Montana

Statewide Rail/Highway Grade Separation Needs Study

Phase I and II Reports

State of Montana
Department of Transportation
Rail, Transit & Planning Division

March 2003

INTRODUCTION

The Statewide Rail/Highway Grade Separation Needs Study was commissioned by the Montana Department of Transportation (MDT) to address public concerns regarding existing at-grade rail/highway crossings. The study was commissioned to fill a specific need; that of a tool to qualitatively evaluate and prioritize railroad grade crossings for improvement to grade-separated crossings. Without a qualitative evaluation/prioritization tool, MDT frequently found it difficult to respond effectively to political and public pressures for grade separation improvements at various locations. It was desired, therefore, to develop a methodology to evaluate the feasibility of grade-separated solutions, and to rank statewide grade crossings on the basis of need. For purposes of this study, MDT selected twenty (20) individual grade crossings for evaluation. The candidate grade crossings represent locations where citizens, local jurisdiction staff, or political representatives have requested grade separations, or locations thought to warrant grade separation solutions by virtue of traffic volume, train volume, crash history or a combination of these.

The study process included two phases; Phase I evaluated the feasibility of implementing a grade-separated alternative at each selected location and determined the evaluation criteria to be used for a need-based prioritization tool; Phase II addresses the cost to construct feasible alternatives at candidate locations and includes development and application of an evaluation/prioritization tool. During Phase I, the consultant team gathered data about, and performed a field evaluation of each candidate location. A public/agency input process was also conducted to obtain public and agency perceptions, and determine public/agency support for construction of grade separation alternatives at each candidate location. Public and agency input was also sought as input to selection of the evaluation criteria to be utilized in Phase II of the project.

At the conclusion of Phase I, a judgment regarding the feasibility of constructing a grade-separated alternative at each candidate location was reached. Recommendations regarding the criteria to be used in the evaluation/prioritization process base on community input were also made.

Phase II of the project will entail development of conceptual design solutions for grade separations at feasible candidate locations. Conceptual solutions will be developed to a level sufficient to develop planning-level construction cost estimates for each feasible solution. Costs will include construction costs for the roadway, rail and utilities as well as estimate right of way and business acquisition costs. An evaluation/prioritization tool will also be developed during Phase II of the project. The tool will apply the selected evaluation criteria for each location to prioritize each location according to need. Cost estimate data will be utilized to develop a separate benefit-cost evaluation for each candidate location. The desired results of these two separate analyses will be a prioritization of at-grade crossings based on need, with a separate benefit-cost evaluation for each location. These two results will serve as input to funding decisions made by MDT for possible advancement of further, more detailed grade separation evaluations at locations demonstrating superior need and benefit-cost ratios.

FEASIBILITY ASSESSMENT

The feasibility of grade separation alternatives considered several definitions of "feasibility" contained in Federal Highway Administration documents. Documented definitions of project "feasibility" include the following:

- Degree to which a given alternative is economically justified.
- Degree to which an alternative is considered preferable from an environmental or social perspective.
- Degree to which eventual construction and operation of an alternative can be financed and managed.

For purposes of this study and for development of an evaluation tool to prioritize existing at-grade crossings for development as grade-separated solution projects, it was decided to eliminate cost as a consideration of feasibility. Economics of alternative solutions were not considered to any significant degree. Feasibility, as used for development of this evaluation tool, was defined as follows:

> *"Degree to which an alternative is capable of being accomplished or dealt with successfully"*

The following discussion documents the elements of the feasibility analysis and is based primarily upon the "physical impacts" and "physical feasibility" of a grade separation solution at each location. When establishing the level of "physical impacts" and "physical feasibility" that would be acceptable to Montana communities the following criteria were considered.

- Geometric / Physical constraints: Can something be built at the crossing location using standard engineering designs?
- Community economic impact: Will the creation of a grade separation at the crossing location significantly disrupt the community's economic base?
- Community input for crossings at the specific location: Would the community support a crossing improvement at this location?

At each of the candidate grade separation locations, overpass and underpass alternative solutions were developed based on the design criteria of the crossing facility. Design criteria were developed for each at-grade crossing based on the requirements of the MDT Roadway Design Manual considering the roadway functional classification and its location (urban or rural). Design criteria considered include:

- Roadway design speed
- Maximum vertical grade allowed
- Minimum vertical clearance required

The MDT design criteria were utilized without modification for all candidate locations except one; 27th Street in Billings. As the only candidate location on a National Highway System (NHS) route, the design criteria for this location are "out of character" for the physical roadway environment. NHS system designation would require design speeds of 45 mph with maximum grades not to exceed 6%. Currently posted speeds on 27th Street are 25 mph. For purposes of alternative solution development, we have assumed design deviations would be allowed for 27th Street allowing use of a 30 mph design speed and grade to a maximum of 10%. It is only through use of a design deviation that the 27th Street location could be considered feasible. Design criteria for all study locations are shown in Table 1.

Table 1 – Design Criteria

Community	Project Site	Functional Classification	Rural	Urban	Posted Speed	Design Speed	Max. Approach Grade (%)
Belgrade	Broadway St	Collector		X	25	30	10
Belgrade	Jack Rabbit Ln	Collector		X	45	30	10
Billings	27th Street	Principal Arterial		X	25	30*	7-10*
Billings	28th Street	Collector		X	25	30	10
Billings	29th Street	Major Collector		X	25	30	10
Billings	Moore Ln	Collector		X	25	30	10
Bozeman	Griffin Dr	Collector		X	25	30	10
Bozeman	Rouse Ave	Collector		X	35	30	10
Columbus	Pratton St	Minor Arterial	X		25	35	10
Cut Bank	N Central Ave	Collector	X		25	30	10
Glasgow	4th Street	Collector	X		25	30	10
Helena	Benton Ave	Minor Arterial		X	35	35	10
Helena	Montana Ave	Principal Arterial		X	30	40	6
Helena	Roberts St	Collector		X	25	30	10
Laurel	5th Avenue	Collector		X	25	30	10
Livingston	5th Street	Collector		X	25	30	10
Miles City	Leighton Blvd	Collector		X	25	30	10
Missoula	Greenough Dr	Collector		X	25	30	10
Shelby	2nd Avenue	Collector	X		25	30	10
Wolf Point	6th Street	Collector	X		25	30	10

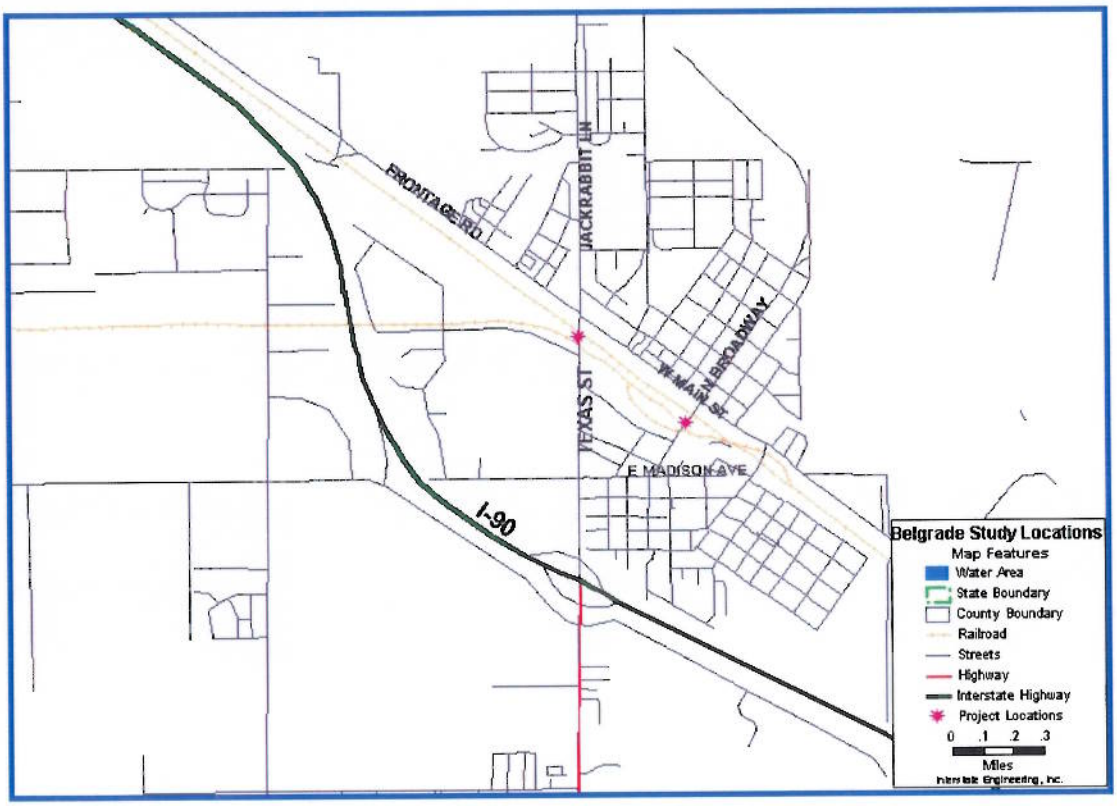
*Design Deviation Assumed

Each of the candidate grade crossings are discussed separately in the following sections, organized by community. Both overpass and underpass solution alternatives are considered. Discussion sections provide brief descriptions of the candidate locations, discuss impacts of both over and underpass solutions, summarize community input, and conclude with a recommendation of whether a location should be considered feasible or infeasible. Graphics showing overpass and underpass solution alternatives at each location are included in Appendix A.

COMMUNITY OF BELGRADE

Two candidate locations are within the community of Belgrade. Candidate locations include railroad grade crossings on Broadway Street and Jackrabbit Lane. Candidate locations are shown in Figure 1.

Figure 1 – Belgrade Grade Crossing Study Locations



Broadway Street Grade Crossing

Existing Geometry & Traffic

Broadway Street crosses the mainline tracks of Montana Rail Link at crossing ID 060 085T and railroad milepost 014998. One set of mainline tracks are crossed at this location. Broadway Street is a two-lane collector with current traffic of 4,700 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad / highway at-grade intersection is approximately 250 feet south of the Broadway Street intersection with Main Street, and approximately 700 feet north of the Broadway Street intersection with Northern Pacific Ave. There is no significant elevation difference between the railroad crossing and the Broadway Street / Main Street intersection or the Broadway Street / Northern Pacific Ave. intersection. Main Street is a major collector through Belgrade carrying approximately 8,180 vehicles per day. The three blocks of Main Street either side of the Broadway Street contain approximately half of the businesses within downtown Belgrade. Access to businesses along this section of Main Street is provided

by on-street parking and a block long parking lot located between Main Street and the railroad line on the west side of Broadway Street.

Grade Separation Alternatives

Grade separation of the railroad crossing would require elimination of through traffic on Main Street or modification of the Main Street vertical grades. No additional roadway intersections would be impacted. An underpass at this location would lower the elevation of the Broadway / Main Street intersection by approximately 8 feet. An overpass solution at this location would raise the elevation of the Broadway / Main Street by approximately 15 feet. The resulting change in grade on Main Street would eliminate storefront access and existing on-street parking to a significant portion of Main Street businesses. Grade separation alternatives would cause the loss of a significant percentage of downtown businesses within Belgrade.

Community Input

During the public involvement process, City staff and community members expressed concerns for a crossing at this location due to the business impacts in downtown Belgrade.

Recommendation

The physical constraints of existing Main Street intersection and businesses impacts make the construction of a grade-separated solution at the Montana Rail Link mainline and Broadway Street infeasible at its existing location. The community expressed strong reservations about construction of a grade separation due to business impacts.

Based on our investigation, and based on community input, alternative locations should be sought for construction of a grade separation. In this community, two locations were subject to this study, the Broadway Street crossing and the Jackrabbit Lane crossing. Although the Broadway Street location was deemed infeasible, the Jackrabbit Lane location was deemed feasible for construction of an underpass solution (see following section) and would be the preferred choice for grade separating an existing crossing within the community. A grade separated crossing in the vicinity of the Belgrade/Bozeman Airport was recommended to accommodate future needs within Belgrade.

Jackrabbit Lane Grade Crossing

Existing Geometry & Traffic

Jackrabbit Lane crosses the mainline tracks of Montana Rail Link at crossing ID 060 090P and railway milepost 015039. Jackrabbit Lane is a two-lane collector carrying 9,300 vehicles per day. A single mainline track crossing occurs at this location with a low volume spur line located about 900 ft. to the south. The crossing occurs at a 70° angle to the tracks. The railroad / highway at-grade intersection is approximately 350 feet south of the Jackrabbit Lane / W. Main Street intersection and about 380 feet north of the Jackrabbit Lane / Arden Drive intersection. The railroad crossing is about 6 ft.

higher than the Jackrabbit Lane/W. Main Street intersection and the Jackrabbit Lane/Arden Drive intersection.

W Main Street is a major collector through Belgrade carrying traffic volumes of approximately 11,180 vehicles per day. There are no structures with direct frontage onto the street within the proposed project limits. An existing commercial bank is set back approximately 130 feet from the edge of the roadway. Modification of vehicle access to the bank property would be required.

Grade Separation Alternatives

Grade separation of the railroad crossing would require modification of both W. Main Street and Arden Dr. vertical grades. Underpass touchdown points would extend north and south from the rail crossing approximately 450 feet, beyond both the W. Main Street and Arden Dr. intersections. An underpass through this location would require lowering the elevation of the W. Main Street intersection by approximately 4 feet and lowering the elevation of the Arden Dr. intersection by approximately 2 feet. Overpass touchdown points for a new Jackrabbit Lane alignment would extend north and south from the rail crossing approximately 650 feet and impact the same two roadway intersections. An overpass solution that maintained access to intersecting streets would require raising the W. Main Street intersection by approximately 17 feet and Arden Drive intersection by about 11 feet.

Community Input

During the public involvement process City staff and community members expressed no strong opinions regarding a grade separated crossing at this location. However, an alternative location was recommended in the vicinity of the Belgrade/Bozeman airport.

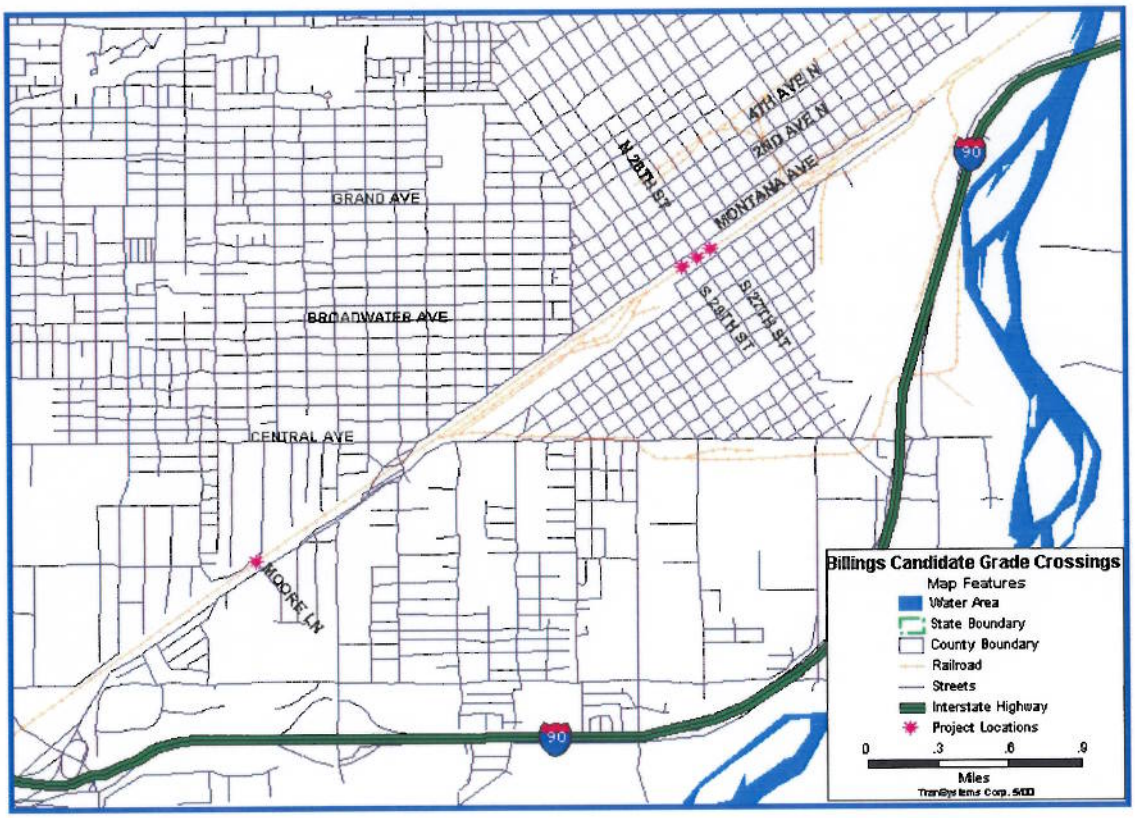
Recommendation

The physical constraints of the W. Main Street and Arden Drive intersections make an overpass solution at the Montana Rail Link mainline and Jackrabbit Lane infeasible. An underpass solution at this location is considered the feasible solution alternative.

COMMUNITY OF BILLINGS

Four candidate locations are sited within the community of Billings. Candidate locations include 27th, 28th and 29th Streets, and Moore Lane. Billings' candidate railroad grade crossing locations are shown in Figure 2.

Figure 2 – Billings Grade Crossing Study Locations



27th Street Grade Crossing

Existing Geometry & Traffic

27th Street crosses a set of mainline tracks and a set of spur line tracks of the Montana Rail Link at crossing ID 087 491T and railway milepost 022576. 27th Street is a four-lane principal arterial on the National Highway System with current traffic of 13,250 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad/highway at-grade intersection is approximately 150 feet south of the 27th Street / Montana Avenue intersection and 180 feet north of the 27th Street / Minnesota Avenue intersection. The railroad crossing is about 2 feet higher than the Montana Avenue and Minnesota Avenue intersections. Montana Avenue is a principal arterial street in Billings carrying 18,883 vehicles per day. Minnesota Avenue is a collector street carrying a volume of 4,200 vehicles per day. No on-street parking is allowed along 27th Street throughout the project impact area. On-street parking is allowed along Montana Avenue and Minnesota Avenue. There are structures located on three corners of the 27th Street / Montana

Avenue intersection with a street level parking area for the Sheraton Hotel on the fourth corner.

As a principal arterial with National Highway System designation, the design criteria for 27th Street are significantly different than other candidate locations with respect to design speed and maximum grades. The criteria design speed of 45 mph is significantly higher than the posted speed limit of 25 mph.

Grade Separation Alternatives

Grade separation of this rail crossing under the design criteria of a National Highway System route would be severely disruptive to downtown business frontage, access, and to intersecting streets. Impacts under NHS design criteria would extend well beyond 1st Avenue North, to the north, and beyond 1st Avenue South to the south. Unless design exceptions are allowed that recognize the physical and functional nature of this facility and its urban setting, construction of an overpass or underpass solution is not feasible at this location. The following discussion of overpass and underpass alternatives is based on the assumption that design exceptions are allowed that reduce the design speed to 30 mph and allow maximum grades of 10% for an overpass and 7% for an underpass.

Any grade separation solution for the 27th Street railroad crossing would require significant vertical adjustments to Montana Avenue and Minnesota Avenue to match the new 27th Street grades, or elimination of these intersections by grade separating the Montana Avenue and Minnesota Avenue intersections from 27th Street.

An underpass at this location would require lowering the elevation of Montana and Minnesota Avenues at 27th Street 15 to 18 feet, affecting the vertical alignment and street access on these intersecting streets for 180-200 feet on either side of 27th Street. As an alternative, these streets could be maintained at approximately existing elevations and allowed to cross over 27th Street to maintain through traffic function, but without any turning movements to or from 27th Street. Underpass touchdown points on 27th Street would extend north and south from the rail crossing approximately 500 feet using a 30 mph design speed and maximum grades of 7%. An underpass solution under these criteria would not impact intersection elevations or grades of 1st Avenue North or 1st Avenue South.

An overpass solution alternative would require raising the elevation of the Montana Avenue and Minnesota Avenue intersections with 27th Street by approximately 28 feet. This adjustment would change the vertical elevation on these two intersecting streets for a distance of 300 feet either side of 27th Street. As with the underpass alternative these streets could be maintained as cross streets, but without access to 27th Street, by taking them under a 27th Street overpass. Street level business access and frontage would be impacted or eliminated throughout this length on these two cross streets. Overpass touchdown points on 27th Street would extend north and south from the rail crossing approximately 675 feet, extending beyond the 27th Street intersections with 1st Avenue North and 1st Avenue South.

Even with relaxed design criteria, impacts of a grade separation are significant to business access and frontage along 27th Street as well as intersecting streets (Montana and Minnesota Avenues). Due to the traffic volumes present on these intersecting streets and their importance to circulation of traffic within and through the downtown area of Billings, simply discontinuing these facilities or eliminating their intersections with 27th Street were not considered reasonable consequences.

A further grade separation alternative variation was developed for this location which shows promise, and may be able to maintain cross street function and preserve business frontage and access. This alternative variation grade separates only the *center* two lanes of 27th Street, leaving the outside lanes at-grade. Due to the lower grades and shorter impact zones required, this variation was explored only for the underpass alternative.

Under this variation, through traffic *and* turning traffic can be maintained between intersecting streets and 27th Street. Through and turning movement access is maintained by constructing an overpass to carry Montana and Minnesota Avenues over 27th Street. Turning movements can be accommodated at the intersection of the at-grade lanes of 27th Street with cross streets. To accommodate required vertical clearance on 27th Street at Montana and Minnesota Avenues without extending the touchdown points beyond 1st Avenue North or 1st Avenue South, the elevation of Montana and Minnesota Avenues will need to be raised 2-3 feet at the crossing of 27th Street. Adjustments on Montana and Minnesota Avenues would restrict parking and limit business access on these cross streets for a distance of about 80 feet either side of 27th Street. As an alternative, a height-restricted underpass might also be considered to preserve the vertical alignment of these cross streets.

Community Input

During the public involvement process, City staff and community members expressed strong support for a grade separated crossing at this location. An advocacy group has formed in Billings that has been pressing for a solution to this at-grade railroad crossing and they were well represented at the public forum urging selection of the 27th Street grade crossing as a top priority.

Recommendation

The physical constraints of the existing cross streets of 1st Avenue North, Montana Avenue, Minnesota Avenue, and 1st Avenue South as well as the elevated pedestrian facilities crossing 27th Street make an overpass solution at the Montana Rail Link mainline and spur line and 27th Street not feasible. An underpass solution at this location where only the center two lanes of 27th Street are grade separated from the railroad tracks is considered a feasible solution, with or without adjustments to vertical grades on Montana and Minnesota Avenues.

Another alternative often mentioned is complete relocation of the railway tracks. The potential relocation alignment most often mentioned is to re-route the railroad mainline tracks along I-90 rather than through the heart of the community.

28th Street Grade Crossing

Existing Geometry & Traffic

28th Street crosses a set of mainline tracks and a set of spur line tracks of Montana Rail Link at crossing ID 087 492A and railway milepost 022583. 28th Street is a four-lane collector with current traffic of 4,320 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad crossing is approximately 150 feet south of the 28th Street / Montana Avenue intersection and 180 feet north of the 27th Street / Minnesota Avenue intersection. The railroad crossing is about 2 feet higher than the Montana and Minnesota Avenue intersections. Montana Avenue is a principal arterial carrying traffic volumes of 18,883 vehicles per day. Minnesota Avenue is a collector street carrying 4,200 vehicles per day. No on-street parking is allowed along 28th Street between Montana Avenue and Minnesota Avenue. On street parking on 28th Street is allowed north of Montana Avenue and south of Minnesota, and along Montana Avenue and Minnesota Avenue. There are commercial structures located on three corners of the 28th Street / Montana Avenue intersection with a parking area on the fourth corner.

Grade Separation Alternatives

Grade separation of the rail crossing would require significant modification of the Montana Avenue and Minnesota Avenue elevations to match the new 28th Street grades or grade-separation of Montana and Minnesota Avenues from 28th Street.

An underpass at this location would lower the elevation of 28th Street at Montana Avenue and Minnesota Avenue by approximately 12-15 feet. Underpass touchdown points would extend north and south from the rail crossing approximately 500 feet and only impact the Montana Avenue and Minnesota Avenue intersections. These touchdown points would be prior to the next major street intersections of 1st Avenue North and 1st Avenue South. Modifications to the elevations of Montana and Minnesota Avenues would extend about 280 feet in both directions from 28th Street and would impact business frontage and access over this distance. Construction of retaining walls would be necessary to maintain these commercial structures. Access to the parking lot would need to be reconstructed to maintain the existing use of the lot.

The elevation of 28th Street at Montana Avenue and Minnesota Avenue intersections would be raised by approximately 28 feet with an overpass solution. Through traffic could be maintained on Montana Avenue and Minnesota Avenue by carrying them under the new 28th Street alignment, although access from Montana and Minnesota Avenues to 28th Street would be lost. Touchdown points for a 28th Street overpass would extend north and south from the railroad crossing approximately 675 feet and the 28th Street intersections with 1st Avenue North and 1st Avenue South. These additional intersections would need to be raised approximately 3-5 feet to tie into the new 28th Street alignment. Adjusting the grades of 1st Avenue North and 1st Avenue South would affect business frontage and access for about 150 feet either side of 28th Street. Construction of retaining walls would be necessary to maintain these commercial structures. Access to the parking lot would need to be reconstructed to maintain the existing use of the lot.

Community Input
During the public involvement process, City staff and community members did not have strong opinions on a grade separation at this location. Community input was chiefly targeted to the 27th Street rail grade crossing and respondents felt a grade separation at 28th Street was a much lower priority.

Recommendation
The physical constraints presented by the intersecting cross streets make an overpass solution at the Montana Rail Link mainline and spur line and 28th Street infeasible. The underpass solution at this location is considered a feasible solution.

Another alternative often mentioned is complete relocation of the railway tracks. The potential relocation alignment most often mentioned is to re-route the railroad mainline tracks along I-90 rather than through the heart of the community.

29th Street Grade Crossing

Existing Geometry & Traffic
29th Street crosses a set of mainline tracks and a set of spur line tracks of Montana Rail Link at crossing ID 087 493G and railway milepost 000006. 29th Street is a four-lane collector with current traffic of 4,320 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad/highway at-grade intersection is approximately 150 feet south of the 29th Street / Montana Avenue intersection and 180 feet north of the 29th Street / Minnesota Avenue intersection. There is an approximate 2 feet elevation difference between the railroad grade crossing and the Montana Avenue and Minnesota Avenue intersections. Montana Avenue is a principal arterial through Billings carrying 18,883 vehicles per day. Minnesota Avenue is a collector street carrying 4,100 vehicles per day. No on-street parking is allowed along 29th Street between Montana Avenue and Minnesota Avenue. On-street parking is allowed on 29th Street north of Montana Avenue and south of Minnesota, and along Montana Avenue and Minnesota Avenue. There are structures located on three corners of the 29th Street / Montana Avenue intersection with a parking area on the fourth corner.

Grade Separation Alternatives
Grade separation of the rail crossing would require significant modification of the Montana Avenue and Minnesota Avenue elevations to match the new 29th Street grades or grade- separation of Montana and Minnesota Avenues from 29th Street.

An underpass at this location would lower the elevation of 29th Street at Montana Avenue and Minnesota Avenue by approximately 12-15 feet. Underpass touchdown points would extend north and south from the rail crossing approximately 500 feet and only impact the Montana Avenue and Minnesota Avenue intersections. These touchdown points would be prior to the next major street intersections of 1st Avenue North and 1st Avenue South.

Modifications to the elevations of Montana and Minnesota Avenues would extend about 280 feet in both directions from 29th Street and would impact business frontage and access over this distance.

The elevation of 29th Street at the Montana Avenue and at the Minnesota Avenue intersections would be raised by approximately 28 feet with an overpass solution. Through traffic could be maintained on Montana Avenue and Minnesota Avenue by constructing an underpass through the new 29th Street alignment, although access from Montana and Minnesota Avenues to 29th Street would be lost. Touchdown points for the new 29th Street overpass grade would extend north and south from the crossing approximately 675 feet and impact two additional roadway intersections, 1st Avenue North and 1st Avenue South. These additional intersections would need to be raised approximately 3-5 feet to tie into the new 29th Street alignment. Adjusting the grades of 1st Avenue North and 1st Avenue South would affect business frontage and access for 150 feet either side of 29th Street.

Community Input

During the public involvement process, City staff and community members did not have strong opinions on a grade separation at this location. Community input was chiefly targeted to the 27th Street rail grade crossing and respondents felt a grade separation at 29th Street was a much lower priority.

Recommendation

The physical constraints presented by the intersecting cross streets make an overpass solution at the Montana Rail Link mainline and spur line and 29th Street infeasible. The underpass solution at this location is considered the a solution.

Another alternative often mentioned is complete relocation of the railway tracks. The potential relocation alignment most often mentioned is to re-route the railroad mainline tracks along I-90 rather than through the heart of the community.

Moore Lane Grade Crossing

Existing Geometry & Traffic

Moore Lane crosses the mainline tracks of Montana Rail Link at crossing ID 087 383W and railway milepost 000219. Moore Lane is a three-lane collector with current traffic of 14,440 vehicles per day. The crossing occurs at a 70° angle to the tracks. The railroad grade crossing is approximately 250 feet north of the Moore Lane / Laurel Road intersection and 200 feet south of the Moore Lane / Monad Road intersection. Moore Lane south of the Laurel Road intersection is a dead end roadway serving commercial and industrial properties, although future extensions of this roadway are planned. The railroad crossing is about 5 feet higher than both the Laurel Road and Monad Road intersections. Laurel Road is a four lane principal arterial carrying 11,639 vehicles per day. Monad Road is a collector carrying 6,879 vehicles per day. No on-street parking is allowed along Laurel Road. On-street parking is allowed along Moore Lane north of

Monad Road. There is a structure located on the northwest corner of the Moore Lane / Monad Road intersection with a commercial storage lot and structure on the northeast corner. Railroad right-of-way abuts Monad Road.

Grade Separation Alternatives

Grade separation of the railroad grade crossing would require modification of the Laurel Road and Monad Road elevations to match the new Moore Lane vertical alignment and maintain intersection access.

An underpass at this location would lower the elevation of Moore Lane at Laurel Road by about 14 feet. The elevation at the Monad Road intersection would be lowered approximately 10 to 12 feet. Underpass touchdown points would extend north from the rail crossing approximately 350 feet along Moore Lane and south from the crossing approximately 550 feet. The additional length south of the crossings is required to accommodate a level Laurel Road Intersection. Touch down points for the Laurel Road vertical alignment (Non-NHS Principal Arterial, 40 mph design speed, 6% maximum approach grade) would extend approximately 750 feet each side of the Moore Lane intersection. Access revisions for existing businesses would need to be made for commercial properties south of Laurel Road either side of the intersection. Retaining walls would be required on both sides of Laurel road for approximately 450 each side of the intersection.

The elevation of the Moore Lane at Laurel Road and Monad Road would be raised by approximately 26 feet for an overpass solution. An elevated Moore Lane would eliminate access to approximately 5 businesses north of the railroad crossing. Monad Road would also need to be raised to match the new Moore Lane alignment, causing the loss of access to the businesses along Monad Road for a distance of 380 feet west of Moore Lane. New access roads to Moore Lane would need to be constructed through the existing commercial and industrial properties south Laurel Road.

Community Input

During the public involvement process, City staff and community members expressed doubts that a grade separation could be accomplished at this location, but expressed strong feelings that safety improvements of some sort were needed.

Recommendation

The physical constraints of the existing Laurel Road and Monad Road intersections make an overpass grade separated solution of the Montana Rail Link mainline at Moore Lane infeasible at its existing location. An underpass at this location is considered feasible and would provide attractive connectivity with a planned future southward extension of Moore Lane.

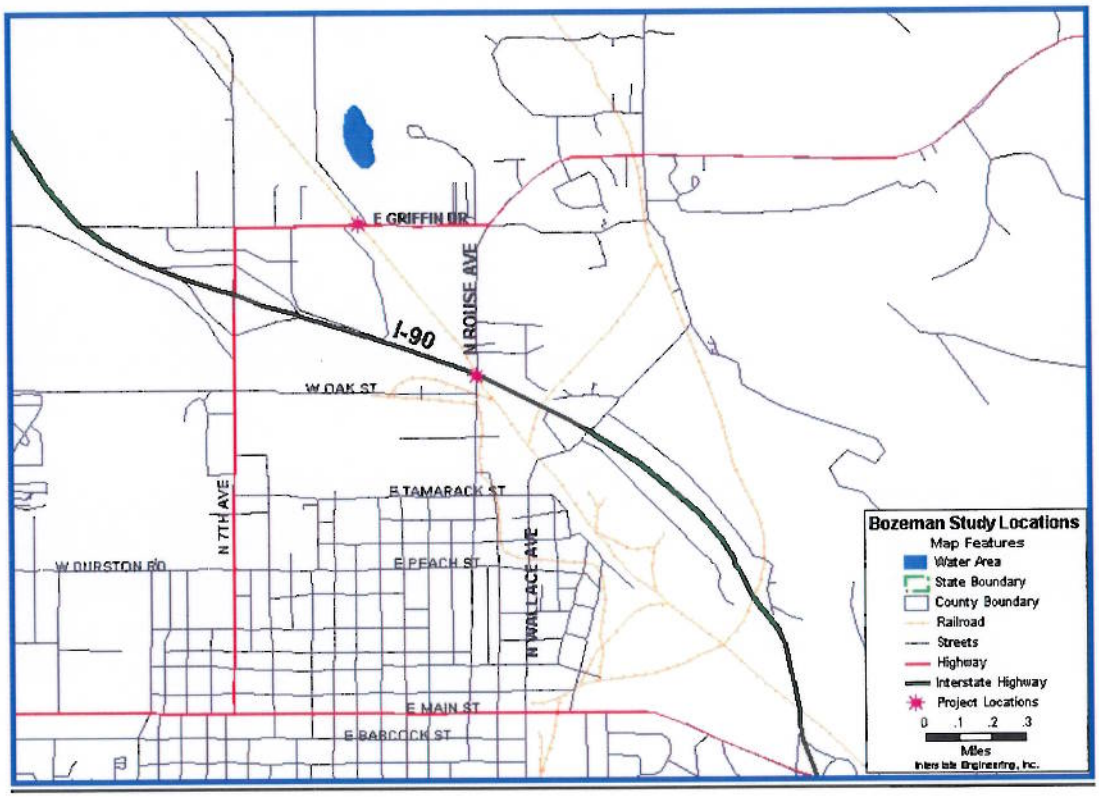
Alternatives for grade-separated crossings in this vicinity are limited by the proximity of the railway tracks to Laurel Road. The existing at-grade crossing on Moore Lane has attracted development to the area along with increased traffic demands. An existing overpass/underpass combination exists a short distance to the east (Central Avenue

Underpass), and an overpass also exists about an equal distance to the west (King Avenue). An alternative mentioned by some members of the public is to construct an underpass further west on an alignment with Plainview/Monad Road, or even further west (were there is greater separation between Laurel Road and the railway tracks) with a connection to Daniel Street. Another alternative often mentioned is complete relocation of the railway tracks. The potential relocation alignment most often mentioned is to re-route the railroad mainline tracks along I-90 rather than through the heart of the community.

COMMUNITY OF BOZEMAN

Two candidate locations are sited within the community of Bozeman. Candidate locations include Griffin Drive and Rouse Avenue. Bozeman railroad grade crossing locations are shown in Figure 3.

Figure 3 – Bozeman Grade Crossing Study Locations



Griffin Drive Grade Crossing

Existing Geometry & Traffic

Griffin Drive crosses the mainline tracks of Montana Rail Link at crossing ID 060 073Y and railway milepost 014138. Griffin Drive is a two-lane collector carrying 7,130 vehicles per day. The crossing occurs at an 80° angle to the tracks. The highway grade crossing is located approximately 200 feet east of the Griffin Drive / Evergreen Dr. intersection, and approximately 200 feet west of the Griffin Drive / Manley Rd. intersection. There is no significant elevation difference between the railroad grade crossing and the adjacent roadway intersections. There are no major structures with direct frontage onto Griffin Dr. within the proposed project limits. Existing structures are set back approximately 25-50 feet from the edge of the roadway.

Grade Separation Alternatives

Grade separation of the railroad crossing would require modification of the Evergreen Dr. and Manley Rd. vertical grades as well as Griffin Drive. An underpass through this

location would lower the elevation of the Evergreen Dr. and Manley Rd. intersections by approximately 14 feet. Underpass touchdown points would extend east and west from the rail crossing approximately 450 feet and would impact the vertical alignment of Evergreen Dr. and Manley Rd. for a distance of 180 feet either side of Griffin Drive. Modifications would need to be made to existing driveways to maintain access to Griffin Drive or either of the side streets.

An overpass solution would raise the Evergreen Dr. and Manley Rd. intersections by approximately 20 feet. Overpass touchdown points for the new Griffin Drive alignment would extend east and west from the crossing approximately 575 feet and would impact the elevation of Evergreen Dr. and Manley Rd. for a distance of 300 feet either side of Griffin Drive. Modifications would need to be made to existing driveways to maintain access to Griffin Drive or either of the side streets.

Community Input

Comments were received from emergency response staff indicating concerns for delays caused trains blocking the tracks within this area. Bozeman's training facility for fire crews is within this area. Emergency vehicles have been delayed at this crossing responding to calls that have occurred during training operations.

Recommendation

Both underpass and overpass solutions are considered feasible at this location.

Rouse Avenue Grade Crossing

Existing Geometry & Traffic

Rouse Avenue crosses the mainline tracks of Montana Rail Link at crossing ID 060 055B and railway milepost 014085. Rouse Avenue is a two-lane collector street carrying 9,300 vehicles per day. The crossing occurs at a 60° angle to the tracks directly beneath an I-90 overpass structure. The railroad / highway grade crossing is approximately 600 feet north of the Rouse Avenue / Oak Street intersection and 600 feet south of the Rouse Avenue / Bond Street intersection. There is no significant elevation difference between the railroad crossing and either the Rouse Avenue / Oak Street intersection or the Rouse Avenue / Bond Street intersection. Oak Street is a collector street carrying approximately 10,740 vehicles per day. Bond Street is an access roadway serving several businesses and residential homes. There are no major structures with direct frontage onto Rouse Avenue within approximately three blocks of the railroad crossing. Existing structures are set back approximately 25 feet from the edge of the roadway.

Grade Separation Alternatives

The existing I-90 overpass at this location makes the potential for an overpass solution infeasible since it would entail complete relocation of I-90. An underpass solution at this at-grade intersection would require excavation very close to structural supports for the I-

90 overpass, potentially exposing the structural support and requiring their replacement or modification. Underpass touchdown points would extend north and south from the rail crossing approximately 600 feet and would impact the elevation of Oak Street by approximately 10 feet and Bond Street by approximately 3 feet at their intersections with Rouse Avenue. Modification to existing accesses into commercial businesses on both sides of the crossing would also be required.

Community Input

While comments received recognized the need to eliminate delays to emergency service vehicles/personnel at this location, it was recognized that a grade-separated crossing at the current rail crossing location would be very difficult due to the I-90 overpass and a high ground water table.

Recommendation

The physical constraints of the I-90 overpass make a grade separation solution at the Montana Rail Link mainline and Rouse Avenue infeasible at its existing location.

As an alternative to the existing location, a new alignment for Rouse Avenue to the east or west of its existing alignment may present more feasible solutions. By moving Rouse Avenue further east or west, it becomes possible to cross under the railroad and I-90 with separate structures. It may also be feasible to improve the Wallace Street/L Street route with a grade separation to provide alternate access to the Bridger Canyon area of Bozeman.

COMMUNITY OF COLUMBUS

One candidate location is sited within the community of Columbus. The candidate location is the Pratton Street rail grade crossing, which is shown in Figure 4.

Figure 4 – Columbus Grade Crossing Study Location

Pratton Street Grade Crossing

Existing Geometry & Traffic

Pratton Street crosses a set of mainline tracks and a set of spur line tracks of Montana Rail Link at crossing ID 059 909U and railway milepost 004017. Pratton Street is a two-lane minor arterial carrying 4,760 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad/highway grade crossing is approximately 175 feet south of the Pratton Street intersection with E. Pike Ave. and 100 feet north of the Pratton Street / Clough Ave. S. intersection. There is approximately 4 feet of elevation difference between the grade crossing and the Pratton Street / E. Pike Ave. intersection and approximately 2 feet on elevation difference between the Pratton Street / Clough Ave. S. intersection and the grade crossing. E. Pike Ave. is a major collector through Columbus carrying approximately 5,250 vehicles per day. E. Pike Ave. provides frontage and access for the majority of businesses located in downtown Columbus, with on-street parking provided.

Grade Separation Alternatives

Grade separation of the at-grade crossing would require elimination of through traffic on E. Pike Ave. and Clough Ave. S. or modification of the E. Pike Ave. and Clough Ave. S. vertical grades. An underpass at this location would require lowering the elevation of the Pratton Street / E. Pike Ave. intersection by about 16 feet and would lower the elevation of the Pratton Street / Clough Ave. S. intersection by approximately 20 feet.

An overpass solution at this location would require raising the elevation of the Pratton Street / E. Pike Ave. intersection by about 28 feet and raising the elevation of the Pratton Street / Clough Ave. S. intersection by approximately 28 feet. The resulting change in grade for Pratton Street and E. Pike Ave. would eliminate storefront access to the street as well as existing on street parking for a distance of 550 feet for an underpass alternative and for 650 feet for an overpass alternative. The proposed solutions would cause the loss or relocation of a significant percentage of downtown businesses within Columbus.

Community Input

Community comments were received in opposition of a grade-separated crossing at this location. Loss of business within this small community was a major concern. Alternate crossings location to the east of the existing crossing where discussed.

Recommendation

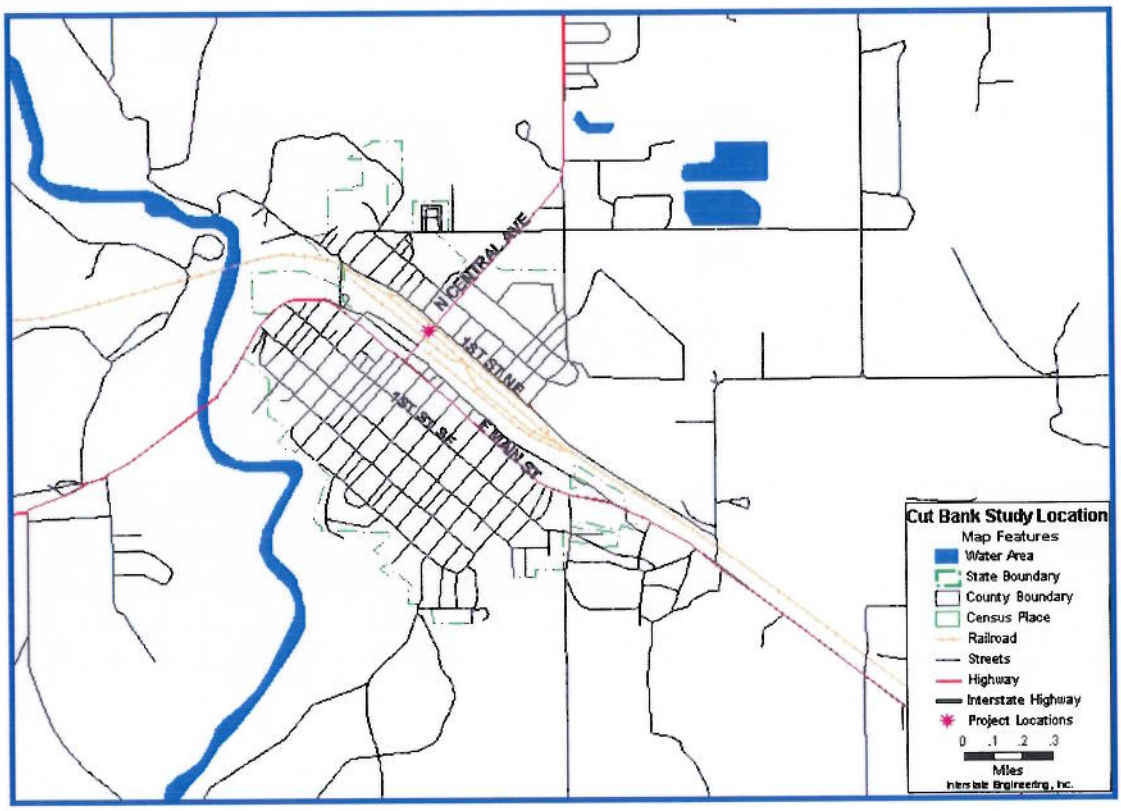
The physical constraints presented by the close proximity of the E. Pike Ave. and Clough Ave. S. intersections, coupled with significant businesses impacts make the construction of a grade separated solution at the Montana Rail Link mainline and Pratton Street infeasible at its existing location.

As an alternative, a grade-separation at 9th Street should be investigated. This alternative would keep the physical impacts of a grade separation out of the downtown central business district, but would also direct the main flow of traffic away from the same area. As an alternative to grade separating this location, traffic signal control of the Pike Avenue/Pratton Street intersection was also mentioned as a method of preventing traffic queues from being caught on the northbound Pratton Street approach when rail traffic approaches. Proper traffic signal operations would allow this queue to clear before trains arrive by stopping traffic on Pike Avenue.

COMMUNITY OF CUT BANK

One candidate location is sited within the community of Cut Bank. The candidate location is the N. Central Avenue rail grade crossing, which is shown in Figure 5.

Figure 5 – Cut Bank Grade Crossing Study Location



N. Central Avenue Grade Crossing

Existing Geometry & Traffic

N. Central Avenue crosses one mainline, one switching track and one spur track of the Burlington Northern Santa Fe Railway at crossing ID 088 081X and railway milepost 109001. N. Central Avenue is a two-lane collector carrying 8,140 vehicles per day. The crossing occurs at a 90° angle to the tracks. The nearest track is approximately 200 feet south of the N. Central Avenue intersection with 1st St. NE and 400 feet north of the N. Central Avenue intersection with Railroad Street. There is no significant elevation difference between the railroad crossing and the N. Central Avenue / 1st St. NE intersection or the N. Central Avenue / Railroad Street intersection. 1st St. NE is a collector street carrying approximately 3,930 vehicles per day. Railroad Street is also a collector street and carries about 2,830 vehicles per day. Approximately 200 feet south of the mainline railroad crossing is a spur line that provides delivery of goods to an agricultural business and an elevator located between the tracks. Access to this business is restricted to N. Central Avenue.

Grade Separation Alternatives

Grade separation of the railroad crossing would require an underpass or overpass to extend over both the mainline tracks and the active spur line track. A grade separation solution would require the elimination of through traffic on both 1st St. NE and Railroad Street, or would require significant modification of the 1st St. NE and Railroad Street vertical alignments.

An underpass at this location would lower the elevation of the N. Central Avenue / 1st St. NE intersection by approximately 14 feet and the elevation of the N. Central Avenue / Railroad Street intersection by approximately 2 feet. An overpass solution at this location would raise the elevation of the N. Central Avenue / 1st St. NE by approximately 12 feet and the elevation of the N. Central Avenue / Railroad Street intersection by approximately 2 feet. The resulting change in grade would eliminate access to an operating elevator / agriculture business and two other commercial businesses which front both the spur line and N. Central Avenue. Access to the elevator / agriculture business could only be maintained by creating an additional at-grade crossing. The proposed solutions would cause the loss a significant percentage of businesses for the community of Cut Bank.

Community Input

During the public involvement process, City staff and community members expressed opposition to a grade separated crossing at this location. Community leaders emphasized the need for a railroad grade separation within the community and noted an alternate location had already been selected. Design activities have already been initiated for the alternate location.

Recommendation

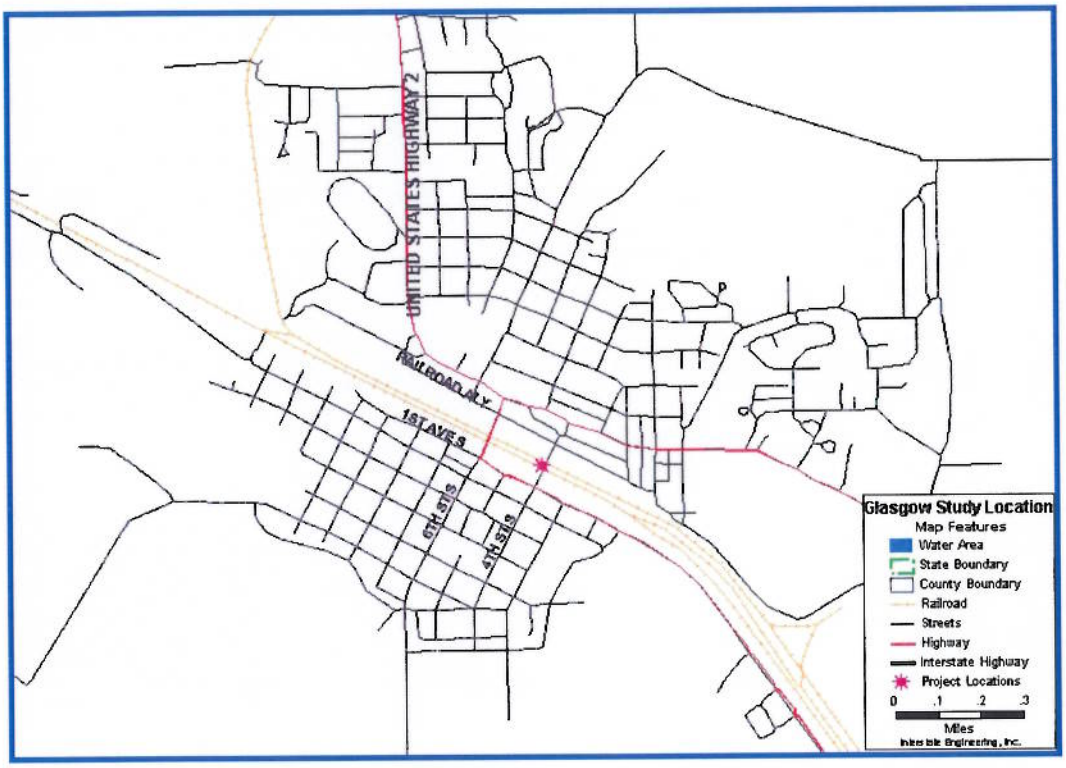
The physical constraints of the spur line and associated businesses impacts make the construction of a grade separation solution at the Burlington Northern Santa Fe Railway and N. Central Avenue infeasible at its existing location.

A feasible grade separation is currently being pursued by the community at a location further west, where the physical topography is more conducive to an overpass grade separation and where the physical impacts of a grade separation will be more easily tolerated.

COMMUNITY OF GLASGOW

One candidate location is sited within the community of Glasgow. The candidate location is the 4th Street rail grade crossing, which is shown in Figure 6.

Figure 6 – Glasgow Grade Crossing Study Location



4th Street Grade Crossing

Existing Geometry & Traffic

4th Street crosses three sets of mainline tracks of Burlington Northern & Santa Fe Railroad at crossing ID 059 544P and railway milepost 027743. 4th Street is a two-lane collector street with current traffic of 4,930 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad / highway grade crossing is approximately 600 feet south of the 4th Street intersection with State Highway 2 (1st Avenue N.), and is about 200 feet north of the 1st Ave. S intersection with 4th Street. There is no significant elevation difference between the railroad crossing and the 4th Street / Highway 2 intersection or the 4th Street / 1st Ave. S. intersection. Highway 2 is NHS route through Glasgow and carries 5800 vehicles per day near its intersection with 4th Street. 1st Ave. S. is a collector street carrying approximately 4,250 vehicles per day.

Grade Separation Alternatives

Grade separation of the railroad crossing would require elimination of through traffic on 1st Ave. S. or modification of the 1st Ave. S. vertical alignment. An underpass at this location would lower the elevation of the 4th Street / 1st Ave. S. by approximately 14 feet, affecting the vertical alignment of 1st Ave. S. for a distance of 250 feet either side of 4th Street.

An overpass solution at this location would raise the elevation of the 4th Street / 1st Ave. S. intersection by approximately 22 feet. The resulting change in grade for 1st Ave. S. would eliminate storefront access to the street as well as existing on street parking for a distance of 250 feet either side of 4th Street. Both overpass and underpass alternatives would impact a significant percentage of downtown businesses within Glasgow.

Community Input

Comments from the public involvement meeting indicated the existing crossing at 6th Street should be improved prior to constructing a second crossing in the community.

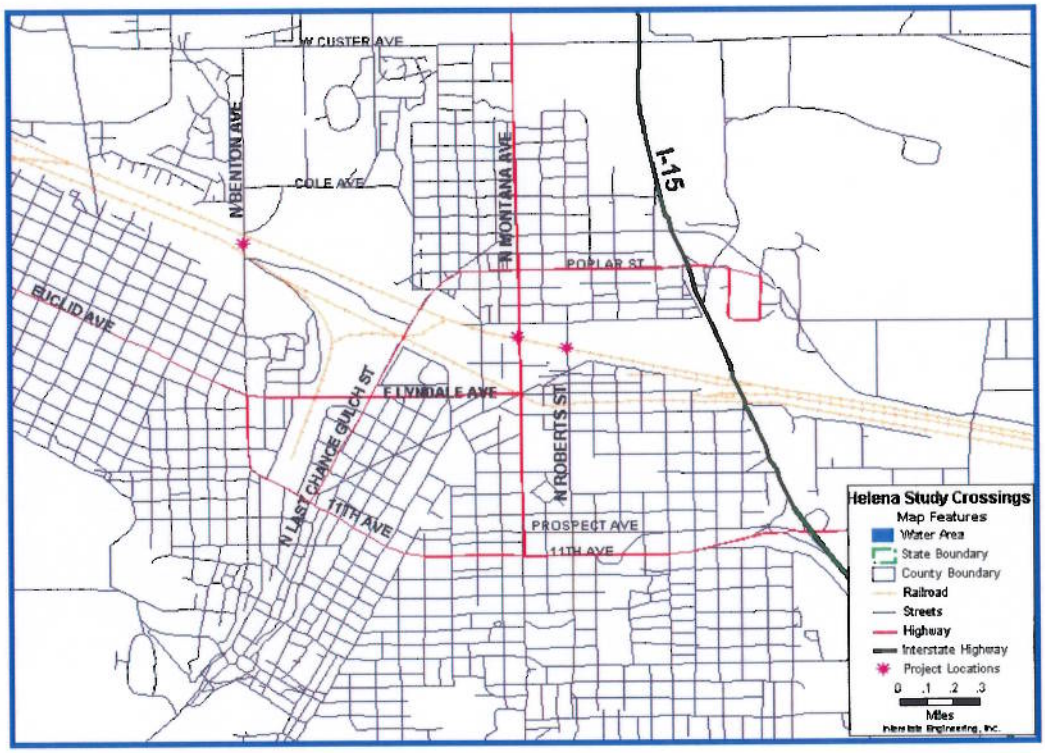
Recommendation

The physical proximity of the existing 1st Ave. S. intersection, coupled with businesses and property impacts make the construction of a grade separation solution at the Burlington Northern Santa Fe Railway mainline and 4th Street infeasible. Reconstruction / modification of the 6th Street underpass (two blocks to the west) to current standards should be considered and is supported by the community.

COMMUNITY OF HELENA

Three candidate locations are sited within the community of Helena. Candidate locations include Benton Avenue, Montana Avenue and Roberts Street. Helena railroad grade crossing locations are shown in Figure 7.

Figure 7 – Helena Grade Crossing Study Locations



Benton Avenue Grade Crossing

Existing Geometry & Traffic

Benton Avenue crosses two sets of mainline tracks and a set of spur line tracks of the Montana Rail Link at crossing ID 060 199F and railway milepost 000127. Benton Avenue is a two-lane minor arterial carrying 8,830 vehicles per day. The crossing occurs at about an 80° angle to the tracks. The railroad / highway grade crossing is located approximately 500 feet north of the Benton Avenue / Oakwood Lane intersection and about 120 feet north of driveway access to a significant recreational complex (athletic fields). The rail crossing is about 6 feet higher than the Benton Avenue / Oakwood Lane intersection. Oakwood Lane is a local access roadway.

Grade Separation Alternatives

Grade separation of the at-grade intersection would require modification of the Oakwood Lane vertical alignment to meet the new underpass / overpass grade. An underpass through this location would lower the elevation of the Oakwood Lane intersection by

approximately 1 foot. Underpass touchdown points would extend approximately 500 feet to the north and 800 feet to the south from the mainline rail crossing and impact the Oakwood Lane intersection and the athletic complex driveway. The vertical alignment of Oakwood Lane would be affected only in the immediate vicinity of the Benton Ave. intersection. The vertical alignment of the athletic complex access would be lowered approximately 14 feet.

For an overpass alternative, the elevation of the Benton Ave. / Oakwood Lane intersection would be raised by approximately 3 feet. Overpass touchdown points for the new Benton Avenue alignment would extend approximately 600 feet to the south and 900 feet to the north from the mainline rail crossing and impact the Oakwood Lane intersection and the athletic complex driveway. The vertical alignment of Oakwood Lane would be affected only in the immediate vicinity of the Benton Ave. intersection. The vertical alignment of the field access would be raised approximately 20 feet. The driveway to the athletic field would also need to be modified for any grade-separated solution.

Community Input

During the public involvement process, City staff and public input generally favored a grade separation at this location but recognized the Montana Avenue location was a much higher priority. Community input was chiefly targeted to the Montana Avenue rail grade crossing.

Recommendation

The underpass and overpass solutions are both considered feasible at this location.

Montana Avenue Grade Crossing

Existing Geometry & Traffic

Montana Avenue crosses two mainline tracks and one spur track of the Montana Rail Link at crossing ID 060 193P and railway milepost 000030. Montana Avenue is a four-lane principal arterial street carrying 13,430 vehicles per day. The crossing occurs at a 85° angle to the tracks. The Montana Avenue / Phoenix Ave intersection is approximately 300 feet south of the nearest tract and the Montana Avenue / Argyle Street intersection is approximately 250 feet north of the nearest track. The railroad crossing is approximately 6 feet higher than the intersection of Montana Avenue / Phoenix Ave., and about 6 feet lower than the Montana Avenue / Argyle Street intersection. Phoenix Ave. is a local access roadway. There are numerous commercial driveways onto Montana Avenue through the project limits. The existing commercial structures are set back from the edge of the roadway by approximately 50 feet.

Grade Separation Alternatives

Grade separation of the at-grade intersection would require modification of the Phoenix Ave., Argyle Street, Bozeman Street and Walnut Street vertical alignments to meet the

new underpass / overpass grade on Montana Avenue (and maintain intersection access). Underpass touchdown points would extend approximately 750 feet to the north and 600 feet to the south from the rail crossing. An underpass through this location would require lowering the elevation of the Phoenix Ave. intersection by approximately 10 feet, Argyle Street intersection by approximately 10 feet, and the Bozeman Street intersection by approximately 5 feet to maintain access to the intersecting streets.

Touchdown points for a Montana Avenue overpass alternative would extend approximately 1050 feet to the north and 850 feet to the south from the rail crossing. An overpass solution alternative would raise the Phoenix Ave. intersection by approximately 23 feet, Argyle Street intersection by approximately 24 feet, Bozeman Street intersection by approximately 18 feet, and the Walnut Street intersection by approximately 5 feet to maintain intersection access. No additional roadway intersections would be impacted. Modification of all driveways within the affected area would be required for any grade separation solution

Commercial driveway access could be maintained through the design of frontage roads adjacent to Montana Avenue. Access to these commercial properties from intersecting side streets would be difficult to maintain.

Community Input

Community input was focused on the Montana Avenue grade crossing. Due to the recent completion of a feasibility study of this location, community members were well educated on grade separation issues and comments were instead focused on how to obtain funding to make a grade separation at Montana Avenue a reality. Local jurisdiction staff and the general public were very much in favor of a grade separation at this location.

Recommendation

For the purposes of this study, both underpass and overpass solutions are considered feasible at this location. Grade separation alternatives at this location have been examined in some detail through a city-sponsored study by WGM Group, Inc. That study concluded that an underpass solution was preferred.

Roberts Street Grade Crossing

Existing Geometry & Traffic

Roberts Street crosses 3 sets of mainline tracks of Montana Rail Link at crossing ID 060 192H and railway milepost 000004. Roberts Street is a two-lane minor arterial with current traffic of 3,230 vehicles per day. The crossing occurs at close to a 90° angle to the tracks. The railroad / highway grade crossing is approximately 550 feet south of the Roberts Street / Phoenix Ave. intersection and approximately 400 feet north of the Roberts Street / Helena Ave. intersection. There is approximately 6 feet of elevation difference between the railroad crossing and the Roberts Street / Phoenix Ave. intersection, and approximately 6 feet of elevation difference between the railroad crossing and the Roberts Street / Helena Ave. intersection. There are no major structures

with direct frontage onto Roberts Street within approximately three blocks of the at-grade intersection. Existing structures are set back approximately 25-50 feet from the edge of the roadway.

Grade Separation Alternatives

Grade separation of the railroad crossing would require modification of the Phoenix Ave., Helena Ave. and Gallatin Ave. vertical grades to meet the new underpass / overpass grade. Underpass touchdown points would extend approximately 350 feet to the north and 400 feet to the south from the rail crossing and impact the Helena Ave. intersection and Gallatin Ave. intersections. An underpass through this location would lower the elevation of the Helena Ave. intersection by approximately 1 foot.

Touchdown points for an overpass solution alternative would extend approximately 600 feet to the north and 500 feet to the south from the rail crossing. An overpass solution would require raising the Phoenix Ave. intersection by approximately 1 foot, the Helena Ave. intersection by approximately 4 feet, and the Gallatin Ave. intersection by approximately 2 feet. No additional roadway intersections would be impacted.

Community Input

During the public involvement process, City staff and community members did not have strong opinions on a grade separation at this location. Community input was chiefly targeted to the Montana Avenue rail grade crossing and respondents felt a grade separation at Roberts Street was a much lower priority. Many suggested this location could be closed if a grade separation was constructed for Montana Avenue.

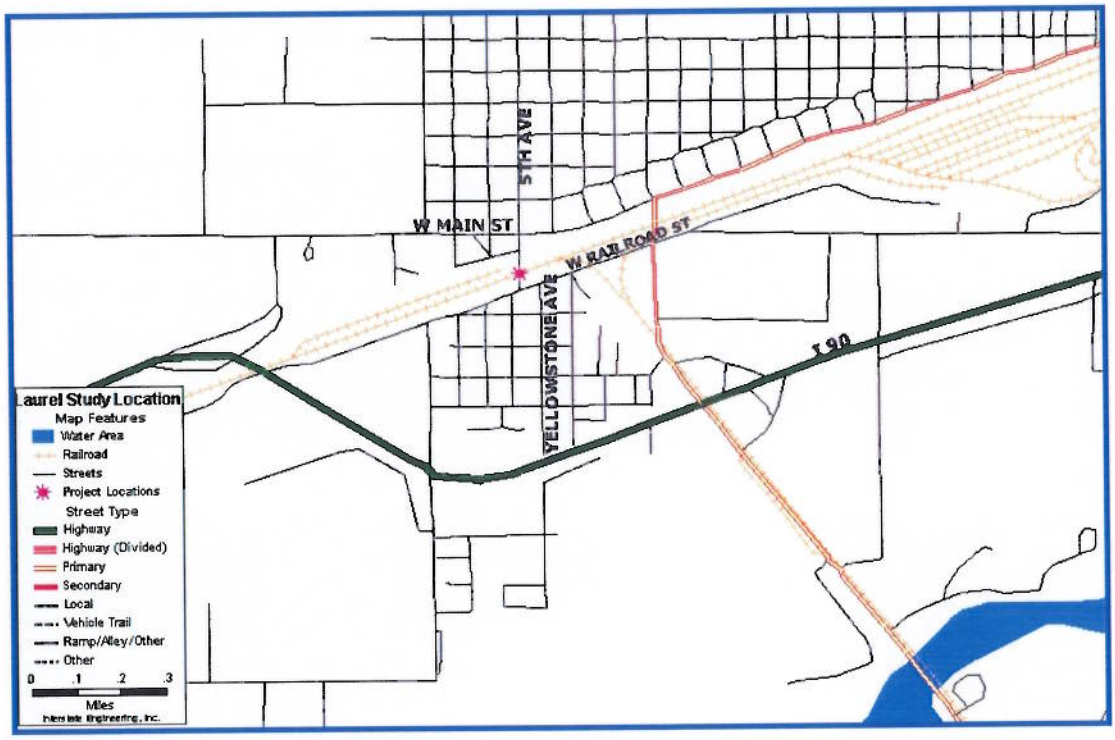
Recommendation

Both underpass and overpass solutions are considered feasible at this location.

COMMUNITY OF LAUREL

One candidate location is sited within the community of Laurel. The candidate location is the 5th Avenue rail grade crossing, which is shown in Figure 8.

Figure 8 – Laurel Grade Crossing Study Location



5th Avenue Grade Crossing

Existing Geometry & Traffic

5th Avenue crosses 3 sets of tracks of Montana Rail Link at crossing ID 104 007M and railway milepost 001547. 5th Avenue is a two-lane minor arterial carrying 4,760 vehicles per day. The crossing occurs at approximate an 80° angle to the tracks. The railroad / highway grade crossing is approximately 600 feet south of the 5th Avenue intersection with W. Main Street and 400 feet north of the "T" intersection of 5th Street with W Railroad Street. The railroad crossing is about 4 feet higher than the W. Main Street and W. Railroad Street intersections. W. Main Street is a major collector through Laurel carrying approximately 5,910 vehicles per day. The impacted area along 5th Avenue and along W. Railroad Street contains a large volume oil / asphalt distribution company. Access to this local business is from both W. Railroad Street and 5th Avenue.

Grade Separation Alternatives

No adjustments would be required on W. Main Street for either grade separation alternative. An underpass at this location would lower the elevation of the 5th Avenue / W. Railroad Street intersection by approximately 2 feet. The "T" intersection of 5th

Avenue and W. Railroad Street would require modification of the W. Railroad Street vertical alignment for approximately 75 feet each side of the 5th Street.

An overpass solution at this location would raise the elevation of the 5th Avenue / W. Railroad Street intersection by approximately 15 feet. The resulting change in grade for W. Railroad Street would impact the street for about 400 feet either side of the 5th Street intersection, eliminating the existing access to the street oil / asphalt distribution company. A proposed overpass solution could cause the loss / relocation of the oil / asphalt distribution company, a significant business within community of Laurel.

Community Input

During the public involvement process, City staff and community members expressed support for a crossing at this location. Support centered not on convenience issues, but on issues of emergency vehicle access since this grade crossing represents one of only two accesses to the neighborhood and school south of the railroad. Emergency services personnel noted that train traffic frequently blocks both grade crossings simultaneously.

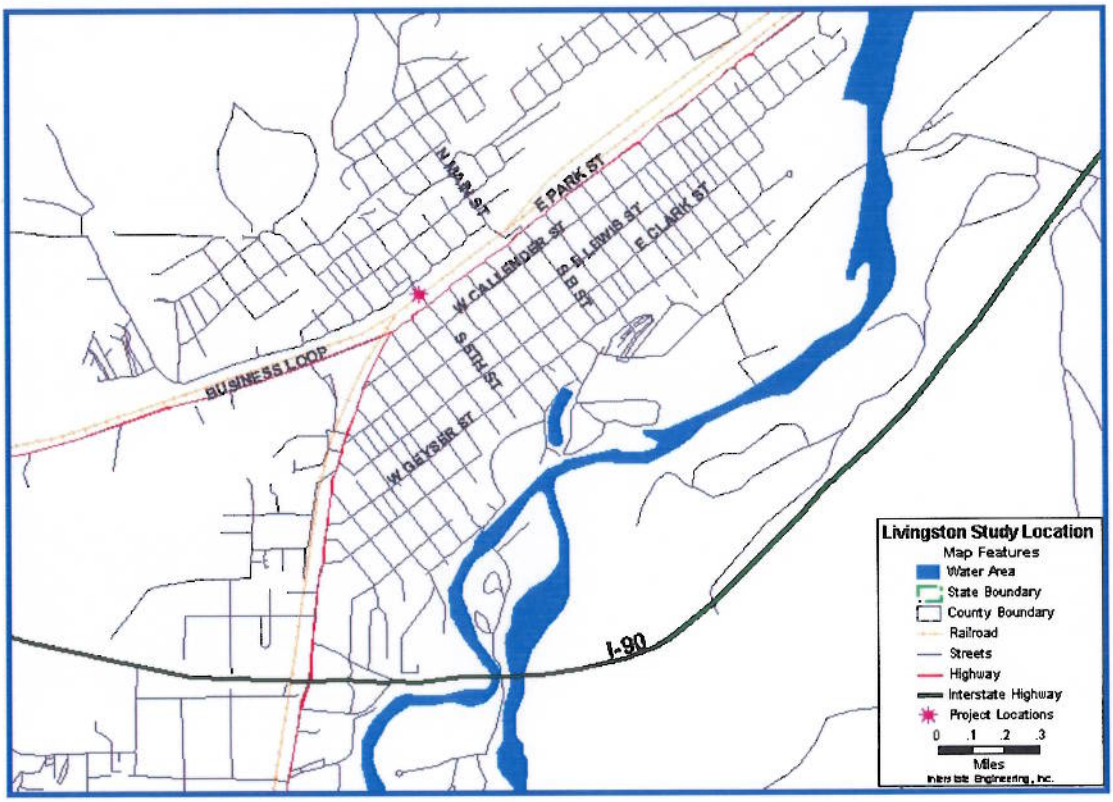
Recommendation

The physical constraints of existing 5th Avenue / W. Railroad Street intersection and business impacts make the construction of an overpass solution at the Montana Rail Link mainline and 5th Avenue infeasible at its existing location. An underpass solution was determined to be feasible.

COMMUNITY OF LIVINGSTON

One candidate location is sited within the community of Livingston. The candidate location is the 5th Street rail grade crossing, which is shown in Figure 9.

Figure 9 – Livingston Grade Crossing Study Location



5th Street Grade Crossing

Existing Geometry & Traffic

5th Street crosses two sets of mainline tracks and a set of spur line tracks of Montana Rail Link at crossing ID 060 021G and railway milepost 011561. 5th Street is a two-lane collector carrying 5,810 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad / mainline crossing is 100 feet south of a spur line track, approximately 150 feet north of the 5th Street intersection with W. Park Street, and 300 feet south of the intersection of 5th Street with W. Front Street. There is no significant elevation difference between the railroad crossing and the W. Park Street and W. Front Street intersections. W. Park Street is a major collector through Livingston carrying approximately 13,520 vehicles per day. The impacted area along 5th Street and along W. Front Street contains residential homes and businesses. Access to business is from both Park Street and 5th Street.

Grade Separation Alternatives

Grade separation solutions would need to cross both the mainline tracks as well as the spur line track. An underpass at this location would lower the elevation of the 5th Street / W. Park Street intersection by approximately 18 feet. The vertical alignment of Park Street would be impacted for a distance of approximately 300 feet each side of the 5th Street intersection. The 5th Street and W. Front Street intersection would need to be lowered approximately 12 feet. The vertical alignment of W. Front Street would require adjustments for approximately 200 feet each side of the 5th Street intersection.

An overpass solution at this location would raise the elevation of the 5th Street / W. Park Street intersection by approximately 18 feet. Grades along W. Park Street would need modification for approximately 300 feet each side of 5th Street. Grades along Front Street would need to be raised by approximately 12 feet. The vertical alignment of Front Street would require adjustments for approximately 200 feet each side of the 5th Street intersection. The resulting change in grade for 5th Street would eliminate access to multiple homes and the food service business.

Community Input

During the public involvement process, City staff and community members expressed concern regarding a grade separated crossing at this location due to impacts to the neighborhoods and business community. Public comment expressed strong support for the need for a grade crossing in the west end of the community. City staff and community members expressed strong support for an alternate crossing identified in the City's long-range transportation plan east of 7th street.

Recommendation

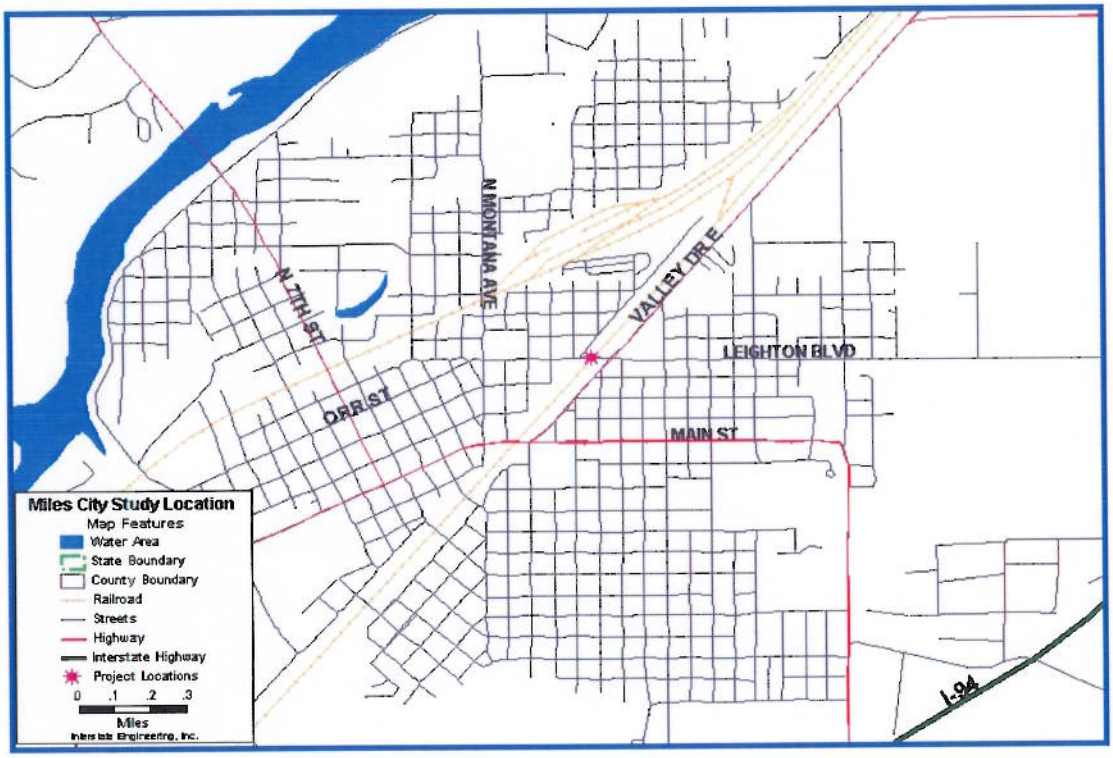
The physical proximity of the 5th Street / W. Park Street intersection, spur line separation from the main tracks, and community impacts make the construction of a grade separation solution at the Montana Rail Link mainline and 5th Street infeasible at its existing location.

As an alternative to construction of a grade separation at the 5th Street location, many people in the community expressed support for a grade-separated crossing further to the west. Most everyone commented that current and expected future growth will be concentrated in the northwest section of town, and the vicinities of 7th Street/Front Street and 14th Street/Front Street were suggested as viable locations for grade separations.

COMMUNITY OF MILES CITY

One candidate location is sited within the community of Miles City. The candidate location is the Leighton Boulevard rail grade crossing, which is shown in Figure 10.

Figure 10 – Miles City Grade Crossing Study Location



Leighton Boulevard Grade Crossing

Existing Geometry & Traffic

Leighton Blvd. crosses two sets of mainline tracks of Burlington Northern Santa Fe Railroad at crossing ID 092 664R and railway milepost 007777. Leighton Blvd. is a two-lane collector carrying about 7,400 vehicles per day. The crossing occurs at a 70° angle to the tracks. The railroad/highway grade crossing is approximately 200 feet west of the Leighton Blvd. intersection with Valley Dr. E. and 150 feet east of the intersection of Leighton Blvd. with Albert Dr. There is no significant elevation difference between the railroad crossing and the Valley Dr. E. and Albert Dr. Street intersections. Valley Dr. E. is a major collector street carrying approximately 6,020 vehicles per day. The impacted area along Leighton Blvd. and along Albert Dr. contains residential homes.

Grade Separation Alternatives

Grade separation solutions would need to cross the mainline tracks at this location. An underpass at this location would lower the elevation of the Leighton Blvd. / Valley Dr. E. intersection by approximately 15 feet. The vertical alignment of Valley Dr. E. would need to be modified for approximately 350 feet each side of the Leighton Blvd.

intersection. Modifying the vertical alignment of Valley Drive E. will require lowering the North Custer Avenue / Valley Drive E. intersection by approximately 5 feet. The vertical alignment of North Custer Avenue would need to be modified for approximately 100 feet from the intersection of Valley Drive E. The Leighton Blvd. / Albert Dr. intersection would need to be lowered approximately 19 feet. The vertical alignment of Albert Dr. would need to be modified for approximately 200 feet from the Leighton Blvd. intersection. The Leighton Blvd. / North Lake Avenue intersection will be lowered by approximately 10 feet. The vertical alignment along North Lake Avenue would need to be modified for approximately 150 from the intersection of Leighton Blvd. The Leighton Blvd. / North Jordan Avenue intersection would be lower approximately 3 feet. The vertical alignment along North Jordan Avenue would need to be modified for approximately 75 each side of Leighton Blvd.

An overpass solution at this location would raise the elevation of the Leighton Blvd. / Valley Drive E. intersection by approximately 22 feet. The vertical alignment of Valley Drive E. would need to be modified for approximately 500 feet each side of Leighton Blvd. Modifying the vertical alignment of Valley Drive E. will require raising the North Custer Avenue / Valley Drive E. intersection by approximately 10 feet. The vertical alignment of North Custer Avenue would need to be modified for approximately 200 feet. The Leighton Blvd / Albert Dr. intersection would be raised approximately 24 feet. The vertical alignment for Albert Dr. will need to be modified for approximately 300 feet from the Leighton Blvd. intersection. The Leighton Blvd. / North Cottage Grove intersection would be raised by approximately 1 foot. Minor modifications would need to be made to the North Cottage Grove alignment for approximately 50 feet. The Leighton Blvd. / North Lake Avenue intersection will be raised by approximately 18 feet. The vertical alignment along North Lake Avenue would need to be modified for approximately 300 from the intersection of Leighton Blvd. The Leighton Blvd. / North Jordan Avenue intersection would be raised approximately 8 feet. The vertical alignment of North Jordan Avenue would need to be modified for approximately 200 feet each side of Leighton Blvd.

The impacts to residential access near Albert Drive, North Lake Avenue and North Cottage Grove will require purchasing residential properties fronting Leighton Blvd. and the first 150 feet of each intersection roadway.

Community Input

During the public involvement process, City staff and community members expressed support for a grade separated crossing at this location. Supporters often cited the substandard clearance and the flooding frequency of the existing underpass. Miles City has proposed an alternative crossing location west of the existing Main Street underpass/overpass at S 4th Street. They also discussed the alternative of upgrading their existing Main Street underpass.

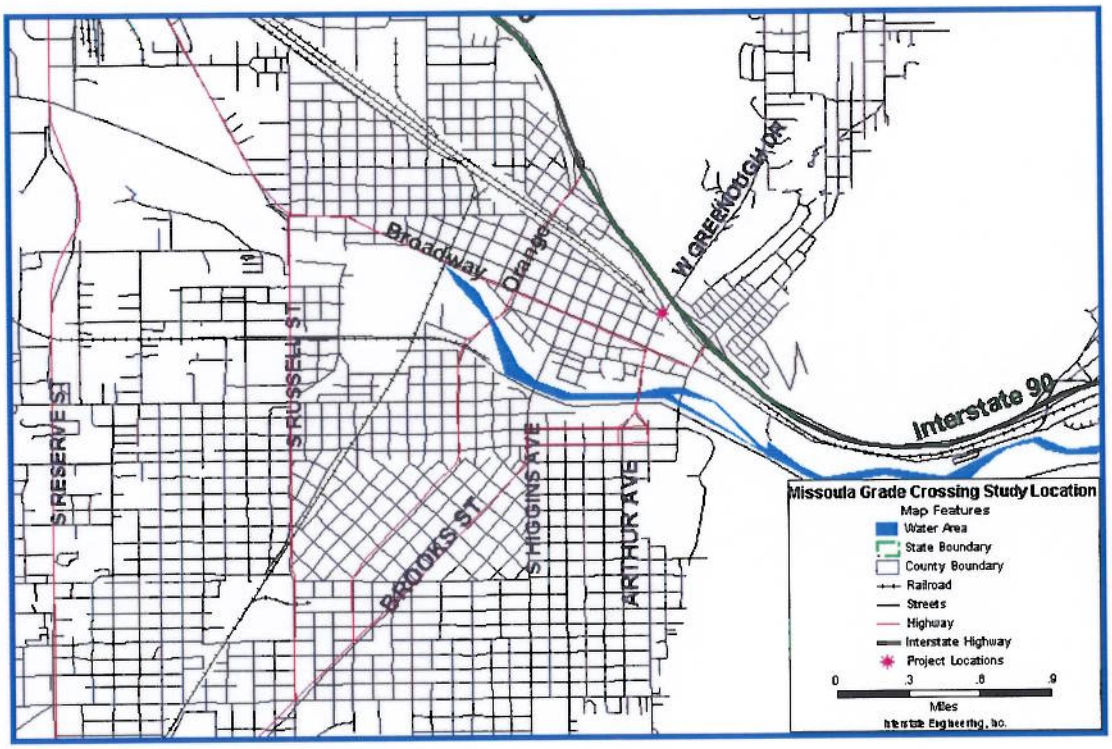
Recommendation

Both underpass and overpass solutions are considered feasible at this location.

COMMUNITY OF MISSOULA

One candidate location is sited within the community of Missoula. The candidate location is the Greenough Drive rail grade crossing, which is shown in Figure 11.

Figure 11 – Missoula Grade Crossing Study Location



Greenough Drive Grade Crossing

Existing Geometry & Traffic

Greenough Drive crosses the mainline tracks of Montana Rail Link at crossing ID 060 399P and railway milepost 011894. Greenough Drive is a two-lane collector carrying about 6,350 vehicles per day. The crossing occurs at a 60° angle to the tracks and is about 250 feet south of an I-90 overpass that spans Greenough Drive and Rattlesnake Creek. The railroad/highway grade crossing is approximately 150 feet north of the Greenough Drive/Madison Street intersection. There is no significant elevation difference between the at-grade intersection and the Greenough Drive/Madison Street intersection. Madison Street is collector street carrying approximately 4,138 vehicles per day. Numerous residential and several home/residential businesses have frontage onto Madison Street within the project limits. Existing structures have minimum set backs. Parking through the project area is limited almost entirely to on-street parking.

Grade Separation Alternatives

The existing I-90 overpass at this location makes the potential for an overpass solution infeasible. An underpass solution at this grade crossing would require excavation close

to the I-90 structure, potentially exposing and requiring modifications to the structural support for the I-90 overpass. An underpass solution would place the vertical grade of the new Greenough Drive close to or below the flow line elevation of Rattlesnake Creek. An underpass alternative would require lowering the elevation of the Madison Street intersection by approximately 15 feet, impacting Madison Street frontage and access for a distance of 200 feet. Underpass touchdown points would extend north and south from the rail crossing approximately 500 feet on Greenough Drive.

Community Input

During the public involvement process City staff and community members recognized the need for grade separated access to the Rattlesnake area, but expressed opposition to a grade separated crossing at this location. A no-build alternative was recommended at this location.

Recommendation

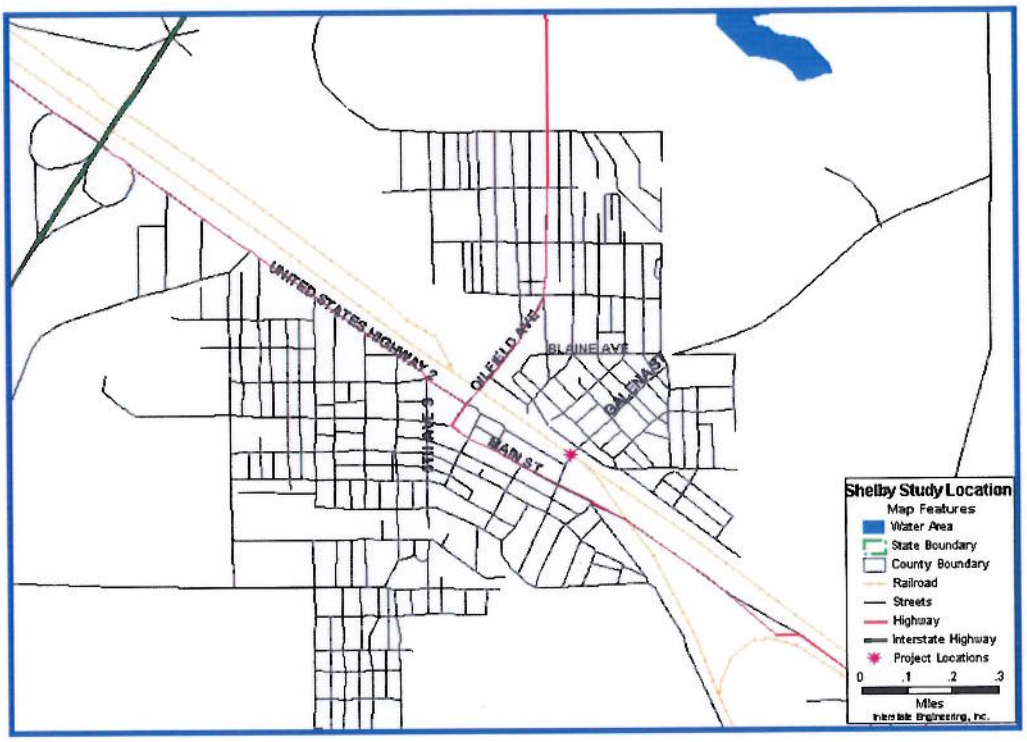
The physical constraints of the I-90 overpass and location of Rattlesnake Creek make a grade separation solution at the Montana Rail Link mainline and Greenough Drive infeasible at its existing location.

Public comment and staff input both supported some sort of improvement at this location. Most often noted was the fact that Greenough Drive is one of only two ways to access the Rattlesnake area, a rapidly growing residential area of the city. Due to topographic constraints, alternate crossing locations would not easily serve as access to the Rattlesnake area. Most often suggested were improvements at the existing location to improve street intersection geometry and crossing protection location.

COMMUNITY OF SHELBY

One candidate location is sited within the community of Shelby. The candidate location is the 2nd Avenue / Galena Street rail grade crossing, which is shown in Figure 12.

Figure 12 – Shelby Grade Crossing Study Location



2nd Avenue Grade Crossing

Existing Geometry & Traffic

2nd Avenue crosses a set of mainline tracks of Burlington Northern Santa Fe Railway at crossing ID 088 059K and railway milepost 106558. 2nd Avenue is a two-lane collector carrying 4,050 vehicles per day. The crossing occurs at a 90° angle to the tracks. The railroad / highway grade crossing is approximately 250 feet north of the 2nd Avenue / Highway 2 / Main Street intersection and 125 feet south of the 2nd Avenue / Central Ave. intersection. Highway 2 is a National Highway System Route carrying about 5,040 vehicles per day. The railroad crossing is approximately 6 feet lower than the 2nd Avenue / Highway 2 intersection and 3 feet higher than 2nd Ave / Galena Ave.

Grade Separation Alternatives

An underpass at this location would require lowering the elevation of the 2nd Avenue / Highway 2 intersection by approximately 14 feet. The vertical alignment of Highway 2 would need to be modified for approximately 450 feet each side of the 2nd Avenue intersection for an underpass solution. The 2nd Avenue / Central Ave. intersection would need to be lowered by about 18 feet to accommodate an underpass solution. The grade of

Central Ave. would require modification for approximately 450 feet each side of the 2nd Avenue intersection.

An overpass solution at this location would raise the elevation of the 2nd Avenue / Highway 2 intersection by approximately 8 feet. Grades along Highway 2 would need modification for approximately 250 each side of 2nd Avenue. The 2nd Avenue / Central Ave. intersection would be raised approximately 22 feet and require the modification of Central Ave. grades for approximately 600 feet each side of 2nd Avenue.

Under either alternative, impacted structures include a group of commercial businesses north of the 2nd Avenue / Central Ave. intersection and a gas station/convenience store at the 2nd Avenue / Highway 2 intersection.

Community Input

During the public involvement process, City staff and community members expressed concern regarding the business impact of a grade separation at this location. An alternative location further east (Highway 2 crossing) that would route traffic (especially truck traffic) around the downtown area was strongly supported by staff. Staff also noted that an existing overpass at Oilfield Ave approximately 1400 feet to the west is to be widened and improved in 2004, further reducing the need for a grade separation at Galena Street.

Recommendation

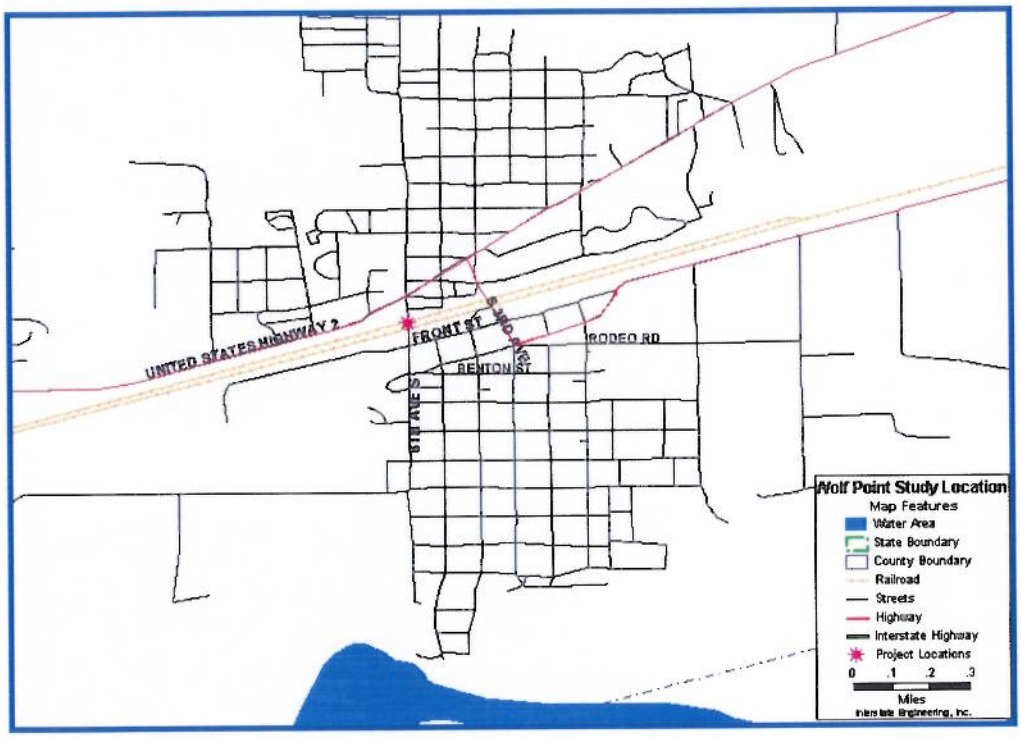
The physical constraints of the Highway 2 and Central Ave. intersections, impacts to businesses along Galena Street as well community opposition at this location make a grade separation solution at the Burlington Northern Santa Fe Railway mainline and 2nd Avenue infeasible.

As an alternative to grade-separating Galena Street, the community strongly supports a grade separation of Highway 2 further to the east. City staff noted that a Highway 2 grade separation would allow routing of truck traffic out of the downtown area and grade separate the only at-grade crossing of Highway 2 in the entire state. Topography in the area of the suggested grade separation is conducive to construction of an overpass grade separation.

COMMUNITY OF WOLF POINT

One candidate location is sited within the community of Wolf Point. The candidate location is the 6th Street rail grade crossing, which is shown in Figure 13.

Figure 13 – Wolf Point Grade Crossing Study Location



6th Street Grade Crossing

Existing Geometry & Traffic

6th Avenue crosses a mainline track and a spur line track of the Burlington Northern Santa Fe Railway at crossing ID 059 580K and railway milepost 022801. 6th Avenue is a two-lane collector street carrying about 4,050 vehicles per day. The crossing occurs at about a 90° angle to the tracks. The railroad / highway grade crossing is approximately 450 feet south of the 6th Avenue / Highway 2 intersection and 225 feet north of the 6th Avenue / Front Street intersection. The 6th Avenue / Front Street intersection is approximately 3 feet lower than the railroad grade crossing. The 6th Avenue/ Highway 2 intersection is approximately 5 higher than the railroad grade crossing. Highway 2 is a National Highway System route carrying about 5,040 vehicles per day.

Grade Separation Alternatives

An underpass at this location would require lowering the elevation of the 6th Avenue / Highway 2 intersection by approximately 1 foot. The Highway 2 grade would need to be modified for approximately 100 feet each side of the 6th Avenue intersection. Impacted structures would include a gas station / convenience store at the 6th Avenue / Highway 2

intersection. The 6th Avenue / Front Street intersection would need to be lowered approximately 11 feet with an underpass alternative. Front Street would require modification for approximately 250 feet each side of the 6th Avenue intersection to accommodate the vertical grade adjustment.

An overpass solution at this location would raise the elevation of the 6th Avenue / Highway 2 intersection by approximately 2 feet. Grades along Highway 2 would need to be modification for approximately 75 feet each side of 6th Street to accommodate this elevation change. The 6th Avenue / Front Street intersection would be raised approximately 20 feet and require the modification of Front Street vertical alignment for approximately 450 feet each side of 6th Avenue.

Under either alternative, the local high school on Front Street and a gas station / convenience store at the 6th Avenue / Highway 2 intersection would be impacted.

Community Input

During the public involvement process, City staff and community members expressed no strong opinions regarding a grade-separated crossing at this location. Public comments suggested improving the existing underpass at 3rd Avenue or improving the driving surface at the 6th Avenue grade crossing may be viable alternatives to a grade separation alternative.

Recommendation

Both underpass and overpass solutions are considered feasible at this location

SUMMARY RECOMMENDATIONS

Twenty candidate railroad / highway grade crossings were considered for this assessment. Considered were both underpass and overpass solution alternatives constrained to the existing grade crossing location. Candidate locations were evaluated on a somewhat subjective basis to determine if construction of a grade separation (either overpass or underpass) would be feasible. Of the twenty candidate locations, twelve locations were determined to be feasible for construction of either an underpass or overpass grade separation. The candidate locations studied and the recommendations of this analysis are summarized in Table 2.

Table 2 – Feasibility Recommendation Summary

Community	Location	Highway Overpass	Highway Underpass
Belgrade	Broadway Street	Infeasible	Infeasible
Belgrade	Jackrabbit Lane	Infeasible	**Feasible**
Billings	27th Street	Infeasible	**Feasible***
Billings	28th Street	Infeasible	**Feasible**
Billings	29th Street	Infeasible	**Feasible**
Billings	Moore Lane	Infeasible	**Feasible**
Bozeman	Griffin Drive	**Feasible**	**Feasible**
Bozeman	Rouse Avenue	Infeasible	Infeasible
Columbus	Pratton Street	Infeasible	Infeasible
Cut Bank	N. Central Avenue	Infeasible	Infeasible
Glasgow	4th Street	Infeasible	Infeasible
Helena	Benton Avenue	**Feasible**	**Feasible**
Helena	Montana Avenue	**Feasible**	**Feasible**
Helena	Roberts Street	**Feasible**	**Feasible**
Laurel	5th Avenue	Infeasible	**Feasible**
Livingston	5th Street	Infeasible	Infeasible
Miles City	Leighton Boulevard	**Feasible**	**Feasible**
Missoula	Greenough Drive	Infeasible	Infeasible
Shelby	2nd Avenue	Infeasible	Infeasible
Wolf Point	6th Street	**Feasible**	**Feasible**

*Requires criteria design exception

EVALUATION CRITERIA

Following the feasibility screening evaluation of candidate grade separation locations, an evaluation will be completed to determine a prioritized ranking of feasible candidate locations. The evaluation will be conducted using a spreadsheet evaluation tool and will consider numerous aspects of the rail, traffic, and site characteristics.

Candidate evaluation criteria were developed early in the project and presented for review/comment to MDT, local jurisdiction staff and the general public. Candidate criteria was a combination that included information utilized in the Department's TIS Railroad Inventory database for grade crossing evaluations as well as an exhaustive list of potential criteria. The process resulted with a list of over 30 potential evaluation criteria. The potential evaluation criteria were developed without consideration of evaluation methodologies, data collection requirement, or the ability to perform quantitative evaluations utilizing the criteria. Listed below are the candidate evaluation criteria.

- Crossing Width
- Construction Cost
- Maintenance Cost
- Accident Experience (History)
- Potential Accident Exposure
- School Bus Crossing Volume
- Hazardous Materials Crossing Volume
- Emergency Vehicle Response Time
- Approach Sight Distance
- Traffic Volume
- Traffic Speed
- Number of Travel Lanes
- Approach Grade (uphill or downhill grade)
- Alignment of Highway Approach (curves, etc.)
- Angle of Highway Crossing
- Distance to Nearest Grade Separation
- Local Intersection Interference
- Train Volume (duration/frequency of closures)
- Train Speed
- Number of Tracks
- Type of Train Traffic
- Traffic and/or Train Noise
- Vehicle Emissions
- Visual / Aesthetic Impacts
- Impact to Historical / Cultural Resources
- Neighborhood / Community Cohesiveness
- Vehicle Operating Costs
- Cost to Business / Commerce
- Accident Costs
- Costs to Citizens (value of lost time)

- Business Impacts (loss or relocation costs)
- Tax Base Impacts (prop. value, loss of business, etc.)

Input from the general public, local agency staff, and elected officials was sought to determine which of the potential criteria were most (and least) important. During the Phase I public/agency meeting phase of this project, surveys were distributed to local agency staff, elected/appointed public officials, and to the general public in attendance at project public meetings. The survey form asked respondents to rank the importance of each candidate evaluation criteria on a scale of 1 to 5, or to indicate that the criteria should not be utilized to evaluate candidate grade separation locations. A total of 129 surveys were completed; 34 from rural communities and 94 from urban communities.

Nine of the 31 candidate evaluation criteria received a ranking of 1 or "highest importance" more frequently than any lower importance rank. Those criteria most frequently selected as "highest importance" by staff, elected officials and the public are listed below along with the number of respondents that indicated these criteria should receive the "highest importance" ranking:

1. Accident Experience (history) [36]
2. Potential Accident Exposure [56]
3. School Bus Crossing Volume [42]
4. Hazardous Materials Crossing Volume [38]
5. Emergency Vehicle Response Time [87]
6. Traffic Volume [44]
7. Local Intersection Interference [46]
8. Train Volume [53]
9. Business Impacts (loss or relocation costs) [32]

The data clearly indicates that grade crossing impacts to emergency vehicle response time and potential accident exposure are chief concerns among the respondents, indicating that safety issues are paramount.

Three of the candidate evaluation criteria received a ranking of 2 or "high importance" more frequently than any lower importance rank. Those criteria most frequently selected as "highest importance" by staff, elected officials and the public are listed below along with the number of respondents that indicated these criteria should receive the "highest importance" ranking:

1. Approach Sight Distance [33]
2. Train Speed [36]
3. Cost to Citizens (value of lost time) [37]

The data indicates again that safety issues rank high with survey respondents, but also indicates that convenience issues (delay) also are important considerations when evaluating at-grade crossings for grade separation improvements.

Table 1 summarizes the results of the surveys received, showing the frequency of importance level selections by respondents. Also shown are other suggestions for evaluation criteria.

Table 1 – Evaluation Criteria Importance, Survey Results

	1	2	3	4	5	?	Total
Construction Cost of Grade Separation Solution	23	25	X 34	27	9	11	129
Maintenance Cost of Grade Separation Solution	15	20	X 45	30	8	11	129
Accident Experience (history)	X 36	27	25	19	15	7	129
Potential Accident Exposure	X 56	30	13	12	12	6	129
School Bus Crossing Volume	X 42	31	32	8	8	8	129
Hazardous Materials Crossing Volume	X 38	30	29	10	13	9	129
Emergency Vehicle Response Time	X 87	17	10	6	9	0	129
Approach Sight Distance	17	X 33	32	26	16	5	129
Traffic Volume	X 44	43	23	8	7	4	129
Traffic Speed	12	24	X 49	28	12	4	129
Number of Travel Lanes	14	25	X 41	18	17	14	129
Approach Grade (uphill or downhill grade)	8	15	X 41	13	37	15	129
Alignment of Highway Approach (curves, etc.)	10	21	X 35	21	29	13	129
Angle of Highway Crossing	11	20	X 29	27	X 29	13	129
Distance to nearest Grade Separation (overpass or underpass)	19	27	X 30	19	21	13	129
Local Intersection Interference (proximity to crossing)	X 46	29	26	13	10	5	129
Train Volume (duration / frequency of closures)	X 53	39	16	10	7	4	129
Train Speed	28	X 36	29	16	14	6	129
Number of Tracks	15	25	X 41	24	17	7	129
Type of Train Traffic	16	24	X 34	25	18	12	129
Traffic / Train Noise	22	18	X 34	23	20	12	129
Vehicle Emissions	12	21	23	X 34	32	7	129
Visual / Aesthetic Impacts	12	19	X 38	30	23	7	129
Impact to Historical / Cultural Resources	10	13	29	29	X 37	11	129
Neighborhood / Community Cohesiveness	29	21	X 36	18	17	8	129
Vehicle Operating Costs	5	7	31	X 33	27	26	129
Cost to Business / Commerce	25	28	X 38	16	14	8	129
Accident Costs	14	31	X 41	17	11	15	129
Costs to Citizens (value of lost time)	24	X 37	33	21	13	1	129
Business Impacts (loss or relocation costs)	X 32	26	25	27	11	8	129
Tax Base Impacts (prop. value, loss of business, etc.)	20	31	X 32	25	11	10	129

Other Suggested Evaluation Criteria
Economic increase or decrease during & after construction
Support and consideration of downtown redevelopment
What provides most economic development
Urban and Rural should be evaluated separately
Signing - (traffic confusion)
Pedestrian Hazard
Weather Influence and Safety
Bike Traffic
Truck Traffic
Handicap Accessibility
Drainage
Adequate space for vehicleswhile train is in crossing
Operational Efficiency

Key
1 = Highest
2 = High
3 = Medium
4 = Low
5 = Lowest
? = No opinion

X = Highest score per category

To further rank survey respondents opinions, a weighted analysis was performed. In the weighted analysis, each candidate evaluation criteria received "points" for importance score selections made by survey respondents. When candidate criteria received a selection of #1 (highest importance), it was awarded five (5) points. Four (4) points were awarded for a selection of #2 (high importance), three (3) points for a selection of #3 (medium importance), and so on. One (1) point was subtracted when a candidate criteria received a selection of ? (do not use criteria). Points for each candidate evaluation criteria were then summed for each survey received to get a total "score" for each candidate criteria. Total scores were tabulated for all survey respondents and were also tabulated for rural and urban respondents separately. Figures 1-3 show the weighted importance scores for all surveys, urban respondents, and rural respondents, respectively.

Figure 1 – Weighted Importance Score – All Respondents

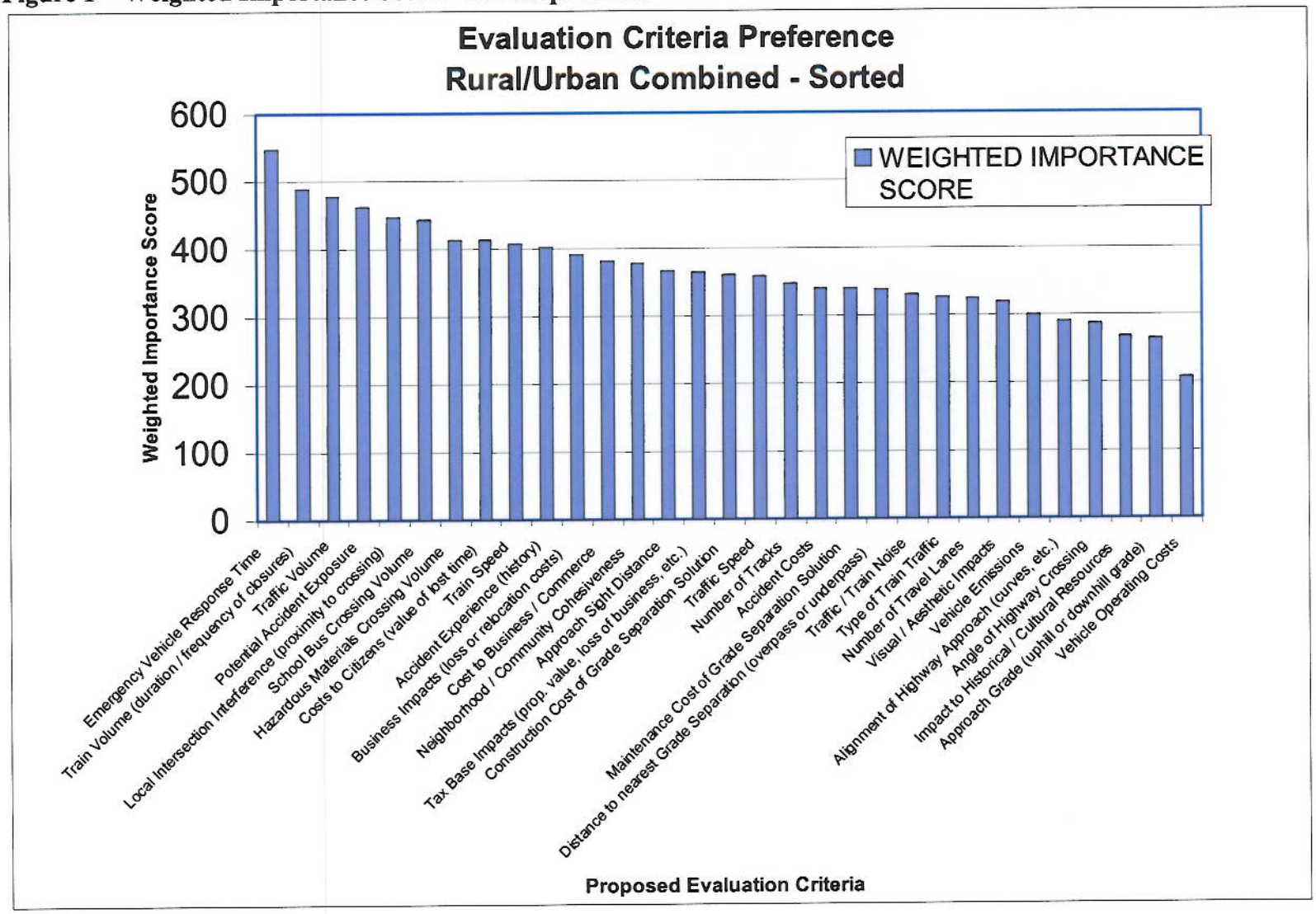


Figure 2 - Weighted Importance Score – Urban Community Respondents

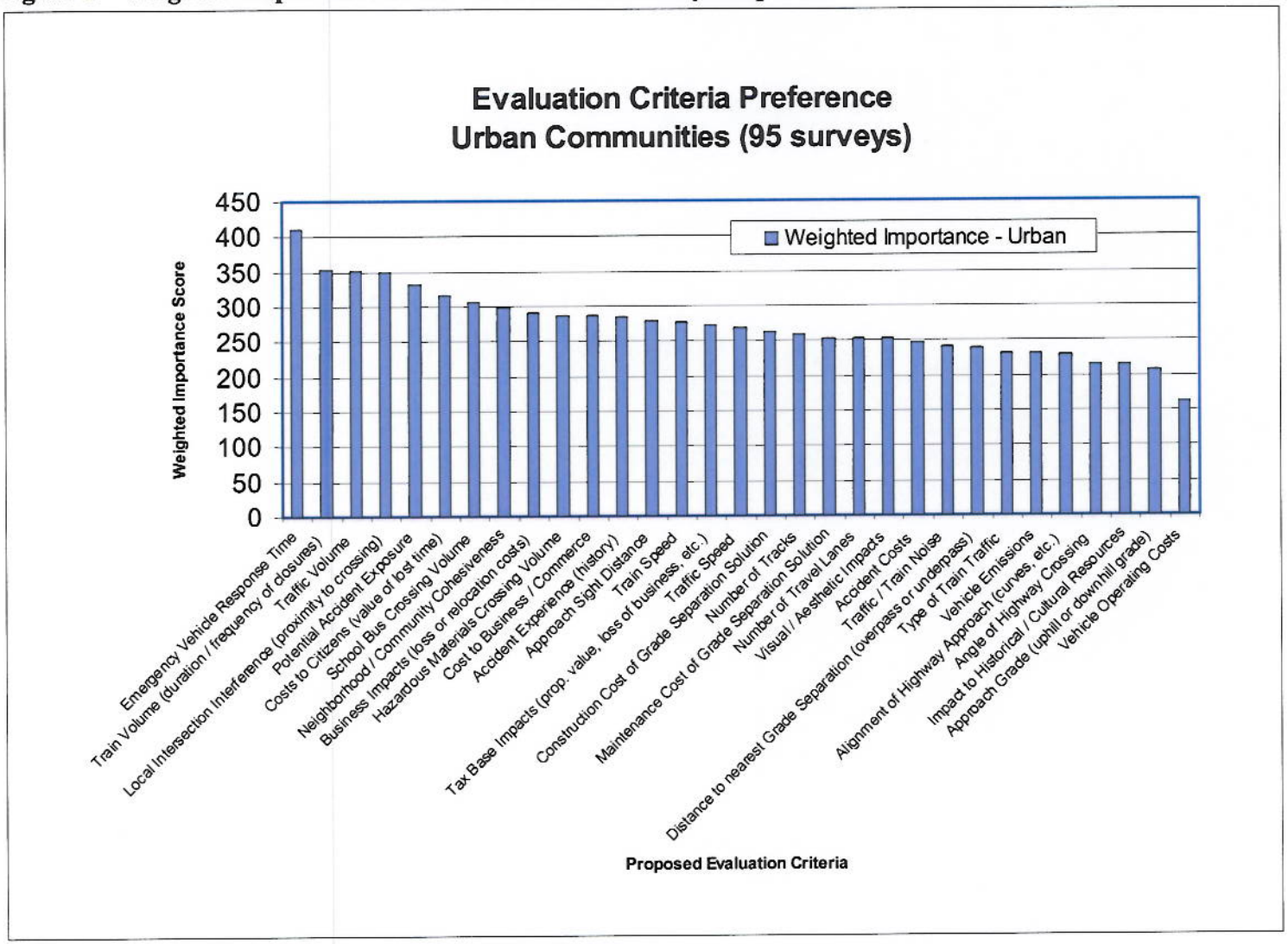
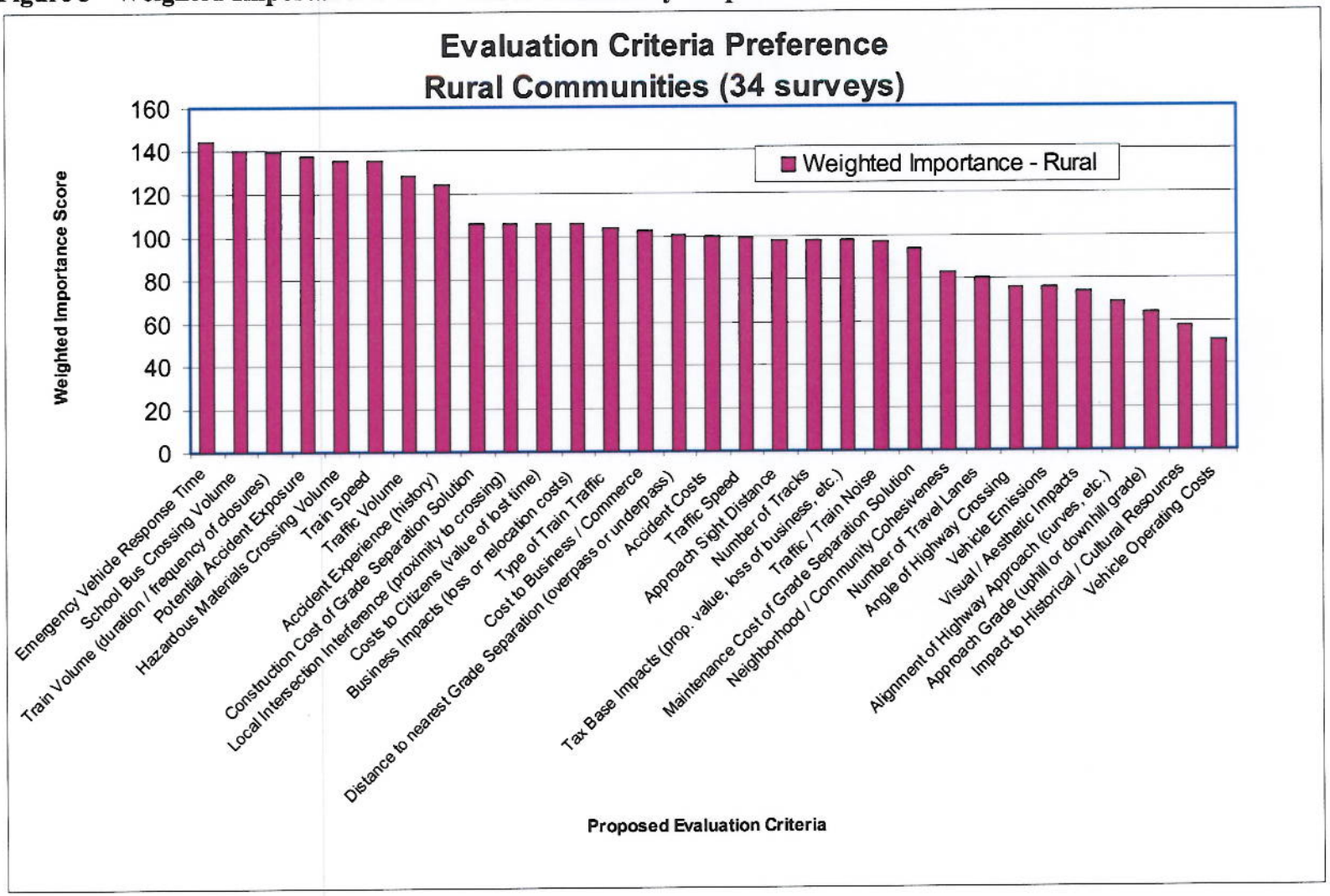


Figure 3 - Weighted Importance Score – Rural Community Respondents



The results of the importance factor surveys served as guidance to screen candidate evaluation criteria that will be utilized for detailed assessment, evaluation and prioritization of each feasible grade crossing location. Also considered were:

- Ease of implementation/data gathering to perform evaluation
- Consideration of how criteria will be used to eliminate potential duplication that could result with "double counting" some criteria or factors.

The following sections discuss each of the candidate evaluation criteria and contain a recommendation for either retaining the criteria for use in the evaluation/priorotization model, or to drop the criteria.

Construction Cost of Grade Separation Solution – Drop this criteria from the evaluation/prioritization model, but retain for use outside the model using concept-level cost estimates. These cost estimates will include costs for right-of-way acquisition and acquisition/relocation costs for impacted residential and nonresidential properties. Construction costs were not ranked high by either rural or urban communities (combined ranking was 16th) and will not be utilized for purposes of prioritizing at-grade crossings in terms of need. Instead, cost information will be developed separately to assist MDT with budgeting and funding decisions.

Input data:

- Construction costs per square foot of roadway and structure
- Right of Way cost per square foot – Based upon location
- Utility relocation costs lump sum – Based upon location

Maintenance Cost of Grade Separation Solution – Drop this criteria. Maintenance of grade separation structures will largely be consistent from one location to the next. Since maintenance of a railroad overpass (railroad structure) will be borne by the operating railroad, use of this criterion may have a tendency to promote highway underpass solutions. This criterion received a combined ranking of 20th.

Accident Experience (history) – Retain this criteria using an accident severity index-type of rating to reflect accident history. Use all types of accidents that occurred within close proximity of a grade crossing since construction of a grade separation will likely change the character of the area roadways to have an influence on all types of accidents (eliminate proximate intersections, eliminate stopping at crossing, etc.). Accident history (severity index) should be expressed in terms of cost ($) for use with benefit-cost assessment.

Input data:

- State Accident Data

Potential Accident Exposure – Retain this criteria using the product of traffic volume and train volume to calculate the potential exposure. This criteria has the ability to reflect future accident potential rather than just past accident experience.

Input data:

- Traffic Volumes
- Train Volumes

School Bus Crossing Volume – Retain this criteria. It is easy to establish a numerical value for this criteria. Reflects a specific measure of safety, also reflects a specific measure of delay since school busses are required to stop at all railroad grade crossings (delay to bus as well as following traffic). Use this criteria in a similar fashion to accident exposure (product of bus volume and train volume), but with higher weighting.

Input data:

- Number of School Buses Crossing Tracks – School District Data

Hazardous Materials Crossing Volume – Retain this criteria using a measure of truck traffic to estimate the amount of hazardous materials trucked across the grade crossing. It will be nearly impossible to determine the volume of hazardous material that moves by rail, but may be easier to quantify the volume moved by truck across the tracks. The % of total truck traffic utilized as "hazardous materials volume" will be estimated based on the best available information and is not intended to represent actual volume of hazardous materials shipped at a specific grade crossing.

Input data:

- % of total truck traffic

Emergency Vehicle Response Time – Retain this criteria. This factor was ranked highest of all proposed criteria by the public. Numerical value for increased response time can be estimated based on route distances and travel speed. This criteria will also tend to include aspects of the "distance to nearest grade separation" criteria.

Input data:

- Train Volumes
- Train Speeds
- Train Lengths
- Distance to Nearest Crossing
- Travel Speeds of Emergency Vehicles

Approach Sight Distance – Drop this criteria. All of the grade crossings included in this study were equipped with vehicle gates and lights/bells for mainline tracks and switching tracks (only little-used sidings were sometimes excluded from the crossing protection zone). In addition, many of the grade crossings had multiple mainline tracks. In the situation of multiple tracks, a stopped train could block sight distance to a moving train and sight distance would have to be assumed to be zero (therefore, sight distance would be variable depending of the time-specific circumstances).

Traffic Volume – Retain this criteria as a measure of impacted public, vehicle delay and accident exposure. Also is a measure of impact to commerce (commercial vehicle traffic delays). Easy to quantify for evaluation purposes.

Input data:

- ADT

Traffic Speed – Drop this criteria. Although traffic speeds are a reflection of the reaction and advance notification required at grade crossings, properly functioning crossing protection can accommodate high approach speeds. In addition, the use of traffic speed as a criterion may tend to favor rural highway crossing locations will little traffic or little delay.

Number of Travel Lanes – Retain this criteria. This is not only a measure of roadway functional class and importance, but also a factor where visibility of crossing gates/lights is concerned.

Input data:

- Lane number from roadlogs

Approach Grade (uphill or downhill grade) – Retain this criteria as a measure of the difficulty of stopping or starting. Easy to quantify using approach grades.

Input data:

- Percent Grade of roadway approach

Alignment of Highway Approach (curves, etc.) – Retain this criteria as a measure of visibility and driver awareness of grade crossing.

Input data:

- Tangent or location on Curve

Angle of Highway Crossing – Retain this criteria as a measure of the available sight distance and drivers ability to clear the tracks.

Input data:

- Angle of crossing

Distance to nearest Grade Separation (overpass or underpass) – Retain this criteria as a measure of need. Even though this will be measured indirectly through emergency vehicle response time criteria, this also reflects community need and addresses the potential that the nearest grade separated crossing may not be suitable for emergency vehicle traffic (height or weight restrictions).

Input data:

- Distance to Grade Separation that can be used by emergency service vehicles

Local Intersection Interference (proximity to crossing) – Retain this criteria as a measure of safety. Proximate intersections may interfere with traffic flow near grade crossings, add complexity to the driver environment, and also present additional costs or loss of circulation in the event of construction of a grade separation. For this reason, intersections should only be considered proximate to the grade crossing if they are within the project limits of a grade separation project.

Input data:

- Distance to intersection
- Intersection volumes

Train Volume – Retain this criteria. This is a reflection of the number of times the grade crossing is blocked and is also an influence to accident potential. Use this criteria separately only to estimate the *frequency* of closures.

Input data:

- Train data

Train Speed – Retain this criteria as a measure of crossing closure duration and driver frustration. This criteria should not be used separately, but should be combined with train volume/length to formulate a indicator of closure *duration* on a daily basis for evaluation. Easy to quantify for evaluation purposes. Except at very low speeds, train speed probably has little to do with accident severity in a car-train collision.

Input data:

- Train data

Number of Tracks – Retain this criteria. Multiple tracks at one crossing add complexity to crossing maneuvers, increase the chances that a stalled vehicle will be on the tracks, increase the crossing time for vehicles and pedestrians, and pose sight-distance restrictions when trains are parked on one of the tracks.

Input data:

- Train data

Type of Train Traffic – Drop this as a separate criteria. The long grade crossing closures associated with switching operations and slower moving trains will be addressed through train volume (frequency) and speed (duration) criteria. There is no overwhelming reason that freight trains should be treated differently than passenger trains for consideration of grade separations.

Traffic / Train Noise – Drop this criteria. Although train whistles produce noise at grade crossings, it is unlikely that installation of a grade separation will eliminate train whistle

noise due to the presence of other close-by at-grade crossings that will still require a whistle. Other train noise (wheel noise, brake noise, locomotive noise) is unlikely to be affected by construction of a grade separation.

Vehicle Emissions – Drop this criterion. Even though it will be fairly easy to calculate waiting vehicle emissions, both rural and urban communities rated this criterion low. The low rating is an indication that air quality impacts are not an important consideration.

Visual / Aesthetic Impacts – Drop this criteria. This criterion will be very difficult to quantify and was rated low by both urban and rural communities (combined ranking of 25th).

Impact to Historical / Cultural Resources – Drop this criteria. Cultural/historical impacts could be avoided by staying within existing rights-of-way (even at an added expense). This criterion was rated very low by both rural and urban communities (combined ranking of 29th).

Neighborhood / Community Cohesiveness – Drop this criteria. Very difficult to quantify, as a grade separation can be a community divider just like the railroad tracks. Mixed rating…rated fairly high by urban communities (ranked 8th), but low by rural communities (ranked 23rd). Would be difficult to define "Neighborhoods" and difficult to quantify the impacts of constructing a grade separation.

Vehicle Operating Costs – Drop this criteria. Rated dead last by both rural and urban communities. Cost is minor when compared to costs to citizens and cost to business/commerce (labor, value of time). Cost to business and cost to citizens' criteria were both rated much higher and should be used to reflect traffic delay costs.

Cost to Business / Commerce – Retain this criteria. This criterion ranked in the upper one-half of the candidate criteria (combined rank of 12th). This cost can be estimated through estimation of commercial traffic within the duration of closure and use of a higher hourly cost (higher than private individual).

Input data:

- Truck traffic volumes
- Value of driver time

Accident Costs – Drop this criteria. This criteria was rated low by both rural and urban communities (combined rank of 19th) while accident experience and accident potential were ranked much higher. Since accident experience can be evaluated in terms of cost (to achieve a benefit-cost rating), this criteria is somewhat redundant.

Costs to Citizens (value of lost time) – Retain this criterion. This criterion (cost) will be how delays are expressed using frequency & duration of closures due to train activity.

This criteria was also ranked fairly high by both rural and urban communities (combined rank of 8th).

Input data:

- Traffic Volumes
- Value of citizen time

Business Impacts (loss or relocation costs) – Drop this as a separate criteria. Since most of the candidate locations are in commercial/industrial areas, the impacts of construction will mean loss of property and/or access for some properties. This cost will be included with the construction cost criteria. This criteria was ranked fairly high by both rural and urban communities (combined rank of 11th).

Tax Base Impacts (prop. value, loss of business, etc.) – Drop this criteria. Ranked in the bottom half of the candidate criteria by both rural and urban communities (combined rank of 15th), this criteria will be difficult to quantify due to the varied development/re-development options for property impacted by construction of a grade separation. In addition, while loss of businesses in the immediate vicinity of the project may occur, the existence of a grade separation may improve the business opportunities elsewhere within the community, thereby off-setting these losses.

OTHER EVALUATION CRITERIA SUGGESTED:

Economic Increase or Decrease During and After Construction – Do not add this as an evaluation criteria. This will be difficult to quantify and is very subjective. Disruption during period of construction activity should not be considered (temporary).

Support and Consideration of Downtown Redevelopment – Do not add this as an evaluation criteria. While it is recognized that attracting new businesses to a community may be enhanced by the presence of a grade separation, the monetary impact of building a grade separation will be extremely difficult to quantify and is highly subjective.

Potential for Economic Development – Do not add this as an evaluation criteria for the same reasons enumerated for the item above.

Pedestrian Crossing Volume – Add this as an evaluation criteria. Rather than just pedestrian volume, this criteria may be better utilized as a non-motorized crossing volume to also include bicycle traffic since non-motorized modes face different issues than motorized crossing traffic.

Input data:

- Designated Pedestrian/Bike Route
- Alternate Crossings Available

Bicycle Crossing Volume – Do not add as a separate evaluation criteria, but rather include bicycle crossing volume as part of the non-motorized crossing volume discussed above.

Truck Crossing Volume – Truck traffic volume is already considered in several previous categories (hazardous materials volume, cost to business/commerce). Do not add this as a separate criteria.

Handicap Accessibility – Do not add as a separate evaluation criteria. Disabled persons riding/driving in vehicles do not need to be treated differently than ordinary motorized vehicle traffic. As pedestrians, disabled persons will be included with non-motorized crossing volumes. We need to assume that any grade separation construction will be in compliance with ADA. Retrofitting existing at-grade crossings to make them ADA compliant is not the purpose of this evaluation.

Criteria proposed to be used in the evaluation process are as follows

- Emergency Response Time
- Traffic Volumes
- Train Volumes
- Intersection Interference
- Accident Exposure
- School Bus Crossings
- Train Speed
- Hazardous Materials
- Accident Experience
- Cost to Citizens
- Cost to Businesses
- Number of Tracks
- Traffic Lanes
- Pedestrian Impacts
- Second Grade Crossing Available
- Horizontal Alignment Location
- Angle of Crossing
- Traffic Approach Grade

APPENDIX A

GRADE SEPARATION SOLUTION ALTERNATIVES

(Drawings available by request)

PHASE II - INTRODUCTION

The study process included two phases; Phase I evaluated the feasibility of implementing a grade-separated alternative at each selected location and determined the evaluation criteria to be used for a need-based prioritization tool; Phase II addresses the cost to construct feasible alternatives at candidate locations and includes development and application of an evaluation/prioritization tool.

Phase II of the project details the "need" based evaluation / prioritization tool developed utilizing Phase I data. The tool applies the selected evaluation criteria for each location to rank each location according to need. Phase II also details the development of conceptual design solutions for grade separations at feasible candidate locations. Conceptual solutions were developed to a level sufficient to develop planning-level construction cost estimates for each feasible solution. Costs included roadway construction costs, rail and utility costs, and estimated right of way and business acquisition costs. Cost estimate data was used to develop a separate benefit-cost evaluation for each candidate location.

Application of these tools will prioritize at-grade crossings based on need, with a separate benefit-cost evaluation. These two results can be used as input to funding decisions made by MDT for possible advancement of further, more detailed grade separation evaluations at locations demonstrating superior need and benefit-cost ratios.

NEED BASED EVALUATION TOOL

The need based evaluation tool was established to rank relative need for a grade separation at select locations within Montana. Approximately 32 criteria were proposed in Phase I of the study. Of these, 18 were selected for use in the final evaluation tool. Selected criteria are as follows:

- Emergency Response Time
- Traffic Volumes
- Train Volumes
- Intersection Interference
- Accident Exposure
- School Bus Crossings
- Train Speed
- Hazardous Materials
- Accident Experience
- Cost to Citizens
- Cost to Businesses
- Number of Tracks
- Traffic Lanes
- Pedestrian Impacts
- Second Grade Crossing Available
- Horizontal Alignment Location

- Angle of Crossing
- Traffic Approach Grade

Utilizing input from 129 responses from the 13 communities involved in Phase I of the study, a weighted importance score for each criterion was established. (Figure 1 – Phase I report) The weight of each criterion was developed based upon the ratio of the relative weighted importance score to the lowest criteria used in the evaluation (Traffic Approach Angle). The total of all the criteria weights were factored into a numeric value of 1000 points and rounded to the nearest multiple of 5 to establish the maximum points for each criterion. The Department has the ability to modify these numbers in the models when they feel conditions are warranted. The criteria, weight factor, and the maximum points (score) established for the model are as follows:

Criteria	Weight	Score
Emergency Vehicle Response Time	2.3	80
Train Volumes	2.0	70
Traffic Volumes	2.0	70
Potential Accident Exposure	1.9	65
Local Intersection Interference	1.9	65
School Bus Crossing Volumes	1.9	65
Hazardous Material Volumes Crossing	1.7	60
Costs to Citezens	1.7	60
Train Speed	1.6	55
Accident Experience	1.6	55
Number of Tracks	1.4	50
Number of Lanes	1.4	50
Distance to Nearest Crossing	1.4	50
Ped & Bike Conflicts	1.4	50
Costs to businesses	1.1	40
Horizontal Alignment	1.1	40
Angle of Crossing	1.1	40
Traffic Approach Angle	1.0	35
Total Points		*1000*

Every crossing may not be eligible for a score as defined by several criteria. These criteria are:

- School Bus Crossing - School buses may not cross at each crossing on a regular scheduled basis and result in a scope of zero.
- Angle of Crossing - The vertical grade for the crossing may be zero and the model would give the crossing a zero score.
- Traffic Approach Angle – The approach angle for the crossing may be at 90^0 and the model would give the crossing a zero score.

To minimize the potential for increasing the weight of these criteria score and skewing the overall results; the points allowed for these criteria were prorated depending upon the percentage of crossings eligible for points. Because of the critical importance of accident experience this criteria was not prorated.

The results of the needs based evaluation are summarized in Table 1. The individual scores for each criteria are shown in Figures 1 through 18. As shown in Figure 10, only one accident was reported over the three year data period.

Table 1 - Needs Ranking

Rank	Community	Crossing Location	Crossing ID	Score
1	Billings	Moore Ln	087383W	134.82
2	Helena	Montana Ave	060193P	113.38
3	Billings	27th Street	087491T	99.43
4	Helena	Benton Ave	06199F	83.11
5	Miles City	Leighton Blvd	092664R	81.69
6	Belgrade	Jack Rabbit Ln	060090P	73.84
7	Bozeman	Griffin Dr.	060073Y	65.23
8	Wolf Point	6th Street	059580K	64.50
9	Laurel	5th Avenue	104007M	64.32
10	Helena	Roberts St.	060192H	59.11
11	Billings	28th Street	087492A	47.71
12	Billings	29th Street	087493G	46.63

Figure 1 - Emergency Response Time:

- Based on - Available alternate routes / train traffic volumes / operating speeds of trains

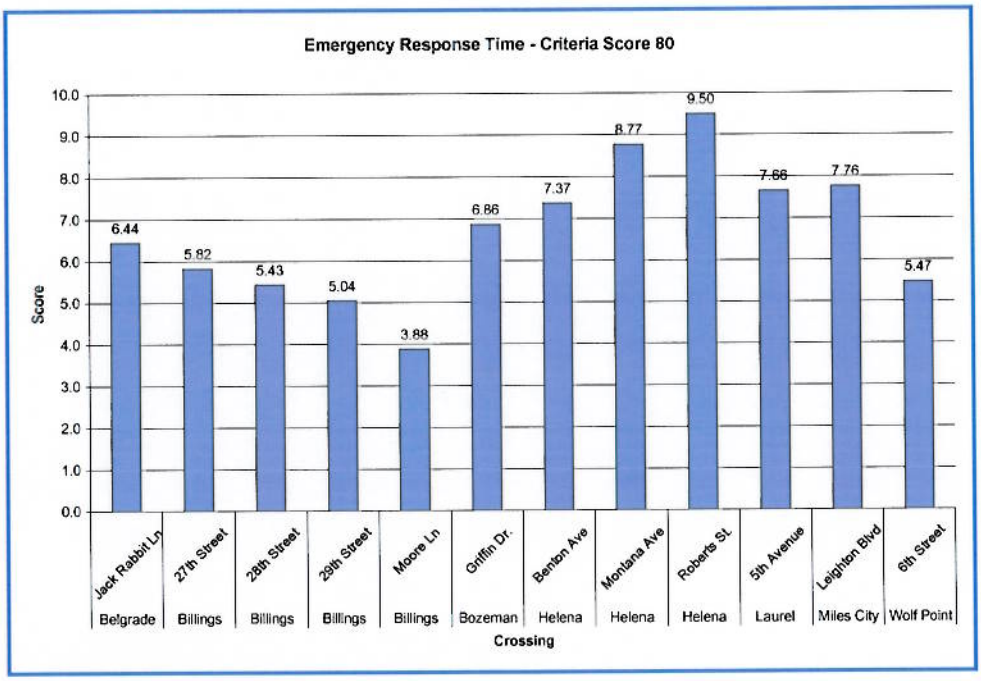


Figure 2 - Traffic Volumes:

- Based on - Average Annual Daily Vehicle Traffic

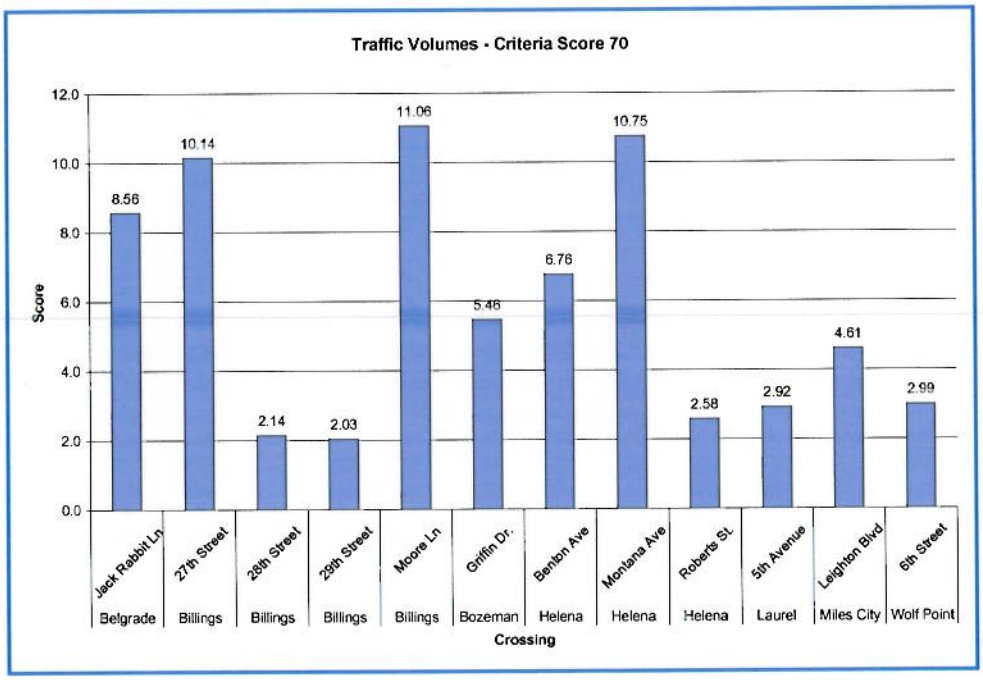


Figure 3 - Train Volumes:

- Based on - Average Daily Train Traffic

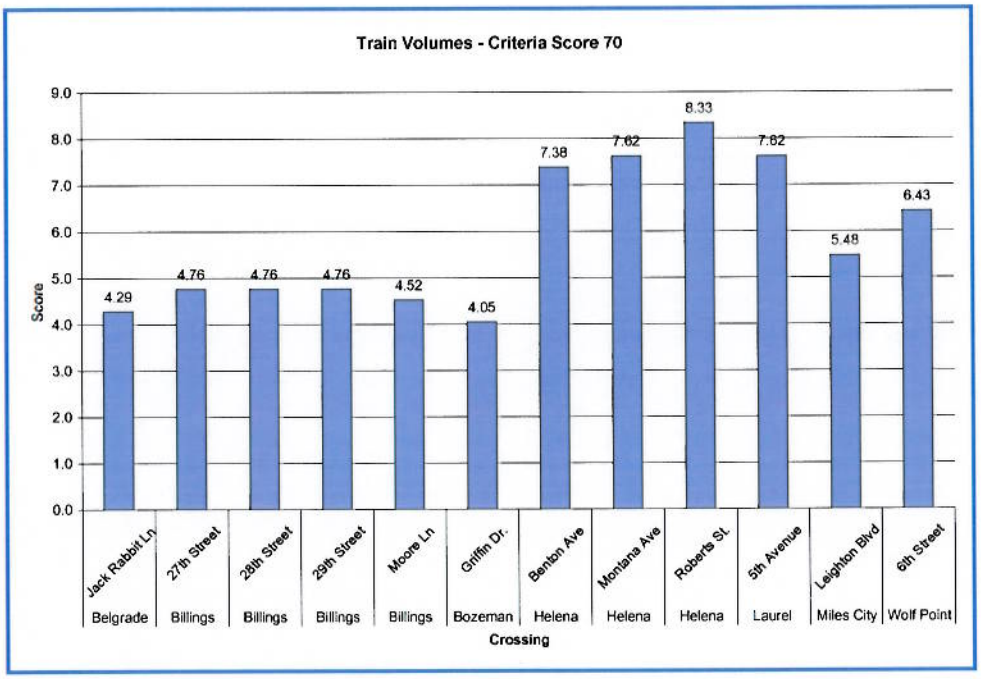


Figure 4 - Intersection Interference:

- Based on - Total conflict between Auto's at nearest intersection

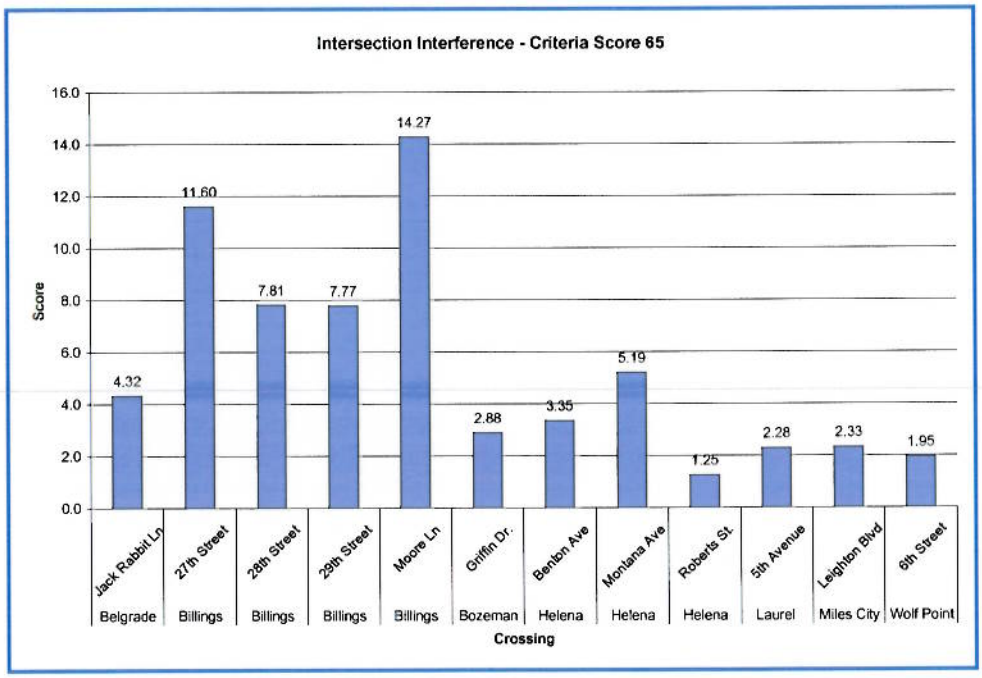


Figure 5 - Accident Exposure:

- Based on - Total conflict between Auto's & Trains

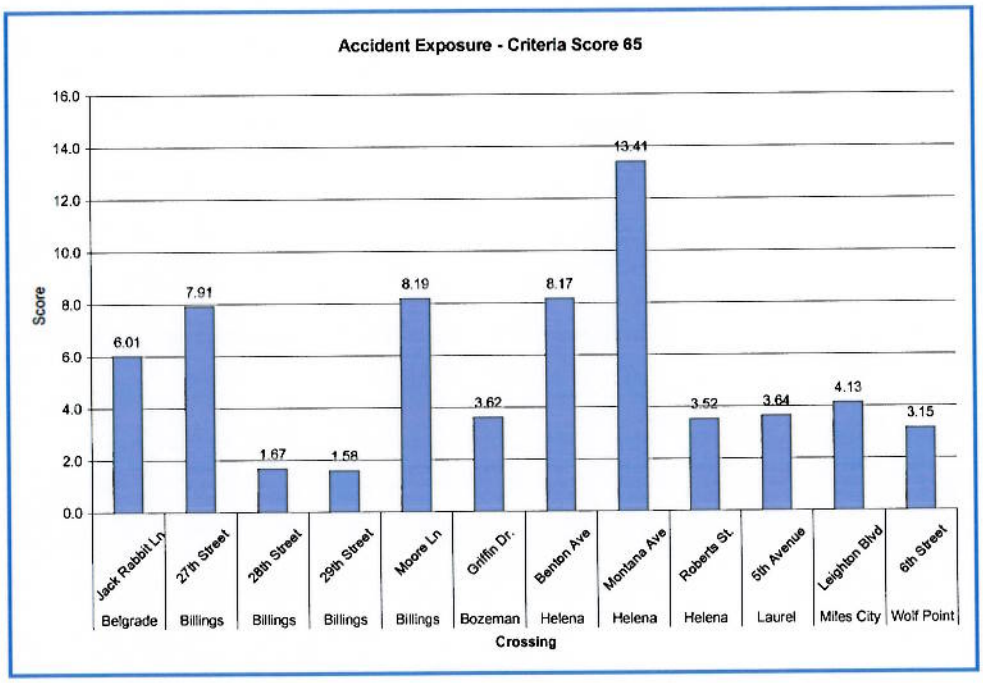


Figure 6 - School Bus Crossings:

- Based on - Average daily school buses crossing at the crossing

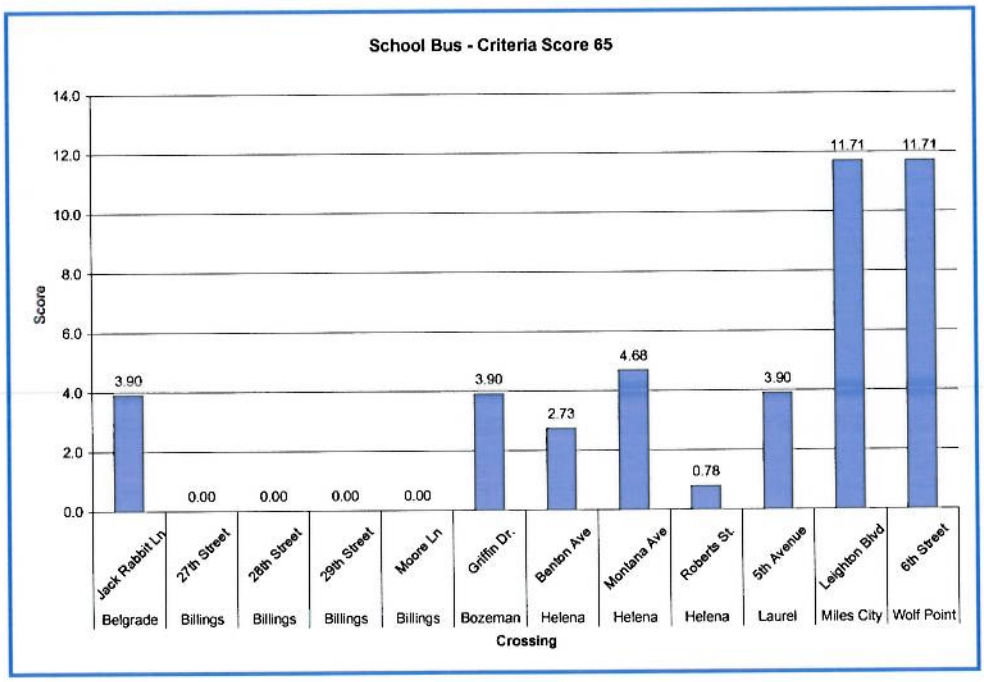


Figure 7 - Cost to Citizens:

- Based on - Average cost to citizens delayed at crossing

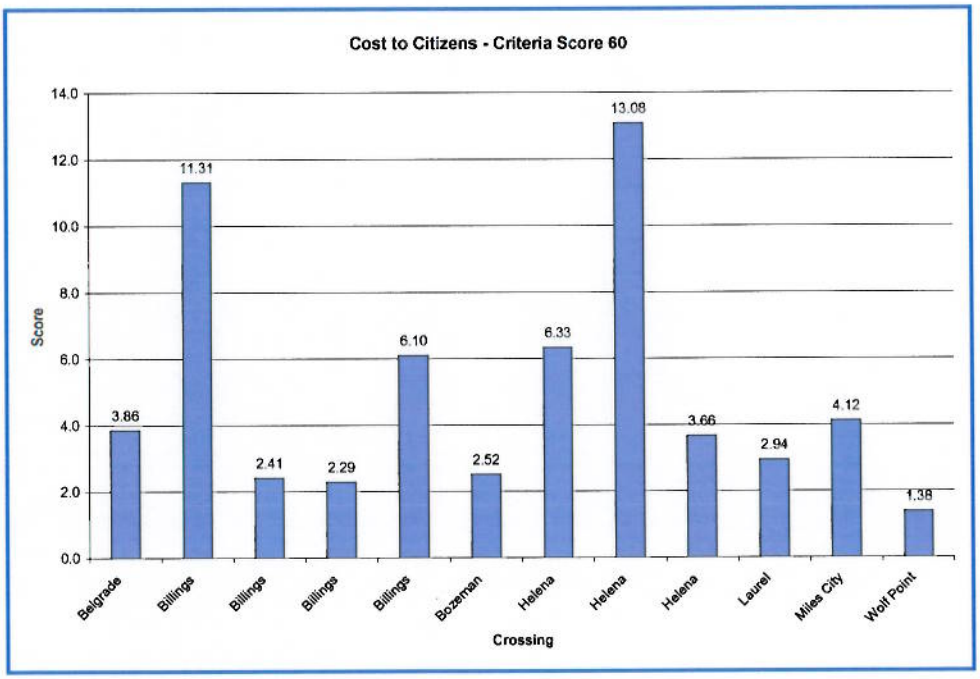


Figure 8 - Hazardous Materials:

- Based on - Percentage of trucks at the crossing

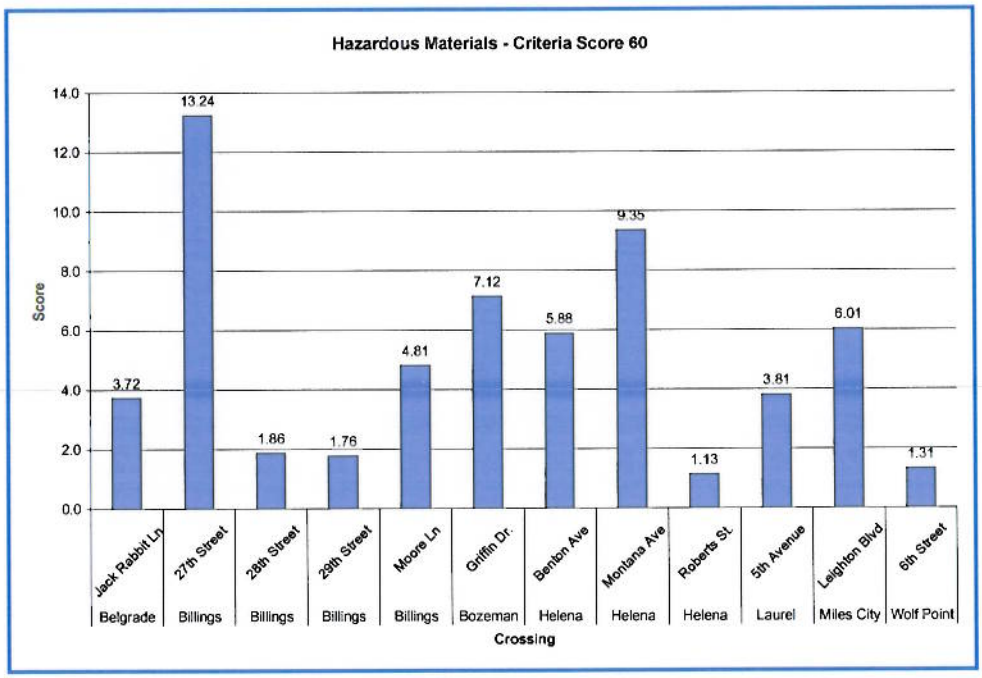


Figure 9 - Train Speeds:

- Based on - Maximum rate train speeds at each crossing

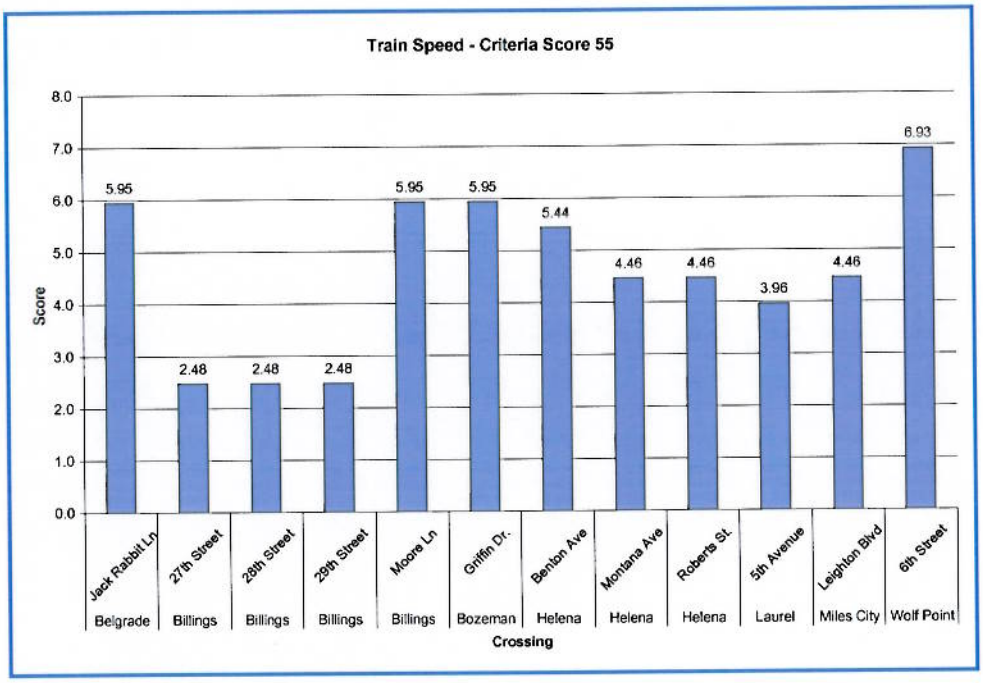


Figure 10 - Accident Experience:

- Based on - Number of accidents over a five year period (1996-2001)

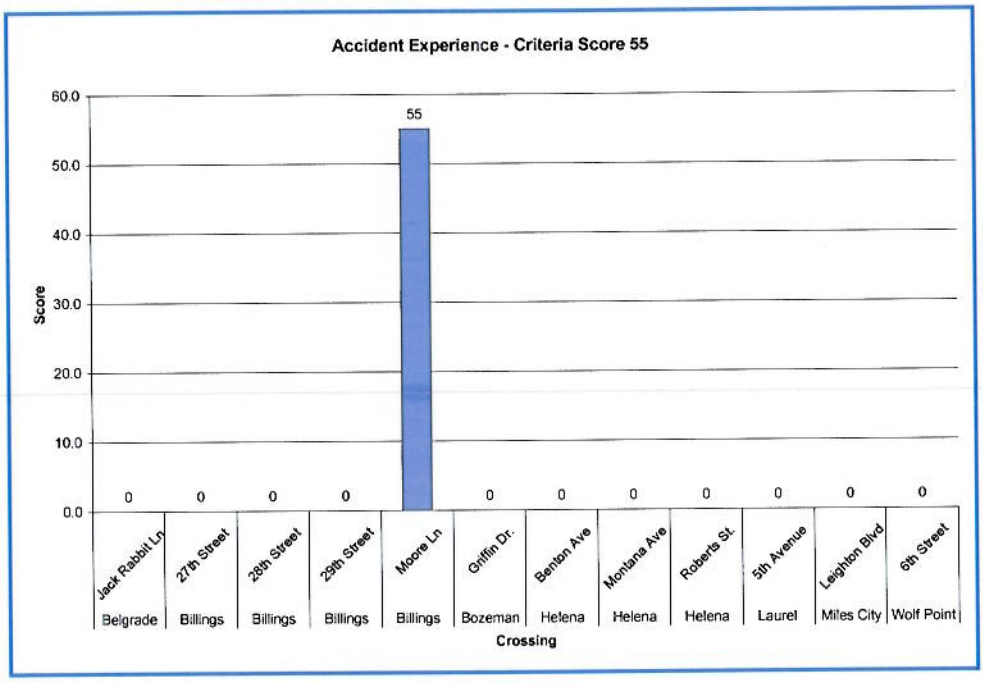


Figure 11 - Traffic Lanes:

- Based on - Number of traffic lanes crossing the tracks

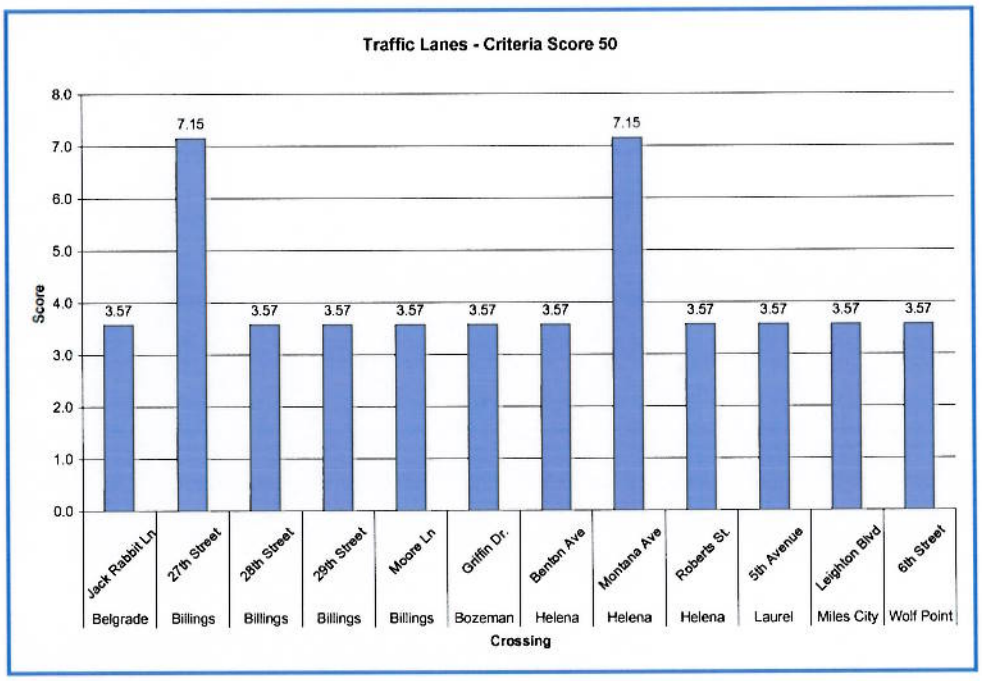


Figure 12 - Number of Tracks:

- Based on - Number of tracks within the gates

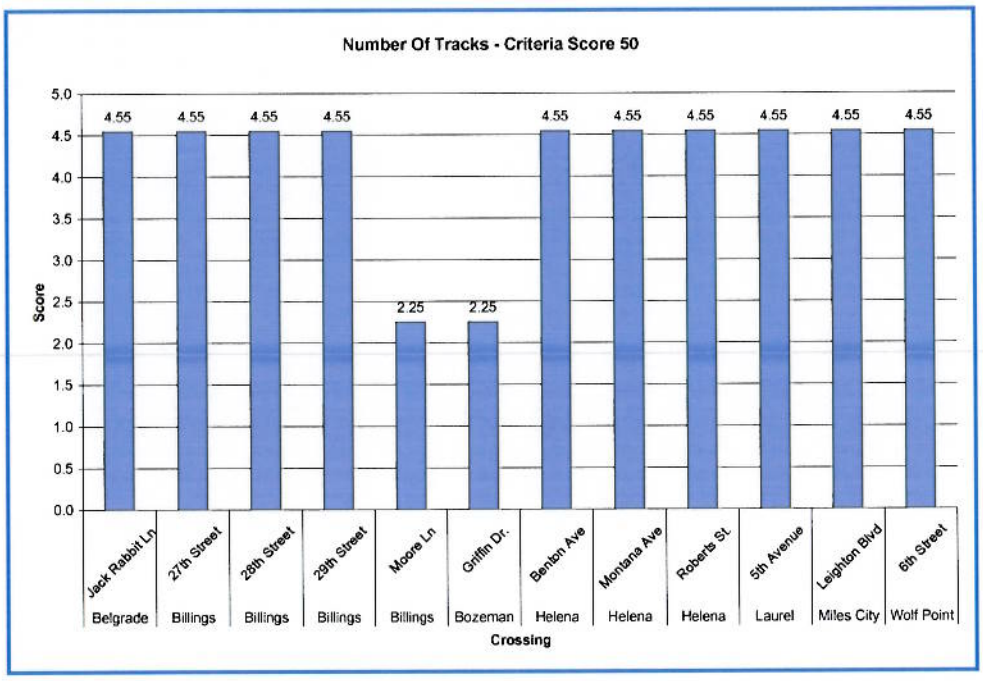


Figure 13 - Second Grade Crossing:

- Based on - Distance to alternative grade crossing able to carry emergency vehicles.

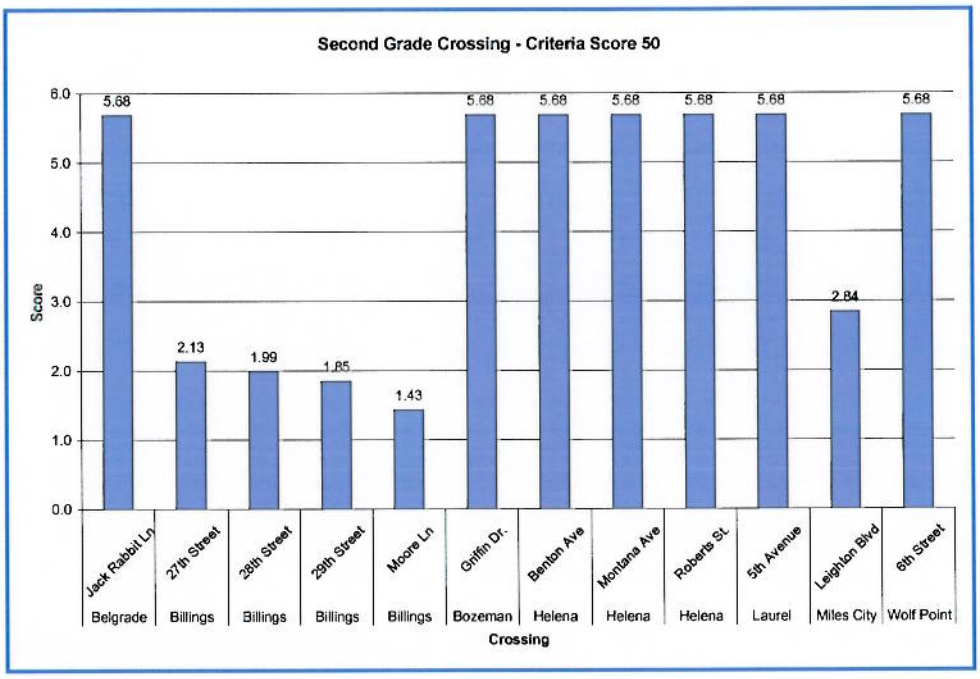


Figure 14 - Pedestrian Impacts:

- Based on - Pedestrian use exists at the crossing. If pedestrians have a grade separated alternative within the vicinity answer No, otherwise Yes.

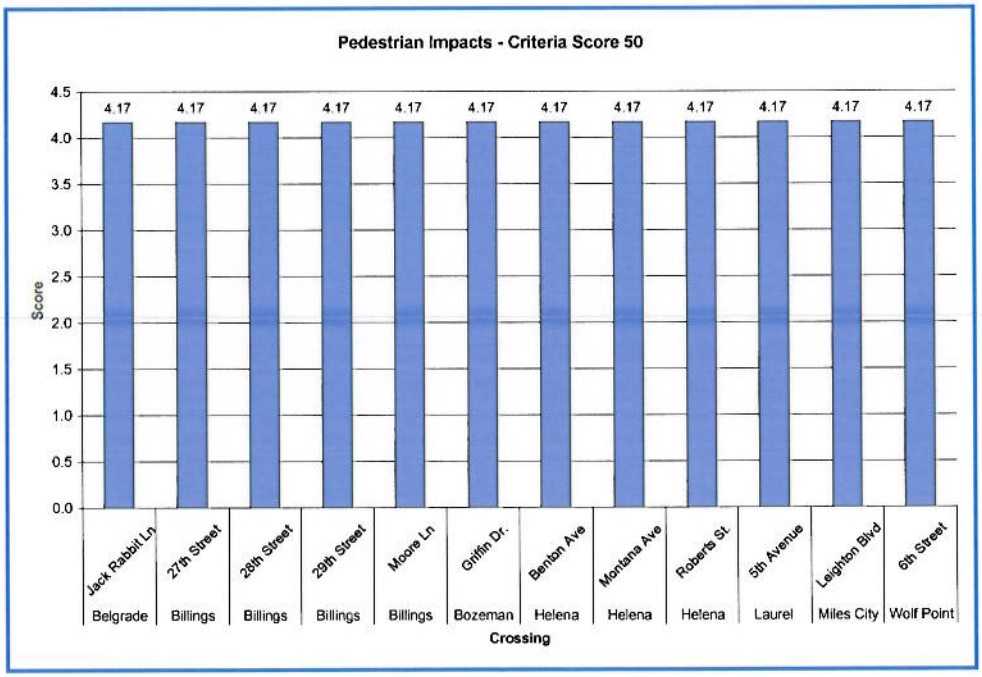


Figure 15 - Horizontal Curve:

- Based on - Roadway crossing is within a highway curve. If the alignment is in a horizontal highway curve answer Yes, otherwise No.

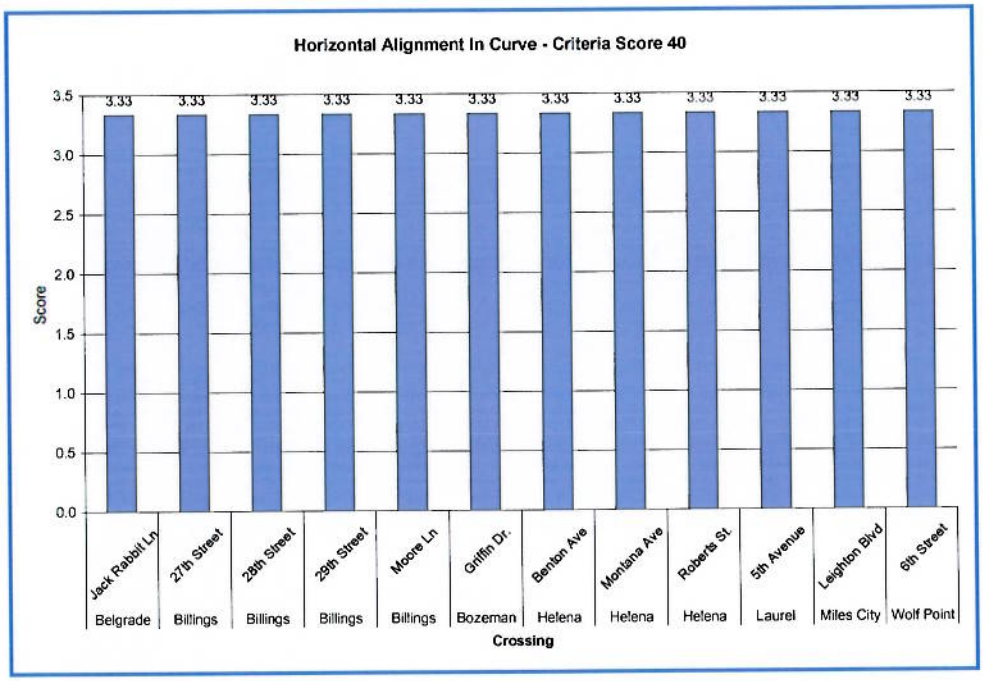


Figure 16 - Angle of Crossing:

- Based on - Highway is skewed at the crossing

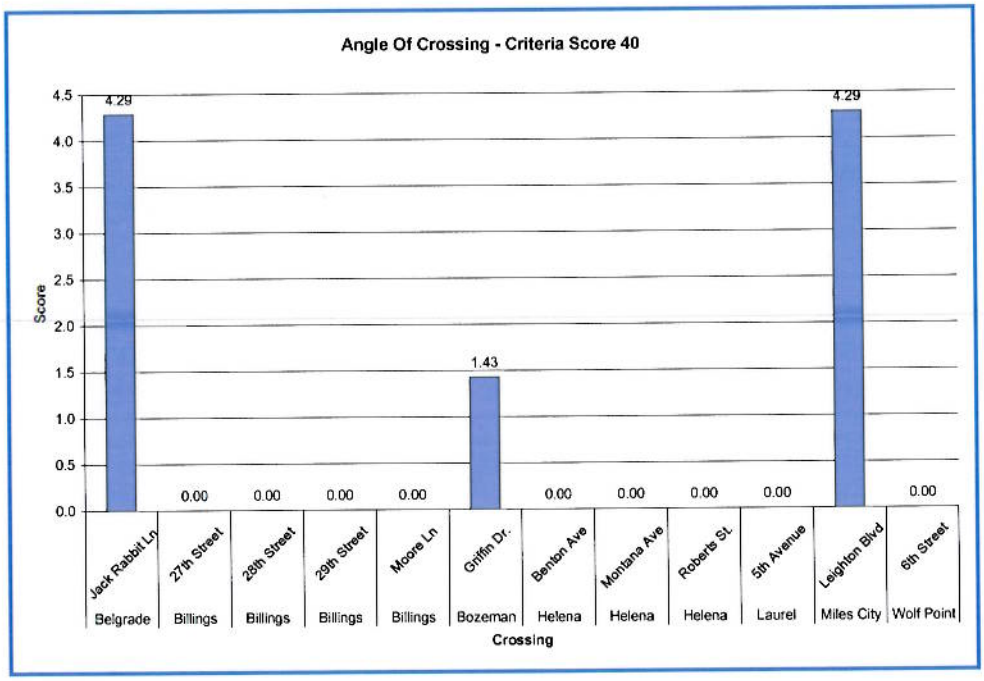


Figure 17 - Cost to Businesses:

- Based on - Percent truck traffic and costs to citizens

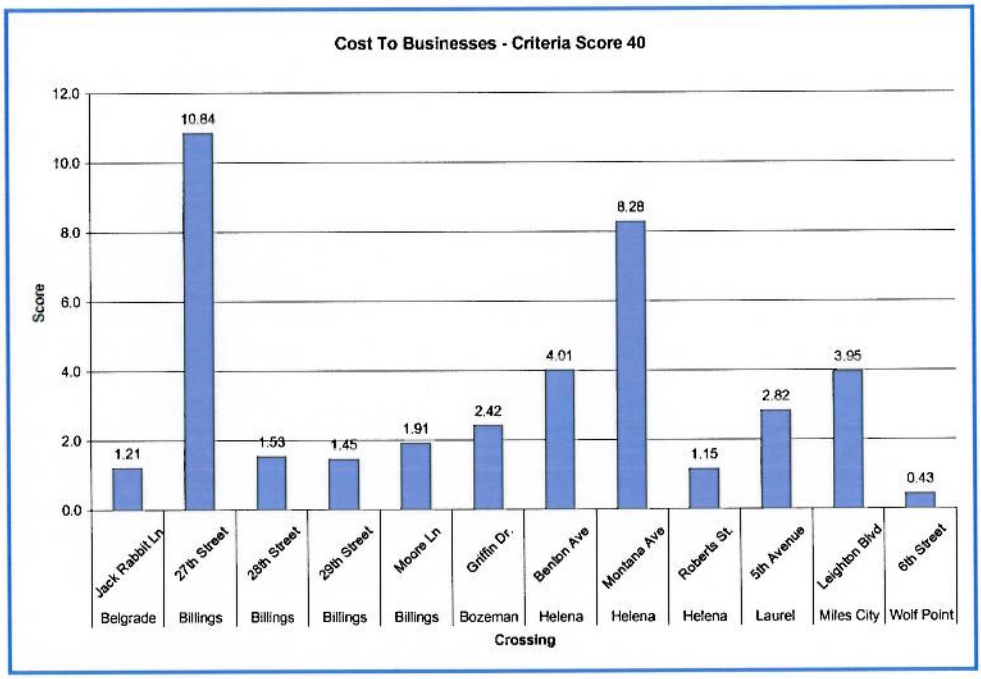


Figure 18 - Traffic Approach Grade:

- Based on - Vertical grade of the approaching roadway

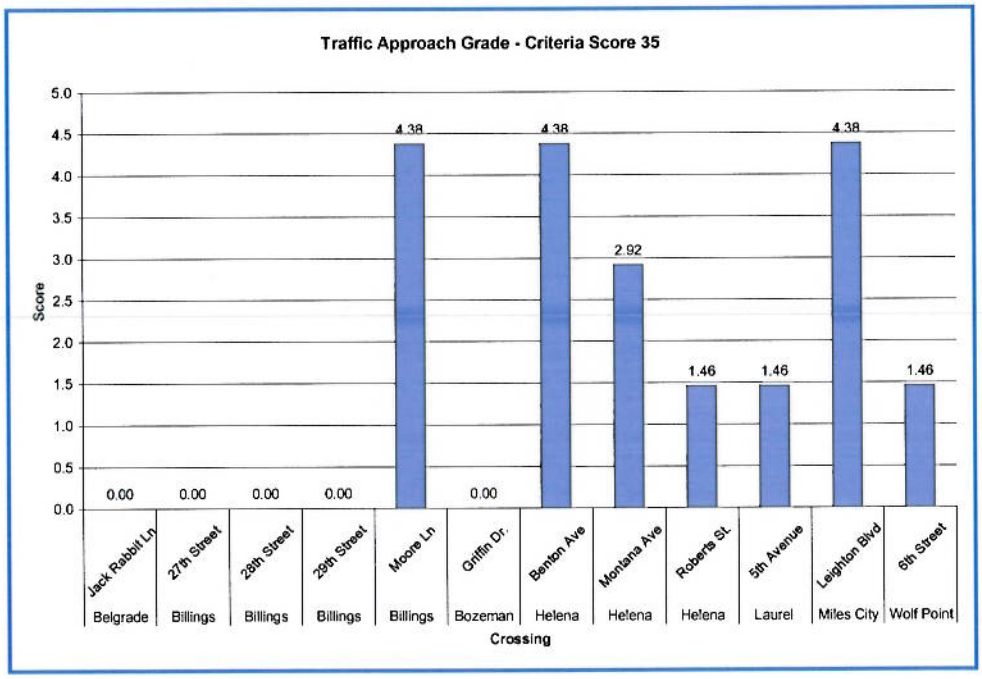


Figure 19 in the Conclusion portion of this report illustrates the cumulative needs evaluation score and the benefit cost evaluation for each crossing within the same graphic.

BENEFIT - COST EVALUATION TOOL

Benefits Tool

A second tool requested by MDT as a part of this study was a Benefit - Cost tool to rank each crossing. The software utilized to evaluate Benefit – Cost with this study is "GradeDec 2000" by the Federal Railroad Administration. This software is freeware and is available on the internet.

GradeDec 2000 is a stand-alone, software package that functions as an investment decision support tool. It allows state and local decision makers to prioritize rail / highway grade crossing investments based upon an array of benefit-cost measures. GradeDec 2000 evaluates the benefit-cost of grade crossing improvements while explicitly reporting results for each crossing and each benefits category. The MDT model will consider the benefits from the categories of safety, time savings, vehicle operating costs, and local benefits. Additional benefit categories of reduce emissions and network benefits are also calculated by the program but are not utilized for this evaluation.

GradeDec 2000's underlying methodology is consistent with current benefit-cost methodologies employed by United States Department of Transportation Agencies (Federal Railroad Administration, Federal Highway Administration, Federal Transit Administration and Federal Aviation Administration) and with Executive Order 12893, which governs the principles of federal infrastructure investments. The model is transparent in all of its assumptions. Model inputs are readily accessible to allow adjustments to more closely reflect local conditions. A User's Manual was created for MDT to direct staff through the steps of modifying the program to meet local conditions. The model results given in this Phase II Report are based upon input data from MDT and not the data base supplied by the Federal Railroad Administration. The input data can easily be updated as conditions at study locations change.

Construction Methodology & Costs

Cost analysis was based upon costing major components of a grade separation project. Units of each major item of work were estimated from the design alternatives developed as a part of this study and are contained in Appendix A. Unit costs for the estimated quantities were based upon evaluation of the Montana Department of Transportation Contract Plans Sections – Items Catalog. Descriptions of the construction methods required at each location, and for each alternative investigated assumed are included in

Appendix A. Results of the Benefit – Cost evaluation for study locations and alternatives are summarized in Table 2.

Table 2 - Benefit Cost Ranking

Location	Alt	Benefit	Cost	Benefit/Cost
Billings - 27th Street	Underpass	$7,845,800	$22,408,701	0.35
Helena - Montana Avenue	Underpass	$3,951,800	$16,430,995	0.24
Helena - Montana Avenue	Overpass	$3,951,800	$20,331,690	0.19
Helena - Benton Avenue	Underpass	$2,725,400	$14,940,052	0.18
Belgrade - Jackrabbit Lane	Underpass	$1,604,180	$9,301,892	0.17
Helena - Benton Avenue	Overpass	$2,725,400	$17,961,660	0.15
Bozeman - Griffin Dr.	Underpass	$1,285,300	$9,141,440	0.14
Miles City - Leighton Blvd.	Underpass	$1,562,900	$11,331,400	0.14
Laurel - 5th Avenue	Underpass	$992,500	$7,770,678	0.13
Bozeman - Griffin Dr.	Overpass	$1,285,300	$10,693,774	0.12
Helena - Roberts Street	Underpass	$1,007,600	$8,844,728	0.11
Billings - Moore Lane	Underpass	$2,674,200	$23,800,891	0.11
Miles City - Leighton Blvd.	Overpass	$1,562,900	$17,225,271	0.09
Billings - 28th Street	Underpass	$1,211,800	$18,177,529	0.07
Billings - 29th Street	Underpass	$1,211,800	$18,177,529	0.07
Wolf Point - 6th Street	Underpass	$522,860	$8,597,926	0.06
Helena - Roberts Street	Overpass	$1,007,600	$17,283,482	0.06
Wolf Point - 6th Street	Overpass	$522,860	$10,440,730	0.05

Figure 19 in the Conclusion portion of this report illustrates the benefit cost evaluation and the cumulative needs evaluation score for each crossing within the same graphic.

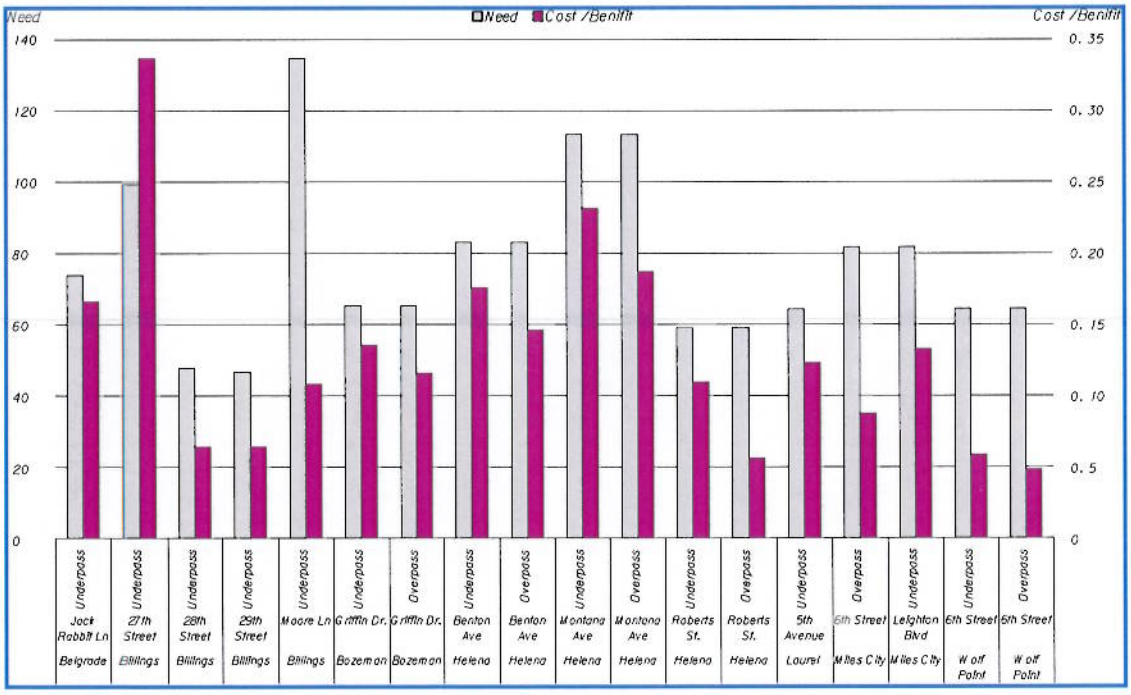
CONCLUSIONS

Utilizing the data supplied for this study from the Montana Department of Transportation, the "Needs" based model developed for this project, GradeDec 2000 and the cost figures listed in Appendix A, the Cumulative "Need" and Benefit –Cost for each alternative investigated is shown in Table A.

Table 3 – Model Results

Community	Crossing Location	Crossing ID	Need Score	Benefit/Cost Underpass	Benefit/Cost Overpass
Belgrade	Jack Rabbit Ln	060090P	73.84	0.17	NA
Billings	Moore Ln	087383W	134.82	0.11	NA
Billings	27th Street	087491T	99.43	0.35	NA
Billings	28th Street	087492A	47.71	0.07	NA
Billings	29th Street	087493G	46.63	0.07	NA
Bozeman	Griffin Dr.	060073Y	65.23	0.14	0.12
Helena	Montana Ave	060193P	113.38	0.24	0.19
Helena	Benton Ave	06199F	83.11	0.18	0.15
Helena	Roberts St.	060192H	59.11	0.11	0.06
Laurel	5th Avenue	104007M	64.32	0.13	NA
Miles City	Leighton Blvd	092664R	81.69	0.14	0.09
Wolf Point	6th Street	059580K	64.50	0.06	0.05

Figure 19 – Graphic Model Results



The Montana Department of Transportation Rail / Highway Grade Separation Needs Study involved thirteen communities within the state and involved hundreds of public officials and private citizens. Public input from this study placed high priority on criteria dealing with emergency vehicle response times (delay) and the operating safety of each crossing. This emphasis on safety was reflected in both urban and rural communities. The need based model developed for use by the Department emphasizes the health and safety of the traveling public.

The need based model and the benefit–cost model developed in this study provide the Montana Department of Transportation with the tools to aid with the prioritizing of Federal and State funds that could be used for rail crossing improvements including rail/highway grade separations, should such funding become available. The data required to run these evaluations is maintained by different MDT divisions and bureaus or is readily available by contacting emergency service providers, local school districts, or local agencies.

The results of the application of these models will not necessarily result with the funding of any specific grade separation improvements. Use of the words "will be" or "would be" in Appendix B – Construction Sequence and Construction Costs was for the purpose of developing planning level construction costs at each location.

APPENDIX B- Construction Sequence and Cost Analysis

and

APPENDIX C- GradeDec 2000 Results

(Appendices available by request)

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