

I-70 Exit 97 Silt Interchange Study

Prepared For:



CDOT Region 3

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Table of Contents

INTRODUCTION	1
EXISTING CONDITIONS.....	1
Geometry.....	3
Signs & Markings	5
Traffic Volumes.....	5
Crash History.....	5
ALTERNATIVES.....	6
2025 Design Option	6
2040 Design Options	8
<i>Diamond Interchange</i>	9
<i>Roundabout Interchange</i>	9
<i>Diverging Diamond Interchange (DDI)</i>	10
EVALUATION & FINDINGS	14
IMPLEMENTATION PLAN	15
APPENDIX.....	17

Table of Figures

Figure 1: Location Map.....	2
Table 1: Summary of Relevant Design Criteria	3
Figure 2: Existing Geometry.....	4
Figure 3: 2025 Design Option.....	7
Figure 4: 2040 Diamond Interchange	11
Figure 5: 2040 Roundabout Interchange	12
Figure 6: Diverging Diamond Interchange.....	13
Table 2: Evaluation Criteria Matrix.....	14
Table 3: Project Implementation	15

INTRODUCTION

The Colorado Department of Transportation (CDOT) has identified a need to review the existing interchange on I-70 at Exit 97 in Silt. The study area includes: mainline I-70 in the vicinity of the interchange; the interchange including auxiliary lanes, ramps, and ramp terminal intersections; the crossing arterial and the nearest intersections along the crossing arterial on either side of the interchange (including the US Hwy 6 intersection).

CDOT initiated this study to evaluate existing conditions at I-70 Exit 97; to identify observed deficiencies; to prioritize alternatives for improving the operational and safety characteristics of the interchanges; and to make recommendations regarding the opportunity for corrective action.

Based on stakeholder input, the following goals for the study were established to guide the prioritization of improvements for implementation:

- Improve safety for interchange traffic and through traffic on I-70.
- Identify long-term improvements that accommodate 2040 traffic growth.
- Maintain compatibility with the intent of previous planning efforts.
- Elevate projects that can be implemented and maintained easily.
- Minimize impacts to the adjacent community and resources.
- Support the development of alternative modes.

This report summarizes the study process, existing conditions, analyses, findings, and recommendations for interchange improvements on I-70 at Exit 97.

EXISTING CONDITIONS

I-70 Exit 97 provides access to US 6 and River Frontage road, which serves residential, business, and recreational areas in the Town of Silt. A large portion of traffic is commuter traffic leaving Silt in the morning to head to points east, such as Glenwood Springs, and then returning to Silt in the evening. The location of the interchange is shown in Figure 1.

The layout of the interchange at I-70 Exit 97 is an existing diamond interchange that is situated between the Colorado River and the Union Pacific Railroad (UPRR). The UPRR and River Frontage Road run closely parallel to I-70 and the ramps, influencing the geometry of the existing interchange. The intersections at the interchange are stop controlled at the off-ramp termini only.

Concrete barrier has been placed at the corners of the eastbound and westbound off-ramps, which show signs of displacement and cracking due to possible impact by turning vehicles.



Concrete barrier condition at the westbound off-ramp



COLORADO
Department of
Transportation

EXIT 97 - SILT INTERCHANGE
JULY 14, 2015
Figure 1

Stolfus

The bridge over I-70 has a structural sufficiency rating of 79.5 and the bridge over UPRR has a rating of 58.6 based on the most current CDOT bridge inspection reports in 2014. They are in relatively good condition; therefore, they are not in need of replacement in the near future.

Geometry

As-built geometry was evaluated using aerial photography supplemented by field observations and measurements. Geometry was evaluated against current design criteria (CDOT Design Guide 2005). Based upon posted speed limits along the mainline as well as ramps, the following criteria were established.

Table 1: Summary of Relevant Design Criteria

Element	I-70	Ramps
Minimum Design Speed	75 MPH	35 MPH
Maximum Superelevation	6%	6%
Maximum Grade	5%	6%
Minimum Stopping Sight Distance	820 ft	360 ft
Minimum Lane Width	12 ft	15 ft
Minimum Shoulder Width	4 ft inside / 10 ft outside	4 ft inside / 6 ft outside
Accel / Decel Length	1420 / 482 (3% Upgrade)	

When the above design criteria are applied, it is apparent that there are a number of substandard aspects of the interchange, including:

I-70 Eastbound Off-Ramp

- Minimum Shoulder Width – Inside (3 ft)
- Minimum Shoulder Width – Outside (2 ft)
- Deceleration Lane Length (175 ft)

I-70 Westbound Off-Ramp

- Minimum Shoulder Width – Inside (3 ft)
- Minimum Shoulder Width – Outside (2 ft)
- Deceleration Lane Length (275 ft)

I-70 Eastbound On-Ramp

- Minimum Shoulder Width – Inside (2 ft)
- Minimum Shoulder Width – Outside (2 ft)
- Acceleration Lane Length (1245 ft)

I-70 Westbound On-Ramp

- Minimum Shoulder Width – Inside (2 ft)
- Minimum Shoulder Width – Outside (2 ft)
- Acceleration Lane Length (1320 ft)

I-70 Mainline

- Minimum Shoulder Width – Inside (4 ft)
- Minimum Shoulder Width – Outside (10 ft)

Existing geometry is illustrated in Figure 2.

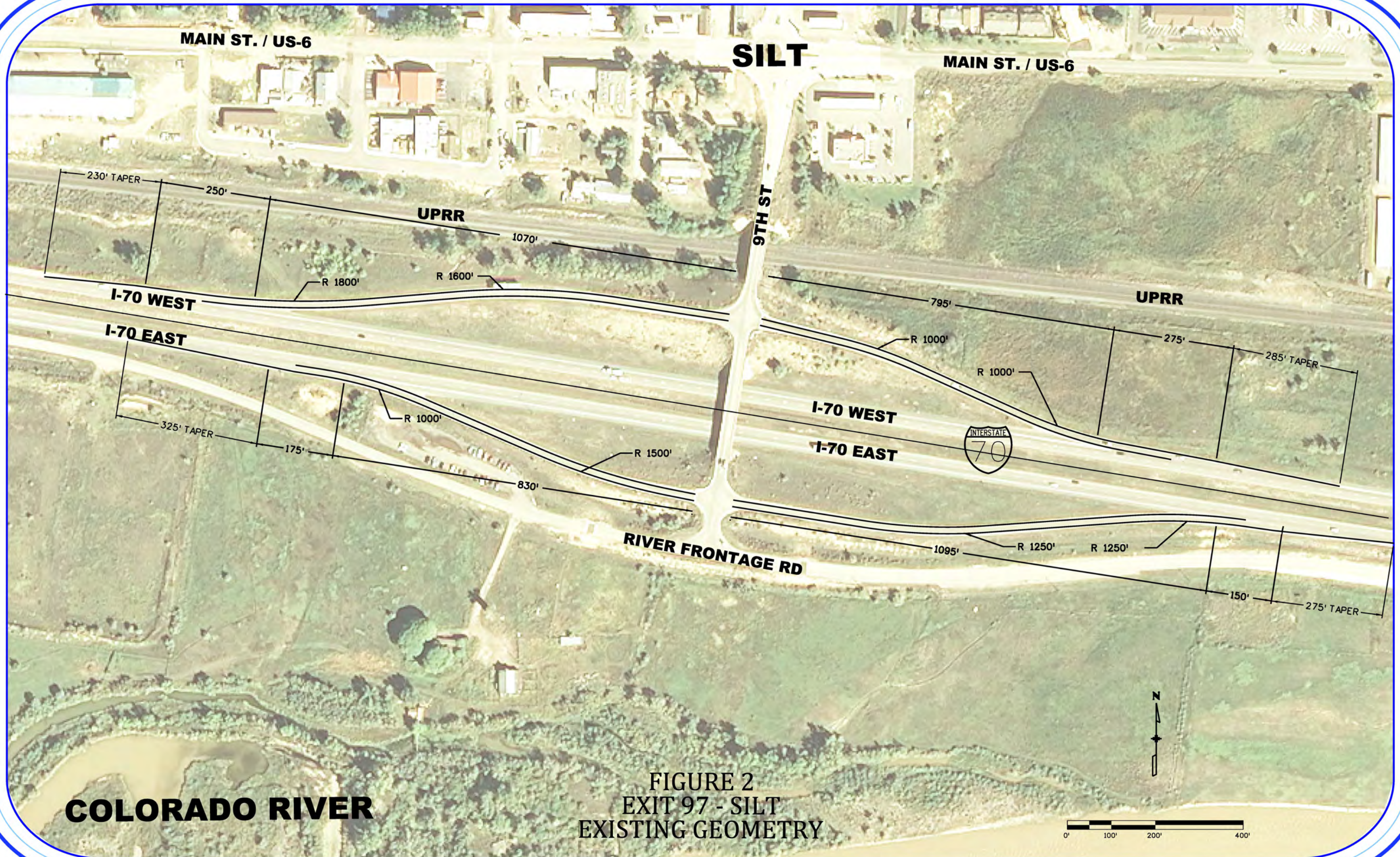


FIGURE 2
EXIT 97 - SILT
EXISTING GEOMETRY

Signs & Markings

Existing signs and pavement markings at the interchange are appropriately placed and are in good condition. However, the existing guide signs at the interchange ramps do not meet current design standards specified in the Manual on Uniform Traffic Control Devices (MUTCD).

Traffic Volumes

AM and PM intersection turning movement counts were collected in the study area intersections on a weekday in August of 2015. 24 hour roadway segment counts on the I-70 ramps and in the vicinity of the interchange were also collected. The traffic counts collected have shown that the heaviest movements are on the west segment of Main Street and the eastbound on-ramp in the AM peak hour; and on the west segment of Main Street and the westbound off-ramp in the PM peak hour. This is reflective of the heavy commuter traffic from Silt to other destinations east of the interchange. It has been noted that traffic on the eastbound off-ramp in the afternoon tends to back up on the existing ramp. Existing traffic volumes and ramp junction level-of-service results are provided in the Appendix.

Year 2025 and 2040 traffic volumes were developed for the I-70 Exit 97 Interchange Study at the request of CDOT. The year 2040 traffic volumes were used to evaluate the need for capacity improvements at the interchange and adjacent intersections. Future development planned in the vicinity of the interchange was taken into account when developing the future traffic volumes. Future projected traffic volumes methodology, analysis results, and level-of-service results for alternatives considered are provided in the appendix.

Crash History

Five years of crash data were analyzed for this study, from January 1, 2010 through December 31, 2014. An analysis was completed for the stretch of I-70 from the beginning of the Silt interchange (milepost 93.99) to the end of the New Castle interchange (milepost 109.00 at Exit 105). There were 494 crashes reported along the I-70 mainline. There were 108 collisions that caused injuries (142 persons injured) and six (6) fatal crashes (7 persons killed). The study segment generally performs better than expected in terms of safety when compared to other mountainous 4-lane divided freeways in rural areas.

Collisions with wild animals were the most common crash type along this segment of I-70. A year-by-year analysis of the crashes shows that the installation of wildlife fencing in 2013 was very effective and reduced crashes of this type by approximately 90%.

Despite the existing geometric deficiencies, the crash history did not reveal any suspicious clusters or crash patterns at any of the ramp merge/diverge points with the freeway or along the individual ramps that may be correctible through geometric improvement. Crash data, documented as a CDOT Safety Study, is provided in the Appendix.

ALTERNATIVES

2025 Design Option

A design option was developed that upgrade the existing configuration to current design standards. This option was intended to use as much of the existing configuration as possible and be designed to accommodate five-year future traffic volumes, while minimizing impacts to the existing bridge structures and improving ramp safety and capacity. A number of improvement opportunities have been identified for this interchange, including:

- Increasing the acceleration and deceleration lengths on all four ramps to bring to current design standards
- Adding signals at the ramp intersections
- Providing two receiving lanes at the end of the eastbound off-ramp to separate left-turn traffic from right-turn traffic
- Increasing turning radii at all right-turn movements where feasible to facilitate wider right-turns and avoid over tracking
- Replacing concrete barrier where necessary at the ramp intersections.

It is anticipated that, based on the assumed growth rates, the signal at the ramp intersections will most likely meet peak hour warrant; however, a complete warrant analysis (for all applicable warrants) and accompanying approval by the Region 3 Traffic Engineer will be required prior to the installation of a traffic signal.

The existing bridges across I-70 and the UPRR would not have to be widened to accommodate projected volumes. The Town of Silt observes that the existing barrier at the ramps has been struck several times and is in need of replacement. Evaluation of the existing turning radii shows that the current right-turn design does not accommodate some of the large vehicles that travel through this interchange, which may result in the barrier being struck by wheels of these large vehicles. The existing bridge locations and widths create limitations to how much the right-turns can be improved without replacing parts of the bridge. Therefore, it is recommended that to implement a 2025 improvement in the near future, the existing bridges should be left as-is, and the radii of the curves should be increased as much as physically possible without impacting the bridges.

The existing roundabout at US 6 and 9th Street functions at an acceptable level of service (LOS) in 2025, but capacity improvements are needed shortly after 2025.

The engineer's opinion of probable cost is \$4,690,000 (see Appendix for detailed estimate). The proposed improvement layout can be found in Figure 3.



Figure 3
EXIT 97 - SILT
2025 IMPROVEMENTS

2040 Design Options

Alternative design options were developed that will accommodate projected 20-year future traffic volumes. Design options include upgrading the current configuration and interchange reconfigurations that could accommodate future traffic volumes and patterns. Impacts to structures and right-of-way were minimized, where possible.

Alternatives were developed using future projected traffic volumes. Design options incorporated capacity improvements to ensure acceptable traffic operations in 2040, such as turn lanes, storage bays, number of lanes, and sufficient merge/weave distances. Refer to traffic memo for traffic findings.

It was noted by the Town of Silt that they would like to improve the grade of the eastbound off-ramp. Detailed vertical analysis was not included in this study, therefore additional design and consideration should be made when any improvements are in final design.

A total of five interchange alternatives were initially identified in the study as potential design solutions that were evaluated:

- Diamond Interchange
- Roundabout Interchange
- Diverging Diamond Interchange (DDI)
- Diverging Diamond Interchange with a Roundabout
- Single Point Urban Interchange (SPUI)

Ultimately, the diamond, roundabout, and DDI options moved forward into detailed analysis and evaluation. Based on the structure needs and the characteristics of the existing community, the DDI with roundabout and the SPUI overall did not fit well in this project area, so they were eliminated from consideration. Initial interchange concepts can be found in the Appendix.

All 2040 options assume that the acceleration/deceleration lengths and tapers at the ramps remain the same as the 2025 option. The existing bridges will need to be widened to accommodate any of the 2040 options. It was assumed that the bridges would be widened from the middle of the existing structure. Further analysis of the existing bridge structures is needed to determine what additional improvements may be required to support the preferred option.

All alternatives include increasing the size and capacity of the existing roundabout at US 6 and 9th Street from a one-lane to a two-lane roundabout. Improvements will therefore be necessary along Main Street (US 6) and 9th Street to accommodate the additional entering and exiting lanes. These improvements are reflected on each of the 2040 options. However, the roundabout could also be converted back to a traditional intersection with added turn lanes and through lanes if a larger roundabout is not desired.

The three options are summarized below.

Diamond Interchange

The diamond interchange option offers the following improvements:

- Increasing the turning radii at the westbound ramps to accommodate a WB-67 design vehicle and increasing the turning radii at the eastbound ramps to accommodate a WB-40 design vehicle.
- Providing two receiving lanes on the eastbound on and off-ramps, and at the westbound off-ramps to provide additional capacity.
- Realigning River Frontage Road to create more space between the 9th Street intersections with the eastbound ramps and River Frontage Road.
- Adding signals at the ramp intersections and the intersection of River Frontage Road and 9th Street.
- Widening the existing bridge from two to four lanes.
- Walls are anticipated on the two eastbound ramp corners towards the railroad bridge due to the vertical difference and the close proximity between the ramps and the bridge.

The walls are needed to adjust for the vertical difference between the existing ground and the proposed layout in areas where fill slopes would be difficult to construct and maintain. Additional vertical design would be needed in the future to determine the exact limits and height of the vertical walls.

The engineer's opinion of probable cost is \$23,080,000 (see Appendix for detailed estimate). The proposed layout is shown in Figure 4.

Roundabout Interchange

The roundabout interchange option offers the following improvements:

- Adding roundabouts at the ramp intersections.
- Accommodating a WB-67 at all interchange movements with the roundabout design and the use of truck aprons.
- Providing two receiving lanes on the eastbound on-ramp and westbound off-ramp.
- Eliminating the intersection of 9th Street and River Frontage Road by combining the movements with the roundabout at the eastbound ramps.
- Widening the existing bridge from two to three lanes. The additional lane is added in the southbound direction towards the eastbound off-ramp.
- Walls are anticipated at the four corners of the westbound ramps, the two corners adjacent to I-70 at the eastbound ramps, and along the realigned River Frontage Road.

Construction of the roundabouts could be phased as-needed once the 2025 improvements are made. The engineer's opinion of probable cost is \$22,010,000 (see Appendix for detailed estimate). The proposed layout is shown in Figure 5.

Diverging Diamond Interchange (DDI)

The diverging diamond interchange option offers the following improvements:

- Adding two receiving lanes at each of the ramps.
- Increasing the turning radii at all movements at the westbound ramps and movements to and from the Town of Silt at the eastbound ramps to accommodate a WB-67 design vehicle.
- Increasing the turning radii at the eastbound ramps to accommodate a WB-40 design vehicle approaching and leaving River Frontage Road.
- Realigning River Frontage Road to create more space between the 9th Street intersections with the eastbound ramps and River Frontage Road.
- Adding signals at the ramp intersections and the intersection of River Frontage Road and 9th Street.
- Widening the existing bridge from two to four lanes, with a median in the center that is required for the DDI design.
- Walls are anticipated at the four corners adjacent to I-70 at the ramps.

The DDI provides more capacity compared to the diamond and roundabout interchanges, providing a longer design life that extends past 2040. This is partially because the DDI has a two-phase operation and free left-turn movements. Drivers are able to enter the interstate from the minor roads faster.

Construction of the DDI would have to be completed as a whole, and could not be phased in pieces. The engineer's opinion of probable cost is \$28,230,000 (see Appendix for detailed estimate). The proposed layout is shown in Figure 6.



Figure 4
EXIT 97 - SILT
2040 ALTERNATIVE
DIAMOND INTERCHANGE



Figure 5
EXIT 97 - SILT
2040 ALTERNATIVE
ROUNDBOUT INTERCHANGE



Figure 6
EXIT 97 - SILT
2040 ALTERNATIVE
DIVERGING DIAMOND INTERCHANGE

EVALUATION & FINDINGS

At the beginning of the study, a set of goals was established, as listed in the Introduction. Based on these goals, an evaluation matrix was developed to provide a logical means for measuring which alternatives best met the established project goals. The matrix identified a set of evaluation criteria that correspond with each project goal. A simple rating system that identifies the alternative as favorable, neutral or unfavorable with respect to each criterion was defined. Each of the three ratings under each criterion was then given a definition specific to the criteria to assist in the evaluation. The goals and associated evaluation criteria are listed in Table 2. Rating definitions can be found in the Evaluation Matrix in the Appendix.

Table 2: Evaluation Criteria Matrix

Goal	Evaluation Criteria
Improve safety for interchange traffic and through traffic on I-70.	Accident patterns
	Geometric conditions
	Design vehicle
Identify long-term improvements that accommodate 2040 traffic growth.	Intersection delay
	Queue length
	I-70 operations (mainline, merge/diverge)
	Weaving (between intersections)
Maintain compatibility with the intent of previous planning efforts.	Compatibility with local planning efforts
	Local support
Elevate projects that can be implemented and maintained easily.	Construction cost
	Funding opportunities
	Construction phasing opportunities
	Project implementation opportunities
	Physical constraints
	Project clearances
	Constructability
	Long-term maintenance
Minimize impacts to the adjacent community and resources.	Environmental impacts
	Private property impacts (ROW)
	Railroad impacts
Support the development of alternative modes.	Compatibility with established/future pedestrian and bicycle routes

The results of the evaluation by alternative are listed in the Appendix.

In summary, the 2025 Design Option ranked highly overall and had no fatal flaws. It is recommended that these improvements identified in this study be made prior to 2025 to address the design deficiencies in the short term.

Any of the three 2040 options are capable of accommodating future traffic demand. However, the roundabout interchange ranked the highest based on evaluation criteria parameters. As a comparison, the roundabout interchange had an evaluation score of +10 overall, whereas the

diamond interchange and the DDI had scores of +6 and +2, respectively. The roundabout interchange also fits well with previous planning efforts that have been done prior to this study, in which roundabouts were proposed at the ramps. The Town of Silt has gained positive feedback on the existing roundabout in place at US 6 and 9th Street, therefore the Town feels that the additional roundabouts will be accepted by stakeholders. The roundabout option could also be phased based on availability of funding.

IMPLEMENTATION PLAN

Based on a review of existing conditions and operations of the Silt Interchange, development and evaluation of improvement alternatives, and input gathered from project stakeholders, the I-70 Exit 97 Silt Interchange Improvements Study developed an Implementation Plan that prioritizes potential future improvements that may be implemented as funding becomes available. The Implementation Plan provides short-term (year 2025 analysis) and long-term (year 2040 analysis) recommendations. The short-term recommendations identify those improvements that provide proven solutions for existing deficiencies, result in relatively minor physical impacts, and can be easily implemented in terms of funding and project clearances. The long-term recommendations identify those improvements that may require additional investigation to confirm effectiveness of the solution, result in more significant physical impacts, and/or require moderate to significant effort to obtain project clearances and funding.

Table 3 below summarizes the individual prioritization of projects for implementation. While the recommended improvements have been identified as short and long term for general planning purposes, precise time periods have not been attributed to each category since demand for implementation is dependent upon a number of influences including: effectiveness of previous implementation strategies, future demand, development of future conditions and technology, and availability of funding. In addition, the Implementation Plan is not intended to dictate the exact order of implementation required. CDOT should maintain flexibility to take advantage of opportunities that arise to advance particular projects based on new information or changing conditions, or to combine related projects that may be individually prioritized separately to realize cost and/or resource savings.

Table 3: Project Implementation

Rank	Project	Timing
1	Improve ramps -- acceleration/deceleration lane extensions, separate turn lanes on ramps.	Short-term
2	Install signals at the I-70 ramp intersections, if warranted.	Short-term
3	Increase roundabout capacity at US 6 and 9 th Street.	Short-term
4	Widen bridge over UPRR.	Long-term
5	Widen bridge over I-70.	Long-term
6	Install roundabout at I-70 eastbound ramps.	Long-term
7	Install roundabout at I-70 westbound ramps.	Long-term

As conditions in the corridor and technologies change, CDOT will need to review and update this plan. CDOT should continue to monitor operations of the existing interchange to determine the appropriate time frame for implementation of future projects and to identify the need for consideration of other solutions.

APPENDIX

Existing and Future Traffic Volumes

Level-of-Service (LOS)

Safety Assessment Report

Initial Interchange Concepts

Opinions of Probable Cost

Evaluation Criteria Tables