Makawasha Avenue
087403F	Forsyth	10th Avenue
059544P	Glasgow	4th Street
060193P	Helena	Montana Avenue
060199F	Helena	Benton Avenue
060190U	Helena	Carter Drive
060192H	Helena	Roberts Street
098742R	Helena	Joslyn Street
087386S	Huntley	Northern Avenue
087371C	Laurel	S 72nd Street W
060021G	Livingston	N 5th Street
060017S	Livingston	Bennett Street
060097M	Manhattan	Broadway
060399P	Missoula	Madison Street/Greenough Drive
088059K	Shelby	2nd Avenue
059580K	Wolf point	6th Avenue S

Table 2-4. 25 Grade-Separated Crossings

Bridge ID	City	Location
R00045000+07981	Big Timber	US 191
R01022003+00951	Billings	13th Street
R99999999+99999	Billings	21st Street
R01025000+06001	Billings	6th Street
R00029087+08181	Butte	Harrison Avenue
R01805000+06001	Butte	S Montana Street
R01807001+02821	Butte	Continental Drive
R18203000+01001	East Glacier	Highway 49
R00042076+00441	Glasgow	6th Street S
R11211000+03001	Glendive	Douglas Street/Barry Street
R05205001+03841	Great Falls	River Drive S
R05209001+03601	Great Falls	6th Street N
R05210001+07011	Great Falls	1st Avenue N
R05810000+06471	Helena	Henderson Street
R00001121+07211	Kalispell	US 2
R00004054+07361	Laurel	S 1st Avenue
R07406000+00941	Livingston	N Main Street
R07406000+00942	Livingston	N Main Street
R00061157+05661	Malta	US 191/Central Avenue
R00002003+01501	Miles City	Main Street
R08107002+00251	Missoula	Orange Street
R00071004+06381	Missoula	N Van Buren Street
R00065000+00371	West Glacier	Going-To-The-Sun Road
R00027079+08841	Wibaux	N Wibaux Street
R00025052+07241	Wolf Point	S 3rd Avenue

3 Rail Crossing Selection Process

This section presents the evaluation criteria and methodology used to identify the final crossings for further analysis. A combination of quantitative and qualitative analyses, including holistic considerations, was used to reduce the 25 at-grade and 25 grade-separated crossings to a final list of 10 at-grade and 12 grade-separation locations. Conceptual plans, planning-level cost estimates and BCAs were developed for each of the final 10 at-grade crossings. Figure 3-1 depicts the overall crossing selection process.

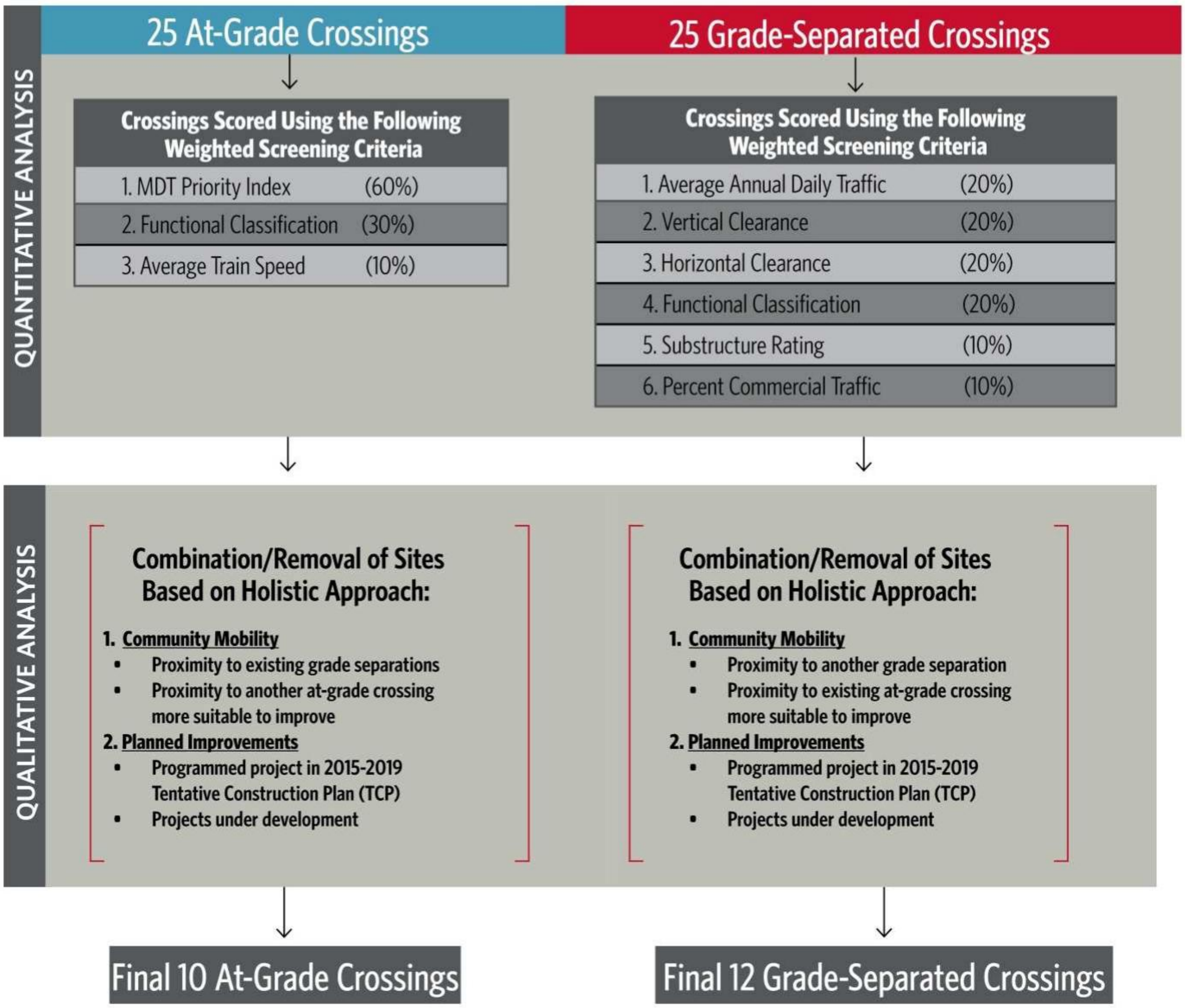

Figure 3-1. Crossing Selection Process

3.1 Quantitative Analysis

The quantitative selection process methodology was based on a weighted multi-criteria analysis. Similar to the initial screening process, criteria differed between at-grade and grade-separated crossings.

3.1.1 At-Grade Crossing Criteria

Table 3-1 explains the criterion used to reduce the at-grade crossing list to 10 crossings.

Table 3-1. At-Grade Crossing Evaluation Criteria

Criteria		Description/Purpose	Weight
1	**Montana Department of Transportation (MDT) Priority Index**	The MDT Priority Index is a formula used to compute the hazard potential of each public crossing based on train traffic, vehicular traffic, and other existing physical conditions of the crossing. The metric (formula defined below) is used to prioritize safety improvements to public highway-rail crossings.	60%
2	**Roadway Functional Classification**	Functional classification groups highways by the character of service they provide. Higher functionally classified roads generally have higher capacity and mobility significance. Functional classification is directly tied to the Federal-Aid Highway System and eligibility for federal transportation funding, and was therefore considered an important criterion.	30%
3	**Average Train Speed**	This criterion represents an average speed based on posted train speed, and timetable speeds for specific movements (passenger trains, freight trains and switching trains). Higher train speeds can increase accident probability/severity and create additional safety concerns.	10%
Total			100%

3.1.1.1 AT-GRADE CRITERIA WEIGHTING AND SCORING

The Priority Index (Criterion 1) is a formula used to compute “hazardous conditions” of each public crossing based on train traffic, vehicular traffic, and other existing physical conditions. Physical conditions include type of train movement, trackage, sight distance, approach angle, highway alignment, number of roadway lanes, approach grades, vertical sight distance, crossing width and local interference. The Priority Index score was computed by dividing the Priority Index value for each crossing by the maximum value available for the 25 crossings evaluated, which resulted in a numerical score ranging from 0 to 1. A value of 1 represented the highest value possible, or 100 percent of the maximum score. A weighting factor of 60 was calculated, with a maximum value of 60 representing the highest value for this criterion. This approach served to normalize crossing scores relative to each other.

The roadway functional classification criterion (Criterion 2) was assigned a score based on each roadway intersecting the at-grade crossing. Using this method, higher functional classification crossings received higher scores. Classifications ranged from Principle Arterial – Non-Interstate (highest score) to local road (lowest score) and their weighted scores are shown in Table 3-2.

Table 3-2. Weighted Scoring for Functional Classification Criteria

Functional Classification	Score
Principle Arterial*	30
Minor Arterial	24
Major Collector	18
Minor Collector	12
Local Road	6

* Principle Arterials evaluated were all located on the NHS Non-Interstate system. No crossings evaluated were located on the Interstate System.

The average train speed criterion (Criterion 3) was categorized into a range of speeds and assigned a score based on average train speeds, with higher speeds receiving higher scores. The average train speed at each crossing was calculated using the following formula:

*(# of freight trains * max speed) + (# of switching trains * min speed) / total # of trains*

A combination of MDT and FRA data was used to calculate average train speed due to minor discrepancies between the two databases. For this calculation the number of trains was determined using MDT's crossing database while the train speeds were determined using the FRA's crossing database. Weighted scoring for train speeds is shown below in Table 3-3:

Table 3-3. Weighted Scoring for Average Train Speed Criteria

Average Train Speed (miles per hour)	Score
> 49	10
40-49	8
30-39	6
20-29	4
< 20	2

3.1.2 Grade-Separated Crossing Criteria

Table 3-4 lists the criteria used to reduce the 25 grade-separated crossings to 12 crossings, followed by a description of the criteria.

Table 3-4. Grade-Separated Crossing Criteria

Criteria		Description/Purpose	Weight
1	**Average Annual Daily Traffic (AADT)**	AADT was evaluated for each crossing. Higher traffic volumes are representative of higher potential for collisions and/or usage by commercial vehicles.	20%
2	**Vertical Clearance**	This criterion represents the minimum vertical clearance from the roadway (travel lanes only) to the underside of the superstructure. Sub-standard vertical clearances represent a safety concern as well as restrictions for commercial vehicles.	20%
3	**Horizontal Clearance**	The horizontal clearance was evaluated using the minimum right lateral clearance distance underneath the structure. The lateral clearance is measured from the right edge of the roadway (excluding shoulders) to the nearest substructure unit (pier, abutment, etc.), to a rigid barrier (concrete bridge rail, etc.), or to the toe of slope steeper than 1:3 ratio. The measurement is the minimum distance available for both directions of travel.	20%
4	**Roadway Functional Classification**	Functional classification places highways by the character of service they provide. Higher functionally classified roads generally have higher capacity and mobility significance. Functional classification is directly tied to the Federal-Aid Highway System and eligibility for federal transportation funding, and was therefore considered an important criterion.	20%
5	**Substructure Rating**	The substructure rating for underpasses was obtained from the MDT Bridge Management System. This metric is based on the National Bridge Inventory rating system and represents the overall condition of the	10%

Criteria		Description/Purpose	Weight
		substructure structural elements. Values range from 0 to 9, with 0 representing a "failed condition" and 9 representing "excellent condition."	
6	**Percent Commercial Traffic**	The number of commercial trucks as a percentage of total AADT was examined for each crossing and used in the evaluation.	10%
Total			100%

3.1.2.1 GRADE-SEPARATED CRITERIA WEIGHTING AND SCORING

The AADT (Criterion 1) was indexed similar to the Priority Index described in Section 3.1.1.1. This criterion was weighted by a factor of 20 percent to produce a score, with a maximum of 20 representing the highest value available for this criterion.

Evaluation criteria 2 through 6 were categorized into ranges of values and assigned scores. Weighted scoring for evaluation criteria 2 through 6 are shown below in Table 3-5:

Table 3-5. Weighted Scoring for Grade-Separated Crossing Criteria

Vertical Clearance (feet)	Score
< 11.0	20
11.0 – 11.99	16
12.0 – 12.99	12
13.0 - 13.99	8
> 14.0	4

Horizontal Clearance (feet)	Score
< 1.0	20
1.0 – 1.99	16
2.0 – 2.99	12
3.0 – 5.0	8
> 5.0	4

Functional Classification	Score
Principle Arterial*	20
Minor Arterial	16
Major Collector	12
Minor Collector	8
Local Road	4

* Principle Arterials evaluated were all located on the NHS Non-Interstate system. No crossings evaluated were located on the Interstate System.

Substructure Rating*	Score
0-1	10
2-3	8
4-5	6
6-7	4
8-9	2

* Ratings for crossings evaluated ranged from 4 to 7

Percent Commercial Vehicles	Score
> 5.0	10
3.0 - 4.99	8
2.0 – 2.99	6
1.0 – 1.99	4
< 1.0	2

3.2 Qualitative Analysis

3.2.1 Holistic Approach

The qualitative analysis included reviewing the 25 at-grade and 25 grade-separated crossings using a holistic community approach. This method involved combining and/or eliminating crossings based on a review of proximity to other grade-separated crossings, community mobility, and construction projects planned for the crossing. This step resulted in several crossings being combined or removed from further consideration.

For this analysis, proximity was generally defined as within a 1-mile radius from another crossing determined to be more suitable for improvement. Specifically, this included:

- At-grade crossings in proximity to existing grade separations, or multiple crossings on the prioritized lists within proximity to another crossing determined to be more suitable for improvement; or
- Grade-separated crossings within proximity to another grade separation, or in proximity to an at-grade crossing determined to be more suitable for improvement.

The community mobility assessment included a review of vehicular traffic patterns based on major origins and destinations near each crossing. In some instances crossings located within 1 mile of each other were not combined holistically due to the variance in community locations served (e.g., major subdivisions/neighborhoods, commercial districts, event centers).

3.3 Selection Process Results

The scores for each criterion were weighted to achieve a relative importance factor and combined to derive a final score for each of the 25 at-grade and grade-separated crossings.

3.3.1 At-Grade Crossings

Table 3-6 presents results of the at-grade crossing selection process including the 3 evaluation criteria (priority index, functional classification, and train speed). Crossings are arranged in descending order based on final composite scores. The “Notes” column provides justification based on the qualitative analysis.

3.3.2 Grade-Separated Crossings

Table 3-7 presents results of the grade-separated crossing selection process including the six evaluation criteria (AADT, vertical clearance, horizontal clearance, functional classification, substructure rating and percent commercial vehicles). Crossings are arranged in descending order based on final composite scores.

Two additional grade-separated crossings were added to the list of 25 crossings. These crossings did not make the list of 25 crossings based on quantitative analysis; however, they were identified by MDT District Administrators as priority locations and have therefore been included in the evaluation. These crossings are:

- Missoula, E Broadway, Bridge ID R08112001+06401
- Highway 200, 1M SE Trout Creek, Bridge ID R00006031+03791

Table 3-7 also includes a “Notes” column that provides justification based on the qualitative analysis.

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Table 3-6. Selection Process Results for At-Grade Crossing Locations

City	Location	AADT[1]	No. of Trains/ Day (ADTT)[2]	Avg. Train Speed[3]	MDT Priority Index[2] (PI)	Functional Classification[1] (FC)	Warning Device[2]	System Designation[1]	MDT PI Score (60pts)	FC Score (30pts)	Train Speed Score (10pts)	Composite Score	Notes
Billings	27th Street	14260	38	9	39015	Principle Arterial	Gates + Cantilevers	NHS Non-Interstate	60	30	2	**92**	Crossing combined holistically with 21st underpass and 28th (Broadway) and 29th Street at-grade. The 21st underpass is located 0.5 mile from 27th Street crossing via alternate roadway access.
Helena	Montana Avenue	12850	35	20	31080	Principle Arterial	Gates + Cantilevers	NHS Non-Interstate	48	30	4	**82**	Crossing combined holistically with Roberts Street at-grade crossing. Roberts Street at-grade is located less than 0.5 mile from the Montana Avenue crossing via alternate roadway access. Access provided by each crossing is similar.
Belgrade	Jackrabbit Lane	15060	28	60	24036	Principle Arterial	Gates + Cantilevers	NHS Non-Interstate	37	30	10	**77**	Crossing combined holistically with Broadway Street at-grade crossing located 0.5 mile from Jackrabbit via alternate roadway access. This crossing has higher priority and fewer R/W constraints than Broadway Street with similar traffic origins/destinations.
Bozeman	Rouse Avenue	10580	38	35	26535	Minor Arterial	Gates	Primary	41	24	6	**71**	
Helena	Benton Avenue	9630	35	45	22596	Minor Arterial	Gates	Urban	35	24	8	**67**	
Bozeman	Griffin Drive	8090	28	60	15177	Minor Arterial	Gates	Urban	23	24	10	**57**	
Billings	Moore Lane	7100	32	55	17949	Major Collector	Gates	Local	28	18	10	**56**	
Belgrade	Broadway	6570	28	60	13613	Minor Arterial	Gates	Urban	21	24	10	**55**	Crossing combined holistically with Jackrabbit Lane. See notes for Jackrabbit Lane crossing.
Columbus	Pratten Street	7400	26	45	14815	Minor Arterial	Gates	Primary	23	24	8	**55**	
Crow Agency	Makawasha Avenue	6722	28	60	14304	Major Collector	Gates	Local	22	18	10	**50**	
Missoula	Madison Street/ Greenough Drive	5540	35	23	16094	Major Collector	Gates	Local	25	18	4	**47**	
Belgrade	Valley Center Road	4600	28	60	7857	Minor Arterial	Gates	Local	12	24	10	**46**	
Livingston	N 5th Street	5770	42	27	15510	Major Collector	Gates	Urban	24	18	4	**46**	
Helena	Carter Drive	5360	33	41	6191	Minor Arterial	Gates	Urban	10	24	8	**42**	
Huntley	Northern Avenue	4142	30	50	8325	Major Collector	Gates	Secondary	13	18	10	**41**	
Laurel	S 72nd Street W	2980	32	59	7629	Major Collector	Gates	Local	12	18	10	**40**	
Livingston	Bennett Street	2400	42	28	7056	Minor Arterial	Gates	Urban	11	24	4	**39**	
Manhattan	Broadway	3280	28	60	6704	Major Collector	Gates + Cantilevers	Secondary	10	18	10	**38**	
Helena	Roberts Street	3290	49	17	11607	Major Collector	Gates + Cantilevers	Local	18	18	2	**38**	Combined holistically with Montana Avenue. See notes for Montana Avenue crossing.
Helena	Joslyn Street	2970	35	45	6965	Major Collector	Gates	Local	11	18	8	**37**	Combined holistically with Henderson Street underpass due to proximity and access provided by each crossing is similar.
Wolf Point	6th Avenue S	3284	39	79	11847	Local Street	Gates	Local	18	6	10	**34**	Combined holistically with S 3rd Avenue underpass due to proximity. 6th Avenue S is located approximately 3 city blocks from S 3rd Avenue and access provided by each crossing is similar.
Glasgow	4th Street	3684	40	35	13305	Local Street	Gates	Local	20	6	6	**32**	Combined holistically with 6th Street S underpass due to proximity. The 4th Street at-grade crossing is located 2 city blocks from 6th Street S underpass and access provided by each crossing is similar.
Shelby	2nd Avenue	2810	42	45	9395	Local Street	Gates	Primary	14	6	8	**28**	Combined holistically with Oil Field Avenue overpass due to proximity. The 2nd Avenue crossing is located 2 city blocks from Oil Field Avenue and access provided by both crossings is similar.
Forsyth	10th Avenue	3243	28	60	6656	Local Street	Gates	Local	10	6	10	**26**	
Billings	28th Street (Broadway)	2470	38	9	6289	Local Street	Gates + Cantilevers	Local	10	6	2	**18**	Combined holistically with 27th Street, 29th Street, and 21st Street underpass due to proximity. See notes for 27th Street crossing.

Sources: [1] Montana Department of Transportation Montana Traffic Data Web Mapping Service (July 2015)
[2] Montana Department of Transportation Public At-Grade Crossing Database (February 2015)
[3] Federal Rail Administration Office of Safety Analysis, Highway-Rail Crossing Inventory (January 2015)

Table 3-7. Final Grade-Separated Crossing Locations

City	Location	AADT[1]	Vertical Clearance (FT)[2]	Horiz. Clearance (FT)[2]	Substr. Rating[2]	Percent Com. Traffic (%)[1]	Functional Classification[1]	System Designation[1]	AADT Score (20pts)	Vert. Clearance Score (20pts)	Horiz. Clearance Score (20pts)	FC Score (20pts)	Substr. Rating Score (10pts)	% Com. Traffic Score (10pts)	Composite Score	Notes
Kalispell	US 2	22630	14.58	1.60	4	3.44	Principle Arterial	NHS Non-Interstate	20	4	16	20	6	8	**74**	Future Industrial Park potentially impacting grade separation
Missoula	Orange Street	16150	13.48	2.24	5	2.72	Principle Arterial	NHS Non-Interstate	14	8	12	20	6	6	**66**	
Laurel	S 1st Avenue	13690	14.00	1.74	5	1.26	Principle Arterial	NHS Non-Interstate	12	4	16	20	6	4	**62**	Underpass improvements being made with a programmed project; Crossing combined holistically with 5th Avenue at-grade crossing due to proximity. Access provided by both crossings is similar.
Great Falls	1st Avenue N	17620	14.60	1.50	6	0.90	Principle Arterial	NHS Non-Interstate	16	4	16	20	4	2	**62**	
Glasgow	6th Street S	8020	12.75	1.00	5	0.76	Minor Arterial	Primary	7	12	16	16	6	2	**59**	Crossing combined holistically with 4th Street at-grade crossing. The 6th Street S underpass is located approximately 2 city blocks from the 4th Street at-grade crossing. Access provided by both crossings is similar.
Great Falls	River Drive S	9050	13.85	1.15	7	2.34	Minor Arterial	Urban	8	8	16	16	4	6	**58**	
Wolf Point	S 3rd Avenue	6550	14.33	0.70	5	2.17	Minor Arterial	Primary	6	4	20	16	6	6	**58**	Crossing combined holistically with 6th Avenue at-grade crossing. Crossings are approximately 3 city blocks from each other and access provided by both crossings is similar.
Billings	6th Street	17250	14.50	1.00	6	0.00	Minor Arterial	Urban	15	4	16	16	4	2	**57**	Underpass improvements being made with a programmed project
Great Falls	6th Street N	3050	12.99	1.97	6	2.46	Minor Arterial	Urban	3	12	16	16	4	6	**57**	
Butte	Harrison Avenue	14110	13.91	17.24	4	2.27	Principle Arterial	NHS Non-Interstate	12	8	4	20	6	6	**56**	
Malta	US 191/Central Avenue	3860	13.94	2.99	5	2.33	Principle Arterial	NHS Non-Interstate	3	8	12	20	6	6	**55**	
East Glacier	Highway 49	890	12.70	0.66	6	2.47	Major Collector	Local	1	12	20	12	4	6	**55**	
Miles City	Main Street	9840	12.11	3.00	6	0.82	Principle Arterial	NHS Non-Interstate	9	12	8	20	4	2	**55**	Crossing combined holistically with Leighton Boulevard at-grade crossing. Crossings are within 0.5 mile of each other and access provided by both crossings is similar.
Livingston	N Main Street	4180	13.66	1.00	7	2.39	Minor Arterial	Urban	4	8	16	16	4	6	**54**	
Livingston	N Main Street	4180	13.50	1.00	7	2.39	Minor Arterial	Urban	4	8	16	16	4	6	**54**	
Big Timber	US 191	1550	13.66	2.50	5	6.00	Minor Arterial	Primary	1	8	12	16	6	10	**53**	
Missoula	N Van Buren Street	15980	15.00	6.50	7	2.60	Principle Arterial	NHS Non-Interstate	14	4	4	20	4	6	**52**	
Missoula	E Broadway*	7890	15.25	2.00	5	2.92	Minor Arterial	Urban	7	4	12	16	6	6	**51**	
Helena	Henderson Street	7600	14.17	1.05	7	1.45	Minor Arterial	Urban	7	4	16	16	4	4	**51**	Crossing combined holistically with Joslyn Street at-grade crossing. Crossings are located with 0.5 to 1.0 mile of each other via alternate roadways and access provided by both crossings is similar.
Butte	S Montana Street	14350	14.58	10.73	5	1.53	Principle Arterial	NHS Non-Interstate	13	4	4	20	6	4	**51**	
Billings	13th Street	9190	14.00	4.24	6	3.16	Minor Arterial	Urban	8	4	8	16	4	8	**48**	
1m SE Trout Creek	Highway 200*	1880	16.00	2.20	7	5.53	Minor Arterial	Primary	2	4	12	16	4	10	**48**	
Billings	21st Street	2570	8.50	1.54	0	0.00	Local Street	Local	2	20	16	4	0	2	**44**	Combined holistically with 27th Street and Broadway (28th) Street and 29th Street at-grade crossings due to proximity and similar traffic access patterns.
Wibaux	N Wibaux Street	2270	14.00	6.23	6	5.81	Minor Arterial	Primary	2	4	4	16	4	10	**40**	
West Glacier	Going-to-the-Sun Road	4560	14.00	7.24	5	1.62	Minor Arterial	Primary	4	4	4	16	6	4	**38**	
Butte	Continental Drive	7110	14.58	10.50	6	0.90	Minor Arterial	Urban	6	4	4	16	4	2	**36**	
Glendive	Douglas/Barry Street	6630	14.01	5.00	6	0.00	Local Street	Urban	6	4	8	4	4	2	**28**	

*District Administrator priority crossing added to list following initial screening
Sources: [1] Montana Department of Transportation Montana Traffic Data Web Mapping Service (July 2015)
[2] Montana Department of Transportation Bridge Management System Database (July 2015)

4 At-Grade Rail Crossing Projects

The following section presents the steps involved in determining the final 10 at-grade rail crossing locations from the list presented in Table 3-6, including in-depth analysis of those sites. The 10 at-grade rail crossing locations were determined by systematically working through the crossings with field reviews to determine which locations were feasible for a grade-separated crossing. The field reviews were conducted to verify the feasibility or practicability of constructing grade-separated crossings. Locations determined feasible for grade separation, which were not previously removed or combined in the holistic analysis conducted above, were included in the list of final at-grade crossings for conceptual design.

Based on the evaluation process, three cities (Billings, Bozeman, and Helena) had multiple crossings considered for feasibility of grade separation. Additional evaluation will be needed to determine which crossing or crossings would be viable, cost effective, and provide the greatest benefit for each city. If a crossing enhancement is implemented at one location, a re-evaluation of crossing needs may be necessary for the impacted community.

4.1 Final At-Grade Crossings for Conceptual Design

4.1.1 Final At-Grade Crossings

The list of 25 at-grade crossings (above in Section 3, Table 3-6) were field reviewed in descending order to examine in detail the feasibility of constructing a grade separation. The list was reduced to 10 crossings determined feasible to grade separate and for which conceptual plans, cost estimates and a BCA were developed. Table 4-1 presents the final at-grade crossings alphabetized by city and proposed grade separation solution.

Table 4-1. Final At-Grade Crossings and Proposed Grade Separation Solution

City	Location	Feasible Grade Separation Solution
Belgrade	Jackrabbit Lane	Underpass
Billings	27th Street	Partial Overpass and Partial Underpass
Billings	Moore Lane	Underpass
Bozeman	Griffin Drive	Underpass
Bozeman	Rouse Avenue	Underpass
Helena	Benton Avenue	Overpass and Underpass
Helena	Carter Drive	Underpass
Helena	Montana Avenue	Underpass
Huntley	Northern Avenue	Overpass
Laurel	S 72nd Street W	Overpass

Existing at-grade crossings determined to be feasible or practical to grade separate are discussed in detail in Sections 4.4 through 4.13. Several of the crossings, due to the proximity to adjacent at-grade or grade-separated crossings, were treated as an “area” project to provide both traffic safety and traffic flow improvements by constructing a grade-separated crossing or improvements to several adjacent roads. These included:

- 27^{th} Street, Billings
  - Combined holistically with the 21st Street underpass, as well as the 28th Street (Broadway) and 29^{th} Street at-grade crossings. A new partial grade separation at 27^{th} Street could allow closure of the 28th Street (Broadway) at-grade crossing due to proximity and origin/destination of traffic utilizing the crossing.
- Montana Avenue, Helena
  - Combined holistically with Roberts Street and National Avenue. A new grade separation at Montana Avenue could allow closure of Roberts Street and National Avenue. A pedestrian overpass would be recommended at Roberts Street as part of the potential closure work to maintain neighborhood pedestrian connectivity between schools and residential areas.
- Jackrabbit Lane, Belgrade
  - Combined holistically with Broadway Street. A new grade separation of Jackrabbit Lane would improve traffic mobility in the area. While the Broadway Street at-grade crossing appears unable to be closed due to local business and residential traffic access, improvements to the intersection with Main Street north of the tracks could improve safety for the Broadway Street at-grade crossing.

4.1.1.1 LIVINGSTON AREA CROSSINGS

It was determined early in the study process that crossings located in the Livingston area would not be evaluated in detail or include developing conceptual plans and cost estimates. MDT and the City of Livingston are currently working through a process separate from this study to evaluate potential grade separation locations within the community. The selection process identified the Bennett Street at-grade crossing as a feasible location for a grade separation; however, the Bennett Street crossing was not evaluated further in this study.

4.2 Feasibility Assessment and Conceptual Designs

4.2.1 Site Visit Overview

The feasibility or practicability of grade separating a crossing was determined by performing conceptual engineering for each site as well as applying experience in designing and constructing railroad-highway grade separation projects in Montana, elsewhere in the United States, and internationally. Existing crossing conditions and area topography were reviewed to determine if an underpass or overpass would be most feasible by location. Observations at existing crossings included lane configurations and widths, traffic control signage and signalization, railroad trackage, sight distances, and roadway horizontal and vertical alignments.

Photo 4-1. Road where queue distance and lane configuration modifications could reduce congestion and trapped cars at railroad crossing

Site visits were conducted in August and September of 2015 by HDR staff. Locations included Belgrade, Billings, Bozeman, Columbus, Crow Agency, Helena, Huntley, Livingston, Laurel and Missoula areas.

4.2.2 Feasibility Assessment

The feasibility or practicability of grade separating a crossing or improving an existing grade-separated crossing included the following analysis factors:

- Impact on surrounding residences, resident parking and access to residence driveways.
- Impacts on surrounding businesses and office buildings including parking and access to parking.
- Ability to construct the underpass and maintain or provide facilities for drainage and avoid construction below potential groundwater elevations.
- Avoid route closures connecting schools and other infrastructure in or near housing areas.
- Avoid impacts on potential Section 4(f) properties and/or potential historic sites and structures.
    - Identification of potential Section 4(f) properties and potential historic sites or structures was based on visual inventory only. Historic buildings were identified in the field based on presence of a historic placard. No detailed record searches were conducted.
    - The former Northern Pacific and Great Northern Railroads' Main Line are known historic resources and considered eligible for listing on the National Register of Historic Places (NRHP). The railroad corridor's historical status is potentially applicable to crossings evaluated within this section as the final at-grade crossings identified are located within these corridors.
    - Irrigation ditches, due to their age and cultural significance, are commonly identified as historic resources.

  For crossings evaluated, a cultural resources inventory and evaluation of Section 4(f) properties could occur during future project development should a project be progressed beyond this study. Impacts could be determined to not be detrimental to the historical resource or mitigation plans to address the impact could be developed as a result of the evaluation.
- Avoid or degree of mitigation needed to maintain access to subdivisions and parks.
- Known environmental hazard areas.

4.2.3 Overpass/Underpass Considerations

At each of the crossings, the area features, road/track profile and geometry and potential impacts were evaluated to determine the feasibility and practicality to design an overpass (roadway over the railroad) or an underpass (roadway passing under the railroad) solution. Part of this decision was based on the potential impacts for an overpass, which extends approximately 600 feet each direction from the existing at-grade crossing with approximately 30 feet of height gain to obtain the necessary vertical clearance over the railroad. An underpass would typically impact approximately 350-400 feet each side of the existing at-grade crossing, including approximately 20 feet of depth to provide the necessary clearance under the railroad tracks (see Figure 4-1). In addition, any gain in reducing the height or depth due to the tracks being lower or higher than the prevailing roadway grade could further reduce the impact area for the overpass or underpass consideration. Note the dimensions shown on Figure 4-1 are approximate; the actual overpass or underpass dimensions vary depending on the approximate structure depth required for the crossing.

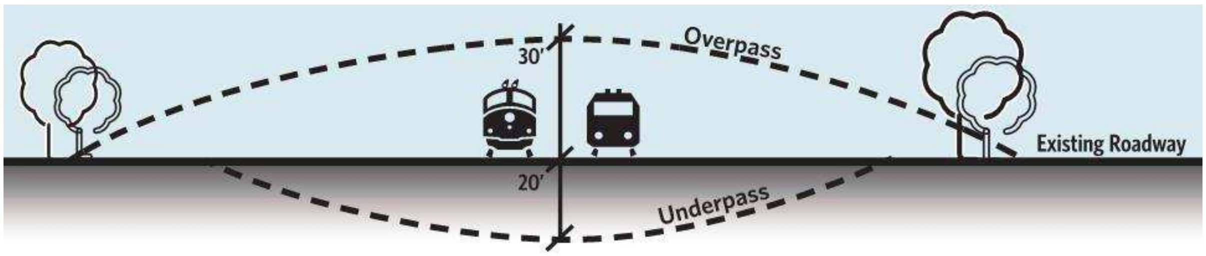


Figure 4-1. Basic Grade Separation Concept

In this analysis, if the roadway grades approaching an at-grade crossing were above or even with the railroad elevation, a roadway overpass was proposed, unless the length of the approaches, grading, access difficulties and impacts appeared too great to overcome with an engineered solution (see Photo 4-2). Generally, if the roadway approaches were three feet or greater below the existing railroad elevation or the impacts of an overpass structure were too substantial to overcome, a roadway underpass was recommended. In either case, overpass or underpass, if the impacts could not be resolved with an engineered solution, i.e., historical buildings were impacted, or access to a number of residences or business would be eliminated or impacted, the existing at-grade crossing was noted as infeasible or impractical to grade separate.

Photo 4-2. Typical crossing for proposed overpass

In the case of the railroad corridor being an eligible historic property, the alignment of the railway would be perpetuated as would its historic/current function and there would not be diminution in the service provided by the line as a result of the project. A segment of the line, however, would be altered to accommodate the grade separation project, so there would be an effect to the resource, albeit a minor one. The Montana State Historic Preservation Office on other similar projects has noted no significant impact to the railroad corridor and it is anticipated a similar approach would occur with crossings in this study.

4.2.4 Conceptual Designs and Cost Estimates

For each crossing an exhibit was prepared noting the most feasible method of grade separation, either over or under the railroad tracks, based on the results of the field observations. The scaled exhibits developed for each location show conceptual grading, roadway layout, road network impacts and right-of-way needs as well as track configuration. Where utility and irrigation impacts are known, they are indicated. The aerial image background presented in the exhibits represents 2014 conditions (or 2015 if information was available).

Order of magnitude conceptual estimates of probable project construction costs were developed for the feasible options. Conceptual earthwork, roadway bridge and roadway feature quantities were calculated based on the preliminary site and roadway layouts. Anticipated utility and approximate right-of-way impacts were included within the cost estimates based on potential impacts noted during site visits. Track and railroad bridge costs were calculated based on railroad industry typical unit costs per track foot. The unit costs utilized are documented in Appendix B.

4.3 Design Criteria

The MDT *Road Design Manual* was used for the roadway design standards for the proposed grade separations. Current MDT roadway standards were applied for the roadway features and modified for some roadway classifications to meet the general standards listed below. The BNSF/UPRR *Guidelines for Railroad Grade Separation Projects, April 2007*, adopted by MRL as a standard, was used for the railroad standards for grade separations. The following general standards were utilized:

- Minimum vertical clearance from railroad track to low chord of a highway overpass bridge of 23 feet and 4 inches, extending 25 feet each side of the existing or future track(s).
- Minimum horizontal clearance from center of existing or future tracks to any overhead bridge substructure of 25 feet.
- Additional horizontal clearance to include one additional track, if single track railroad, at 20-foot centers to be included.
- Minimum vertical clearance from highway to low chord of a railroad overpass structure is 17'-0".
- Roadway travel lane width of 12 feet.
- Maximum vertical grade of 6%.
- Roadway features will meet current MDT geometric design requirements for the specific roadway classifications, with adjustments for local requirements for bicycle, pedestrian, shoulders and curb/gutter configurations.
- Pedestrian walkways will be placed at grades to meet ADA requirements where practicable.
- For railroad structures, skew angles are measured from a line 90 degrees, or normal, to the railroad track. American Railway Engineering and Maintenance-of-Way Association (AREMA) and the BNSF/UPRR Guidelines allow a maximum of 30 degree skew on steel spans and a 15 degree skew on precast concrete spans.
- Roadway crossing angles are measured per MDT standards.
- 35 miles per hour (mph) roadway design speed was assumed unless posted or known otherwise for the existing at-grade crossings.

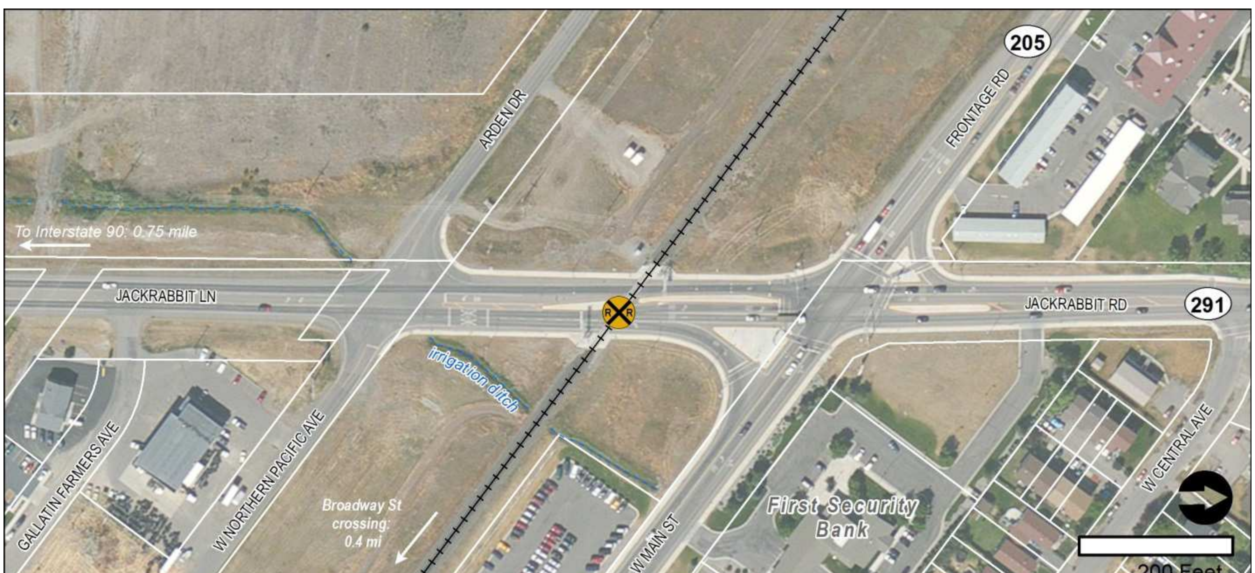
The following sections describe the 10 final at-grade locations determined feasible to grade separate. Each description presents a conceptual design of the feasible improvements, including the existing roadway and railroad conditions, adjacent land uses, conceptual engineering approach to the grade separation, potential impacts caused by the option, an order of magnitude conceptual cost estimate and results of the Benefit-Cost Analysis.

4.4 Jackrabbit Lane, Belgrade, Route N-291N, MRL MP 150.39, DOT #060090P

4.4.1 Overview

The Jackrabbit Lane at-grade railroad crossing is located within the City of Belgrade and experiences daily volumes of vehicles of over 16,400 AADT in 2014 with a projection of over 32,600 in 2034. Twenty-eight (28) railroad trains travel through this crossing daily. This crossing has the greatest number of daily vehicle volumes of all crossings analyzed in the study and traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. Figure 4-2 shows the crossing area and provides a summary of the key statistics for this crossing.

To ease congestion and increase safety, grade separating the roadway from the railroad is proposed. The proximity of the surrounding intersections makes an overpass challenging without impacting nearby businesses and access to those businesses. An overpass would require closure of existing intersections or relatively large amount of grading to maintain street network connectivity especially the intersection with Main Street (Highway 205) which is 250-feet north of the at-grade crossing. The elevation profile of Jackrabbit Lane is lower on both the north and south approaches to the existing railroad track elevation, making an underpass the most feasible solution at this location as minimal changes to the surrounding street network connectivity could be required.



DOT Crossing # 060090P
2014 AADT: *16,430*
2034 AADT: *32,690*
Trains per day: *28*
Train Speed: *50 - 60 mph*

Functional Classification: *Principle Arterial*
System Designation: *NHS Non-Interstate*
Warning Device: *Automatic Gates with Flashing Lights and Bells + Cantilevers*
MDT Adjusted Priority Index: *2,644*

Figure 4-2. Jackrabbit Lane Crossing Overview

4.4.2 Regional Context

Jackrabbit Lane is signed as Route 291 and designated as a National Highway System (NHS) Non-Interstate route on the state's highway network. Jackrabbit Lane serves as a major linkage between the City of Belgrade, Interstate 90 (I-90), Montana Highway 85 (MT-85) and the Four Corners area to the south. Figure 4-3 depicts the Jackrabbit Lane crossing in context with other railroad crossings in the vicinity.

Two other at-grade railroad crossings exist within a distance of less than one mile of Jackrabbit Lane crossing. As measured along the railroad main line, the Broadway Street and Oregon Street crossings are located approximately 0.4 mile and 0.75 miles southeast, respectively, from the Jackrabbit Lane crossing. No roadway grade separations exist within the vicinity of the Jackrabbit Lane crossing. The Broadway Street crossing was combined holistically with the Jackrabbit Lane due to the close proximity of the crossings and direct roadway connections between crossings via Main Street and W. Northern Pacific Avenue.

Figure 4-3. Belgrade Area Highway-Rail Crossings

4.4.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

In 2003, MDT conducted a statewide railroad grade separation feasibility study. Twenty individual grade crossings were evaluated in that study across Montana. The 2003 study identified the Jackrabbit Lane crossing as the sixth highest statewide crossing priority. That study identified an overpass solution as infeasible due to the physical constraints of the West Main Street and Arden Drive intersections. An underpass solution was determined to be feasible. That study's analysis also examined the Broadway Street crossing and determined a grade separation was not feasible at the Broadway Street location due to the physical constraints of nearby intersections and business impacts. Community input also supported the Jackrabbit Lane crossing location over the Broadway Street crossing for improvement.

4.4.3 Existing Crossing Features

The following sections describe the existing conditions at the Jackrabbit Lane crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 18, 2015.

4.4.3.1 EXISTING ROADWAY

Photo 4-3. Main Street looking at Jackrabbit Lane intersection

Jackrabbit Lane is functionally classified as a Principle Arterial and designated as a NHS Non-Interstate route. The 2014 AADT within the vicinity of the railroad crossing is 16,430 vehicles per day with a projected AADT in 2034 of 32,690. At the location of the at-grade crossing, Jackrabbit Lane is a 3-lane roadway (two lanes in each direction and a northbound right-turn lane) with additional turn lane tapers developing near the crossing for adjacent intersections. According to MDT data, the existing paved surface width is 71 feet. A raised median exists between the northbound and southbound lanes with the railroad passing through a break in the median. The intersection with Main Street extends into the crossing limits with northbound turn lanes extending into current at-grade crossing limits. Roadway shoulders for the northbound lane are approximately 6 feet wide and approximately 8 feet wide for the southbound lane. Sidewalks exist on both sides of the crossing and are approximately 6 feet wide.

Photo 4-4. South approach to Jackrabbit Lane at-grade crossing

Existing traffic control along Jackrabbit Lane within the vicinity of the crossing includes a signal at the intersection with Main Street. The intersections of Gallatin Farmers Avenue, W. Northern Pacific Avenue/Arden Drive, and W. Central Avenue are all controlled with a stop sign at their approaches to Jackrabbit Lane. Northern Pacific Avenue continues to the east and ties into Broadway Street. The posted speed limit south of the crossing is 45 mph and is reduced to 25 mph north of Main Street.

4.4.3.2 EXISTING RAILROAD FEATURES

A single track, Main Track, crosses Jackrabbit Lane which is a major east-west national freight train link. The railroad crossing experiences 28 trains daily. The Main Track speed at this location is between 50 – 60 mph. The tracks cross Jackrabbit Lane at an approximate 52 degree skew angle. The current at-grade crossing has gates, flashing signals on cantilever supports and bells for vehicle protection. The Main Track crossing uses precast concrete panels.

4.4.3.3 EXISTING NON-MOTORIZED FEATURES

As stated previously, sidewalks approximately 6 feet wide exist on both sides of the roadway through the crossing. Shoulder widths varying from 6 – 8 feet are adequate to accommodate bicycles but are currently not striped as dedicated bike lanes.

4.4.3.4 UTILITIES

Photo 4-5. Irrigation ditch west of Jackrabbit Lane

Existing underground utilities, which are known based on filed visits or other sources, include fiber optic, natural gas, power and an irrigation crossing (Photo 4-5). An overhead power line parallels the railroad alignment west of the at-grade crossing and a second power line is west of Jackrabbit Lane and crosses the tracks. The irrigation ditch crosses under Jackrabbit Lane at the intersection with W. Northern Pacific Avenue/Arden Drive from the southwest quadrant to the northeast quadrant. The irrigation ditch continues to the northeast and crosses under the railroad east of the Jackrabbit Lane at-grade crossing. The irrigation ditch then enters a closed system before crossing Main Street to extend farther north. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.4.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Jackrabbit Lane crossing consists of an easement across railroad property which appears to be a total width of approximately 100 feet. MRL/BNSF right-of-way varies in the vicinity of the crossing extending between approximately 175-feet and 180 feet from centerline of main track to the north and 200 feet south of the centerline of north main track. Existing land uses within the immediate vicinity of the crossing consist primarily of commercial and light industrial uses.

4.4.4.1 EXISTING BUSINESSES

Limited development exists within the immediate four quadrants of the crossing. To the east of the crossing on north side of the tracks abutting Main Street is Ressler of Belgrade, an automobile dealership. First Security Bank is located north of Main Street along the east side of Jackrabbit Lane. Whalen Tire and Belgrade Auto Lube are located immediately east of Jackrabbit Lane off of Gallatin Farmers Avenue. Additional businesses are located along Gallatin Farmers Avenue. Northern Pacific Avenue provides a secondary access to businesses along Gallatin Farmers Avenue.

4.4.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned properties for public recreation exist within the crossing vicinity. No historic buildings were identified within the immediate vicinity of crossing. Per the 2008 Environmental Assessment prepared for the I-90 East Belgrade Interchange project, the Northern Pacific Railroad Main Line was identified as a historic feature and eligible for listing in the NHRP but no significant impacts were found from the proposed grade separation project. The irrigation ditch is also a historic feature which could be eligible for listing in the NHRP but its current undercrossing of Jackrabbit Lane may not contribute to the historical status and modifications may not be a significant impact. The irrigation ditch is a potential historic feature and could be eligible for listing in the NRHP although the canal's culvert under Jackrabbit Lane may not contribute to the corridor's historic status or modifications to the canals undercrossing of Jackrabbit Lane may not impact the eligibility of the canal.

4.4.4.3 RESIDENTIAL

Residential areas exist north of the crossing and north of Main Street. An apartment complex exists at the northwest corner of Jackrabbit Lane and Main Street/I-90 Frontage Road. A neighborhood exists to the northeast of the crossing and is accessed via W. Central Avenue. No residential areas exist south of the crossing along Jackrabbit Lane.

4.4.5 Proposed Solution

The proposed crossing solution at this location is an underpass with Jackrabbit Lane traversing underneath the railroad.

An underpass versus overpass option was analyzed as part of the field visit and conceptual design process. An overpass solution would impact nearby businesses and would make access to Main Street from Jackrabbit Lane as well as businesses along Jackrabbit Lane and Main Street infeasible due to the grade raise required for an overpass. The existing vertical grade of Jackrabbit Lane is lower than the railroad grade on the north and south side of the railroad embankment, making an underpass favorable at this location. Refer to Figure 4-4 for the proposed conceptual plan and profile for the underpass.

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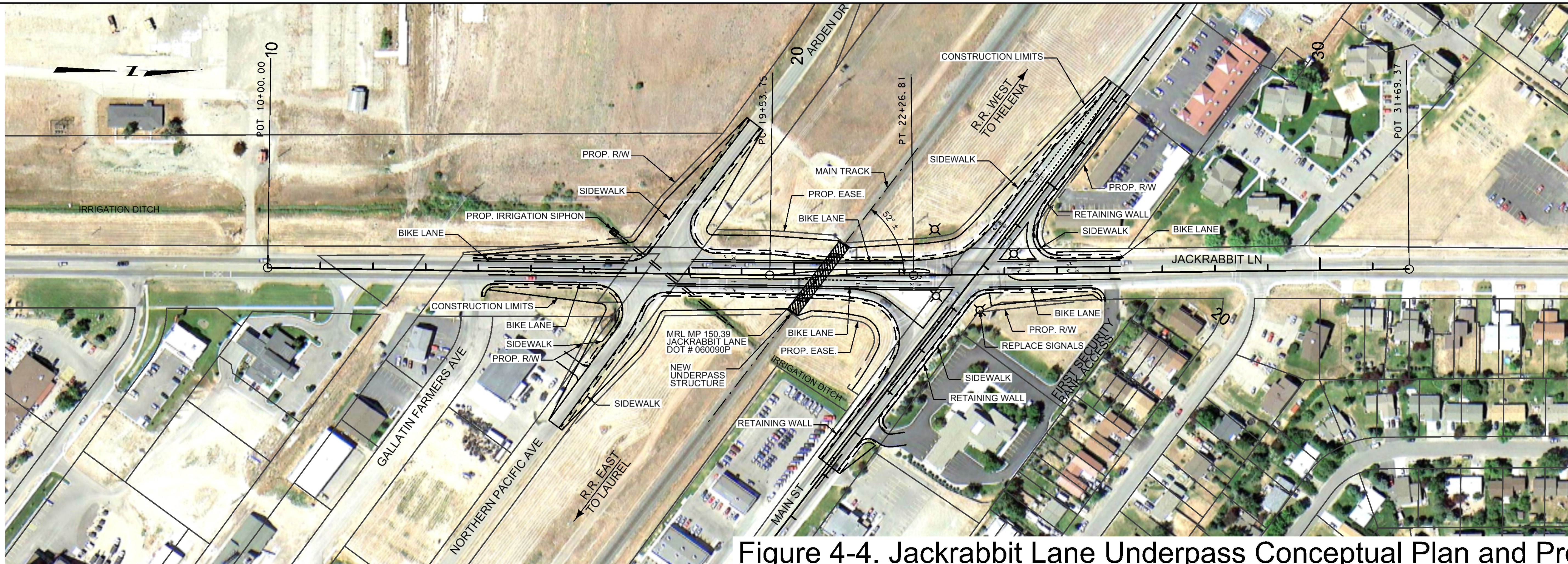
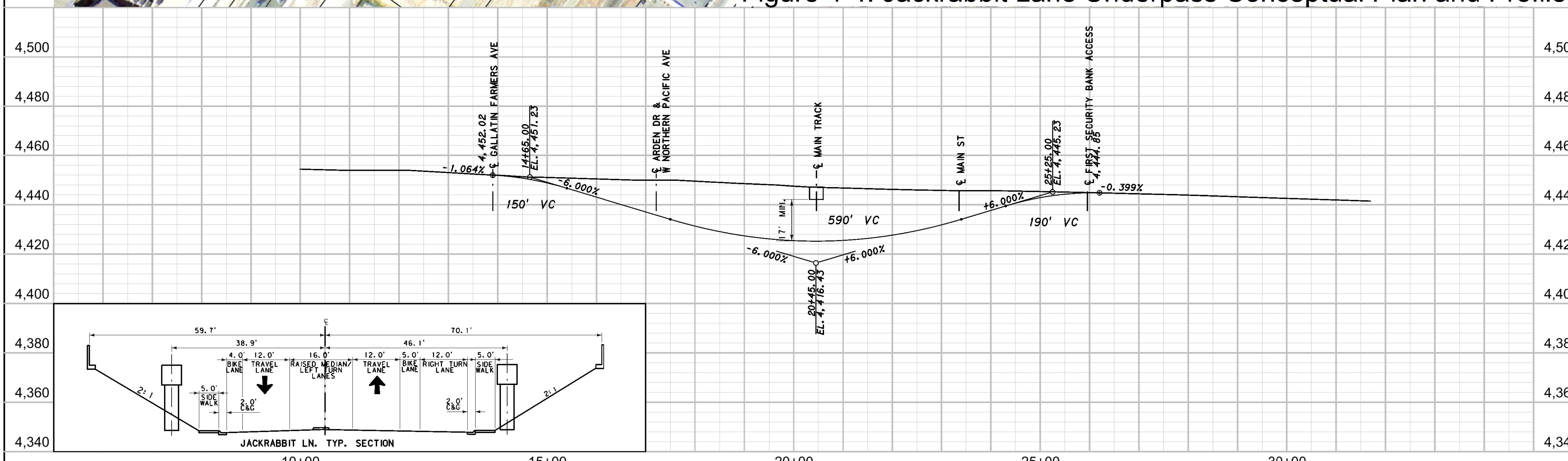


Figure 4-4. Jackrabbit Lane Underpass Conceptual Plan and Profile



MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\RD\RDPLPZ03_Jackrabbit_Ln.dgn 1/25/2016 12:40:35 PM tericksо	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS / GALLATIN COUNTY	PRELIMINARY	MONTANA RAIL GRADE SEPARATION STUDY / N/A / SCALE 1"=200'	BELGRADE, MT / SHEET X OF X

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4.4.5.1 PROPOSED ROADWAY FEATURES

The two intersections of Northern Pacific Avenue/Arden Drive and Main Street are located within the proposed Jackrabbit Lane underpass limits. The Main Street intersection is signalized and would require street lighting and traffic signal replacement as part of the intersection reconstruction. The proposed underpass would require both the Main Street and Northern Pacific Avenue intersections be reconstructed to match the new Jackrabbit Lane roadway profile.

The proposed roadway underpass would match the existing Jackrabbit Lane typical section and provide one through travel lane in each direction, a raised median, new curb and gutter and 5-foot sidewalks. A center turn lane will be maintained at the intersection with Northern Pacific Avenue and northbound left- and right-turn lanes will be introduced at the south approach to Main Street. The horizontal alignment of both Jackrabbit Lane and Main Street would perpetuate the existing conditions and the proposed vertical profile would utilize 6 percent maximum grades. Vertical curvature would meet 35 mph design speed criteria. A future traffic study would be required and could identify the need for additional lanes on Jackrabbit Lane.

Local business access would need to be maintained with the addition of an underpass. The First Security Bank access north of the Main Street intersection marks the northern limits of the underpass improvements and would only require minimum improvements. Retaining walls would be required along Main Street east and west of Jackrabbit in order to minimize impacts on the car dealership in the southeast quadrant and the apartment building on the northwest corner. The first driveway west of the intersection would need to be closed due to the grade differential between the apartment buildings and the Main Street reconstruction. The second driveway to the east would be maintained and provide primary access to the apartment complex.

4.4.5.2 PROPOSED RAILROAD FEATURES

The railroad bridge, due to its crossing skew of approximately 38 degrees, would consist of a ballast deck 198-foot single track, steel three-span bridge. The approach spans could be wide flange beam spans or through plate girder spans with one end square at the abutments and the other end matching the maximum 30 degree skew allowed for railroad bridges. The center span would be a steel through plate girder span approximately 100 feet long, skewed at both ends. The central railroad span and supporting piers would be built at the allowable 30 degree skew with the steel approach spans square to the track at the abutments. The substructure could consist of concrete spill through abutments and cast-in-place concrete wall or drilled shaft column piers. The sloped abutment design is less expensive than a single span with concrete wall style abutments and provides a more open crossing reducing the opportunity to trap snow.

4.4.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would match current conditions along Jackrabbit Lane and include 5-foot sidewalks on both sides of the roadway. The roadway profile exceeds the maximum grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk.

4.4.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

By increasing maximum vertical grades to 6 percent and utilizing retaining walls, impacts on adjacent businesses would be minimized. Additional right-of-way appears to be necessary for the underpass construction, which includes easement within MRL property and proposed right-of-way as fee from private property owners. A total of approximately 6,300 $ft.^2$ is estimated for right-of-way acquisition, at $\$20/ft.^2$ (2015$), which is market value for commercial properties for this area of Belgrade per local analysis of publically available information.

4.4.5.5 UTILITIES

Existing underground and overhead utilities could require relocation or adjustment within the limits of construction for the underpass. Existing utilities were identified based on field visits or other sources and include fiber optic, natural gas, power and an irrigation crossing. A more extensive survey would need to be completed as part of final design using One-Call services. In order to maintain irrigation service, a syphon will likely be required at the Jackrabbit Lane underpass. A lump sum amount of $500,000 has been included in the estimate of probable cost as an allowance for utility relocations.

4.4.5.6 OTHER FEATURES

4.4.5.6.1 Emergency Vehicle Considerations

The Jackrabbit Lane crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.4.5.6.2 Drainage

It appears prevailing drainage is to the north. It is assumed the drainage from the undercrossing could be day-lighted in this direction. However, an allowance for a dewatering system is included in the conceptual order of magnitude estimate of probable project cost.

4.4.5.6.3 Retaining Walls

Retaining walls could be utilized in order to minimize impacts on private property north of the crossing. Retaining walls are proposed along Main Street on both the east and west approach to the Jackrabbit Lane intersection.

The retaining walls proposed for this crossing are tie back or pile and lagging style walls with precast or cast-in-place concrete fascia. These walls are constructed from the top down which minimizes excavation and the amount of right-of-way needed for the project. In addition, they can be designed to withstand hydraulic pressure from ground water. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.4.5.6.4 Irrigation Facilities

An existing irrigation ditch exists within the crossing vicinity. The ditch crosses under Jackrabbit Lane from west to east, south of the railroad crossing, and crosses under the railroad approximately 180 feet east of the centerline of Jackrabbit Lane. A proposed irrigation siphon would be required to perpetuate the flows in the irrigation ditch for the underpass option.

4.4.5.6.5 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates Operations and Maintenance (O&M) costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.4.6 Constructability

4.4.6.1 ROADWAY CONSTRUCTION

Due to the nature of the construction for the roadway underpass, Jackrabbit Lane and portions of Main Street would be closed during construction. The excavation required for the underpass and construction of the retaining walls along Main Street would make it difficult to maintain through access within the project limits without creating a detour road, temporary at-grade rail crossing over the shoofly track and a new intersection with Main Street. Business access would need to be maintained during construction from the north or south side of the crossing.

4.4.6.2 RAILROAD CONSTRUCTION

A single track shoofly would be required to maintain railroad operations while allowing construction of the railroad bridge on the current railway alignment. The shoofly is estimated to be approximately 1,000 feet long constructed on an average 5-foot-tall embankment to match the existing profile. The existing crossing signals and precast concrete crossing planks would be removed once train traffic was routed onto the shoofly. The track would be removed for the bridge excavation and construction. The track would be replaced once the bridge and backfill was complete and shoofly removed to allow the roadway excavation and construction to be completed. Railroad flagging would be required any time the contractor was working or had the potential to foul a zone within 25 feet of the track.

Driven H-pile with footings and columns or cast-in-place concrete drilled shafts could be used to support the caps for the railroad structure. Further geotechnical analysis will be needed to finalize the substructure design.

There appears adequate open space near the crossing for a contractor storage, equipment and lay-down area.

4.4.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

During construction, business access would be maintained while through traffic is diverted to Broadway Street east of Jackrabbit Lane. Detour signing would need to be placed to help direct traffic. Public outreach would also need to be included in order to keep the general public updated on construction status and any short-term closures.

4.4.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $17,300,000 (2015$). Table 4-2 shows the various cost components for the Jackrabbit Lane underpass option.

Table 4-2. Jackrabbit Lane Underpass Option Cost Estimate

Jackrabbit Lane Cost Components	Cost ($)
Road Work	$3,004,000
Railroad Work	$630,000
New Structure(s)	$3,366,000
Hydraulics	$300,000
Utilities	$500,000
Miscellaneous Items	$400,000
Mobilization (18%)	$1,400,000
Contingencies (25%)	$2,400,000
Preliminary Engineering (15%)	$1,800,000
Construction Engineering (15%)	$1,800,000
Right-of-Way	$126,000
IDC (10.37%)	$1,600,000
TOTAL COSTS (2015$)	**$17,300,000**

4.4.8 Benefit-Cost Analysis

A BCA was conducted for the Jackrabbit Lane grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the U.S. Department of Transportation (DOT) Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Jackrabbit Lane grade separation. Refer to Appendix B for more information on the BCA.

Considering all monetized benefits and costs of the Jackrabbit Lane grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $14.51 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $1.77 million, of which the largest benefit is $1.08 million worth of travel time savings, while the total costs amount to $16.29 million. Table 4-3 and Table 4-4 provide a summary of the BCA results.

Table 4-3. Monetized Benefits by Category for Jackrabbit Lane Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$2.42	$1.67	$1.08
Improved Safety	$0.96	$0.66	$0.43
Vehicle Operating Cost Savings	$0.15	$0.10	$0.07
Reduced Environmental Costs	$0.02	$0.01	$0.01
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$3.92**	**$2.72**	**$1.77**

Table 4-4. Benefit-Cost Analysis Results for Jackrabbit Lane Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$3.92	$2.72	$1.77
Total Costs ($2015 M)	$17.54	$16.97	$16.29
Net Present Value (NPV)	-$13.62	-$14.25	-$14.51
Return on Investment (ROI)	-77.65%	-83.98%	-89.11%
Benefit-Cost Ratio (BCR)	0.22	0.16	0.11
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-10.74%	-13.34%	-16.56%

Figure 4-5 illustrates the 20 years of undiscounted benefits following construction of the Jackrabbit Lane grade separation.

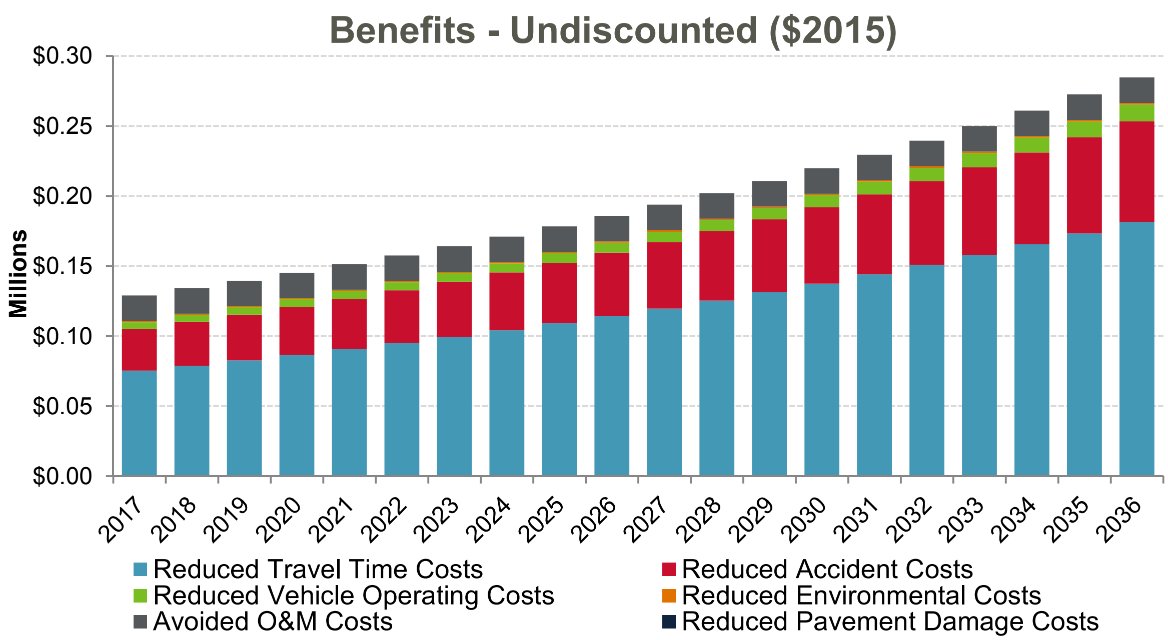


Figure 4-5. Projected Undiscounted Benefits for Jackrabbit Lane Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis—either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.4.9 Summary

The Jackrabbit Lane at-grade crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification, priority index, and average train speeds. Based on a review of existing conditions and published documents, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety.

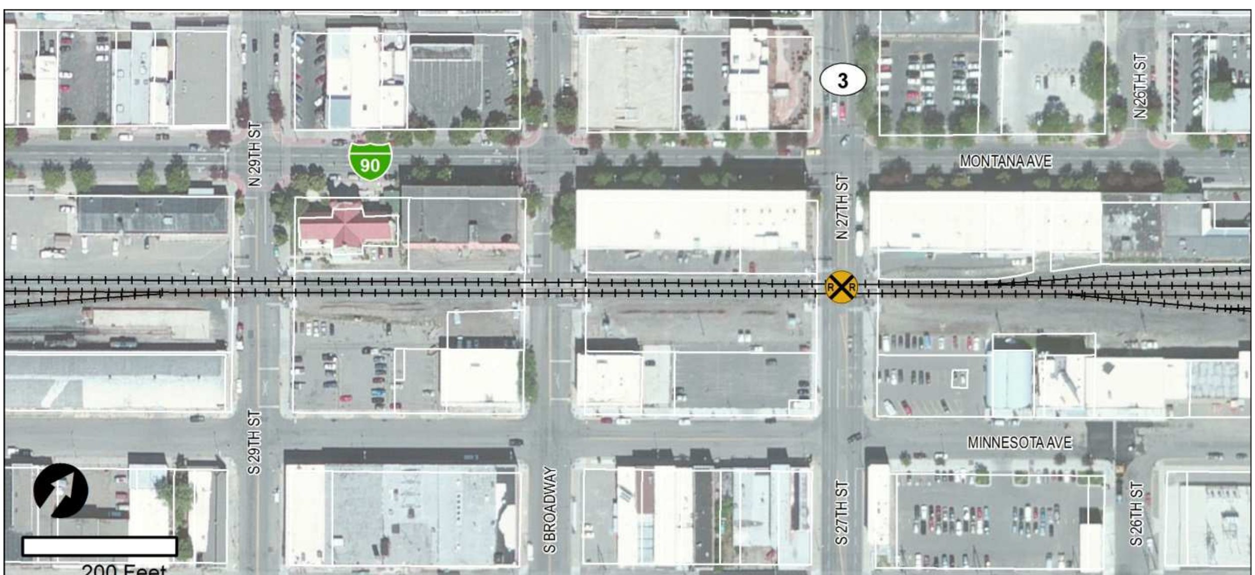
The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under National Environmental Policy Act (NEPA) and Montana Environmental Policy Act (MEPA) during project development.

4.5 27th Street, Billings, Route N-53N, MRL MP 225.76, DOT #087491T

4.5.1 Overview

The 27th Street at-grade railroad crossing is located in the heart of downtown City of Billings (City) between Minnesota Avenue and Montana Avenue. The 27th Street crossing is one of the busiest at-grade railroad crossings within the state in terms of daily vehicles and trains. The AADT on 27th Street at the location of the crossing is 13,640 vehicles with a projected AADT in 2034 of 16,643 vehicles. Thirty-eight (38) railroad trains travel through this crossing daily. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing resulting in impacts on the rest of the downtown area traffic flow. This location has been identified in multiple previous studies as a high priority for the City to find a method to reduce congestion. Figure 4-6 shows the crossing area and provides a summary of the key statistics for this crossing.

Due to the urban setting, built environment, proximity to buildings, and the relationship with the local roadway network, a full 4-lane underpass or overpass for 27th Street would present challenges in maintaining business access and on-street parking while maintaining the local traffic network and would not be practical or feasible as a solution. For these reasons, a partial underpass and a partial overpass (with the two inside travel lanes traversing grade-separated across the railroad and the two outside lanes remaining at-grade) is reviewed for consideration at this location.



DOT Crossing # 087491T
2014 AADT: *13,640*
2034 AADT: *16,643*
Trains per day: *38*
Train Speed: *5 - 10 mph*

Functional Classification: *Principle Arterial*
System Designation: *NHS Non-Interstate*
Warning Device: *Automatic Gates with Flashing Lights and Bells + Cantilevers*
MDT Adjusted Priority Index: *4,292*

Figure 4-6. 27th Street Crossing Overview

4.5.2 Regional Context

27th Street in downtown Billings is signed as Montana Highway 3 and designated as a NHS Non-Interstate route on the state's highway network. 27th Street is functionally classified as a principle arterial roadway and serves as a major linkage connecting Interstate 90 to downtown Billings, the Billings Logan International Airport and to Highway 3 above the rims.

Two other at-grade railroad crossings exist within close proximity to the 27th Street crossing. The 28th Street (Broadway) and 29th Street crossings are located to the west of 27th Street. Four existing grade-separated crossings are located within the vicinity of the crossing as well. To the east, the 21st Street underpass and the 13th Street underpass are located approximately a half mile and 1 mile, respectively, from the 27th Street crossing. Approximately 1.5 miles to the west, the Access Street underpass and Laurel Road overpass provide a grade separation of the railroad. The Billings Railroad Yard is located between 29th Street and the Laurel Road Overpass. Figure 4-7 depicts the 27th Street crossing in context with other railroad crossings in the vicinity.

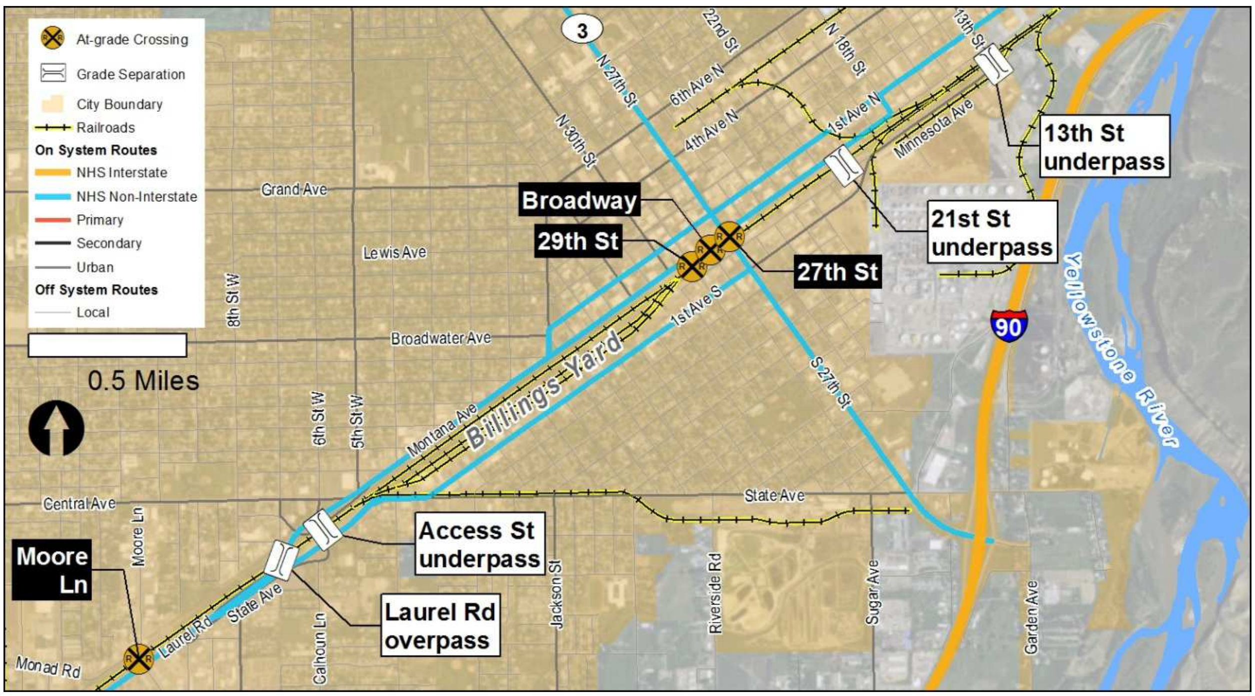


Figure 4-7. Billings Area Highway-Rail Crossings

Due to their proximity to the 27th Street crossing, the 28th Street (Broadway) and 29th Street at-grade crossings and the 21st Street grade separation was combined holistically in the feasibility analysis with 27th Street.

4.5.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The at-grade railroad crossings in downtown Billings have been the subject of multiple previous studies dating back to 1958. Previous studies have examined the gamut of potential improvement options, including overpass versus underpass options as well as relocating the railroad south of downtown.

In 2003 the City of Billings commissioned a feasibility study to examine grade separation opportunities in the downtown Billings area. Following a ranking evaluation, the study determined a long-term solution that included raising the railroad and constructing an underpass was most feasible. Additionally, the study looked at short-term improvements that included traffic signal upgrades, quiet zones, and railroad switch modifications.

In 2003 MDT conducted a statewide railroad grade separation feasibility study. Twenty individual grade crossings were evaluated in the study across Montana. That study identified the 27th Street crossing as the third highest statewide crossing priority. Given the physical constraints of the existing cross streets, that study concluded a partial underpass option with the center two lanes grade-separated from the railroad was the most feasible option.

The 2014 *Billings Urban Area Long Range Transportation Plan* was reviewed with respect to improvement recommendations and committed project located on 27th Street. The plan highlights several projects occurring within the 27th Street corridor, which include:

- 27th Street – 1st Avenue S to Airport Road. This project is a pavement preservation project including replacing traffic signals, luminaires and ADA upgrades. The project is programmed in MDT's Tentative Construction Plan and is currently in the design phase. Another project aspect is including an additional advanced warning railroad crossing sign/beacon north of the railroad tracks for downtown Billings.
- 27th Street – State Avenue to Poly Drive. This project is a recommended congestion management project including updating the signal timing for 11 signals within the 27th Street corridor.

4.5.3 Existing Crossing Features

The following sections describe the existing conditions at the 27th Street crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 11, 2015.

4.5.3.1 EXISTING ROADWAY

27th Street is a principle arterial roadway designated as a NHS Non-Interstate (Montana Highway 3). The 2014 AADT within the vicinity of railroad crossing is 14,260. At the location of the current at-grade crossing, 27th Street is a 4-lane roadway approximately 66 feet wide including a striped center median which develops turn lanes on either side of the railroad crossing. Existing traffic control along 27th Street within the vicinity of the crossing includes signals at 1st Avenue South and Montana Avenue. The intersection of 27th Street and Minnesota Avenue is controlled by a stop sign on the Minnesota Avenue approaches. Sidewalks exist on both sides of the roadway including automatic pedestrian railroad crossing gates. On-street parking is not provided along 27th Street. The posted speed limit is 25 mph within the vicinity of the crossing. Overhead crossing occupied flashing warning signs are located on 27th Street approximately 1100 feet north and south of the at-grade crossing.

The 2014 LRTP identifies 27th Street operating at a roadway segment LOS D throughout the downtown area.

4.5.3.2 EXISTING RAILROAD FEATURES

Two mainline tracks cross 27th Street. These are part of a major east-west national freight train link across southern Montana. Thirty-eight (38) railroad trains travel through this site daily, which includes 32 through freight trains and six switching trains. The main track speed for the crossing is 25 mph with the trains switching in the Billings yard operating at 10 mph or less. While the DOT and MDT's database shows the speed as 10 mph, observation of trains at the crossing shows the usage of the railroad's timetable allowable speed of 25 mph for through freight trains. The tracks cross 27th Street making a perpendicular (90 degree) crossing. The current at-grade crossing has crossing gates, flashing signals on cantilever arms and bells for vehicle protection and separate crossing gates for pedestrians. The crossing is signaled and protected to allow for "whistle free" railroad operations. The two main tracks use precast concrete crossing panels for the roadway crossing material at the tracks. The crossing material is extended to allow for pedestrian use and ties in with the sidewalks to the north and south, both sides of the street.

Photo 4-6. East side of 27th Street at-grade crossing

The railroad crossing signal system is tied to the existing street intersection signals and advance warning signs. The street signal link allows for cars to be flushed out and not be trapped on the crossing when a train approaches. Existing advanced warning railroad crossing signs with flashing lights are located on 27th Street between 2nd and 3rd Avenue S, and between 2nd and 3rd Avenue N which are activated during train crossing events at the 27th Street at-grade crossing. An additional advanced railroad crossing warning sign is planned for future installation on 27th Street between 4th Avenue and 6th Avenue N as part of the proposed MDT improvements project along 27th Street from I-90 to Airport Road.

The east end of the railroad's Billings Yard is just west of the 29th Street at-grade crossing, approximately 800 feet west of 27th Street. This yard allows the dropping off of local rail freight traffic and allows for marshalling of pick-up and delivery to railroad customers in the Billings area. East of 27th Street, additional tracks exist which provide staging tracks for Billing's area rail-based customers as well as providing for access to additional railroad tracks that run from the main freight corridor into other industrial and commercial areas in Billings.

4.5.3.3 EXISTING NON-MOTORIZED FEATURES

Sidewalks exist on both sides of 27th Street north and south of the railroad crossing, including automatic pedestrian gates. The main track uses precast concrete panels that extend beyond the roadway providing a sidewalk surface for pedestrians. The roadway does not have dedicated bicycle facilities.

4.5.3.4 UTILITIES

Existing utilities, which are known based on field visits or other sources, include overhead power, fiber optic, high pressure natural gas, gas service lines, sanitary sewer, water and telecommunications. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.5.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the 27th Street crossing consists of an easement across railroad property and appears to be a total width of approximately 80 feet. MRL/BNSF right-of-way extends north of the Westbound Main Track (north track) approximately 120 feet and south of this track approximately 160 feet in the crossing vicinity and includes multiple structures and parking areas, either owned or leased by other companies, along Montana and Minnesota avenues. The existing land uses within the immediate vicinity of the 27th Street crossing are primarily commercial. There is approximately 70 to 90 feet of open space on which the tracks are roughly centered.

4.5.4.1 EXISTING BUSINESSES

Commercial buildings exist on both sides of 27th Street north of the railroad crossing. The St. Vincent du Paul Thrift Store is located on the northeast corner and Anytime Fitness on the northwest corner. The southeast and southwest corners of the railroad crossing intersection have paved surface parking lots.

Within the vicinity of the underpass/overpass extents, the existing land use is mainly commercial with local hotels, restaurants and parking structures.

4.5.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

The Downtown Skate Park is a skateboard recreation facility located approximately 400 feet south of the 27th Street crossing on the northeast corner of 27th Street and 1st Avenue and is a known Section 6(f) resource site. No other public recreation sites are located within the vicinity of the 27th, 28th Street (Broadway) or 29th Street crossings.

Photo 4-7. Original Billings Parmly Library

The original Billings Public Library, now used as a visitor's information center, is located adjacent to the 29th Street crossing and is just north of the tracks (Photo 4-7). This building is a registered historic landmark. The Billings Old Town District and Billings Townsite District are also recognized on the NRHP. These districts extend north and south of the crossing tracks in the crossing area. The railroad corridor is also historic and eligible for listing in the NRHP although elements of the at-grade crossings may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

4.5.4.3 RESIDENTIAL

No known residences front 27th Street within the vicinity of the railroad crossing. No known residences are located within a one-block radius of either the 28th (Broadway) or 29th Street crossings. There are several major hotels within a two block radius of the crossing as well as homeless shelters.

4.5.5 Proposed Solution Options

This is a very complex crossing due to its downtown, central urban district location, amount of traffic and need for connectivity with the roadway network to maintain traffic patterns and reduce impacts on the businesses in the project area. In addition, the available railroad right-of-way free of obstructions constricts opportunities for track shoofly locations during construction. Accordingly, two options using only two lanes going over or under the railroad tracks are seen as potential grade separation solutions. While not completely closing the 27th Street at-grade crossing, they allow for traffic that is not originating or stopping in the downtown area to pass through with minimal delay from trains. Local traffic and access to the businesses is maintained with minimal impact although there will still be delays by trains at the at-grade crossings.

In both options, closure of the 28th Street (Broadway) at-grade crossing could be identified as a traffic safety improvement allowed by the partial grade separation of 27th Street and could be a safety benefit from the railroad standpoint. Closure of 28th (Broadway) Street could initiate the cost support by the railroad as noted in the Federal Regulations. This closure is seen as having minimal impact on traffic in the downtown area and is justified by the reduced congestion from allowing the through traffic to pass at 27th Street. The 29th Street at-grade crossing would remain open to provide another crossing of the railroad tracks to access the downtown region to the west of 27th Street. Traffic patterns observed seemed to indicate closure of 28th Street (Broadway) and maintaining 29th Street at-grade crossings would be the most practical solution along with partial grade separation of 27th Street.

Improvements to the existing grade separations at 21st Street and 13th Street could provide some congestion relief to 27th Street and avoid delays for some users for train crossing events, especially during construction of a partial grade separation at 27th Street. Improvement options for 21st Street and 13th Street underpasses are described in further detail in Section 5.2 as they are considered improvement options for the prioritized grade-separated crossings and could be considered for short-term improvement options benefiting operations at the 27th Street at-grade crossing.

Figures 4-8 and 4-9 present the details of the proposed conceptual plan and profile for the partial underpass and partial overpass improvement options. Further description of these concepts is provided in the following sections.

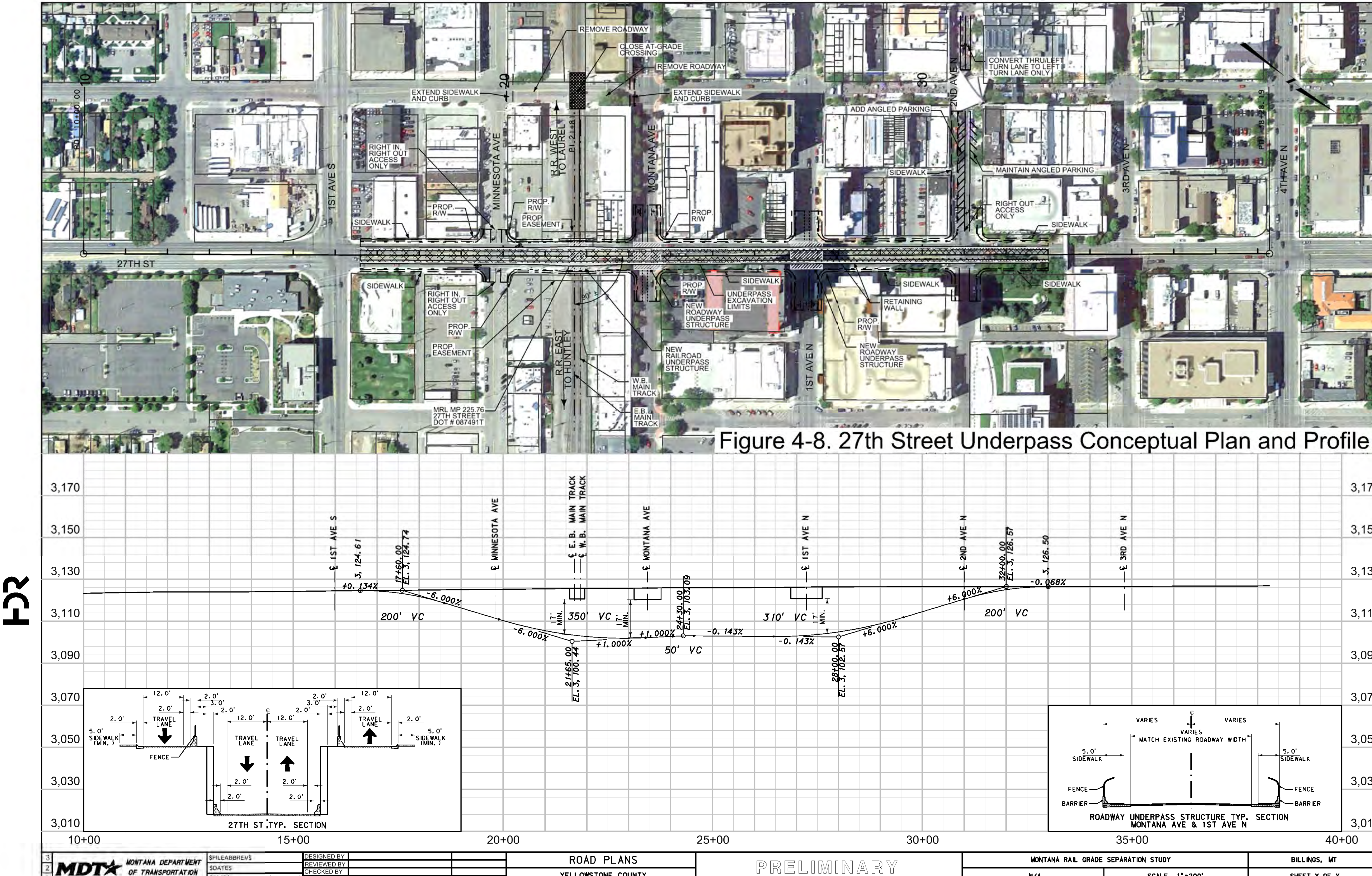


Figure 4-8. 27th Street Underpass Conceptual Plan and Profile

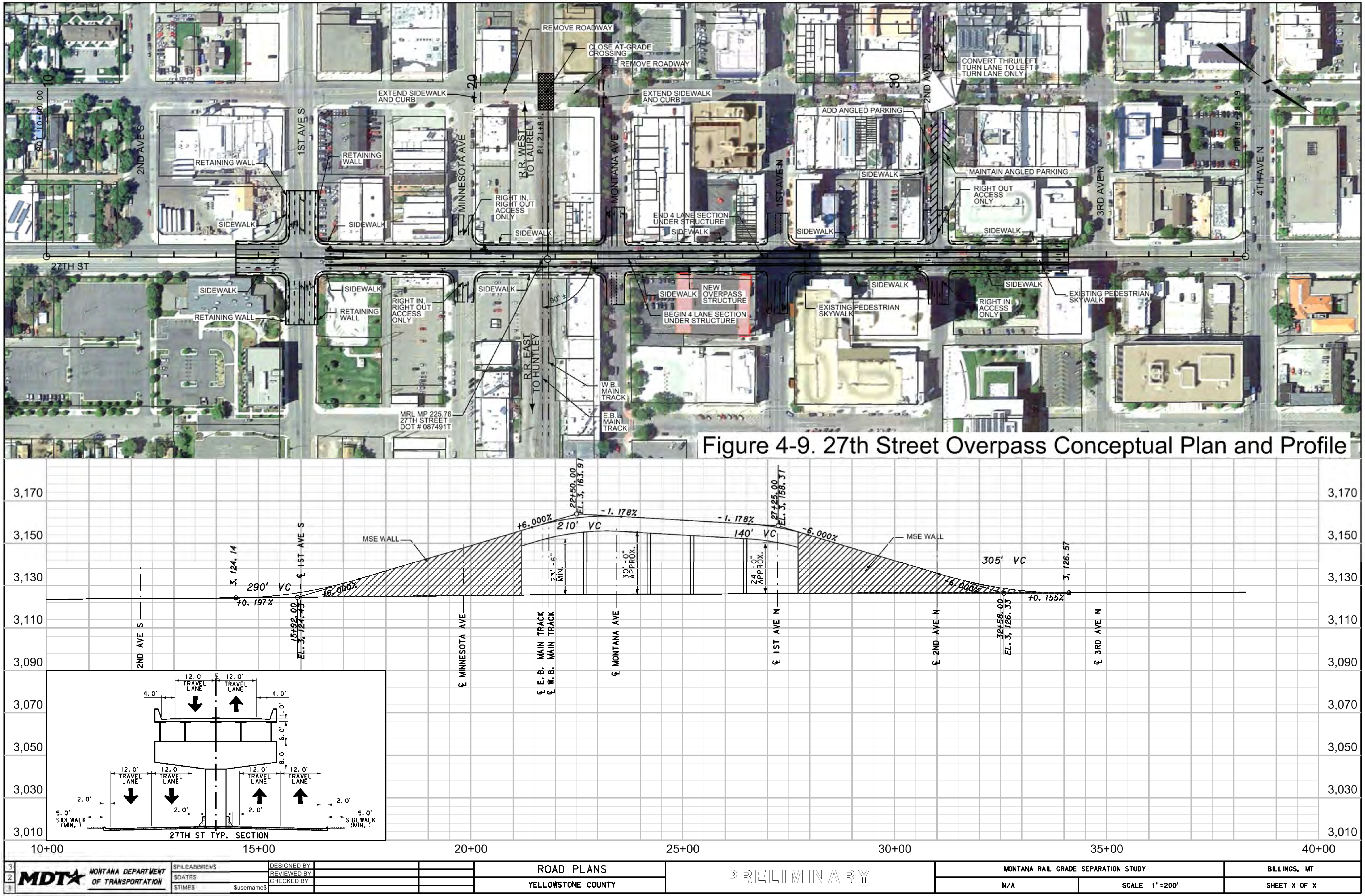


Figure 4-9. 27th Street Overpass Conceptual Plan and Profile

4.5.5.1 ROADWAY FEATURES – UNDERPASS OPTION

The partial underpass option could consist of one travel lane in each direction, concrete barrier and retaining walls crossing under the railroad tracks. The at-grade crossing could be maintained with one travel lane in each direction, new curb and gutter and 5-foot (minimum) sidewalks located outside of the underpass limits. Refer to Figure 4-8 for the proposed typical section of a 27th Street partial underpass. The horizontal alignment of 27th Street and all intersecting streets could be maintained to match existing. The proposed vertical profile for the underpass section of 27th Street would utilize 6 percent maximum grades to meet current MDT standards and provide safe traversable grades for all motorized users. Vertical curvature would meet 35 mph design speed criteria due to roadway classification and traffic volumes typical to this corridor.

As previously mentioned, this section of 27th Street is located in downtown Billings where intersections are tightly spaced. A total of four intersections will be impacted with the construction of the partial underpass: Minnesota Avenue, Montana Avenue, 1st Avenue N, and 2nd Avenue N. Montana Avenue and 1st Avenue N are principle arterials and a critical one-way couplet for the mobility of downtown traffic, therefore access to and across 27th Street needs to be maintained. The intersections with Montana Avenue and 1st Avenue N would require a new roadway bridge to overpass the depressed section of 27th Street. These structures would need to maintain a minimum vertical clearance of 17.0 feet. The intersection with Minnesota Avenue would be limited to right-in, right-out access only and would include minor intersection improvements for access to the lanes remaining at-grade on 27th Street. The proposed profile of 27th Street would begin climbing back up to meet the existing grade after the 1st Avenue N intersection clearance has been met. The intersection with 2nd Avenue N would be modified to a right-in, right-out access only for the appropriate one-way legs of the street access and would include minor intersection, striping and parking modifications to accommodate access to the lanes remaining at-grade on 27th Street.

4.5.5.2 RAILROAD FEATURES – UNDERPASS OPTION

The railroad bridge could consist of 45-foot double track precast concrete double cell box girder spans with walkways cast integral to the spans supported on cast-in-place concrete wall style abutments. Exterior girders on each span would have a steel crash protection angle installed. Use of a fascia beam for crash protection, which would also act as a railroad access walkway, could be explored if the project progresses into design and an agreement reached with the railroad. Steel wide flange beams could also be used although the railroad bridge cost would be approximately 40 percent higher than the precast, prestressed concrete beams. It is anticipated the minimum vertical clearance from the roadway to the low chord of the bridge would be 17 feet.

4.5.5.3 NON-MOTORIZED FEATURES – UNDERPASS OPTION

The proposed roadway typical section under the railroad would not include dedicated non-motorized features, as the sidewalk would be perpetuated to cross at-grade with the railroad. The sidewalk would be reconstructed, including the pedestrian ramps at intersections, and would be designed to meet ADA and Public Right-of-Way Accessibility Guidelines, or

PROWAG, design criteria. A separate bike lane is not included in the proposed roadway typical section, which matches the current configuration of the roadway lanes and uses.

4.5.5.4 LAND USE AND RIGHT-OF-WAY ISSUES – UNDERPASS OPTION

The underpass option would require a small amount of additional right-of-way at the location of the underpass to accommodate sidewalks and intersection improvements at Minnesota, Montana, and 1st avenues. A total of approximately 5,000 square feet is estimated for right-of-way acquisition in fee, at $20 per square foot (2015$), which appears to be market value for commercial properties for this area of Billings per research of available local information. An easement within railroad property would also be required as shown on the exhibit.

4.5.5.5 OTHER FEATURES – UNDERPASS OPTION

4.5.5.5.1 Emergency Vehicle Considerations

The 27th Street crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.5.5.5.2 Drainage

A series of storm drains need to be constructed to capture storm and snow melt carrying the water to a central pump station possibly located near the existing railroad crossing. This pump structure could house pumps, open surge tanks and a grit separator, be accessible for maintenance and have automatic monitoring and controls with linkage to the City's emergency management for monitoring. The drainage water could be pumped into the City's storm drain system.

4.5.5.5.3 Groundwater

According to the Montana Bureau of Mines and Geology (MBMG), groundwater monitoring wells exist in the near vicinity of the 27th Street at-grade crossing. Wells within the area indicate static water levels around 14.5 feet to 15.5 feet below existing ground line.

The underpass option will need to incorporate the use of a structural concrete seal to allow construction of the underpass. This seal is placed as construction of the roadway excavation and placement of the retaining walls proceeds. The anticipated length of the concrete seal is approximately 970 feet, with an average thickness of 2 feet. The seal is assumed to be structural as it may also act as a strut depending on final design of the retaining walls.

4.5.5.5.4 Retaining Walls

The retaining walls proposed for the underpass option could include tie back or pile and lagging style walls with precast or cast-in-place concrete fascia. These walls are constructed from the top down which minimizes excavation and the amount of right-of-way needed for the project. In addition, they can be designed to withstand hydraulic pressure from groundwater. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.5.5.5.5 Maintenance

Due to the vertical grades associated with an underpass, maintaining through access for traffic during winter weather could be challenging. Front end loaders would need to be utilized when removing snow from underpass in order to clear the roadway as the proposed typical section does not accommodate snow storage. Another option would be to incorporate a heated roadway within the underpass limits to help keep this stretch of 27th Street free of snow and/or ice. There could also be costs associated with the drainage and storm water pumping system.

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.5.5.6 ROADWAY CONSTRUCTION – UNDERPASS OPTION

Due to the nature of the construction for the partial underpass option, 27th Street would be closed during construction. The excavation required for the underpass and construction of tie-back retaining walls would make it difficult to maintain through access within the project limits. Business access would need to be maintained during construction by utilizing the adjacent street network and streets which cross 27th Street. The roadway underpass could be constructed in phases, allowing for closure of one or two block segments at a time, to reduce overall mobility impacts on the traveling public in downtown Billings.

4.5.5.7 RAILROAD CONSTRUCTION – UNDERPASS OPTION

To construct the undercrossing, both main tracks could be temporarily detoured, or shooflied, south of the existing main tracks to maintain the railroad's capacity to meet trains and operate the yard. The farthest south track, the Eastbound Main, could be placed 12 feet from the existing right-of-way fence in this area with the Westbound Main located 15 feet north and roughly parallel to the Eastbound Main. Due to the anticipated shoofly design, three temporary turnouts could be needed to maintain connectivity to the non-main line tracks just east of 27th Street. The shoofly trackage could tie into the existing main line track alignment just east of the 29th Street crossing. New temporary at-grade (whistle required) crossings would be constructed for 28th Street (Broadway). Shoring would be required between the railroad bridge construction area and the shifted tracks while the proposed railroad structure is constructed. The railroad structure can be built prior to full excavation for the roadway, thereby bringing train traffic back online within shorter construction durations. This allows the remainder of the excavation, placement of the structural seal concrete, roadway and fascia for the retaining walls to be placed without interruption of railroad traffic. It is anticipated the contractor access for the railroad bridge construction would be from the north; however, a temporary access could be coordinated with MRL to allow crossing of the

Photo 4-8. Proposed shoofly area, south of tracks, looking east

tracks from the south for construction personnel and equipment. This temporary crossing may require additional flagging support.

4.5.5.8 TRAFFIC IMPACTS DURING CONSTRUCTION – UNDERPASS OPTION

27th Street could be closed during construction of the underpass option and traffic would likely be diverted west to 28th Street (Broadway) or 29th Street and east to 13th Street or 21st Street. Detour signing would need to be placed to help direct traffic. Public outreach would also need to be included in order to keep the general public updated on construction status and any short-term closures. Lowering of the roadway to increase vertical clearance at the 21st Street underpass and reconfiguring the vertical and horizontal curvature at the 13th Street underpass could enhance use of these grade separated crossings as detour routes for traffic from a closed 27th Street during construction.

The 27th Street corridor and intersections include some of the busiest in Billings and preserving access while maintaining traffic flows will be critical during construction. Strategies to reduce traffic impacts during construction could include a complete Transportation Management Plan (TMP), possible incentive/disincentive special provisions to try to accelerate construction and exploration of innovative construction techniques. Roadway Features – Overpass Option

The partial overpass option would consist of one travel lane in each direction, concrete barrier and retaining walls crossing over the railroad tracks. The overpass option would accommodate traffic intending to travel through downtown Billings along 27th Street as access from the overpass to the downtown area would not be provided. The existing 27th Street at-grade crossing would be maintained with one travel lane in each direction. Between the railroad tracks and 1st Avenue N, two travel lanes in each direction could be maintained at-grade below the overpass due to utilizing single shaft, hammerhead piers for the overpass, which maintains all intersection turning movements, including left-turn lanes for Montana Avenue and 1st Avenue N to perpetuate the current intersection configurations. The southbound left-turn lane at the intersection with 1st Avenue S would need to be eliminated due to the touchdown location of the partial overpass, blocking the ability for merging maneuvers to make southbound to eastbound left turns at the intersection. The four lane roadway section below the overpass between the railroad and 1st Avenue N could also include raised median, with barriers protecting the bridge piers. The inside lane in each direction would accommodate through and left-turn movements, as appropriate, at the various intersections within the project limits. Between 1st Avenue S and the railroad tracks as well as between 1st Avenue N and the overpass limits, the roadway would include a single travel lane in each direction, retaining walls supporting the overpass embankment and barriers protecting the retaining walls. New sidewalks and curb and gutter would be required throughout the project limits to keep all improvements within existing right-of-way.

The proposed overpass structure would consist of concrete substructure and either concrete or steel superstructure. The maximum span for the overpass would be approximately 150 feet and the piers would be spaced to span the existing intersections so piers would not be placed in conflict with vehicular traffic below on 27th Street. A concrete deck and integrated concrete parapets would be included in the proposed overpass structure. A deck storm drain system would need to be included with the partial overpass option conveying storm water from the overpass to the existing storm drain system along 27th Street. The conceptual bridge design includes standard construction methods for the superstructure. A non-standard construction method could include beams integral with the caps, which could save on overall height of the overpass structure. The integral beams could be considered as part of future design phases. See Figure 4-8 for the typical section, plan and profile for this option.

4.5.5.9 RAILROAD FEATURES – OVERPASS OPTION

For the overpass option, the railroad features would maintain as existing with modifications to the at-grade crossing signals for protection of the at-grade lanes under the overpass structure. The railroad crossing would maintain two lanes at-grade in each direction, and also maintain the existing pedestrian railroad crossing with automatic gates and flashing lights. The minimum vertical clearance from the railroad to the low chord of the roadway structure would be 23 feet and 4 inches extending for 25 feet each side of the tracks.

4.5.5.10 NON-MOTORIZED FEATURES – OVERPASS OPTION

The proposed roadway typical section over the railroad would not include dedicated non-motorized features, and the existing sidewalk would be perpetuated at the railroad crossing beneath the overpass structure. The existing sidewalks and pedestrian ramps would need to be replaced with the overpass option to keep all improvements within the existing right-of-way. The proposed roadway typical section under the overpass structure does not include bike lanes, which perpetuates the current lane configuration of 27th Street.

The overpass option would impact the existing pedestrian skywalk just north of 1st Avenue N which connects the City of Billings parking garage on the NE corner of 27th Street and 1st Avenue N to the mixed use building on the NW corner of 27th Street and 1st Avenue N. The pedestrian skywalk between 2nd Avenue N and 3rd Avenue N, which connects the County Courthouse to City Hall, would not be impacted with the overpass option. Further public outreach would be required regarding the impacts on the pedestrian skywalk.

4.5.5.11 LAND USE AND RIGHT OF WAY ISSUES – OVERPASS OPTION

The overpass option would not require any additional right-of-way to construct the proposed improvements. With an elevated roadway right-of-way impacts are avoided. An aerial easement would be needed across MRL property.

4.5.5.12 OTHER FEATURES – OVERPASS OPTION

4.5.5.12.1 Emergency Vehicle Considerations

The 27th Street crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.5.5.12.2 Drainage

The overpass structure would have an integral storm system as part of the structure including pipe drains which could tie into the City of Billings storm drain system.

4.5.5.12.3 Retaining Walls

Retaining walls are proposed at the beginning of the roadway grade until there is a minimum of 16 feet of clearance under the proposed bridge. The retaining walls could be mechanically stabilized earth (MSE) tie back or pile and lagging style walls with precast or cast-in-place concrete fascia to contain the fill. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.5.5.12.4 Maintenance

Winter maintenance on the overpass option would include clearing snow, and utilizing the shoulders on the overpass for snow storage. If shoulders are inadequate for snow storage, front loaders, or blowers with dump trucks would need to be utilized to remove the snow from the overpass option, without pushing the snow to the traveling public utilizing the roadway below.

The maintenance cost for major design features for the overpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.5.5.13 ROADWAY CONSTRUCTION – OVERPASS OPTION

With the proposed overpass including single column piers, a single travel lane in each direction could be able to be maintained during some of the construction activities along 27th Street. The substructure could be installed with closure of the existing inside lanes along 27th Street, and partial roadway closures would be required to set the superstructure in place for the safety within the construction site. The remaining roadway features on existing 27th Street would require short term, single lane closures, which include asphalt patching, installation of concrete barriers, raised median curb, sidewalk, curb and gutter as well as signing and striping throughout the project limits.

4.5.5.14 RAILROAD CONSTRUCTION – OVERPASS OPTION

To meet railroad safety requirements, railroad flagging will be required for work occurring within 25 feet of the railroad tracks or have the potential to foul the zone within 25 feet of the railroad tracks. Brief closures for setting of spans may be coordinated with the railroad in advance of the need for the closures. Other than span setting, construction work would typically proceed with work within or potentially fouling the safety zone stopped and personnel and equipment clear just before, during and just after a train passes by.

4.5.5.15 TRAFFIC IMPACTS DURING CONSTRUCTION – OVERPASS OPTION

27th Street could have short term closures during construction of the overpass option and traffic would likely be diverted west to 28th Street (Broadway) or 29th Street and east to 13th Street or 21st Street. Detour signing would need to be placed to help direct traffic. Public outreach would also need to be included in order to keep the general public updated on construction status and any short-term closures. Lowering of the roadway to increase vertical clearance at the 21st Street underpass and reconfiguring the vertical and horizontal curvature at the 13th Street underpass could enhance use of these grade separated crossings as detour routes for traffic from a closed 27th Street during construction.

The 27th Street corridor and intersections include some of the busiest in Billings and preserving access while maintaining traffic flows will be critical during construction. Strategies to reduce traffic impacts during construction could include a complete Transportation Management Plan (TMP), possible incentive/disincentive special provisions to try to accelerate construction and exploration of innovative construction techniques.

4.5.6 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $55,000,000 (2015$) for the underpass option and $29,200,000 (2015$) for the proposed overpass option. Table 4-5 shows the various cost components for both an overpass and underpass option for the proposed 27th Street improvements.

Table 4-5. 27th Street Overpass and Underpass Option Cost Estimate

27th Street Components	Underpass Cost ($)	Overpass Cost ($)
Road Work	$14,957,000	$7,808,000
Railroad Work	$2,830,000	$48,000
New Structure(s)	$5,563,000	$4,694,000
Hydraulics	$750,000	$500,000
Utilities	$2,000,000	$750,000
Miscellaneous Items	$1,300,000	$700,000
Mobilization (18%)	$4,700,000	$2,500,000
Contingencies (25%)	$8,000,000	$4,300,000
Preliminary Engineering (15%)	$4,800,000	$2,600,000
Construction Engineering (15%)	$4,800,000	$2,600,000
Right-of-Way	$100,000	$0
IDC (10.37%)	$5,200,000	$2,700,000
TOTAL COSTS (2015$)	**$55,000,000**	**$29,200,000**

4.5.7 Benefit-Cost Analysis

A BCA was conducted for the 27th Street grade separation project to include both an underpass and overpass option. The BCA provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the 27th Street grade separation. Refer to Appendix C for more information on the BCA.

4.5.7.1 UNDERPASS RESULTS

Considering all monetized benefits and costs of the 27th Street underpass grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $36.87 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $14.65 million, of which the largest benefit is $11.92 million worth of travel time savings, while the total costs amount to $51.52 million. Table 4-6 and Table 4-7 provide a summary of the BCA results for the underpass option.

Table 4-6. Monetized Benefits by Category for 27th Street Grade Separation – Underpass Option

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$25.27	$17.86	$11.92
Improved Safety	$3.18	$2.25	$1.50
Vehicle Operating Cost Savings	$1.53	$1.08	$0.72
Reduced Environmental Costs	$0.22	$0.16	$0.15
Avoided Operations and Maintenance Costs	$0.73	$0.53	$0.36
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$30.93**	**$21.88**	**$14.65**

Table 4-7. Benefit-Cost Analysis Results for 27th Street Grade Separation – Underpass Option

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$30.93	$21.88	$14.65
Total Costs ($2015 M)	$55.24	$53.57	$51.52
Net Present Value (NPV)	-$24.31	-$31.69	-$36.87
Return on Investment (ROI)	-44.01%	-59.16%	-71.56%
Benefit-Cost Ratio (BCR)	0.56	0.41	0.28
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-4.75%	-7.52%	-10.95%

Figure 4-10 illustrates the 20 years of undiscounted benefits following construction of the 27th Street grade separation.

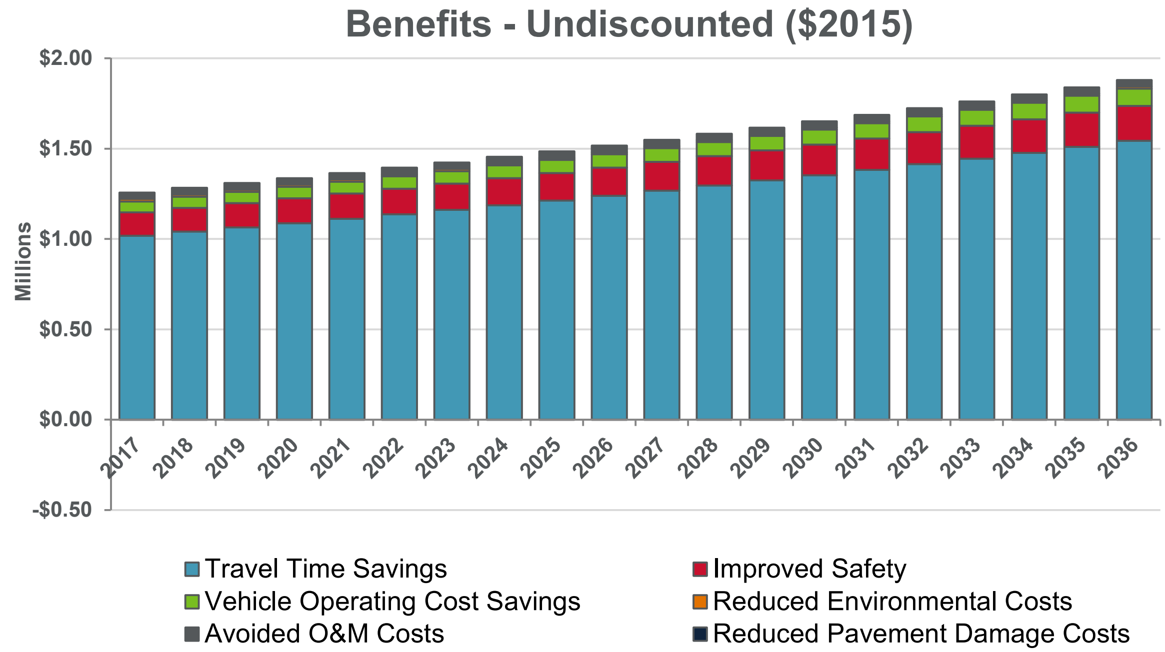


Figure 4-10. Projected Undiscounted Benefits for 27th Street Grade Separation

4.5.7.2 OVERPASS RESULTS

Considering all monetized benefits and costs of the 27th Street underpass grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $12.75 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $14.65 million, of which the largest benefit is $11.92 million worth of travel time savings, while the total costs amount to $27.40 million. The monetized benefits for the 27th Street overpass option are identical to the underpass option and are shown in Table 4-6 and Figure 4-10 above. Table 4-8 provides a summary of the BCA results for the overpass option.

Table 4-8. Benefit-Cost Analysis Results for 27th Street Grade Separation – Overpass Option

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$30.93	$21.88	$14.65
Total Costs ($2015 M)	$29.42	$28.51	$27.40
Net Present Value (NPV)	$1.51	-$6.63	-$12.75
Return on Investment (ROI)	5.13%	-23.26%	-46.52%
Benefit-Cost Ratio (BCR)	1.05	0.77	0.53
Payback Period	12.92	N/A	N/A
Internal Rate of Return (IRR)	0.45%	-2.47%	-6.09%

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build (both underpass and overpass options) and no-build scenario.

4.5.8 Summary

The 27th Street at-grade crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification and priority index. Based on a review of existing conditions, consideration of impacts on adjacent properties, and consideration of traffic operations, a partial underpass or partial overpass of the railroad were evaluated at this location.

Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with the long-range vision for the Downtown Billings corridor as documented in previous studies. The information within this section provides a planning-level assessment of potential impacts and benefits. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

4.6 Moore Lane, Billings, MRL MP 2.19, DOT #087383W

4.6.1 Overview

The Moore Lane at-grade railroad crossing is located within the City of Billings. While signed as Moore Lane, Monad Road intersects with Moore Lane immediately north of the at-grade railroad crossing. The Moore Lane at-grade railroad crossing accommodates traffic from both roads prior to intersecting with Laurel Road to the south and with Moore Lane continuing south. Moore Lane had a 2014 AADT of over 3,800 and a projected AADT over 4,700 in 2034. Traffic volumes on the adjacent intersecting roadways of Monad and Laurel roads were 7,880 and 24,310 vehicles per day, respectively, in 2014. The traffic counter on Moore Lane was located just north of the intersection with Monad Road. The traffic counter on Monad Road was located just west of the intersection with Moore Lane. The at-grade rail crossing carries traffic from both roads as it is south of the Moore Lane/Monad Road intersection. Assuming 10% of the Moore Lane/Monad Road traffic traverses directly between the two roads and does not cross the tracks, the 2014 AADT over the at-grade railroad crossing is estimated at 10,575. Based on a 1% growth rate, which was provided by MDT, the 2034 AADT at the crossing is estimated at 12,900. Thirty-two (32) railroad trains travel through this crossing daily. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. The traffic, roadway conditions and safety hazards at this crossing resulted in it being identified as a priority within the state.

To ease congestion and increase safety at this crossing, grade separating the roadway from the railroad is proposed. Due to the proximity of Laurel Road immediately to the south of the at-grade crossing and the intersection of Monad Road with Moore Lane to the north, an overpass at this location would result in impacts on the adjacent intersections and businesses. It was therefore determined an underpass solution, with Moore Lane traveling underneath the railroad, was the most feasible grade separation solution at this location. Figure 4-11 shows the crossing area and provides a summary of the key statistics for this crossing.

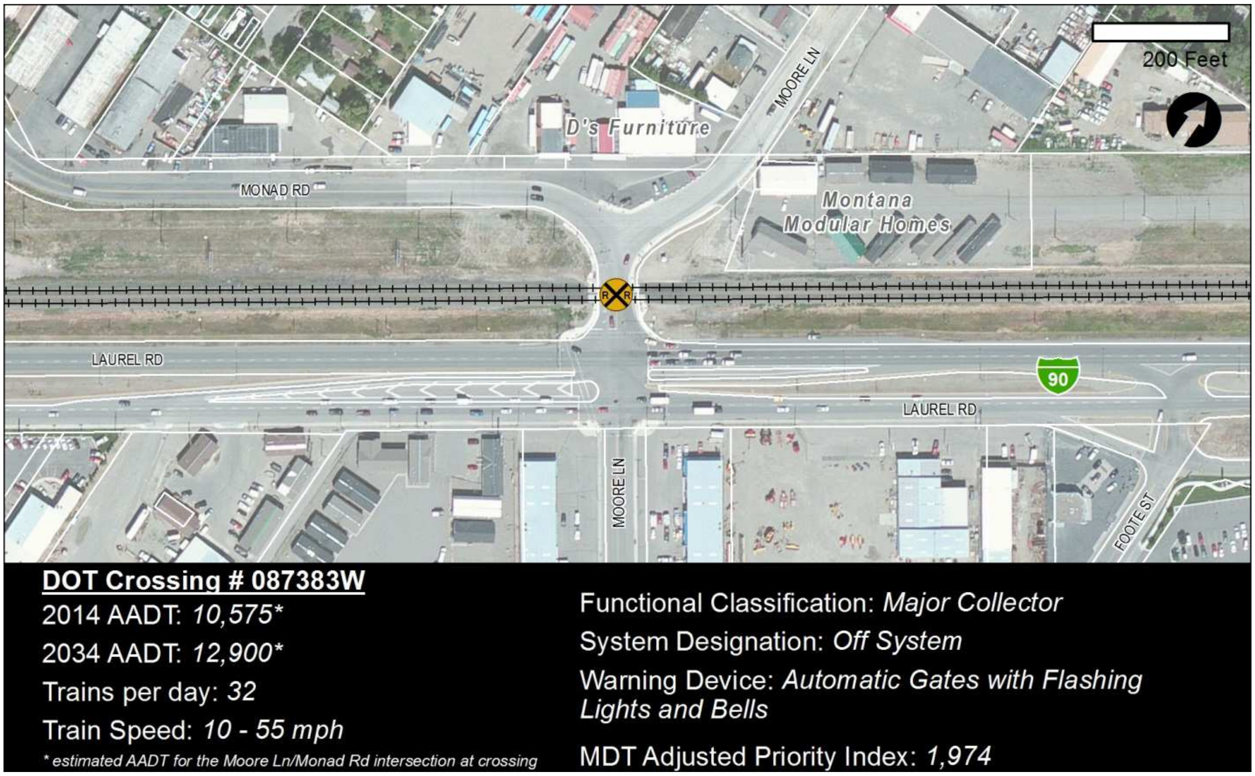


Figure 4-11. Moore Lane Crossing Overview

4.6.2 Regional Context

The Moore Lane railroad crossing is located on an off system route (i.e., not state maintained) and serves as an important north-south linkage over the railroad between densely developed parts of Billings. The Moore Lane crossing is located toward the western edge of the city and outside of the downtown area.

Two grade-separated crossings are located within an approximate one-mile radius of the Moore Lane crossing. The Laurel Road overpass and the Access Street underpass are located to the northeast approximately 0.5 mile. Mullowney Lane (at the King Avenue West/Mullowney Lane interchange) is located approximately 1.2 miles to the southwest of the Moore Lane crossing. Figure 4-12 depicts the Moore Lane crossing in context with other railroad crossings in the vicinity.

Due to the road network accessible from Monad Road and Moore Lane, compared to the Laurel Road overpass and Access Street underpass, Moore Lane was not combined from a holistic perspective with either of these crossings.

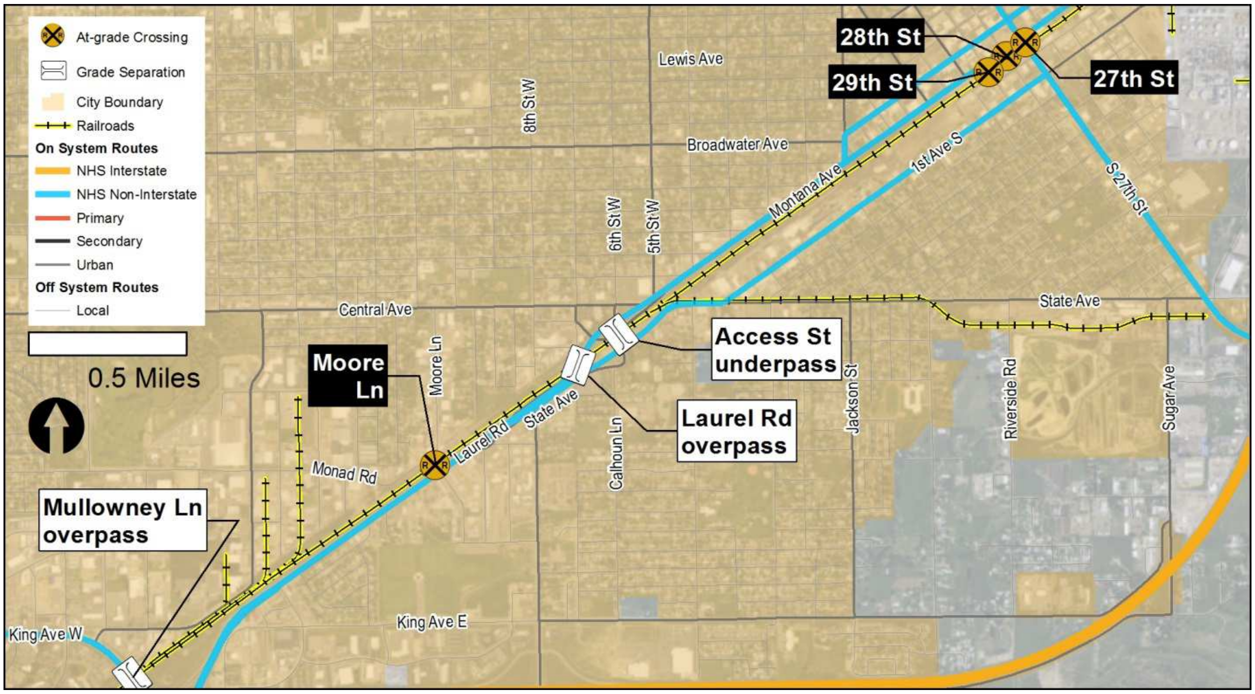


Figure 4-12. Billings Area Highway-Rail Crossings

4.6.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The at-grade railroad crossings in downtown Billings have been examined in previous studies; however, the Moore Lane crossing is removed from the downtown region and has not been as high of a priority within the context of the Billings transportation system.

In 2003, MDT conducted a statewide railroad grade separation feasibility study. Twenty individual grade crossings in thirteen communities were evaluated in the study across Montana. That study identified the Moore Lane crossing as the number one statewide crossing priority based on a needs-based evaluation. That study concluded an overpass was infeasible but an underpass was feasible. The 2003 study noted community input strongly suggested safety improvements at Moore Lane were necessary.

Moore Lane was made a minor route connection to a revised T-intersection with Monad Road north of the railroad tracks and a right angle crossing with the railroad was constructed and the at-grade crossing signals were upgraded in the 2007-2008 timeframe. Moore Lane north of the intersection with Monad Road was widened and improved in 2012.

The 2014 *Billings Urban Area Long Range Transportation Plan* (LRTP) was reviewed with respect to improvement recommendations within the vicinity of the Moore Lane crossing. The plan noted improvements were desired at the Monad Road/ Moore Lane/Laurel Road intersection based on input from the community and oversight committee. The 2014 LRTP recommends several projects occurring within the vicinity of the Moore Lane crossing, which include:

- Moore Lane & Laurel Road Pedestrian Crossing. This project includes pedestrian crossing treatment at an undetermined location.

- Moore Lane/Monad Road Bike Lane. This project includes completing bike lanes along Monad Road/Moore Lane to Central Avenue.

4.6.3 Existing Crossing Features

The following sections describe the existing conditions at the Moore Lane crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 11, 2015.

4.6.3.1 EXISTING ROADWAY

Moore Lane is functionally classified as a major collector roadway with a 2014 AADT of 3,870 and a projected 2034 AADT of 4,722. Moore Lane intersects with Monad Road north of the railroad crossing. Construction in 2007-2008 made Moore lane the "minor" connection and Monad Road traffic the main through traffic at the intersection. At the location of the current at-grade crossing, Moore Lane is a 3-lane roadway with one northbound lane, widened for turning movements and a shared through/left-turn lane and right-turn only lane in the southbound direction with a minimum width of 43 feet at the railroad crossing. The roadway has approximately 3-foot-wide shoulders. Turn lanes have been widened to allow for truck turning radii. North of the crossing, Monad Road curves and joins Moore Lane at a 3-way intersection. The major intersection of Moore Lane and Laurel Road is located less than one hundred feet south of the railroad crossing. Laurel Road is a principle arterial roadway carrying over 24,000 vehicles per day. South of the Moore Lane/Laurel Road intersection, Moore Lane veers due south and tees into Simpson Street at Amend Park.

Photo 4-9. Moore Lane intersection with Monad Road, north of tracks

Existing traffic control within the vicinity of the crossing consists of signals at the intersection north of the crossing on Monad Road and Moore Lane and the 4-way Moore Lane/Laurel Road intersection has traffic signals on all four approaches which are tied to the at-grade crossing signals and railroad train approach detection. On-street parking is available along Moore Lane south of the Laurel Road intersection. North of the crossing, Moore Lane is a 3-lane roadway with a center two-way left-turn lane and on-street parking is prohibited. The posted speed limit is 35 mph within the vicinity of the crossing.

Monad Road is functionally classified as a major collector roadway with a 2014 AADT of 7,880. The existing roadway is a 2-lane facility with unpaved shoulders. Numerous business accesses exist along Monad Road, and are generally uncontrolled access points. At the intersection with Moore Lane, curb and gutter exists along Monad Road, and a right-turn lane develops for the intersection with Laurel Road. The posted speed limit is 25 mph within the vicinity of the crossing and the intersection with Moore Lane.

The railroad embankment is approximately two feet above the Moore Lane/Monad Road intersection elevation with both roads rising up to meet the intersection. Laurel Road is approximately four feet below the railroad grade.

4.6.3.2 EXISTING RAILROAD FEATURES

Moore Lane crosses two main tracks which provide a major east-west national freight train link. The railroad crossing experiences 32 trains daily. The main track timetable speed at this location is 60 mph. The DOT database shows a speed of 55 mph. Some local Billings-Laurel switching trains may run at slower speeds. The tracks cross Moore Lane at an approximate 90 degree angle. The current at-grade crossing has gates, flashing signals and bells for vehicle protection with the crossing gates partially blocking the sidewalks when trains are crossing providing pedestrian protection. The main tracks use precast concrete crossing panels.

Photo 4-10. At-grade crossing looking west

4.6.3.3 EXISTING NON-MOTORIZED FEATURES

Sidewalks exist along Moore Lane both north and south of the crossing on both sides of the roadway. Pedestrian crosswalks exist at the north, south and west approach of the Moore Lane/Laurel Road intersection. Dedicated bike facilities do not exist along Moore Lane.

4.6.3.4 UTILITIES

Existing underground utilities which are known based on field visits or other sources were identified. It is assumed existing utilities in the vicinity of this crossing include fiber optic, underground and overhead electrical transmission lines, natural gas, water and sanitary sewer. Existing utilities identified above are not all inclusive. A more detailed survey using One-Call services would be required as part of a future design effort.

4.6.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Moore Lane crossing consists of an easement across railroad property and appears to be a total width of approximately 60 feet. MRL/BNSF right-of-way extends approximately 200-feet north of the westbound main track, north track, and to the edge of the pavement along Laurel Road to the south approximately 75 to 80 feet south of the westbound main track. Existing land uses within the vicinity of the crossing are predominantly commercial. MRL is currently leasing some of its right-of-way, east of the at-grade crossing and north of the tracks to a pre-manufactured modular home company. A railroad car unloading ramp is located north of the tracks on railroad spur tracks approximately 950 feet west of the at-grade crossing.

4.6.4.1 EXISTING BUSINESSES

Moore Lane is a commercial corridor along its entire length from Simpson Street to Central Avenue. Businesses are located on all four corners of the intersection in close proximity to the railroad crossing. South of Laurel Road, commercial strip malls exist on both sides of Moore

Lane. North of the crossing, Montana Modular Homes is located on the east side of Moore Lane and D's Furniture is located on the west side of the road.

Numerous businesses are accessed from Monad Road and have businesses located along the north side, as the roadway parallels the railroad tracks. Monad Road also accesses businesses to the north and west of the crossing location which is an industrial area of Billings.

4.6.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned recreational properties exist within the crossing vicinity. Based on a visual inventory, no potential historic buildings were identified during the field visit. The railroad corridor is also historic and eligible for listing in the NRHP although elements of the at-grade crossings may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

4.6.4.3 RESIDENTIAL

No residences are located along Moore Lane within the vicinity of the crossing. A residential area exists between Moore Lane and Monad Road within proximity to the crossing; however, access is not provided from Moore Lane or Monad Road.

4.6.5 Proposed Solution

The proposed crossing solution at this location is an underpass with Moore Lane traversing underneath the railroad.

An overpass versus underpass option was analyzed as part of the field visit and conceptual design process. Due to the proximity of Laurel Road and Monad Road, as well as proximity of businesses to the crossing along Moore Lane, Monad Road and Laurel Road, an overpass at this location would result in impacts on the adjacent intersections, potentially cutting off access, and increased right-of-way acquisition and relocation of area businesses. The railroad being elevated above the roadways also favors going under the tracks. It was therefore determined an underpass solution was the more feasible and practical at this location. Refer to Figure 4-13 for the proposed conceptual plan and profile for the underpass.

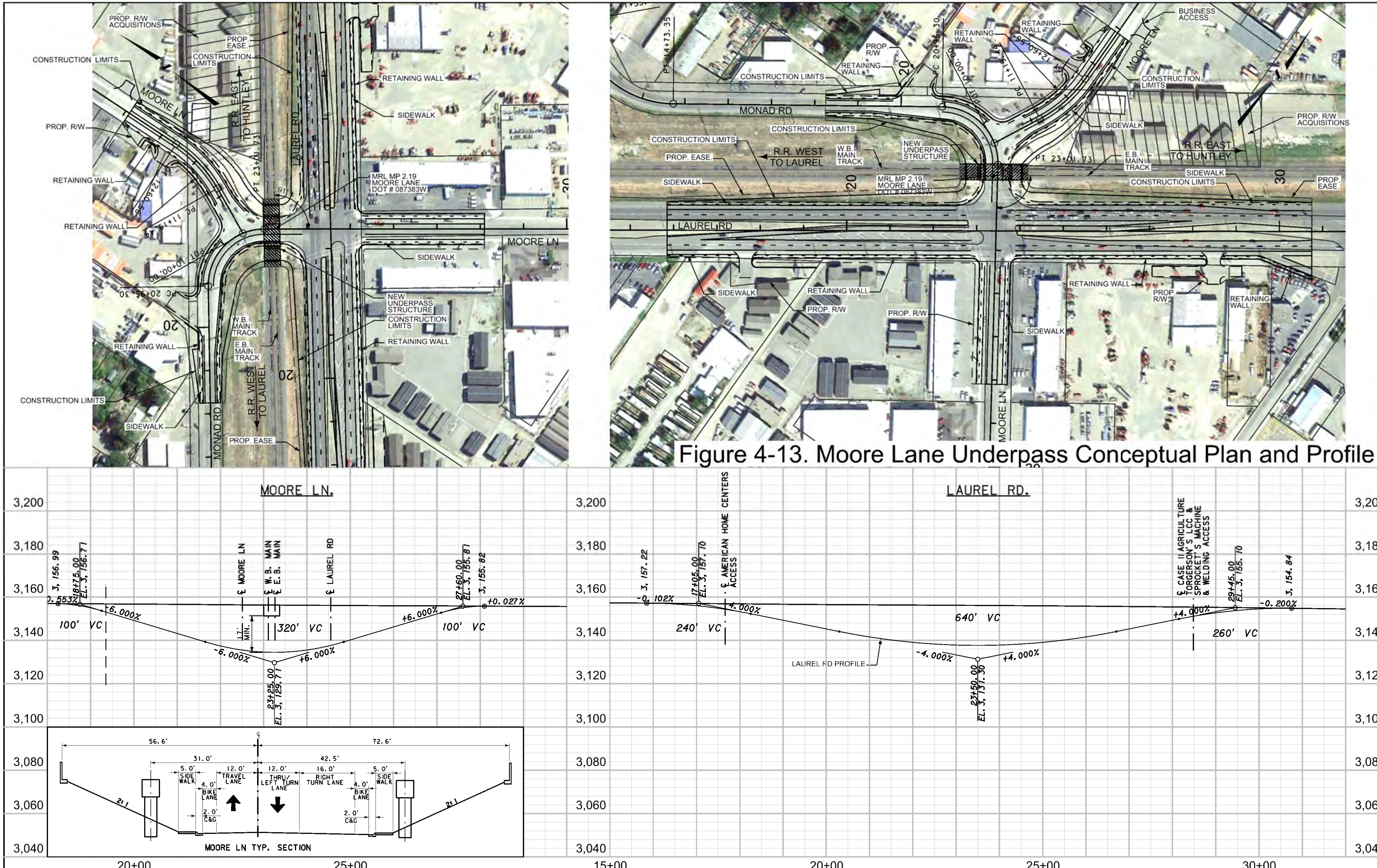


Figure 4-13. Moore Lane Underpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\RD\RDPLPZ07_Moore_Ln.dgn 12/15/2015 4:29:22 PM bmartish	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS YELLOWSTONE COUNTY	PRELIMINARY
MONTANA RAIL GRADE SEPARATION STUDY	N/A	SCALE 1"=200'	BILLINGS, MT	SHEET X OF X

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4.6.5.1 PROPOSED ROADWAY FEATURES

The roadway underpass along Moore Lane would consist of a 3-lane section, combined shoulders and bike lanes, new curb and gutter and 5-foot sidewalks. The proposed 3-lane section would include a southbound right-turn lane, southbound through/left-turn lane, and a widened northbound through lane for the intersection with Laurel Road, which is consistent with the existing intersection configuration. The combination of widened lanes and shoulders would provide the necessary turning radius for trucks moving onto and off-of the Moore Lane/Laurel Road intersection. The horizontal alignment will maintain the existing right angle crossing while the proposed vertical profile for the underpass will utilize 6 percent maximum grades along Moore Lane.

Due to the proximity of the Laurel Road intersection, approximately 1400 feet of Laurel Road would be reconstructed to match the new vertical grade of Moore Lane. The vertical profile for Laurel road would utilize 4 percent maximum grades and match the existing lane configuration and horizontal alignment. Retaining walls would be needed along Moore Lane, Laurel Road and Monad Road to minimize private property and local business impacts. Two business accesses would be reconstructed along the south side of Laurel Road to the east and west of the intersection. The improvements north of the crossing would extend along Moore Lane and Monad Road until the 6 percent grade catches existing ground. Shoofly construction would cause relocation of Montana Modular Homes and it is anticipated no provisions to maintain access to this business would be necessary.

4.6.5.2 PROPOSED RAILROAD FEATURES

A ballast deck steel beam span double track bridge on concrete foundation would be constructed over the lowered Moore Lane. The center span would go over the proposed traffic lanes and sidewalks. There is sufficient room to excavate for the Moore Lane undercrossing and the associated lowering of Laurel Road to provide drainage along the road using standard 2:1 slopes up to the railroad track.

4.6.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would include a shared shoulder/bike lane and 5-foot sidewalks on either side of the roadway. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of concrete barrier or small retaining walls along the edge of roadway to allow the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk.

4.6.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

By utilizing maximum vertical grades and retaining walls, impacts on adjacent businesses could be minimized. Additional right-of-way appears to be necessary for the underpass construction, which includes easement within railroad property and proposed right-of-way as fee from private property owners. A total of approximately 39,400$ft.^2$ is estimated for right-of-way acquisition, at \$15/$ft.^2$ (2015\$), which is market value for commercial properties for this area of Billings per research of Montana Cadastral property values and other local publically available information.

4.6.5.5 OTHER FEATURES

4.6.5.5.1 Emergency Vehicle Considerations

The Moore Lane crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.6.5.5.2 Drainage

It appears prevailing drainage is to the south and east. It is assumed the drainage from the undercrossing could be day-lighted in this direction; however, an allowance for a dewatering system including pumps is included in the conceptual order of magnitude estimate of probable project cost. Nearby well records are inconclusive on ground water depth. Further geotechnical investigation would be needed to verify if a concrete seal slab were needed. At this time, it is assumed the excavation would be dry and ground water would not be encountered.

4.6.5.5.3 Retaining Walls

Retaining walls are recommended along the north side of Monad Road and Moore Lane and along the south side of Laurel Road are needed in order to minimize the footprint of the underpass improvements. The retaining walls reduce the need for additional right-of-way which could negatively impact the businesses adjacent to Moore Lane crossing.

The retaining walls proposed for this crossing are tie back or pile and lagging style walls with precast or cast-in-place fascia. These walls are constructed from the top down which minimizes excavation and the amount of right-of-way needed for the project. In addition, they can be designed to withstand hydraulic pressure from ground water. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.6.5.5.4 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.6.6 Constructability

4.6.6.1 ROADWAY CONSTRUCTION

Due to the nature of the construction for the roadway underpass, Moore Lane would be closed during construction and Laurel Road would require construction staging while keeping at least a single lane in each direction open to traffic. The excavation required for the underpass and construction of the retaining walls would make it difficult to maintain an at-grade crossing within the project limits. Business access would need to be maintained during construction from the surrounding approaches to the crossing work area.

4.6.6.2 RAILROAD CONSTRUCTION

Temporary detouring, or shoofly, of both main tracks to the north of the existing railroad alignment would be required to maintain train traffic while construction of the underpass structure was performed. Shoring would be required between the existing north main track and the shooflied south main track with the shooflied north main track being 15 feet farther north. The shoofly would be constructed on an estimated 2 feet of embankment to maintain the existing track profile. Construction would initially involve partial excavation of the substructure to allow setting the new spans and restoring train service on the original alignment. Once service was restored on the original alignment, the remaining excavation and final road construction would be completed.

To meet railroad safety requirements, a railroad flagger would provide on-track safety for construction occurring, or having the capacity to foul a zone, within 25 feet of railroad tracks.

While not included, a temporary at-grade crossing could be constructed approximately 800 feet west of the existing at-grade crossing. This temporary crossing would connect with Monad Road and possibly reduce some impacts for the industrial traffic from the area that connects with Monad Road. Further traffic studies of the construction impacts on traffic and the connection with Laurel Road would be necessary before finalizing this detour option.

4.6.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

During construction, Moore Lane traffic could be detoured to Central Avenue, King Avenue or 6^{th} Street. Traffic on Laurel Road would experience multiple construction phases with lane closures. Along with a detour route for Moore Lane, public outreach would be essential in order to keep the traveling public informed of temporary road closures and alternate routes for the project area.

4.6.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $24,800,000 (2015$). Table 4-9 shows the various cost components for the Moore Lane underpass option.

Table 4-9. Moore Lane Underpass Option Cost Estimate

Moore Lane Cost Components	Cost ($)
Road Work	$5,911,000
Railroad Work	$1,130,000
New Structure(s)	$2,259,000
Hydraulics	$750,000
Utilities	$650,000
Miscellaneous Items	$500,000
Mobilization (18%)	$1,900,000
Contingencies (25%)	$3,300,000
Preliminary Engineering (15%)	$2,500,000
Construction Engineering (15%)	$2,500,000
Right-of-Way	$1,091,000
IDC (10.37%)	$2,300,000
TOTAL COSTS (2015$)	**$24,800,000**

4.6.8 Benefit-Cost Analysis

BCA was conducted for the Moore Lane grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Moore Lane grade separation. Refer to Appendix C for more information on the BCA.

Considering all monetized benefits and costs of the Moore Lane grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $21.35 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $1.94 million, of which the largest benefit is $1.25 million worth of improved safety, while the total costs amount to $23.29 million. Table 4-10 and Table 4-11 provide a summary of the BCA results.

Table 4-10. Monetized Benefits by Category for Moore Lane Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.01	$0.71	$0.47
Improved Safety	$2.66	$1.88	$1.25
Vehicle Operating Cost Savings	$0.06	$0.04	$0.03
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$4.10**	**$2.90**	**$1.94**

Table 4-11. Benefit-Cost Analysis Results for Moore Lane Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$4.10	$2.90	$1.94
Total Costs ($2015 M)	$25.04	$24.25	$23.29
Net Present Value (NPV)	-$20.94	-$21.34	-$21.35
Return on Investment (ROI)	-83.63%	-88.03%	-91.65%
Benefit-Cost Ratio (BCR)	0.16	0.12	0.08
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-13.05%	-15.58%	-18.73%

Figure 4-14 illustrates the 20 years of undiscounted benefits following construction of the Moore Lane grade separation.

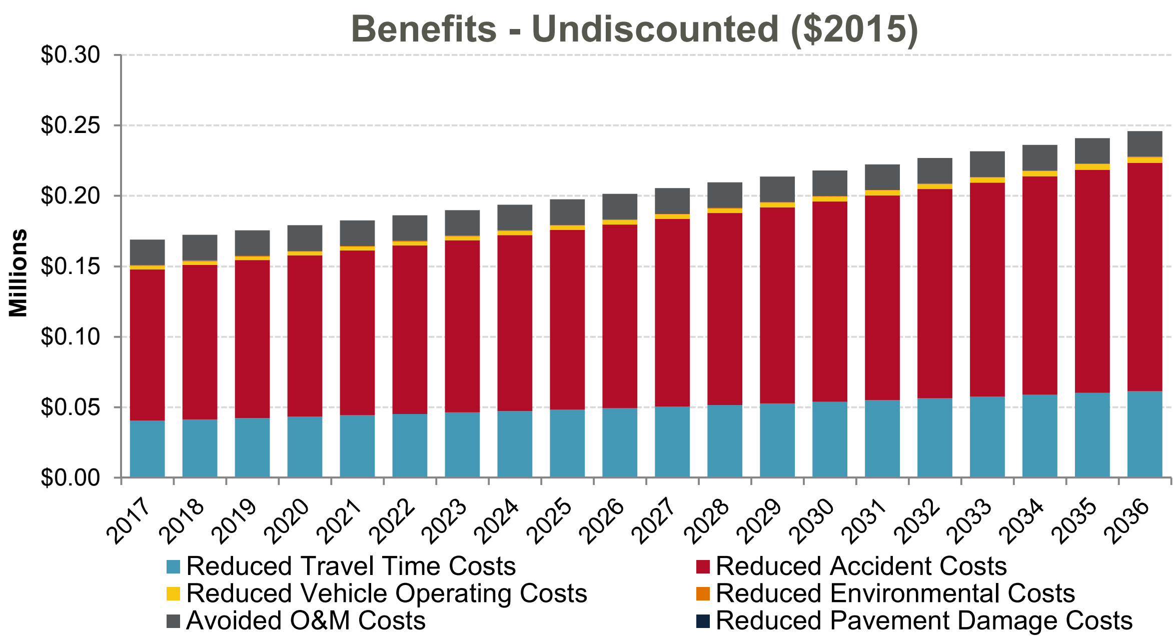

Figure 4-14. Projected Undiscounted Benefits for Moore Lane Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.6.9 Summary

The Moore Lane at-grade railroad crossing is located within the city limits of Billings and was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high priority index and high average train speeds. Based on a review of existing conditions and published documents, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. Improvements to bicycle and pedestrian accessibility at this crossing including the addition of bike lanes along Moore Lane would be consistent with recommendations for the corridor found in the 2014 LRTP.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

4.7 Griffin Drive, Bozeman, Route U-1217N, MRL MP 141.41, DOT #060073Y

4.7.1 Overview

The Griffin Drive at-grade railroad crossing is located within the City of Bozeman and experiences high daily volumes of vehicles: over 8,300 AADT in 2014 with a projection of over 12,600 in 2034. Twenty-eight (28) railroad trains travel through this crossing daily. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. The railroad crossing has been identified in the 2007 *Bozeman Area Transportation Plan* as separating the northeast portion of city from emergency vehicle services and creating traffic congestion during train crossing events.

This crossing was selected for further analysis to ease congestion and increase safety by proposing a grade-separated roadway from the railroad. Due to the railroad embankment being approximately 10 feet above the surrounding topography and Griffin Drive graded up to the tracks from both sides of the crossing, a roadway underpass is favored at this crossing due to reduced grading and avoidance of major impacts to commercial business entrances on Griffin Drive and the Manly Road and Evergreen Drive intersections with Griffin Drive. An overpass, while potentially constructible, would likely cut off access to the petroleum tank farm facilities in the southwest quadrant and a transfer and storage business in the northeast quadrant of the crossing intersection while requiring embankments to be built to maintain intersections with Manly Road and Evergreen Drive. Figure 4-15 shows the crossing area and provides a summary of the key statistics for this crossing.

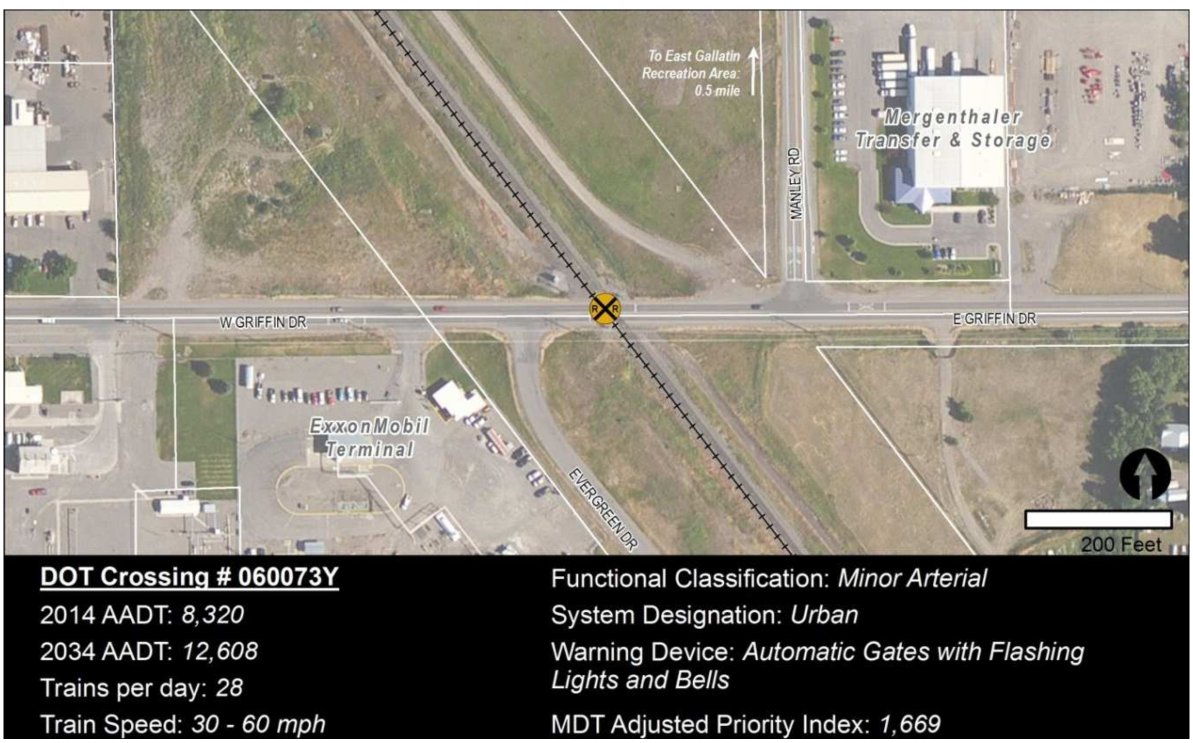

Figure 4-15. Griffin Drive Crossing Overview

4.7.2 Regional Context

Griffin Drive is designated as an Urban Route on the state's highway network and serves as an important east-west linkage between N. 7th Avenue and N. Rouse Avenue (Montana Highway 86). Figure 4-16 depicts the Griffin Drive crossing in context with other railroad crossings in the vicinity.

Figure 4-16. Bozeman Area Highway-Rail Crossings

Two other at-grade railroad crossings exist within one mile of the Griffin Drive crossing. As measured along the railroad main line, the N. Rouse Avenue and Wallace Avenue crossings are located southeast of the Griffin Drive crossing approximately 0.6 and 0.9 miles, respectively.

Four existing roadway grade separations exist within the Bozeman region as well. These crossings include the I-90 overpasses on the east side of Bozeman and at North Rouse Avenue, and the N. 7th Avenue and N. 19th Avenue overpasses which are both located on Bozeman's north side. The Griffin Drive railroad crossing was analyzed separately (i.e., no crossings combined holistically) from all other at-grade and grade-separated crossings in the region due to the unique traffic patterns from the northwest and northeast not served by other railroad crossings and access provided from Griffin Drive to local businesses and residences.

4.7.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The 2007 *Bozeman Area Transportation Plan* was reviewed with respect to improvement recommendations for Griffin Drive. The traffic model results identified projected congestion along Griffin Drive based on future traffic conditions (2030). Griffin Drive has been identified within the plan as having a gap in pedestrian and bicycle facilities. The plan recommends bicycle lanes and sidewalks along Griffin Drive from N. 7th Avenue to N. Rouse Avenue. The plan also recommends a grade-separated crossing of Griffin Drive and the railroad as one of its

Major Street Network Projects. Included in the plan as MSN-23, the plan recommends an underpass along Griffin Drive to address the issue of emergency vehicle access and traffic congestion caused during crossing closures caused by train traffic.

4.7.3 Existing Crossing Features

The following sections describe the existing conditions at the Griffin Drive crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 18, 2015.

4.7.3.1 EXISTING ROADWAY

Griffin Drive is a minor arterial roadway with a 2014 AADT of 8,320 and a projected 2034 AADT of 12,608. At the location of the current at-grade crossing, Griffin Drive is a 2-lane roadway approximately 32 feet wide including a shoulder width of approximately 4 feet. Existing traffic control within the vicinity of the crossing consists of stop signs on Manley Road and Evergreen Drive at their intersections with Griffin Drive. Traffic signals exist at the intersections of Griffin Drive with N. 7th Avenue to the west and N. Rouse Avenue to the east. The posted speed limit is 35 mph within the vicinity of the crossing. Griffin Drive rises up to meet the railroad embankment elevation approximately 10 feet above the surrounding ground. Both Manley Road and Evergreen Drive rise up to their intersections with Griffin Drive.

Photo 4-11. Griffin Drive looking east toward railroad crossing

4.7.3.2 EXISTING RAILROAD AND RAILROAD FEATURES

A single main track crosses Griffin Drive, which is a major east-west national freight train link. The railroad crossing experiences 28 trains daily. The main track timetable speed at this location is 60 mph. Eastbound trains may be slowing to the 35 mph zone which starts approximately ½-mile east of the Griffin Drive at-grade crossing and westbound trains accelerating as they leave the 35 mph speed zone through Bozeman to match the DOT's database speeds between 30 – 60 mph. The tracks cross Griffin Drive at an approximate 54 degree skew angle. The current at-grade crossing has gates, flashing signals and bells for vehicle protection. The main track crossing uses precast concrete panels for the roadway crossing material.

Photo 4-12. Griffin Drive at-grade crossing looking west

4.7.3.3 EXISTING NON-MOTORIZED FEATURES

Griffin Drive currently does not have any dedicated non-motorized facilities adjacent to the roadway. No sidewalks or bike lanes exist within the vicinity of the crossing. Shoulder widths are approximately 4 feet wide. Bike lanes exist along Manley Road from Griffin Drive to north of the East Gallatin Recreation Area.

4.7.3.4 UTILITIES

Existing utilities consist of overhead power lines, underground fiber optic, a petroleum product pipeline and a natural gas line. An underground water line may also exist. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.7.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Griffin Drive crossing consists of an easement across railroad property and appears to be a total width of approximately 90 feet. MRL/BNSF right-of-way records indicate a width of 400 feet with the track centered in the right-of-way. Existing land uses within the vicinity of the crossing consist primarily of commercial and light industrial uses with a trailer park residential area near Griffin Drive's intersection with Rouse Avenue to the east.

4.7.4.1 EXISTING BUSINESSES

Limited development exists within the immediate four quadrants of the crossing. The ExxonMobil Terminal, a petroleum tank farm, occupies a parcel to the southwest of the crossing in the southwest quadrant of the intersection of Evergreen Drive and Griffin Drive. Access to the property is from Griffin Drive where two driveways are located west of the railroad crossing approximately 275 feet and 700 feet. To the east of the crossing, Mergenthaler Transfer & Storage is accessed from Griffin Drive approximately 550 feet from the crossing.

4.7.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned recreation properties exist within the immediate crossing vicinity. No historic buildings were identified within the crossing vicinity. Manley Road is the access to the East Gallatin Recreation Area and Griffin Drive is used as an access from the west and north to and from the Bridger Bowl Ski area, which is north and east of Bozeman via its connection with Rouse Avenue. The Northern Pacific Railroad Main Line is a historic feature and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

4.7.4.3 RESIDENTIAL

One residential property is located on the south side of Griffin Drive east of the crossing. The structure is setback from the roadway and the driveway is located approximately 830 feet east of the crossing. No other residences are located along Griffin Drive within the vicinity of the railroad crossing.

4.7.5 Proposed Solution

The proposed crossing solution at this location is an underpass with Griffin Drive traversing underneath the railroad.

An underpass versus overpass option was analyzed as part of the field visit and conceptual design process. An overpass solution would potentially cut off access to petroleum tank farms in the southwest quadrant and a shipping business in the northeast quadrant. Due to the railroad embankment being approximately 10 feet above the surrounding topography, and the existing grade on Griffin Drive being lower than the railroad tracks on either side of the crossing, a roadway underpass is the recommended grade separation solution at this location. Refer to Figure 4-17 for the proposed conceptual plan and profile for the underpass.

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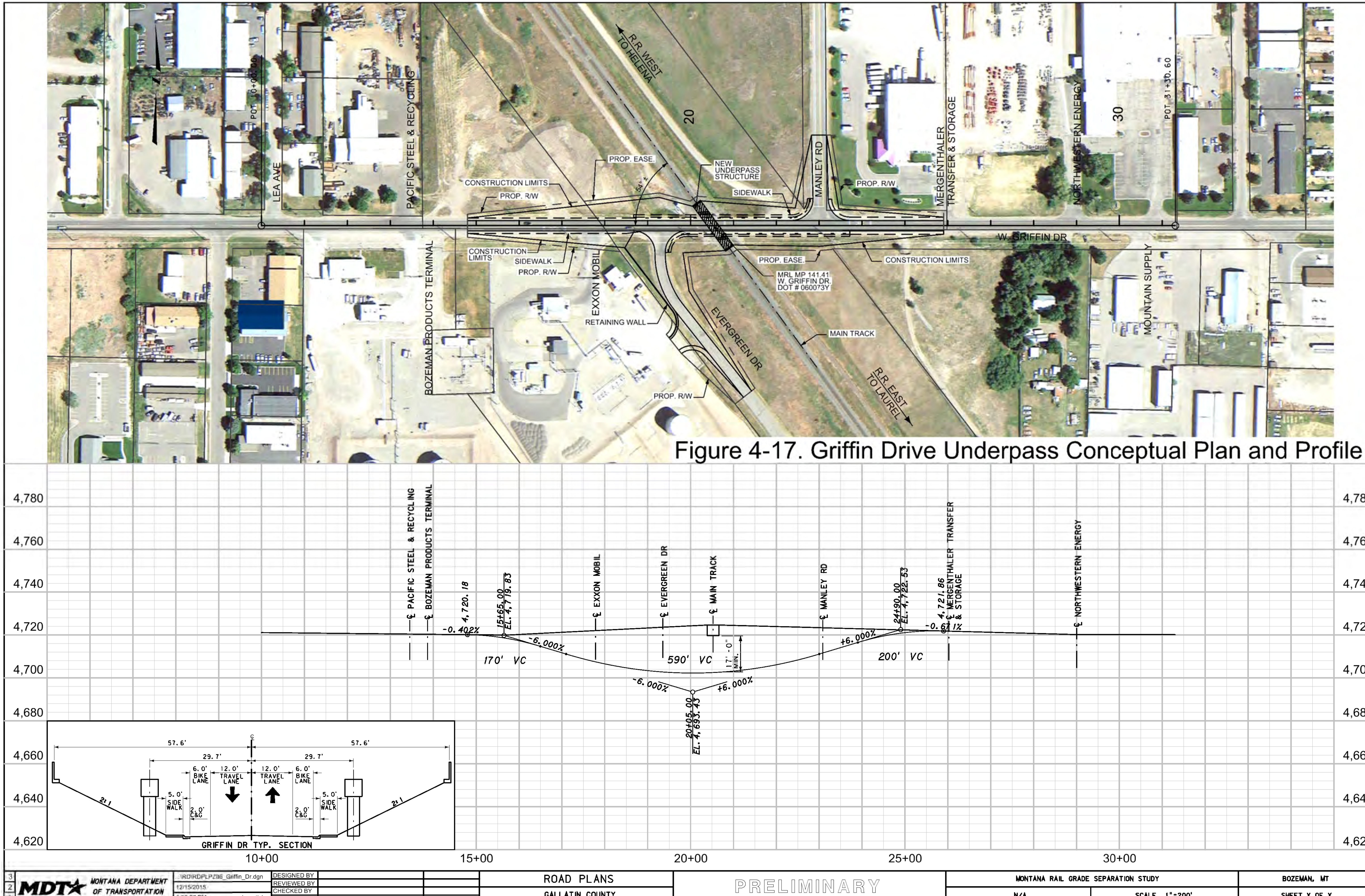

Figure 4-17. Griffin Drive Underpass Conceptual Plan and Profile

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4.7.5.1 PROPOSED ROADWAY FEATURES

The roadway underpass would consist of two travel lanes, 6-foot shoulders, which can accommodate bike lanes, new curb and gutter and 5-foot sidewalks to provide pedestrian access under the tracks. There will be no major changes to the horizontal alignment of Griffin Drive. The new vertical profile for the undercrossing would utilize 6 percent maximum slopes and vertical curve lengths would follow MDT design standards for a 35 mph design speed. In order to minimize the need of retaining walls and reduce the overall cost of the proposed improvements, 2H:1V cut slopes are recommended along Griffin Drive and the railroad embankment.

The required grading for the underpass would impact the intersections with Evergreen Drive and Manley Road. Manley Road intersects with Griffin Drive in the northwest quadrant approximately 230 feet from the tracks and Evergreen Drive intersects with Griffin Drive in the southwest quadrant approximately 100 feet from the tracks. Both roads would require excavation work in order to connect with a lowered Griffin Drive. These intersections would be reconstructed to match the new vertical grade along Griffin Drive along with any business accesses that are within the underpass improvement limits.

In addition, it is recommended the petroleum tank farm's entrance be moved from Griffin Drive to Evergreen Drive. This may reduce the current turn-around and backing movements that are used to get to the load-out racks and provide a safer entrance for the tank trucks onto public roads.

Photo 4-13. Tank truck accessing Griffin Drive from tank farm

4.7.5.2 PROPOSED RAILROAD FEATURES

The proposed single track, 3-span railroad bridge would be built using spill through abutments and 2:1 abutment slopes per railroad standards. The roadway skew angle to the railroad tracks of 36 degrees is greater than the allowable 30 degrees, requiring the intermediate piers to be slightly skew to the roadway but constructed at 30 degrees to the railroad with the abutments normal or right angles to the tracks. The total proposed railroad bridge length is 140 feet, consisting of two average 40-foot-long, wide flange beam approach spans which have a 30 degree skewed end and square abutment end and a 60-foot center wide flange beam span skewed 30 degrees. The prevailing railroad grade is approximately 0.7 percent down toward the west.

4.7.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would include 6-foot shoulders which could accommodate bike lanes and 5-foot sidewalks on either side of the roadway. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk.

4.7.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

Additional right-of-way appears to be necessary for the underpass construction, which includes easement within MRL property and proposed right-of-way as fee from private property owners. A total of approximately 29,100 ft.^{2} is estimated for right-of-way acquisition, at \$15/ft.^{2} (2015\$), which is market value for commercial properties for this area of Bozeman per research of local, publically available information and Montana Cadastral property values.

4.7.5.5 OTHER FEATURES

4.7.5.5.1 Emergency Vehicle Considerations

The Griffin Drive crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.7.5.5.2 Drainage

Drainage from the undercrossing could require a stormwater pump to convey stormwater away from the crossing. An allowance for a stormwater pumping system is included in the order of magnitude conceptual estimate of probable project costs.

Well logs from the Montana Bureau of Mines and Geology show most groundwater levels in the area to be around 4 to 10 feet below ground line. The ground line where the well logs were located is approximately 12 feet below the railroad track based on field visit observations. This places groundwater at about the same elevation of the proposed underpass road. At this time, a seal slab is not proposed but further geotechnical evaluation is necessary during future phases of design to verify ground water elevation and determine an engineering solution to minimize maintenance and potential water inflow from an underpass.

4.7.5.5.3 Retaining Walls

Short height retaining walls (less than 4 feet) may be needed along Evergreen Drive to minimize impacts to the petroleum tank farm’s property. Retaining walls reduce the need for additional right-of-way, which if required could negatively impact the functionality of the property.

4.7.5.5.4 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing

4.7.6 Constructability

4.7.6.1 ROADWAY CONSTRUCTION

Due to the nature of the construction for the roadway underpass, Griffin Drive would be closed during construction. The excavation required for the underpass would make it difficult to maintain through access within the project limits. Private and business access would need to be maintained during construct from the east or west side of the crossing.

4.7.6.2 RAILROAD CONSTRUCTION

To maintain train traffic during construction a shoofly track would be required. In order to maintain the 60 mph track speed, the single track railroad shoofly would be approximately 2,000 feet long with an average height of 10 feet to match the existing track profile. Once the shoofly was constructed, the bridge work could proceed. Upon completion of the bridge and train traffic moved back to its original alignment, the remainder of the road work would be completed and the shoofly embankment removed.

4.7.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

Traffic would be detoured to alternate routes while this section of Griffin Drive is closed for construction. Public outreach would be necessary in order to keep the traveling public informed of temporary road closures and alternate routes for this area.

4.7.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $13,800,00 (2015$). Table 4-12 shows the various cost components for the Griffin Drive underpass option.

Table 4-12. Major Cost Components for Griffin Drive Underpass Option

Griffin Drive Cost Components	Cost (2015$)
Road Work	$1,846,000
Railroad Work	$1,114,000
New Structure(s)	$1,540,000
Hydraulics	$500,000
Utilities	$1,000,000
Miscellaneous Items	$300,000
Mobilization (18%)	$1,100,000
Contingencies (25%)	$1,850,000
Preliminary Engineering (15%)	$1,400,000
Construction Engineering (15%)	$1,400,000
Right-of-Way	$436,000
IDC (10.37%)	$1,300,000
TOTAL COSTS (2015$)	**$13,800,000**

4.7.8 Benefit-Cost Analysis

A BCA was conducted for the Griffin Drive grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Griffin Drive grade separation. Refer to Appendix B for more information on the BCA.

Considering all monetized benefits and costs of the Griffin Drive grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $12.02 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $0.99 million, of which the largest benefit is $0.48 million worth of travel time savings, while the total costs amount to $13.01 million. Table 4-13 and Table 4-14 provide a summary of the BCA results.

Table 4-13. Monetized Benefits by Category for Griffin Drive Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.05	$0.73	$0.48
Improved Safety	$0.63	$0.44	$0.29
Vehicle Operating Cost Savings	$0.07	$0.05	$0.03
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$2.12**	**$1.49**	**$0.99**

Table 4-14. Benefit-Cost Analysis Results for Griffin Drive Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$2.12	$1.49	$0.99
Total Costs ($2015 M)	$14.04	$13.57	$13.01
Net Present Value (NPV)	-$11.92	-$12.08	-$12.02
Return on Investment (ROI)	-84.89%	-89.01%	-92.38%
Benefit-Cost Ratio (BCR)	0.15	0.11	0.08
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-13.59%	-16.11%	-19.23%

Figure 4-18 illustrates the 20 years of undiscounted benefits following construction of the Griffin Drive grade separation.

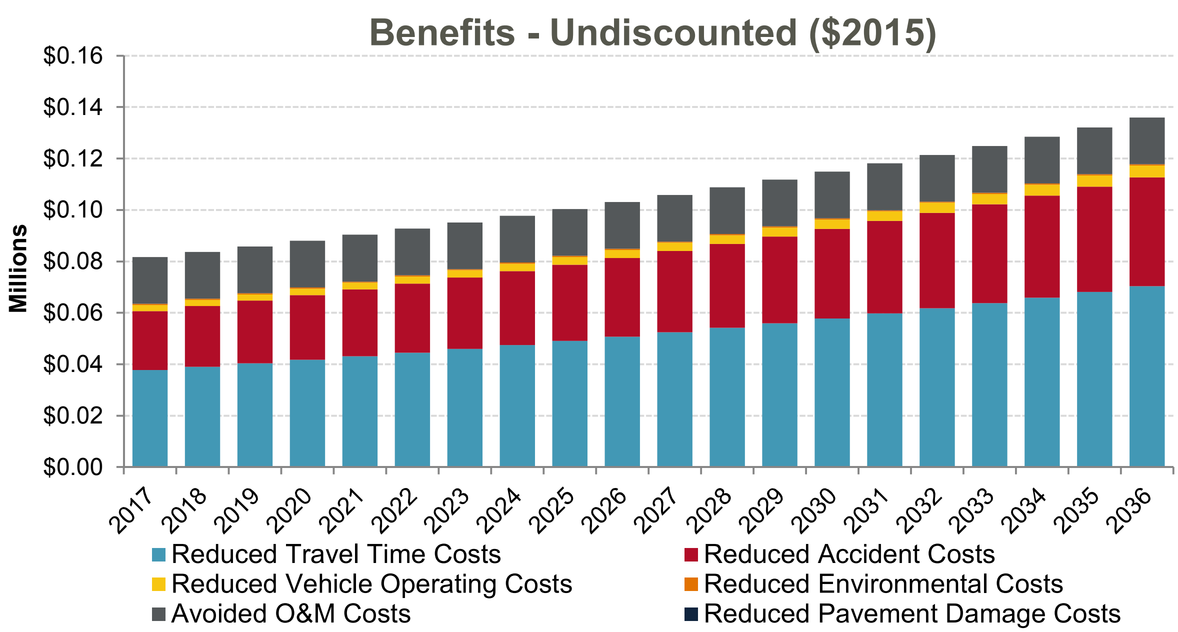

Figure 4-18. Projected Undiscounted Benefits for Griffin Drive Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.7.9 Summary

The Griffin Drive at-grade railroad crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification and priority index. Based on a review of existing conditions and published documents, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with the long-range vision for the Griffin Drive corridor as documented in previous studies.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

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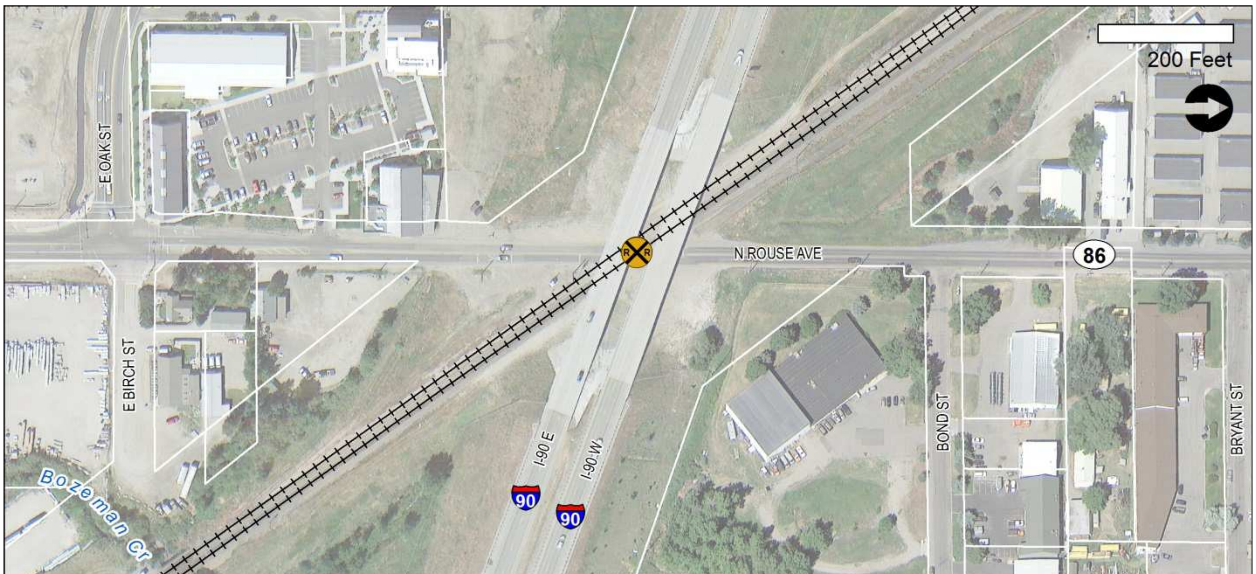
4.8 N. Rouse Avenue, Bozeman, Route P-86N, MRL MP 140.85, DOT #060055B

4.8.1 Overview

The North Rouse Avenue (Rouse Avenue) at-grade railroad crossing is located within the City of Bozeman and experiences daily volumes of vehicles of over 12,500 AADT in 2014 with a projection of over 16,200 in 2034. Thirty-eight (38) railroad trains travel through this crossing daily. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. Figure 4-19 shows the crossing area and provides a summary of the key statistics for this crossing.



DOT # 060055B
2014 AADT: *12,560*
2034 AADT: *16,262*
Trains per day: *38*
Train Speed: *10-35 mph*

Functional Classification: *Minor Arterial*
System Designation: *Primary Route*
Warning Device: *Automatic Gates with Flashing Lights and Bells*
MDT Adjusted Priority Index: *2,919*

Figure 4-19. Rouse Avenue Crossing Overview

To ease congestion at this crossing and increase safety, grade separating the roadway from the railroad is proposed. An overpass solution is infeasible due to the conflict with I-90. The overpass grading would extend south of the East Birch/East Oak Street intersection and north beyond Bryant Street, affecting access to adjacent businesses and residences. Due to the I-90 bridges crossing over this at-grade crossing and the potential impacts of an overpass, the most feasible solution is a roadway undercrossing for a grade separation.

4.8.2 Regional Context

Rouse Avenue is signed as Montana Highway 86 and designated as a primary route on the state's highway network. Rouse Avenue is functionally classified as a minor arterial roadway and serves as a major linkage between the City of Bozeman, residential and commercial development, as well as recreational opportunities located in Bridger Canyon. Figure 4-20 depicts the Rouse Avenue crossing in context with other railroad crossings in the vicinity.

Figure 4-20. Bozeman Area Highway-Rail Crossings

Two other at-grade railroad crossings exist within one mile of the Rouse Avenue crossing. As measured along the railroad main line, the Wallace Avenue crossing is located approximately 0.3 miles southeast and the Griffin Drive crossing is located 0.55 miles northwest from the Rouse Avenue crossing.

Four existing roadway grade separations exist within the Bozeman region as well. These crossings include I-90 overpasses on the east side of Bozeman and over Rouse Avenue, and the N 7th Avenue and N. 19th Avenue overpasses which are both located on Bozeman's north side. The existing roadway or railroad grade separations do not provide a logical crossing for traffic utilizing Rouse Avenue; therefore, Rouse Avenue was not combined holistically with any other crossings within the Bozeman area.

4.8.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

Improvements to North Rouse Avenue have been identified in previous studies and a reconstruction project of Rouse Avenue from Oak Street to Story Mill Road, which includes the at-grade crossing, is currently programmed in 2016 per MDT Tentative Construction Plan. None of previous studies reviewed recommend or include plans for a grade separation of Rouse Avenue from the railroad.

The 2007 *Bozeman Area Transportation Plan* was reviewed with respect to improvement recommendations for North Rouse Avenue. The plan recommends improvements to Rouse Avenue from Main Street to Story Mill Road as a top ten major improvement project for the region. This recommendation calls for upgrading the roadway to a 3-lane urban arterial. The Rouse Avenue at-grade railroad crossing is located within this stretch of roadway. This section of Rouse Avenue has been identified within the plan as having a gap in pedestrian and bicycle facilities. The plan recommends bike lanes along this segment of Rouse Avenue.

The 2008 *Rouse Avenue Environmental Assessment* (EA) identified the need for improved vehicular Level of Service and enhanced bicycle and pedestrian facilities along the Rouse Avenue corridor. The 2008 EA identified a preferred alternative consisting of a 3-lane urban section, including bike lanes and sidewalks on both sides of the roadway. The 3-lane, which includes a two-way left-turn lane, would be narrowed to 2 lanes throughout the segment of roadway passing under the interstate at the location of the railroad crossing. The 2008 EA did not examine a grade separation at this location. Since then, the I-90 bridges over Rouse were reconstructed and the opening between bridge piers for Rouse Avenue under the bridge was widened.

4.8.3 Existing Crossing Features

The following sections describe the existing conditions at the Rouse Avenue crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 18, 2015.

4.8.3.1 EXISTING ROADWAY

North Rouse Avenue is functionally classified as a minor arterial and designated as a primary route on the state's highway system (Montana Highway 86). The 2014 AADT within the vicinity of the railroad crossing is 12,560 vehicles per day with a projected AADT in 2034 of 16,262. At the location of the at-grade crossing, Rouse Avenue is a 2-lane roadway approximately 25 feet wide. From the Oak Street intersection heading northbound, the roadway has approximately a 6-foot-wide paved shoulder which tapers down to no shoulder approaching the crossing. North of the crossing the shoulders become gravel and vary from 2 to 4 feet in width. Wide gravel pull-out areas exist on either side of the crossing underneath the I-90 bridges carrying the eastbound and west bound lanes over Rouse.

Rouse Avenue between Oak Street and Story Mill Road is planned for reconstruction in 2016. Per preliminary construction plans provided by MDT, the reconstructed roadway will consist of two 11-foot lanes, with 5-foot bike lanes, curb and gutter, and boulevard separated sidewalks.

Existing traffic control along Rouse Avenue within the vicinity of the crossing includes a signal at E. Oak Street/E. Birch Street south of the railroad crossing and the intersections of Bond Street and E. Bryant Street north of the railroad crossing are controlled by a stop sign on their approaches to Rouse Avenue. The posted speed limit is 35 mph within the vicinity of the crossing.

4.8.3.2 EXISTING RAILROAD AND RAILROAD FEATURES

Two tracks cross Rouse Avenue, a main track that is a major east-west national freight train link and a spur track providing rail service to Cardinal Distributing. Thirty-eight (38) railroad trains travel through this site daily. West of the at-grade crossing, main track speed is 60 mph. East of the crossing, main track speed is 35 mph. Industry spur track trains travel at 10 mph. The tracks cross Rouse Avenue at an approximate 52 degree angle from perpendicular at roughly the same location as the I-90 crossing. The current at-grade crossing has gates, flashing signals and bells for vehicle protection. The main track uses precast concrete panels and the industry spur track uses rubber panels for the roadway crossing material at the tracks.

4.8.3.3 EXISTING NON-MOTORIZED FEATURES

The railroad crossing currently does not have dedicated non-motorized facilities adjacent to the roadway. No sidewalks exist within the vicinity of the crossing. Shoulder widths vary throughout the vicinity of the crossing, as mentioned above.

4.8.3.4 UTILITIES

Existing underground utilities, which are known based on field visits or other sources, include fiber optic, high pressure natural gas, gas service lines, sanitary sewer and an irrigation crossing. Overhead power lines are located parallel to and crossing Rouse Avenue north of I-90 and the existing railroad crossing. The irrigation ditch appears unused. Existing utilities listed above are not all inclusive and a more exhaustive survey utilizing One-Call services will be required as part of a future design effort.

4.8.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Rouse Avenue crossing consists of an easement across railroad property and appears to be a total width of approximately 60 to 70 feet. MRL/BNSF right-of-way is approximately 380 feet wide in the area of the Rouse Avenue crossing. In addition, the I-90 right-of-way is approximately 300 feet wide in the crossing area. The I-90 crossing also uses an easement to cross the railroad property. Existing land uses within the immediate vicinity of the crossing consist primarily of commercial and light industrial uses.

4.8.4.1 EXISTING BUSINESSES

Commercial and light industrial development exists in the crossing area. A commercial shopping area is located south of the crossing on the west side of the roadway (Photo 4-14). This area includes a parking lot that provides access to a gardening store, gymnastics and swim school, offices, miscellaneous shops and restaurants. This shopping area is accessed from both Oak Street and Rouse. There are other businesses with access off of Rouse Avenue including an asphalt paving company.

Photo 4-14. Existing open area mall access from N. Rouse approximately 420 feet from railroad tracks

4.8.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned properties for public recreation exist within the crossing vicinity. No historic buildings or sites were identified within the crossing vicinity. The 2008 Environmental Assessment prepared for the Rouse Avenue corridor noted the Northern Pacific Railroad Main Line railroad grade is a historic feature eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossing may not impact the eligibility of the larger corridor or surrounding buildings.

4.8.4.3 RESIDENTIAL

One residential property exists on the east side of the roadway on the northeast corner of Rouse Avenue and Oak Street.

4.8.5 Proposed Solution

The proposed crossing solution at this location is an underpass with Rouse Avenue traversing underneath the railroad.

An overpass versus underpass option was analyzed as part of the field visit and conceptual design process. An overpass solution is not feasible as it would conflict with the existing I-90 overpass structures. In addition, an overpass grading limits could extend south of the East Birch/East Oak Street intersection and north beyond Bryant Street and potentially close access to a small commercial mall, businesses and residences in the area. The most feasible solution is a roadway underpass for a grade separation of the road and railroad. The underpass solution avoids impacting I-90, does not impact intersections to the north and south and minimizes business access impacts. Refer to Figure 4-21 for the proposed conceptual plan and profile for the underpass.

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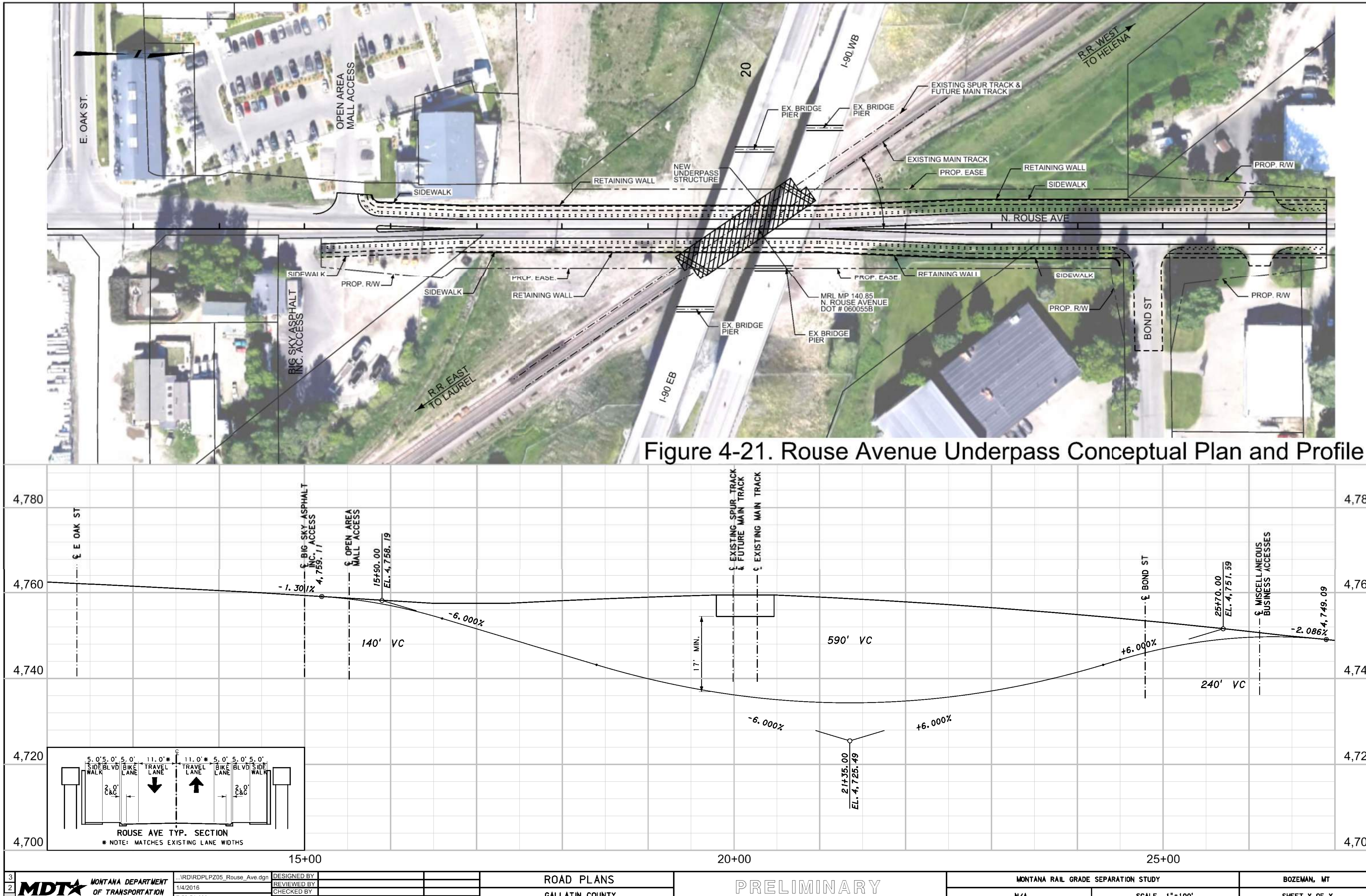

Figure 4-21. Rouse Avenue Underpass Conceptual Plan and Profile

HDR

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4.8.5.1 PROPOSED ROADWAY FEATURES

The proposed roadway under the assumed single span railroad bridge would match the proposed construction project planned by MDT consisting of two 11-foot travel lanes and 5-foot bike lanes, new curb and gutter, 5-foot boulevard and 5-foot sidewalks on either side of Rouse Avenue. There will be no major changes to the horizontal alignment of Rouse Avenue at this location. The new vertical profile would utilize 6 percent maximum grades in order to minimize impacts on adjacent properties and access points, while maintaining consistency with current MDT roadway design standards. Vertical curve lengths will meet the criteria for a 35 mph design speed. The roadway typical section will match future improvements along Rouse Avenue per preliminary construction plans provided by MDT for reconstruction in Fiscal Year 2016 as identified in MDT's Tentative Construction Plan.

The area businesses that are accessed from Rouse Avenue appear to have driveway approaches that could be adjusted to meet a lowered road profile or they are far enough away from the railroad crossing that minimal adjustment may be necessary. The access for the Open Area Mall would have the largest impacts with adjustments to meet the revised Rouse Avenue profile. Parking currently exists along the access road, which would need to be adjusted with the revised profile. Depending on the limits of impacts, a few parking stalls along this access road may need to be eliminated.

4.8.5.2 PROPOSED RAILROAD FEATURES

The proposed railroad bridge, due to the crossing skew to the railroad of approximately 55 degrees, could consist of a 148-foot double track through plate girder structure on either a wall shaft abutment, estimated 5 feet thick by 25 feet wide, or a 170-foot double track through-plate girder bridge on a more open partial walled, partial slope using a spill through drilled shaft supported abutment. The railroad structure would be built at the allowable 30 degree skew with concrete approach slabs placed to square the track approach. The structure cost would be approximately the same for the different length bridges due to the increased cost of the wall abutment on the short span.

4.8.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would include bike lanes and 5-foot sidewalks on either side of the roadway. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk. The inclusion of a bike lane and sidewalk are consistent with the preferred alternative for the roadway typical section from the *2008 Rouse Avenue – Bozeman EA* and associated roadway reconstruction project to be completed by MDT in Fiscal Year 2016.

4.8.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

By increasing maximum vertical grades to 6 percent, impacts on adjacent businesses would be minimized. Additional right-of-way appears to be necessary for the underpass construction, which includes easement within MRL property and proposed right-of-way as fee from private property owners. A total of approximately 20,200 $ft.^2$ is estimated for right-of-way acquisition, at

$20/ft.^{2} (2015$), which is market value for commercial properties for this area of Bozeman per discussions with MDT right-of-way agents and other local information available.

4.8.5.5 UTILITIES

Existing underground and above ground utilities would require relocation or adjustment within the limits of construction for the underpass. As previously mentioned the existing utilities were identified based on field visits or other sources and include fiber optic, high pressure natural gas, gas service lines, septic sewer, overhead electric lines and an irrigation crossing. A lump sum amount of $1.5M has been included in the estimate of probable cost as an allowance for utility relocation. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.8.5.6 OTHER FEATURES

4.8.5.6.1 Emergency Vehicle Considerations

The Rouse Avenue crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.8.5.6.2 Drainage

It appears prevailing drainage is to the north and west but due to the depth of the proposed undercrossing, a pump system could be required to convey stormwater away from the underpass. An allowance for a pump system is included in the conceptual order of magnitude estimate of probable project cost.

4.8.5.6.3 Retaining Walls

Retaining walls or a combined wall/partial slope cross section could be utilized depending on the extents of the footings for the I-90 Bridges. The retaining walls reduce the need for additional right-of-way which could negatively impact the businesses adjacent to Rouse Avenue in the crossing vicinity.

The retaining walls proposed for this crossing are tie back or pile and lagging style walls with precast or cast-in-place concrete fascia. These walls are constructed from the top down which minimizes excavation and the amount of right-of-way needed for the project. In addition, they can be designed to withstand hydraulic pressure from ground water. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.8.5.6.4 Concrete Seal

The static water level for groundwater appears to be a minimum of 10 feet below the existing terrain surface according to well logs available at the Montana Bureau of Mines and Geology (MBMG) website for wells. Accordingly, use of a structural seal to allow construction of the underpass has been included in the estimate. This seal is placed as construction of the roadway excavation and placement of the retaining walls proceeds. The depth will vary throughout its estimated approximate 700 feet of length with an average depth of 3 feet used in the estimate. The seal is assumed to be structural as it may also be required to act as a strut depending on final design of the retaining walls.

4.8.5.6.5 Maintenance

Due to the vertical grades associated with an underpass, maintaining through access for traffic during winter weather could be challenging. Boulevards along the project could be used for snow storage in winter, allowing for current snow removal operations through the underpass limits. During snowfall events, front loaders may need to be utilized when removing snow from Rouse Avenue in order to clear the underpass without impacting the pedestrian facilities. A heated roadway, not included in the project at this time, could minimize snow and ice removal but requires an expensive initial investment and maintenance costs.

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing

4.8.6 Constructability

With the recent reconstruction of the I-90 bridges, the supporting piers are located far enough from the roadway to allow for construction taking place. The pier locations allow room for the railroad bridge as well as temporary shoofly of tracks to facilitate the construction.

4.8.6.1 ROADWAY CONSTRUCTION

Due to the nature of the construction for the roadway underpass, Rouse Avenue would be closed during construction. The excavation required for the underpass and construction of the retaining walls would make it difficult to maintain through access within the project limits. Private and business access would need to be maintained during construct from the north or south side of the crossing.

4.8.6.2 RAILROAD CONSTRUCTION

To construct the undercrossing, the railroad would require the main line track to be temporarily rerouted to maintain train traffic. It is assumed the existing Cardinal Distributing industry spur track can be temporary closed for the construction duration and a single track shoofly approximately 1,500 feet long could be constructed using part of the spur track embankment and constructing new as needed south of this embankment. The shoofly would be a minimum of 12 feet clear to the north of existing I-90 westbound Pier 2. The bridge span, due to the tight overhead clearance from the I-90 bridges, could be erected to the north side of the existing track alignment and slid into place using rollers.

4.8.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

During construction, traffic would be diverted to N 7th Avenue via Oak Street and Griffin Drive. A temporary crossing could be built near the new underpass but would be a more expensive alternative than the traffic diversion.

4.8.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction costs, including PE, CE, IDC, right-of-way and 25 percent contingency is $36,400,000 (2015$). Table 4-15 shows the various cost components for the Rouse Avenue underpass option.

Table 4-15: Rouse Avenue Underpass Option Cost Estimate

Rouse Avenue Cost Components	Cost ($)
Road Work	$6,753,000
Railroad Work	$905,000
New Structure(s)	$6,542,000
Hydraulics	$600,000
Utilities	$1,500,000
Miscellaneous Items	$800,000
Mobilization (18%)	$2,900,000
Contingencies (25%)	$5,000,000
Preliminary Engineering (15%)	$3,800,000
Construction Engineering (15%)	$3,800,000
Right-of-Way	$403,000
IDC (10.37%)	$3,400,000
TOTAL COSTS (2015$)	**$36,400,000**

4.8.8 Benefit-Cost Analysis

A BCA was conducted for the Rouse Avenue grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Rouse Avenue grade separation. Refer to Appendix C for more information on the BCA.

Considering the monetized benefits and costs of the Montana Avenue grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $31.82 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $2.31 million, of which the largest benefit is $1.72 million worth of travel time savings, while the total costs amount to $34.14 million. Table 4-16 and Table 4-17 provide a summary of the BCA results.

Table 4-16: Monetized Benefits by Category for Rouse Avenue Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$3.67	$2.59	$1.72
Improved Safety	$0.60	$0.43	$0.28
Vehicle Operating Cost Savings	$0.23	$0.16	$0.11
Reduced Environmental Costs	$0.03	$0.02	$0.02
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$4.90**	**$3.46**	**$2.31**

Table 4-17: Benefit-Cost Analysis Results for Rouse Avenue Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$4.90	$3.46	$2.31
Total Costs ($2015 M)	$36.64	$35.51	$34.14
Net Present Value (NPV)	-$31.74	-$32.05	-$31.82
Return on Investment (ROI)	-86.63%	-90.26%	-93.23%
Benefit-Cost Ratio (BCR)	0.13	0.10	0.07
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.09%	-16.59%	-19.69%

Figure 4-22 illustrates the 20 years of undiscounted benefits following construction of the Rouse Avenue grade separation.

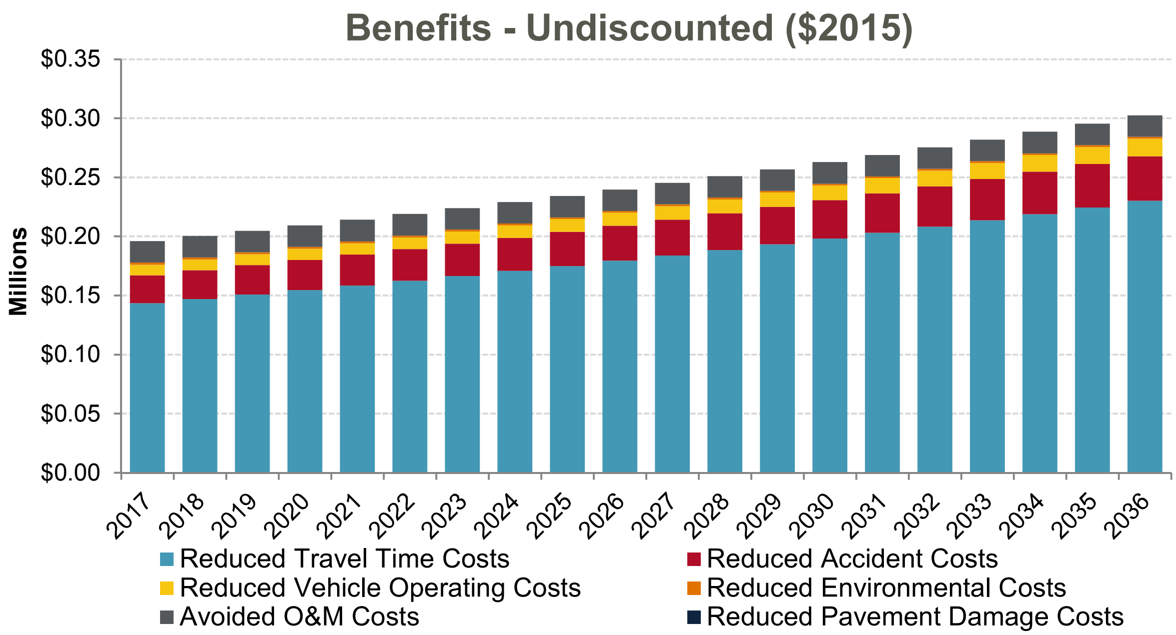

Figure 4-22. Projected Undiscounted Benefits for Rouse Avenue Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.8.9 Summary

The Rouse Avenue at-grade crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria previously described in this study. Based on a review of existing conditions and published documents, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with the long-range vision for the Rouse corridor as documented in previous studies as well as the roadway reconstruction project programmed in MDT's Tentative Construction Plan for Fiscal Year 2016.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

4.9 Benton Avenue, Helena, Route U-5805S, MRL MP 1.27, DOT #060199F

4.9.1 Overview

The North Benton Avenue (Benton Avenue) at-grade railroad crossing is located within the City of Helena and experiences daily volumes of vehicles of over 8,800 AADT in 2014 with a projection of over 11,200 in 2034. Thirty-five (35) railroad trains travel through this crossing daily. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. The traffic, roadway conditions, and safety hazards at this crossing resulted in it being identified as a priority within the state for improvement.

To ease congestion at this crossing and increase safety, grade separating the roadway from the railroad is proposed. Figure 4-23 shows the crossing area and provides a summary of the key statistics for this crossing.

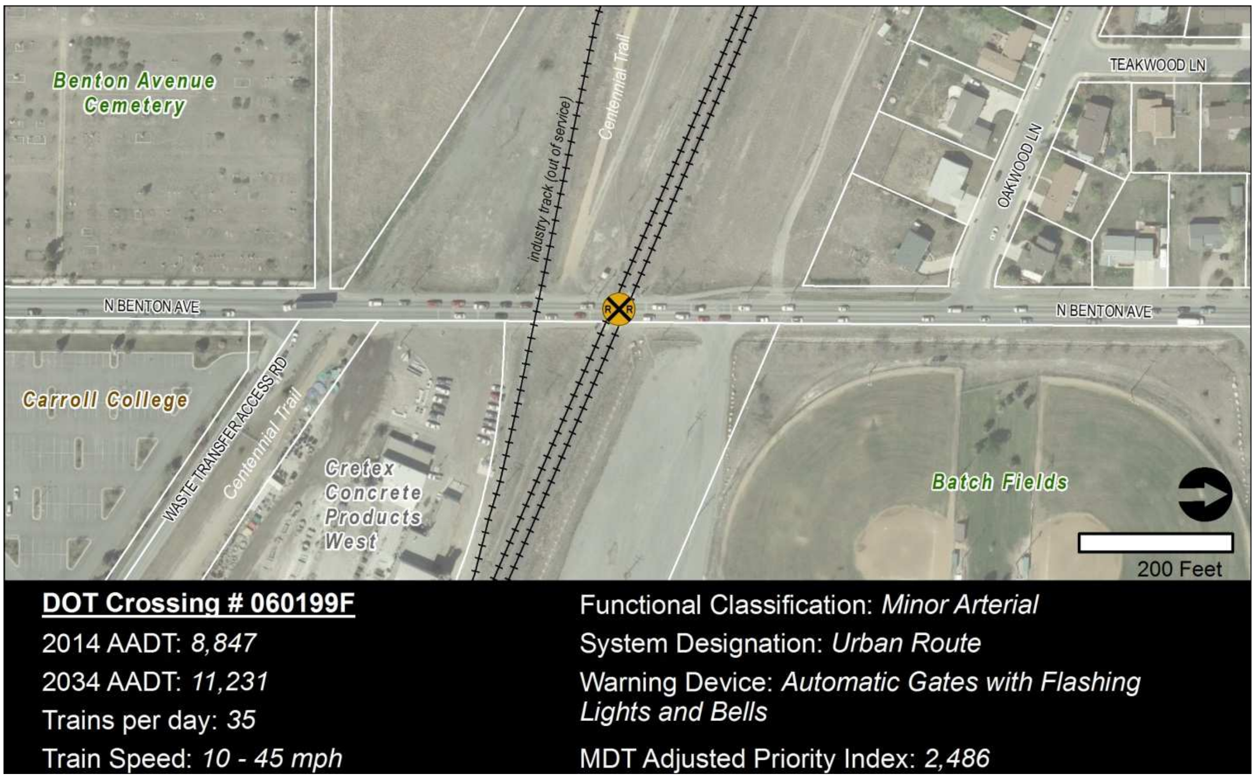

Figure 4-23. Benton Avenue Area Highway-Rail Crossings

4.9.2 Regional Context

Benton Avenue is functionally classified as a minor arterial roadway and designated as an Urban Route on the state's highway network. Benton Avenue provides a major linkage between Euclid Avenue/W Lyndale Avenue (US Highway 12) to the south of the crossing and West Custer Avenue to the north. Within the vicinity of the railroad crossing, Benton Avenue provides access to major features, including Carroll College, Bill Roberts Golf Course and Batch Fields, the Benton Avenue Cemetery, the Helena Waste Transfer Facility, Cretex Precast Manufacturing and the residential subdivisions west of Benton Avenue.

Five other at-grade crossings exist within the Helena urban area; however, no at-grade crossings are located within an approximate 1-mile radius from this crossing. The nearest crossings to the Benton Avenue crossing that are grade separated include: Henderson Street underpass to the west and Last Chance Gulch to the east. Figure 4-24 depicts the Benton Avenue crossing in context with other railroad crossings in the vicinity.

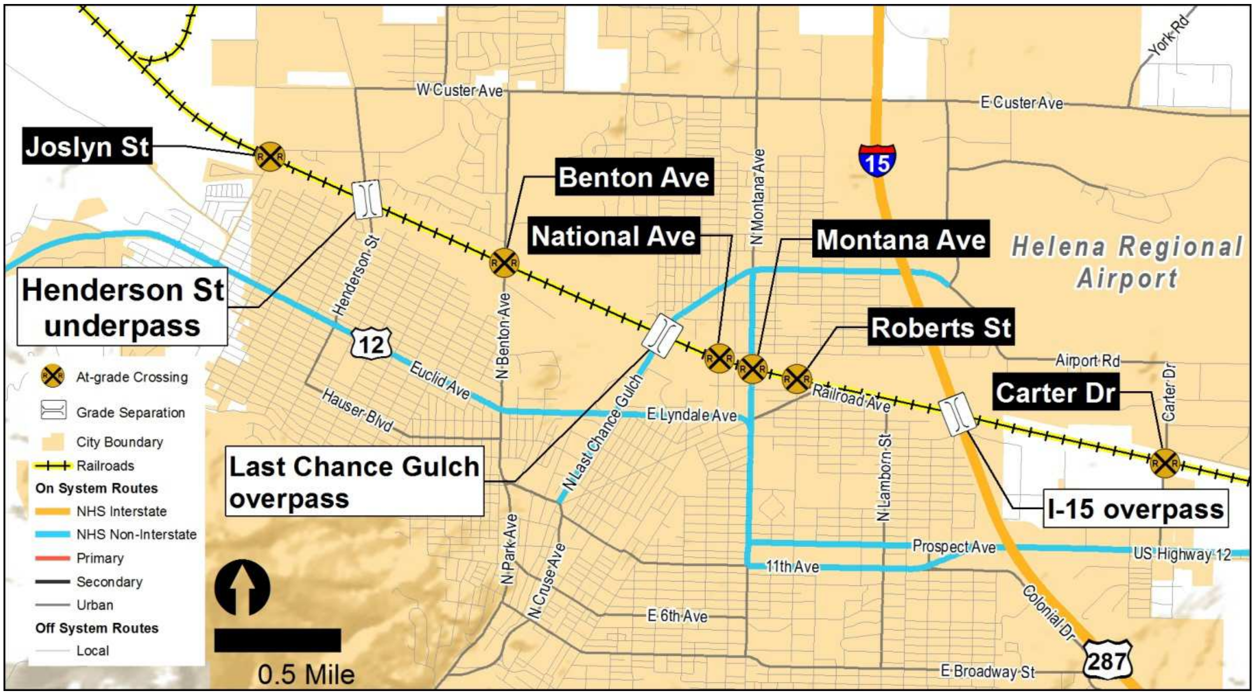

Figure 4-24. Helena Area Highway-Rail Crossings

4.9.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The *Greater Helena Area Long Range Transportation Plan—2014 Update* (2014 LRTP) was reviewed with respect to improvement recommendations for North Benton Avenue. The plan identified increasing traffic congestion and conflicts between turning movements and through traffic along this segment of Benton Avenue. The plan recognizes the delay and operational concerns at the Benton Avenue railroad crossings and recommends a grade separation feasibility study at this location to determine the feasibility of an overpass or an underpass grade-separated crossing (Project ID MSN-23). A grade separation is important for emergency service providers and overall traffic flow operations on Benton Avenue. The plan also recommends the segment of Benton Avenue from the railroad to Custer Avenue be brought up to the City's complete streets standards (Project ID MSN-21). Recommended improvements include widened driving lanes, shoulders, and lighting, as well as pedestrian features (i.e., east side sidewalk and/or path). Bicycle lanes and widened shoulders are also recommended.

Pedestrian improvements to the Centennial Trail are recommended at this location within the 2014 LRTP to include a rectangular rapid flashing beacon (RRFB) and creation of a waiting area for trail users to avoid blocking the bike lanes.

In 2003, MDT conducted a statewide railroad grade separation feasibility study. Twenty (20) individual grade crossings were evaluated in the study across Montana. That study identified the Benton Avenue crossing as the fourth highest statewide crossing priority. Both an overpass and underpass option were determined feasible; however, that study notes community input recognized the Montana Avenue crossing as a much higher priority for the city of Helena.

4.9.3 Existing Crossing Features

The following sections describe the existing conditions at the Benton Avenue crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 7, 2015.

4.9.3.1 EXISTING ROADWAY

The 2014 AADT within the vicinity of the railroad crossing is 8,847 vehicles per day with a projected AADT in 2034 of 11,231. At the location of the at-grade crossing, the 36-foot-wide Benton Avenue is a 2-lane roadway with two 12-foot lanes and 6-foot shoulders. This typical section continues north of the at-grade crossing and includes a 6-foot asphalt multi-use path along the west side of Benton Avenue that connects with the Centennial Park Trail and to the residential subdivision at Oakwood Lane. The existing roadway section south of the access for the City of Helena Transfer Station is an urban typical section with curb, gutter, boulevards, and sidewalks on both sides of the roadway.

Existing traffic control along Benton Avenue within the vicinity of the crossing includes stop signs at the Solid Waste Transfer Station access road, Batch Field access road, Oakwood Lane and Cole Avenue. No traffic signals exist in the vicinity of the crossing. The posted speed limit on Benton Avenue is 35 mph within the vicinity of the crossing.

4.9.3.2 EXISTING RAILROAD AND RAILROAD FEATURES

Photo 4-15. Benton Avenue south of crossing area, looking north

Benton Avenue crosses two existing main tracks at approximately 14-foot centers and a third out-of-service industry spur track approximately 99 feet south of the southerly main track. The main track crossing has flashing lights, gates and bells for crossing protection of vehicular traffic. Crossing signals do not exist on the spur track as it is out of service and not connected to any operating track. All three tracks have precast concrete panels as the crossing surface for the roadway. The main tracks are on a six to eight foot embankment with the roadway graded up on both sides to meet the track elevation. An advance crossing blocked warning signal exists for southbound traffic on Benton approximately one-half mile south of the at-grade crossing to allow traffic to exit Benton onto Wilder Avenue to detour around the blocked at-grade rail crossing. Railroad timetable operating speeds through the crossing area are 45 mph.

4.9.3.3 EXISTING NON-MOTORIZED FEATURES

No dedicated on-street bicycle facilities exist along Benton Avenue within the vicinity of the crossing. The east-west Centennial Trail is a shared use path that crosses Benton Avenue south of the railroad tracks. The trail uses the shoulder of Benton Avenue on the west side of the roadway with an unmarked Benton Avenue crossing to connect to the other portions of the trail. There are trail systems both north and south of the crossing going east. There is no designated trail crossing on Benton Avenue to provide a safe connection between trail segments. Designated shared use shoulder/bicycle lanes exist on Benton Avenue starting approximately 400 feet south of the at-grade crossing and running south toward downtown Helena.

4.9.3.4 UTILITIES

Existing utilities include overhead power located primarily on the west side and parallel to Benton Avenue with a 2nd overhead transmission line paralleling the railroad tracks crossing Benton Avenue on the north side of the railroad crossing. Existing underground utilities, which are known based on field visits or other sources, include a high pressure natural gas line, water, fiber optic and possibly sanitary sewer. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.9.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Benton Avenue crossing consists of an easement across railroad property and appears to be a total width of approximately 40 feet. MRL/BNSF right-of-way varies in the vicinity of the crossing between 400 to 500 feet with tracks roughly centered in the right-of-way. Existing land uses within the immediate vicinity of the crossing is a mix of a cemetery, commercial, light industrial, recreational, and residential uses.

4.9.4.1 EXISTING BUSINESSES

The Cretex Concrete Products West business is located southeast of the railroad crossing. The property includes fabrication space, areas of parking and product storage immediately off of Benton Avenue. The business lacks a defined entrance to/from Benton Avenue as no curbs exist at this location. South of the Waste Transfer Facility access road, a parking lot for Carroll College is located on the east of Benton Avenue which has an access to Benton Avenue when used for games or special events. No businesses exist immediately north of the railroad crossing.

Photo 4-16. Cretex Concrete entrance area from Benton Avenue

4.9.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

Public recreational facilities in the vicinity of the railroad crossing include Batch Fields, a baseball/softball complex, to the northeast as well as the Centennial Trail which crosses near the railroad crossing. A parking area for Batch Park softball/baseball fields exists immediately north of the crossing. An access road to the parking area is located approximately 130 feet north of the crossing. The Northern Pacific Railroad Main Line and the Great Northern Railroad Line that the Centennial trail is located near are historic features and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

The Benton Avenue Cemetery is a site of historical significance listed on the NRHP and is located to the southwest of the crossing. One gated entrance to the cemetery exists off of Benton Avenue. Records indicate not all graves are within the fenced area of the cemetery.

Batch Fields and Centennial Trail are potential Section 4(f) properties and additional analysis would be required to determine their Section 4(f) applicability. Because of its listing on the NRHP, the Benton Avenue Cemetery is afforded protection under Section 4(f). Should either an underpass or overpass option be progressed at this location, a Section 4(f) evaluation may be required to determine the extent of the cemetery protected under Section 4(f) (e.g., the entire property versus select grave sites) and the level of impact, or "use," resulting from the improvements. Visual and/or noise impacts on the cemetery may need to be evaluated; however, due to the existing presence of the adjacent roadway and railroad, it is unlikely visual and/or noise impacts would substantially impair the features or attributes of the cemetery that are responsible for its inclusion on the NRHP.

4.9.4.3 RESIDENTIAL

Residential areas exist along the west side of Benton Avenue, both north and south of the railroad. Most immediate to the railroad crossing is the residential area to the northwest of the crossing. Oakwood Lane, located approximately 450 feet north of the crossing, provides one of two access means into the subdivision from Benton Avenue.

Photo 4-17. Oakwood Lane & Benton Avenue Intersection, looking west

4.9.5 Proposed Solution

The Benton Avenue at-grade crossing initially lends itself to an underpass solution, based on the existing roadway grade generally being lower than the railroad crossing grade, as well as consideration to the adjacent residential development to the north of the crossing. However, an underpass solution could result in impacts on the Benton Avenue Cemetery and access/circulation issues at the Cretex facility and affect access to the Helena Waste Transfer Station and Carroll College parking lot. With an underpass, the entrance to the Cretex, Helena Waste Transfer Station and Carroll College could be approximately 15 feet below existing grade, making it difficult or possibly infeasible to provide access for trucks entering and exiting the Cretex facility even with a relocated entrance from the Transfer Station Road due to a sloped access into the Cretex facility and resultant take in Cretex yard space. The Centennial Trail crossing could require additional trail improvements to bring the crossing at Benton Avenue down to meet the proposed underpass profile. An underpass option has minor impacts on the residential neighborhood located northwest of the crossing. The underpass grading requires a sloped access road to be constructed to Batch Fields located northeast of the crossing to accommodate approximately 15 feet of grade difference from Benton Avenue to the Batch Fields southern parking lot with a portion of the lot supported by retaining wall. The underpass option could also require a double track shoofly.

An overpass option shifts the roadway vertical profile changes to the north of the crossing. This decreases the impacts for Cretex, the Helena Waste Transfer Station and Carroll College while avoiding direct impacts on the Benton Avenue Cemetery. The profile shift, however, increases impacts on the residential neighborhood located northwest of the crossing. The intersection of Benton Avenue and Oakwood Lane is approximately 15 feet above the existing ground and could require relocation of approximately five residences in order to maintain access to Oakwood Lane, which is the second access to the residential neighborhood from Benton for emergency vehicles. An analysis could be performed of traffic patterns in the residential area to determine if other accesses to W. Custer Avenue and Henderson are adequate and maintaining connectivity to Oakwood Lane is not needed. The overpass option would provide a grade-separated pedestrian underpass for the Centennial Trail crossing located south of the railroad tracks. A temporary shoofly would not be required for an overpass option but a lowering of the tracks in this area minimizes overpass impacts.

Henderson Street and its underpass to the west are one of the alternate routes for vehicles if the Benton Avenue crossing is blocked by trains. This route results in a 1 ¾ to 2 mile detour with traffic having to divert at Euclid Avenue to the south or Custer Avenue on the north. The existing underpass structure for Henderson Street under the railroad is signed for 14-foot clearance. Further discussion of improving this existing grade-separated structure is included in Section 5.2.2. This undercrossing may serve as an alternative to grade separating Benton Avenue; however, additional traffic studies may be needed to determine the usefulness of this route if Benton Avenue remains unchanged.

Figures 4-25 and 4-26 provide detail of the proposed conceptual plan and profile for both the underpass and overpass improvement options. Further description of these concepts is provided in the following sections.

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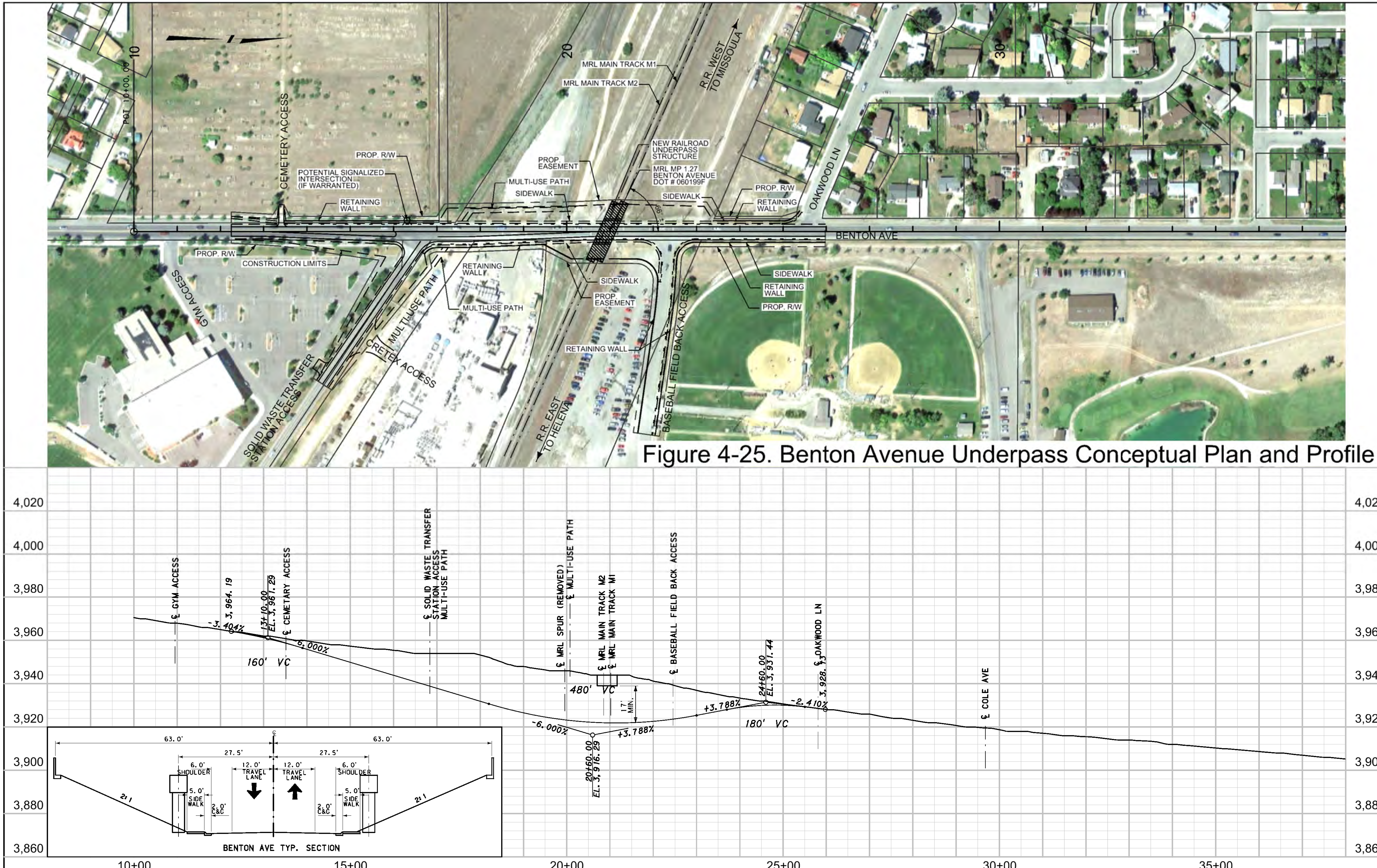


Figure 4-25. Benton Avenue Underpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	$FILEABBREV$ $DATE$ $TIME$ $username$	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS	PRELIMINARY	MONTANA RAIL GRADE SEPARATION STUDY	HELENA, MT
			LEWIS AND CLARK COUNTY		N/A / SCALE 1"=200'	SHEET X OF X

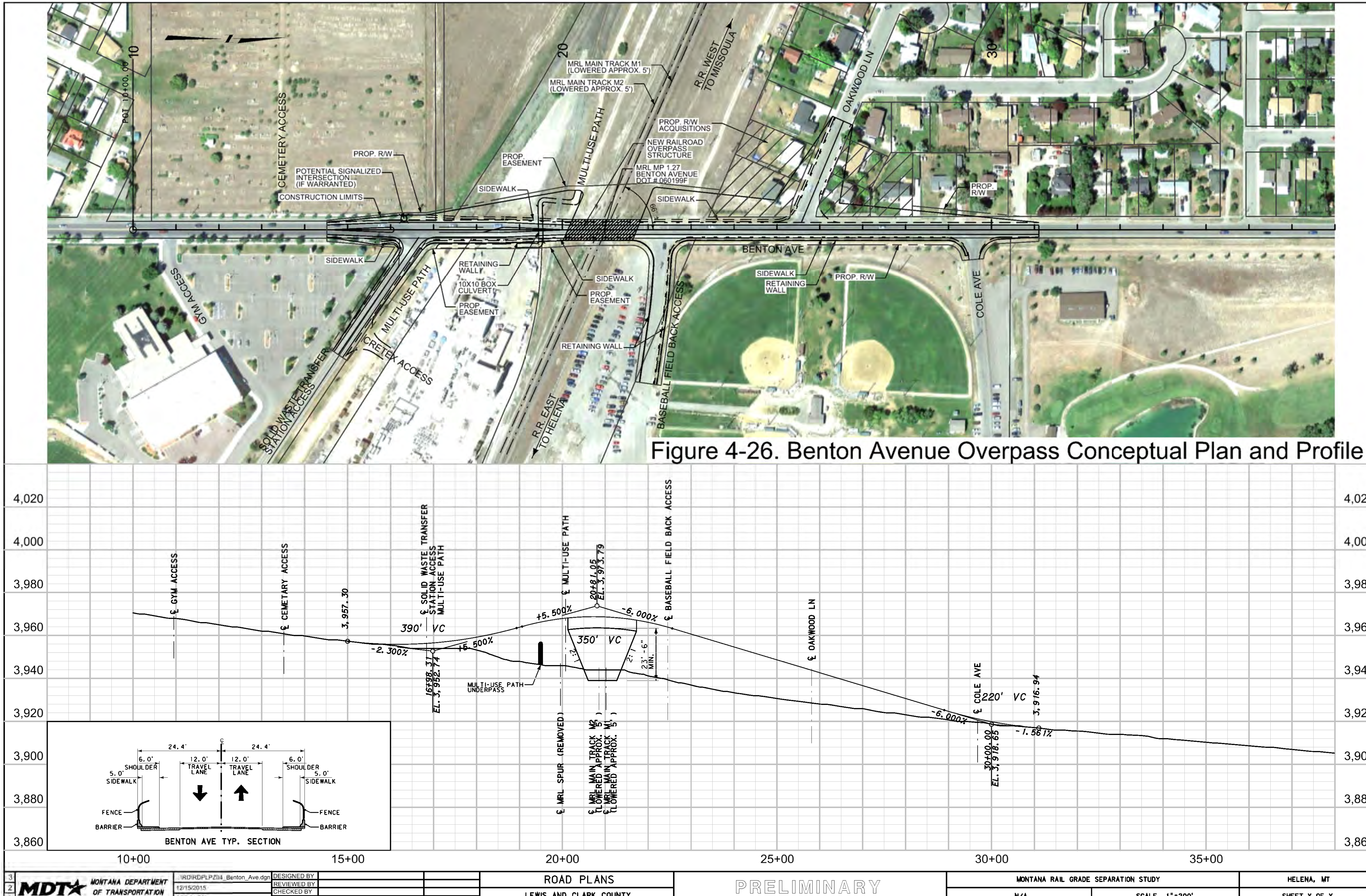


Figure 4-26. Benton Avenue Overpass Conceptual Plan and Profile

4.9.5.1 PROPOSED ROADWAY FEATURES – UNDERPASS OPTION

The roadway underpass along Benton Avenue would consist of two 11-foot travel lanes with, 6-foot shoulders, curb and gutter, with 5-foot sidewalks on each side. The proposed roadway typical section would match the existing conditions along Benton Avenue. The horizontal alignment would perpetuate existing conditions while the vertical profile for the underpass would utilize 6 percent maximum grades south of the railroad tracks in an effort to minimize impacts on the adjacent properties. Vertical curvature is designed to meet 35 mph design criteria. Refer to Figure 4-25 for the proposed conceptual plan and profile for the underpass.

Retaining walls could be utilized on the southwest approach of the underpass to reduce impacts on the Benton Avenue Cemetery. They could also be used along the Cretex property on the southeast approach and along the northwest approach to minimize right-of-way impacts and avoid private property acquisition. Retaining walls could also be used along the Batch Field access in order to minimize impacts on the recreational property. Roadway excavation would be required to construct cut slopes where retaining walls are not required. Cut slopes on the south end of the underpass, at the railroad structure and along the Helena Solid Waste Transfer Station Access would be 2H:1V.

Accesses located directly north and south of the crossing would also need to be reconstructed. Access to the City of Helena Solid Waste Transfer Station and Cretex would be combined. The Cretex access off of Benton Avenue would be replaced with an access off the Solid Waste access road to limit impacts on Cretex's property layout and circulation. The underpass option would require Cretex's access to be farther set-back from Benton Avenue due to the proposed vertical grades. The Batch Fields access located northeast of the crossing would be reconstructed with minimal impacts on the parking located between the railroad tracks and the baseball fields.

4.9.5.2 RAILROAD FEATURES – UNDERPASS OPTION

A double track 3-span ballast deck steel wide flange beam span structure supported on concrete foundation founded on drilled shafts or steel piling would support the two main tracks over the undercrosing. The spans and substructure would be skewed 24 degrees to the tracks to parallel the roadway which is less than the 30 degree skew allowed. Concrete approach slabs would be used to square the ends of the bridge to the tracks. This bridge provides an open structure underneath which enhances sight distances for vehicles from Batch Park and the proposed combined Waste Transfer/Cretex road. The disconnected and unused spur track would be removed. With the railroad grade descending to the west in this area, a track raise in the area of the crossing would steepen the grade west of the crossing, which is undesirable to the railroad.

4.9.5.3 NON-MOTORIZED FEATURES – UNDERPASS OPTION

The existing trail crossing at Benton Avenue would need to be maintained or reconstructed. A new at-grade trail crossing is recommended to minimize trail grading and additional improvements needed with the addition of the roadway underpass. The trail crossing location is shown in Figure 4-25. The roadway underpass would also accommodate 5-foot sidewalks to provide continuous pedestrian access along Benton Avenue to the proposed improvement limits north of the railroad tracks. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk.

4.9.5.4 LAND USE AND RIGHT-OF-WAY ISSUES – UNDERPASS OPTION

Right-of-way impacts are anticipated along the east side of Benton Avenue at the beginning of the underpass. Limited impacts are anticipated along the remainder of the project limits due to the use of retaining walls. The intersection of Benton Avenue and Oakwood Lane would likely require minor right-of-way changes associated with the intersection reconstruction. The use of retaining walls south of the intersection would likely not require property relocations in this area. The use of retaining walls along portions of the east side of the roadway helps to limit the impacts on the Cretex and Batch Field properties. The total area of right-of-way required to construct the overpass is estimated around 78,900 square feet.

4.9.5.5 UTILITIES – UNDERPASS OPTION

The existing utilities previously mentioned would most likely require adjustments and relocation in order to accommodate the roadway underpass. These utilities include overhead power, high pressure natural gas line, water, fiber optic and possibly sanitary sewer. These utilities are not all inclusive and a more exhaustive survey using One-Call services will be required as part of a future design effort.

4.9.5.6 OTHER FEATURES – UNDERPASS OPTION

4.9.5.6.1 Emergency Vehicle Considerations

The Benton Avenue crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.9.5.6.2 Drainage

Drainage improvements would be required to accommodate the proposed grading for the underpass. Additional storm drain facilities would be included in the underpass improvements in order to capture and convey the surface drainage to match current conditions which drain to the north or be kept on-site in newly designed detention facilities. Groundwater levels appear to be around 40 feet below ground elevations in the crossing area. Construction is anticipated to be in the dry.

4.9.5.6.3 Retaining Walls

As stated previously, retaining walls would be constructed along the majority of the improvement limits for the underpass in order to minimize right-of-way and property impacts. These areas include the frontage of the Benton Avenue Cemetery, Cretex, the residential neighborhood on the northwest approach and Batch Fields.

The retaining walls proposed for this crossing estimate are tie back or pile and lagging style walls with precast or cast-in-place concrete fascia. These walls are constructed from the top down which minimizes excavation and the amount of right-of-way needed for the project. However, due to the historic designation of the cemetery and records indicating graves are outside the cemetery boundaries, tie-backs could not be used in this area and walls would be more expensive along the cemetery limits. The face of the walls can vary from standard plain concrete panels to use of architectural form liner and colorizing to meet the desires of the local community.

4.9.5.6.4 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.9.5.7 ROADWAY CONSTRUCTION – UNDERPASS OPTION

Construction of the new roadway underpass would require Benton Avenue to be temporarily closed. A temporary detour route would need to be established as well as coordination with local properties to maintain access during construction. Alignment for a temporary at-grade crossing of shoofly tracks, which would be located north of the existing tracks and west of existing Benton Avenue, would be difficult to fit with the skew of the crossing and proximity of the residential area and cemetery.

4.9.5.8 RAILROAD CONSTRUCTION – UNDERPASS OPTION

A double track shoofly would be required to meet the train operations requirements during construction of the underpass. The shoofly would be built to the north of the existing tracks due to the Cretex location on the south side. An 8- to 10-foot high temporary embankment would need to be constructed to maintain the railroad profile. To maintain the 45 mph operations, the shoofly is estimated to be approximately 1,500 feet long for a total track length of 3,000 track feet. Once train traffic was diverted, the railroad bridge could be constructed and once completed and trains back on the original alignment, the remainder of the underpass would be constructed.

Photo 4-18. Shoofly track area, north of crossing, looking west

4.9.5.9 TRAFFIC IMPACTS DURING CONSTRUCTION – UNDERPASS OPTION

Due to the nature of the underpass construction, Benton Avenue would be closed and a temporary detour route would be established. Temporary impacts due to increased congestion on North Montana Avenue and Henderson Street and their intersections with Custer Avenue and Euclid Avenue/Lyndale Avenue would be expected during construction. Public outreach would be required in order to keep the general public and business owners informed of project status and temporary closures.

4.9.5.10 ROADWAY FEATURES – OVERPASS OPTION

The roadway overpass along Benton Avenue could consist of two11-foot travel lanes, 6-foot shoulders and 5-foot sidewalks. A pedestrian fence would be required above the concrete barrier to provide pedestrian safety on the new overpass structure and prevent debris from being tossed on the railroad tracks per railroad standards. The proposed roadway typical section would match the existing conditions along Benton Avenue. The horizontal alignment would perpetuate existing conditions while the vertical profile for the overpass would utilize 6 percent maximum grades in an effort to minimize impacts on the adjacent properties. Vertical curvature is designed to meet 35 mph design criteria. Refer to Figure 4-26 for the proposed conceptual plan and profile for the overpass.

Retaining walls would be utilized on the southeast approach of the new roadway structure to reduce impacts on the Cretex property and their current business operations. Retaining walls would also be used along the Bench Field access in order to minimize impacts on the recreational property. Embankment material will be placed and fill slopes constructed where retaining walls are not required. The area to the northeast of the crossing would most likely require 2H:1V fill slopes in order to not impact Batch Field, which would require guardrail or some other approved roadside safety barrier. Fill slopes located on the west side of Benton could be flattened to 3H:1V to improve roadside safety.

Photo 4-19. Existing Waste Transfer Access Road and intersection with Benton Avenue, looking east (Carroll College parking gate to right)

Private accesses located directly north and south of the crossing would also need to be reconstructed. Access to the City of Helena Solid Waste Transfer Station and Cretex would be combined. The Cretex access off of Benton Avenue would be replaced with an access off the Solid Waste access road to limit impacts on Cretex's property layout and circulation. The Batch Fields access located northeast of the crossing would be reconstructed with minimal impacts on the parking located between the railroad tracks and the baseball fields. The intersection with Cole Avenue north of the baseball fields would also be reconstructed to match the improvements along Benton Avenue. The Cole Avenue improvements would be concentrated at the intersection with Benton and mainly consist of minor grading improvements.

4.9.5.11 PROPOSED RAILROAD FEATURES – OVERPASS OPTION

To minimize impacts of the proposed overpass, lowering of the two existing mainline tracks four to five feet is proposed. This reduces impacts by nearly 200 feet of total length including reducing impacts on the historical cemetery, a potential Section 4(f) property, access to the Carroll College parking area, and the connection with the proposed shared road to Cretex and the Waste Transfer Station. In addition, impacts are reduced to Batch Fields, another potential Section 4(f) property, and residential area north of the tracks. In reviewing the railroad profile, there is a relative crest approximately 1,500 feet east of Benton Avenue and the railroad is on a 6- to 8-foot embankment through the crossing. Lowering the track involves temporary embankment and track shifting, removal of existing embankment material and reconstruction of the track at a lower level. This work would be coordinated with the roadway and roadway bridge work. The lowering would extend approximately 600 feet west of the Benton Avenue crossing. It is unknown if the railroad embankment material to be excavated is suitable for fill on the roadway overpass, but if suitable, it could be used to minimize borrow material for the roadway fill.

The lowering helps provide the required 23 feet 4 inches clearance and minimize the length of the roadway impacts. It is proposed the out-of-service spur track be removed. Further discussions with the railroad could result in concurrence with the railroad grade lowering and removal of the out-of-service spur track crossing.

Photo 4-20. Looking east at relative crest to be lowered

4.9.5.12 PROPOSED NON-MOTORIZED FEATURES – OVERPASS OPTION

The existing trail crossing at Benton Avenue would need to be maintained or reconstructed. A trail underpass is recommended to minimize trail grading and additional improvements needed with the addition of the roadway overpass. The trail underpass structure could be a 10-foot-by-10-foot box culvert as shown in Figure 4-26. The roadway overpass would also accommodate 5-foot sidewalks to provide continuous pedestrian access along Benton Avenue to the proposed improvement limits north of the railroad tracks. The roadway profile for an overpass exceeds the maximum running grade for ADA accessibility. Based on impacts for an overpass with grades to meet ADA guidelines, exceptions would need to be discussed based on the most practicable alternative for the roadway grade of the overpass, which is consistent with FHWA, ADA and PROWAG guidelines.

4.9.5.13 LAND USE AND RIGHT-OF-WAY ISSUES – OVERPASS OPTION

Right-of-way impacts are anticipated along the west side of Benton Avenue due to the fill slopes required to construct the overpass. The neighborhood located northwest of the railroad crossing would be impacted by the reconstructed intersection of Benton Avenue and Oakwood Lane. The intersection is located 450 feet north of the railroad crossing, which will require a grade raise of approximately 15 feet in order to match the proposed vertical profile for Benton Avenue. It is estimated five residential structures within the subdivision would require property relocations. The use of retaining walls along portions of the east side of the roadway helps to limit the impacts on the Cretex and Batch Field properties. The total area of right-of-way required to construct the overpass is estimated around 38,200 ft^2.

4.9.5.14 UTILITIES – OVERPASS OPTION

The existing utilities previously mentioned would most likely require adjustments and relocation in order to accommodate the roadway overpass. These utilities include overhead power, high pressure natural gas line, water, fiber optic and possibly sanitary sewer. These utilities are not all inclusive and a more exhaustive survey using One-Call services will be required as part of a future design effort.

4.9.5.15 OTHER FEATURES – OVERPASS OPTION

4.9.5.15.1 Emergency Vehicle Considerations

The Benton Avenue crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.9.5.15.2 Drainage

Additional culverts and/or storm drain facilities would be included in the overpass improvements. This would capture and convey the surface drainage to match current conditions. An alternative, which is not included in this study, if the project were progressed, could be to use on-site stormwater detention ponds. However additional right-of-way or an easement from the railroad could be required.

4.9.5.15.3 Retaining Walls

As stated previously, retaining walls would be constructed on the southeast approach of the overpass to reduce impacts on the Cretex property as well as along the entrance to the parking area south of Batch Field. These could be MSE style walls, precast or cast-in-place concrete fascia for aesthetics could be used.

4.9.5.15.4 Maintenance

The maintenance cost for major design features for the overpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.9.5.16 ROADWAY CONSTRUCTION – OVERPASS OPTION

Construction of the new roadway overpass would require Benton Avenue to be temporarily closed. A temporary detour route would need to be established as well as coordination with local properties to maintain access during construction.

4.9.5.17 RAILROAD CONSTRUCTION – OVERPASS OPTION

For safety requirements during the overpass construction, MRL would also be providing railroad flagging to protect trains and construction workers while working within, or having the capability of fouling, 25 feet from the track centerlines. Railroad track lowering uses a combination of temporary track shifting, removal of material and shifting track back onto the lowered reconstructed embankment.

4.9.5.18 TRAFFIC IMPACTS DURING CONSTRUCTION – OVERPASS OPTION

Due to the nature of the construction, Benton Avenue would be closed and a temporary detour route would be established. Temporary impacts due to increased congestion on North Montana Avenue and Henderson Street and their intersections with Custer Avenue and Euclid Avenue/Lyndale Avenue would be expected during construction. Public outreach would be required in order to keep the general public and business owners informed of project status and temporary closures.

4.9.6 Cost Estimate

4.9.6.1 COST ESTIMATE

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $28,300,000 (2015$) for the underpass option and $25,900,000 (2015$) for the proposed overpass option. Table 4-18 shows the various cost components for both an overpass and underpass option for the proposed Benton Avenue improvements.

Table 4-18. Benton Avenue Underpass and Overpass Options Cost Estimate

Benton Avenue Cost Components	Underpass Cost ($)	Overpass Cost ($)
Road Work	$5,968,000	$6,046,000
Railroad Work	$1,596,000	$2,094,000
New Structure(s)	$3,036,000	$1,460,000
Hydraulics	$600,000	$100,000
Utilities	$1,000,000	$1,000,000
Miscellaneous Items	$600,000	$500,000
Mobilization (18%)	$2,200,000	$1,900,000
Contingencies (25%)	$3,800,000	$3,300,000
Preliminary Engineering (15%)	$2,800,000	$2,500,000
Construction Engineering (15%)	$2,800,000	$2,500,000
Right-of-Way	$1,182,000	$2,073,000
IDC (10.37%)	$2,700,000	$2,400,000
TOTAL COSTS (2015$)	**$28,300,000**	**$25,900,000**

4.9.7 Benefit-Cost Analysis

A BCA was conducted for the Benton Avenue grade separation project to include both an underpass and overpass option. The BCA provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Benton Avenue grade separation. Refer to Appendix C for more information on the BCA.

4.9.7.1 UNDERPASS RESULTS

Considering all monetized benefits and costs of the Benton Avenue underpass grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $25.03 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $1.53 million, of which the largest benefit is $0.97 million worth of travel time savings, while the total costs amount to $26.57 million. Table 4-19 and Table 4-20 provide a summary of the BCA results.

Table 4-19. Monetized Benefits by Category for Benton Avenue Grade Separation – Underpass Option

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$2.06	$1.45	$0.97
Improved Safety	$0.66	$0.47	$0.31
Vehicle Operating Cost Savings	$0.13	$0.09	$0.06
Reduced Environmental Costs	$0.02	$0.01	$0.01
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$3.23**	**$2.29**	**$1.53**

Table 4-20. Benefit-Cost Analysis Results for Benton Avenue Grade Separation – Underpass Option

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$3.23	$2.29	$1.53
Total Costs ($2015 M)	$28.54	$27.65	$26.57
Net Present Value (NPV)	-$25.30	-$25.36	-$25.03
Return on Investment (ROI)	-88.67%	-91.73%	-94.24%
Benefit-Cost Ratio (BCR)	0.11	0.08	0.06
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-15.17%	-17.64%	-20.70%

Figure 4-27 illustrates the 20 years of undiscounted benefits following construction of the Benton Avenue grade separation.

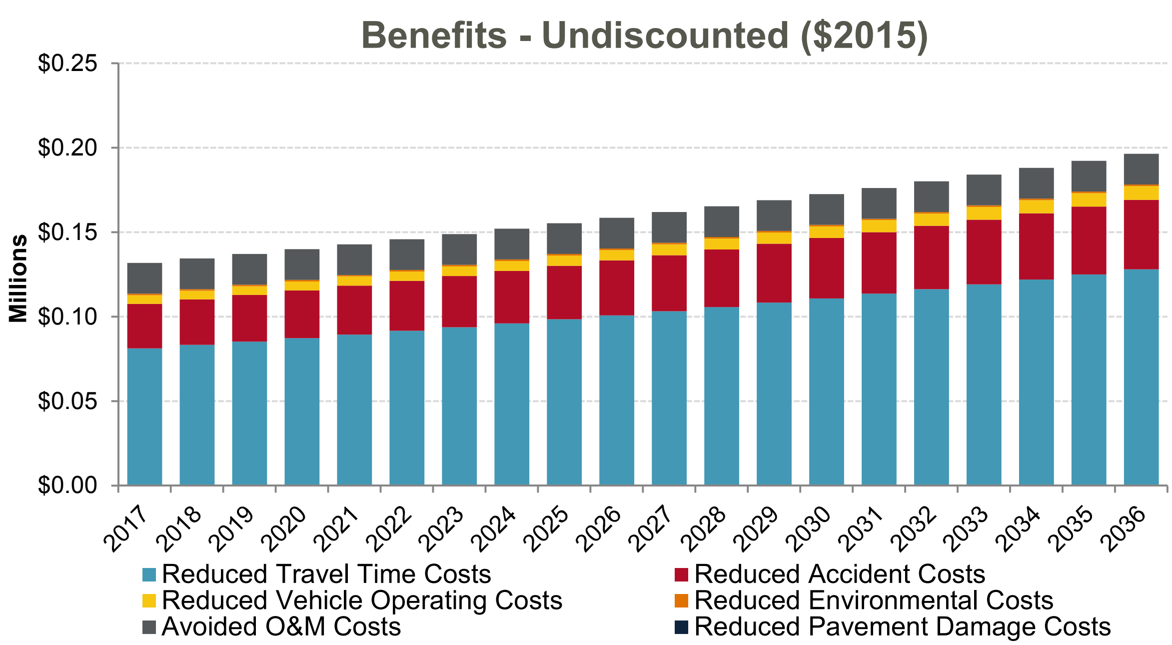


Figure 4-27. Projected Undiscounted Benefits for Benton Avenue Grade Separation – Underpass Option

4.9.7.2 OVERPASS RESULTS

Considering all monetized benefits and costs of the Benton Avenue grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $22.78 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $1.53 million, of which the largest benefit is $0.97 million worth of travel time savings, while the total costs amount to $24.31 million. The monetized benefits for the Benton Avenue overpass option are identical to the underpass option and are shown in Table 4-19 and Figure 4-27 above. Table 4-21 provides a summary of the BCA results for the overpass option.

Table 4-21. Benefit-Cost Analysis Results for Benton Avenue Grade Separation – Overpass Option

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$3.23	$2.29	$1.53
Total Costs ($2015 M)	$26.12	$25.30	$24.31
Net Present Value (NPV)	-$22.89	-$23.02	-$22.78
Return on Investment (ROI)	-87.62%	-90.96%	-93.70%
Benefit-Cost Ratio (BCR)	0.12	0.09	0.06
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.66%	-17.14%	-20.22%

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build (both underpass and overpass options) and no-build scenario.

4.9.8 Summary

The Benton Avenue at-grade crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification and priority index. Based on a review of existing conditions and published documents, both an underpass and overpass were evaluated at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with the 2014 LRTP.

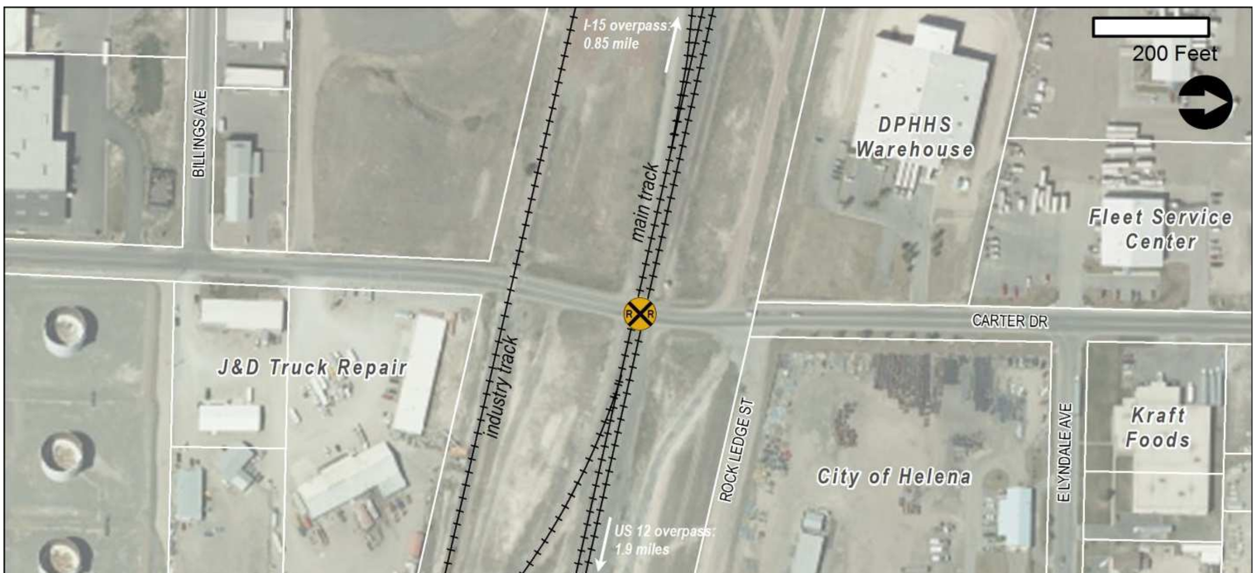
As illustrated in this section, both the overpass and underpass options would result in impacts within the vicinity of the crossing. An underpass option, while reducing impacts on several residences, would result in impacts on commercial/industrial access as well as access to Carroll College, and impacts the Benton Avenue Cemetery. An overpass solution, while resulting in impacts on several residences, could avoid impacting the Benton Avenue Cemetery and have fewer impacts on surrounding businesses and Carroll College parking. The information provides a planning-level assessment of potential impacts and benefits. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

4.10 Carter Drive, Helena, Route U-5806E, MRL MP 236.98, DOT #086240V

4.10.1 Overview

The City of Helena's Carter Drive has an at-grade railroad crossing with an AADT of over 4,000 in 2014 and a projection of over 6,100 vehicles per day in 2034. Thirty-three (33) railroad trains travel through this crossing daily, with additional switching moves from the east end of the railroad yard. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. The traffic, roadway conditions, and safety hazards at this crossing resulted in it being identified as a priority within the state.

To ease congestion at this crossing and increase safety, grade separating the roadway from the railroad is proposed. Carter Drive generally slopes down to the north, rising up to, and dropping rather quickly, in elevation from the crossing, making an underpass solution the most feasible grade separation solution at this location. Figure 4-28 shows the crossing area and provides a summary of the key statistics for this crossing.



DOT Crossing # 060190U

2014 AADT: *4,002*

2034 AADT: *6,184*

Trains per day: *33*

Train Speed: *10 - 45 mph*

Functional Classification: *Minor Arterial*

System Designation: *Urban Route*

Warning Device: *Automatic Gates with Flashing Lights and Bells*

MDT Adjusted Priority Index: *681*

Figure 4-28. Carter Drive Crossing Overview

4.10.2 Regional Context

Carter Drive is designated as an Urban Route on the state's highway network and serves as an important north-south linkage between Prospect Avenue (US 12/US 287) and Airport Road on Helena's east side. Figure 4-29 depicts the Carter Drive crossing in context with other railroad crossings in the vicinity.

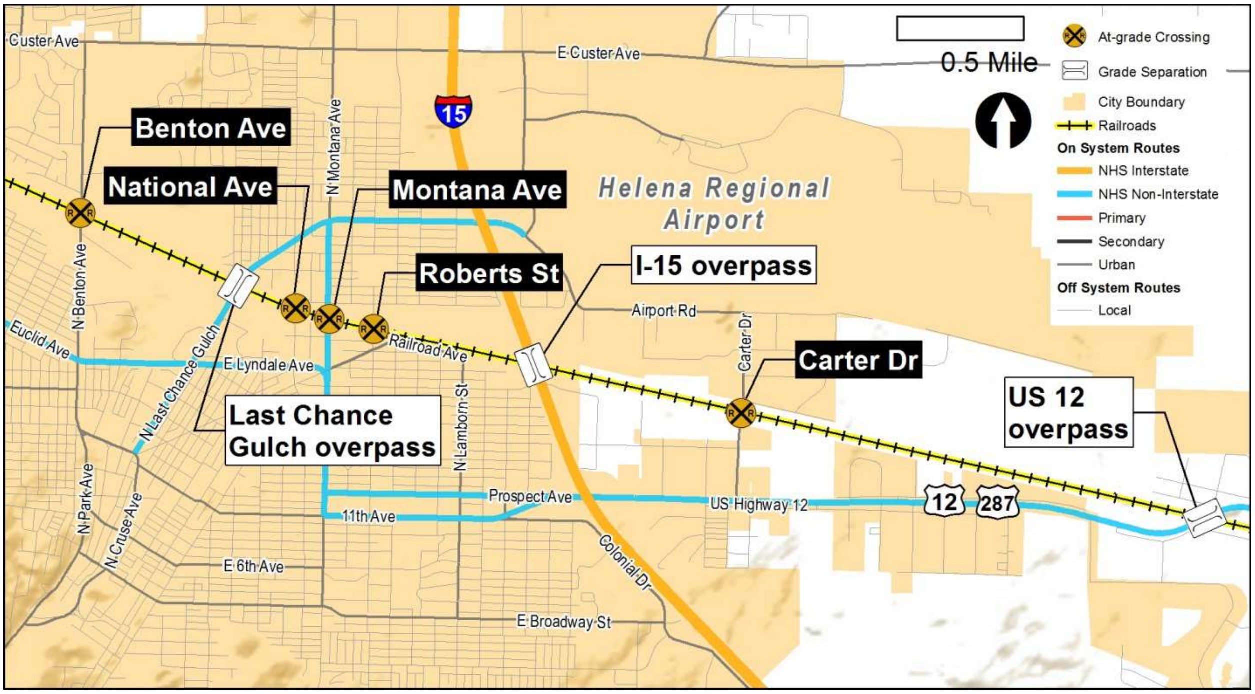


Figure 4-29. Helena Area Highway-Rail Crossings

Carter Drive serves as the only crossing of the railroad tracks east of the I-15 overpass and west of the US-12 overpass for this industrialized area. As measured along the railroad, the US 12 overpass is located approximately 1.9 miles east of the Carter Drive crossing and the I-15 overpass is located approximately 0.85 mile to the west. No other at-grade crossings are located within a one-mile radius of the Carter Drive crossing. The Carter Drive railroad crossing was analyzed separately (i.e., no crossings were combined holistically) from the other at-grade and grade-separated crossings in the region due to the unique traffic patterns and industrial and business access it provides across the tracks for the area.

4.10.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The *Greater Helena Area Long Range Transportation Plan—2014 Update* (2014 LRTP) was reviewed with respect to improvement recommendations for Carter Drive. The plan highlights several projects occurring within the Carter Drive corridor, which include:

- Carter Drive – Prospect Avenue to Billings Avenue reconstruction. This project recommends a reconstruction of Carter Drive south of the railroad crossing to City complete streets standards.
- Carter Drive – Prospect Avenue to Airport Road bike lanes. The plan recommends removing on-street parking and providing for 6.5 foot bike lanes throughout the corridor.

A number of trucking operations exist in the vicinity of Carter Drive and near the airport that utilize Airport Road and Carter Drive to access US 12 and I-15. Carter Drive is proposed as a truck route within the 2014 LRTP suggesting the Carter Drive corridor will continue to see an increase in commercial trucks and congestion due to railroad blockages.

In 2003, MDT conducted a statewide railroad grade separation feasibility study. Twenty (20) individual grade crossings were evaluated in that study across Montana, including Benton Avenue, Montana Avenue, and Roberts Street within the city of Helena. Carter Drive, however, was not a crossing examined in that study.

4.10.3 Existing Crossing Features

The following sections describe the existing conditions at the Carter Drive crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on September 9, 2015.

4.10.3.1 EXISTING ROADWAY

Carter Drive is functionally classified as a Minor Arterial roadway and designated as an Urban Route on the state's highway system. At the location of the at-grade crossing, Carter Drive is a 2-lane roadway approximately 32 feet wide. The roadway is not striped for paved shoulders. As it crosses the railroad the embankment drops off from the edge of pavement. Existing traffic control within the vicinity of the crossing consists of stop signs at the intersections to Carter Drive on Billings Avenue, Livingston Avenue, and Rock Ledge Street. Carter Drive is stop-controlled at Airport Road and controlled by a traffic signal at Prospect Avenue. The posted speed limit is 35 mph within the vicinity of the crossing.

4.10.3.2 EXISTING RAILROAD FEATURES

There are three tracks crossing Carter Drive. The northerly track is the East Long Lead track to the Helena Yard. The adjacent track to the south is the Main Track. An industry connection track runs along the south side of the railroad right-of-way separated from the other two tracks by approximately 220 feet. The railroad crossing experiences 33 trains daily with some switching moves at the east end of the yard which also block the crossing.

Photo 4-21. Carter Drive looking north at main track, industry connection track in foreground

Due to the crossing's location within railroad yard operational limits, the main track railroad timetable speed is 20 mph. The DOT database shows 45 mph as the crossing speed. Currently through trains stop in Helena for changing crews. Westbound trains on the main track are decelerating from 60 mph and eastbound trains leaving the yard on the main track are starting to accelerate to 60 mph with the speed change and yard limits occurring approximately 1,500 feet east of the Carter Drive crossing. The horizontal alignment of Carter Drive shifts to the east on the north side of the railroad. Carter Drive crosses the tracks at an approximate 90 degree angle. The current Main and Long Lead tracks at-grade crossing has gates, flashing signals and bells for vehicle protection. The industry connection track has flashing lights and bells for warning vehicles. All three tracks use precast concrete panels for the crossing material.

4.10.3.3 EXISTING NON-MOTORIZED FEATURES

Carter Drive currently does not have any dedicated non-motorized facilities adjacent to the roadway between Livingston Avenue and Rock Ledge Street. Sidewalks exist on the west side of Carter Drive north of Rock Ledge Street as well as south of Livingston Avenue.

Photo 4-22. Sidewalk north of Rock Ledge Street

4.10.3.4 UTILITIES

Existing underground utilities were identified based on field visits or other sources. Existing utilities in the vicinity of this crossing include fiber optic, overhead and underground electrical, natural gas and water. A more detailed survey using One-Call services will be required as part of a future design effort, as other utilities may be within the area.

4.10.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Carter Drive crossing consists of an easement across railroad property and appears to be a total width of approximately 60 feet. MRL/BNSF right-of-way is approximately 470 feet wide in the area of the crossing with the main tracks approximately 200 feet south of the northern right-of-way limits. Existing land uses within the immediate vicinity of the railroad crossing include commercial and light industrial uses. The railroad accesses its property and access roads along its tracks from Carter Drive.

4.10.4.1 EXISTING BUSINESSES

Several businesses are located immediately adjacent to railroad and roadway right-of-way. South of Livingston Avenue is the Montana Carpenters Training Center on the west side of the road and J&D Truck Repair on the east side of the road. North of the crossing, the Department of Public Health and Human Services (DPHHS) food distribution and commodity warehouse is located on the west side of Carter Drive and a City of Helena maintenance and storage facility on the east side of the road, just north of Rock Ledge Street.

4.10.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned recreational properties exist within the crossing vicinity. Based on a visual inventory, no potential historic sites were identified during the field visit. The Northern Pacific Railroad Main Line is a historic feature and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor’s historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

4.10.4.3 RESIDENTIAL

No residences are located within the vicinity of the Carter Drive crossing.

4.10.4.4 ADDITIONAL FEATURES

Contaminated soil is known to be present within the MRL Helena rail yard in the vicinity of I-15 and Carter Drive. Some studies show a 2-foot deep layer of contamination. Additional investigations would be required to further evaluate the extent and levels of contamination.

4.10.5 Proposed Solution

The proposed crossing recommendation at this location is an underpass with Carter Drive traversing underneath the railroad.

An overpass versus underpass option was analyzed as part of the field visit and conceptual design process. The current vertical grade of Carter Drive is lower on the north side of the crossing, and an overpass would increase overall impacts, cutting off business and street access on the north side of the crossing. In addition the approach on the south side of the main tracks is below the main track elevation favoring an underpass due to reduced earthwork and construction limits. The anticipated embankment south of the railroad right-of-way for an overpass alternative would also impact business and street access to Carter Drive. Due to these existing grades and reduction in impacts, an underpass appears to be a more feasible and practical solution at this location. Refer to Figure 4-30 for the proposed conceptual plan and profile for the underpass.

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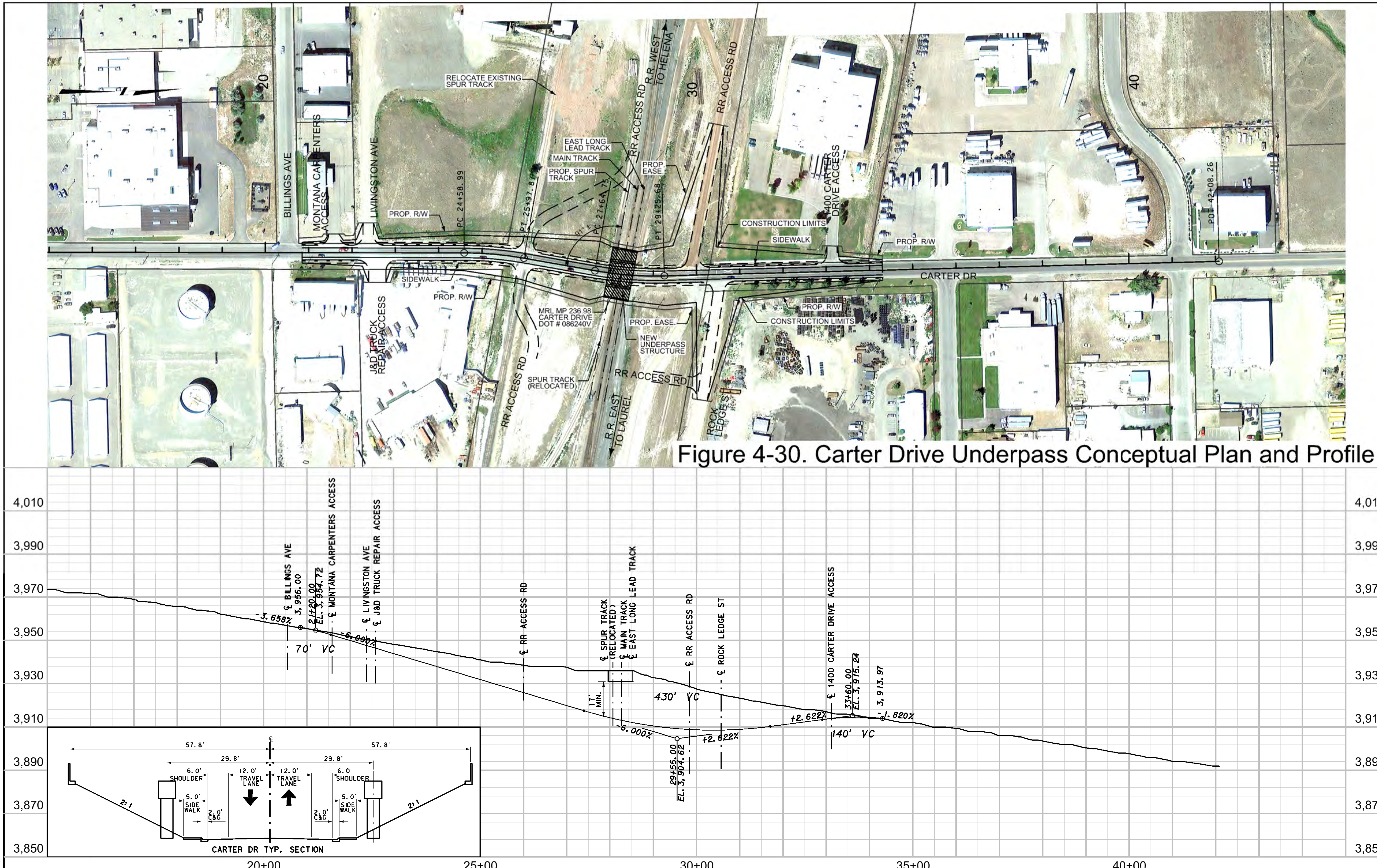

Figure 4-30. Carter Drive Underpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	\RD\RDPLPZ09_Carter_Dr.dgn 12/15/2015 4:40:12 PM bmartish	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS / LEWIS AND CLARK COUNTY	PRELIMINARY	MONTANA RAIL GRADE SEPARATION STUDY / N/A / SCALE 1"=200'	HELENA, MT / SHEET X OF X

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4.10.5.1 PROPOSED ROADWAY FEATURES

The proposed underpass would follow the existing horizontal alignment of Carter Drive, although further design work could improve and slightly shift an alignment under the proposed railroad bridge. The proposed vertical profile would utilize 6 percent maximum slopes south of the tracks in order to minimize the improvement limits. Vertical curvature would meet 35 mph design speed criteria. The underpass would match the existing typical section of Carter Drive north and south of the railroad right-of-way and consist of one travel lane in each direction, 6-foot shoulders/bike lanes, new curb and gutter and 5-foot sidewalks. In an effort to reduce the overall cost for the underpass construction, 2H:1V cut slopes could be utilized instead of retaining walls and a concrete wall style bridge abutment behind the new sidewalk.

The Carter Drive underpass would require improvements to the intersections with Livingston Avenue and Rock Ledge Street. In addition to these intersections, there are five private accesses that would require reconstruction. Figure 4-30 shows the extents of the improvements at these approaches.

4.10.5.2 PROPOSED RAILROAD FEATURES

Due to the anticipated span lengths and open excavation construction, the railroad bridge could consist of a ballast deck three span steel wide flange beam structure supported on a concrete substructure using spill-through abutments. This structure could support three tracks, the East Long Lead, Main and relocated industry connection tracks, over the roadway. Currently the industry connection track is unused at this location, but it does provide connectivity with a petroleum tank farm east of Carter Drive. The relocation consolidates the tracks to make a grade separation feasible and is acceptable to the railroad. Access roads from Carter Drive need to be provided to allow railroad access to the tracks and cross over east of Carter Drive and the east end of the Helena Yard west of Carter Drive. These railroad features are shown in Figure 4-30.

An alternative, constructing the bridges south of the existing Main Track and relocating the East Long Lead, Main and industry connection tracks, could be built. This alternative potentially requires the same new track construction as the temporary shoofly construction but does not require a second temporary at-grade crossing during construction and reduces the amount of track cut-overs and railroad signal shifting back and forth. The offset in saved construction costs would be the potential connectivity redesign for Livingston Avenue and commercial access along the south project extents. Further design and coordination with the railroad along with survey and roadway profile development would finalize the optimum approach and final design elements.

4.10.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would include a 6-foot shoulder providing room for bike lanes and 5-foot sidewalks on either side of the roadway. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk. The inclusion of bike lanes is consistent with the 2014 LRTP.

4.10.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

Right-of-way acquisition would be required in order to accommodate the cut slopes for the underpass excavation when not on railroad property. The on-site parking at J&D Truck Repair located adjacent to Carter Drive may be impacted as part of the right-of-way acquisition. An easement would also be needed within MRL property. The proposed right-of-way required would be acquired as fee from private property owners. A total of approximately 55,100 ft^2 is estimated for the underpass, at $15/$ft^2$ (2015$), which is market value for commercial properties for this area of Helena per research of Montana Cadastral property values and other local publically available information.

4.10.5.5 UTILITIES

Existing underground utilities would require relocation or adjustment within the limits of construction for the underpass. The existing utilities identified based on field visits or other sources include fiber optic, natural gas, gas service lines, septic sewer and an irrigation crossing. A more extensive survey would need to be completed as part of final design using One-Call services. A lump sum amount of $1M has been included in the estimate of probable cost as an allowance for utility relocation.

4.10.5.6 OTHER FEATURES

4.10.5.6.1 Emergency Vehicle Considerations

The Carter Drive crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.10.5.6.2 Drainage

It appears prevailing drainage is to the north. It is assumed the drainage from the undercrossing could be day-lighted in this direction. Groundwater appears to be below the proposed roadway profile at this location based on the Montana Bureau of Mines and Geology well log records.

4.10.5.6.3 Contaminated Soils

If a project is progressed at this location, additional subsurface soil investigations appear necessary to ascertain the limits of contaminated soils near this crossing. Once the extent of contaminated soils was determined, a contaminated soils special provision would be required and disposal of this material would need to be included as part of the contract bid documents. A cost for Contaminated Soil Disposal has been included in the conceptual cost estimate.

4.10.5.6.4 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.10.6 Constructability

4.10.6.1 ROADWAY CONSTRUCTION

A temporary at-grade rail crossing could be constructed prior to beginning construction on the overpass. This maintains the connectivity use of the only railroad crossing between the I-15 and US12 overpasses. The temporary crossing would act as a detour for traffic using Carter Drive during the underpass excavation and construction. The temporary crossing avoids a long detour that potentially would involve traveling on I-15 or Montana Avenue to simply get across the tracks in this area. Business access would need to be maintained during construction along Carter Drive.

4.10.6.2 RAILROAD CONSTRUCTION

There are two methods of constructing the proposed underpass. One method uses temporary track relocations, or shoofly, and constructs the railroad bridge on the existing track alignment. The second method leaves the tracks in place, constructs the bridges to the south of the existing track alignment, then relocates the tracks on a new alignment to construct the bridge. Both methods are potentially feasible given the alignment of the East Long Lead and Main Tracks west of the Carter Road at-grade crossing. The permanent realignment of tracks may result in a less costly overall project; however, the offset in saved construction costs would be the potential connectivity redesign for Livingston Avenue and commercial access along the south project extents. Further design and coordination with the railroad along with survey and roadway profile development would finalize the optimum approach. The shoofly construction method was used in the development of construction costs and BCA.

Photo 4-23. Looking east at cross-overs and trackage

4.10.6.2.1 Shoofly Construction

To maintain railroad operations at the east entrance to Helena Yard, both the Main and East Long Lead tracks would be temporarily shooflied at the start of construction. Due to the yard track turnout connections west and the track cross-overs between tracks east of the proposed underpass construction area, layout of the temporary track design needs to be closely coordinated with the railroad. Grading is less if the tracks were temporarily relocated south of the existing alignment. There could be six turnouts that need to be constructed to maintain yard track connectivity in addition to the grading, railroad signal work and temporary at-grade crossing construction. The existing industry connection track would remain as an access track along the south railroad right-of-way to the petroleum tank farm until the railroad bridge was completed and the East Long Lead and Main Tracks could be shifted back to their original alignments on the new structure and the bridge and alignment for the industry connection track could be completed. A spur track would be maintained under the abandoned load out building located west of Carter Road along the southerly railroad right-of-way. A second temporary at-grade crossing would be required once the tracks were relocated back to the original alignments. As the railroad bridges and track relocation work was completed, the roadway excavation and construction could be completed. Once traffic was placed on the completed underpass the temporary at-grade crossing would be removed.

4.10.6.2.2 Relocation Construction

In this option, railroad operations continue on existing trackage while the new bridge is constructed to the south. A temporary at-grade road crossing would be constructed to maintain traffic flow. While the bridge was constructed, the grading for the proposed realigned trackage would be completed. Once the bridge was completed and railroad operations shifted to the new structure and track alignment, the roadway excavation and construction could be completed and the road detour along with its temporary at-grade crossing removed. The industry connection track would still be realigned with a spur left extending under the abandoned load-out facility. Cross-overs and yard turnouts would be permanently relocated instead of temporarily relocated and then shifted back. There may be a potential of extending a few of the yard tracks depending on how the realigned East Long Lead Track connection with these tracks was maintained in the final configuration.

Photo 4-24. East end of Helena Yard, looking west. Left track is main track

4.10.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

A temporary at-grade rail crossing could be constructed east of the existing crossing for use during construction in order to keep Carter Drive open to through traffic. Advanced warning signs would need to be placed in to inform drivers of possible delays. Public outreach would also need to be included in order to keep the general public updated on construction status.

4.10.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $27,800,000 (2015$). Table 4-22 shows the various cost components for the Carter Drive underpass option.

Table 4-22. Carter Drive Underpass Option Cost Estimate

Carter Drive Components	Cost ($)
Road Work	$2,444,000
Railroad Work	$4,330,000
New Structure(s)	$4,026,000
Hydraulics	$400,000
Utilities	$1,000,000
Miscellaneous Items	$600,000
Mobilization (18%)	$2,200,000
Contingencies (25%)	$3,800,000
Preliminary Engineering (15%)	$2,800,000
Construction Engineering (15%)	$2,800,000
Right-of-Way	$826,000
IDC (10.37%)	$2,600,000
TOTAL COSTS (2015$)	**$27,800,000**

4.10.8 Benefit-Cost Analysis

A BCA was conducted for the Carter Drive grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Carter Drive grade separation. Refer to Appendix C for more information on the BCA.

Considering all monetized benefits and costs of the Carter Drive grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $24.98 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $1.12 million, of which the largest benefit is $0.60 million worth of travel time savings, while the total costs amount to $26.10 million. Table 4-23 and Table 4-24 provide a summary of the BCA results.

Table 4-23. Monetized Benefits by Category for Carter Drive Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.31	$0.91	$0.60
Improved Safety	$0.64	$0.45	$0.29
Vehicle Operating Cost Savings	$0.08	$0.06	$0.04
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$2.40**	**$1.69**	**$1.12**

Table 4-24. Benefit-Cost Analysis Results for Carter Drive Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$2.40	$1.69	$1.12
Total Costs ($2015 M)	$28.04	$27.16	$26.10
Net Present Value (NPV)	-$25.63	-$25.47	-$24.98
Return on Investment (ROI)	-91.42%	-93.78%	-95.71%
Benefit-Cost Ratio (BCR)	0.09	0.06	0.04
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-16.58%	-19.01%	-22.02%

Figure 4-31 illustrates the 20 years of undiscounted benefits following construction of the Carter Drive grade separation.

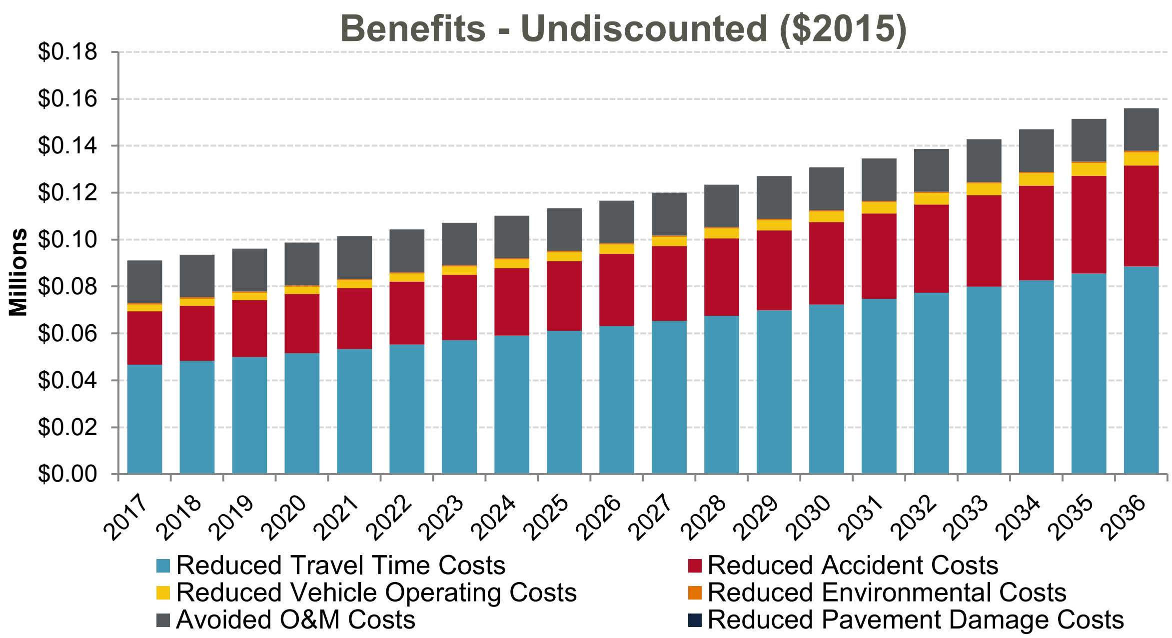

Figure 4-31. Projected Undiscounted Benefits for Carter Drive Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.10.9 Summary

The Carter Drive at-grade railroad crossing was identified as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification. Based on a review of existing conditions, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements, which include the addition of bike lanes, would be consistent with the long-range vision for the Carter Drive corridor as documented in the 2014 LRTP.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

4.11 Montana Avenue, Helena, Route N-128N, MRL MP 0.30, DOT #060193P

4.11.1 Overview

The North Montana Avenue (Montana Avenue) at-grade railroad crossing is located within the city limits of Helena and experiences relatively high daily volumes of vehicles. The AADT in 2014 was 11,930 vehicles and the projected AADT in 2034 is estimated at 14,557. Thirty-five (35) railroad trains travel through this crossing per day. Traffic delays due to frequent train crossings of the roadway are experienced at this urban crossing. This location has been identified in previous studies as a high priority for the City to find a method to reduce congestion. Figure 4-32 shows the crossing area and provides a summary of the key statistics for this crossing.

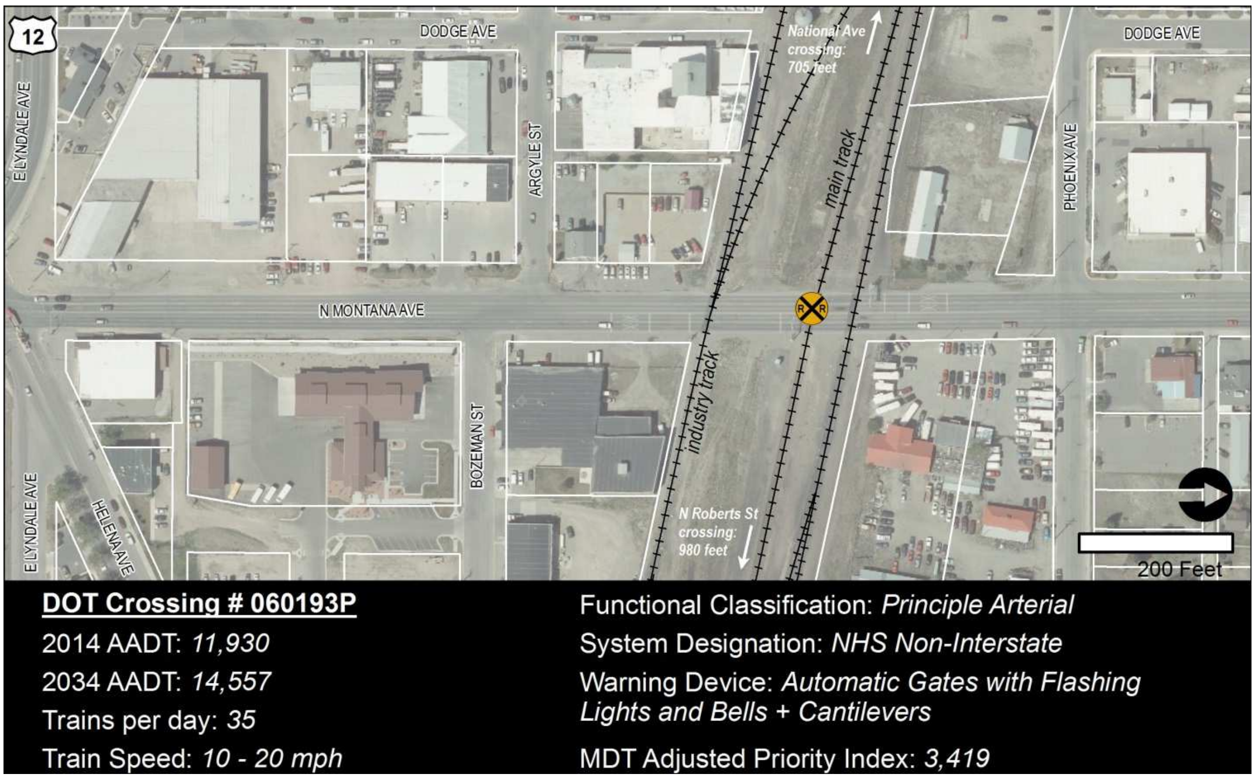

Figure 4-32. Montana Avenue Crossing Overview

A grade separation of the roadway from the railroad is proposed at this location to ease congestion at this crossing and increase safety.

4.11.2 Regional Context

Montana Avenue is designated as a NHS Non-Interstate Route and functionally classified as a Principle Arterial. Montana Avenue provides a major north-south linkage through the city, linking the Capitol area and surrounding residential areas to commercial and residential uses extending to the north, beyond Lincoln Road.

Figure 4-33 depicts the Montana Avenue crossing in context with other railroad crossings in the vicinity. Two other at-grade crossings are located in close proximity to the Montana Avenue crossing. As measured along the railroad main line, the Roberts Street and National Avenue at-grade crossings are located approximately 980 feet to the east and 705 feet to the west, respectively. There are two grade-separated crossings in the vicinity of the Montana Avenue crossing: the I-15 overpass is located to the east and the Last Chance Gulch overpass to the west. Further removed from the Montana Avenue crossing are the at-grade crossings located at Benton Avenue to the west and Carter Drive to the east, as well as an existing underpass on Henderson Street.

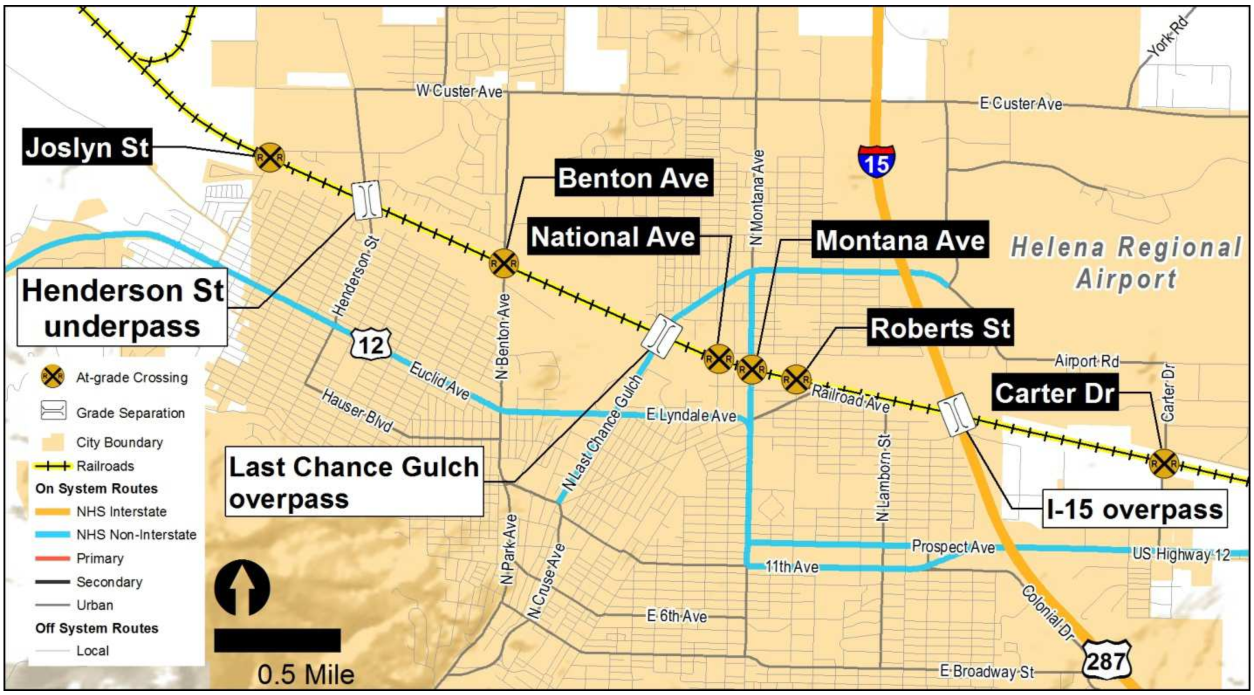

Figure 4-33. Helena Area Highway-Rail Crossings

Due to the proximity with Montana Avenue, the crossings at Roberts Street and National Avenue were combined holistically with the crossing. Both Roberts Street and National Avenue crossings carry traffic serving similar locations serviced by Montana Avenue. National Avenue also has direct connections with East Lyndale Avenue (Highway 12) to the south and North Last Chance Gulch (I-15 Business Loop) to the north. All three crossings are impacted similarly by railroad operations. If it is determined to closing Roberts Street, constructing a pedestrian overpass could increase safety for school age users to access either side of the tracks. Minimal impacts onto local traffic is anticipated by closing both of these crossings due to maintained access to residential, industrial and commercial areas from Montana Avenue. .

Based on the yard tracks crossing Roberts Street, and switching movements occurring at the crossing, it is assumed Roberts Street would be a priority crossing to close from the perspective of railroad safety and operations.

4.11.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The *Greater Helena Area Long Range Transportation Plan—2014 Update* (2014 LRTP) was reviewed with respect to improvement recommendations for North Montana Avenue. The Montana Avenue rail grade separation is a major street network improvement identified in the previous 2004 plan as well as the 2014 update. The 2014 plan identifies the need for pedestrian and bicycle facility improvements along the Montana Avenue corridor and recommends sidewalks and bicycle lanes as separate projects.

The 2003 MDT Statewide Rail Grade Separation Study identified the Montana Avenue crossing as the second highest statewide crossing priority. Both an overpass and underpass option was determined feasible at this location.

In 2002, the City of Helena commissioned a grade separation feasibility study for the Montana Avenue at-grade crossing. The study examined four conceptual alternatives: a 4-lane overpass, a 4-lane underpass, a 2-lane overpass with two at-grade lanes, and a 2-lane underpass with two at-grade lanes. Based on public outreach on the alternatives, public preference sided for a full grade separation of four lanes and the majority of the public favored an underpass because it would have less visual impact than an overpass.

4.11.3 Existing Crossing Features

The following sections describe the existing conditions at the Montana Avenue crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 7, 2015.

Photo 4-25. Montana Avenue looking north

4.11.3.1 EXISTING ROADWAY

Montana Avenue at the location of the at-grade crossing is a 4-lane roadway approximately 56 feet wide. Curbs and gutters do not exist along Montana Avenue between Argyle Street/Bozeman Street and Phoenix Road; however, it does exist north and south of these intersections. Due to lack of curbs and gutters, the access into adjacent businesses is not defined between Argyle Street/Bozeman Street and Phoenix Road. An overhead crossing occupied flashing warning sign is located on Montana Avenue approximately 2000 feet south of the at-grade crossing near Townsend Avenue.

4.11.3.2 EXISTING RAILROAD FEATURES

The current at-grade crossing has gates, flashing signals and bells for vehicle protection. There are three tracks crossing Montana Avenue, two main line tracks and an industry track. Currently, the main line tracks are approximately 51 feet apart

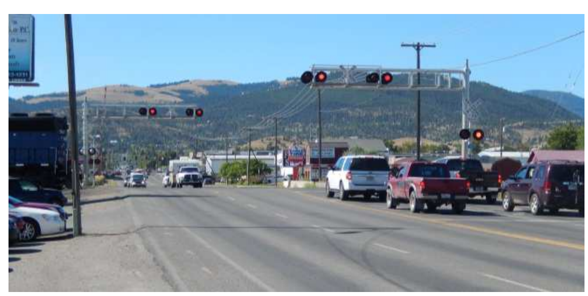

Photo 4-26. Typical switch train movement blocking Montana Avenue

in the northerly portion of the railroad right-of-way. At-grade crossing protection is provided by cantilever supports for flashing lights, gates and bells for the two main tracks (DOT Crossing #060193P). A third track, southernmost in the railroad right-of-way, is separated south of the south main track by approximately 135 feet. This at-grade crossing (DOT Crossing #060198Y) has separate flashing lights, gates and bells for traffic protection. This industry spur track serves Pacific Steel and Recycling to the west of Montana Avenue and provides access to a loading dock to the east of Montana Avenue.

4.11.3.3 EXISTING NON-MOTORIZED FEATURES

The Montana Avenue crossing does not have any dedicated non-motorized facilities adjacent to the roadway. No sidewalks or bicycle facilities exist near the Montana Avenue crossing. Roadway shoulder widths vary from approximately 3 to 6 feet on either side or the roadway throughout the vicinity of this crossing and provide the only means for non-motorized users outside of the vehicular travel lanes.

4.11.3.4 UTILITIES

Existing underground utilities which are known based on field visits or other sources and likely include fiber optic, underground electrical, natural gas, water and sanitary sewer. Overhead power and telephone lines parallel Montana Avenue through the project area. Existing utilities identified above are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.11.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Montana Avenue crossing consists of an easement across railroad property which appears to be a total width of approximately 80 feet south of the crossing and between 85 and 140 feet north of the crossing. MRL/BNSF right-of-way averages approximately 400 feet in width throughout the crossing vicinity with the main tracks roughly centered.

4.11.4.1 EXISTING BUSINESSES

Existing land uses within the Montana Avenue corridor near the railroad crossing are predominantly commercial. Businesses within the immediate intersection quadrants of Montana Avenue and the railroad include a used automobile dealership to the northeast, a vacant petroleum product distribution business to the northwest, a tire shop to the southwest, and an automotive glass company to the southeast.

4.11.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No public recreational facilities or historic sites are located immediately adjacent to the Montana Avenue railroad crossing. The Northern Pacific Railroad Main Line is a historic feature and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings.

4.11.4.3 RESIDENTIAL

No residences are located on Montana Avenue within the vicinity of the railroad crossing. Although not abutting Montana Avenue, private residences do exist within one block of Montana

Avenue along Phoenix Road and Walnut Street and both of these roads provide access to a residential neighborhood located northeast of the crossing.

4.11.5 Proposed Solution

The proposed crossing solution at this location is an underpass with Montana Avenue traversing underneath the railroad.

An overpass verses underpass analysis was conducted as part of the field visit and the conceptual design process. The existing terrain slopes gradually toward the north and the existing railroad tracks create level benches on the roadway grade. Connecting a constant grade from the south side of the tracks to the north side of the tracks, the grade line is approximately three feet below existing railroad grade, therefore accommodating an underpass solution based on existing roadway grade.

Based on the existing grade of the roadway, an overpass solution could create greater impacts extending south and north of the crossing compared to impacts from an underpass solution. In particular, an overpass option would have greater impacts to business access and intersecting streets north of the crossing due to the existing grade of the roadway. An overpass option, providing 23-foot-4-inch minimum clearance over the railroad tracks, would create impacts on business access as well as connectivity along Montana Avenue, Bozeman Street, Argyle Street, Phoenix Road, Walnut Street and Chestnut Street. All public streets and business accesses in this area could have revised grades, or access eliminated from Montana Avenue if a proposed overpass solution was progressed.

An underpass option has fewer impacts on adjacent businesses and access, and creates a solution with less view shed impacts. Based on the existing roadway grade, an underpass solution utilizes the approximate 3 feet of grade difference from the approaching roadway to the railroad grade to reduce the overall undercrossing length. Through this initial evaluation comparing the potential impacts, an underpass is considered the most practical solution for this crossing.

A partial underpass solution with two lanes grade separated and two at-grade lanes is also a feasible solution for this location; however, this option would not allow for a full closure of the Montana Avenue at-grade crossing and would therefore not require railroad participation in project funding. A full underpass solution is preferred from a safety perspective to eliminate traffic traversing the railroad tracks at-grade, grade separates non-motorized traffic, provides potential for railroad participation with project funding and still allows access to businesses and residences along the corridor, although direct access to Montana Avenue is restricted for cross streets located nearest the potential underpass. Refer to Figure 4-34 for the proposed conceptual plan and profile for the underpass.

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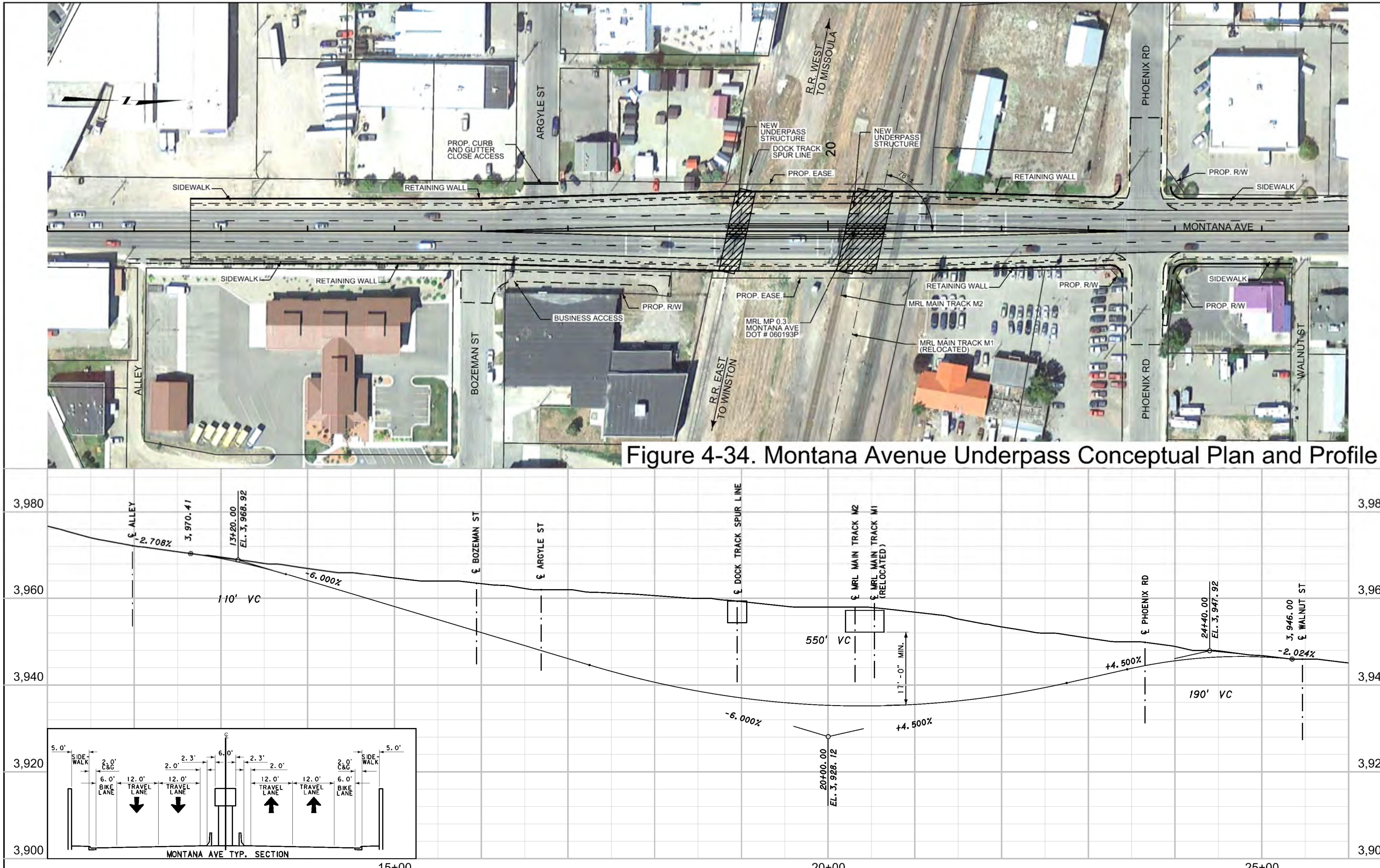

Figure 4-34. Montana Avenue Underpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	...\RD\RDPLPZ02_Montana_Ave.DGN 12/15/2015 4:39:34 PM bmartish	DESIGNED BY / REVIEWED BY / CHECKED BY	
ROAD PLANS	LEWIS AND CLARK COUNTY	PRELIMINARY	
MONTANA RAIL GRADE SEPARATION STUDY	N/A	SCALE 1"=100'	HELENA, MT / SHEET X OF X

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4.11.5.1 PROPOSED ROADWAY FEATURES

There are two intersections located within the proposed Montana Avenue underpass limits, Argyle/Bozeman Street to the south of the crossing and Phoenix Road to the north. These intersections will require modification due to the excavation required for an underpass and the use of retaining walls along Montana Avenue. Both Bozeman Street and Argyle Street would need to be reconstructed and would result in closing direct access to Montana Avenue. Bozeman Street would become a dead end at Montana Avenue. A new local business access would be constructed to the north along the frontage of Speedy Glass. A cul-de-sac is proposed to be added at Argyle Street, blocking access to/from Montana Avenue. The surrounding streets would provide access to businesses along both these local streets. The Phoenix Road intersection would remain a full access intersection and would be reconstructed to match the new vertical grade of Montana Avenue. The proposed underpass typical section, plan and profile including modifications to the street network are shown in Figure 4-34.

The roadway underpass would match the existing Montana Avenue typical section and include four travel lanes, two bike lanes, new curb and gutter, and 5-foot sidewalks. Concrete barrier would be used in the median of the roadway where structures are located to protect traffic from the proposed new bridge piers. As previously mentioned, retaining walls would be recommended along the underpass to minimize impacts on neighboring properties. The horizontal alignment would not change, and the proposed vertical profile would utilize 6 percent maximum slopes to minimize the extents of the improvements. Vertical curvature would meet 35 mph design speed criteria.

Should the existing at-grade crossing at Roberts Street be closed as part of grade separating Montana Avenue, it is proposed a pedestrian overcrossing be placed to maintain and improve access and safety to and from Central Elementary School (at the Lincoln Building) and Lincoln Park which is located to the north of the existing at-grade crossing at Roberts Street. It also maintains pedestrian access from north of the railroad tracks to Helena High School which is south of the tracks. Overall safety could be improved by eliminating a crossing within the zone used for changing train crews and high railroad yard switching movements.

Due to its close proximity to Montana Avenue, closing National Avenue is also feasible. With three at-grade crossings closed, one reconstructed with a grade separation and a pedestrian bridge maintaining the pedestrian access to schools and neighborhoods, the full benefits of the proposed project can be reached for both the public and railroad. The railroad could identify greater benefits from closure of all three crossings, and funding from railroads could be initiated per federal regulations for each crossing closed.

4.11.5.2 PROPOSED RAILROAD FEATURES

The north main track could be shifted to 22-foot track centers with the south main track and meet track alignment geometry requirements. This proposed track

Photo 4-27. Mainline tracks converging west of Montana Avenue.

shift was agreed upon during the 2002 Montana Avenue feasibility study. The track shift allows a two track bridge using adjacent tracks and reduces the overall limits of the Montana Avenue underpass. A separate single track bridge would be required for the southerly industry track to maintain service to the industry and connection with the loading dock.

The proposed railroad bridges would consist of a two span precast concrete double cell box girder structure supported on concrete wall style abutments and a center concrete pier. Due to the use of a center median, the individual span lengths for each bridge are approximately 45 feet. Steel wide flange beams could also be used, although the railroad bridge cost would be approximately 40 percent higher compared to the precast prestressed concrete beams used in this study. A single span structure using through plate girders approximately 90-feet in length would be more expensive than the wide flange beam alternative. It is anticipated the minimum vertical clearance from the roadway to the low chord of the bridge would be 17 feet.

4.11.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section under the railroad would include bike lanes and 5-foot sidewalks on either side of the roadway. The roadway profile exceeds the maximum running grade for ADA accessibility. Alternatives to meet ADA guidelines include the use of cast-in-place concrete barrier walls along the edge of roadway and allowing the sidewalk to be raised compared to the roadway profile, minimizing the overall grade on the sidewalk.

4.11.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

Additional right-of-way will be required for the construction of the underpass, which includes easement within MRL property and proposed right-of-way as fee from private property owners. Construction of the underpass would impact several businesses by affecting direct access to Montana Avenue and result in a loss of visibility, potentially requiring the relocation of several businesses immediately adjacent to the underpass. Additional analysis and local participation during the design phase would seek to minimize impacts to adjacent businesses and maintain access to Montana Avenue where possible. Given the potential for relocations, however, a conservative estimate of $2M for right-of-way was included in the planning-level cost estimate.

4.11.5.5 UTILITIES

Existing underground and overhead utilities would require relocation or adjustment within the limits of construction for the underpass. The existing utilities were identified based on field visits or other sources and include fiber optic, underground electrical and likely natural gas and sanitary sewer. A more extensive survey would need to be completed as part of the final design using One-Call services. A lump sum amount of $1.5M has been included in the estimate of probable cost as an allowance for utility relocation.

4.11.5.6 OTHER FEATURES

4.11.5.6.1 Emergency Vehicle Considerations

The Montana Avenue crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.11.5.6.2 Drainage

It is assumed the drainage from the undercrossing could be day-lighted to the north to tie into existing storm drains. However, an allowance for a pump system is included in the conceptual order of magnitude estimate of probable project cost to accommodate the need to convey storm water within the undercrossing. Ground water does not appear to be high enough to warrant a seal slab or a special type of construction. Final drainage features and need for structural seal concrete would be determined during future phases of design work.

4.11.5.6.3 Retaining Walls

Retaining walls are proposed to be utilized to reduce the need for additional right-of-way and full relocation of businesses along Montana Avenue. The retaining walls proposed for this crossing are tie-back or pile and lagging style walls with precast or cast-in-place concrete fascia. The walls are constructed from the top down, which minimizes excavation and the magnitude of construction limits required for the project. The face of the walls can vary from standard plain concrete panels to the use of architectural form liner and colorization to meet the desires of the local community.

4.11.5.6.4 Maintenance

Due to the vertical grades associated with an underpass, maintaining through access for traffic during winter weather introduces some challenges. Front loaders may need to be utilized when removing snow from Montana Avenue in order to clear the underpass. A heated roadway, not included in the proposed project for this study could be used as an alternative within the underpass limits to help keep this stretch of Montana Avenue free of snow and/or ice.

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.11.6 Constructability

4.11.6.1 ROADWAY CONSTRUCTION

Due to the nature of the construction for the roadway underpass, Montana Avenue would be closed during construction. The excavation required for the underpass and construction of the retaining walls would make it difficult to maintain through access within the project limits. Private and business access would need to be maintained during construction from the north or south side of the crossing utilizing the adjacent street network for access.

4.11.6.2 RAILROAD CONSTRUCTION

MRL has indicated the spur access must be continuous throughout construction and traffic on the main line tracks must be maintained. The project will feature track shooflies, signal work for the temporary track detours and final track work, temporary track detours, and new temporary turnouts to maintain railroad traffic as well as require construction phasing to balance the railroad costs for temporary trackage with the overall construction cost. For safety requirements, MRL will also be providing railroad flagging to protect trains and construction workers while working within, or having the capability of fouling, 25 feet from the track centerlines.

As part of the grade-separated solution, it is assumed the existing north main track could be shifted to 22-foot track centers with the south main track and meet track alignment geometry requirements. This concept was agreed upon during the 2002 Montana Avenue feasibility study and would need to be reevaluated should a project be progressed at this location.

4.11.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

A full Transportation Management Plan (TMP) would be required during engineering phases of the project to identify complete needs for maintaining traffic during construction. Business access could be maintained utilizing access from adjacent streets, while local through traffic is diverted to Roberts Street or National Avenue and general detours could be placed for traffic to utilize Last Chance Gulch Road, or other crossings of the railroad in the area of this crossing to access either side of Montana Avenue. Final vehicle traffic detours need to be determined and include consideration for children and pedestrians accessing Central School (at the Lincoln Building) and Lincoln Park. Detour signing would need to be in place to help direct traffic as well as public outreach to keep the general public and nearby businesses of additional short-term closures or traffic control issues.

Consideration for the new pedestrian access at Roberts Street and closure of the National Avenue at-grade crossing would need to be coordinated with the Montana Avenue improvements. National Avenue could be used as part of a detour route. Use of Roberts Avenue as a detour route would need to be mitigated with the pedestrian access to the elementary school to the north and high school to the south. Once the Montana Avenue undercrossing is constructed, improvements to Roberts Street could begin and National Avenue could be closed.

4.11.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $29,600,000 (2015$) for lowering Montana Avenue and constructing precast, prestressed concrete span bridges supporting the railroad tracks. Table 4-25 shows the various cost components for the Montana Avenue underpass option.

The anticipated order of magnitude conceptual estimate of probable construction cost for the Roberts Street crossing closure and construction of a pedestrian overpass Including PE, CE, IDC and 25 percent contingency is $4,500,000 (2015$) and is not included in the Montana Avenue underpass cost estimate, but is included in Appendix B for a breakdown of conceptual quantities and costs.

Table 4-25. Montana Avenue Underpass Option Cost Estimate

Montana Avenue Cost Components	Cost ($)
Road Work	$5,705,000
Railroad Work	$1,446,000
New Structure(s)	$3,249,000
Hydraulics	$500,000

Montana Avenue Cost Components	Cost ($)
Utilities	$1,500,000
Miscellaneous Items	$600,000
Mobilization (18%)	$2,200,000
Contingencies (25%)	$3,800,000
Preliminary Engineering (15%)	$2,900,000
Construction Engineering (15%)	$2,900,000
Right-of-Way	$2,000,000
IDC (10.37%)	$2,800,000
TOTAL COSTS (2015$)	**$29,600,000**

4.11.8 Benefit-Cost Analysis

A BCA was conducted for the Montana Avenue grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Montana Avenue grade separation. Refer to Appendix C for more information on the BCA.

Considering all monetized benefits and costs of the Montana Avenue grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $21.38 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $6.40 million, of which the largest benefit is $4.42 million worth of travel time savings, while the total costs amount to $27.78 million. Table 4-26 and Table 4-27 provide a summary of the BCA results.

Table 4-26. Monetized Benefits by Category for Montana Avenue Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$9.37	$6.62	$4.42
Improved Safety	$2.79	$1.97	$1.32
Vehicle Operating Cost Savings	$0.13	$0.09	$0.06
Reduced Environmental Costs	$0.10	$0.08	$0.07
Avoided Operations and Maintenance Costs	$1.09	$0.79	$0.54
Reduced Pavement Damage Costs	-$0.03	-$0.02	-$0.01
TOTAL	**$13.45**	**$9.53**	**$6.40**

Table 4-27. Benefit-Cost Analysis Results for Montana Avenue Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$13.45	$9.53	$6.40
Total Costs ($2015 M)	$29.84	$28.91	$27.78
Net Present Value (NPV)	-$16.39	-$19.38	-$21.38

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Return on Investment (ROI)	-54.92%	-67.04%	-76.97%
Benefit-Cost Ratio (BCR)	0.45	0.33	0.23
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-6.39%	-9.12%	-12.48%

Figure 4-35 illustrates the 20 years of undiscounted benefits following construction of the Montana Avenue grade separation.

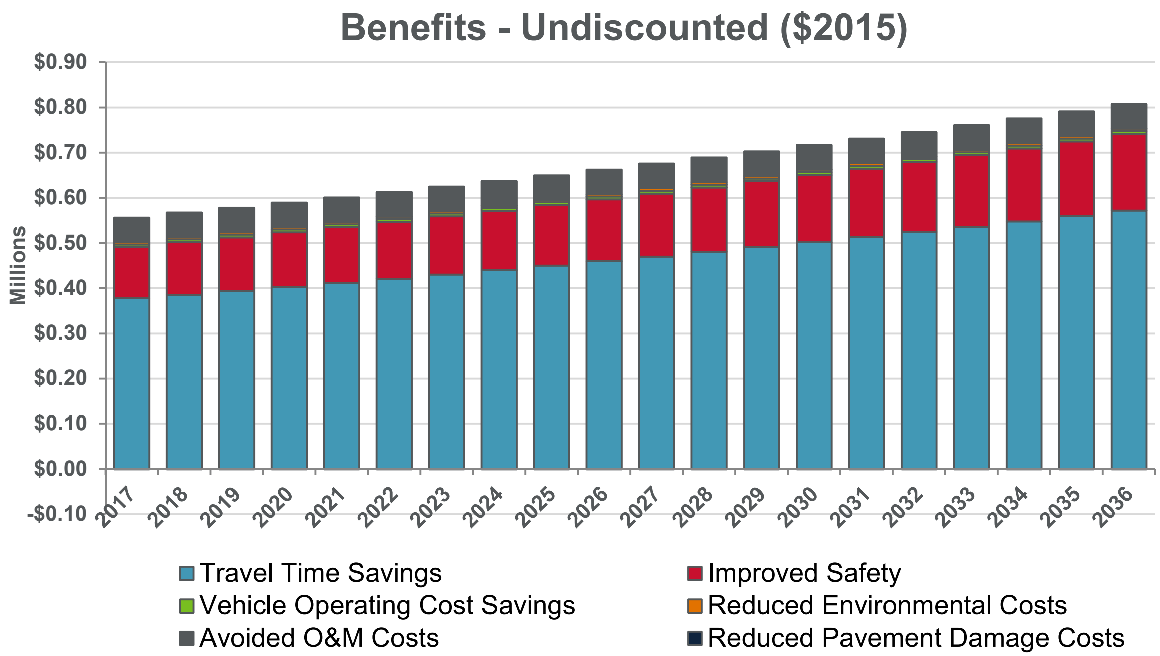

Figure 4-35. Projected Undiscounted Benefits for Montana Avenue Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.11.9 Summary

The Montana Avenue at-grade crossing was identified in this study as a priority location due to the high volumes of vehicles and trains experienced at the crossing as well as other screening criteria including high functional classification and priority index. Based on a review of existing conditions, published documents, and consideration of public sentiment, an undercrossing of the railroad is recommended at this location. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with the long-range vision for the Montana Avenue corridor as documented in previous studies.

Helena is a train crew change point. Eastbound and westbound through freights stop at the depot area to allow crew changes. Helena also has a classification yard. With the closure of all three crossings, average 35 times a day train blockage is eliminated. Traffic and pedestrians would not be exposed to train traffic. It is understood the railroad is interested in closing all three at-grade crossings to increase the safety for the traveling public as well as railroad operations. The City of Helena, due to the traffic impacts on Montana Avenue, also desires a grade separation be constructed.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

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4.12 Northern Avenue, Huntley, Route S-522E, MRL MP 213.36, DOT #087386S

4.12.1 Overview

The Northern Avenue at-grade railroad crossing is located near the community of Huntley approximately 10 miles east of Billings. Northern Avenue serves as the west entrance to Huntley, connecting it to the I-94 interchange to the south of the railroad crossing. This crossing has daily volumes of vehicles of nearly 4,200 AADT in 2014 with a projection of nearly 7,000 in 2034[2]. Thirty (30) trains travel through this crossing per day which is just west of the connection with BNSF's lines running south into the coal basin in Wyoming and a line continuing east across Montana to Minnesota. Traffic delays at this entrance into Huntley due to frequent train crossings are experienced by people leaving or traveling to this area using the Interstate and those traveling to and from the Pryor Creek area south of the Interstate. Figure 4-36 shows the crossing area and provides a summary of the key statistics for this crossing.

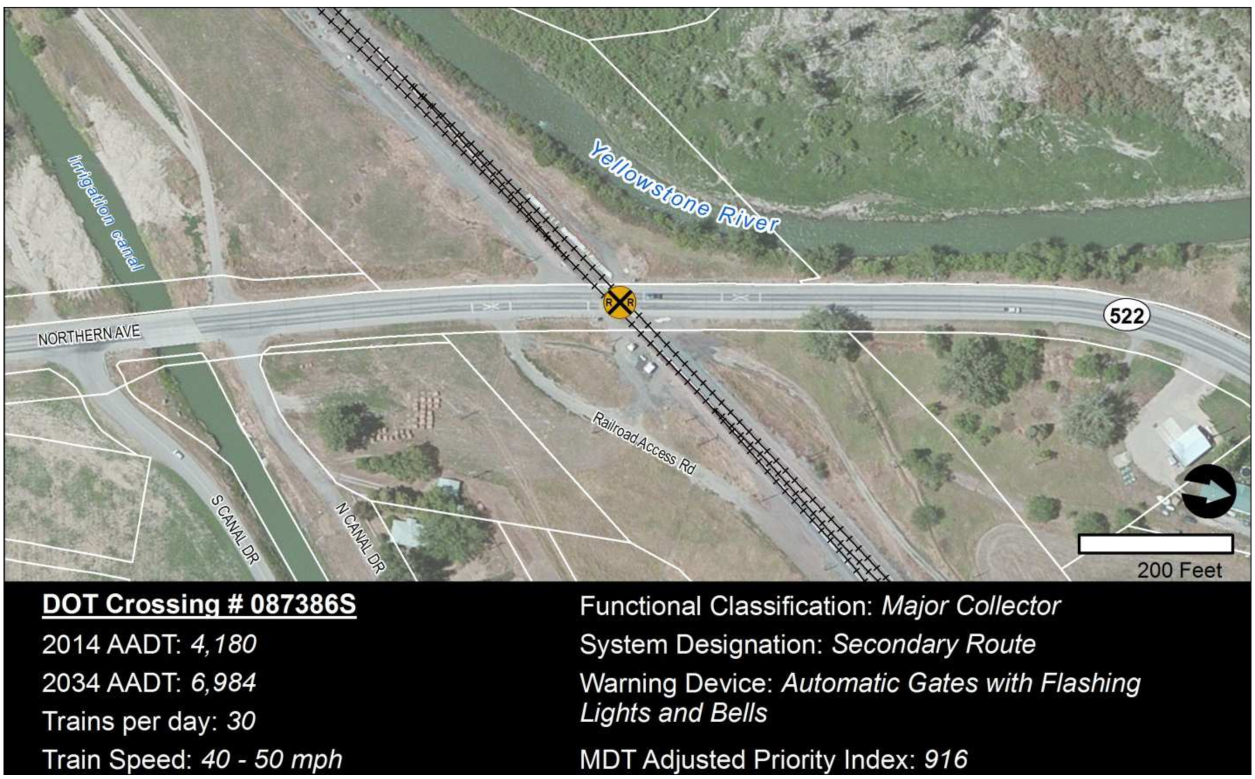

Figure 4-36. North Avenue, Huntley Area Highway-Rail Crossings

To ease congestion and increase safety at this location, grade separating the roadway from the railroad is proposed. Due to the existing constraints of the Yellowstone River and the irrigation canal to the south of the crossing, and to minimize impacts on the traveling public and railroad

[2] Traffic projection based on a 2.6% growth rate (MDT, 2015) and does not include adjustments to account for the Billings Bypass Project. Per the draft Old Highway 312 Corridor Study Existing and Projected Conditions Report, Highway 522 has a projected 2035 AADT of 6,100 without the Billings Bypass (using a 1.8% growth rate) and 4,400 with the Billings Bypass.

operations during construction, the most feasible and practical solution is to grade separate using an overpass, with Northern Avenue traversing over the railroad.

4.12.2 Regional Context

Northern Avenue is designated as Montana Secondary Highway 522 (S-522) and connects I-94 to the Huntley community and Highway 312 to the north. Growth in the rural regions outside of Billings and an influx of commuters has in recent years resulted in increased traffic volumes and congestion along Highway 522 and 312. Figure 4-37 depicts the Northern Avenue crossing in context with other railroad crossings in the vicinity.

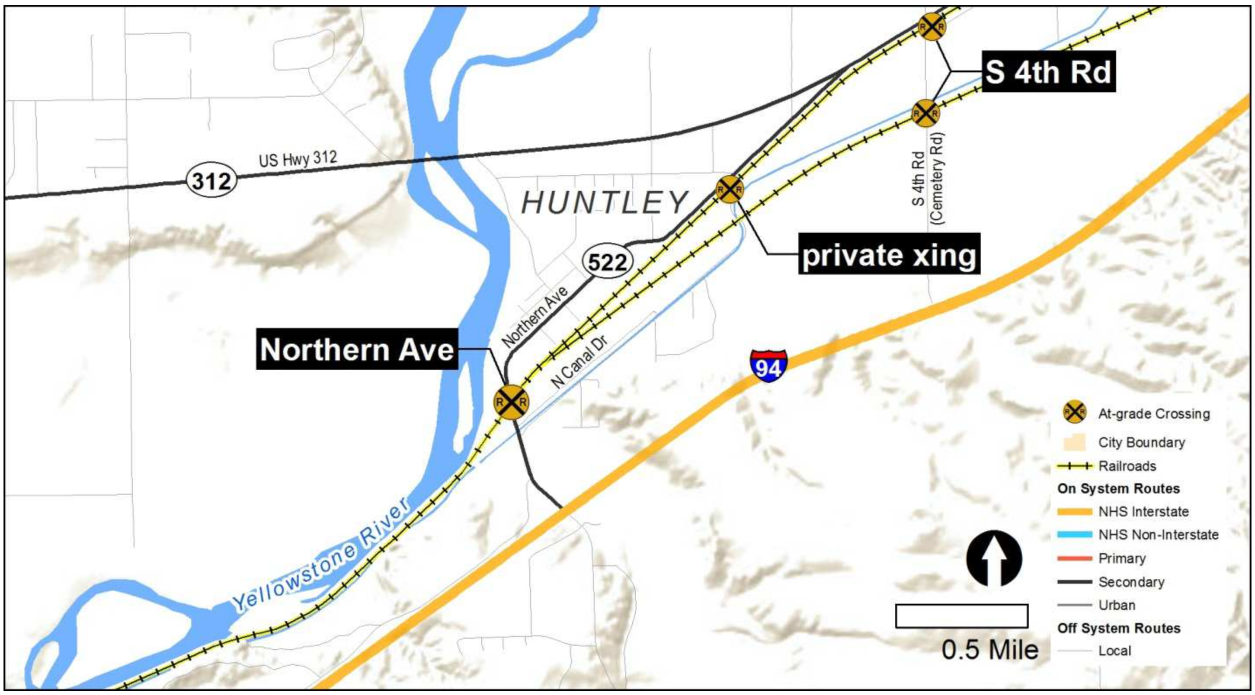

Figure 4-37. Huntley Area Highway-Rail Crossings

Northern Avenue provides an important link between Highway 312 and I-94 and the at-grade railroad crossing is the only crossing within the region linking these highways. Three other at-grade crossings exist to the northeast of the Northern Avenue crossing which provide local or private access only.

4.12.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

MDT is conducting a corridor planning study of the Highway 312 corridor from its junction with US 87 near Billings to its terminus at I-94 and includes S-522. The goal of the study is to assess current and projected conditions within the study area and identify options to address the transportation needs. Currently,

Photo 4-28. Looking south along Northern Avenue

no improvement options have been identified for the S-522 portion of the study area.

4.12.3 Existing Crossing Features

The following sections describe the existing conditions at the Northern Avenue crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on September 12, 2015.

4.12.3.1 EXISTING ROADWAY

Northern Avenue is functionally classified as a major collector roadway and designated as a Secondary Route on the state's highway system. At the location of the current at-grade crossing, Northern Avenue is approximately 40 feet wide consisting of two 12-foot lanes with a shoulder width of approximately 8 feet on each side. W-beam guardrail is used on the west side of the road adjacent to the Yellowstone River as Northern Avenue approaches the at-grade crossing from the north. Existing traffic control within the vicinity of the crossing consists of stop signs on South Canal Drive and North Canal Drive at their approaches to Northern Avenue. The grade descends as one proceeds north from the interstate, over the canal and across the at-grade crossing into Huntley. The posted speed limit is 45 mph starting just south of the at-grade crossing. The horizontal curve just north of the crossing has a posted speed limit of 35 mph.

4.12.3.2 EXISTING RAILROAD FEATURES

Northern Avenue crosses a main, north track and siding track, south track. Approximately 80 feet east of the crossing, BNSF's mainline track from Wyoming connects with the siding track. Approximately 50 feet west of the crossing is the start of a cross over track between the siding and main tracks. The at-grade crossing experiences 30 trains per day. The main track speed at this location is between 45 and 50 mph with the siding track restricted to 25 mph operations. The tracks cross Northern Avenue at an approximate 46 degree angle from perpendicular. The current at-grade crossing has gates, flashing signals and bells for vehicle protection. Both tracks use precast concrete panels for the road crossing surface.

4.12.3.3 EXISTING NON-MOTORIZED FEATURES

Northern Avenue currently does not have any dedicated non-motorized facilities adjacent to the roadway. No sidewalks or bike lanes exist within the vicinity of the crossing. Existing shoulder widths are approximately 8 feet wide, which may be used by bicyclists.

4.12.3.4 UTILITIES

Overhead power lines and underground fiber optic and natural gas lines exist in the crossing area (Photo 4-29). Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

Photo 4-29. Fiber optic warning sign near crossing

4.12.3.5 ADDITIONAL FEATURES

The Yellowstone River is a prominent natural feature in close proximity to the Northern Avenue crossing. A channel of the river flows in a southwest to northeast direction and is located at the toe of the bank supporting the roadway and railroad embankment. Northern Avenue north of the crossing is constrained by the river and mapped floodplain which is located as close as 30 feet west of the roadway in some locations. The crossing is not within the mapped floodplain.

The Huntley Main Canal near the crossing is a part of the Huntley Project Irrigation District and is approximately 50 feet in width providing water to irrigated areas near Huntley and to the east. A bridge structure spans the irrigation canal. Bridge deck deterioration including severe deck delamination markings were noted during the field visit.

4.12.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the Northern Avenue crossing consists of an easement across railroad property and appears to be a total width of approximately 60 feet. MRL/BNSF right-of-way is approximately 200 feet each side of the tracks at the crossing. The area surrounding the crossing is largely undeveloped. Existing land uses are railroad right-of-way, agricultural, and rural residential uses.

4.12.4.1 EXISTING BUSINESSES

No businesses or commercial structures exist within the vicinity of the crossing.

4.12.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned recreational parks exist within the immediate crossing vicinity. The Yellowstone River is located in close proximity to the crossing and is a popular recreational feature. Based on a visual inventory, no potential historic structures were identified during the field visit. The Northern Pacific Railroad Main Line is a historic feature and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings. The Huntley Main Canal is likely a historic feature and eligible for listing in the NRHP although the road bridge over the canal may not contribute to the corridor's historic status or modifications to the road bridge crossing may not impact the eligibility of the canal.

4.12.4.3 RESIDENTIAL

Residences exist along North Canal Drive south of the crossing. The North Canal Drive access is located 500 feet south of the crossing. North of the crossing, one residential structure is located at the roadway curve on the south side of Northern Avenue. Additional residences front Northern Avenue as the road travels into Huntley.

4.12.5 Proposed Solution

An overpass versus underpass analysis was conducted as part of the field visit and conceptual design process and the proposed crossing solution at this location is an overpass, with Northern Avenue traversing over the railroad.

An underpass solution could potentially undercut the Huntley Main Canal and negatively impact residential access to Northern Avenue. In addition, the anticipated roadway excavation for an underpass north of the tracks would be low enough to allow encroachment from Yellowstone River flood waters requiring road closure during flood events or construction of flood water retaining walls. Also, the static water level for groundwater appears to be a minimum of 15 feet below the existing terrain surface according to well logs available at the Montana Bureau of Mines and Geology (MBMG) website, which could require the use of a concrete seal for an underpass solution. An underpass would require a railroad shoofly to detour trains during construction and create difficulties in maintaining connectivity and train operations for both the main and siding tracks. An overpass, while requiring reconstruction of the roadway bridge over the Huntley Main Canal, avoids the underpass flooding issues, reduces the residential impacts for access onto Northern Avenue, and avoids the difficult temporary trackage to keep the railroad operational during construction. Refer to Figure 4-38 for the proposed conceptual plan and profile for the overpass.

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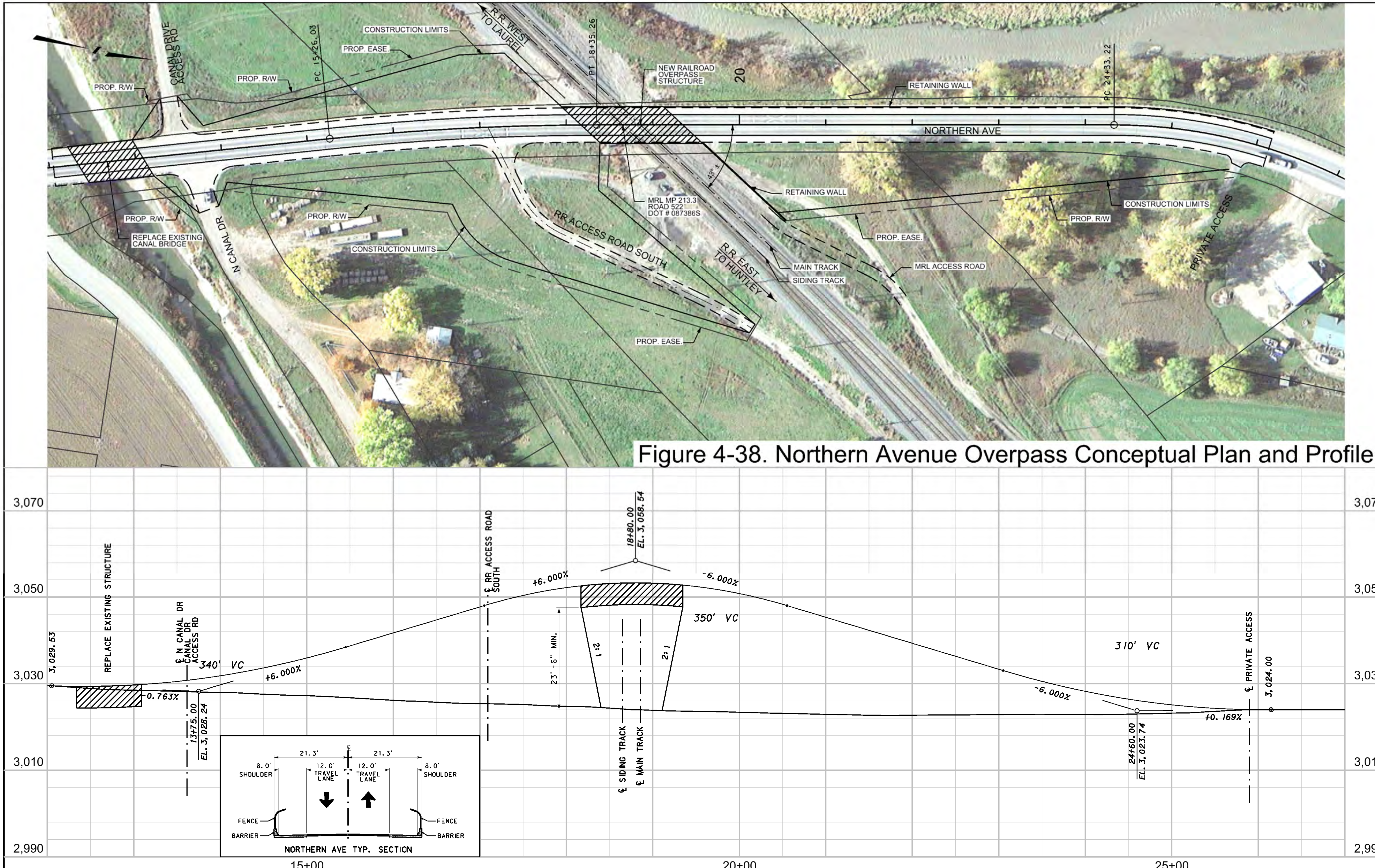

Figure 4-38. Northern Avenue Overpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	\RD\RDPLPZ10_Northern_Ave.DGN 12/15/2015 4:30:05 PM bmartish	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS / YELLOWSTONE COUNTY	PRELIMINARY	MONTANA RAIL GRADE SEPARATION STUDY / N/A / SCALE 1"=100'	HUNTLEY, MT / SHEET X OF X

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4.12.5.1 PROPOSED ROADWAY FEATURES

The roadway overpass along Northern Avenue would consist of one travel lane in each direction and 8-foot shoulders which meet current design standards for rural collector roads. The roadway overpass bridge would include concrete barrier and pedestrian fence to prevent debris from being tossed on the railroad tracks and for pedestrian safety. The horizontal alignment will match the existing alignment while the vertical profile for the overpass would utilize 6 percent maximum grades in an effort to minimize impacts on the surrounding areas. Vertical curvature is designed to meet 35 mph design criteria. Fill slopes would be required to accommodate the profile changes. A 3H:1V slope has been assumed in order to minimize the need of roadside barrier along the overpass with a retaining wall used along the Yellowstone River Channel. These fill slopes would require new right-of-way acquisition along the improvement limits. Figure 4-38 shows the typical section, plan and profile including extents of right-of-way impacts along Northern Avenue.

The existing Huntley Main Canal crossing south of the at-grade crossing would be replaced with the addition of the overpass in order to match the new vertical profile of Northern Avenue. Reconstruction would be needed at North Canal Drive and the railroad access road to match the elevation increase of Northern Avenue in these locations. Minor grading modifications would also be required to maintain MRL's access along the tracks north of the crossing.

4.12.5.2 PROPOSED RAILROAD FEATURES

The railroad tracks will remain as they are. The overpass bridge would need to allow for 23-foot and 4-inch vertical clearance 25 feet each way from the tracks. Piers must be a minimum of 25 feet clear of the nearest railroad track for safety and to allow railroad access to maintain the tracks.

4.12.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section includes 8-foot shoulders but no other non-motorized features are included at this time. Currently there are no dedicated pedestrian facilities in the area to connect to and no future dedicated non-motorized projects have been identified along Northern Avenue in this area.

4.12.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

New right-of-way acquisition would be required to accommodate the footprint of the proposed overpass including an easement within MRL property limits. The proposed right-of-way would be acquired from private property owners. A total of approximately 31,000 ft^2 is estimated for the underpass at $4/$ft^2$ (2015$), which is market value for commercial properties for this area of Huntley per research of Montana Cadastral information and other local publically available information.

4.12.5.5 OTHER FEATURES

4.12.5.5.1 Emergency Vehicle Considerations

It is assumed the Northern Avenue crossing is used by emergency vehicles and a grade separation at this location would positively benefit emergency vehicle response times by improving overall traffic flow operations.

4.12.5.5.2 Drainage
The proposed overpass crossing would require a new overpass structure of the Huntley Main Canal to accommodate the new vertical profile for the overpass.

4.12.5.5.3 Retaining Walls
Retaining walls could be used at the northeast corner of the Northern Avenue overpass to keep the MRL access road functioning under the overpass and eliminate fill slopes in this area. The railroad needs to maintain its current access to the siding and turnouts within the crossing vicinity on both sides of Northern Avenue. A MSE wall would be recommended for this type of location. The face of the walls can vary to meet the desires of the local community.

4.12.5.5.4 Maintenance
The maintenance cost for major design features for the overpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category the avoided O&M costs for the at-grade crossing.

4.12.6 Constructability

4.12.6.1 ROADWAY CONSTRUCTION
Construction of the new roadway overpass would require Northern Avenue to be temporarily closed. A temporary roadway detour over the railroad tracks could be graded in order to maintain access for through traffic. Temporary grading would be required to reroute traffic around the construction activities at a safe distance. Coordination with MRL and local residents would be needed in order to maintain access during construction.

4.12.6.2 RAILROAD CONSTRUCTION
A temporary at-grade rail crossing using concrete planks and crossing signals consisting of gates, flashing lights and warning bells would be constructed by the railroad for the detour road. As a requirement of railroad safety, any work performed within 25 feet of the tracks or having the potential to foul the zone within 25 feet of the tracks must have a railroad flagger present. The temporary and permanent crossing material and signals would be removed as part of the project completion process.

4.12.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION
Northern Avenue provides a direct link from Huntley to I-94 and temporary access should be maintained. A temporary at-grade crossing could be constructed east of the existing crossing in order to provide access to through traffic during the overpass construction. Advanced signing would need to be placed to help direct traffic to the temporary crossing. Public outreach would also need to be included in order to keep the general public updated on construction status. Due to the location of the BNSF Wyoming track connection, a temporary MSE retaining wall could be used to support the Northern Avenue overpass embankment until traffic could be shifted onto it to allow construction of the fill slopes and access roads on the east side of the overpass approach embankments.

4.12.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $13,200,000 (2015$). Table 4-28 shows the various cost components for the Northern Avenue overpass option.

Table 4-28. Northern Avenue Overpass Option Cost Estimate

Northern Avenue Cost Components	Cost ($)
Road Work	$3,649,000
Railroad Work	$548,000
New Structure(s)	$1,253,500
Hydraulics	$200,000
Utilities	$250,000
Miscellaneous Items	$300,000
Mobilization (18%)	$1,100,000
Contingencies (25%)	$1,800,000
Preliminary Engineering (15%)	$1,400,000
Construction Engineering (15%)	$1,400,000
Right-of-Way	$124,000
IDC (10.37%)	$1,200,000
TOTAL COSTS (2015$)	**$13,200,000**

4.12.8 Benefit-Cost Analysis

A BCA was conducted for the Northern Avenue grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the Northern Avenue grade separation. Refer to Appendix C for more information on the BCA.

Considering all monetized benefits and costs of the Northern Avenue grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $11.62 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $0.82 million, of which the largest benefit is $0.37 million worth of travel time savings, while the total costs amount to $12.44 million. Table 4-29 and Table 4-30 provide a summary of the BCA results.

Table 4-29. Monetized Benefits by Category for Northern Avenue Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$0.80	$0.56	$0.37
Improved Safety	$0.55	$0.38	$0.25
Vehicle Operating Cost Savings	$0.05	$0.03	$0.02
Reduced Environmental Costs	$0.01	$0.00	$0.00

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Avoided Operations and Maintenance Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$1.77**	**$1.24**	**$0.82**

Table 4-30. Benefit-Cost Analysis Results for Northern Avenue Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$1.77	$1.24	$0.82
Total Costs ($2015 M)	$13.42	$12.97	$12.44
Net Present Value (NPV)	-$11.65	-$11.73	-$11.62
Return on Investment (ROI)	-86.79%	-90.41%	-93.38%
Benefit-Cost Ratio (BCR)	0.13	0.10	0.07
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.33%	-16.83%	-19.92%

Figure 4-39 illustrates the 20 years of undiscounted benefits following construction of the Northern Avenue grade separation.

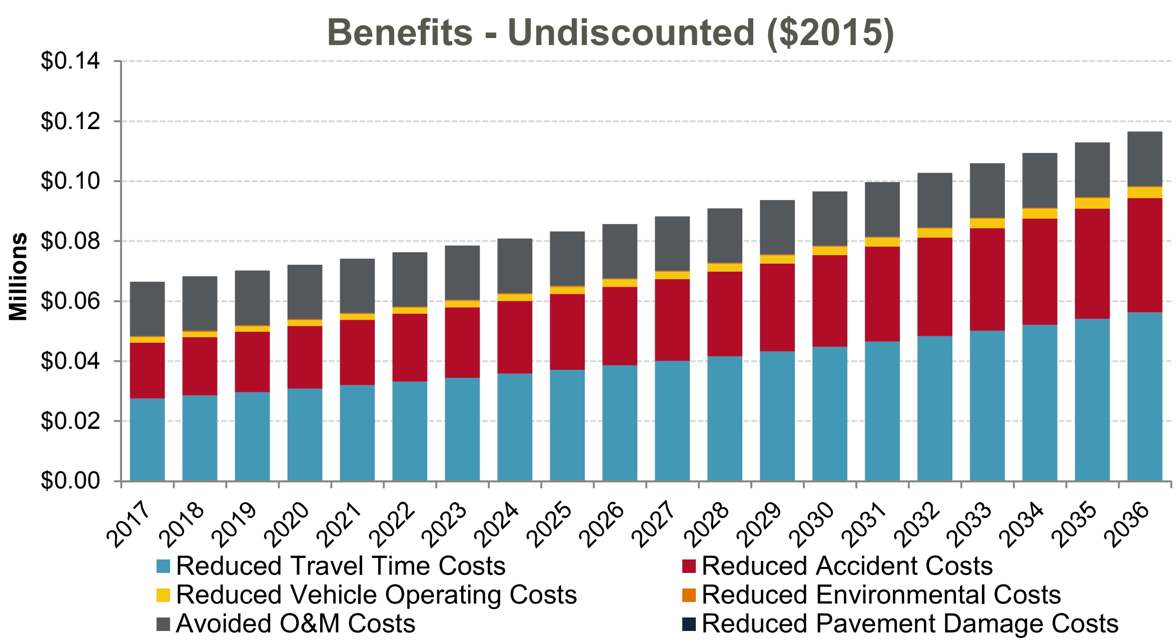

Figure 4-39. Projected Undiscounted Benefits for Northern Avenue Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.12.9 Summary

Based on a review of existing conditions, an overpass of the railroad is recommended at this location especially as this road is the only link between the Huntley area and Interstate 94. Besides the structure over the railroad tracks, the project would include a new structure over the Huntley Main Canal due to the required roadway profile change to create the overpass. During construction, a detour road would maintain connectivity with Huntley, the Interstate and the rural area along Pryor Creek. Providing a grade separation of the railroad at this location could positively benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

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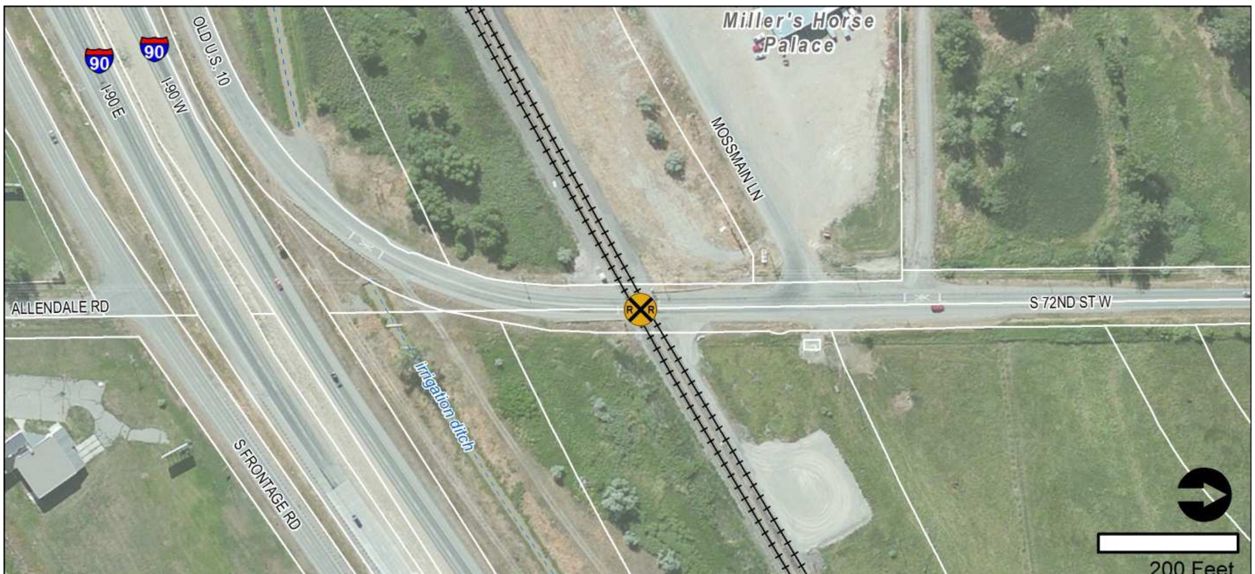
4.13 South 72nd Street West, Laurel, MRL MP 11.42, DOT #087371C

4.13.1 Overview

The South 72nd Street West (72nd Street) at-grade railroad crossing is located east of Laurel approximately 3.7 miles via Main Street and Old U.S. 10. The 72nd Street crossing experiences daily volumes of vehicles of nearly 2,300 AADT in 2014 with a projection of over 3,600 in 2034. Thirty-two (32) railroad trains travel through this crossing daily. The traffic, roadway conditions, and safety hazards at this crossing resulted in it being identified as a priority crossing to be grade-separated within the state. Figure 4-40 shows the crossing area and provides a summary of the key statistics for this crossing.



DOT Crossing # 087371C
2014 AADT: *2,290*
2034 AADT: *3,609*
Trains per day: *32*
Train Speed: *10 - 59 mph*

Functional Classification: *Major Collector*
System Designation: *Off System*
Warning Device: *Automatic Gates with Flashing Lights and Bells*
MDT Adjusted Priority Index: *839*

Figure 4-40. 72nd Street Crossing Overview

To ease congestion at this crossing and increase safety, grade separating the roadway from the railroad is proposed. An underpass would undercut the irrigation canal, require retaining walls along I-90 and a temporary railroad track construction to support train detours. Potential wetlands and high groundwater in this location present constraints as well. The roadway approach north of the existing at-grade crossing is higher than the railroad and, with the constraints of an irrigation canal and Interstate 90 located south of the crossing at essentially the same elevation as the crossing, a roadway overpass was determined to be the most feasible and practical grade separation solution at this site.

4.13.2 Regional Context

72nd Street is designated as an off system route and is maintained by Yellowstone County. 72nd Street serves as an important north-south linkage between the city of Laurel and Billings' King Avenue West arterial roadway and provides access from rural properties and businesses located in between the cities. 72nd Street crosses the MRL/BNSF mainline then turns into Old U.S. Highway 10 which provides access to Interstate 90 at the interchange located southwest of the crossing. Figure 4-41 depicts the 72nd Street crossing in context with other railroad crossings in the vicinity.

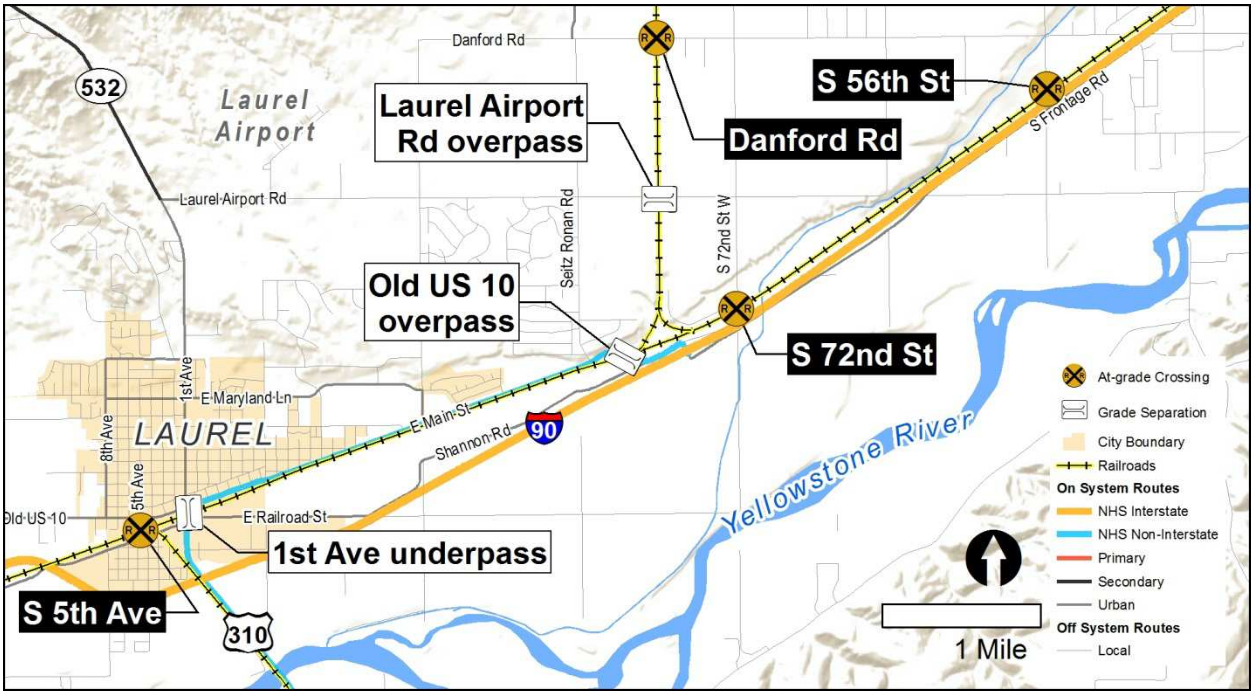


Figure 4-41. Laurel Area Highway-Rail Crossings

An existing at-grade crossing, 56th Street West, is located approximately 2.3 miles east of the 72nd Street crossing. An existing grade separation exists within a one-mile radius of the 72nd Street crossing for Old US 10. It is an overpass located approximately 0.75 mile from the 72nd Street crossing and provides a grade-separated crossing of the railroad before turning into E. Main Street. Within Laurel city limits, one existing grade separation, an underpass, is at S. 1st Avenue, approximately 3.4 miles west of 72nd Street and one existing at-grade crossing at S. 5th Avenue provides access north and south of the railroad. Two crossings, a grade separation on Laurel Airport Road and an at-grade crossing on Danford Road, cross the BNSF track that heads north to Great Falls.

4.13.2.1 EXISTING PLANNING AND ENVIRONMENTAL STUDIES

The 2014 *City of Laurel Long Range Transportation Plan* was reviewed with respect to improvement recommendations located in the vicinity of 72nd Street and the railroad crossing. The plan did not identify any safety or operational concerns along 72nd Street within the vicinity of the crossing; however, the crash analysis identifies several incapacitating injuries located along Old US 10 west of the railroad crossing. No projects were identified in the plan involving improvement recommendations for 72nd Street.

4.13.3 Existing Crossing Features

The following sections describe the existing conditions at the 72nd Street at-grade crossing. The information provided was gathered from field review as well as review of public data sources. HDR conducted a field evaluation of this crossing on August 11, 2015. During this field visit, it was noted dump trucks and other heavy haul equipment used this crossing for access to and from the gravel pits to the north.

4.13.3.1 EXISTING ROADWAY

72nd Street is functionally classified as a major collector roadway with a 2014 AADT of 2,290 and a projected 2034 AADT of 3,609 vehicles. At the location of the current at-grade crossing, 72nd Street is a 24-foot wide paved roadway consisting of two 12-foot lanes with gravel shoulders approximately 4 feet wide (Photo 4-30). Nearby intersecting roadways are located north of the crossing on the west side of 72nd Street. They include a railroad access road located approximately 150 feet north of the crossing, Mossmain Lane located another 100 feet to the north, and an unnamed access road located another 150 feet north of Mossmain Lane. The intersecting roadways have stop signs to control access onto 72nd Street. The posted speed limit north of the at-grade crossing is 60 mph. The curve to the south has a 45 mph warning sign and 50 mph speed limit when it parallels the Interstate. Advance curve warning signs and chevron signs are located through the curve south of the existing at-grade crossing.

Photo 4-30. S. 72nd Street West looking north, crossing features and roadway grade

4.13.3.2 EXISTING RAILROAD FEATURES

Two railroad tracks, East Bound Main and West Bound Main, cross 72nd Street. Photo 4-31 shows the railroad crossing features. This corridor is part of a major east-west national freight train link across the southern part of the state. In addition, the wye connecting this track segment with BNSF's tracks going to Great Falls and connecting with the Hi-Line route is approximately 600 feet west of the at-grade crossing location. Located approximately a half mile to the west of the crossing is the start of tracks for MRL's Laurel Yard. The railroad crossing experiences 32 trains daily with some blockage created by switching operations from the east end of the railroad yard. The track speeds at this location vary between 10–60 mph as westbound trains slow to enter the yard or go north toward Great Falls and eastbound trains accelerate as they go east. The tracks cross 72nd Street at an approximate 29 degree skew

Photo 4-31. Railroad features west of 72nd Street

angle from the roadway. The current at-grade crossing has gates, flashing lights and warning bells for vehicle protection. Both main tracks use precast concrete crossing panels for the roadway.

4.13.3.3 EXISTING NON-MOTORIZED FEATURES

72nd Street currently does not have any dedicated non-motorized facilities adjacent to the roadway. No sidewalks or bike lanes exist within the vicinity of the crossing. Unpaved shoulder widths are approximately 4 feet wide.

4.13.3.4 UTILITIES

An overhead local service power transmission line and a power service drop exist in the crossing area. Fiber optic lines and a natural gas line are underground in the crossing vicinity. Existing utilities identified are not all inclusive. A more detailed survey using One-Call services will be required as part of a future design effort.

4.13.4 Land Uses and Rights-of-Way

Roadway right-of-way in the vicinity of the 72nd Street crossing consists of an easement across railroad property and appears to be a total width of approximately 70 feet. MRL/BNSF right-of-way extends approximately 200-feet north of the westbound main track centerline and approximately 180-feet south. Adjacent properties are largely undeveloped within the vicinity of the crossing. Nearby land uses consist primarily of commercial, agricultural, and light industrial uses.

4.13.4.1 EXISTING BUSINESSES

Several businesses are located along Mossmain Lane within the vicinity of the crossing. Miller's Horse Palace is located within the closest proximity to the crossing, access to which is provided from Mossmain Lane. Additional businesses located farther west on Mossmain Lane include Brenntag Pacific, The Amusement Park Drive-In, and Western Sugar. Several businesses which appear to be commercial truck generators are located to the north of the crossing that access 72nd Street, including two gravel pits one owned by JLM Gravel West, LLC and a the second owned by Fischer Sand and Gravel.

4.13.4.2 PUBLIC RECREATIONAL FACILITIES AND/OR POTENTIAL HISTORIC SITES

No publicly owned properties for public recreation appear to exist within the crossing vicinity. No apparent historic sites were identified within the crossing vicinity. The Northern Pacific Railroad Main Line is a historic feature and eligible for listing in the NRHP although elements of the at-grade crossing may not contribute to the corridor's historic status or modifications to the crossings may not impact the eligibility of the larger corridor or surrounding buildings. The Canyon Creek Ditch is likely a historic feature and eligible for listing in the NRHP although the canal's culvert under 72nd Street may not contribute to the corridor's historic status or modifications to the canals undercrossing of 72nd Street may not impact the eligibility of the canal.

4.13.4.3 RESIDENTIAL

No residences are located along 72nd Street within the vicinity of the railroad crossing.

4.13.4.4 ADDITIONAL FEATURES

The Canyon Creek Ditch is approximately 18 feet wide and located south of the crossing. The irrigation canal flows into an approximately 15-foot-wide concrete box culvert underneath 72nd Street about 300 feet south of the track in the roadway's horizontal curve. This canal roughly parallels the railroad and interstate.

Per the USFWS National Wetland Inventory database, a potential wetland area exists on the west side of 72nd Street approximately 600 feet north of the crossing. Wetlands may exist directly adjacent to the crossing. If a project is progressed at this location, wetland delineations would be required to confirm the presence or absence of wetlands.

4.13.5 Proposed Solution

The proposed crossing solution at this location is an overpass with 72nd Street traversing over the railroad.

An overpass versus underpass option was analyzed as part of the field visit and conceptual design process. The existing vertical grade along 72nd Street climbs a relatively steep grade on the north side of the crossing and accommodates an overpass coming off the hill from the north. This, in addition to the existing horizontal curve, irrigation canal south of the crossing, high groundwater and potential wetlands result in an overpass being a more feasible improvement at this location. Refer to Figure 4-42 for the proposed conceptual plan and profile for the overpass.

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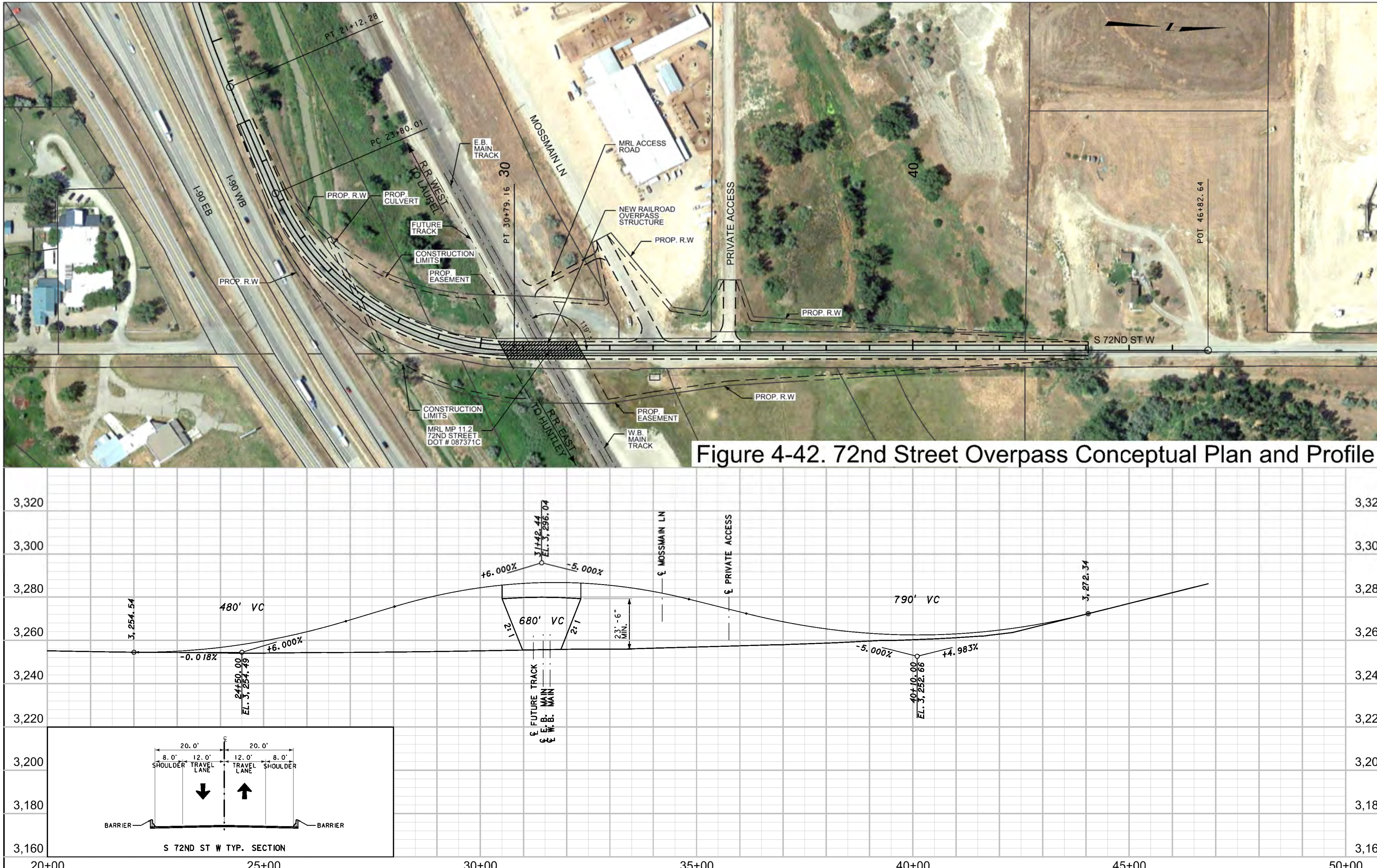

Figure 4-42. 72nd Street Overpass Conceptual Plan and Profile

MDT MONTANA DEPARTMENT OF TRANSPORTATION	\RD\RDPLPZ11_S72ndStW.dgn 12/16/2015 10:53:37 AM bmartish	DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS / YELLOWSTONE COUNTY	PRELIMINARY	MONTANA RAIL GRADE SEPARATION STUDY / N/A / SCALE 1"=200'	LAUREL, MT / SHEET X OF X

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4.13.5.1 PROPOSED ROADWAY FEATURES

The roadway overpass along 72nd Street would consist of one 12-foot travel lane in each direction and 8-foot shoulders. The roadway overpass bridge would include concrete barrier including fencing over the railroad tracks. The horizontal alignment would match the existing 72nd Street Alignment. In order to minimize impacts on I-90 and neighboring properties, the proposed vertical profile would utilize 6 percent maximum grades. Vertical and horizontal curvature is designed to meet 45 mph matching current posted speeds south of the at-grade crossing.

Fill slopes required to construct the roadway overpass are assumed to be 3H:1V in order to minimize the need of roadside barrier. The required construction limits for these fill slopes and other improvements would require new right-of-way acquisition. Figure 4-42 shows the typical section, plan and profile as well as approximate right-of-way impacts along the improvement limits.

Impacts on local access are limited due to the rural nature of the area. Mossmain Lane and the private access road located north of the crossing would require reconstruction to match the proposed profile of 72nd Street. A new MRL access road would be constructed off of the west side of the raised 72nd Street north of the crossing to provide access to the tracks east and west of the proposed overpass.

4.13.5.2 PROPOSED RAILROAD FEATURES

A minimum of 23-foot-4-inch vertical clearance, per railroad requirements, would be provided with the horizontal opening designed to handle existing trackage, a future track to the south of the exiting tracks and maintain the railroad’s access to the signals west and railroad track east of the proposed overpass. 25-foot horizontal clearance from any track centerline is required as well. As a result, the minimum clear opening would be 85 feet, toe of slope or edge of pier to the opposite side.

4.13.5.3 PROPOSED NON-MOTORIZED FEATURES

The proposed roadway typical section includes 8-foot shoulders but no other dedicated non-motorized features are included at this time. Currently there are no pedestrian facilities in the area to connect to and no future dedicated non-motorized projects have been identified along 72nd Street in this area.

4.13.5.4 LAND USE AND RIGHT-OF-WAY ISSUES

New right-of-way acquisition would be required to accommodate the construction limits of the proposed overpass including an easement within MRL property limits. The proposed right-of-way would be acquired from private property owners. A total of approximately 52,800 ft^2 is estimated for the underpass at $10/$ft^2$ (2015$), which is assumed market value for commercial properties for this area of Laurel per review of Montana Cadastral and other local publically available information.

4.13.5.5 OTHER FEATURES

4.13.5.5.1 Emergency Vehicle Considerations

The 72nd Street crossing is used by emergency vehicles from Laurel accessing rural properties to the north as it provides a direct north-south route connection with King Avenue West and as a central road serves residential areas and the Hesper, MT area. A grade separation at this location would positively benefit emergency vehicle response times by improving access and eliminating delays caused by train blockages.

4.13.5.5.2 Drainage

As previously mentioned, an irrigation canal is piped underneath 72nd Street south of the railroad tracks. This crossing would require a new structure to accommodate the extended embankment limits for the overpass grading.

4.13.5.5.3 Retaining Walls

Based on the conceptual engineering, retaining walls are not included in the planning estimate as construction limits could be accommodated within the project area. If this option is progressed additional review would be required to determine construction constraints.

4.13.5.5.4 Maintenance

The maintenance cost for major design features for the underpass are included in the BCA described below. The BCA incorporates O&M costs for the proposed grade separation which are included along with capital costs to estimate total project costs for the 20-year analysis period. The BCA also includes as a benefit category for the avoided O&M costs for the at-grade crossing

4.13.6 Constructability

4.13.6.1 ROADWAY CONSTRUCTION

Construction of the new roadway overpass would require 72nd Street to be temporarily closed. A temporary detour route would need to be established as well as coordination with local properties to maintain access during construction.

4.13.6.2 RAILROAD CONSTRUCTION

During construction, to meet railroad safety requirements, a railroad flagger would be needed whenever work was within 25 feet of the tracks or had the potential to foul the area. Construction activities required over or within the track safety zone would be done during railroad agreed upon train outages assumed to be 8 hours or less.

4.13.6.3 TRAFFIC IMPACTS DURING CONSTRUCTION

72nd Street would be closed during construction and traffic could be diverted to the west off the interstate. Alternate local access would be provided via S. 80th Street W/Seitz Ronan Road and Laurel Airport Road. It is unknown if the Laurel Road timber railroad overpass would restrict rerouting of the gravel trucks from the pits that currently use 72nd Street. Detour signing would need to be placed to help direct traffic. Public outreach would also need to be included in order to keep the general public updated on construction status. Access to the railroad tracks will be maintained throughout construction.

4.13.7 Cost Estimate

The anticipated order of magnitude conceptual estimate of probable construction cost including PE, CE, IDC, right-of-way and 25 percent contingency is $14,800,000 (2015$). Table 4-31 shows the various cost components for the 72nd Street overpass option.

Table 4-31. 72nd Street Overpass Option Cost Estimate

72nd Street Components	Cost ($)
Road Work	$3,606,000
Railroad Work	$94,000
New Structure(s)	$1,800,000
Hydraulics	$100,000
Utilities	$500,000
Miscellaneous Items	$300,000
Mobilization (18%)	$1,100,000
Contingencies (25%)	$1,900,000
Preliminary Engineering (15%)	$1,400,000
Construction Engineering (15%)	$1,400,000
IDC (10.37%)	$1,153,000
Right-of-Way	$1,400,000
TOTAL COSTS (2015$)	**$14,800,000**

4.13.8 Benefit-Cost Analysis

A BCA was conducted for the 72nd Street grade separation which provides a conceptual framework that totals up the monetized value of the benefits and costs of the project over a 20-year analysis period to determine the soundness of the investment. The BCA considered the following five benefit categories: travel time, safety, vehicle operating costs, environmental (emissions), and pavement maintenance. The methodology developed for the study is consistent with the DOT Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program guidance. The following information summarizes the BCA results for the 72nd Street grade separation. Refer to Appendix C for more information on the BCA.

Considering all monetized benefits and costs of the 72nd Street grade separation, the estimated net present value of the project with a 7 percent discount rate is a net cost of $13.36 million. The project's estimated total benefits over the 20-year analysis period in present value terms are worth $0.58 million, of which the largest benefit is $0.21 million worth of travel time savings, while the total costs amount to $13.94 million. Table 4-32 and Table 4-33 provide a summary of the BCA results.

Table 4-32. Monetized Benefits by Category for 72nd Street Grade Separation

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$0.47	$0.33	$0.21
Improved Safety	$0.38	$0.26	$0.17
Vehicle Operating Cost Savings	$0.03	$0.02	$0.01
Reduced Environmental Costs	$0.00	$0.00	$0.00
Avoided Operations and	$0.36	$0.26	$0.18

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Maintenance Costs			
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
TOTAL	**$1.24**	**$0.87**	**$0.58**

Table 4-33. Benefit-Cost Analysis Results for 72nd Street Grade Separation

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits ($2015 M)	$1.24	$0.87	$0.58
Total Costs ($2015 M)	$15.02	$14.53	$13.94
Net Present Value (NPV)	-$13.78	-$13.65	-$13.36
Return on Investment (ROI)	-91.75%	-93.99%	-95.82%
Benefit-Cost Ratio (BCR)	0.08	0.06	0.04
Payback Period	N/A	N/A	N/A
Internal Rate of Return (IRR)	-17.26%	-19.67%	-22.66%

Figure 4-43 illustrates the 20 years of undiscounted benefits following construction of the 72nd Street grade separation.

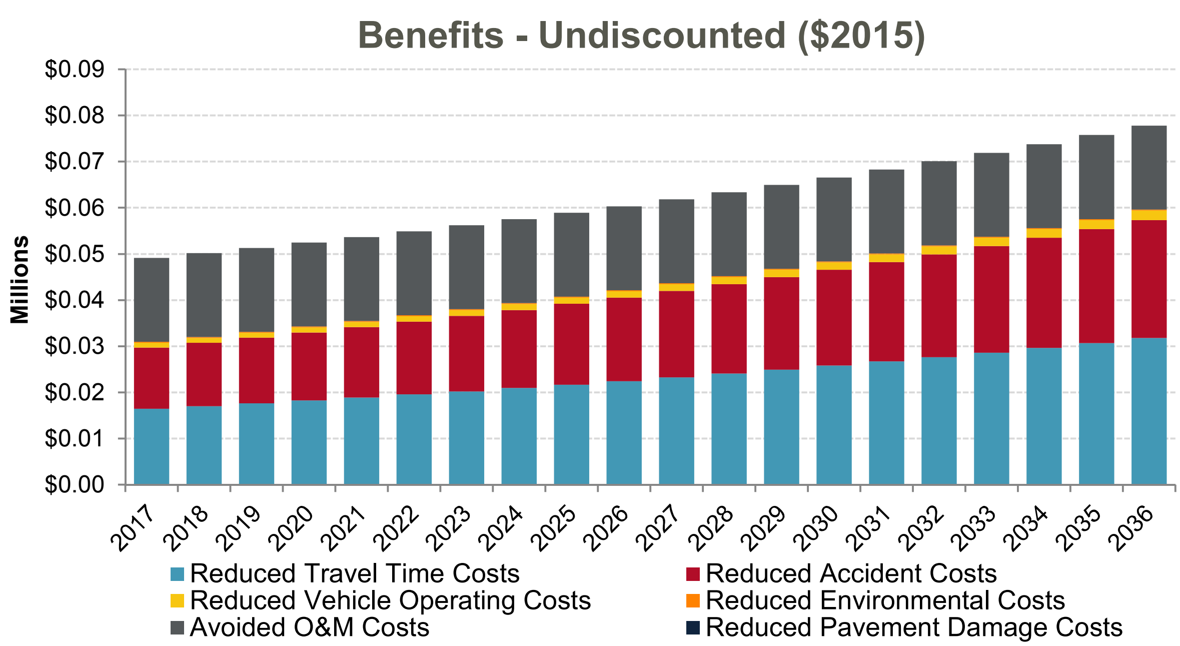

Figure 4-43. Projected Undiscounted Benefits for 72nd Street Grade Separation

The BCA is intended to assist transportation decision makers in prioritizing highway-rail grade crossing investment of federal and state dollars based on an array of benefit-cost measures. The BCA is predicated on defensible and credible monetization of externalities, which means other benefits are not captured in the analysis - either due to a lack of empirical data, or constraints in carrying out a highly detailed analysis of each crossing. These could include improved access to first responders, travel time reliability, among other benefits. Additionally, the analysis is constrained by a 20-year analysis and, although not captured in the results, benefits would be expected to continue well beyond this timeframe. Although funding is currently unavailable to fund the proposed improvements, the results establish a useful comparison of existing and future conditions under a build and no-build scenario.

4.13.9 Summary

The 72nd Street at-grade crossing was identified as a priority location due to the volumes of vehicles and trains experienced at the crossing as well as other screening criteria including train speeds and priority index. Based on a review of existing conditions and published documents, an overpass of the railroad is recommended at this location. New connections with local streets could be constructed to meet the overpass grade. During construction, traffic would be detoured around the site using the existing local road network. Providing a grade separation of the railroad at this location could benefit traffic operations, improve travel times, and increase vehicular and non-motorized safety. The improvements would be consistent with those identified in the 2014 LRTP.

The information within this section provides a planning-level assessment of potential impacts. Should funding become available and a project progressed at this location, an environmental analysis of impacts and their significance level would be required under NEPA/MEPA during project development.

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5 Grade-Separated Rail Crossing Recommendations

This section presents a summary of the final results from the grade-separated crossing selection process and provides improvement recommendations for selected grade-separated crossings. Section 5.1 lists the final 12 grade-separated crossings that were identified based on the quantitative and qualitative analyses previously presented in Section 3. Section 5.2 describes potential improvements for 5 existing grade-separated crossings that may be considered. The five grade-separated crossings are included in the initial list of 25 crossings and were identified by the Rail Grade Separation Study Project Team, MDT Planning personnel, and MDT District Administrators as locations of interest due to limitations in vertical or horizontal clearance and/or geometric roadway issues.

5.1 Final Grade-Separated Crossings

A final list of 12 grade-separated railroad crossings was determined by reviewing the 25 grade-separated crossings (Section 3, Table 3-7) in descending order and removing from further consideration crossings determined infeasible to improve and, where applicable, crossings already programmed for improvement by MDT in the Tentative Construction Plan. Table 5-1 lists alphabetically by city the final list of 12 grade-separated rail crossings identified at the conclusion of the selection process. Note that it is not the intention of this study to develop improvement recommendations for all crossings listed in Table 5-1, but rather identify crossings where future improvements may be considered based on the crossing criteria examined. Further evaluation would be necessary to determine which crossing or crossings would be most viable, cost effective and beneficial to each community to improve.

Table 5-1. Final Grade-Separated Crossings

City	Location
Big Timber	US 191
Butte	Harrison Avenue
East Glacier	Highway 49
Glasgow	6th Street S
Great Falls	1st Avenue N
Great Falls	6th Street N
Kalispell	US 2
Malta	US 191
Miles City	Main Street
Missoula	Orange Street
Missoula	N Van Buren Street
Wolf Point	S 3rd Avenue

As stated above, several grade-separated crossings initially within the final list of 12 crossings were removed from the list based on results of the qualitative assessment. Table 5-2 lists these crossings and the rationale for their removal.

Table 5-2. Grade-Separated Crossings Removed from Final List

City	Location	Rationale for Removal
Laurel	S. 1st Avenue	Underpass improvements being made with a programmed project (Fiscal Year 2015)
Great Falls	River Drive S.	Infeasible to make improvements due to location and elevation of the roadway adjacent to the Missouri River
Billings	6th Street	Underpass improvements being made with a programmed project (Currently in Preliminary Engineering Phase)
Livingston	N. Main Street	Infeasible to make improvements due to geometric constraints of the entering roadway

The final list of the 12 grade-separated crossings and general questionnaire were distributed to district staff in the five MDT Districts where the crossings were located to gather local input on general conditions and issues. The questionnaire requested additional information such as reasons for regular closures, detours lengths, pedestrian and bus access, identified plans for improvement, any other facts about the grade-separated crossings. Based on the responses from this survey, the District responses did not provide many additional suggestions to either the list of grade-separation locations or the types of improvement projects that could benefit each crossing location. The questionnaire and results are provided in Appendix A. The District's responses are included in the discussions of specific existing grade-separated crossings, as applicable.

5.2 Recommended Improvements to Select Grade Separations

This section presents improvement options to selected existing underpass crossings. It is not the intention of this study to develop improvement recommendations for the final 12 grade-separated crossings. The crossings listed below were selected qualitatively based on input by the Project Team, MDT Planning personnel, and MDT District staff to identify crossings to develop improvement options. The crossings described in this section were included on the list of 25 grade-separated crossings as presented in Section 3, however were not all included in the final list of 12 grade separated crossings.

Due to vertical or horizontal limitations or geometric issues, these crossings typically are difficult for commercial traffic to fully utilize. These crossings were examined in greater detail to identify potential improvements that could benefit safety and traffic operations. The improvement options include potential roadway adjustments or reconstruction alternatives designed to enhance the utilization of the existing grade-separated crossings or discuss complete reconstruction to meet current standards. Improvement options are presented below for the following grade-separated crossings:

1. Orange Street, Missoula;
2. Henderson Street, Helena;
3. S 3rd Avenue, Wolf Point;
4. 13th Street, Billings; and
5. 21st Street, Billings.

Where noted, the proposed improvements at these crossings could allow better utilization of the existing underpass, and potentially avoid delaying construction of new infrastructure. At some locations, however, reconstruction of the grade separation is suggested as the existing structure is not feasible to modify in order meet current standards or future expansion. Current AADT is provided for each crossing from 2014 MDT data. Projected 2034 AADT was not provided for inclusion in the Study for existing grade-separated crossing locations. Specific recommendations for select underpasses are included in the following sections.

5.2.1 Orange Street, Missoula, MRL MP 119.6, DOT#060400G

5.2.1.1 EXISTING CONDITIONS OVERVIEW

The Orange Street underpass in Missoula is located on a principle arterial roadway. It has a signed vertical clearance of 13 feet. The MDT BMS documents the vertical clearance at 13.48 feet. The current AADT at the underpass is above 16,000 vehicles per day, with approximately 2.7 percent of the traffic being commercial vehicles. The BMS also notes the horizontal clearance as 2.24 feet and a substructure rating of 5. There are sidewalks on both sides of the underpass that are separated from the roadway and non-ADA compliant due to grade.

Photo 5-1. Orange Street, south side looking north

The Orange Street Bridge opened in 1939 as the result of a Federal Aid Grade Crossing Project and supports two streets, N. 1st and Railroad streets, two buildings actively used as businesses, and the MRL railroad yard tracks. The buildings supported by the Orange Street Bridge are privately owned and located on leased property from the railroad. The undercrossing structure measured along Orange Street is approximately 390 feet long. Orange Street crosses under the tracks at an approximate 86 degree skew angle. An at-ground-level extension of Orange Street, which provides access to residences, business and links with Railroad Street, extends immediately adjacent and west of Orange Street's approach to the underpass structure.

The existing Orange Street underpass is listed on the NRHP as part of Montana's Steel Stringer and Steel Girder Bridges Multiple Property Submission. A roundabout connection with the south side of I-90 ramps for the north end of Orange Street is programmed in MDT's Tentative Construction Plan for Fiscal Year 2016.

5.2.1.2 POTENTIAL IMPROVEMENTS TO CROSSING

The option of reconstructing the Orange Street crossing as an overpass is not feasible due to the impacts on businesses including an out-patient hospital, residences, street network being cut off from access with Orange Street and the impact on the I-90 ramp connectivity. While requiring right-of-way and utility work, reconstructing the underpass to provide for current and future traffic using this main entrance to the Missoula downtown area appears to be the most feasible alternative. Based on the AADT, the undercrossing roadway could consist of the following configuration:

- Four 12-foot lanes, two in each direction, with 6-foot outside shoulders and curb and gutter
- 5-foot raised sidewalks on each side to meet ADA requirements

To provide for a totally open deck area for the railroad yard to match the current 125-foot-width over Orange Street, a center median and pier, with a total width of 6 feet would be utilized. This makes the total bridge length along the tracks 84 feet, accommodating an 80-foot underpass opening using either steel wide flange beams or precast concrete double cell beams.

The roadway would be lowered 4 feet to obtain the minimum required vertical clearance of 17 feet. The at-ground level extension of Orange Street would likely be closed and retaining walls used throughout the approaches to the undercrossing structure. A new pump system with holding cistern capabilities would be included to handle stormwater drainage. The Missoula aquifer is typically 30 to 35 feet below grade in this area.

It is assumed the new structure could still carry N. 1st and Railroad streets over Orange Street and the businesses could be relocated back onto the reconstructed structure or the area vacated made available for other uses.

Construction could occur in phases over an approximate 2-year period, with roads closed, traffic detoured around the underpass construction area and tracks shifted within the available yard corridor during each phase.

Additional study is warranted for this undercrossing, which restricts convenient access to the Missoula downtown area based on below standard vertical clearances. A rough conceptual order of magnitude opinion of probable project cost is $60 million for the alternative described.

5.2.2 Henderson Street, Helena, MRL MP 1.9, DOT#060201E

5.2.2.1 EXISTING CONDITIONS OVERVIEW

The Henderson Street underpass in Helena is located on a minor arterial roadway crossing under two main tracks. Improving this grade separation was identified during the study by MDT as an alternative to creating a grade-separated crossing at Benton Avenue in Helena. The existing road consists of two travel lanes, a total curb to curb roadway width of 40-foot-wide, reducing to a width of approximately 24 feet between guardrails under the railroad bridge. It has a signed vertical clearance of 14 feet while the MDT BMS documents the vertical clearance at 14.17 feet. The current AADT at the underpass is around 7,600 vehicles per day, with approximately 1.5 percent of the traffic being commercial vehicles. The BMS also notes the horizontal clearance as 1.05 feet and a substructure rating of 7. The existing undercrossing includes a sidewalk located east of the roadway. The roadway crosses the railroad at an approximate 58 degree skew angle. The existing underpass structure was constructed in 1964 as a replacement for an earlier constructed timber underpass structure.

The Centennial Trail bike/pedestrian crossing of Henderson Street is approximately 200 feet south of the railroad tracks. Hudson Street/Broadway Circle intersects with Henderson Street approximately 700 feet south of the underpass structure. Anderson Boulevard, which accesses a housing development in the northeast quadrant of the crossing, intersects with Henderson

Street approximately 400 feet north of the underpass structure. The roadway is lowered from the surrounding terrain to cross under the tracks with the general terrain of the area dropping from south to north.

The existing 120-foot-long double track ballast deck steel beam span railroad bridge is supported on a steel bent substructure. Some bents are oriented square to the railroad with those adjacent to the roadway located parallel to the roadway. The existing substructure orientation and layout virtually eliminates the ability to place additional lanes or widen the existing roadway under the bridge with little room to construct portions of a new bridge under the existing structure. Photo 5-2 shows the bridge as one travels to the north from the south side.

Photo 5-2. Henderson Street under MRL Bridge 1 looking north (Google Street View)

5.2.2.2 POTENTIAL IMPROVEMENTS TO CROSSING

The 2014 Helena LRTP identifies Henderson Street as limiting for commercial vehicles on this portion of the major street network due to limitations in vertical clearance. The 2014 LRTP recommends replacement of the bridge structure to provide 16.5-foot vertical clearance and horizontal opening to match the City's road standards, providing room for bicycle lanes and improving the Centennial Trail crossing of the roadway. There are alternatives that include simply replacing the undercrossing with an improved undercrossing, as described below. Further studies could refine the approaches and estimated project costs and recommend an alternative to meet Helena's overall transportation goals.

5.2.2.2.1 Road Lowering

The existing bridge could stay in place and the roadway simply lowered using retaining walls and concrete barrier to support the excavation and protect the bridge support piling if the goal was to increase vertical clearance without increasing horizontal clearance. The steel H-pile foundation could be checked to verify the structural integrity of the substructure given the additional exposed height. Drainage would also need to be reviewed with a possible pump station required to handle stormwater that could potentially collect due to the lowered profile under the bridge. A rough conceptual order of magnitude opinion of probable project cost is under $1 million for this road lowering concept.

5.2.2.2.2 Reconstruction

A new underpass or overpass could be constructed to replace the existing undercrossing. The additional lowering of Henderson Street would not impact street intersections north or south of the underpass. Groundwater in the area is below anticipated roadway grades but it is unknown what drainage may be needed for stormwater. An overpass could potentially impact access to one subdivision at Anderson Boulevard.

A new underpass would likely involve the following work:

- Close Henderson Street and redirect traffic
- Shoofly both main tracks to maintain train traffic
- Remove existing structure
- Construct new double track railroad structure – approximately 140-feet-long.
    - Roadway consists of two 12-foot lanes, two 6-foot shoulders and 2-foot curb and gutter with 5-foot sidewalks each side (matches existing road template)
    - “Open” construction using sloped excavation
    - Steel wide flange spans due to skewed span layout on concrete and pile supported substructure
- Shift railroad traffic onto new structure and complete road construction

A new overpass would likely involve the following work:

- Close Henderson Street and redirect traffic
- Construct overpass bridge – bridge approximately 180-feet in length
- Fill existing road excavation and place fill under bridge
- Using train free time periods, for each track, remove superstructure, complete fill and place new subballast, ballast and track
- Complete roadway construction
- Centennial Trail could remain as an at-grade crossing or be shifted and use a “culvert” crossing under the roadway

A rough conceptual order of magnitude opinion of probable project cost is approximately $16 to $18 million for these grade separation reconstruction project alternatives. Further studies could refine the approaches and estimated project costs and recommend an alternative to meets Helena’s overall transportation goals. In addition, traffic studies could indicate how much traffic could divert from Benton Avenue to an improved Henderson Street grade separated crossing.

5.2.3 S 3rd Avenue, Wolf Point, BNSF MP 227.78, DOT #059583F

5.2.3.1 EXISTING CONDITIONS OVERVIEW

The S 3rd Avenue underpass in Wolf Point is located on a minor arterial roadway designated State Highway 25 and crosses under the BNSF mainline, a siding track north of the mainline track and an industry/house track to the south. The undercrossing has a signed vertical clearance of 13 feet 10 inches, while the MDT BMS documents the vertical clearance at 14.33 feet. The AADT at the underpass is 6,550 vehicles per day, with approximately 2.17 percent of the traffic being commercial vehicles. The BMS also notes the horizontal clearance as 0.70 foot and a substructure rating of 5. The roadway and underpass have a sidewalk located on both sides. The undercrossing connects with N. 4th Avenue to the north and S. 3rd Avenue to the south with the roadway crossing under the tracks at an approximate 67 degree angle. The S. 3rd Avenue underpass is the only grade-separated crossing within the community of Wolf Point. An at-grade crossing with flashing lights, gates and bells for protection exists at 6th Avenue, approximately 1200 feet west of the S. 3rd Avenue undercrossing.

Figure 5-1. S. 3rd Avenue Crossing Area, Wolf Point

5.2.3.2 POTENTIAL IMPROVEMENTS TO CROSSING

The crossing was identified as a priority due to substandard vertical clearance and occasional closures due to flooding, over-height vehicle accidents, and snow drifting. An improved grade separation with increased vertical clearance could increase use by commercial truck traffic and reduce congestion and delays at the 6th Avenue at-grade crossing, which has a relatively high number of trains crossing the road on a daily basis. Replacing the existing structure with an overpass is not feasible due to the impacts on the downtown Wolf Point area including separation of businesses from street access and streets being closed.

Replacing the existing structure with an improved underpass is likely feasible but could require:

- Temporary closure of 3rd Avenue at the underpass and detouring of traffic
- Phase structure removal and placement of backfill for shoofly track
- Shooflying or temporary detouring of track to maintain train operations. It is unknown if phased demolition and new construction can reduce the amount of shoofly track needed.
- Due to the skew, a steel beam span railroad bridge supporting the tracks in their current location could be constructed. Discussions with BNSF need to occur to determine if the tracks could be moved together by a potential realignment of the southerly industry/house track. The bridge could be approximately 120 feet long depending on the final roadway configuration utilizing an “open” sloped abutment concept rather than the current retaining walls and vertical wall abutments.
- Reconstruction of the roadway to meet current standards including lowering of the profile by approximately three feet
- A new pump station with overflow storage would be included in the project

- The roadway lowering may require some adjustment to the profile at the S. 3rd Avenue/Front Street intersection which is approximately 200 feet south of the underpass structure.

A rough conceptual order of magnitude opinion of probable project cost is approximately $15 to $17 million for this grade separation reconstruction. The railroad requirements for track spacing and number of tracks needing shooflying greatly impacts the project cost. Further studies could refine the approaches and estimated project costs.

5.2.4 13th Street, Billings, MRL MP 224.75, DOT #088009G

5.2.4.1 EXISTING CONDITIONS OVERVIEW

The 13th Street underpass in Billings is located on a minor arterial roadway crossing under five railroad tracks. It has a signed vertical clearance of 13 feet 8 inches, while the MDT BMS documents the vertical clearance at 14 feet. There is a short sag vertical curve existing under the bridge. The AADT at the underpass is around 9,100 vehicles per day, with approximately 3.2 percent of the traffic being commercial vehicles. The BMS also notes the horizontal clearance as 4.24 feet and a substructure rating of 6.

Photo 5-3. 13th Street, south side showing typical truck encroachment on opposing lane

The existing underpass structure was constructed in the early 1950s as a Federal Aid Project with plans showing a 100-foot sag vertical curve with 5 percent approach grades. Minor beam damage was observed during field visits, likely due to either over-height or longer length trucks striking the structure. The eastbound to northbound trucks are unable to negotiate the curve just south of the underpass without encroaching into the oncoming lane of traffic. The southbound to westbound commercial vehicles had some similar encroachment on the south side of the underpass but not as extensive. Several commercial vehicles were observed during the site visit and none stayed in their own lane. There is a pedestrian sidewalk on the west side of the underpass which appears to meet ADA requirements. The sidewalk and vertical curve are shown in Photo 5-4.

Photo 5-4. 13th Street looking south at vertical curve

The 13th Street underpass is one of two grade separations within the downtown area (21st Street being the second) and has been identified in the 2014 LRTP as a high priority for potential improvements to address capacity and design issues.

5.2.4.2 POTENTIAL IMPROVEMENTS TO CROSSING

Based on observations, several potential improvement options were identified for the 13th Street underpass and are illustrated in Figure 5-2. They include lengthening and adjusting the short vertical curve under the bridge so longer, legal height trucks are not susceptible to hitting the structure. The vertical curve adjustment would also require an adjustment to the roadway approaches. Additional retaining walls could be constructed to allow widening of the 90 degree curve on the south side of the undercrossing to facilitate truck usage and avoid encroaching into oncoming traffic when traversing the curve.

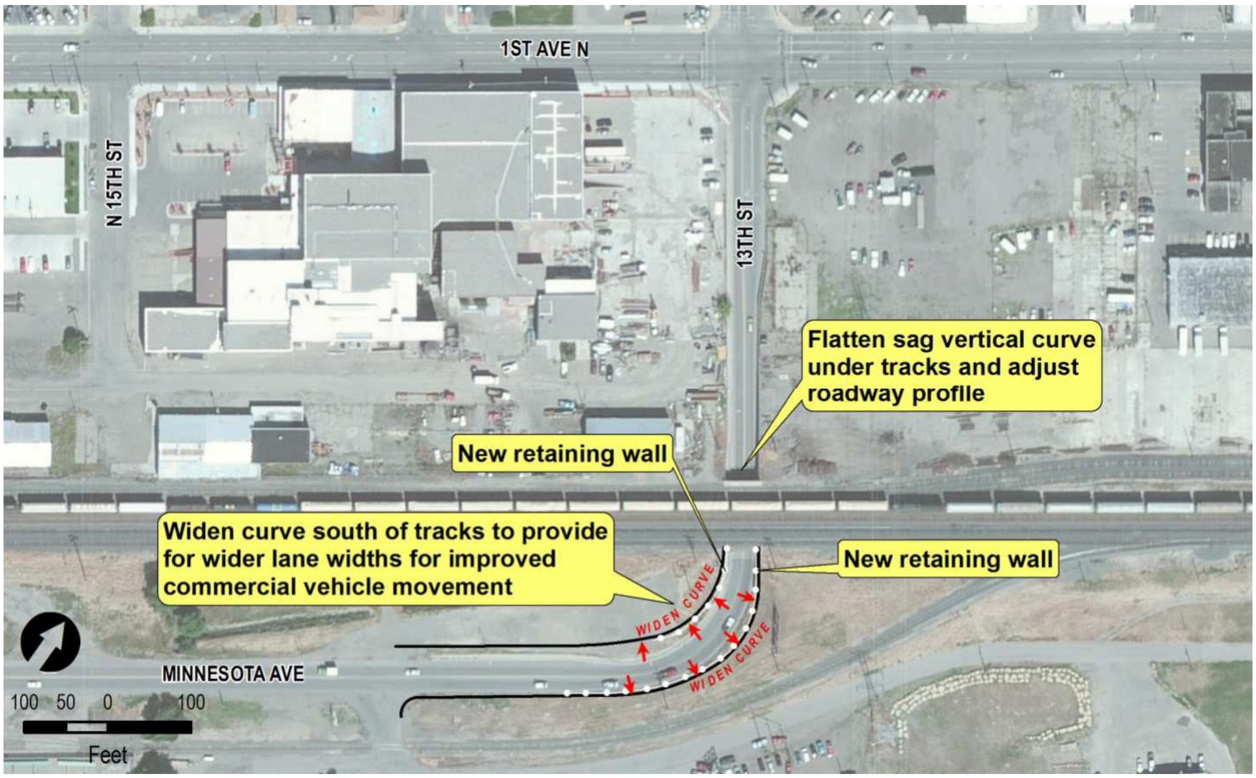

Figure 5-2. Potential Improvements to 13th Street Underpass

The improvement options for the 13th Street underpass, while facilitating current traffic needs, are also seen as an improvement option to support the construction of a grade-separated 27th Street. This underpass could be proposed to become a primary detour route for the 27th Street grade separation alternatives identified in Section 4 and could need to handle additional commercial vehicles if 27th Street is closed for construction of a grade separation. A rough conceptual order of magnitude opinion of probable project cost is approximately $1 to $2 million for these improvements. It is unknown if the roadway modification work would impact the bridge foundations, how much impact will need to be addressed at the 13th Street intersection with 1st Avenue North and what the retaining wall support construction of MRL's spur tracks adjacent to the curve on the south side will involve. Further studies could refine the approaches and estimated project costs as well as determine the actual need as a detour route for the 27th Street grade separation project, if determined to be programmed by MDT.

5.2.5 21st Street, Billings, MRL MP 225.32, DOT# 087450N

5.2.5.1 EXISTING CONDITIONS OVERVIEW

The 21st Street underpass in Billings is located on the local roadway network between the 13th Street underpass and the 27th Street at-grade crossing. The 21st Street underpass was identified as a relief route for lower-height vehicles during construction for a 27th Street grade separation project, if programmed by MDT in the future. The MDT District Administrator identified improvements to 21st Street as an aid to local traffic movement regardless of a 27th Street grade separation project. It has a signed vertical clearance of 8 feet and actual vertical clearance at 8.5 feet with an existing roadway width of 24-feet face to face of curb. The AADT at the underpass is around 2,500 vehicles per day with approximately 1.5 percent of the traffic being low height commercial vehicles. The existing horizontal clearance is 1.54 feet. The structure is not listed in the MDT BMS. The current concrete supported on steel H-pile structure was constructed in 2002 replacing an earlier constructed timber bridge. The roadway undercrossing passes below four railroad tracks and is shown in Photo 5-5.

Photo 5-5. 21st Street underpass, north side of Montana Avenue, looking south

The structure has ADA-compliant pedestrian walkways on both the east side and west sides of the underpass. Montana Avenue, located approximately 100 feet north of the underpass, is a one-way street in the eastbound direction. The undercrossing is used by low-height vehicles and some emergency response units wanting to avoid traffic congestion at 27th Street, especially when passing trains block the at-grade crossing. The current undercrossing has gravity flow storm drainage tied to the City of Billings storm drains.

The 21st Street underpass is one of two grade separations within the downtown area (13th Street being the second) and has been identified in the 2014 LRTP as a high priority project to reconstruct the underpass to enhance clearance and capacity.

5.2.5.2 POTENTIAL IMPROVEMENTS TO CROSSING

Based on observations, several recommendations were identified and potential improvements to increase the vertical clearance under the 21st Street underpass are described and illustrated in Figure 5-3. Improvements include lowering the roadway to increase the vertical clearance of the underpass to enhance capacity. The pile supports for the concrete caps would need to be checked for the increased vertical opening. Discussions with the railroad would need to occur for approval of the retaining wall systems and concrete bent protection for the lowered roadway. The potential lowering of the 21st Street/Minnesota Avenue intersection may impact surrounding businesses; however, their accesses could be modified to accommodate improvements at this existing underpass.

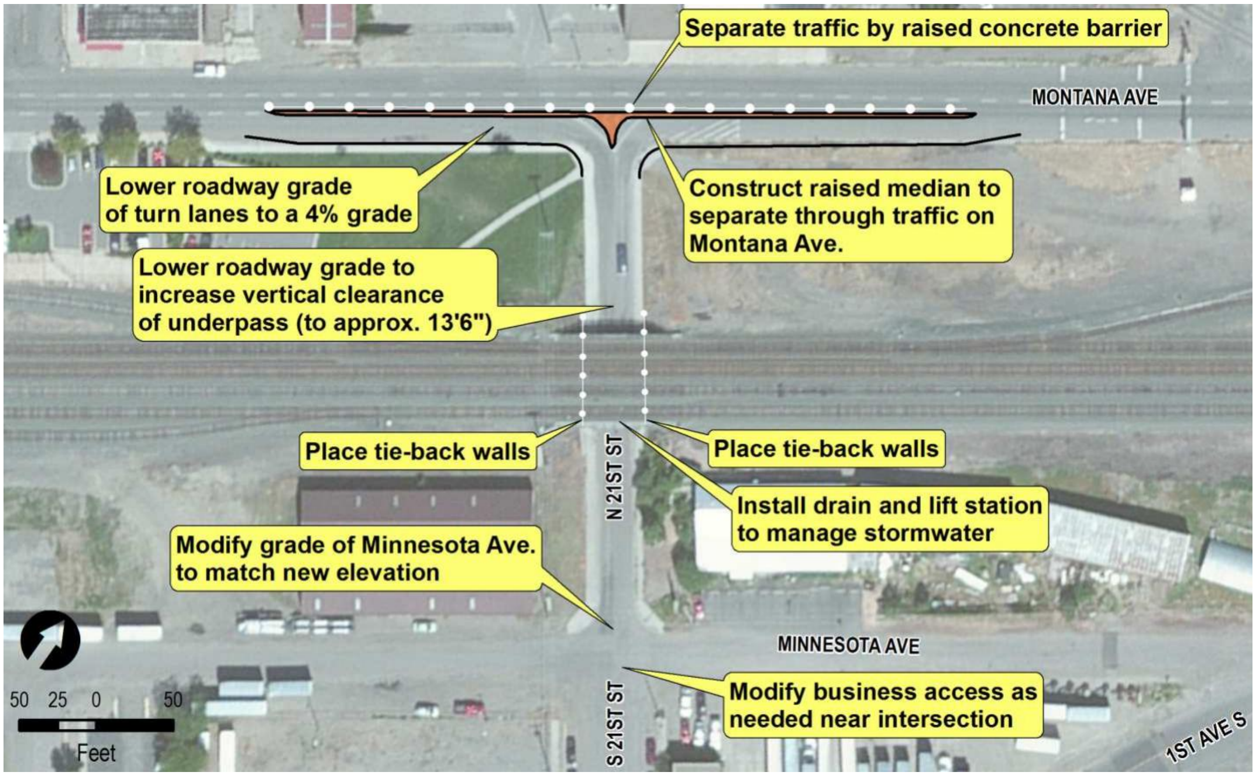

Figure 5-3. Potential Improvements to 21st Street Underpass

The limits of 21st Street within the work area would likely need to be closed during construction to lower the roadway and Montana Avenue could require full or partial lane closures when constructing the retaining wall and lowering the southerly portion of road as shown above. A pump system would likely be needed for storm drainage as the lowered elevation would be below the elevation required for a gravity flow system to connect to the existing storm drain systems. The lowered roadway would still be above the existing groundwater table in the area.

A rough conceptual order of magnitude opinion of probable project cost is approximately $1.5 to $3.0 million for these improvements. The drainage pumping system and potential overflow storage, fiber optic line lowering and potential business impacts south of the underpass have an impact on the opinion of probable project cost. While not providing for full truck passage as recommended in the LRTP, the increased clearance enhances capacity allowing for use of the undercrossing by all emergency equipment and increases usability for most vehicles. Reconstructing the underpass to provide for a minimum of 14 feet of clearance could potentially further impact groundwater at the site and result in greater impact on Montana Avenue and Minnesota Avenue. Further studies and design, as well as coordination with the railroad, would be necessary to refine improvement options and estimated project costs as well as determine the feasibility of accommodating large trucks. If a grade separation project is programmed by MDT for 27th Street, further studies could determine the actual need of 21st Street as a detour route for some of the traffic from 27th Street during construction.

5.2.6 Other Underpass Considerations

The N. Van Buren Street grade-separated crossing under MRL in Missoula was identified as a crossing of interest by the Missoula District Administrator. It is not included in the above list or subsequent detailed discussion as the existing clearance is signed 14 feet 6 inches with MDT's BMS system noting 15-foot vertical clearance, which is greater than the clearance for the crossings listed above and greater than the legal clearance height for commercial vehicles. In addition, a project to construct roundabout intersections with the I-90 off- and on-ramps immediately north of this undercrossing is programmed in the Tentative Construction Plan for Fiscal Year 2017, which would be impacted with a future underpass improvement to improve vertical clearance. Some suggestions for further study, if improvements are needed, include examination of bridge foundations for potential of lowering the roadway and shifting of the sidewalks, using retaining walls outside of the existing bridge piers, to obtain additional horizontal clearance for the underpass.

6 Conclusions and Next Steps

6.1 Funding Grade Separations

Grade separation projects are generally funded by state DOTs and local communities and can include a combination of federal, state, and local funding sources. MDT administers numerous programs that are funded from state and federal sources which may be applied towards funding a grade separation project.

Funding of grade separations can also occur through competitive grants such as the DOT's Transportation Investment Generating Economic Recovery (TIGER) grant program. These grants are awarded to projects nationwide that advance key transportation goals such as safety.

Additionally, partial funding of a grade separation project can come from the railroad. In accordance with 23 CFR 646.210(b)(3), on projects for the elimination of existing at-grade crossings at which active warning devices are in place or ordered to be installed by a State regulatory agency, the railroad share of the project costs can be 5 percent. The required railroad share of the cost under §646.210(b)(3) shall be based on the costs for preliminary engineering, right-of-way and construction for the structure and approaches required to transition to a theoretical highway profile that would have been constructed if there were no railroad present, for the number of lanes on the existing highway and in accordance with the current design standards of the State highway agency. Railroads may voluntarily contribute a greater share of project costs than is required. Also, other parties may voluntarily assume the railroad's share.

6.2 Next Steps

Potential improvements were identified for crossing locations located on NHS Non-Interstate, Primary, Secondary, Urban, and off-system routes. Implementation of any of the improvement options will depend on funding availability which varies based upon the crossing location and the agency responsible. Funding has not been identified to implement improvement options analyzed in this study. Future project development and implementation will require identifying and securing funding and, for federally funded projects, following MDT processes for project nomination and development, including a public involvement process and environmental documentation.

Any project or combination of projects resulting from this study will be required to comply with NEPA requirements, if federal funds or actions are involved, and with MEPA requirements, if state funds or actions are involved. The impact and mitigation analysis in this study should be considered if a project is progressed from this study. Any project developed would have to comply with the Code of Federal Regulations Title 23 Part 771 and Associated Rules of Montana 18, subchapter 2, which set forth the requirements for documenting environmental impacts on highway projects.

Based on results of the evaluation process, three cities (Billings, Bozeman, and Helena) had multiple crossings considered for feasibility of grade separation. Additional evaluation will be necessary to determine which crossing or crossings would be viable, cost effective, and provide the greatest benefit for each city. If a crossing enhancement is implemented at one location, a re-evaluation of crossing needs may be necessary for the impacted community.

This study is a planning-level assessment of existing at-grade and grade separated crossings throughout the state of Montana. The findings and recommendations provided by this study were developed based on field reviews of existing site conditions and review of publically available transportation databases. The recommendations are preliminary and are intended to offer a range of potential mitigation strategies for the identified railroad crossings. Where applicable, recommendations were intended to align with local plans. Community priorities change over time, however, and any project advanced through this study would involve local participation and potentially additional evaluations. In addition, more detailed, site specific data, which could include traffic studies, topographical and cadastral surveys, coordination and agreement on railroad requirements, and environmental investigations would be required should a project be selected and advanced at any of the locations identified by this study. Strategies to mitigate potential impacts would be further developed during project development activities.

Appendix A:
Study Documentation

January 2016

Prepared for:

Montana Department of Transportation

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TASK 2a - TOP AT-GRADE CROSSINGS

Rank	Crossing ID	City	Location	AADT	Number of Trains Per Day (ADTT)	Avg Train Speed (FRA)	MDT Hazard Index (HI)*	MDT Adjusted Hazard Index*	FRA Accident Prediction Value	Functional Classification	System Designation	Urban/ Rural	Warning Device	MDT Hazard Index Score (60 pts)	Functional Classification Score (30 pts)	Train Speed Score (10 pts)	Combined Score (100 pts)	Notes
1	087491T	BILLINGS	27th St/21st St/28th St	14260	38	9	39015	4292	0.0995	Principle Arterial	NHS	U	GATES + CANTILEVERS	60	30	2	92	Crossing combined holistically with 21st underpass and 28th St at-grade. The 21st underpass is located 0.5 mi. from 27th St crossing via alternate roadway access.
2	060193P	HELENA	Montana Ave/Roberts St	12850	35	20	31080	3419	0.0393	Principle Arterial	Urban	U	GATES + CANTILEVERS	48	30	4	82	Crossing combined holistically with Roberts St at-grade crossing. Roberts St at-grade is located less than 0.5 mi. from the Montana Ave crossing via alternate roadway access. Access provided by both crossings is similar.
3	060090P	BELGRADE	Jackrabbit Ln/Broadway	15060	28	60	24036	2644	0.0316	Principle Arterial	Urban	U	GATES + CANTILEVERS	37	30	10	77	Crossing combined holistically with Broadway St at-grade crossing. Broadway St at-grade located 0.5 mi. from Jackrabbit via alternate roadway access. This crossing has higher priority and fewer R/W constraints than Broadway St with similar traffic origins/destinations.
4	060055B	BOZEMAN	Rouse Ave	10580	38	35	26535	2919	0.0266	Minor Arterial	Primary	U	GATES	41	24	6	71	
5	060199F	HELENA	Benton Ave	9630	35	45	22596	2486	0.0297	Minor Arterial	Urban	U	GATES	35	24	8	67	
6	060073Y	BOZEMAN	Griffin Dr	8090	28	60	15177	1669	0.0251	Minor Arterial	Urban	U	GATES	23	24	10	57	
7	087383W	BILLINGS	Moore Ln	7100	32	55	17949	1974	0.1221	Major Collector	Local	U	GATES	28	18	10	56	
	060085T	BELGRADE	Broadway	6570	28	60	13613	1497	0.0240	Minor Arterial	Urban	U	GATES	21	24	10	55	Combined holistically with Jackrabbit Ln. See notes for Jackrabbit Ln crossing.
	059909U	COLUMBUS	Pratten St	7400	26	45	14815	1630	0.0219	Minor Arterial	Primary	U	GATES	23	24	8	55	Infeasible to construct grade separation due to geometric constraints with proximity to Old US 10 and impacts to downtown businesses.
	104062M	CROW AGENCY	Makawasha Ave	6722	28	60	14304	1573	0.0241	Major Collector	Local	U	GATES	22	18	10	50	Infeasible to construct grade separation due to impacts to impacts to downtown businesses and need to lower I-90 to accommodate overpass.
	060399P	MISSOULA	Madison St/Greenough Dr	5540	35	23	16094	1770	0.0267	Major Collector	Local	U	GATES	25	18	4	47	Infeasible to construct grade separation due to geometric constraints with adjacent neighborhoods, adjacent street access, and concerns with proximity to Rattlesnake Creek.
	060076U	BELGRADE	Valley Center Rd	4600	28	60	7857	864	0.0153	Minor Arterial	Local	R	GATES	12	24	10	46	Infeasible to construct grade separation due to geometric constraints with I-90 overpass over MRL Railway tracks and Frontage Road.
	060021G	LIVINGSTON	N 5th St	5770	42	27	15510	1706	0.0247	Major Collector	Urban	U	GATES	24	18	4	46	Infeasible to construct grade separation due to impacts to HWY 89/Park St, as well as residential and business properties.
8	060190U	HELENA	Carter Dr	5360	33	41	6191	681	0.0250	Minor Arterial	Urban	U	GATES	10	24	8	42	
9	087386S	HUNTLEY	Northern Ave	4142	30	50	8325	916	0.0203	Major Collector	Secondary	U	GATES	13	18	10	41	
10	087371C	LAUREL	S 72nd St W	2980	32	59	7629	839	0.0145	Major Collector	Local	R	GATES	12	18	10	40	
11	060017S	LIVINGSTON	Bennett St	2400	42	28	7056	776	0.0210	Minor Arterial	Urban	U	GATES	11	24	4	39	
	060097M	MANHATTAN	Broadway	3280	28	60	6704	737	0.0205	Major Collector	Secondary	U	GATES + CANTILEVERS	10	18	10	38	Infeasible to construct grade separtation due to large retaining walls required adjacent to downtown businesses/buildings, 4(f) park property impacts and access north of the tracks.
	060192H	HELENA	Roberts St	3290	49	17	11607	1277	0.0277	Major Collector	Local	U	GATES + CANTILEVERS	18	18	2	38	Combined holistically with Montana Ave. See notes for Montana Ave crossing.
	098742R	HELENA	Joslyn St	2970	35	45	6965	766	0.0169	Major Collector	Local	U	GATES	11	18	8	37	Combined holistically with Henderson St underpass due to proximity and access provided by both crossings is similar.
	059580K	WOLF POINT	6th Ave S	3284	39	79	11847	1303	0.0640	Local Street	Local	U	GATES	18	6	10	34	Combined holistically with S 3rd Ave underpass due to proximity. 6th Ave S is located approximately 3 city blocks from S 3rd Ave and access provided by both crossings is similar.
	059544P	GLASGOW	4th St	3684	40	35	13305	1464	0.0233	Local Street	Local	U	GATES	20	6	6	32	Combined holistically with 6th St S underpass due to proximity. The 4th St at-grade crossing is located 2 city blocks from 6th St S underpass and access provided by both crossings is similar.
	088059K	SHELBY	2nd Ave	2810	42	45	9395	1033	0.0304	Local Street	Primary	U	GATES	14	6	8	28	Combined holistically with Oil Field Ave overpass due to proximity. The 2nd Ave crossing is locationed 2 city blocks from Oil Field Ave and access provided by both crossings is similar.
	087403F	FORSYTH	10th Ave	3243	28	60	6656	732	0.0212	Local Street	Local	U	GATES	10	6	10	26	Infeasible to construct grade separation due to downtown business impacts and access impacts along Main St. north of the railroad tracks.
	087492A	BILLINGS	28th St or Broadway	2470	38	9	6289	692	0.0241	Local Street	Local	U	GATES + CANTILEVERS	10	6	2	18	Combined holistically with 27th St and 21st St underpass due to proximity. See notes for 27th St crossing.

(green) Combined Holistic Approach
(red) Not Practical for Construction

* MDT Hazard Index includes factors which summarize the various physical conditions encountered or anticipated at the crossing site.
Factors include: Type of train movements, number of tracks, sight distance, approach angle, highway alignment, number of lanes, approach grades, vertical sight distance, crossing width and local interference.
The adjusted hazard index takes into account the type of existing protection at the crossing.

TASK 2a - TOP 12 GRADE SEPARATED CROSSINGS

Rank	City	Location	AADT	Vertical Clearance (FT)	Horizontal Clearance (FT)	Substructure Rating	Percent Commercial Traffic (%)	Functional Classification	System Designation	AADT Score (20 pts)	Vertical Clearance Score (20 pts)	Horizontal Clearance Score (20 pts)	Functional Classification Score (20 pts)	Substructure Rating Score (10 pts)	Percent Commercial Traffic Score (10 pts)	Combined Score (100 pts)	Notes
1	KALISPELL	US 2	22630	14.58	1.60	4	3.44	Principle Arterial	NHS Non-Interstate	20	4	16	20	6	8	74	Future Industrial Park potentially impacting grade separation
2	MISSOULA	ORANGE STREET	16150	13.48	2.24	5	2.72	Principle Arterial	NHS Non-Interstate	14	8	12	20	6	6	66	
	LAUREL	S 1ST AVE/5TH AVE	13690	14.00	1.74	5	1.26	Principle Arterial	NHS Non-Interstate	12	4	16	20	6	4	62	Underpass improvements being made with a programmed project; Crossing combined holistically with 5th Ave at-grade crossing due to proximity. Access provided by both crossings is similar.
3	GREAT FALLS	1ST AVE N	17620	14.60	1.50	6	0.90	Principle Arterial	NHS Non-Interstate	16	4	16	20	4	2	62	
4	GLASGOW	6TH ST S	8020	12.75	1.00	5	0.76	Minor Arterial	Primary	7	12	16	16	6	2	59	Crossing combined holistically with 4th St. at-grade crossing. The 6th St S underpass is located approximately 2 city blocks from the 4th St at-grade crossing. Access provided by both crossings is similar.
	GREAT FALLS	RIVER DR S	9050	13.85	1.15	7	2.34	Minor Arterial	Urban	8	8	16	16	4	6	58	Infeasible to make improvements due to location and elevation of the roadway adjacent to the Missouri River.
5	WOLF POINT	S 3RD AVE/6TH AVE S	6550	14.33	0.70	5	2.17	Minor Arterial	Primary	6	4	20	16	6	6	58	Crossing combined holistically with 6th Ave at-grade crossing. Crossings are approximately 3 city blocks from each other and access provided by both crossings is similar.
	BILLINGS	6TH ST	17250	14.50	1.00	6	0.00	Minor Arterial	Urban	15	4	16	16	4	2	57	Underpass improvements being made with a programmed project
6	GREAT FALLS	6TH ST N	3050	12.99	1.97	6	2.46	Minor Arterial	Urban	3	12	16	16	4	6	57	
7	BUTTE	HARRISON AVE	14110	13.91	17.24	4	2.27	Principle Arterial	NHS Non-Interstate	12	8	4	20	6	6	56	
8	MALTA	US 191/CENTRAL AVE	3860	13.94	2.99	5	2.33	Principle Arterial	NHS Non-Interstate	3	8	12	20	6	6	55	
9	EAST GLACIER	HWY 49	890	12.70	0.66	6	2.47	Major Collector	Local	1	12	20	12	4	6	55	
10	MILES CITY	MAIN STREET/LEIGHTON BLVD	9840	12.11	3.00	6	0.82	Principle Arterial	NHS Non-Interstate	9	12	8	20	4	2	55	Crossing combined holistically with Leighton Blvd at-grade crossing. Crossings are within 0.5 mi. of each other and access provided by both crossings is similar.
	LIVINGSTON	N MAIN ST	4180	13.66	1.00	7	2.39	Minor Arterial	Urban	4	8	16	16	4	6	54	Infeasible to make improvements due to geometric constraints of the entering roadway.
	LIVINGSTON	N MAIN ST	4180	13.50	1.00	7	2.39	Minor Arterial	Urban	4	8	16	16	4	6	54	Infeasible to make improvements due to geometric constraints of the entering roadway.
11	BIG TIMBER	US 191	1550	13.66	2.50	5	6.00	Minor Arterial	Primary	1	8	12	16	6	10	53	
12	MISSOULA	N VAN BUREN ST	15980	15.00	6.50	7	2.60	Principle Arterial	NHS Non-Interstate	14	4	4	20	4	6	52	
	MISSOULA	E BROADWAY	7890	15.25	2.00	5	2.92	Minor Arterial	Urban	7	4	12	16	6	6	51	
	HELENA	HENDERSON ST/JOSLYN ST	7600	14.17	1.05	7	1.45	Minor Arterial	Urban	7	4	16	16	4	4	51	Crossing combined holistically with Joslyn St at-grade crossing. Crossings are located with 0.5 to 1.0 mi. of each other via alternate roadways and access provided by both crossings is similar.
	BUTTE	S MONTANA ST	14350	14.58	10.73	5	1.53	Principle Arterial	NHS Non-Interstate	13	4	4	20	6	4	51	
	BILLINGS	13TH ST	9190	14.00	4.24	6	3.16	Minor Arterial	Urban	8	4	8	16	4	8	48	
	1M SE TROUT CREEK	HWY 200	1880	16.00	2.20	7	5.53	Minor Arterial	Primary	2	4	12	16	4	10	48	
	BILLINGS	21ST ST	2570	8.50	1.54	0	0.00	Local Street	Local	2	20	16	4	0	2	44	Combined holistically with 27th St and 28th St at-grade crossings due to proximity and similar traffic access patterns.
	WIBAUX	N WIBAUX ST	2270	14.00	6.23	6	5.81	Minor Arterial	Primary	2	4	4	16	4	10	40	
	WEST GLACIER	GOING-TO-THE-SUN RD	4560	14.00	7.24	5	1.62	Minor Arterial	Primary	4	4	4	16	6	4	38	
	BUTTE	CONTINENTAL DR	7110	14.58	10.50	6	0.90	Minor Arterial	Urban	6	4	4	16	4	2	36	
	GLENDIVE	DOUGLAS ST/BARRY ST	6630	14.01	5.00	6	0.00	Local Street	Urban	6	4	8	4	4	2	28	

Crossing removed per Notes column

Crossing removed due to programmed project

Grade-Separated Crossing Questions for District Staff

HDR is conducting a study of the 73 grade-separated crossing underpasses located throughout the state. The grade-separated crossing located at ___________in __________ has been placed on a priority list for potential improvements to improve accessibility based on a multi-criteria evaluation. The criteria evaluated included AADT, vertical and horizontal clearances, functional classification, substructure rating, and percent commercial traffic. As part of the study we would like to ascertain some of the following information in order to help prioritize the grade separated crossings for improvement considerations.

1. Is the structure owned by MDT or by the Railroad?
2. Does the roadway under the structure remain open year round?
3. Have you had to close the crossing for any reason?
4. How often is the crossing closed?
5. What is the common issue causing the roadway to be closed?
6. If the roadway is closed, how long is the detour that is used by local traffic?
7. Have potential improvement options to the underpass been discussed by the District and/or the Railroad? If so, what are the recommended improvements and estimated costs?
8. Is the existing underpass used by commercial vehicles? What limitations are there for commercial vehicles?
9. Is the existing underpass used by emergency services and/or used as an emergency route?
10. Is the existing underpass a school bus route?
11. Is the underpass used by pedestrians/bicyclists?
12. Is there a grade separation not on the current list that you feel should be due to either the criteria discussed or some other reason?

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Administrative District Responses to the Grade-Separated Crossing Questionnaire

District	Location	City	Past MDT Closure?	Frequency of Closure	Cause of Closure	Approx. Length of Detour	Emergency Service Vehicle Use?	Commercial Vehicle Use?	School Bus Use?	Bike/ Ped Use?	Improvements Identified?	Notes
1	Orange St.	Missoula	Yes	Rare	Flooding; Maintenance; Accidents	<2 mi.	Yes	Yes	Unknown	Yes	No	Height restriction limits commercial vehicle usage; Bridge ownership is undetermined
1	N. Van Buren St.	Missoula	Yes	Rare	Construction; Accidents	<2 mi.	Yes	Yes	Unknown	Yes	No	Used by UM students and residents accessing the Rattlesnake
1	E. Broadway*	Missoula	Yes	Rare	Construction; Accidents	<2 mi.	Yes	Yes	Unknown	Yes	No; Crossing being evaluated in corridor study for East Missoula	Long-term recommendations identified in New Mobility West corridor study in 2015
1	U.S. 2	Kalispell	Yes	Occasional	Over-height vehicle accidents	NA	Yes	Yes	Yes	Yes	Railroad closure; crossing will become pedestrian overpass	More information found at: http://www.kalispell.com/community_economic_development/Tiger2015.php
2	Harrison Ave.	Butte	No	NA	NA	NA	Yes	Yes	Yes	Yes	No	
2	S. Montana Ave.*	Butte	No	NA	NA	NA	Yes	Yes	Yes	Yes	No	
3	Highway 49	East Glacier	Yes	Common	Flooding; Inadequate storm water drainage	>35 mi.	Yes	Yes	No	Yes	Increase capacity of storm pipe that drains underpass; Improve drain inlet	Detour is approximately 37 mi. and only open in the summer time; Restricted vertical and horizontal clearance
3	6th St. N.	Great Falls	Yes	Rare	Construction	<1 mi.	Yes	Yes	Yes	Yes	No	
3	1st Ave. N.	Great Falls	Yes	Rare	Flooding; Pump failure	<1 mi.	Yes	Yes	Yes	Yes	No	New pumps were installed with the past several years
4	Main St.	Miles City	Yes	Common	Over-height vehicle accidents; Flooding	<1 mi.	Yes	No	Yes	Yes	Increase storm pipe size	Height restrictions limit commercial vehicle use; the City has a truck route established.
4	6th St. S.	Glasgow	Yes	Occasional	Over-height vehicle accidents; Flooding	<1 mi.	Yes	Yes	Yes	Yes	General deteriorating condition	
4	S. 3rd Ave.	Wolf Point	Yes	Occasional	Flooding; Over-height vehicle accidents; Snow drifting	<1 mi.	Yes	Yes	Yes	Yes	General deteriorating condition	
4	U.S. 191 Central Ave.	Malta	Yes	Occasional	Over-height vehicle accidents; Flooding	<2 mi.	Yes	Yes	Yes	Yes	General deteriorating condition	Crossing splits a small portion of town; connects US 191 to US 2
5	13th Street*	Billings	Yes	Common	Accidents; Flooding	<1 mi	Yes	Yes	Unknown	Yes	No	Height and width restrictions limit commercial vehicle use
5	U.S. 191	Big Timber	Yes	Rare	Snow drifting	>25 mi.	Yes	Yes	Yes	Yes (limited)	No	Detour via Greycliff

*Crossing not on top 12 list, but on the top 25 list. Crossing was added to list per Administrative District priority

Appendix B: Proposed Grade Separation Planning-Level Cost Estimates

March 2016

Prepared for:

Montana Department of Transportation

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Planning Level Cost Estimate

Jackrabbit Lane - Belgrade

Montana Rail Grade Separation Study — 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	69,190	CY	$ 10.00	$692,000.00
Street Surfacing	14,470	SY	$ 48.00	$695,000.00
New Curb & Gutter	6,460	LF	$ 23.00	$149,000.00
Sidewalk	2,570	SY	$ 67.00	$172,000.00
Retaining Wall	470	SY	$ 1,000.00	$470,000.00
Underpass Structure (Mainline Bridge - 3 TPG)	198	TF	$ 17,000.00	$3,366,000.00
Railroad Flagging	100	DAY	$ 800.00	$80,000.00
Railroad Shoofly	1000	TF	$ 400.00	$400,000.00
Railroad Signal	1	LS	$ 150,000.00	$150,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 65,000.00	$65,000.00
Traffic Signal	1	LS	$ 225,000.00	$225,000.00
Drainage	1	LS	$ 300,000.00	$300,000.00
Landscaping	1	LS	$ 20,000.00	$20,000.00
Utility Adjustments	1	LS	$ 500,000.00	$500,000.00
Detour Signing	1	LS	$ 30,000.00	$30,000.00
Traffic Control (6%)	1	LS	$ 438,840.00	$439,000.00
Subtotal				$7,800,000.00
Miscellaneous Items			5%	$400,000.00
Mobilization			18%	$1,400,000.00
Subtotal				$9,600,000.00
Contingency			25%	$2,400,000.00
Construction Total				$12,000,000.00
Preliminary Engineering			15%	$1,800,000.00
Construction Engineering			15%	$1,800,000.00
Subtotal				$15,600,000.00
Right-of-Way	6,310.0	SF	$20.00	$126,000.00
Subtotal				$15,700,000.00
Indirect Cost (IDC)			10.37%	$1,600,000.00
Total Cost				**$17,300,000.00**
Inflation	3.00%	10 Years		$5,900,000.00
Total Cost w/ Inflation				**$23,200,000.00**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning Level Cost Estimate

HDR

27th Street Underpass - Billings

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	30,790	CY	$ 10.00	$308,000.00
Street Surfacing	14,670	SY	$ 48.00	$704,000.00
New Curb & Gutter	3,910	LF	$ 23.00	$90,000.00
Roadway Concrete Barrier Rail	6,260	LF	$ 67.50	$423,000.00
Sidewalk	3,950	SY	$ 67.00	$265,000.00
Retaining Wall	7,640	SY	$ 1,350.00	$10,314,000.00
Structural Seal	2,880	CYD	$ 400.00	$1,152,000.00
Roadway Overpass Structure - Montana Ave	7,946	SF	$ 175.00	$1,391,000.00
Roadway Overpass Structure - 1st Ave N	9,260	SF	$ 175.00	$1,621,000.00
Roadway Overpass Structure - 2nd Ave N	8,889	SF	$ 175.00	$1,556,000.00
Underpass Structure (Mainline Bridge - 2 PCB)	90	TF	$ 11,050.00	$995,000.00
Railroad Shoofly	3000	LF	$ 350.00	$1,050,000.00
Temporary at-grade crossings/crossing relocation	1	LS	$ 600,000.00	$600,000.00
Railroad Turnouts	3	EA	$ 200,000.00	$600,000.00
Railroad Signals (incl. crossing removal)	1	LS	$ 500,000.00	$500,000.00
Railroad Flagging	100	DY	$ 800.00	$80,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 150,000.00	$150,000.00
Drainage	1	LS	$ 750,000.00	$750,000.00
Landscaping	1	LS	$ 10,000.00	$10,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Utility Adjustments	1	LS	$ 2,000,000.00	$2,000,000.00
Traffic Control (6%)	1	LS	$ 1,474,740.00	$1,475,000.00
Subtotal				$26,100,000.00
Miscellaneous Items			5%	$1,300,000.00
Mobilization			18%	$4,700,000.00
Subtotal				$32,100,000.00
Contingency			25%	$8,000,000.00
Construction Total				$40,100,000.00
Preliminary Engineering			15%	$4,800,000.00
Construction Engineering			15%	$4,800,000.00
Subtotal				$49,700,000.00
Right-of-Way	4,971	SF	$20.00	$100,000.00
Subtotal				$49,800,000.00
Indirect Cost (IDC)			10.37%	$5,200,000.00
Total Cost				**$55,000,000.00**
Inflation	3.00%	10 Years		$18,900,000.00
Total Cost w/ Inflation				**$73,900,000.00**

Planning Level Cost Estimate

27th Street Overpass - Billings

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Grading - Embankment	25,660	CY	$ 15.00	$385,000.00
Street Surfacing	12,950	SY	$ 48.00	$622,000.00
New Curb & Gutter	4,270	LF	$ 23.00	$98,000.00
Roadway Concrete Barrier Rail	1,350	LF	$ 67.50	$91,000.00
Sidewalk	2,350	SY	$ 67.00	$157,000.00
Retaining Wall	3,750	SY	$ 1,000.00	$3,750,000.00
Roadway Overpass Structure	23,472	SF	$ 200.00	$4,694,000.00
Railroad Flagging	60	DY	$ 800.00	$48,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 875,000.00	$875,000.00
Modify/Replace Signals	4	LS	$ 250,000.00	$1,000,000.00
Drainage	1	LS	$ 500,000.00	$500,000.00
Landscaping	1	LS	$ 50,000.00	$50,000.00
Utility Adjustments	1	LS	$ 750,000.00	$750,000.00
Traffic Control (6%)	1	LS	$ 781,200.00	$781,000.00
Subtotal				$13,800,000.00
Miscellaneous Items			5%	$700,000.00
Mobilization			18%	$2,500,000.00
Subtotal				$17,000,000.00
Contingency			25%	$4,300,000.00
Construction Total				$21,300,000.00
Preliminary Engineering			15%	$2,600,000.00
Construction Engineering			15%	$2,600,000.00
Subtotal				$26,500,000.00
Right-of-Way	0	SF	$20.00	$0.00
Subtotal				$26,500,000.00
Indirect Cost (IDC)			10.37%	$2,700,000.00
Total Cost				**$29,200,000.00**
Inflation	3.00%	10 Years		$10,000,000.00
Total Cost w/ Inflation				**$39,200,000.00**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning Level Cost Estimate

HDR

Moore Lane - Billings

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	112,053	CY	$ 10.00	$1,121,000.00
Street Surfacing	27,710	SY	$ 48.00	$1,330,000.00
New Curb & Gutter	5,000	LF	$ 23.00	$115,000.00
Sidewalk	2,830	SY	$ 67.00	$190,000.00
Retaining Wall	2,400	SY	$ 1,000.00	$2,400,000.00
Underpass Structure (Mainline Bridge - 2 SBM)	158	TF	$ 14,300.00	$2,259,000.00
Railroad Shoofly - 2 tracks	2000	LF	$ 450.00	$900,000.00
Railroad Signals	1	LS	$ 150,000.00	$150,000.00
Railroad Flagging	100	DAY	$ 800.00	$80,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 150,000.00	$150,000.00
Drainage	1	LS	$ 750,000.00	$750,000.00
Detour Signing	1	LS	$ 30,000.00	$30,000.00
Utility Adjustments	1	LS	$ 650,000.00	$650,000.00
Traffic Control (6%)	1	LS	$ 607,500.00	$608,000.00
Subtotal				$10,700,000.00
Miscellaneous Items			5%	$500,000.00
Mobilization			18%	$1,900,000.00
Subtotal				$13,100,000.00
Contingency			25%	$3,300,000.00
Construction Total				$16,400,000.00
Preliminary Engineering			15%	$2,500,000.00
Construction Engineering			15%	$2,500,000.00
Subtotal				$21,400,000.00
Property Relocation	1	EA	$500,000.00	$500,000.00
Right-of-Way	39,420.0	SF	$15.00	$591,000.00
Subtotal				$22,500,000.00
Indirect Cost (IDC)			10.37%	$2,300,000.00
Total Cost				**$24,800,000.00**
Inflation	3.00%	10 Years		$8,500,000.00
Total Cost w/ Inflation				**$31,000,000.00**

Planning Level Cost Estimate

Griffin Drive - Bozeman

Montana Rail Grade Separation Study — 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	52,310	CY	$ 10.00	$523,000.00
Street Surfacing	6,860	SY	$ 48.00	$329,000.00
New Curb & Gutter	910	LF	$ 23.00	$21,000.00
Sidewalk	510	SY	$ 67.00	$34,000.00
Retaining Wall	550	SY	$ 1,000.00	$550,000.00
Underpass Structure (Mainline Bridge - 1 SBM)	140	TF	$ 11,000.00	$1,540,000.00
Railroad Shoofly	2000	LF	$ 450.00	$900,000.00
Railroad Signals	1	LS	$ 150,000.00	$150,000.00
Railroad Flagging	80	DAY	$ 800.00	$64,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 35,000.00	$35,000.00
Drainage	1	LS	$ 500,000.00	$500,000.00
Detour Signing	1	LS	$ 10,000.00	$10,000.00
Utility Adjustments	1	LS	$ 1,000,000.00	$1,000,000.00
Traffic Control (6%)	1	LS	$ 339,360.00	$339,000.00
Subtotal				$6,000,000.00
Miscellaneous Items			5%	$300,000.00
Mobilization			18%	$1,100,000.00
Subtotal				$7,400,000.00
Contingency			25%	$1,850,000.00
Construction Total				$9,300,000.00
Preliminary Engineering			15%	$1,400,000.00
Construction Engineering			15%	$1,400,000.00
Subtotal				$12,100,000.00
Right-of-Way	29,086.0	SF	$15.00	$436,000.00
Subtotal				$12,500,000.00
Indirect Cost (IDC)			10.37%	$1,300,000.00
Total Cost				**$13,800,000.00**
Inflation	3.00%	10 Years		$4,700,000.00
Total Cost w/ Inflation				**$18,500,000.00**

Planning Level Cost Estimate

N. Rouse Avenue - Bozeman

Montana Rail Grade Separation Study — 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices Dollars	Amount Dollars
Excavation - Unclassified	35,880	CY	$ 10.00	$359,000.00
Street Surfacing	5,810	SY	$ 48.00	$279,000.00
New Curb & Gutter	2,500	LF	$ 25.00	$63,000.00
Sidewalk	1,240	SY	$ 70.00	$87,000.00
Retaining Wall	3,190	SY	$ 1,000.00	$3,190,000.00
Groundwater Seal - CIP Concrete (Avg. 3 ft depth x 700 ft length)	4356	CY	$ 400.00	$1,742,000.00
Underpass Structure (Mainline Bridge - 2 TPG)	296	TF	$ 22,100.00	$6,542,000.00
Railroad Flagging	100	DAY	$ 800.00	$80,000.00
Railroad Shoofly - main track only	1500	TF	$ 350.00	$525,000.00
Railroad Turnout	1	EA	$ 300,000.00	$300,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 42,000.00	$42,000.00
Drainage	1	LS	$ 600,000.00	$600,000.00
Landscaping	1	LS	$ 25,000.00	$25,000.00
Utility Adjustments	1	LS	$ 1,500,000.00	$1,500,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Traffic Control (6%)	1	LS	$ 921,000.00	$921,000.00
Subtotal				$16,300,000.00
Miscellaneous Items			5%	$800,000.00
Mobilization			18%	$2,900,000.00
Subtotal				$20,000,000.00
Contingency			25%	$5,000,000.00
Construction Total				$25,000,000.00
Preliminary Engineering			15%	$3,800,000.00
Construction Engineering			15%	$3,800,000.00
Subtotal				$32,600,000.00
Right-of-Way	20,172.0	SF	$20.00	$403,000.00
Subtotal				$33,000,000.00
Indirect Cost (IDC)			10.37%	$3,400,000.00
Total Cost				**$36,400,000.00**
Inflation	3.00%	10 Years		$12,500,000.00
Total Cost w/ Inflation				**$48,900,000.00**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning Level Cost Estimate

HDR

Benton Avenue Underpass - Helena

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	48,617	CY	$ 10.00	$486,170.00
Contaminated Soil Disposal	6,078	CY	$ 50.00	$303,900.00
Street Surfacing	10,340	SY	$ 48.00	$496,320.00
New Curb & Gutter	2,540	LF	$ 23.00	$58,420.00
Roadway Concrete Barrier Rail	380	LF	$ 67.50	$25,650.00
Sidewalk	1,500	SY	$ 67.00	$100,500.00
Retaining Wall	3,380	SY	$ 1,100.00	$3,718,000.00
Underpass Structure (Mainline Bridge - 2 SBM)	276	TF	$ 11,000.00	$3,036,000.00
Railroad Shoofly	3000	TF	$ 450.00	$1,350,000.00
Railroad Turnouts	0	EA	$ 300,000.00	$0.00
Railroad Signals	1	LS	$ 150,000.00	$150,000.00
Railroad Flagging	120	DAY	$ 800.00	$96,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 80,000.00	$80,000.00
Drainage	1	LS	$ 600,000.00	$600,000.00
Landscaping	1	LS	$ 30,000.00	$30,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Utility Adjustments	1	LS	$ 1,000,000.00	$1,000,000.00
Traffic Control (6%)	1	LS	$ 693,057.60	$693,057.60
Subtotal				$12,200,000.00
Miscellaneous Items			5%	$600,000.00
Mobilization			18%	$2,200,000.00
Subtotal				$15,000,000.00
Contingency			25%	$3,800,000.00
Construction Total				$18,800,000.00
Preliminary Engineering			15%	$2,800,000.00
Construction Engineering			15%	$2,800,000.00
Subtotal				$24,400,000.00
Right-of-Way	78,828	SF	$15.00	$1,182,000.00
Subtotal				$25,600,000.00
Indirect Cost (IDC)			10.37%	$2,700,000.00
Total Cost				**$28,300,000.00**
Inflation	3.00%	10 Years		$9,700,000.00
Total Cost w/ Inflation				**$38,000,000.00**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning Level Cost Estimate

HDR

Benton Avenue Overpass - Helena

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Grading - Embankment	69,220	CY	$ 15.00	$1,038,000.00
Contaminated Soil Disposal	1450	CY	$ 50.00	$73,000.00
Street Surfacing	11,250	SY	$ 48.00	$540,000.00
New Curb & Gutter	2,130	LF	$ 25.00	$53,000.00
Roadway Concrete Barrier Rail	310	LF	$ 67.50	$21,000.00
Sidewalk	1,030	SY	$ 70.00	$72,000.00
Retaining Wall	3,470	SY	$ 1,000.00	$3,470,000.00
10' X 10' Box Culvert (Multi-Use Path Crossing)	64	LF	$ 1,500.00	$96,000.00
Roadway Overpass Structure	7300	SF	$ 200.00	$1,460,000.00
Lower 2-tracks 5 feet, 2500 feet each track	5000	TF	$ 400.00	$2,000,000.00
Railroad Xing removal and Signal	1	LS	$ 30,000.00	$30,000.00
Railroad Flagging	80	DAY	$ 800.00	$64,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 50,000.00	$50,000.00
Drainage	1	LS	$ 100,000.00	$100,000.00
Landscaping	1	LS	$ 20,000.00	$20,000.00
Utility Adjustments	1	LS	$ 1,000,000.00	$1,000,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Traffic Control (6%)	1	LS	$ 606,420.00	$606,000.00
Subtotal				$10,700,000.00
Miscellaneous Items			5%	$500,000.00
Mobilization			18%	$1,900,000.00
Subtotal				$13,100,000.00
Contingency			25%	$3,300,000.00
Construction Total				$16,400,000.00
Preliminary Engineering			15%	$2,500,000.00
Construction Engineering			15%	$2,500,000.00
Subtotal				$21,400,000.00
Property Relocation	5	EA	$300,000.00	$1,500,000.00
Right-of-Way	38,179	SF	$15.00	$573,000.00
Subtotal				$23,500,000.00
Indirect Cost (IDC)			10.37%	$2,400,000.00
Total Cost				**$25,900,000.00**
Inflation	3.00%	10 Years		$8,900,000.00
Total Cost w/ Inflation				**$34,800,000.00**

Planning Level Cost Estimate

Carter Drive - Helena

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices Dollars	Amount Dollars
Excavation - Unclassified	65,467	CY	$ 10.00	$655,000.00
Contaminated Soil Disposal	8,184	CY	$ 50.00	$409,000.00
Street Surfacing	7,490	SY	$ 48.00	$360,000.00
New Curb & Gutter	2,700	LF	$ 23.00	$62,000.00
Sidewalk	1,500	SY	$ 67.00	$101,000.00
Underpass Structure (Mainline Bridge - 3 SBM)	366	TF	$ 11,000.00	$4,026,000.00
Railroad Shoofly - track only	4000	LF	$ 400.00	$1,600,000.00
Relocate Railroad Industrial Spur	1000	TF	$ 250.00	$250,000.00
Railroad Turnouts - 5 temporary, 1 permanent	6	EA	$ 250,000.00	$1,500,000.00
Railroad Signals	1	LS	$ 300,000.00	$300,000.00
Railroad Flagging	100	DAY	$ 800.00	$80,000.00
Temp. At-Grade RR Crossing (RR costs & Signal)	2	LS	$ 300,000.00	$600,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 45,000.00	$45,000.00
Drainage	1	LS	$ 400,000.00	$400,000.00
Landscaping	1	LS	$ 20,000.00	$20,000.00
Temporary Roadway Detour	1	LS	$ 140,000.00	$140,000.00
Utility Adjustments	1	LS	$ 1,000,000.00	$1,000,000.00
Traffic Control (6%)	1	LS	$ 692,880.00	$693,000.00
Subtotal				$12,200,000.00
Miscellaneous Items			5%	$600,000.00
Mobilization			18%	$2,200,000.00
Subtotal				$15,000,000.00
Contingency			25%	$3,800,000.00
Construction Total				$18,800,000.00
Preliminary Engineering			15%	$2,800,000.00
Construction Engineering			15%	$2,800,000.00
Subtotal				$24,400,000.00
Right-of-Way	55,075.0 SF		$15.00	$826,000.00
Total Cost				$25,200,000.00
Indirect Cost (IDC)			10.37%	$2,600,000.00
Total w/ IDC				$27,800,000.00
Inflation	3.00%	10 Years		$9,600,000.00
Total Cost w/ Inflation				**$37,400,000.00**

Planning Level Cost Estimate

Montana Avenue - Helena

Montana Rail Grade Separation Study — 3/29/2016

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Excavation - Unclassified	48,617	CY	$ 10.00	$486,000.00
Contaminated Soil Disposal	6,078	CY	$ 50.00	$304,000.00
Street Surfacing	10,340	SY	$ 48.00	$496,000.00
New Curb & Gutter	2,540	LF	$ 23.00	$58,000.00
Roadway Concrete Barrier Rail	380	LF	$ 67.50	$26,000.00
Sidewalk	1,500	SY	$ 67.00	$101,000.00
Retaining Wall	3,380	SY	$ 1,000.00	$3,380,000.00
Underpass Structure (Mainline Bridge - 2 PCB)	196	TF	$ 11,050.00	$2,166,000.00
Underpass Structure (Spurline Bridge)	98	TF	$ 11,050.00	$1,083,000.00
Railroad Shoofly	2000	LF	$ 300.00	$600,000.00
Railroad Turnouts	2	EA	$ 300,000.00	$600,000.00
Railroad Signals	1	LS	$ 150,000.00	$150,000.00
Railroad Flagging	120	DAY	$ 800.00	$96,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 80,000.00	$80,000.00
Drainage	1	LS	$ 500,000.00	$500,000.00
Landscaping	1	LS	$ 30,000.00	$30,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Utility Adjustments	1	LS	$ 1,500,000.00	$1,500,000.00
Traffic Control (6%)	1	LS	$ 700,560.00	$701,000.00
Subtotal				$12,400,000.00
Miscellaneous Items			5%	$600,000.00
Mobilization			18%	$2,200,000.00
Subtotal				$15,200,000.00
Contingency			25%	$3,800,000.00
Construction Total				$19,000,000.00
Preliminary Engineering			15%	$2,900,000.00
Construction Engineering			15%	$2,900,000.00
Subtotal				$24,800,000.00
Right-of-Way				$2,000,000.00
Total Cost				$26,800,000.00
Indirect Cost (IDC)			10.37%	$2,800,000.00
Total w/ IDC				**$29,600,000.00**
Inflation	3.00%	10 Years		$10,200,000.00
Total Cost w/ Inflation				**$39,800,000.00**

Planning Level Cost Estimate

Roberts Street - Helena

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices Dollars	Amount Dollars
Railroad Flagging	15	DAY	$ 800.00	$12,000.00
Pedestrian Overpass	320	LF	$ 4,000.00	$1,280,000.00
Pedestrian Overpass Structural Ramp	900	LF	$ 650.00	$585,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 20,000.00	$20,000.00
Landscaping	1	LS	$ 10,000.00	$10,000.00
Railroad Xing and Signal Removal	1	LS	$ 30,000.00	$30,000.00
Traffic Control (6%)	1	LS	$ 116,220.00	$116,220.00
Subtotal				$2,100,000.00
Miscellaneous Items			5%	$100,000.00
Mobilization			18%	$400,000.00
Subtotal				$2,600,000.00
Contingency			25%	$700,000.00
Construction Total				$3,300,000.00
Preliminary Engineering			10%	$300,000.00
Construction Engineering			15%	$500,000.00
Subtotal				$4,100,000.00
Right-of-Way	0	SF	$0.00	$0.00
Total Cost				$4,100,000.00
Indirect Cost (IDC)			10.37%	$400,000.00
Total w/ IDC				**$4,500,000.00**
Inflation	3.00%	10 Years		$1,500,000.00
Total Cost w/ Inflation				**$6,000,000.00**

Planning Level Cost Estimate

Northern Avenue - Huntley

Montana Rail Grade Separation Study 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Grading - Embankment	61,600	CY	$ 15.00	$924,000.00
Street Surfacing	6,330	SY	$ 48.00	$304,000.00
Retaining Wall	1,240	SY	$ 1,000.00	$1,240,000.00
Roadway Overpass Structure (Track 1 & 2)	5010	SF	$ 250.00	$1,253,000.00
Roadway Structure (Canal)	3305	SF	$ 200.00	$661,000.00
Railroad Flagging	60	DAY	$ 800.00	$48,000.00
Temp At-Grade Crossing for Rd Detour	1	LS	$ 500,000.00	$500,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 55,000.00	$55,000.00
Drainage	1	LS	$ 200,000.00	$200,000.00
Utility Adjustments	1	LS	$ 250,000.00	$250,000.00
Temporary Roadway Detour	1850	LF	$ 70.00	$130,000.00
Traffic Control (6%)	1	LS	$ 334,000.00	$334,000.00
Subtotal				$5,900,000.00
Miscellaneous Items			5%	$300,000.00
Mobilization			18%	$1,100,000.00
Subtotal				$7,300,000.00
Contingency			25%	$1,800,000.00
Construction Total				$9,100,000.00
Preliminary Engineering			15%	$1,400,000.00
Construction Engineering			15%	$1,400,000.00
Subtotal				$11,900,000.00
Right-of-Way	31,013 SF		$4.00	$124,000.00
Total Cost				$12,000,000.00
Indirect Cost (IDC)			10.37%	$1,200,000.00
Total w/ IDC				**$13,200,000.00**
Inflation	3.00%	10 Years		$4,500,000.00
Total Cost w/ Inflation				**$17,700,000.00**

Planning Level Cost Estimate

S 72nd Street - Laurel

Montana Rail Grade Separation Study — 12/31/2015

Item Description	Estimated Quantities	Unit	Unit Prices	
			Unit Prices	Amount
			Dollars	Dollars
Grading - Embankment	132,710	CY	$ 15.00	$1,991,000.00
Street Surfacing	19,820	SY	$ 48.00	$951,000.00
Roadway Overpass Structure	7200	SF	$ 250.00	$1,800,000.00
Railroad Xing removal and Signal	1	LS	$ 30,000.00	$30,000.00
Railroad Flagging	80	DAY	$ 800.00	$64,000.00
Traffic Items (Lights, Signs, Pavement Marking)	1	LS	$ 50,000.00	$50,000.00
Box Culvert Replacement (Irrigation Ditch)	290	LF	$ 750.00	$218,000.00
Drainage	1	LS	$ 100,000.00	$100,000.00
Utility Adjustments	1	LS	$ 500,000.00	$500,000.00
Detour Signing	1	LS	$ 20,000.00	$20,000.00
Traffic Control (6%)	1	LS	$ 343,440.00	$343,000.00
Subtotal				$6,100,000.00
Miscellaneous Items			5%	$300,000.00
Mobilization			18%	$1,100,000.00
Subtotal				$7,500,000.00
Contingency			25%	$1,900,000.00
Construction Total				$9,400,000.00
Preliminary Engineering			15%	$1,400,000.00
Construction Engineering			15%	$1,400,000.00
Subtotal				$12,200,000.00
Right-of-Way	115,286 SF		$10.00	$1,153,000.00
Total Cost				$13,400,000.00
Indirect Cost (IDC)			10.37%	$1,400,000.00
Total w/ IDC				**$14,800,000.00**
Inflation	3.00%	10 Years		$5,100,000.00
Total Cost w/ Inflation				**$19,900,000.00**

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Appendix C: Benefit-Cost Analyses

March 2016

Prepared for:

Montana Department of Transportation

Contents

Benefit-Cost Analysis

Introduction

This document provides a methodological overview of the Benefit-Cost Analysis (BCA) being conducted for the MDT Rail Grade Separation Study. Section 1 outlines the overall approach and discusses the benefits that arise from the grade crossing upgrade. Section 2 introduces the model that is utilized for the BCA and provides detailed calculations and the logical structure of its parts. Section 3 outlines the BCA model inputs and, finally, Section 4 presents the BCA results.

Section 1: Overall approach and benefit categories

Approach Description

Benefit-Cost Analysis (BCA) is a conceptual framework that totals up the monetized value of the benefits and costs of a project to determine the soundness of the investment. It also provides a basis for comparing various alternatives to the status quo. In general, benefit-cost analysis identifies choices that increase welfare from a utilitarian perspective. In other words, central to BCA is the idea that people are best able to judge what is “good” for them and what improves their well-being.

BCA also assumes that the project has a positive value if it is Pareto efficient, meaning that the benefits to some groups within society outweigh losses of others. This implies that a project would be rated positively if it generates a net increase in welfare, even though some individuals are made worse-off.

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

The methodology developed for the study incorporated the above principles and is consistent with the TIGER guidelines. In particular, the methodology complies with the following requirements:

- Establish existing and future conditions under the build and no-build scenarios;
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and reduction in air emissions, while relying on industry best practice for the valuation of other effects; and
- Discounting future benefits and costs with the real discount rates recommended by the US DOT (7%, and 3% for sensitivity analysis).

Benefit Categories

The following five benefit categories are considered in the model:

TRAVEL TIME IMPACTS

This impact calculates the monetized travel time benefits of a grade separation due to the change in delay experienced by drivers while traffic is blocked by passing train at the grade crossing. The calculations account for incremental travel time costs incurred by drivers forced to detour the closed nearby grade crossing.

SAFETY IMPACTS

This impact captures the benefits accruing to society as a result of reduced vehicle-train accidents from reducing the statistical likelihood of loss of life, limb or property damage from accidents. The calculations account for incremental accident costs of additional vehicle mileage and road traffic while driving around the closed nearby grade crossing.

VEHICLE OPERATING COST IMPACTS

This impact quantifies benefits that result from decreased fuel and motor oil consumption by highway vehicles due to improvements in traffic flows. The calculations account for incremental vehicle operating costs incurred by drivers forced to detour the closed nearby grade crossing.

ENVIRONMENTAL IMPACTS

This impact calculates benefits from the reduction in vehicle emissions due to improvements in traffic flows and reduced idling time at the grade crossing. The calculations account for incremental vehicle emissions from additional mileage while driving around the closed nearby grade crossing.

PAVEMENT DAMAGE IMPACTS

This impact calculates benefits associated with reduced use-related road maintenance costs. Additional vehicle miles travelled (VMT) contribute to pavement deterioration and increase in maintenance and repair.

Section 2: Description of the BCA Model Logic

Travel Time Savings

The grade separation will eliminate traffic congestion and improve traffic flows, which will result in shorter travel times. Under the base case, an Average Delay Time per Vehicle is a function of Gate Blockage Time at the Grade Crossing and the Number of Freight and Passenger Trains per day. Under the base case, the blockage time is assumed to be a function of the average train length, average train speed and the standard lead and lag time for grade crossings. To quantify the reduced vehicle delay time, the value of time by vehicle type and the average number of drivers and passengers per vehicle by vehicle type are used based on US DOT TIGER Guidance and the Corporate Average Fuel Economy (CAFE) database. Under the alternative case all delays are assumed to be zero, but given the closing of a nearby crossing, vehicles forced to detour incur additional travel time costs. The logic model of each calculation is presented in Figures 1 and 2.

Figure 1: Travel Time Savings from Avoided Wait Time at Grade Grossing

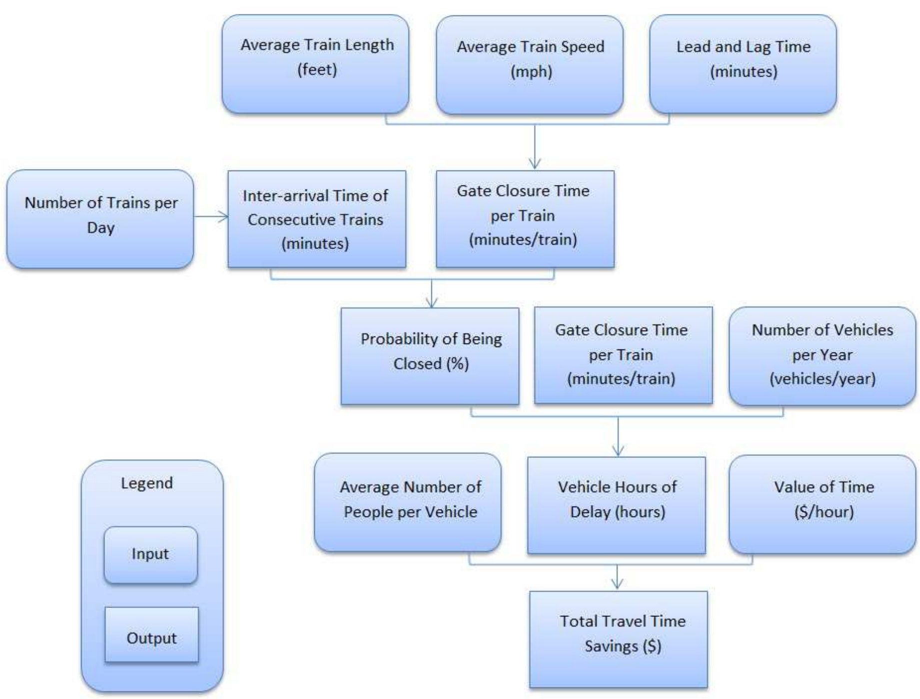
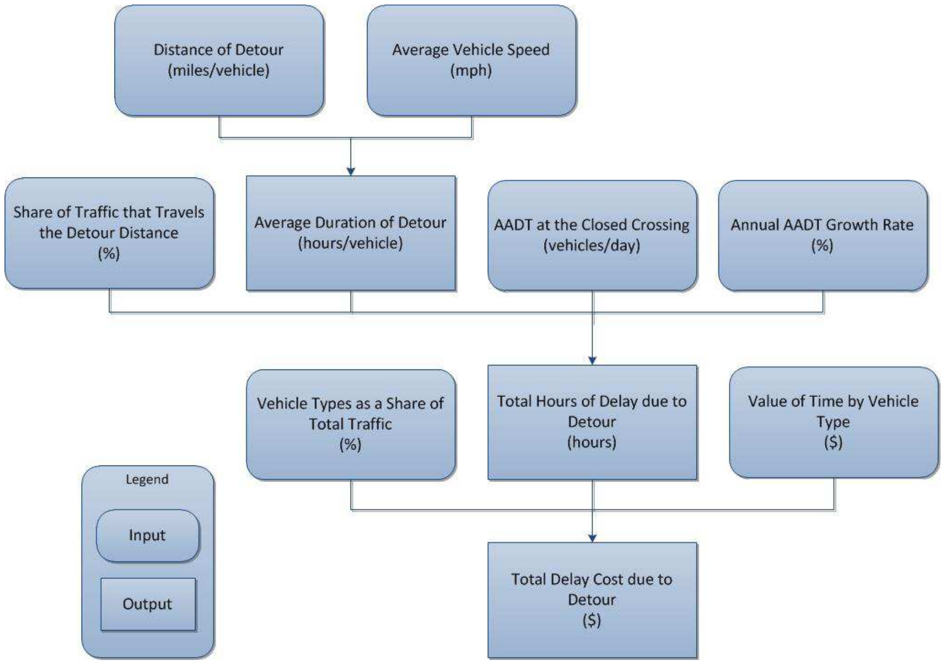


Figure 2: Travel Time Costs from Detour Mileage around the Closed Crossing



Reduced Accident Costs

Accident costs are calculated by first determining Total Vehicle Accidents and the shares of accidents that result in Property Damage Only (PDO), fatalities and injuries. Then, the count of each accident type is multiplied by respective costs per accident and summed together. The calculations are performed for the base and alternative cases, and the difference in costs represents the safety benefit. Under the alternative case, any drivers forced to re-route due to the closed crossing run the risk of a road accident and incur additional road safety costs. Figures 3 and 4 demonstrate the logic model.

Figure 3: Improved Safety from Grade Separation

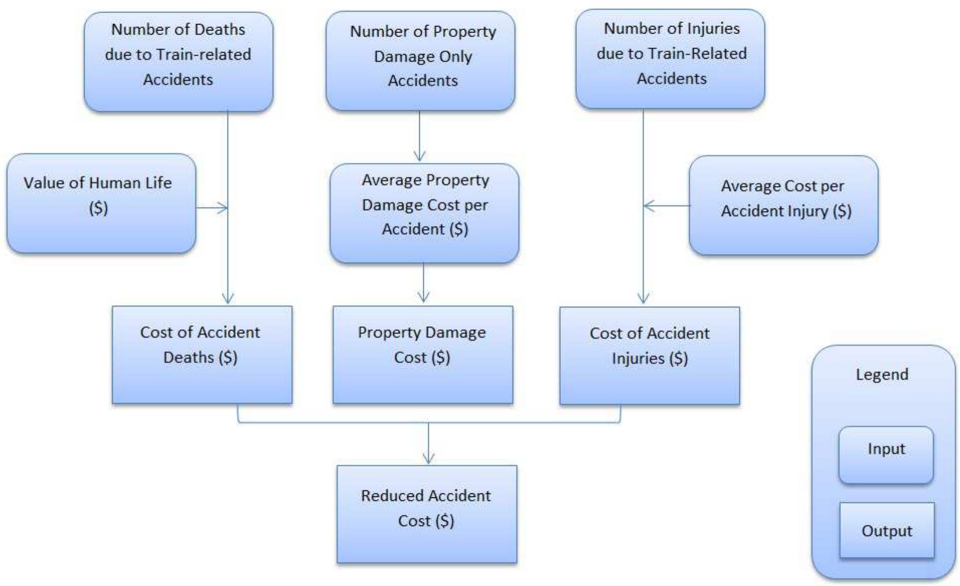
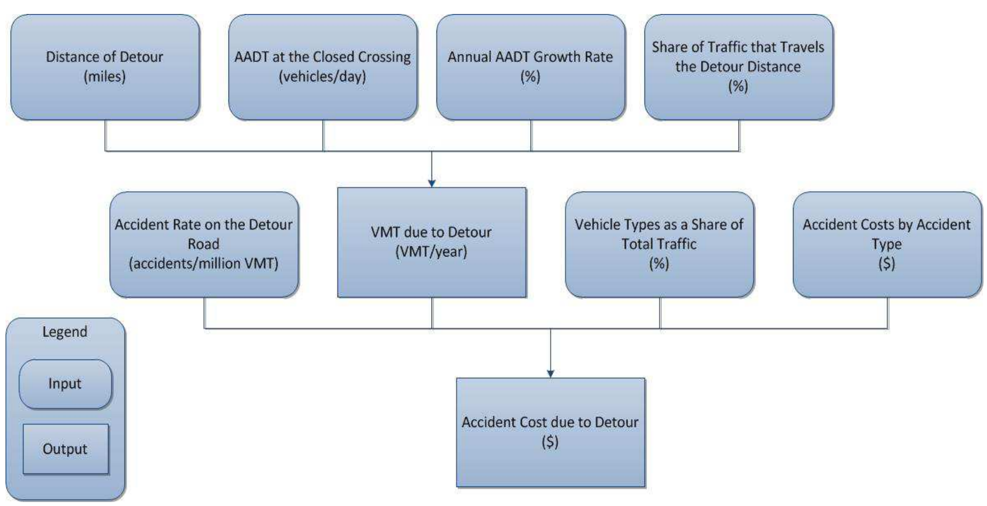


Figure 4: Safety Costs from Detour Mileage around the Closed Crossing



Reduced Vehicle Operating Costs

Savings are generated from the reduction in delay at the grade crossing following the grade separation construction, which will lead to decreased fuel consumption by vehicles on the highways. Fuel burned by vehicles at the grade crossing is computed for each vehicle type by using idle speed consumption rates and multiplying them by the time delay. Vehicle operating cost savings are then calculated by aggregating the change in fuel and oil consumption for different vehicle types and multiplying it by consumption costs (i.e. cost of gallon of fuel and motor oil). Under the alternative case, some drivers are forced to re-route due to the closed crossing and incur additional vehicle operating costs. See Figures 5 and 6 for details.

Figure 5: Reduced Vehicle Operating Costs from Idling at Grade Crossing

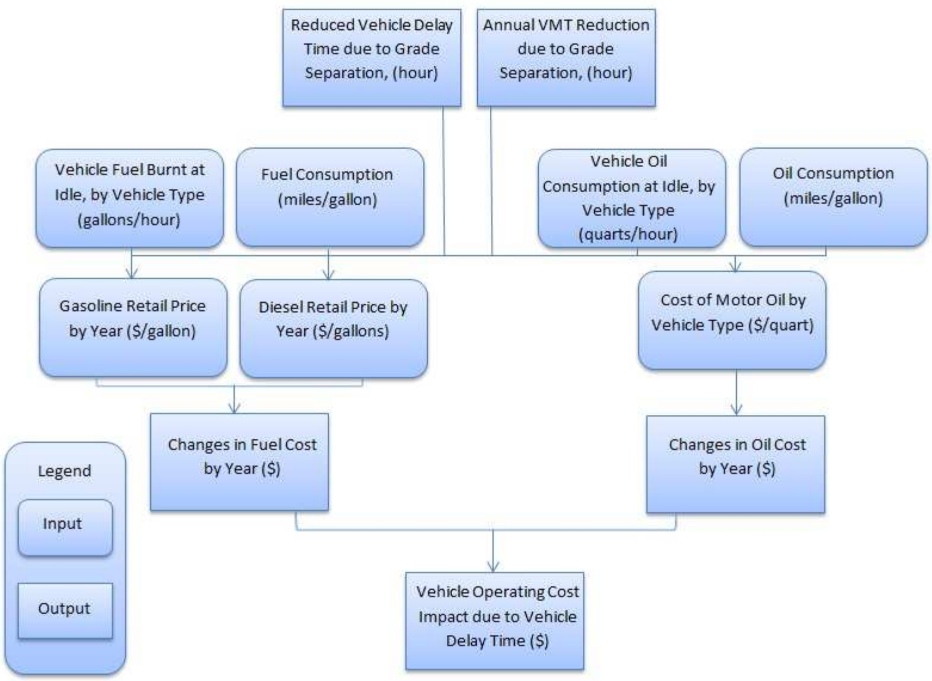
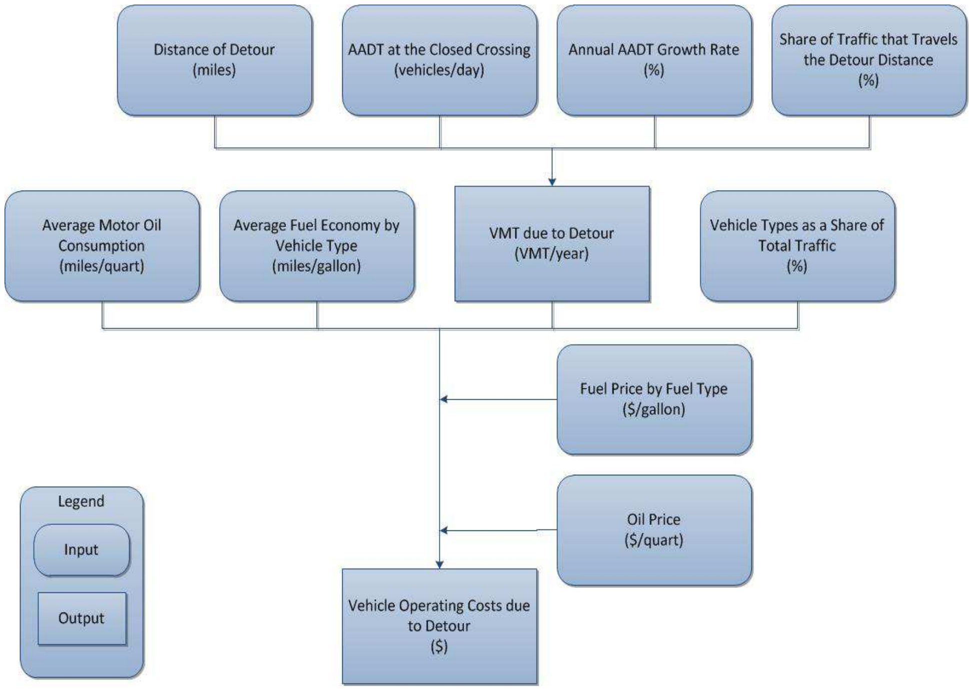


Figure 6: Vehicle Operating Costs from Detour Mileage around the Closed Crossing



Environmental Impacts

A grade crossing separation will result in a more efficient traffic flow and transportation network, which will result in the reduction of vehicle emissions and, therefore, a positive environmental impact. Environmental benefits are computed for four types of emissions: nitrous oxide (NOx), carbon dioxide (CO2), volatile organic compounds (VOC) and particulate matter (PM). To arrive at the increased emission number for each type of fuel, the data on the total fuel consumption and grams of the chemical per gallon of fuel burned is used. Multiplying an increase in emission by pollutant type by respective costs and summing gives the aggregate emission cost impact due to vehicle delay time. While there is no idling under the alternative case, extra detour mileage around the closed crossing generates emissions. Figures 7 and 8 demonstrate the structure of the impact calculations.

Figure 7: Environmental Savings from Reduced Vehicle Idling at Grade Crossing

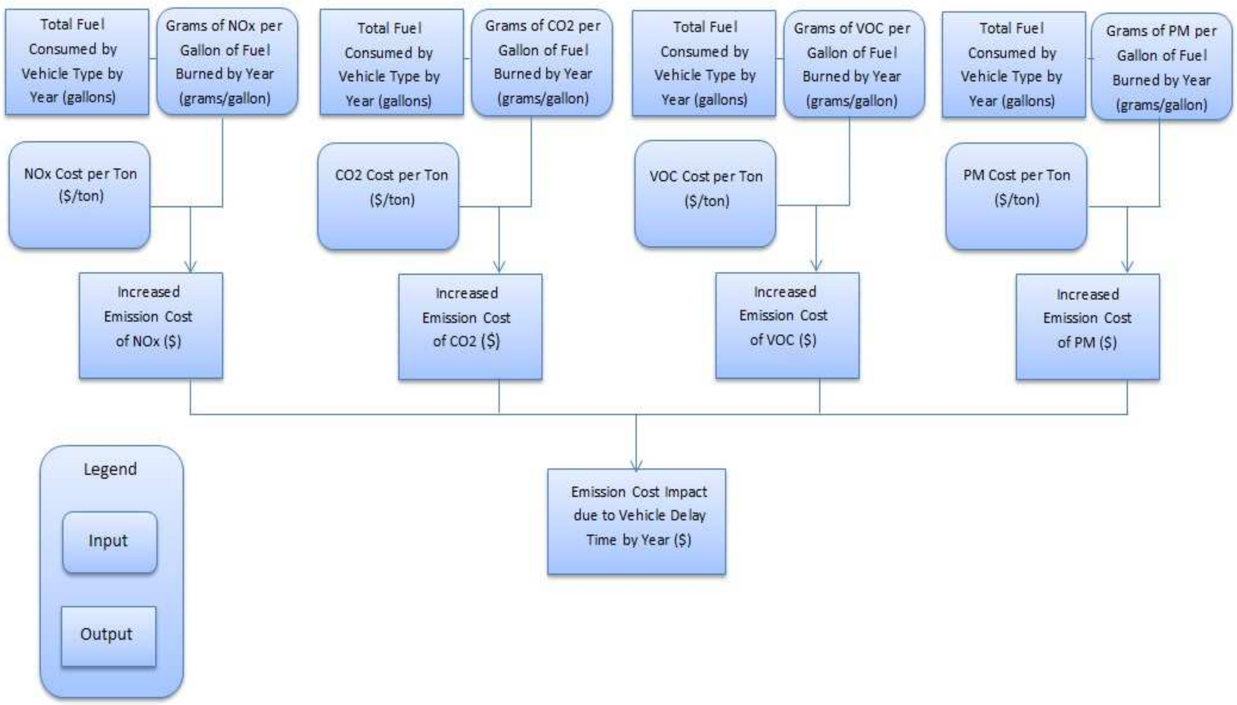
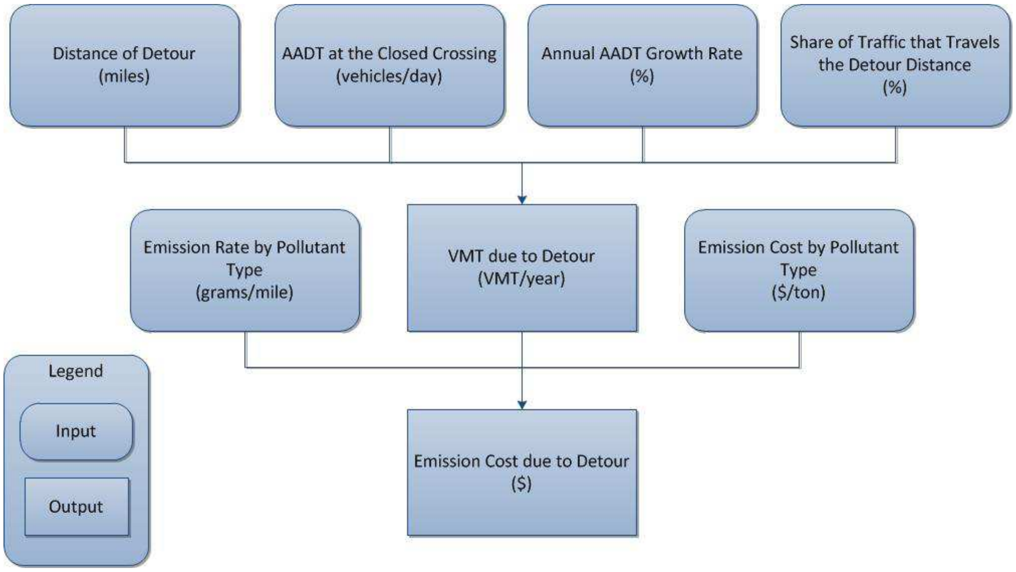


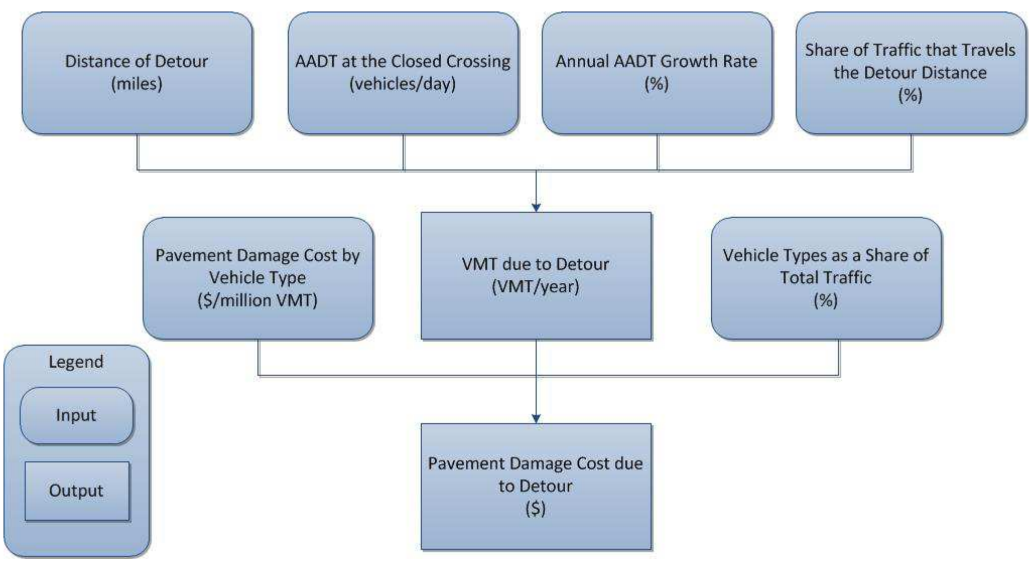
Figure 8: Environmental Costs from Detour Mileage around the Closed Crossing



Pavement Damage Impacts

Pavement damage cost captures use-related rehabilitation and maintenance costs and represents the contribution of each incremental vehicle mile traveled by vehicle type to pavement deterioration and the costs of repairing the damage. There is no pavement damage from idling so the cost is zero in the base case while extra detour mileage in the alternative case results in increased pavement maintenance costs. Figure 9 demonstrates the structure of the impact calculations.

Figure 9: Pavement Damage Costs from Detour Mileage around the Closed Crossing



Section 3: BCA Inputs

General Inputs

Input Name	Units	Value	Source
General Assumptions			
Base year	year	2015	Assumption
Project start year	year	2016	Assumption
First year of benefits	year	2017	Assumption
Discount rate	%	7%	USDOT Guidance
Discount rate (sensitivity)	%	3%	USDOT Guidance
Travel Time Impacts			
Average through train length	feet	7,000	Assumption
Average switching train length	feet	1,000	Assumption
Average switching train dwell time	minutes	1	Assumption
Lead and lag time at crossing	minutes	0.6	Assumption
Hours of delay due to idling-Alt case	hours/day	0	Assume no delay due to grade separation.
Automobiles as a share of total traffic	%	94.6%	MDT 2014 Weighted AADT, average for all urban routes.
Buses as a share of total traffic	%	0.4%	
Trucks as a share of total traffic	%	5.0%	
Average number of persons per automobile	persons	1.21	NHTSA Corporate Average Fuel Economy for MY 2017-2025 Page 876 Table VIII-7.
Average number of passengers per bus	persons	63	Highway Capacity Manual 2010. Assume 90% of transit bus maximum occupancy (70 people).
Value of time for automobile driver and passenger	2015$/hour	$13.18	USDOT (2014) Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis. For bus passengers, the lower bound of value of time for personal local travel is used. For truck passengers, automobile passenger's value of time is applied.
Value of time for bus driver	2015$/hour	$27.08	
Value of time for bus passenger	2015$/hour	$8.86	
Value of time for truck driver	2015$/hour	$26.17	
Annual growth in value of time	%	1.2%	
Safety Impacts			
Grade crossing expected accident rate per year - Alt case	accidents/year	0	No accidents due to grade separation

Input Name	Units	Value	Source
Grade crossing fatalities as a share of total accidents	%	8.2%	FRA Railroad Safety Statistics 2010 annual report Table 1-1 Accident/Incident historical summary.
Grade crossing injuries as a share of total accidents	%	27.3%	
Grade crossing PDO accidents as a share of total accidents	%	64.5%	
Detour road accident rate per year - 2011	accidents/million VMT	1.7380	Montana Statewide crash rate, Montana Impaired Driving Data 2011 Table 2 Crash Exposure by Factors and Table 3 Crashes by Severity.
Value of a statistical life	2015$	$9,533,480	US DOT, Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses. 2015.
Average cost per accident injury	2015$	$172,824	USDOT, Based on MAIS Injury Severity Scale and KACBO-AIS Conversion if Severity of Injury is Unknown. Department of Transportation Analyses. 2015.
Average cost per PDO accident	2015$	$3,983	USDOT, TIGER BCA Resource Guide, based on The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (April 2015).
Growth of the cost of accidents	%	1.18%	Adjusted for growth in real income (source: US DOT).
Vehicle Operating Costs			
Automobile fuel burned at idle	gallons/hour	0.3575	US DOE: Alternative Fuels Data Center and Argonne National Laboratory, "Idle Reduction Savings Worksheet" (2014) - Average of gasoline passenger vehicles, transit bus and a combination of trucks, respectively.
Bus diesel burned at idle	gallons/hour	0.9700	
Truck diesel burned at idle	gallons/hour	0.4900	
Average oil consumption per hour	quarts/hour	0.0345	Based on US DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000miles and

Input Name	Units	Value	Source
			assuming that "One hour of idle time is equal to approximately 25 miles of driving" (Ford Motor Company, 2011).
Automobile cost of motor oil	2015$/quart	$10.04	Average motor oil price sourced from HERS model (1997 value) and inflated to 2014$ by motor oil CPI (BLS CUUR0000SS47021); assumes the same oil cost for bus and truck; includes cost of changing the oil.
Bus cost of motor oil	2015$/quart	$4.01	
Truck cost of motor oil	2015$/quart	$4.01	
Average oil consumption	miles/quart	1,000	Techni/Tips, A publication of the lubrication engineers' technical department.
Average automobile fuel economy	miles/gallon	27.5	NHTSA. Corporate Average Fuel Economy. Average vehicle fuel economy.
Average heavy-duty diesel vehicle fuel economy	miles/gallon	6.3	EPA. MOBILE6.2 output is for heavy-duty diesel vehicles (HDDV).
Environmental Impacts			
CO_2 cost per ton – 2017 – varies by year	2015$/ton	$43.24	USDOT TIGER VII BCA Resource Guide
NOx cost per ton	2015$/ton	$7,247.37	
VOC cost per ton	2015$/ton	$1,839.21	
PM2.5 cost per ton	2015$/ton	$331,576.44	
SO_2 cost per ton	2015$/ton	$42,839.23	
Discount rate for CO_2 emissions	%	3%	
Pavement Damage Impacts			
Automobile pavement damage cost	$/million VMT	$1,379	Addendum to the 1997 Federal Highway Cost Allocation Study Final Report (2000). Buses assumed same as truck.
Bus pavement damage cost	$/million VMT	$250,286	
Truck pavement damage cost	$/million VMT	$42,749	

Inputs Specific to the At-Grade Crossing

For the Benefit-Cost Analysis, Montana Avenue in Helena, MT includes the closure of the nearby Roberts Street and National Ave at-grade crossings, and 27th St in Billings, MT includes the closure of the nearby 28th St at-grade crossing.

Input Name	Units	Helena Montana Ave	Billings 27th St	Belgrade Jackrabbit Ln	Helena Benton Ave	Bozeman Rouse Ave	Bozeman Griffin Dr	Billings Moore Ln	Helena Carter Drive	Huntley Northern Ave	Laurel S 72nd St W	Source
Project capital cost (underpass)	Millions 2015$	$29.60	$55.00	$17.30	$28.30	$36.40	$13.80	$24.80	$27.80	N/A	N/A	Project conceptual estimates
Project capital cost (overpass)	Millions 2015$	N/A	$29.20	N/A	$25.90	N/A	N/A	N/A	N/A	$13.20	$14.80	Project conceptual estimates
Main at-grade crossing annual O&M cost	2015$	$18,187	$18,187	$18,187	$18,187	$18,187	$18,187	$18,187	$18,187	$18,187	$18,187	Assumed O&M costs
Grade separation annual O&M cost (underpass)	2015$	$11,800	$11,800	$11,800	$10,950	$11,800	$11,800	$11,800	$11,800	N/A	N/A	Assumed O&M costs
Grade separation annual O&M cost (overpass)	2015$	N/A	$10,950	N/A	$10,950	N/A	N/A	N/A	N/A	$10,950	$10,950	Assumed O&M costs
Closed at-grade crossing 1 annual O&M cost	2015$	$18,187	$18,187	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed O&M costs
Closed at-grade crossing 2 annual O&M cost	2015$	$18,187	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumed O&M costs
Number of through trains per day at the main at-grade crossing	trains/day	35	32	28	35	38	28	32	29	30	32	MDT Public At-Grade Highway-Rail Crossing Database
Number of through trains per day at the closed at-grade crossing 1	trains/day	35	32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Number of through trains per day at the closed at-grade crossing 2	trains/day	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Number of switching trains per day at the main at-grade crossing	trains/day	0	6	0	0	0	0	0	4	0	0	
Number of switching trains per day at the closed at-grade crossing 1	trains/day	14	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Number of switching trains per day at the closed at-grade crossing 2	trains/day	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Annual through trains growth rate	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Assumption based on historical data
Annual switching trains growth rate	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Average through train speed	mph	20	10	60	45	35	60	55	45	50	59	FRA Maximum Speed
Average switching train speed	mph	10	5	50	10	10	30	10	10	40	10	FRA Minimum Speed

Input Name	Units	Helena Montana Ave	Billings 27th St	Belgrade Jackrabbit Ln	Helena Benton Ave	Bozeman Rouse Ave	Bozeman Griffin Dr	Billings Moore Ln	Helena Carter Drive	Huntley Northern Ave	Laurel S 72nd St W	Source
Number of hours a day trains pass the at-grade crossing	hours/day	24	24	24	24	24	24	24	24	24	24	Assumption based on observations
AADT at the main at-grade crossing	vehicles/ day	12,850	8,556	15,060	9,630	10,580	8,090	7,100	5,360	4,142	2,980	MDT Public At-Grade Highway-Rail Crossing Database
AADT at the closed at-grade crossing 1	vehicles/ day	3,290	1,482	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
AADT at the closed at-grade crossing 2	vehicles/ day	2,070	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Annual AADT growth rate	%	1.0%	1.0%	3.5%	1.2%	1.3%	2.1%	1.0%	2.2%	2.6%	2.3%	A 20-year CAGR, taking an average of 3 years.
Distance of detour from the closed at-grade crossing 1 to the main at-grade crossing	miles	0.3	0.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Google Maps, an estimated detour route through the main grade crossing.
Distance of detour from the closed at-grade crossing 2 to the main at-grade crossing	miles	0.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Average vehicle speed	mph	25	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumption
Share of traffic that travels the detour distance	%	50%	50%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Assumption
Main at-grade crossing expected accident rate per year	accidents/ year	0.0393	0.0995	0.0316	0.0297	0.0266	0.0251	0.1221	0.0250	0.0203	0.0145	Annual WBAPS 2015 accident prediction report, provided by FRA Office of Safety Analysis, Highway-Rail Crossing Safety & Trespass Prevention.
Closed at-grade crossing 1 expected accident rate per year	accidents/ year	0.0277	0.0241	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Closed at-grade crossing 2 expected accident rate per year	accidents/ year	0.0212	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Annual growth rate in at-grade crossing and detour accident rates	%	1.0%	1.0%	3.5%	1.2%	1.3%	2.1%	1.0%	2.2%	2.6%	2.3%	Based on AADT growth rate.
Detour road fatalities as a share of total accidents	%	0.08%	0.14%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	MDT Crash data for Helena and Billings, 2012
Detour road injuries as a share of total accidents	%	0.69%	0.77%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Detour road PDO accidents as a share of total accidents	%	99.23%	99.09%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Section 4: BCA Results

Comparative Analysis

Presented below are the results of the BCA analysis for 12 grade separation projects.

UNDISCOUNTED

	Helena - Montana Ave	Billings - 27th St (underpass)	Billings - 27th St (overpass)	Belgrade - Jackrabbit Ln	Helena - Benton Ave (underpass)	Helena - Benton Ave (overpass)	Bozeman - Rouse Ave	Bozeman - Griffin Dr	Billings - Moore Ln	Helena - Carter Drive	Huntley - Northern Ave	Laurel - S 72nd St W
Total Benefits (2015$M)	$13.45	$30.93	$30.93	$3.92	$3.23	$3.23	$4.90	$2.12	$4.10	$2.40	$1.77	$1.24
Total Costs (2015$M)	$29.84	$55.24	$29.42	$17.54	$28.54	$26.12	$36.64	$14.04	$25.04	$28.04	$13.42	$15.02
Net Present Value (NPV)	-$16.39	-$24.31	$1.51	-$13.62	-$25.30	-$22.89	-$31.74	-$11.92	-$20.94	-$25.63	-$11.65	-$13.78
Return on Investment (ROI)	-54.92%	-44.01%	5.13%	-77.65%	-88.67%	-87.62%	-86.63%	-84.89%	-83.63%	-91.42%	-86.79%	-91.75%
Benefit-Cost Ratio (BCR)	0.45	0.56	1.05	0.22	0.11	0.12	0.13	0.15	0.16	0.09	0.13	0.08
Payback Period (years)	N/A	N/A	12.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Internal Rate of Return (IRR)	-6.39%	-4.75%	0.45%	-10.74%	-15.17%	-14.66%	-14.09%	-13.59%	-13.05%	-16.58%	-14.33%	-17.26%

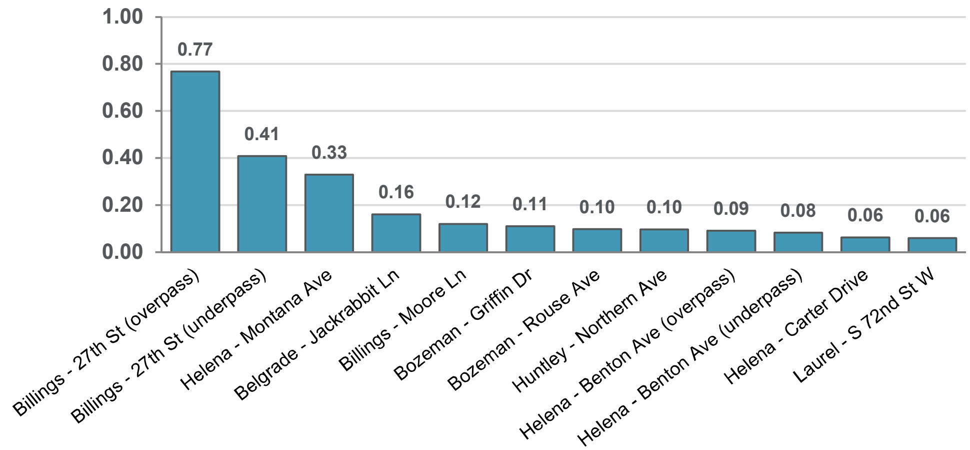
DISCOUNTED AT 3%

	Helena - Montana Ave	Billings - 27th St (underpass)	Billings - 27th St (overpass)	Belgrade - Jackrabbit Ln	Helena - Benton Ave (underpass)	Helena - Benton Ave (overpass)	Bozeman - Rouse Ave	Bozeman - Griffin Dr	Billings - Moore Ln	Helena - Carter Drive	Huntley - Northern Ave	Laurel - S 72nd St W
Total Benefits (2015$M)	$9.53	$21.88	$21.88	$2.72	$2.29	$2.29	$3.46	$1.49	$2.90	$1.69	$1.24	$0.87
Total Costs (2015$M)	$28.91	$53.57	$28.51	$16.97	$27.65	$25.30	$35.51	$13.57	$24.25	$27.16	$12.97	$14.53
Net Present Value (NPV)	-$19.38	-$31.69	-$6.63	-$14.25	-$25.36	-$23.02	-$32.05	-$12.08	-$21.34	-$25.47	-$11.73	-$13.65
Return on Investment (ROI)	-67.04%	-59.16%	-23.26%	-83.98%	-91.73%	-90.96%	-90.26%	-89.01%	-88.03%	-93.78%	-90.41%	-93.99%
Benefit-Cost Ratio (BCR)	0.33	0.41	0.77	0.16	0.08	0.09	0.10	0.11	0.12	0.06	0.10	0.06
Payback Period (years)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Internal Rate of Return (IRR)	-9.12%	-7.52%	-2.47%	-13.34%	-17.64%	-17.14%	-16.59%	-16.11%	-15.58%	-19.01%	-16.83%	-19.67%

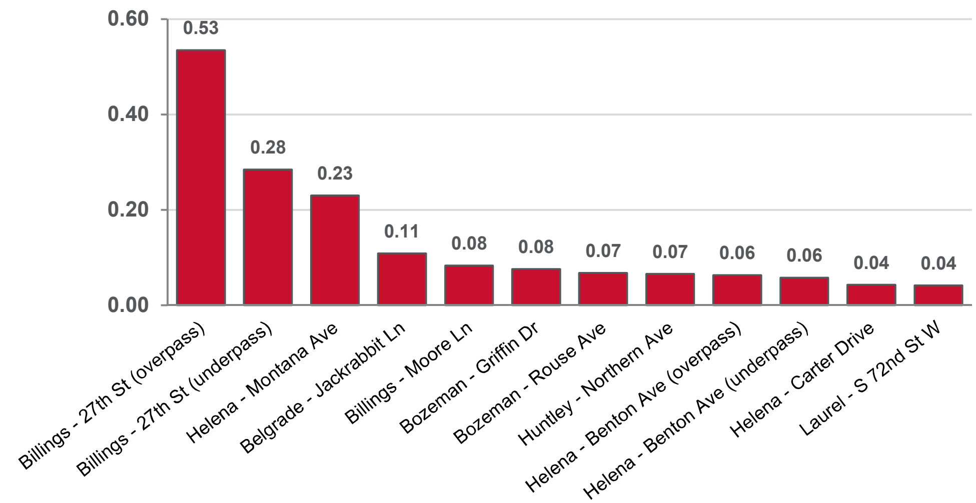
DISCOUNTED AT 7%

	Helena - Montana Ave	Billings - 27th St (underpass)	Billings - 27th St (overpass)	Belgrade - Jackrabbit Ln	Helena - Benton Ave (underpass)	Helena - Benton Ave (overpass)	Bozeman - Rouse Ave	Bozeman - Griffin Dr	Billings - Moore Ln	Helena - Carter Drive	Huntley - Northern Ave	Laurel - S 72nd St W
Total Benefits (2015$M)	$6.40	$14.65	$14.65	$1.77	$1.53	$1.53	$2.31	$0.99	$1.94	$1.12	$0.82	$0.58
Total Costs (2015$M)	$27.78	$51.52	$27.40	$16.29	$26.57	$24.31	$34.14	$13.01	$23.29	$26.10	$12.44	$13.94
Net Present Value (NPV)	-$21.38	-$36.87	-$12.75	-$14.51	-$25.03	-$22.78	-$31.82	-$12.02	-$21.35	-$24.98	-$11.62	-$13.36
Return on Investment (ROI)	-76.97%	-71.56%	-46.52%	-89.11%	-94.24%	-93.70%	-93.23%	-92.38%	-91.65%	-95.71%	-93.38%	-95.82%
Benefit-Cost Ratio (BCR)	0.23	0.28	0.53	0.11	0.06	0.06	0.07	0.08	0.08	0.04	0.07	0.04
Payback Period (years)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Internal Rate of Return (IRR)	-12.48%	-10.95%	-6.09%	-16.56%	-20.70%	-20.22%	-19.69%	-19.23%	-18.73%	-22.02%	-19.92%	-22.66%

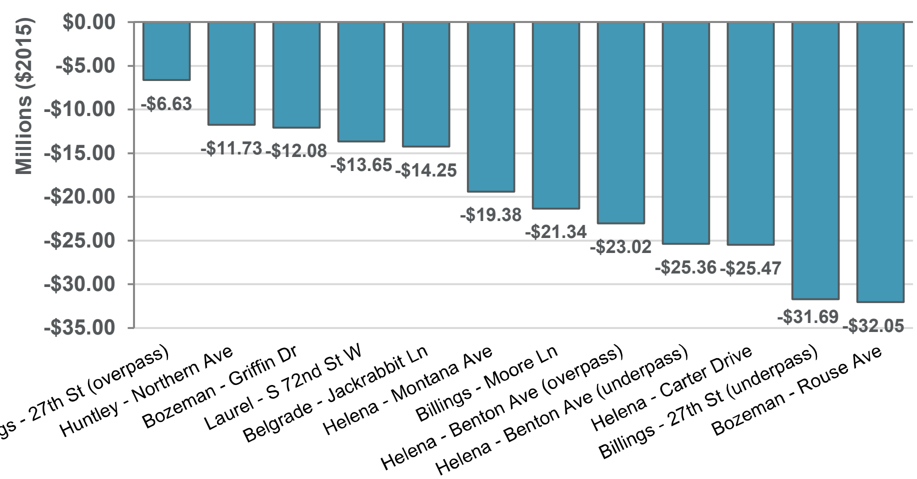
Benefit Cost Ratio Discounted at 3%



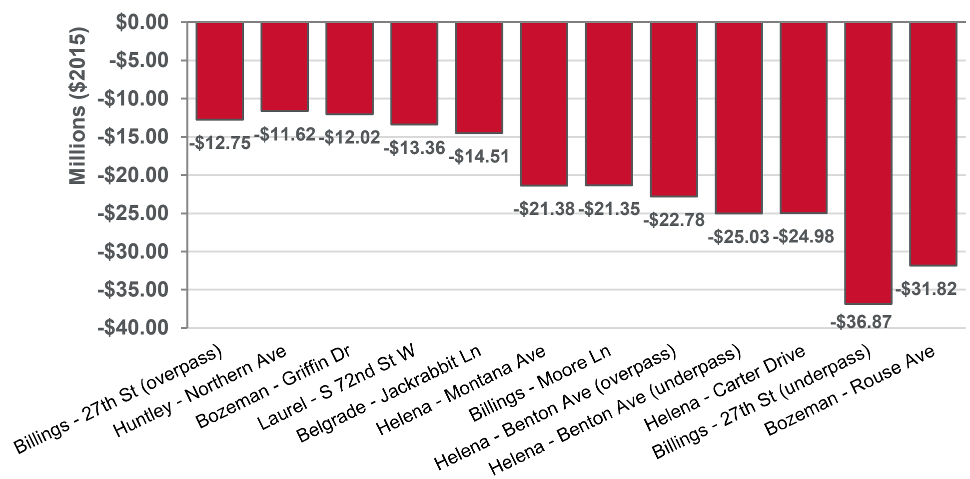
Benefit Cost Ratio Discounted at 7%



Net Present Value Discounted at 3%



Net Present Value Discounted at 7%



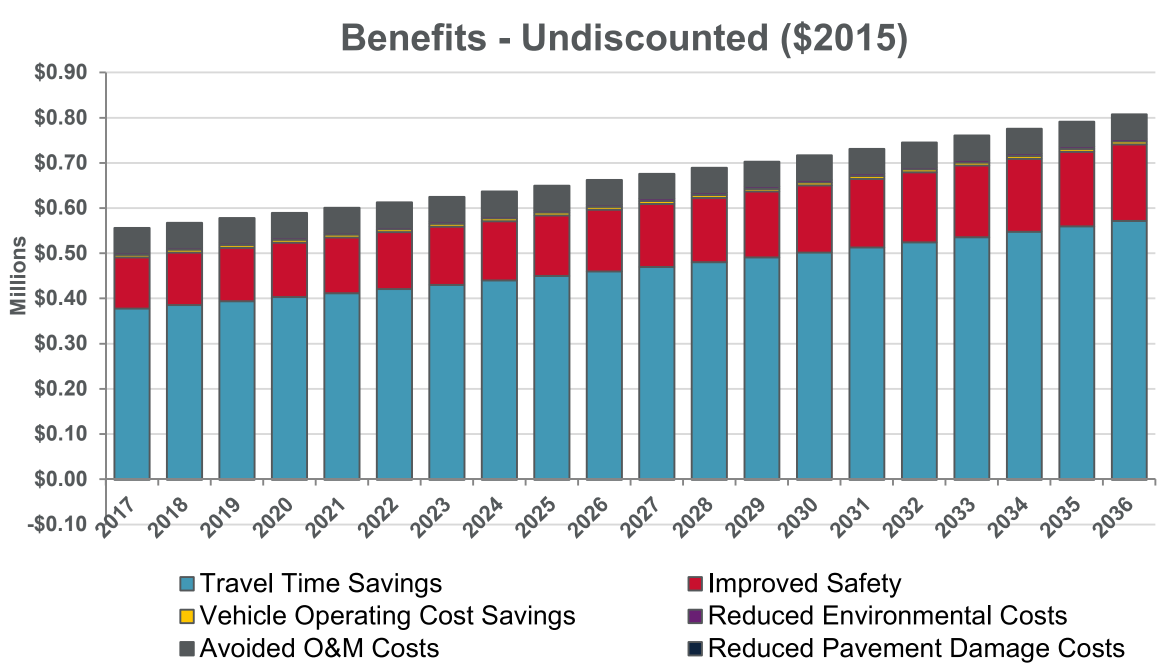
Helena – Montana Ave

Considering all monetized benefits and costs of the Montana Ave crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $21.38 million. The project's total benefits in present value terms are worth $6.40 million - of which the largest benefit is $4.42 million worth of travel time savings - while the total costs amount to $27.78 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$9.37	$6.62	$4.42
Improved Safety	$2.79	$1.97	$1.32
Vehicle Operating Cost Savings	$0.13	$0.09	$0.06
Reduced Environmental Costs	$0.10	$0.08	$0.07
Avoided O&M Costs	$1.09	$0.79	$0.54
Reduced Pavement Damage Costs	-$0.03	-$0.02	-$0.01
Total	**$13.45**	**$9.53**	**$6.40**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$13.45	$9.53	$6.40
Total Costs (2015$M)	$29.84	$28.91	$27.78
Net Present Value (NPV)	-$16.39	-$19.38	-$21.38
Return on Investment (ROI)	-54.92%	-67.04%	-76.97%
Benefit-Cost Ratio (BCR)	0.45	0.33	0.23
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-6.39%	-9.12%	-12.48%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



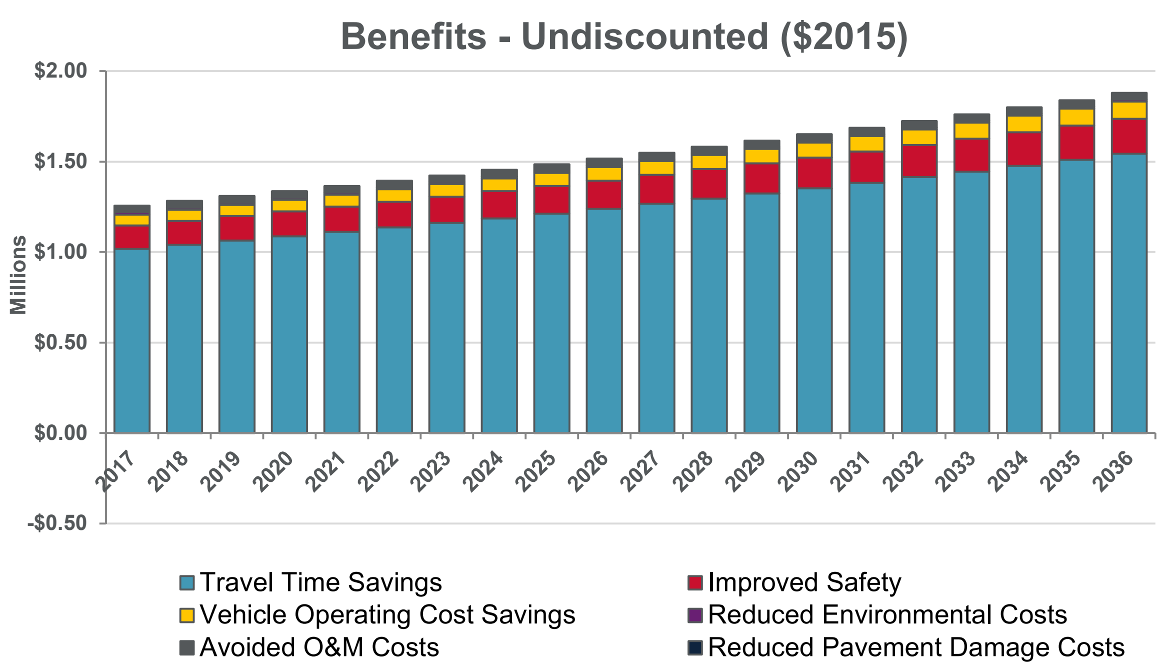
Billings – 27th St (underpass)

Considering all monetized benefits and costs of the 27th St crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $36.87 million. The project's total benefits in present value terms are worth $14.65 million - of which the largest benefit is $11.92 million worth of travel time savings - while the total costs amount to $51.52 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$25.27	$17.86	$11.92
Improved Safety	$3.18	$2.25	$1.50
Vehicle Operating Cost Savings	$1.53	$1.08	$0.72
Reduced Environmental Costs	$0.22	$0.16	$0.15
Avoided O&M Costs	$0.73	$0.53	$0.36
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$30.93**	**$21.88**	**$14.65**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$30.93	$21.88	$14.65
Total Costs (2015$M)	$55.24	$53.57	$51.52
Net Present Value (NPV)	-$24.31	-$31.69	-$36.87
Return on Investment (ROI)	-44.01%	-59.16%	-71.56%
Benefit-Cost Ratio (BCR)	0.56	0.41	0.28
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-4.75%	-7.52%	-10.95%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



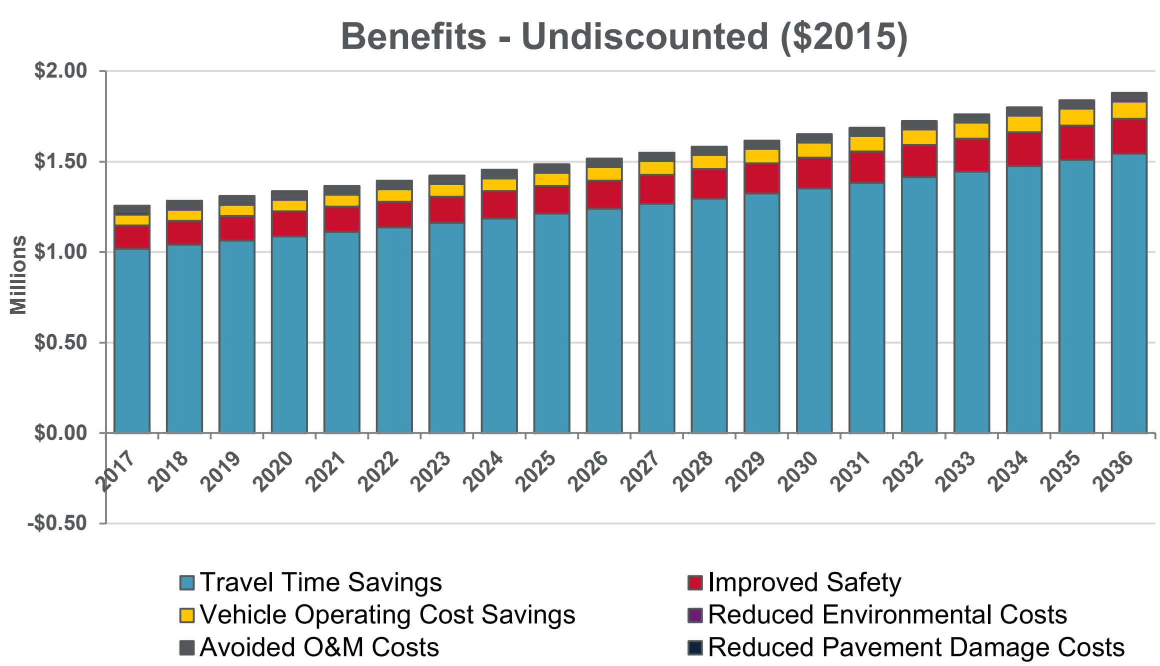
Billings – 27th St (overpass)

Considering all monetized benefits and costs of the 27th St crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $12.75 million. The project's total benefits in present value terms are worth $14.65 million - of which the largest benefit is $11.92 million worth of travel time savings - while the total costs amount to $27.40 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$25.27	$17.86	$11.92
Improved Safety	$3.18	$2.25	$1.50
Vehicle Operating Cost Savings	$1.53	$1.08	$0.72
Reduced Environmental Costs	$0.22	$0.16	$0.15
Avoided O&M Costs	$0.73	$0.53	$0.36
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$30.93**	**$21.88**	**$14.65**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$30.93	$21.88	$14.65
Total Costs (2015$M)	$29.42	$28.51	$27.40
Net Present Value (NPV)	$1.51	-$6.63	-$12.75
Return on Investment (ROI)	5.13%	-23.26%	-46.52%
Benefit-Cost Ratio (BCR)	1.05	0.77	0.53
Payback Period (years)	12.92	N/A	N/A
Internal Rate of Return (IRR)	0.45%	-2.47%	-6.09%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



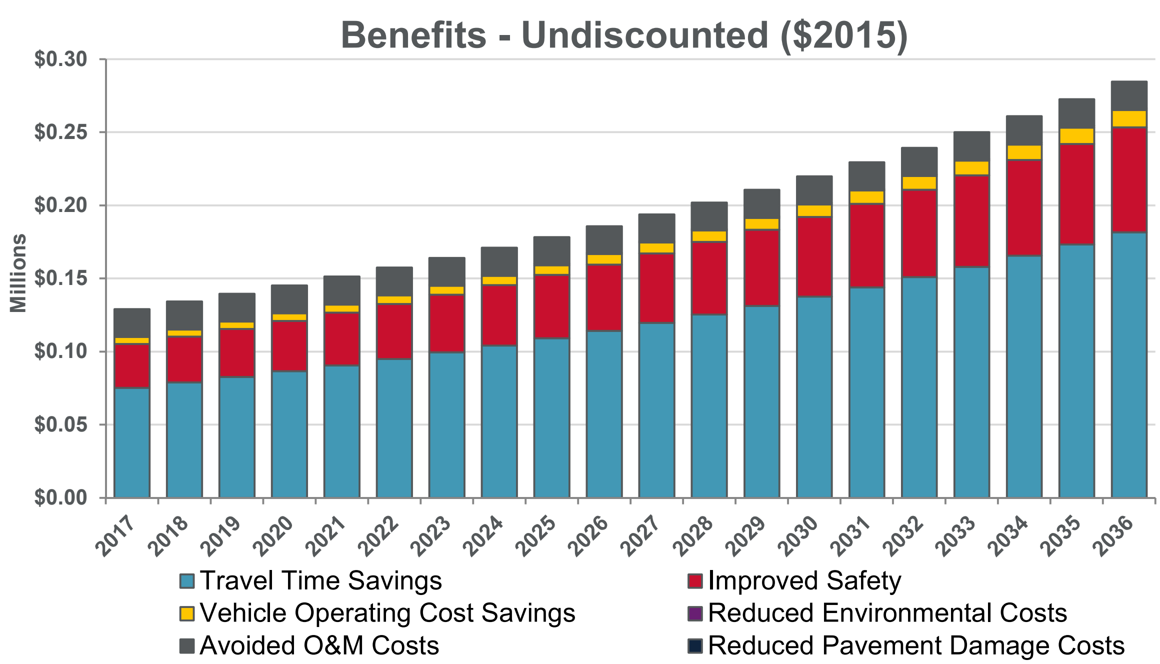
Belgrade – Jackrabbit Lane

Considering all monetized benefits and costs of the Jackrabbit Lane crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $14.51 million. The project's total benefits in present value terms are worth $1.77 million - of which the largest benefit is $1.08 million worth of travel time savings - while the total costs amount to $16.29 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$2.42	$1.67	$1.08
Improved Safety	$0.96	$0.66	$0.43
Vehicle Operating Cost Savings	$0.15	$0.10	$0.07
Reduced Environmental Costs	$0.02	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$3.92**	**$2.72**	**$1.77**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$3.92	$2.72	$1.77
Total Costs (2015$M)	$17.54	$16.97	$16.29
Net Present Value (NPV)	-$13.62	-$14.25	-$14.51
Return on Investment (ROI)	-77.65%	-83.98%	-89.11%
Benefit-Cost Ratio (BCR)	0.22	0.16	0.11
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-10.74%	-13.34%	-16.56%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



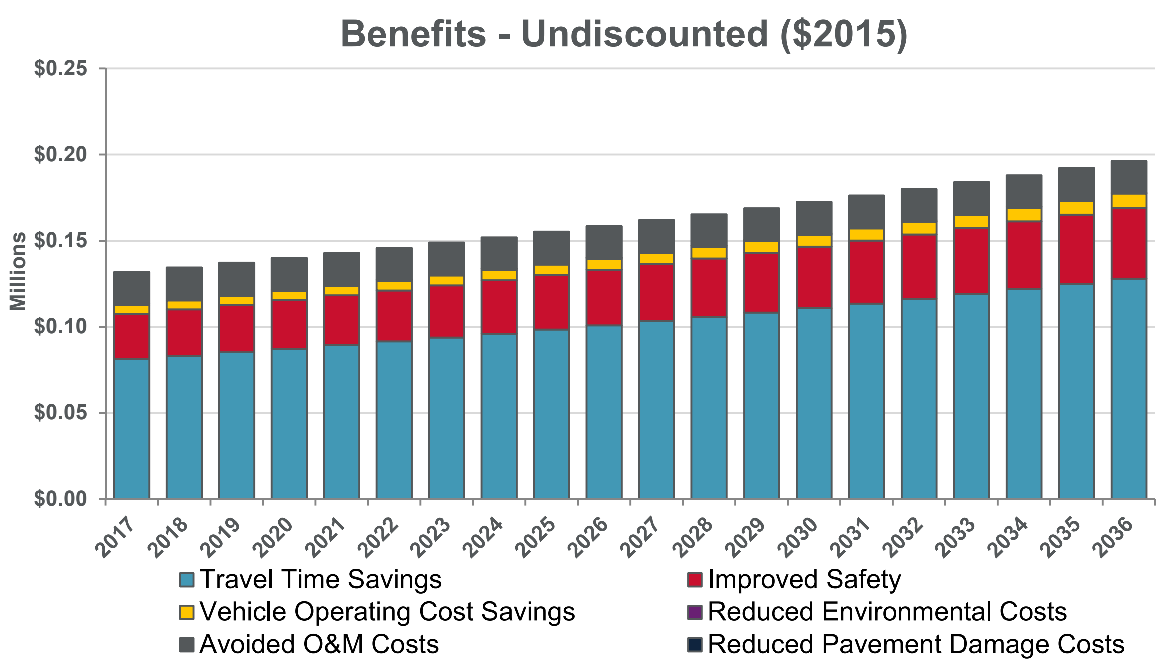
Helena – Benton Ave (underpass)

Considering all monetized benefits and costs of the Benton Ave crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $25.03 million. The project's total benefits in present value terms are worth $1.53 million - of which the largest benefit is $0.97 million worth of travel time savings - while the total costs amount to $26.57 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$2.06	$1.45	$0.97
Improved Safety	$0.66	$0.47	$0.31
Vehicle Operating Cost Savings	$0.13	$0.09	$0.06
Reduced Environmental Costs	$0.02	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$3.23**	**$2.29**	**$1.53**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$3.23	$2.29	$1.53
Total Costs (2015$M)	$28.54	$27.65	$26.57
Net Present Value (NPV)	-$25.30	-$25.36	-$25.03
Return on Investment (ROI)	-88.67%	-91.73%	-94.24%
Benefit-Cost Ratio (BCR)	0.11	0.08	0.06
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-15.17%	-17.64%	-20.70%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



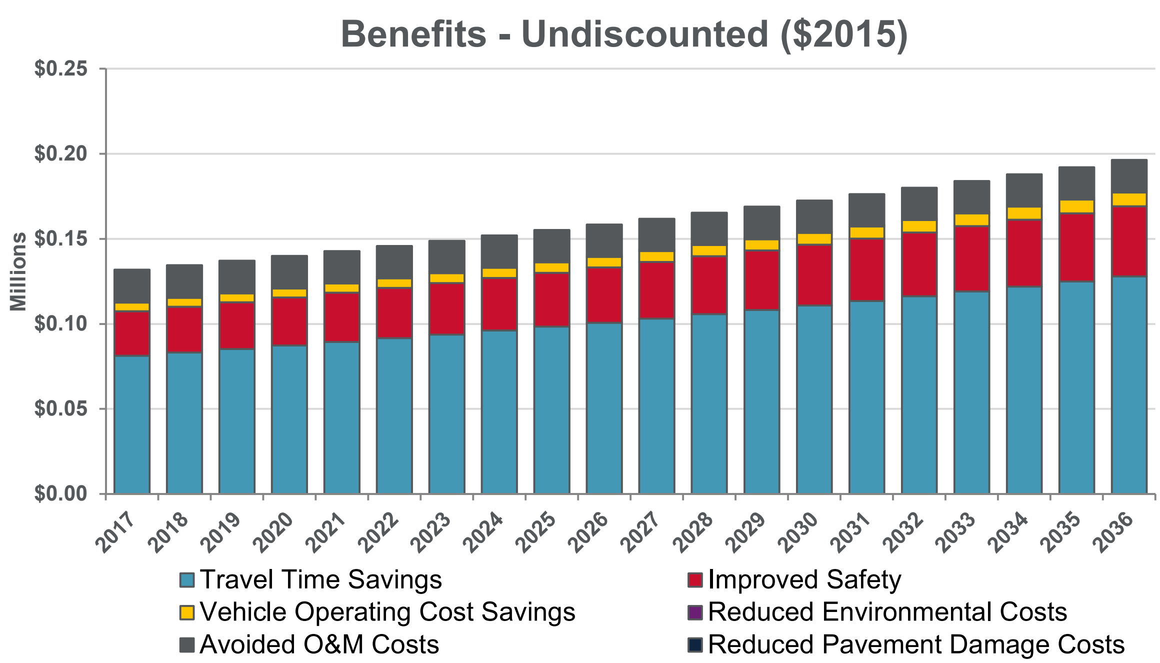
Helena – Benton Ave (overpass)

Considering all monetized benefits and costs of the Benton Ave crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $22.78 million. The project's total benefits in present value terms are worth $1.53 million - of which the largest benefit is $0.97 million worth of travel time savings - while the total costs amount to $24.31 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$2.06	$1.45	$0.97
Improved Safety	$0.66	$0.47	$0.31
Vehicle Operating Cost Savings	$0.13	$0.09	$0.06
Reduced Environmental Costs	$0.02	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$3.23**	**$2.29**	**$1.53**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$3.23	$2.29	$1.53
Total Costs (2015$M)	$26.12	$25.30	$24.31
Net Present Value (NPV)	-$22.89	-$23.02	-$22.78
Return on Investment (ROI)	-87.62%	-90.96%	-93.70%
Benefit-Cost Ratio (BCR)	0.12	0.09	0.06
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.66%	-17.14%	-20.22%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



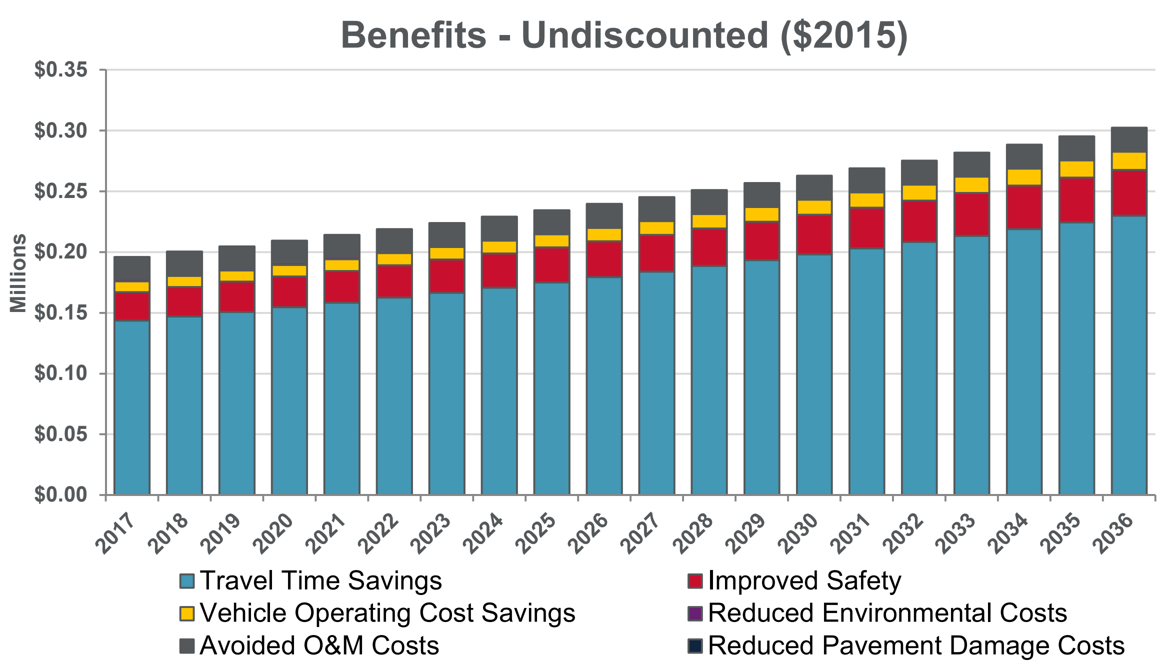
Bozeman – Rouse Ave

Considering all monetized benefits and costs of the Rouse Ave crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $31.82 million. The project's total benefits in present value terms are worth $2.31 million - of which the largest benefit is $1.72 million worth of travel time savings - while the total costs amount to $34.14 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$3.67	$2.59	$1.72
Improved Safety	$0.60	$0.43	$0.28
Vehicle Operating Cost Savings	$0.23	$0.16	$0.11
Reduced Environmental Costs	$0.03	$0.02	$0.02
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$4.90**	**$3.46**	**$2.31**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$4.90	$3.46	$2.31
Total Costs (2015$M)	$36.64	$35.51	$34.14
Net Present Value (NPV)	-$31.74	-$32.05	-$31.82
Return on Investment (ROI)	-86.63%	-90.26%	-93.23%
Benefit-Cost Ratio (BCR)	0.13	0.10	0.07
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.09%	-16.59%	-19.69%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



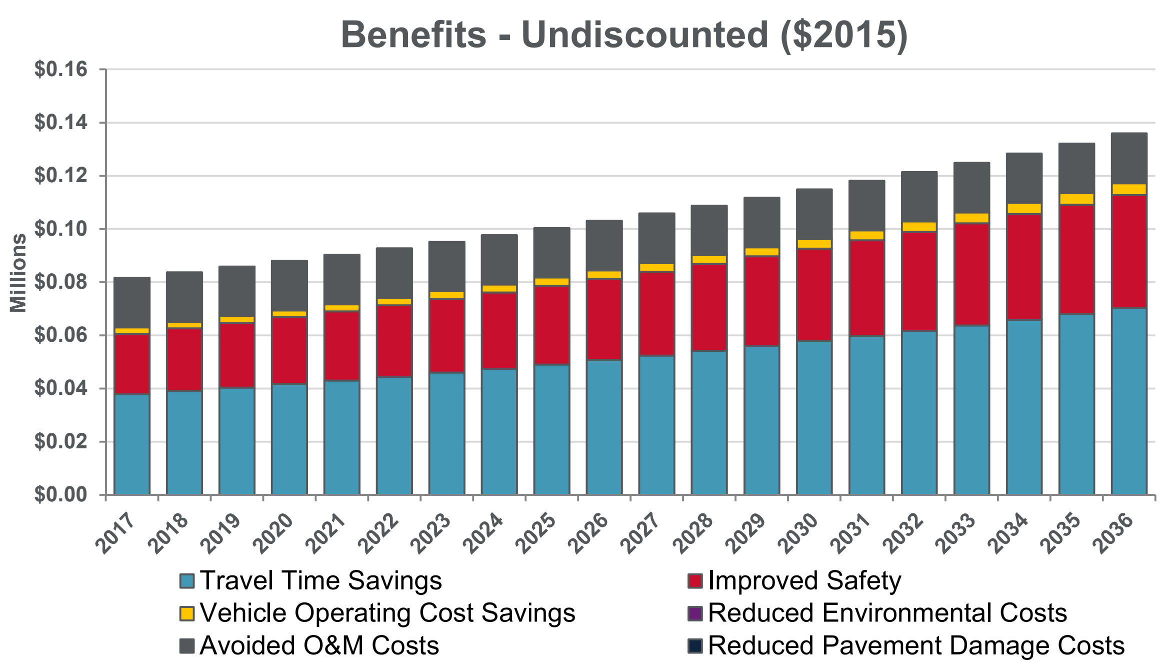
Bozeman – Griffin Drive

Considering all monetized benefits and costs of the Griffin Drive crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $12.02 million. The project's total benefits in present value terms are worth $0.99 million - of which the largest benefit is $0.48 million worth of travel time savings - while the total costs amount to $13.01 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.05	$0.73	$0.48
Improved Safety	$0.63	$0.44	$0.29
Vehicle Operating Cost Savings	$0.07	$0.05	$0.03
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$2.12**	**$1.49**	**$0.99**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$2.12	$1.49	$0.99
Total Costs (2015$M)	$14.04	$13.57	$13.01
Net Present Value (NPV)	-$11.92	-$12.08	-$12.02
Return on Investment (ROI)	-84.89%	-89.01%	-92.38%
Benefit-Cost Ratio (BCR)	0.15	0.11	0.08
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-13.59%	-16.11%	-19.23%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



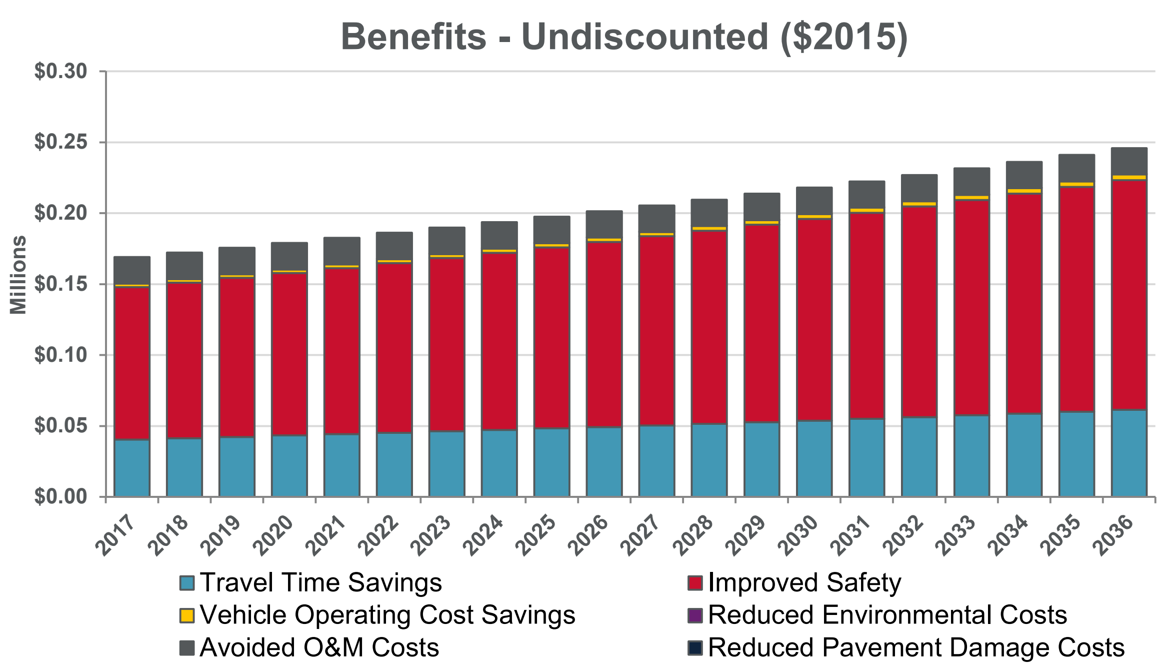
Billings – Moore Lane

Considering all monetized benefits and costs of the Moore Lane crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $21.35 million. The project's total benefits in present value terms are worth $1.94 million - of which the largest benefit is $1.25 million worth of improved safety - while the total costs amount to $23.29 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.01	$0.71	$0.47
Improved Safety	$2.66	$1.88	$1.25
Vehicle Operating Cost Savings	$0.06	$0.04	$0.03
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$4.10**	**$2.90**	**$1.94**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$4.10	$2.90	$1.94
Total Costs (2015$M)	$25.04	$24.25	$23.29
Net Present Value (NPV)	-$20.94	-$21.34	-$21.35
Return on Investment (ROI)	-83.63%	-88.03%	-91.65%
Benefit-Cost Ratio (BCR)	0.16	0.12	0.08
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-13.05%	-15.58%	-18.73%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



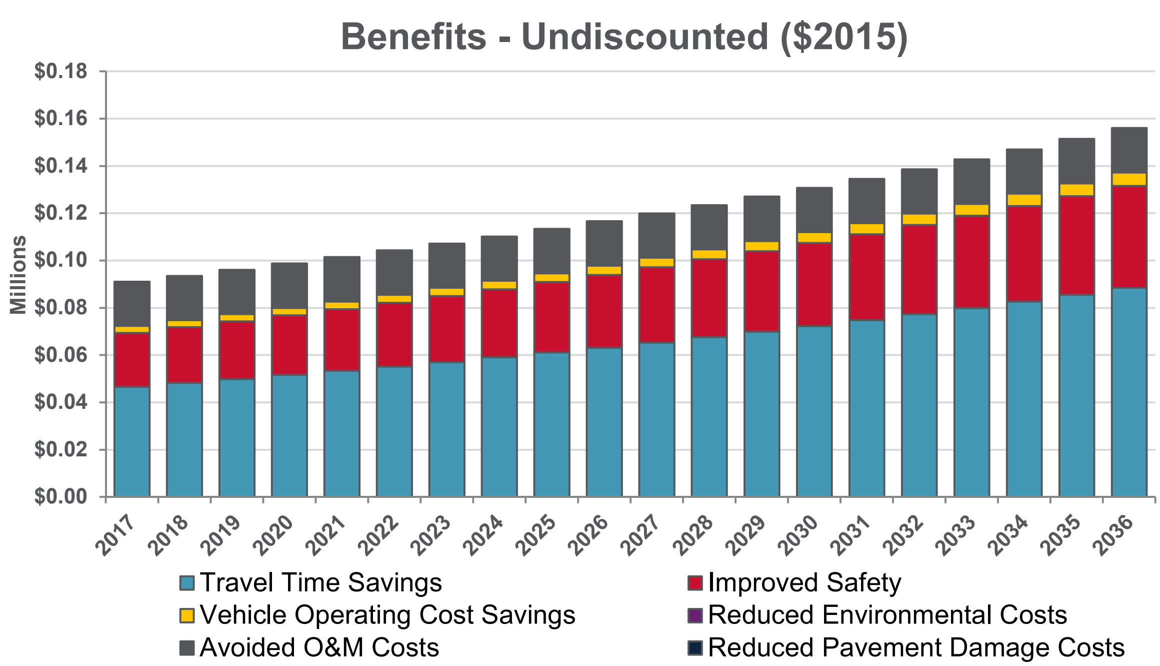
Helena – Carter Drive

Considering all monetized benefits and costs of the Carter Drive crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $24.98 million. The project's total benefits in present value terms are worth $1.12 million - of which the largest benefit is $0.60 million worth of travel time savings - while the total costs amount to $26.10 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$1.31	$0.91	$0.60
Improved Safety	$0.64	$0.45	$0.29
Vehicle Operating Cost Savings	$0.08	$0.06	$0.04
Reduced Environmental Costs	$0.01	$0.01	$0.01
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$2.40**	**$1.69**	**$1.12**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$2.40	$1.69	$1.12
Total Costs (2015$M)	$28.04	$27.16	$26.10
Net Present Value (NPV)	-$25.63	-$25.47	-$24.98
Return on Investment (ROI)	-91.42%	-93.78%	-95.71%
Benefit-Cost Ratio (BCR)	0.09	0.06	0.04
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-16.58%	-19.01%	-22.02%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



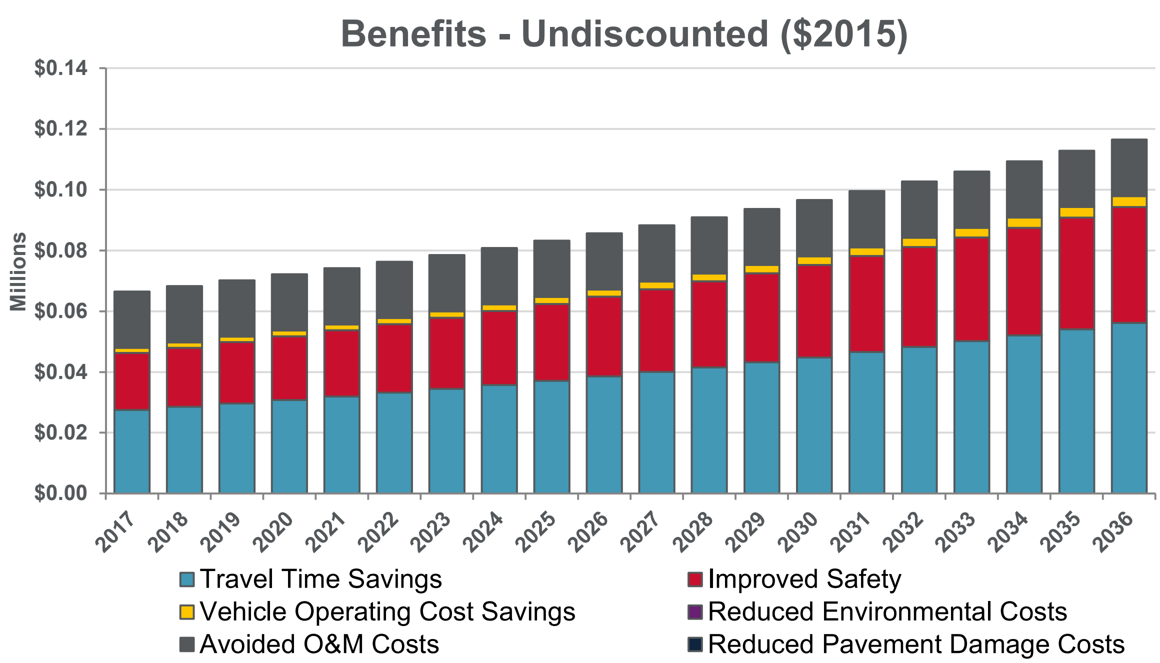
Huntley – Northern Ave

Considering all monetized benefits and costs of the Northern Ave crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $11.62 million. The project's total benefits in present value terms are worth $0.82 million - of which the largest benefit is $0.37 million worth of travel time savings - while the total costs amount to $12.44 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$0.80	$0.56	$0.37
Improved Safety	$0.55	$0.38	$0.25
Vehicle Operating Cost Savings	$0.05	$0.03	$0.02
Reduced Environmental Costs	$0.01	$0.00	$0.00
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$1.77**	**$1.24**	**$0.82**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$1.77	$1.24	$0.82
Total Costs (2015$M)	$13.42	$12.97	$12.44
Net Present Value (NPV)	-$11.65	-$11.73	-$11.62
Return on Investment (ROI)	-86.79%	-90.41%	-93.38%
Benefit-Cost Ratio (BCR)	0.13	0.10	0.07
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-14.33%	-16.83%	-19.92%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.



Laurel – S 72nd St W

Considering all monetized benefits and costs of the S 72nd St W crossing, the estimated net present value of the project with a 7% discount rate is a net cost of $13.36 million. The project's total benefits in present value terms are worth $0.58 million - of which the largest benefit is $0.21 million worth of travel time savings - while the total costs amount to $13.94 million.

Benefit Category	Total Undiscounted Benefits (2015$ M)	Total Benefits Discounted at 3% (2015$ M)	Total Benefits Discounted at 7% (2015$ M)
Travel Time Savings	$0.47	$0.33	$0.21
Improved Safety	$0.38	$0.26	$0.17
Vehicle Operating Cost Savings	$0.03	$0.02	$0.01
Reduced Environmental Costs	$0.00	$0.00	$0.00
Avoided O&M Costs	$0.36	$0.26	$0.18
Reduced Pavement Damage Costs	$0.00	$0.00	$0.00
Total	**$1.24**	**$0.87**	**$0.58**

Financial Metrics	Undiscounted	Discounted at 3%	Discounted at 7%
Total Benefits (2015$M)	$1.24	$0.87	$0.58
Total Costs (2015$M)	$15.02	$14.53	$13.94
Net Present Value (NPV)	-$13.78	-$13.65	-$13.36
Return on Investment (ROI)	-91.75%	-93.99%	-95.82%
Benefit-Cost Ratio (BCR)	0.08	0.06	0.04
Payback Period (years)	N/A	N/A	N/A
Internal Rate of Return (IRR)	-17.26%	-19.67%	-22.66%

Presented below is a chart illustrating 20 years of undiscounted benefits following construction.