I-70 Mountain Corridor CSS

I-70 Reversible Lane - Phase II

Phase II Feasibility Study

Evaluation and Screening of Operational Alternatives

Submitted for Federal Highway Administration Review

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1.0 INTRODUCTION AND BACKGROUND

The section of Interstate 70 (I-70) between the Eisenhower Johnson Memorial Tunnel (EJMT) and Denver experiences recurring peak period congestion on weekends. This 45-mile, four-lane section of I-70 is the primary access route from Denver to the mountains of western Colorado where there are numerous opportunities for outdoor activities: skiing in the winter, as well as camping, hiking, biking, sightseeing, etc. in the summer and fall. Consequently, this corridor experiences heavy flows of westbound traffic on Friday afternoons as well as Saturday and Sunday mornings. Eastbound traffic is heavy later in the day, and the highest peak hour congestion occurs on Sunday afternoons when both day and weekend visitors are returning for the start of the work week.

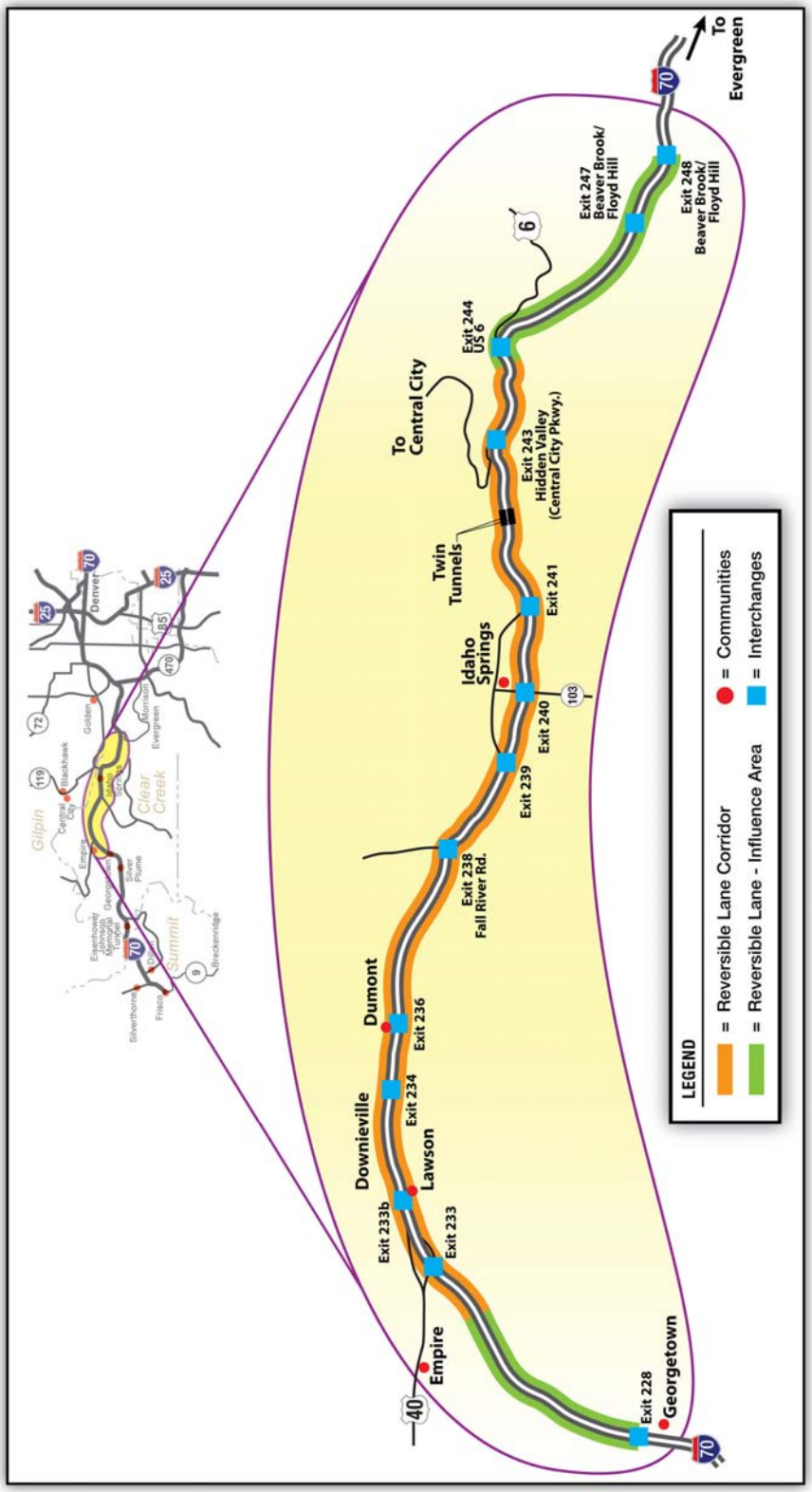
The majority of this congestion occurs in the segment between Georgetown and the Floyd Hill area (see **Figure 1**) for the following reasons:

- Heavy traffic volumes enter and exit I-70 at Empire Junction (the US 40 interchange serves numerous recreational opportunities in Grand County that use Berthoud Pass) just east of Georgetown.
- The roadway geometry through Idaho Springs and west of the Hidden Valley interchange is constrained, with narrow shoulders and tight curves.
- The Twin Tunnels (located between Idaho Springs and Floyd Hill) are operationally constrained because of the narrow shoulder widths.
- The I-70 Mountain Corridor carries an average of approximately 10 percent truck traffic.
- Roadway users also have to contend with 3 percent to 4 percent grades. Slow-moving vehicles contribute to congestion.

These operational and geometric issues lead to several consequences:

- The traveling public experiences substantial delays during congested periods. Travel times can double when compared to uncongested conditions.
- Motorists divert to an adjacent local roadway and cause congestion on this route, affecting areas beyond the Interstate. This local road is the “main street” for Lawson, Downieville, and Dumont and the only continuous east-west street through Idaho Springs. It provides access to numerous adjacent properties throughout its length and has an appropriately lower speed. Thus, it is not suitable as an alternate route for I-70 traffic.
- Additional crashes occur in the traffic backups, further delaying motorists.
- Congested travel conditions result in traffic metering at the EJMT, a process of holding and releasing traffic to prevent backups within the tunnel. Metering results in additional backups, further exacerbating these conditions.
- Emergency services and transportation-dependent commerce are delayed.

Figure 1 Study Area for Proposed Reversible Lane Only Alternative



The Colorado Department of Transportation (CDOT) has been studying the I-70 Mountain Corridor for more than 20 years and has worked extensively with stakeholders to develop a long-term (50-year) transportation solution for the corridor. In response to a 2004 draft National Environmental Policy Act (NEPA) document, stakeholders grew distrustful of CDOT and asked for a greater role in the decision-making. CDOT and the Federal Highway Administration (FHWA) responded by convening a Collaborative Effort to explore long-term solutions for the corridor. This effort involved 27 members who were selected to participate in a three year process to explore long-term solutions and recommend a preferred alternative. In June 2008, FHWA and CDOT adopted their recommendation as a Preferred Alternative. The process is documented in the *I-70 Mountain Corridor Draft Programmatic Environmental Impact Statement* (I-70 Mountain Corridor PEIS), September 2010. The Collaborative Effort process used on this corridor was precedent setting. CDOT and FHWA have committed considerable time and staff resources to moving this process forward, and they are working with the stakeholders to identify a long-term solution through the I-70 Mountain Corridor Context Sensitive Solutions (CSS) process. The CSS process has brought together a multi-disciplined, multi-interest stakeholder group to discuss, debate, and capture what they respect and will work to preserve in the corridor. However, due to funding limitations it is anticipated that the improvements will be implemented over many years, resulting in persistent and worsening congestion and delays until major, long-term improvements can be made.

The desire for immediate congestion relief led to the passage of Senate Bill 10-184 in 2010, by the Colorado General Assembly. While CDOT had already begun looking into the possibility of a reversible lane, the legislation directed the Department to study and implement (if appropriate) a reversible lane along I-70 from EJMT to Floyd Hill, consistent with the planning and environmental process. The legislation identified a goal to implement (if appropriate) and report to the legislature by January 1, 2011. The legislation also authorized the Colorado High Performance Transportation Enterprise (HPTE) to enter into a single or multiple lease or lease-purchase agreement to operate the reversible lane.

To address current congestion in the near future until long-term improvements can be implemented, CDOT considered a number of alternatives. From these, CDOT advanced two alternatives involving a reversible lane as providing the best opportunity to manage congestion on I-70 west of Denver on winter Sunday afternoons when skiers are returning from mountain resorts. Both of these alternatives would provide additional capacity for eastbound peak traffic periods by converting one westbound lane to eastbound flow using a movable barrier. The Reversible Lane Only Alternative would utilize a moveable barrier for a total distance of 12.7 miles from west of Empire Junction to east of the Hidden Valley interchange. The Hybrid Alternative would utilize a combination of hard shoulder running (6.2 miles from the US 40 on-ramp at Empire Junction to just west of Idaho Springs) and a moveable barrier (5.2 miles from west of Idaho Springs to east of Hidden Valley interchange).

If approved, CDOT anticipates implementing one of the reversible lane alternatives as a two-phased project. A two-year Reversible Lane Pilot Program could be operational in 2011. The Pilot Program, with associated risks and reduced cost, would allow this innovative idea to be tested. After two years, the Pilot Program would be evaluated to determine if it should be continued. An Enhanced Program could then be implemented with appropriate additional features that would improve its performance and facilitate longer-term operations.

CDOT issued the *Phase I Feasibility Study Executive Summary Report* (August 2010) for the reversible lane (included as **Appendix A**), in which several analyses were undertaken to evaluate the initial feasibility of the reversible lane. The goal of the *Phase I Feasibility Study* was to answer the following fundamental questions:

- Would roadway geometry and topography allow construction of transition crossovers to operate safely? Are there other geometric constraints that would prohibit using the movable barrier technology to create an eastbound reversible lane?
- Is implementing a reversible lane in the eastbound direction on winter Sunday afternoons feasible considering traffic volumes? Specifically, what would be the impact to westbound traffic? Would reversible lane operations be feasible in the westbound direction, and would operations be feasible at any other times (Saturdays or summer season)?

Key elements and findings of the *Phase I Feasibility Study* include:

- The analysis determined that the reversible lane would provide the greatest potential benefit on 17 Sundays in the winter season. Analyses showed that other potential reversible lane operational periods would not be feasible or that it would provide limited benefits because traffic volumes are too high or too low, the directionality of traffic is not appropriate, or the window of opportunity is too short. Refer to page 7 of the *Phase I Feasibility Study*.
- Traffic modeling indicates that implementation of the reversible lane on winter Sunday afternoons would provide an overall 13 percent travel time benefit to the traveling public in the I-70 Mountain Corridor.
- Suitable locations for median crossovers were found at each end of the reversible lane.
- Although tight, the westbound direction of I-70 has sufficient width to accommodate the reversible lane operation through the proposed segment.

On the basis of the outcome of the Phase I Feasibility Study, CDOT has considered critical issues in more detail during the Phase II Feasibility Study (included as **Appendix B**). These critical issues included safety and emergency response, maintenance and snow removal, public relations, environmental impacts, modes of operation and project delivery, concept of operation and operational enhancements, and geometric design issues.

Restricting I-70 to one westbound lane constitutes a federal action, consistent with 23 CFR 658.11. Reducing the Interstate to one lane outside of a construction project with a reversible lane system is a fairly unique application of the technology. As such, FHWA has requested an evaluation and screening of possible alternatives to solve congestion in addition to a reversible lane for the entire corridor. These alternatives are limited in scope in that they are intended to be short-term solutions for the corridor before long-term improvements are implemented.

For final approval, FHWA has a rigorous 45-day approval process, and the Colorado Division Office requires the following information prior to submitting the proposal for official FHWA Headquarters review:

- Compare alternatives to analyze other solutions to congestion
- Review safety, benefits, roadway geometry, lane and shoulder width, etc. associated with the proposed alternatives
- Perform a traffic analysis on current proposed reversible lane and other alternatives
- Complete required NEPA clearance
- Provide stakeholder involvement
- Develop operational and incident management plans
- Evaluate impacts on:
    - Access and interchanges
    - Travelers, especially in the westbound direction
    - Interstate commerce
    - Emergency response
    - Public transportation

This work has been completed in support of the Phase II Feasibility Study and has been summarized in the following document.

2.0 PURPOSE OF AND NEED FOR PROJECT

The purpose of this project is to provide short-term operational improvements to relieve traffic congestion on winter Sunday afternoons between 1:00 PM and 7:00 PM when eastbound congestion is highest along I-70 between approximately Empire Junction and Floyd Hill. The operational improvements would comprise measures that could be implemented within a relatively short timeframe and without substantial construction outside of the existing I-70 highway footprint. The project is intended to provide short-term operational improvements in advance of longer-term major improvements to the I-70 Mountain Corridor.

This project is needed to provide eastbound congestion relief and reduce overall travel times in the corridor because:

- The traveling public experiences substantial delays eastbound – typical winter Sunday travel times up to 79 minutes – during congested periods from Georgetown to Evergreen. This represents more than double the travel time during uncongested weekend period conditions.
- Motorists divert to alternate routes, such as the limited frontage road system, causing congestion and affecting areas beyond the Interstate itself.
- Additional crashes occur in the traffic backups, further delaying motorists.
- Emergency services and transportation-dependent commerce are delayed.

3.0 ALTERNATIVES CONSIDERED BUT NOT ADVANCED

A number of operational alternatives were considered for relieving the current peak congestion. The following alternatives were not advanced as standalone alternatives, but some elements are included in alternatives that were advanced:

- Hard Shoulder Running
- Use Restrictions
- Congestion Pricing
- Non-Tolling Pricing
- Active Traffic Demand Management
- Ramp Metering
- Spot Improvements
- Incident Management Plan

These alternatives have been evaluated on the basis of safety, potential environmental impacts and proposed mitigations, traffic operations, stakeholder input, logistical and operational complexity, and legal implications. The following discussion provides a summary of each considered alternative, the conclusion of the evaluation, and an explanation for why it was not advanced for further study.

3.1 HARD SHOULDER RUNNING

3.1.1 Description

Hard Shoulder Running (HSR) utilizes the outside shoulder as a travel lane to increase the capacity of a congested corridor during specified periods. This use of shoulders is often accompanied by new lane striping, special signage, new emergency pullout areas, and variable speed limits to improve safety. Use of hard shoulders for peak hour traffic has been implemented at several locations on the East Coast and in Texas. Its use is more common in Europe.

The logical place to start the hard shoulder would be Empire Junction where eastbound US 40 traffic enters I-70. With the exception of one pinch point at the SH 103 bridge in Idaho Springs, the current width of the eastbound roadway is at least 37 feet. This would allow striping for one- to two-foot shoulders (outside and inside, respectively), one 11-foot lane, one 12-foot lane, and an 11-foot HSR lane/shoulder on the outside.

The use of the shoulder could extend only to the west end of the Twin Tunnels east of Idaho Springs. The roadway width through the tunnels is currently 29 feet and the shoulders are not wide enough to convert to a general traffic lane. HSR would thus need to merge back into two lanes before entering these tunnels. This would create delays similar to today's conditions and would also likely increase the number of crashes.

3.1.2 Conclusion

HSR would not adequately address eastbound peak congestion because the Twin Tunnels east of Idaho Springs are one of the primary constraints in the I-70 Mountain Corridor. Because capacity has not been increased, traffic would back-up from the tunnel as it does today.

Eliminating the constraint of the Twin Tunnels east of Idaho Springs is not an improvement that can be accomplished in the short-term; therefore, it does not meet the purpose of this project. By itself, it also does not meet the need for the project because it would neither provide congestion relief nor reduce delays. However, HSR has been included as an integral element of the Hybrid Alternative west of Idaho Springs which, in combination with a reversible lane through the Twin Tunnels, could improve traffic operations in the study corridor.

3.2 USE RESTRICTIONS

3.2.1 Description

The Use Restrictions Alternative would place restrictions on I-70 traffic, such as prohibiting heavy vehicles (trucks, buses, and large recreational vehicles) during specified periods. Restrictions might be accomplished in a similar manner to winter closures due to adverse road and weather conditions. An information dissemination plan for prohibited heavy vehicles would be needed during the restricted periods. Variable message signs starting at the Utah and Kansas borders would provide information about restrictions. Locations where heavy vehicles can park for short periods have been established along the entire I-70 Mountain Corridor. Developing enforceable restrictions could be problematic since I-70 is a public Interstate highway. Legislation may be needed to accomplish additional restrictions.

The Phase I Feasibility Study analyses determined that prohibiting heavy vehicles on winter Sunday afternoons would result in minor reductions in travel times through the study area (one minute eastbound and nine minutes westbound). Along I-70 in the mountains, it has been observed that many heavy vehicles currently schedule travel in order to avoid congestion. Thus, the percent of heavy vehicles on Sunday afternoon is likely to be less than the average 10 percent overall.

3.2.2 Conclusion

Restrictions to commercial vehicles would require extensive coordination with commercial vehicle operators. Based on discussions with stakeholders during meetings with the Project Leadership Team (PLT), it is highly likely that they would strenuously resist these measures. The resulting project delay would mean that it would not meet the purpose of the project (short-term improvement). In addition, the potential, incremental reduction in congestion and delays resulting from this alternative would not meet the need for the project. This alternative is not being considered for inclusion in other alternatives.

3.3 CONGESTION PRICING

3.3.1 Description

The reversible lane project is not currently funded; therefore, a funding source must be identified in order for the project to move forward. Several potential strategies were qualitatively assessed during the Phase II Feasibility Study to determine the likelihood for funding the project, including traditional federal and state funding programs, grants, innovative financing, and tolling. These included two tolling scenarios that were assessed to determine the extent to which they could fund a portion of the project. The two tolling scenarios considered were 1) pricing the single reversible lane as a congestion-managed lane, and 2) tolling all three eastbound lanes.

It is important to note that several implementation steps must be successfully completed before tolling strategies could be employed for this project. First, authorization for tolling an Interstate

must be gained from FHWA before either alternative would be allowed. Initial discussions with FHWA indicate that authorization could be gained through their Value Pricing Pilot Program, in which CDOT is already participating. Further, the HPTE's charter legislation requires that every tolling project be supported by all local governments that would be potentially affected by the project. Finally, the Denver Regional Council of Governments (DRCOG) may request that the project follow its *1148 Review Procedures* for approving tolling projects because the project is within its planning area. The time required to negotiate these processes must be considered when evaluating a project implementation schedule.

3.3.2 Conclusion

Based on the Phase II analyses, it is unlikely that either of the tolling strategies could be approved and implemented in the short-term and thus would not meet the purpose of the project. In addition, a single congestion managed lane would not meet the project need of providing an overall net time savings for both eastbound and westbound traffic. This is because the premise of tolling the reversible lane is that a relatively low number of drivers would be willing to pay a charge set high enough to keep the travel speeds high. There is a balance between high tolls that keep volumes low and the speeds high. The result is much fewer than one-third of the eastbound traffic using the reversible lane, resulting in much less travel time savings for eastbound traffic as a whole. Factoring in the impact the reversible lane would have to westbound traffic, the overall net travel time difference would not meet the project's needs.

Tolling all three eastbound lanes has the potential to produce significantly more revenue. For the purpose of estimating the potential revenue that could be generated by this scenario, a range of toll rates from $0.05 to $0.20 per mile was assumed, which is consistent with typical rates for rural toll roads around the United States. Based on these assumed toll rates and the volume of traffic using the lanes during the hours of operation only, it is estimated that annual revenues in the range of $200,000 to $750,000 could be generated. This revenue could offset a portion of the $1.76 million O&M costs projected for the Enhanced Program for the Reversible Lane Only Alternative. However, it would be difficult to bond against this funding stream for up-front capital costs. In addition, some traffic would be expected to divert to the parallel frontage road where possible to avoid paying the toll. In summary, neither tolling strategy was advanced for further study. This alternative is not being considered for inclusion in other alternatives.

3.4 NON-TOLLING PRICING ALTERNATIVES

3.4.1 Description

Non-Tolling Pricing Alternatives consist of a menu of potential revenue-generating and/or behavior-modifying actions that are based on the premise that drivers would be charged for using limited transportation resources. In this application, the objective would be to reduce the use of a congested road during peak periods. These alternatives are relatively new and are not widespread or highly integrated. Some examples of these pricing alternatives include:

- Pay-as-you-drive-and-you-save (PAYDAYS) insurance – Automobile insurance is based on the number of miles driven rather than at flat rates. Less driving equals lower rates.
- Variable registration fees – Annual automobile registration fees are based on the number of miles driven rather than at uniform flat rates.
- Visible parking costs – Some ski areas already charge for parking, with only remote parking, served by buses, remaining free at these resorts.

- Car sharing – A single vehicle is shared by several households. Presumably this would lead to fewer vehicles and less vehicle miles of travel (VMT). This could be especially beneficial for congested urban areas. The corridor currently has a high vehicle occupancy rate (approximately 2.6 passengers per vehicle) which is aided by the large parking lots at the Morrison interchange, near Denver. Car sharing of this magnitude can be partially attributed to parking charges and I-70 congestion.
- Variable port access charges for heavy vehicles – The port access fee for truck freight loading varies according to demand, which encourages off-peak usage.

3.4.2 Conclusion

Other than parking charges at resorts (which currently exist), these measures would likely need to be applied on a statewide basis, not solely in the project corridor. Implementation of some of these alternatives would require legislation by the State Legislature. In addition, they could be quite controversial with the public, the result being that implementation on a short-term time horizon would be unlikely. These alternatives would therefore not meet the purpose of the project. Also, because congestion on I-70 and parking charges at ski areas are currently resulting in an increased rate of carpooling, further improvements to meet the need for the project would be unlikely. This alternative is not being considered for inclusion in other alternatives.

3.5 Active Traffic Demand Management

3.5.1 Description

Active Traffic Demand Management (ATDM) includes a number of tools that can maximize safety and traffic flow by dynamically managing and controlling traffic based on the prevailing traffic conditions (*Active Traffic Management (ATM) Feasibility Study*, WSDOT 2007). These alternatives include the following:

- Speed Harmonization involves reducing speed limits in areas of congestion to maintain better traffic flow and reduce the risks of collisions.
- Queue Warning provides motorists with advanced notice of downstream queues and directs traffic to alternate lanes, thereby reducing the likelihood of speed differentials and collisions due to queuing.
- Junction Control directs traffic to specific lanes based on the traffic demand (e.g., utilizes mainline capacity by giving priority to higher ramp volumes).
- Dynamic Rerouting involves changing the destination signing to account for current traffic conditions in order to redirect traffic to less congested facilities.
- Traveler Information involves providing travel times (as well as video of current conditions) that allow motorists to make more informed pre-trip and en-route decisions.

ATDM alternatives have primarily been applied in urban areas of Europe, although Washington State DOT (WSDOT) is currently implementing an ATDM system in the Puget Sound region. CDOT is currently planning an ATDM demonstration project further west on I-70 on each side of the EJMT. Queue warning equipment has been installed on the steep downhill grade to the west between Georgetown and Silver Plume and will begin testing soon. This system has been designed to be portable and could potentially be integrated with other alternatives. Travel time and traveler information are already being displayed along the I-70 Mountain Corridor.

3.5.2 Conclusion

CDOT is currently planning a demonstration project of the applicability of ATDM strategies in other locations in the I-70 Mountain Corridor. An ATDM installation between Empire Junction and Hidden Valley will wait until this demonstration is deemed successful, thus it would not meet the short-term implementation purpose of the project. These measures are effective in delaying the onset of congestion and improving safety during this period but lose their effectiveness once volumes are high enough to create congested (stop and go) conditions. In Europe, they are most commonly deployed in conjunction with Hard Shoulder Running (see previous discussion), and this combination provides the best results. Since these ATDM alternatives by themselves (without HSR) would not increase the basic capacity of eastbound I-70 during winter afternoons, they would be much less effective in meeting the need for the project of reducing congestion and overall travel times. Dynamic Rerouting would not be applicable to this section of the I-70 corridor since there are no viable alternative routes that drivers can divert to. However, several of these measures are already being used (traveler information) or will be considered for inclusion in the Enhanced Program once the Pilot Program is found to be a success (speed harmonization and queue warning, specifically). Thus, this alternative is being considered in conjunction with other alternatives.

3.6 RAMP METERING

3.6.1 Description

Ramp Metering is used to regulate the rate at which ramp traffic merges onto a freeway. This is accomplished through installation of traffic control signals at on-ramp merge points with freeways. The Manual on Uniform Traffic Control Devices (MUTCD) states that ramp meters are "sometimes used if controlling traffic in the freeway corridor could reduce the total expected delay to traffic in the freeway corridor, including freeway ramps and local streets".

Research has shown that ramp meters can increase mainline throughput while reducing travel time, queuing, and frequency of crashes. Other general benefits include temporal shifts by drivers, diversion of short interchange to adjacent interchange trips, and preclusion of drivers exiting and then reentering the mainline at the same interchange to attempt to bypass congestion formed in the merge influence area.

Ramp meters are most effective in delaying the onset of queuing and in helping to recover more quickly from congestion. This is generally the half hour or so on either end of the peak travel period. When traffic exceeds the saturation volumes for the on-ramp and mainline, congestion cannot be avoided and the ramp meters are rendered largely ineffective.

CDOT currently utilizes ramp meters along the I-70 Mountain Corridor during summer and winter weekends when recreational travel is at its peak. These four ramp meters are installed and operational along eastbound I-70 at US 6 (Loveland Pass), US 40 (Empire Junction), Downieville, and Idaho Springs (east). These meters were installed based upon a previous study that identified these locations as being the most beneficial for implementation. If either the Reversible Lane Only Alternative or Hybrid Alternative were implemented, the existing ramp meters in the corridor would continue to operate. Both Enhanced Programs are anticipated to include new ramp meters for the westbound Beaver Brook interchange on-ramp and the westbound US 6 on-ramp at the bottom of Floyd Hill. This would make the frontage road less attractive for drivers to get to the head of the westbound queue.

3.6.2 Conclusion

Ramp meters have already been implemented at the three highest volume, eastbound on-ramps (US 40, Downieville, and Idaho Springs) in the corridor. Additional meters at lower volume on-ramps would have limited additional congestion benefit. Thus, this alternative by itself would not meet the need for the project. This alternative is being considered in conjunction with other alternatives.

3.7 SPOT IMPROVEMENTS

3.7.1 Description

The I-70 Mountain Corridor PEIS considered a number of spot (or localized highway) improvements that have been included in the Preferred Alternative Maximum Program. The Preferred Alternative provides a range of improvements that can only be implemented based on a proven need. These include improvements to three interchanges in the study corridor: Downieville (MP 234), Fall River Road (MP 238) and the base of Floyd Hill/US 6 (MP 241). Improvements to the three interchanges serving Idaho Springs are included in the Maximum Program of the Preferred Alternative if fully implemented but not in the Minimum Program (or initial improvements). A comprehensive study of the Empire Junction / US 40 (MP 232) complex was approved for early action so the process of looking at alternatives to relieve congestion is already underway. Other locations in the reversible lane corridor for either interchange or auxiliary lane improvements were not included in the Preferred Alternative.

3.7.2 Conclusion

These spot improvements have already been considered in much more detail than is possible by the current efforts to determine the feasibility of the reversible lane. Since they are included in the I-70 Mountain Corridor PEIS as long-term improvements, they should not be considered as alternatives to the reversible lane as they do not meet the purpose and need of providing short-term congestion relief. This alternative is not being considered for inclusion in other alternatives.

3.8 INCIDENT MANAGEMENT

3.8.1 Description

Incident Management Plans outline protocols for coordinated response to incidents on a highway. Incident management plans have been prepared and implemented along the I-70 Mountain Corridor and are regularly updated. They include winter storm events, alternative route planning (where available), closure points, standard operating procedures, etc.

The I-70 Mountain Corridor has incident management plans. These plans have reduced the response time to incidents so traffic can return to normal as quickly as possible. Emergency response is a key issue for assessing the feasibility of the reversible lane and has been studied in detail during the Phase II Feasibility Study. It is anticipated that the incident management plan covering the corridor (*I-70 Mountain Corridor Traffic Incident Management Plan for Clear Creek County)* will be updated in cooperation with stakeholders if the decision is made to proceed with one of the alternatives involving a reversible lane.

3.8.2 Conclusion

Additional incident management planning should not be considered as an alternative to the reversible lane as it does not meet the purpose of providing additional short-term congestion relief. However, this alternative is part of the existing, base conditions, and improvements will be used as an essential element of other alternatives.

4.0 Alternatives Considered And Advanced

In addition to the No Action Alternative, CDOT has determined that two improvement alternatives involving a reversible lane would meet the purpose and need for a short-term improvement project on I-70. Reversible lanes have been used in other states to manage traffic flows where there is heavy traffic in one direction and light traffic in the other. Because the direction with the light traffic flow can operate in fewer lanes, one of the lanes is temporarily reversed to accommodate the heavier traffic flow.

From the vicinity of Empire Junction to Idaho Springs, the Reversible Lane Only Alternative would utilize a moveable barrier while the Hybrid Alternative would utilize the existing shoulder (hard shoulder running) to create the necessary additional lane of capacity. To surmount the capacity constraint presented by the Twin Tunnels, both alternatives are the same from just west of Idaho Springs to east of the Hidden Valley interchange. Once traffic has entered the reversible lane, there would be no intermediate access points and the only exit would be east of Hidden Valley. Extending the current exit lane to US 6 from eastbound I-70 for more than a half-mile eases the transition for drivers exiting the reversible lane east of Hidden Valley. Westbound I-70 drivers will merge to one lane at the bottom of Floyd Hill to accommodate the reversible lane operation.

Either of these alternatives would be implemented with an initial, two-year Pilot Program to determine the success of the concept. Should the Pilot Program be extended, additional features may be needed to enhance the program (referred to as the Enhanced Program).

Table 1 outlines the basic elements to these two alternatives.

Table 1 Overview of Considered Alternatives

	Reversible Lane Only Alternative (Figure 2)	Hybrid Alternative (Figure 9)
Pilot Program	Implement an eastbound reversible lane to begin west of Empire Junction and end east of the Hidden Valley interchange, with no midway points for entry or exit (12.7 miles). The Pilot Program includes initial implementation of safety and incident management features for the first two years.	Use existing shoulders to create an additional eastbound lane (hard shoulder running) from east of Empire Junction to west of Idaho Springs (6.2 miles), and implement a reversible lane from Idaho Springs to east of the Hidden Valley interchange (5.2 miles). The Pilot Program includes initial implementation of safety and incident management features in the reversible lane for the first two years.
Enhanced Program	After the two-year Pilot Program, implement remaining features to enhance safety and incident management.	After the two-year Pilot Program, implement remaining features to enhance safety and incident management.

4.1 No Action

4.1.1 Description

The No Action Alternative would entail no improvements or changes to I-70 within the reversible lane corridor by from approximately Empire Junction to Floyd Hill. The current trends and patterns would continue in that severe eastbound traffic congestion would occur during weekend peak periods.

4.1.2 Conclusion

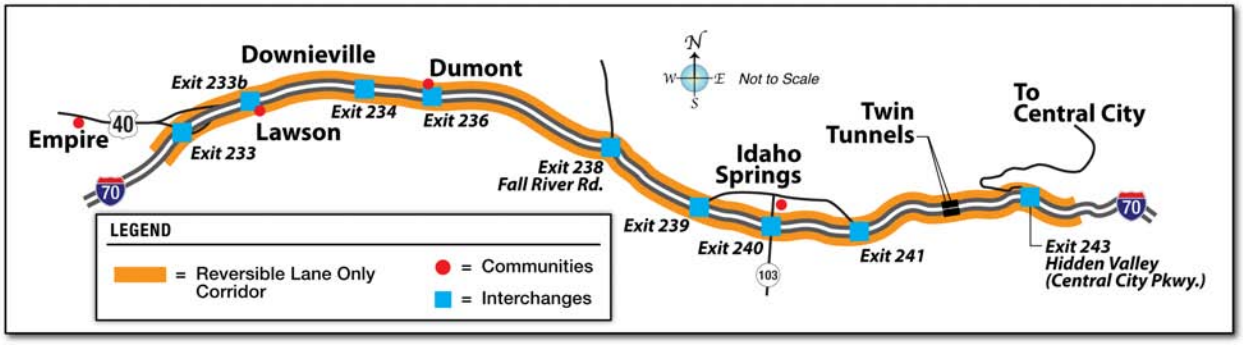
This alternative would provide no operational benefits to I-70 traffic. Congestion and delays would continue to increase in the future as traffic volumes grow. All of the associated issues (e.g., increased vehicle emissions, travel delays, etc.) would remain and continue to be exacerbated over time. Therefore, it would not meet the purpose for the project (no short-term operational improvement) nor does it address the needs (congestion relief, reduced delays, or reduced diversions) for the project. Making no improvements is always an option, and this alternative will also be included in the NEPA documentation that will be necessary for FHWA approval.

4.2 REVERSIBLE LANE ONLY

4.2.1 Description

The Reversible Lane Only Alternative consists of temporarily converting the left westbound lane on I-70 to an eastbound lane from west of Empire Junction to east of Hidden Valley interchange, a distance of approximately 12.7 miles (see **Figure 2**). This would leave only the right lane on westbound I-70 for westbound traffic.

Figure 2 Proposed Reversible Lane Only Alternative



A reversible lane is composed of a moveable barrier made of short concrete and metal segments that are hinged together to form a continuous wall. A special piece of equipment, called a barrier transfer machine, moves the barrier to and from the shoulder and into place for a specified period of time. Traffic crossovers would need to be constructed in the median of I-70 at both ends of the reversible lane. Supplemental improvements (such as signing, Intelligent Transportation Systems (ITS) devices, gates, provisions for incident response, etc.) would also need to be in place for both the Pilot and Enhanced Programs.

4.2.1.1 Vehicles Allowed to Use the Reversible Lane

The reversible lane would be open to passenger vehicles. Heavy vehicles (26,000 pounds Gross Vehicle Weight Rating) would be prohibited from using the eastbound reversible lane due to:

- Lack of access to the Port-of-Entry at the Downieville interchange
- Lack of access to chain stations when chain law is in effect
- Increased complexities in responding to and relieving heavy vehicle incidents (such as a jackknifed semi) in the reversible lane

Heavy vehicles would be allowed in the eastbound general purpose lanes and in westbound lane on I-70 during reversible lane operations.

4.2.1.2 Roadway Changes Necessary to Accommodate the Reversible Lane Only Alternative

Several roadway modifications would be required in order to implement the reversible lane. These modifications would be implemented for the Pilot Program and would continue for the Enhanced Program. These changes can be characterized in the following areas:

- Reversible lane entrance area (near Empire Junction)
- Westbound I-70 roadway changes
  - Reversible lane Corridor
  - Twin Tunnels
- Reversible lane exit area (between Hidden Valley and Floyd Hill)

4.2.1.2.1 Reversible Lane Entrance Area (Near Empire Junction)

The entrance area for the Reversible Lane Only Alternative would be located just west of the County Road 306 bridge (western portion of the US 40 / Empire Junction interchange). The location and schematic layout of the entrance area are illustrated (**Figure 3**).

To implement the Reversible Lane Only Alternative, several changes would be required in this area. Crossover pavement would need to be added to the I-70 median in order to allow eastbound drivers to cross the median from the inside eastbound lane to the reversible lane. Guardrail in this area would need to be modified to a configuration that is safe and effective both when the reversible lane is and is not in operation. Automatic gates would be installed in the taper area of the crossover to ensure that eastbound vehicles could not enter the crossover when the reversible lane is closed.

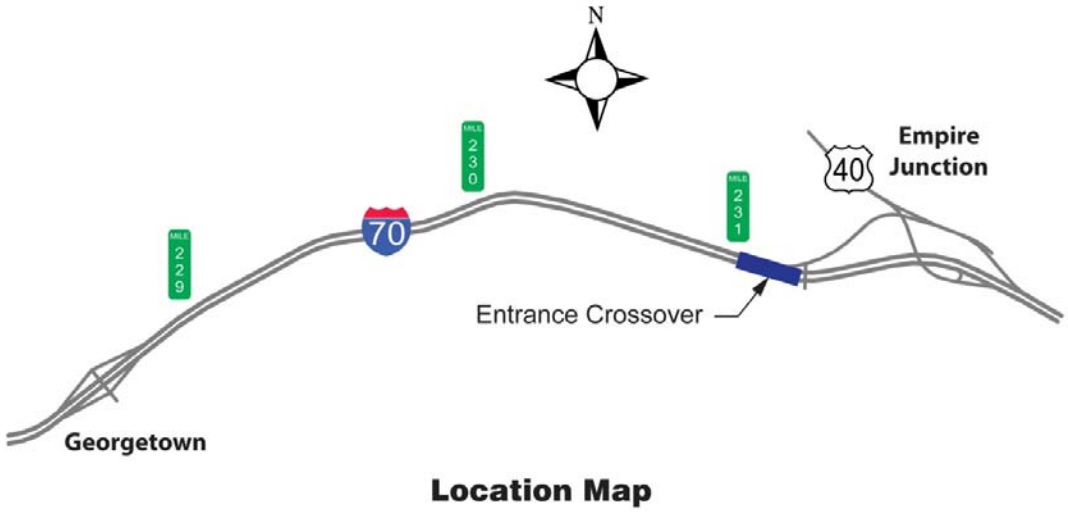
4.2.1.2.2 Reversible Lane Corridor

The Reversible Lane Only Alternative would extend approximately 12.7 miles between the entrance area crossover and the exit area crossover. Here, eastbound vehicles would cross over into the westbound lane and travel on the existing pavement. **Figure 4** illustrates the cross sections for the typical lane configurations in this area for three situations: 1) existing conditions, 2) reversible lane (when not in operation), and 3) reversible lane (during operation).

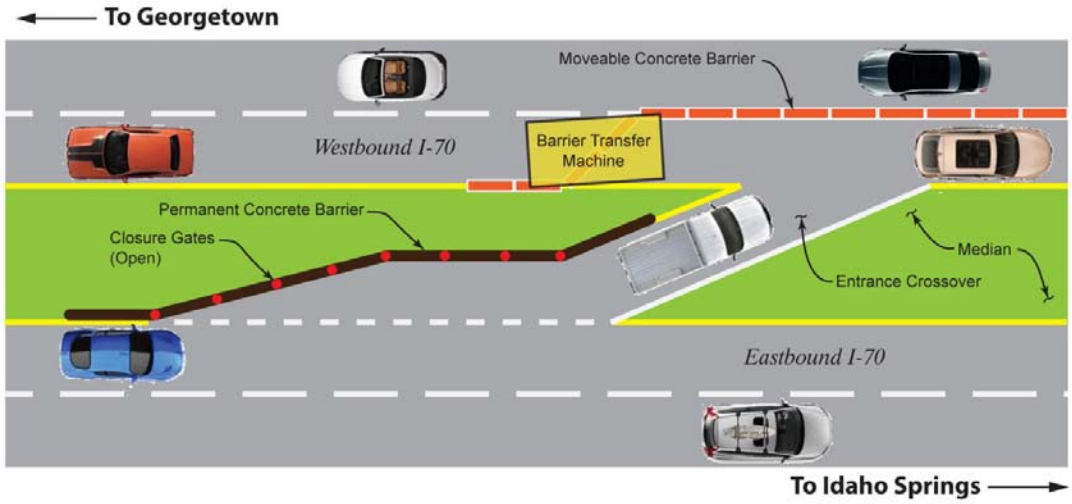
The Reversible Lane Only Alternative would require the following changes to the existing westbound I-70 pavement throughout the entire 12.7-mile corridor:

- Change the directional overlap of the existing metal (w-beam) guardrail on the inside shoulder of westbound I-70 (since the metal guardrail is unsafe for traffic traveling in the reverse direction). Damaged guardrail would also be replaced. During normal operations on westbound I-70, this guardrail is behind the moveable barrier in its resting location, so there is no hazard.
- Remove existing rumble strips from both inside and outside shoulders
- Restripe the lanes to the configuration shown in **Figure 4**

Figure 3 Reversible Lane Only Alternative Entrance Area



Location Map

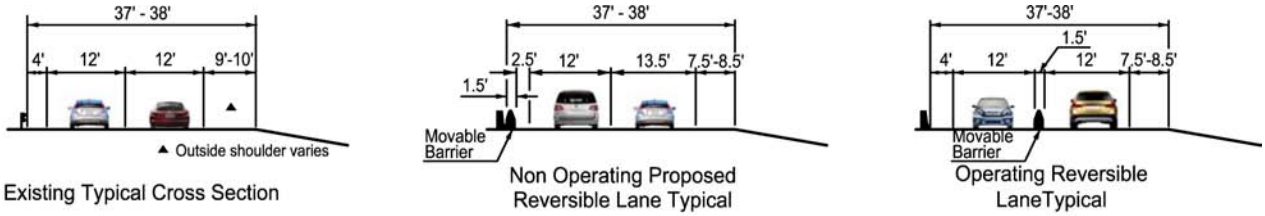


Entrance Crossover Detail

- Install the moveable barrier along the inside edge of the westbound pavement (typically along the face of the permanent median barrier). Install wires and power boxes necessary to guide the transfer machine through the Twin Tunnels only.
- Install signs required for eastbound drivers in the reversible lane (curve warning signs, speed limit signs, etc.)

In addition, a westbound passing lane for slower moving vehicles would be constructed at just west of the Twin Tunnels as an element of the Pilot Program. Currently, there is a section that is 2,700 feet long that includes extra wide shoulders. The passing lane could be provided by changes to the lane striping and signing. In coordination with the PLT, several additions would be considered for the Enhanced Program if the Pilot Program shows that they could improve operations. The section west of the Twin Tunnels could be extended by approximately 1,900 feet and would tie into the existing off-ramp at the east interchange for Idaho Springs (Exit 241). A second westbound passing lane that would be approximately one mile in length could be built between the Fall River Road interchange (Exit 238) and Dumont interchange (Exit 236).

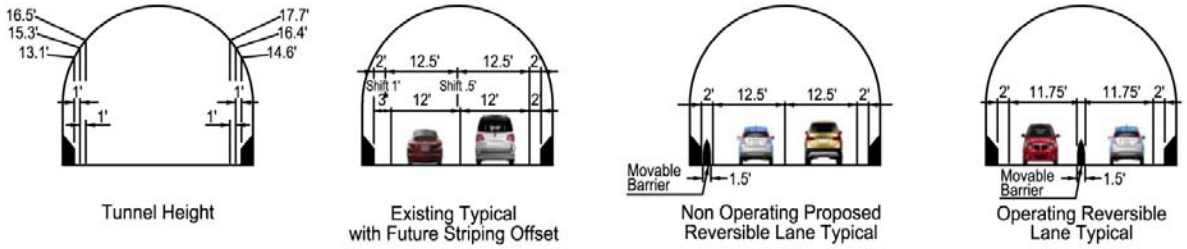
Figure 4 Typical Westbound I--70 Cross Sections (Reversible Lane Corridor)



4.2.1.2.3 Twin Tunnels

Similar changes would also need to be implemented at the Twin Tunnels. The tunnels are narrower than the typical westbound I-70 pavement, and vertical clearance is more limited; therefore, the lane striping would need to be changed to a configuration that works both when the reversible lane is and is not operating (see **Figure 5**)

Figure 5 Typical Westbound I-70 Cross Sections (At the Twin Tunnels)



Lighting changes would also need to be made in the Twin Tunnels. Currently, lighting in the westbound tunnel is directionally oriented to accommodate westbound traffic, shining in front of vehicles. Illumination levels are also higher at the entrance to help drivers adapt to the tunnel lighting. For the Pilot Program, the lighting would be supplemented at the west entrance to the westbound Twin Tunnel to improve driver adaptation for the eastbound reversible lane traffic entering the tunnel. The existing approach lighting is sufficient for westbound traffic. The

Enhanced Program would include replacing all lighting in the westbound tunnel, reducing glare for eastbound traffic and saving power.

4.2.1.2.4 Reversible Lane Exit Area (Near Hidden Valley and Floyd Hill)

The reversible lane exit area would be located just east of the Hidden Valley interchange. The location and schematic layout of the proposed exit area are illustrated in **Figure 6**. Implementation would require crossover pavement to be added in the median in order to allow eastbound drivers to cross from the reversible lane back to the eastbound roadway. The eastbound I-70 pavement at the end of the crossover would need to be widened by one lane east to the base of Floyd Hill. This would create a continuous third lane from the end of the crossover to the beginning of the existing eastbound third lane. Minor signing and striping changes would also be required at the left-side exit ramp to US 6 / Clear Creek Canyon so that vehicles in the third lane could have the option to either exit at US 6 or continue on eastbound I-70. Minor changes to the guardrail, lighting, and guide signing would also be required.

Infrastructure must be installed just east of the reversible lane exit area, in order to safely merge westbound traffic from two lanes to one while the lane is in operation. These improvements would require the installation of automated lane closure gates along the inside edge of the left lane. A permanent overhead lane closure/"merge right" arrow board would be installed and used on the reversible lane facility (see **Figure 7**). Other static and variable-message signing would be installed.

4.2.1.2.5 Westbound Merge

Westbound I-70 motorists will be presented with a series of flip-down, static signs and VMS starting between the Beaver Brook split diamond interchanges (Exits 247 and 248) that inform them of the impending merge to one lane near the Hidden Valley interchange (see **Figure 8**). During the Pilot Program, portable VMS have been spaced to take advantage of existing flat areas behind the shoulder. The Enhanced Program would utilize overhead VMS and variable speed limit (VSL) signs that have real-time messages based on current traffic conditions, as discussed in more detail in the following section.

Figure 6 Reversible Lane Exit Area

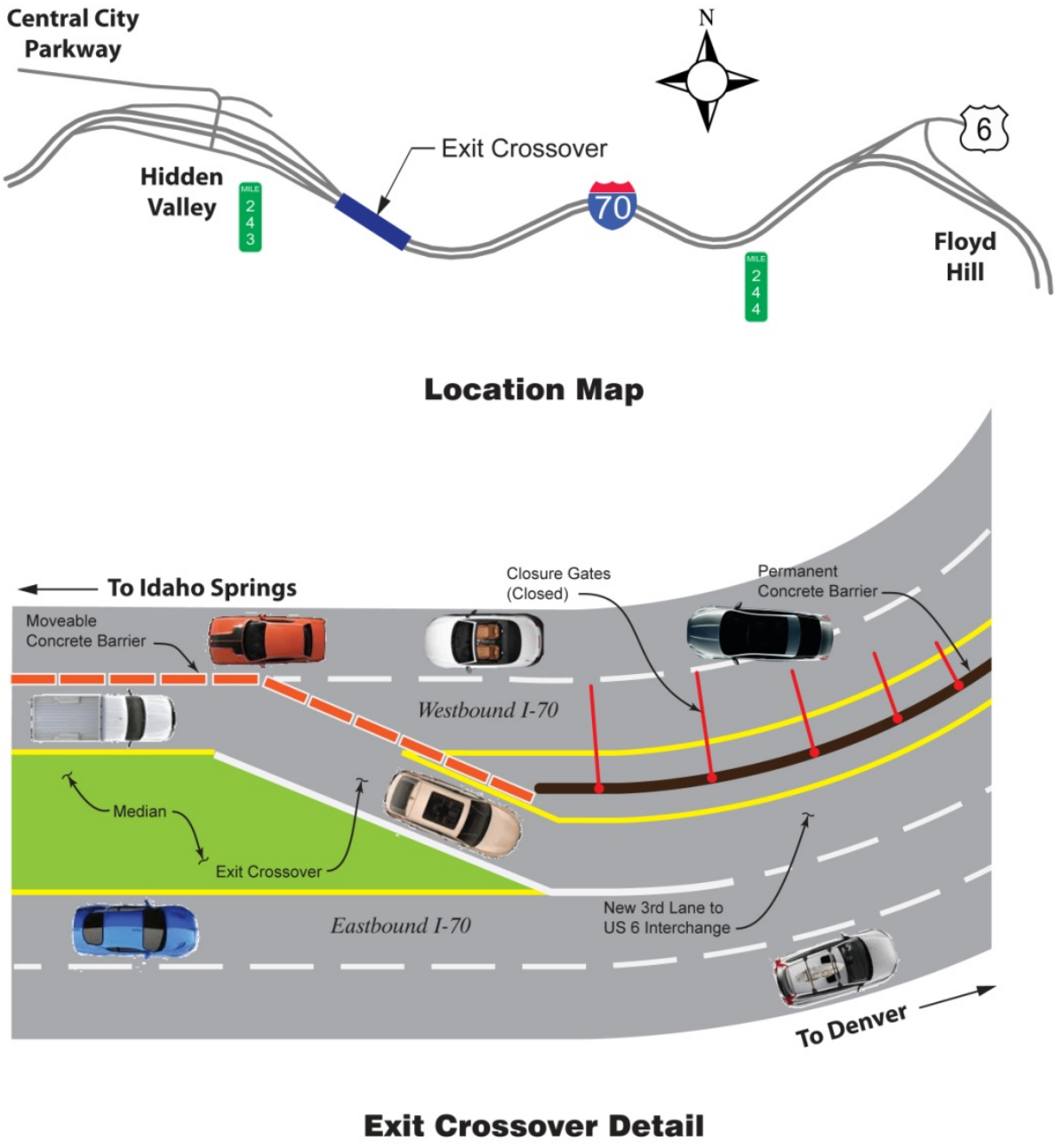
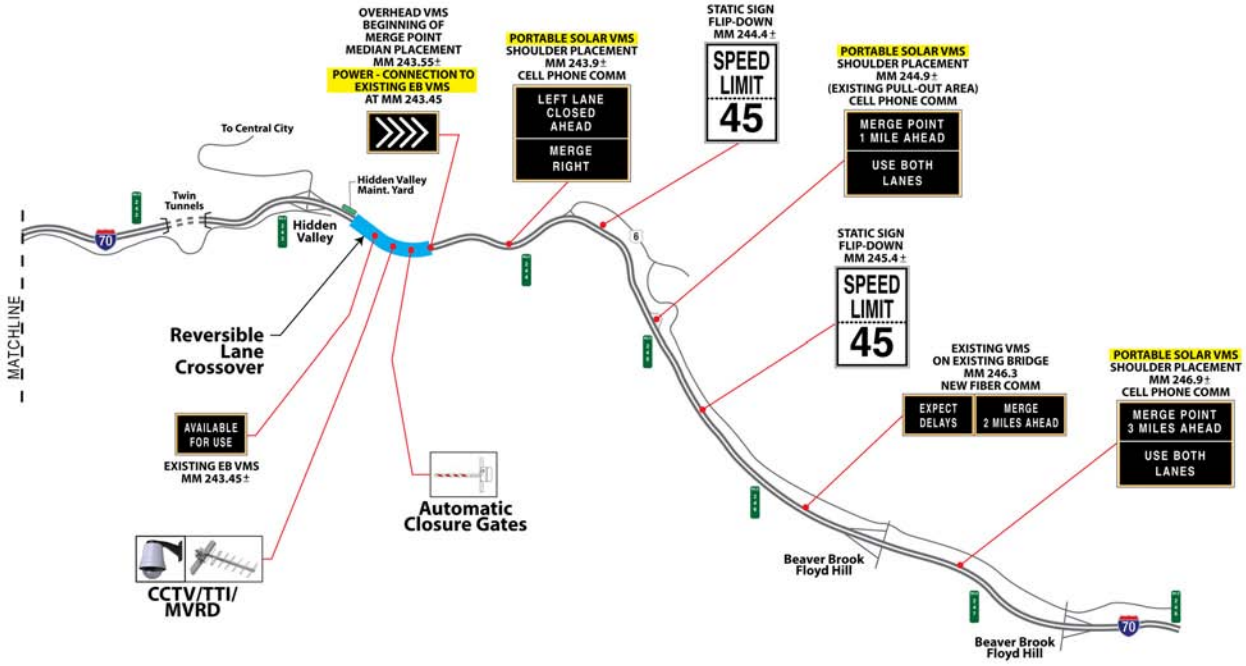


Figure 7 Examples of Permanent Gates and Arrow Board Required for Westbound I-70 Left Lane Closure Approaching Reversible Lane

Figure 8 Hybrid Pilot Program – ITS/Signing Plan



Electronic Technology

Safe and efficient operation of the reversible lane would require additional technology-based transportation devices. The purpose of these devices would be to monitor traffic operations in all lanes of traffic; provide information to travelers in both directions about decisions they must make or conditions that are ahead; and assist in detecting, locating, and responding to incidents that may occur in the reversible lane project area. These devices include:

- **Closed Circuit Television Cameras (CCTV)** to visually monitor the corridor
- **Variable Message Signs (VMS)** to provide up-to-date information to drivers
- **Variable Speed Limit Signs (VSL)** to regulate the speed of traffic
- **Microwave Vehicle Radar Detectors (MVRD)** to measure volume, occupancy, speed, and vehicle classification
- **Travel Time Indicators (TTI)** to estimate the travel time along the corridor
- **Ramp Meter Stations** to control the number of vehicles entering I-70
- **Queue Detection Devices** to help determine and warn of potentials back-ups
- **Automatic Gates** to safely facilitate the opening and closure of the Reversible Lane.

Given the limited construction season along the I-70 Mountain Corridor, only the critical technology-based transportation devices would be constructed and ready for operation on opening day of the Pilot Program. Remaining devices would be installed the following construction season(s) as time and construction budget allows.

ITS devices that would be installed in conjunction with the Reversible Lane Pilot Program include (see **Figure 8**):

- Automatic gates and lighting at the reversible lane entrance and the westbound lane drop and merge
- Two MVRD for spot measurement of vehicular volume, occupancy, speed, and classification
- Two TTI for measurement of the estimated travel time from the beginning to terminus of the reversible lane
- Multiple portable VMS to inform drivers of the open/closing of the reversible lane and lane drop/merge procedures for westbound I-70

The remainder of the ITS devices proposed for the reversible lane (CCTV, VMS, VSL signs, static signs and ramp meter stations) would be implemented in the Enhanced Program. These Enhanced Program ITS devices would provide operational and functional enhancements, which include:

- Full visual surveillance coverage of the reversible lane corridor
- Improved visibility of VMS signs (from portable to permanent)
- Automated detection of possible incidents within the reversible lane
- Queue detection and queue warning for drivers
- Dynamic merge at the westbound lane drop
- Ability for real-time travel time estimates

- Potential for decreased use of the frontage roads to bypass the freeway queues

4.2.1.3 Differences Between the Pilot and Enhanced Programs

As previously mentioned, the Pilot Program with associated risks and reduced cost would allow this innovative idea to be tested. After two years, the Pilot Program would be evaluated to determine if it should be continued. An Enhanced Program could be implemented with appropriate additional features that would improve its performance and facilitate longer-term operations. **Table 2** summarizes the different features of the Pilot and Enhanced Programs.

Table 2 Pilot vs. Enhanced Program Features – Reversible Lane Only Alternative

Element	Pilot Program	Enhancement Program
Twin Tunnels (Westbound direction)	• Add supplemental lighting at west entrance only, standard (non-LED) lighting	• Add directional, LED tunnel lighting
Staged assets for emergency response	• Local agencies responsible for ambulance and fire response,	• Stage additional emergency response vehicles along the reversible lane corridor
Intelligent Transportation System (ITS) components	• Portable variable message signs.	• Implement traffic monitoring equipment and additional ramp metering provided for westbound traffic • Replace portable variable message signs (VMS) with overhead VMS signs. • Complete Closed Circuit Television (CCTV) coverage
Incident Response services	• CDOT only contracts for courtesy patrol and heavy tow services.	• Provide incident command, dedicated operator/dispatcher, and specialized response services

4.2.1.4 Deployment Decision

Traffic conditions are suitable for Reversible Lane deployment on approximately 17 winter Sundays. CDOT will work with area stakeholders to develop a formal Deployment Decision Plan. The decision to deploy the Reversible Lane will be made each time based on several factors. Some initial considerations for the deployment decision factors are summarized in **Table 3**. The final decision plan will be made with local input.

Table 3 Deployment Criteria Factors

Criteria	Threshold	Resources
Traffic volumes	• Westbound volume below 2000 vehicles per hour	• Historic traffic count data • Automatic traffic counters
Weather	• Maximum 1 inch snowfall per hour • Maximum 6 inches of snow accumulation over deployment period	• Forecast weather conditions • Current weather conditions
Snow accumulation since last deployment	• Ability to remove snow during low volume periods pre-deployment	• Historic traffic count data • Forecast weather conditions for pre-deployment period • Current weather conditions
Existing traffic conditions	• Incident free Reversible Lane Corridor • Chain law not in effect	• CDOT Traffic Operations and Maintenance • Colorado State Patrol • CCTV
Reversible Lane equipment condition	• Transfer machine free of mechanical problems • Movable barrier segments free of damage that would disable transfer machine	• Pre-deployment inspection of transfer machine and movable barrier segments

4.2.2 Evaluation

4.2.2.1 Traffic Operations

Traffic volumes were analyzed for the weekday and weekend period when congestion typically occurs on the I-70 corridor. The purpose was to identify times when, and in which direction, the implementation of a reversible lane would be feasible and would have the potential of yielding the greatest benefit. Roadway capacity helps determine when reversible lanes may be beneficial and assesses their impact on the opposite direction travel. A roadway's capacity is often determined by the most constrained section, which in this case is the Twin Tunnels.

Based on historic counts, it is anticipated traffic conditions are suitable for the reversible lane to be deployed on the 17 winter Sundays during the winter ski season assuming weather conditions allow. During the winter, two Monday holidays (Martin Luther King, Jr. Day and Presidents' Day) may also be candidates for deployment due to lower traffic volumes in the westbound direction.

The *Phase I Feasibility Study* demonstrated there would be little benefit to deploying a reversible lane on an average weekday due to traffic flows. Further, the directional split in traffic volumes needed to operate the reversible lane does not occur in the summer. The Phase I study also showed winter Saturdays did not produce conditions that favored reversible lane deployment. In summary, traffic conditions during spring, summer, fall, and winter from the Christmas through New Year's holiday period do not meet the appropriate conditions for activating the system.

4.2.2.1.1 Projected Traffic Growth

Currently, I-70 corridor traffic is increasing 1.5 percent to 1.8 percent annually. If a reversible lane is not implemented, eastbound and westbound traffic would continue to grow at this historic rate, reaching 10 percent growth in approximately five years. If a reversible lane is implemented, it is anticipated westbound traffic volumes will reach the 10 percent threshold in five to 10 years, recognizing the historical growth rate may be less due to westbound traffic backups that occur

with the reversible lane. The opposite occurs in the eastbound direction, where the reversible lane adds additional roadway capacity and creates a higher growth rate of 15 percent in five to 10 years. Given the uniqueness of the corridor, traffic models are unable to predict with certainty the increased amount of traffic that would use (or not use) I-70 if the reversible lane was implemented.

4.2.2.1.2 Projected Travel Time Savings

For 2010 conditions during the reversible lane operation, it is estimated eastbound travel time would decrease by 38 minutes while the westbound travel time would increase by 35 minutes (see **Table 4**). Due to the heavier volume of traffic in the eastbound direction, it is projected that 11,866 person-hours of travel would be saved, which represents about a 13 percent improvement in total person-hours of travel.

Table 4 Travel Times – Reversible Lane Only Alternative

Scenario	Eastbound Travel Time (min)	Westbound Travel Time (min)	Person Hours of Travel Saved[1,2]
2010 Traffic Volumes			
without reversible lane[3]	79	34	—
with reversible lane[3]	41	69	11,866
Future Traffic Volumes			
without reversible lane (baseline 10% growth)	111	34	—
with reversible lane (with additional 5% induced eastbound)	68	97	2,626

[1]Reported person hours of travel savings does not account for delays to eastbound and westbound travelers due to crashes.
[2]Based on Average Vehicle Occupancy of 2.6.
[3]From Phase I Feasibility Study.

In the future with anticipated 10 to 15 percent growth, the eastbound travel time would decrease by 43 minutes (slightly more than the 2010 decrease) if the reversible lane is implemented. However, the westbound travel time would increase by 63 minutes (nearly double the 2010 increase). The large increase in westbound travel time would reduce the amount of person-hours of travel saved to 2,626. While this savings would still be positive, it represents only a 3 percent improvement over maintaining the current condition of I-70.

4.2.2.1.3 Impacts on Westbound I-70

In addition to longer travel times when the reversible lane is implemented, a 2.5-mile traffic back-up on westbound I-70 (top of Floyd Hill) is predicted during the heaviest travel time. It is anticipated incident response when the reversible lane is implemented also will increase backups on westbound I-70, which is discussed in more detail under **4.2.2.2 Safety Impacts**.

Table 5 summarizes the anticipated westbound I-70 backups (or queue lengths) when the reversible lane is implemented and with anticipated traffic growth. Over time, 6.1-mile back-ups (reaching west of I-70/El Rancho Exit) would occur when the 10 percent westbound growth threshold is reached. Historically, a six-mile back-up becomes unmanageable both from an operational and public tolerance perspective.

Table 5 Westbound Traffic Queues

Time (P.M.)	2010 Queue Length (miles)[1,2]	10 percent Growth Queue Length (miles)[2]
1:00	0.8	3.1
2:00	1.6	4.4
3:00	2.5	5.9
4:00	1.8	6.1
5:00	0.9	5.2
6:00	No queue	2.2
7:00	No queue	No queue
8:00	No queue	No queue
9:00	No queue	No queue

[1]From Phase I Feasibility Study.
[2]This does not include backups that will occur during deployment of the reversible lane.

4.2.2.2 Safety Impacts

4.2.2.2.1 Historic Crash Data in the Reversible Lane Corridor

When compared to similar Colorado Interstate highways, this segment of I-70 historically experiences a high number of crashes. The I-70 Mountain Corridor PEIS (Technical Reports, Appendix E, August 2010) identified several existing safety deficiencies in the corridor, including:

- Heavy congestion attributed to frequent rear-end crashes along the corridor
- Moderate grades, ramp merging and weaving movements contribute to rear end and sideswipe crashes
- Sharp curves between the Twin Tunnels and Floyd Hill are a contributing factor to crashes within this segment of the corridor

CDOT has developed Safety Performance Functions (SPF) for many types of highway facilities in Colorado, including mountainous freeways such as I-70. SPFs show the range of crashes per year based on highway volumes for facilities with similar characteristics. Historic crash data on I-70 during heavy periods of winter congestion from 2001 through 2006 were analyzed. The analysis period for crashes in the reversible lane corridor was 17 Sundays during the winter ski season between the hours of 1 PM and 8 PM. During this period, both the eastbound and westbound directions of I-70 currently experience approximately 5.1 crashes for a total of 10.2 crashes per year (as shown in **Table 6**).

From the perspective of crash severity (injury and fatal crashes), the corridor's safety performance is on par with other similar highways. Approximately 20 percent of crashes result in an injury while the remaining 80 percent result in property damage only (PDO). Fatal crashes occur very infrequently.

4.2.2.2.2 Projected Crashes Within the Reversible Lane Corridor

The Reversible Lane Only Alternative is projected to reduce congestion in the eastbound general purpose lanes, thereby reducing the number of crashes in these lanes (for the 17 Sundays during the winter) from 5.1 to 3.5 per year (see **Table 6**).

Table 6 Historic and Predicted Crash Data - Reversible Lane Only Alternative

	2 Eastbound General Purpose Lanes	2 Westbound General Purpose Lanes	1 Westbound General Purpose Lane and Reversible Lane	Estimated Total Number of Crashes
Historic average number of crashes[1]	5.1	5.1	---------	10.2
Projected number of crashes during reversible lane operation	3.5	------	9.3	12.8
Net change	-1.6		+4.2	+2.6

[1]Total crashes annually during winter Sundays.

Safety in the westbound facility would decline as a result of the placement of the moveable barrier, which reduces lane and shoulder widths. Analysis predicts there would be 9.3 crashes per year on the 17 Sundays in the single westbound lane and the single eastbound reversible lane. These results indicate that one crash, on average, would occur for every two days in which the reversible lane is in operation. Of these crashes, approximately 20 percent could involve an injury. It's important to note while these are the predicted crash results, the data is not absolute; crashes could increase or decrease, as could their severity.

The design characteristics of the moveable barrier show it would prevent head-on type crashes. The confined space of the reversible lane means the primary hazard for eastbound vehicles in the lane would be rear-end crashes and fixed-object crashes where a vehicle hits the barrier on either side at a low angle. Although fatal crashes cannot be ruled out as a hazard for the reversible lane, it is anticipated they would occur infrequently.

4.2.2.2.3 Crashes on Floyd Hill

Floyd Hill, just east of the reversible lane corridor, includes a steep two-mile long, 6 percent westbound downgrade. By its nature, Floyd Hill has been the site of serious traffic crashes in the past. As noted in **4.2.2.1 Traffic Operations**, westbound traffic back-ups would occur past the top of Floyd Hill when the reversible lane is operational. Winter driving conditions could also potentially exacerbate this condition, leading to an increase in rear-end crashes or even more serious incidents.

To assess this safety concern, historic crash data from 2001 to 2006 was analyzed for the Floyd Hill segment of I-70. It was determined that heavy congestion and subsequent traffic backups occur most Saturday mornings during ski season on Floyd Hill. This condition is analogous to what could be expected to occur on Sunday afternoons when the reversible lane is in operation.

Close inspection of the Saturday westbound crashes on Floyd Hill shows a distinct spike in rear-end crashes between 6:45 AM and 7:15 AM, which coincides with the time when the westbound traffic queue forms along Floyd Hill. The ratio of Saturday morning to Sunday afternoon traffic volume was applied to the rear-end crashes on Saturday morning to estimate the number of Sunday afternoon rear-end crashes (approximately 1.2 annually during the 17-day winter period). The resulting estimate indicates that westbound traffic along Floyd Hill could expect an additional three rear-end crashes when the reversible lane is in operation during the Pilot Program.

With the installation of crash mitigation measures such as active queue detection and VMS (included in the Enhanced Program), it is estimated that westbound rear-end crashes along Floyd Hill would be reduced by 25 percent. Once installed, these devices would be active at all times (particularly Saturday and Sunday mornings) to monitor queue formation and provide real-time information to reduce crashes. This reduction would mitigate and offset any increase in rear end crashes on Sunday afternoons. Thus, the net safety impact of the project on Floyd Hill (assuming the installation of queue detection and variable message signs) would be neutral.

4.2.2.2.4 Emergency Response to Incidents

Emergency responders and CDOT respond to incidents along the reversible lane corridor area by following the I-70 Mountain Corridor Traffic Incident Management Plan for Clear Creek County. Implementing the reversible lane would necessitate an update to this plan.

To respond to any incident in the reversible lane, a closure of the I-70 westbound lane and I-70 eastbound reversible lane would likely be required. Currently, an average incident on the I-70 Mountain Corridor can be cleared from traffic within approximately 30 minutes. It is anticipated that closures of I-70 to clear incidents would increase queues, clearing rates and travel time.

The Enhanced Program would allow CDOT to maintain current incident clearance times by contracting with private companies to provide additional pre-positioned resources in the corridor. Incident response teams composed of fire, ambulance, law enforcement, towing, courtesy patrol and maintenance personnel and equipment, would be staged at interchanges located throughout the reversible lane corridor to allow immediate response to corridor incidents. The incident response teams would be dedicated to the reversible lane corridor and would not conduct concurrent, off-highway assignments or respond to on-highway incidents outside of the corridor. The incident response teams also would be specifically trained and specially equipped to respond to incidents requiring opening the barrier, holding traffic to facilitate incident access to minimize traffic flow disruption.

The Pilot Program only assumes pre-positioned towing assistance and courtesy patrol, not emergency response (fire, ambulance, and law enforcement). The Pilot Program calls for emergency services to continue to be provided by local resources and therefore would not be staged. Emergency service providers may experience delays in arrival at incident sites if incidents need to be approached from the east, which could result in delayed service to injured parties, as well as extended lane clearance time. In order to help mitigate these issues, the westbound shoulder would have a minimum of 7.5 feet in width to allow for emergency vehicles to pass stopped or slow moving traffic.

4.2.2.2.5 Impact of Incidents on Traffic Operations

Traffic incidents in the eastbound reversible lane and westbound general purpose lanes were modeled. If an incident were to occur in the reversible lane at 3 PM when traffic volumes are at their peak, it's most likely that it would fully block both directions of travel (eastbound reversible lane and westbound general purpose lane) for 30 minutes due to clearance requirements. The average duration of an I-70 incident, based on past incident management experience in the corridor, was determined to be 30 minutes. For the purposes of modeling this condition, the incident was assumed to be located 0.5 miles west of the Twin Tunnels.

The results of the incident analysis show westbound traffic would be more negatively impacted, and might take three to four hours to fully recover from a 30 minute incident. Eastbound travel would only take one to two hours to fully recover. Westbound traffic backups would be

approximately 6.5-miles in length from the point of the crash while eastbound reversible lane traffic would experience a 2.3-mile backup.

4.2.2.3 Summary of Traffic and Operations Impacts

This alternative would satisfy the purpose and need in that it would add a third eastbound lane and provide additional capacity while foregoing a more extensive construction project. Eastbound is by far the heaviest traffic movement during these periods, so improvements would maximize travel time benefits.

This alternative has a number of challenges:

- It would remove a westbound lane and decrease westbound capacity; traffic congestion is forecasted as a result.
- Travelers in the reversible lane would have no access to exits within the corridor.
- Incident response and emergency services would be more complicated.
- CDOT would have to manage the new logistical and operational needs resulting from deployment of the barrier, normal maintenance responsibilities, and snowplowing through the Reversible Lane Corridor.
- Incidents would impact the travel-time benefits of the project when they occur, and weather-related operational issues could reduce the number of days that the moveable barrier can be deployed.
- Local stakeholders (through the PLT) are uncomfortable with the Reversible Lane Only Alternative as currently defined.

4.2.2.4 Social Impacts

4.2.2.4.1 Current Business and Economic Conditions Within the Corridor

Clear Creek County experiences two seasonal business peaks in summer and winter. The summer season is slightly busier than the winter, with 35 to 40 percent of annual retail and eating/drinking sales occurring in the June to September time period. Winter retail and eating/drinking sales account for 30 to 35 percent of annual sales. Over the past 10 to 15 years, annual sales have been increasing and the seasonal swings in sales have lessened. There are concerns that the reversible lane would negatively affect business due to 1) a reduction in the congestion encourages some people to exit the highway for a break and 2) exit restrictions from the reversible lane. It is estimated that winter Sunday retail and eating/drinking sales account for no more than 10 percent of annual sales in Clear Creek County.

4.2.2.4.2 Impact of a Reversible Lane on Business and Economic Conditions

If travel times are shorter and people do not wish to stop in Clear Creek County, there could be a negative impact on sales. Also, there is no access from the reversible lane to highway exits leading to local businesses. Conversely, increased traffic volume could result in increased business, potentially cancelling out negative impacts from drivers not exiting the reversible lane.

Beyond Clear Creek County, other potential business and economic impacts include:

- **Skier Visits.** Many Denver Metro Area day skiers are frustrated with the level of I-70 congestion to the point they have reduced their ski visits. Any improvements to I-70 that increase capacity are likely to induce additional travel, with a projected modest increase in skier visits to Clear Creek, Grand, Summit, and Eagle County ski resorts.

- **Mountain Resident Travel and Shopping Patterns.** The reversible lane will increase westbound travel time on Sunday afternoons. Many westbound travelers are mountain community residents returning from a Denver Metro Area shopping or entertainment trip. Mountain residents may adjust the timing of their trip to avoid the single lane westbound configuration or might forego Denver Metro Area trips altogether, shopping locally and increasing local retail sales.
- **Deliveries.** Travel time for westbound trucks would be slower on winter Sundays when the reversible lane is deployed. Trucks are approximately 10 percent of the total traffic volume on I-70. Trucks account for an even a smaller percentage of traffic volumes on weekends. This suggests there could be a small overall impact on deliveries and supplies to businesses, given the limited days the reversible lane is in operation. However, businesses might be able to adjust their planning to account for the Sunday westbound congestion.

4.2.2.4.3 Input from Project Leadership Team (PLT)

CDOT created a Project Leadership Team consistent with the I-70 Mountain Corridor Context Sensitive Solutions guidance. This 12-member group represented local governments, corridor users, emergency responders, and federal and state agencies. The purpose of this group was to identify questions that needed to be answered before the decision to implement a Reversible Lane was made, as well as review the risks associated with the project. A 40-person technical team supported the study to provide input. Both groups meet at least 6 times over the course of six months to review information.

The Project Leadership Team (PLT) remains concerned with the associated risks and trade-offs identified by the feasibility studies. Many stakeholders felt it was not appropriate to move forward with a Reversible Lane. The PLT acknowledges that short-term solutions are needed and are willing to discuss other strategies that could address congestion (see NEXT STEPS). For the most part, stakeholders are uncomfortable with Reversible Lane Only Alternative as currently defined.

4.2.2.5 Environmental Impacts

CDOT and FHWA jointly prepared the *I-70 Mountain Corridor Draft PEIS,* (October, 2010). It is the most current source of information for the corridor and was referenced in preparation of this summary. The resources described below have been evaluated and have been determined to potentially be impacted. The resources that are not expected to be impacted, and as a result do not require any mitigation measures, are summarized in **Table 7**.

4.2.2.5.1 Visual and Aesthetics

Sightseeing and recreation are major activities throughout the Reversible Lane study area, and visual resources are an important component of both activities. As such, the *I-70 Mountain Corridor Revised Draft PEIS* provides guidelines for aesthetic features to be incorporated into projects.

The elements with the greatest potential for impacts to visual aesthetics are the overhead VMS associated with the project and modification from an open median separating the eastbound and westbound lanes, to the presence of a solid, concrete moveable barrier. To minimize and mitigate for the visual intrusion of the new signage placement, the project should adhere to the aesthetic guidelines prepared as a part of the *I-70 Mountain Corridor Context Sensitive Solutions* (CSS) program, including the Mountain Mineral Belt Aesthetic Guidance.

Visual and aesthetic impacts with implementation of the Pilot Program would be decreased because only mobile VMS (lower to the ground and placed on the edge of the road) would be utilized thereby decreasing the visual intrusion.

4.2.2.5.2 Traffic Noise

CDOT and FHWA guidelines require detailed noise evaluation and consideration of noise abatement measures for transportation projects with certain characteristics (classified as Type 1 projects with nearby noise receptors). The easternmost portion of the Reversible Lane corridor is expected to be Type 1 because the auxiliary lane at the east end of the corridor is proposed to be more than one-half mile long. In addition, there is at least one isolated residence nearby that data from the PEIS indicate experiences traffic noise impacts from I-70. This means that a formal noise analysis would be required prior to installation of the project. This analysis would most likely occur during preparation of the Documented Categorical Exclusion (CatEx). The analysis would need to examine the auxiliary lane segment, but not the remainder of the Reversible Lane corridor. The remainder of the project is not Type 1.

While the noise analysis would be expected to be included in the Documented CatEx, some qualitative observations are presented here. Compared to existing conditions, operating the Reversible Lane during the targeted hours would increase eastbound vehicle speeds (increase noise), and decrease westbound vehicle speeds (decrease noise). However, the targeted hours would not be the corridor's peak noise periods because traffic at these times would be slower than the allowable speed limit achieved outside peak travel times. Little, if any, changes in the peak noise from I-70 are likely to result from Reversible Lane operations. It is rarely feasible or reasonable to provide noise abatement for isolated receptors such as the one residence in the eastern portion of the project.

In traffic noise terms, there would be little, if any, discernable difference between the Pilot Program and Enhanced Program.

4.2.2.5.3 Biological Resources

The primary vegetation in the median and existing right-of-way are grass species, such as smooth brome (*Bromus inermis*), downy brome (*Bromus tectorum*), western wheatgrass (*Pascopyrum smithii*), and various weedy species. Impacts to vegetation would be minimal and occur at the cross-over areas at the east and west end of the Reversible Lane corridor. Impacts to vegetation would mostly occur within the existing vegetated medians; however, the median areas currently do not provide suitable habitat for big game wildlife species (i.e., mule deer, elk, and bighorn sheep).

There is no known terrestrial threatened or endangered species habitat present in the immediate vicinity of the Reversible Lane Project Area. However, portions of Clear Creek have been identified as potential greenback cutthroat trout (a state threatened species) habitat. Clear Creek is adjacent to the project area. Impacts to Clear Creek from the project would result from increased sedimentation from the addition of an impermeable surface; however, best management practices for water quality will be incorporated to mitigate for any sedimentation. Therefore, there are no expected impacts to threatened or endangered species as a result of the project.

Daily and seasonal movement of big game wildlife species could be impacted by the Reversible Lane. The addition of a solid barrier in the median would increase the barrier effect that I-70

currently has on wildlife movement. However, it should be noted that the existing presence of I-70, and associated median barriers, currently acts as a continuous barrier in the I-70 Mountain Corridor, which means that the Reversible Lane would be located in an area of I-70 that already inhibits wildlife movement.

During critical wildlife movement times of the year, primarily spring and fall, the barrier would not be operational, but would remain in the retracted position along the inside shoulder of the westbound lanes. To mitigate and minimize the barrier effect, it would be possible to remove key sections of the barrier during spring and fall. Any potential mitigation would be discussed with A Landscape Level Inventory of Valued Ecosystem Components (ALIVE) and Project Leadership Team (PLT) to continue the collaborative effort. ALIVE is a committee composed of wildlife professionals from federal and state agencies who identified wildlife habitat of high ecological integrity, wildlife habitat linkages, and barriers to wildlife crossing along the I-70 Corridor. They developed a landscape-based ecosystem approach for consideration of wildlife needs and conservation measures, and identified measures to improve existing aquatic and terrestrial ecosystem connectivity across the I-70 Corridor between Denver and Glenwood Springs.

Impacts to wildlife and vegetation would be similar with implementation of the Pilot Program. The analysis of animal vehicle collisions (AVCs) during the Pilot Project may lead to an adjusted mitigation approach for the Enhanced Program.

4.2.2.5.4 Wetlands

Because all ground disturbing activities in the Reversible Lane corridor would occur in the median between the eastbound and westbound lanes of I-70, impacts to wetlands are not anticipated within this area. However, there could be impacts to wetlands at the east end crossover areas because of the potential addition of water quality ponds and associated outlet structures and rip rap associated with water quality ponds. Two areas have been preliminarily identified as potential locations for water quality ponds at the east end crossover (MP 244.0) due to topographic constraints and disturbance of less than one acre water quality ponds are not identified on the west end. The precise configuration and location of water quality ponds, associated rip-rap, and outlet structures will be determined during the final design.

Based on previous work of this nature, the impacts from the outlet structures would likely be very small and are typically covered under a Nationwide Section 404 permit. Using a conservative assumption of 300 square feet (0.006 acres) of wetland impacts, this would be much less than the 0.1 area notification requirement from the United States Army Corp of Engineers (USACE) and should be covered under a Nationwide Section 404 Permit. The mitigation may be through on-site creation of wetlands or the use of a wetland mitigation bank (such as the Warm Springs Wetland Mitigation Bank). Because the project would not be within a primary service area for any USACE-approved wetland mitigation bank, credits could be purchased, but likely greater than a 1:1 ratio, at the discretion of the USACE.

Impacts to wetlands would be similar with implementation of the Pilot Program.

4.2.2.5.5 Water Resources

Clear Creek is the major water feature in the study area and is located immediately south of I-70. Mill Creek and Fall River flow into Clear Creek in the study area, as well. Current water quality conditions in the project area are affected not only from highway runoff, but also by historic mining and channelization from development and urbanization. Clear Creek has been recognized as being impaired due to copper and zinc.

The installation of the Reversible Lane would have little direct effects on water quality, when compared to existing conditions. The additional impervious surface would create slightly more surface water runoff, which would include sediment and other contaminants from the roadway that could eventually enter Clear Creek.

CDOT is a member of a group of stakeholders in the Stream and Wetland Ecological Enhancement Program (SWEEP) which addresses water-based impacts and coordinates mitigation in the I-70 Mountain Corridor. Additionally, the Reversible Lane corridor is within the overall Clear Creek Sediment Control Action Plan (SCAP) project area (currently being initiated) that will provide water quality mitigation for existing conditions. The project team would coordinate the feasibility of providing short-term water quality features at the east and west ends of the Reversible Lane corridor. There are two primary areas that could be utilized for best management practices (BMPs) on the eastern end of the project area. These BMPs would aid in the mitigation of potential water quality impacts. In addition to the water quality ponds, BMPs could include sediment traps, sand filters, etc.

Impacts to water quality would be similar with implementation of the Pilot Program.

4.2.2.5.6 Geologic Hazards

Rockfall, debris flow and soil erosion are the predominant geologic hazards in the Reversible Lane corridor. These hazards are characterized as high or severe, according to the *I-70 Mountain Corridor Draft PEIS*.

Due to the minimal amount of construction associated with the Reversible Lane, it would not introduce additional slope stability concerns. Soil erosion potential in these areas would need to be considered during final design. For signs and gates, potential for damage from rockfall and debris flow would need to be considered during final design.

During operation, the Reversible Lane would be subject to rockfall hazards similar to those experienced under existing conditions. It is anticipated that Reversible Lane operation would require an increased level of operational monitoring and incidence response.

Geologic hazards under the Pilot Program would be similar to those experienced with the Enhanced Program.

4.2.2.5.7 Regulated Materials and Historic Mining

The project could affect regulated materials, primarily as the result of subsurface activities associated with the construction of the new VMS cantilever signs, crossovers at the entrance and exit points and emergency crossover points due to disturbance of soils. For this project, regulated materials would include hazardous substances, hazardous waste, petroleum products, and materials from historic mining activity.

Overall, the potential impacts due to regulated materials would depend on the design associated with the crossover points and Reversible Lane cantilever signs, such as the specific placement of sign foundations and the proposed excavation depth for crossovers. During final

design, the regulated materials and historic mining and mill sites associated with the Reversible Lane project would be analyzed to determine the nature and extent of and measures to avoid, minimize and/or mitigate any impacts. CDOT will follow Standard Specification 250 from the *Standard Specifications for Road and Bridge Construction (2005)* to protect worker health and safety. If determined necessary, a *Materials Handling Plan* could be prepared to address contaminated soil and groundwater that may be encountered.

Regulated materials would be less likely to be encountered during the Pilot Program because subsurface activities, such as those associated with installation of permanent VMS, would not be included.

4.2.2.5.8 Historic Properties

Historic resources identified in the Reversible Lane corridor include several historic properties, including the Georgetown-Silver Plume National Historic Landmark District and a number of individual sites of national, statewide and local significance. Towns throughout the project area contain historic buildings and associations, and historic mining sites are abundant. Full comprehensive surveys have not yet been completed for many properties.

Direct effects to sites adjacent to the Reversible Lane corridor, such as physical destruction, alteration, or removal of historic properties, including archaeological and historic archaeological sites, are not anticipated from the implementation of the Reversible Lane.

The Twin Tunnels are an historically significant feature within the Reversible Lane corridor. Any physical alterations to the Twin Tunnels, such as lighting replacement, would be subject to the requirements of the Section 106 process and the I-70 Mountain Corridor Programmatic Agreement for Historic Resources.

Indirect effects, such as the introduction of visual elements, may occur from the signs associated with the project. The intrusion of signs on historic districts would be mitigated by closely adhering to the visual guidelines, such as the *I-70 Mountain Corridor Aesthetic Guidance for the Mountain Mineral Belt*, established for the corridor.

Impacts to historic properties under the Pilot Program are anticipated to be minimal as signs would be portable and ground level, and would not extend into the viewshed. Additionally, lighting features added to the Twin Tunnels would be temporarily attached and not permanent replacements.

4.2.2.5.9 Other Resources

Information about other resources that would likely not require mitigation is provided in **Table 6**.

Table 7 Resources with No Recommended Mitigation Measures under the Pilot Program and Enhanced Program

Resource	
Air Quality	Compared to existing conditions, the Reversible Lane Only Alternative would have the net effect of increasing the existing very low eastbound vehicle speeds and decreasing the existing relatively high westbound vehicle speeds during hours of currently high eastbound congestion. Both of these speed changes are expected to correlate to reductions in tailpipe emissions. There may be some added emissions from westbound traffic queuing to enter the reversible lane segment. Therefore, with no major changes on overall corridor traffic volumes, the Reversible Lane is expected to reduce overall tailpipe emissions and to improve modestly the air quality situation.
Land Use	The Reversible Lane Only Alternative would not directly impact existing land use in Clear Creek County. Indirect impacts, such as growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate are not expected to occur as a result of the Reversible Lane.
Environmental Justice	Pockets of minority and low-income residents are distributed throughout communities adjacent to the project area. No disproportionate impacts are anticipated to low-income and minority populations within the project area as positive and negative impacts are expected to be shared equally between the general public and minority and low-income residents.
Energy	Compared to existing conditions, the Reversible Lane Only Alternative would have the net effect of reducing overall energy usage in the project area. The expected reductions in automobile fuel consumption due to overall improved traffic operations would more than outweigh the additional electricity would be used to power additional electronic devices.
Recreation and Section 6(f)	6(f) properties are those that are funded with Land and Water Conservation Funds. Recreational travel is the predominant contributor to peak I-70 traffic, especially during summer and winter weekends. Existing traffic during the ski season is characterized by congestion that noticeably affects travel within the project area, and affects the tourism economy. The eastward bound skier experience would be improved in terms of travel time and gridlock relief. No physical impacts are anticipated to recreational facilities. No impacts are anticipated to 6(f) properties as a result of implementing the Reversible Lane Only Alternative.
Paleontology	The project area traverses an area of Pre-Cambrian metamorphic rocks, which do not contain fossils, so paleontological resources are not anticipated to be a concern for this project.

4.2.2.6 Logistical/Operation Complexity

The transfer machine would be stored at CDOT's Hidden Valley Maintenance Yard. On days of deployment, the machine would be moved to the eastern staging area of I-70, escorted by a pilot car due to travel speeds ranging from 10-20 miles per hour (mph).

The barrier transfer process would begin at 11:30 AM. Automatic gates would close the left lane of westbound I-70 at the eastern terminus near the Hidden Valley Interchange. The transfer machine would then move the barrier into place and proceed to the western terminus, where it

would pull beyond the reversible lane and remain parked behind barriers. Transfer machine drivers would need to visually confirm if the barrier was properly deployed and ensure the lane is clear in the Pilot Program. Transfer machine drivers and the addition of surveillance cameras and operators would confirm this in the Enhanced Program. Automatic gates at the eastbound entrance would then open to traffic at 1 PM.

The reversible lane would close at 8 PM, with automatic gates closing the eastbound entrance. The barrier transfer machine would then move the barrier back to the stored position in the south shoulder of the westbound lanes. The transfer machine would complete the transfer and reopen all westbound lanes by approximately 9:30 PM, driving back to the storage facility with a pilot escort on westbound I-70.

If snow accumulated along the moveable barrier during the week, it is estimated an additional 20 minutes would be required to clear the corridor prior to opening the lane. In this case, deployment would begin 20 minutes earlier. After deployment is complete, additional snow removal may be required during off-peak hours.

CDOT would use existing personnel and equipment to remove snow for both the Pilot and Enhanced Programs. Since local CDOT forces do not have excess personnel, crews from other locations within the state would be assigned to the reversible lane corridor during the deployment period. Existing equipment would not fit through the westbound Twin Tunnel portal due to reduced lane width. As such, retrofitting and/or purchasing new equipment for the I-70 Corridor would be necessary to accommodate snow removal operations for the reversible lane for both the Pilot and Enhanced Programs. The shorter plow length will decrease the efficiency of snow removal along other lanes of I-70 and US 6.

Prior to deploying the reversible lane, snow that accumulated since the last deployment would be removed, giving special attention to areas where shading from the movable barrier causes icing on the roadway. For operating conditions with a maximum of 1-inch per hour of snowfall or less than 6 inches of accumulation, standard de-icing materials and plowing operations would be sufficient. However, the reversible lane may need to be closed during the snow removal process if accumulations exceed this amount and cause excessive narrowing in the lane. While manageable, the snow removal operation would cause minor delays for westbound traffic. When reversible lane operations end, snow and ice that has accumulated adjacent to the moveable barrier may need to be removed.

4.2.3 Legal Implications

FHWA must approve this action. Restricting I-70 to one westbound lane constitutes a federal action, consistent with 23 CFR 658.11. Reducing the Interstate to one lane outside of a construction project with a reversible lane system has not been done anywhere in the nation with positive results. As such, FHWA has requested an evaluation and screening of possible alternatives to solve congestion in addition to a reversible lane for the entire corridor.

There are no Colorado statues that would prohibit this action.

4.2.4 Costs of Reversible Lane Only Alternative

The costs of the Reversible Lane Only Alternative project (as shown in **Table 8**) are a significant challenge. There are three major cost elements, and each has differing cost implications depending on whether the Pilot or Enhanced Program is considered, as follows:

- Roadway-related Improvements - including crossovers, passing lanes, the eastbound lane extension from the east crossover to the US 6 exit, ITS equipment, snowplow blade modifications, etc. As previously described, the improvements are more extensive for the Enhanced Program when compared to the initial, Pilot Program.

- Moveable Barrier - The barrier and transfer machine would be supplied by Barrier Systems, Inc. (BSI). BSI has provided proposals to CDOT for different leasing and purchase options. The Pilot Program would involve the leasing of the barrier and transfer machine for two years. At the end of that time if the decision were made to proceed with the Enhanced Program, CDOT would have the option to purchase the equipment. The costs for the lease/purchase option shown in **Table 8** are the total for both Pilot and Enhanced Programs. The final option that BSI has provided a proposal for would be for CDOT to purchase the equipment required for the Enhance Program initially. CDOT does not favor this approach to implementing the reversible lane, but the costs are also shown in **Table 8** for comparison purposes.

- Annual Costs – These costs would include personnel and equipment costs each year for deploying the barrier and emergency response services on the 17 Sunday afternoons during the winter. Again, the Enhance Program is more comprehensive than the Pilot Program.

Table 8 Reversible Lane Only Alternative Costs

	Pilot Program (2 year lease)	Enhanced Program (2 yr lease + purchase)	Enhanced Program (initial purchase)
Roadway	$6,300,000	$14,300,000	$14,300,000
Moveable Barrier (BSI)	$16,000,000[1]	$ 29,600,000	$ 24,900,000
Total One-Time Capital Costs	*$22,300,000*	*$43,900,000*	*$49,200,000*
Operations	$130,000	$540,000	$540,000
Emergency Response	$580,000	$1,230,000	$1,230,000
Total Annual Costs	*$710,000*	*$1,770,000*	*$1,770,000*
[1]Two-year equipment lease			

The final challenge is funding the project. There are several federal and state funding sources that could provide funding for a reversible lane. Given the limited dollars available and the challenges in maintaining the quality of the existing system, priorities would need to be reallocated to fund either program. CDOT and the Colorado Transportation Commission would need to shoulder Pilot Program costs if no user fees are charged. The Colorado High Performance Transportation Enterprise could manage the reversible lane program if user fees were implemented.

4.2.5 Conclusion

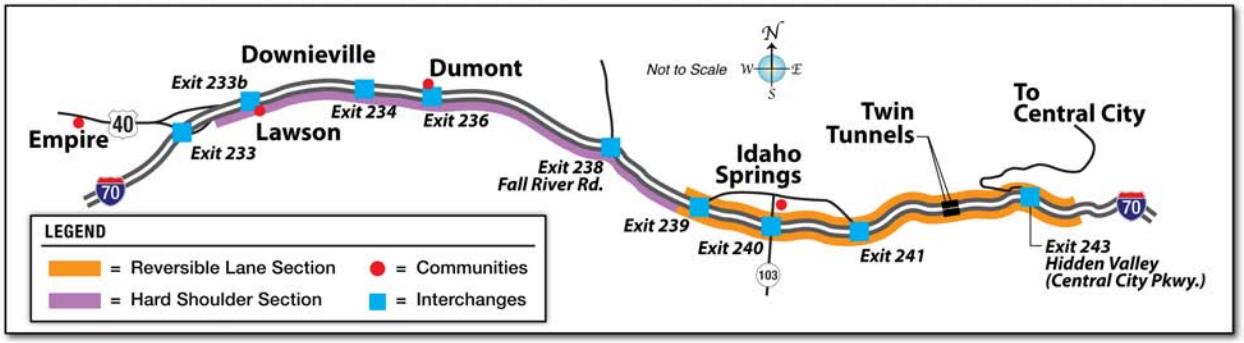
This alternative would satisfy the purpose and need. However while a formal proposal has not been received by the Colorado Division Office, FHWA officials indicated they are not convinced spending over $22 million on the Reversible Lane Only Pilot Program is the best use of public monies. Federal officials note that as part of any formal proposal, CDOT will need to demonstrate to FHWA that other alternatives have been explored and there isn't a better short-term solution to address congestion. For these reasons and a number of others, the Hybrid Alternative appears to be viewed more favorably by FHWA (see the following discussion).

4.3 HYBRID ALTERNATIVE

4.3.1 Description

The Hybrid Alternative has emerged during the Phase II Feasibility Study as the preferred alternative as it would also meet the purpose and need for a short-term improvement that provides congestion relief on I-70 with better operational flexibility, safety, and travel times at a potentially lower cost. The Hybrid Alternative would combine Hard Shoulder Running (HSR) for the western 6.2 miles of the reversible lane corridor and a moveable barrier to traverse the Twin Tunnels bottleneck (5.2 miles), for a total length of 11.4 miles (see **Figure 9**). HSR typically utilizes the outside shoulder as a travel lane to increase the capacity of a congested corridor during specified periods.

Figure 9 Proposed Hybrid Alternative



The Hybrid Alternative would begin on the east side of Empire Junction where the eastbound US 40 on-ramp merges onto I-70. Instead of merging, the hard shoulder would begin at this point, and traffic would be directed to utilize the shoulder as a third travel lane on winter Sunday afternoons. The HSR portion of the Hybrid Alternative would continue for approximately 6.2 miles to just west of the west interchange at Idaho Springs (Exit 239). At this point, the profiles of I-70 are favorable for a crossover so that a moveable barrier can be utilized to take the third lane of traffic through the Twin Tunnels in the same manner as the Reversible Lane Only Alternative. In fact, all of the features of the Hybrid Alternative would be the same as the Reversible Lane Only Alternative from west Idaho Springs east to Floyd Hill, including the east crossover, third eastbound lane extension to the base of Floyd Hill, and the provisions for westbound traffic that would still need to merge to one lane through the Twin Tunnels.

4.3.1.1 Vehicles Restrictions for the Hybrid Alternative

The HSR lane would be open to all vehicles. Heavy vehicles would also be allowed in the other two eastbound general purpose lanes. Both westbound lanes through the HSR segment of the corridor would be open to all vehicles during Hybrid Alternative operations.

The reversible lane portion of the Hybrid Alternative would only be open to passenger vehicles. Heavy vehicles (26,000 pounds Gross Vehicle Weight Rating) would be prohibited from using the eastbound reversible lane due to:

- Lack of access to chain stations when chain law is in effect.
- Increased complexities in responding to and relieving heavy vehicle incidents (such as a jackknifed semi) in the reversible lane.

In the reversible lane segment of the Hybrid Alternative, heavy vehicles would be allowed in the two eastbound general purpose lanes and the single westbound lane.

4.3.1.2 Roadway Changes Necessary to Accommodate the Hybrid Alternative

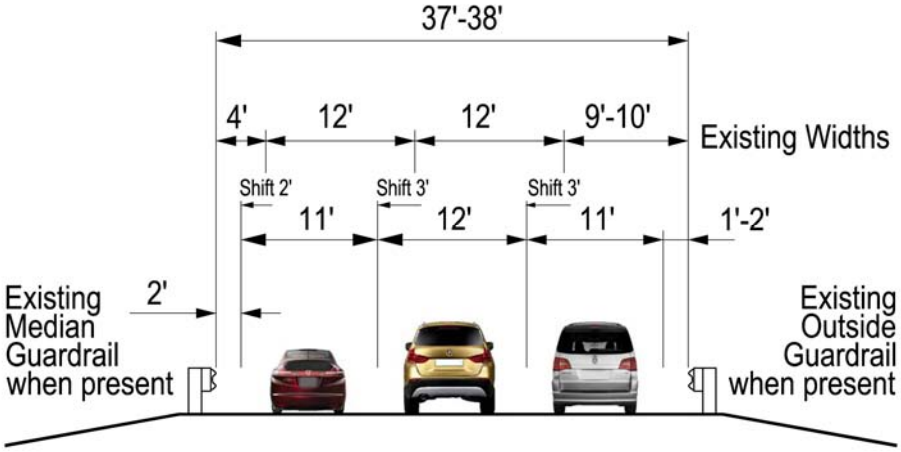
Several roadway modifications would be required in order to implement the Hybrid Alternative. These modifications would be implemented for the Pilot Program and would continue for the Enhanced Program. These changes can be characterized in the following areas:

- Eastbound I-70 roadway changes for hard shoulder running (Empire Junction to Idaho Springs)
- Reversible lane entrance area (west of Idaho Springs)
- Westbound I-70 roadway changes – same as Reversible Lane Only Alternative (see previous discussions and **Figures 4 and 5** for roadway cross sections and **Figure 7** for the automatic gates that would be used for the westbound merge). West of Idaho Springs, none of the changes (rumble strip removal, restriping, re-lapping guardrail, passing lanes, etc.) required for the Reversible Lane Only Alternative would be required for the Hybrid Alternative.
- Reversible lane exit area (see previous discussion and **Figure 6** for east crossover treatment between Hidden Valley and Floyd Hill)
- Westbound Floyd Hill to Hidden Valley – see previous discussion and **Figure 8**

4.3.1.3 Hard Shoulder Running Segment (Empire Junction to Idaho Springs)

The Hybrid Alternative would begin where eastbound US 40 enters I-70 on the east side of Empire Junction. On winter Sunday afternoons, US 40 will be able to continue along the outside shoulder instead of needing to merge with eastbound I-70 traffic coming from Georgetown. To implement the HSR, the striping of lanes would be changed from this location to the Idaho Springs area. The proposed roadway cross section and lane striping is shown in **Figure 10** and would involve narrowing the inside (to two feet wide) and outside (to one foot wide) shoulders in order to create three lanes. The center lane would be 12 feet wide while the inside (left/through) lane would be 11 feet. The outside lane would also be 11 feet wide and would serve as the shoulder when it is not being used for HSR.

Figure 10 Eastbound Typical Section – Hard Shoulder Running



There are six interchanges between Empire Junction and Idaho Springs that are affected by the Hard Shoulder Running lane. These are located at:

- Empire Junction / US 40 (Exit 232) – full movement interchange, but only the eastbound US 40 on-ramp is affected
- Lawson (Exit 233) – partial diamond interchange, off-ramp only
- Downieville (Exit 234) – full diamond interchange
- Dumont (Exit 236) – partial diamond interchange, on-ramp only
- Fall River Road (Exit 238) – full diamond interchange
- West Idaho Springs (Exit 239) – partial diamond interchange, off-ramp only

In total, HSR would affect four locations that have off-ramps and four on-ramps. For the Pilot Program, it is anticipated that separate deceleration lanes will not be constructed. There will be a consistent set of static signs and striping at each of these off-ramps. For the Enhanced Program, there would be a review of how the Pilot Program performed to determine whether exit deceleration lanes would be built at that time.

The four on-ramps locations would require more extensive improvements:

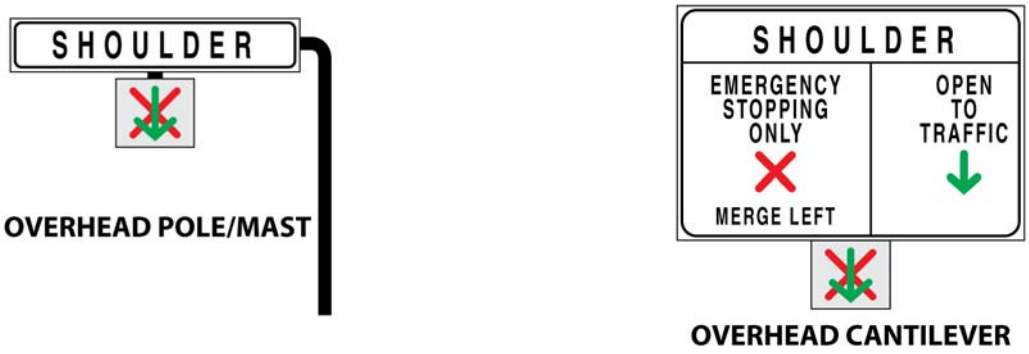
- Just east of each interchange bridge (with the exception of Empire Junction), the alignment of eastbound I-70 would shift into the median in order to add approximately six feet of additional width so that a short acceleration length can be provided. This would require paving, minor drainage adjustments and a water quality pond. Each of these improvements would have a total length of approximately 2,500 feet. It is anticipated that at least one location (Fall River Road) may require a median retaining wall due to a steep cross slope.
- The HSR lane will have a series of VMS to show motorists the status of its use. On winter Sunday afternoons, the VMS would inform motorists on the on-ramps (including Empire Junction) that the HSR is open for traffic ahead. During other times, the VMS would be blank (unless used for other purposes). The VMS would utilize portable equipment along the side of the lane during the Pilot Program. These installations would

be replaced by ground mounted or overhead cantilever mounted VMS for the Enhanced Program.

- The VMS information would be supplemented by a series of lane control signals that show a red X or green down arrow depending on the status of the HSR (**Figure 11**). Immediately downstream of the on-ramps, large overhead static signs would inform motorist of the meaning of the red/green indications. The red X means that the HSR lane is closed and that on-ramp traffic should merge into the two general purpose lanes of eastbound I-70. The green arrow would be shown on winter Sunday afternoons to inform motorists that the HSR lane is in operation and that they should merge with traffic in this lane. Depending on on-ramp separations, the large signs will be supplemented with smaller signals showing only red/green indications that are spaced between one-half and one mile apart to reinforce the message about the status of the HSR lane. The lane control signals are expected to remain the same for the Enhanced Program. Based on experience gained during the Pilot Program, these could be supplemented with additional signals if the need is indicated.

The final significant improvement that would be necessary for the HSR segment of the project would be emergency pullouts. These would be relative short paved areas (between 100 and 150 feet). Disabled vehicles or those involved in minor crashes would use these areas to get out of the traffic stream. They would be plowed Sunday morning to remove any accumulations of snow and have a static sign indicating their purpose. The Pilot Program would include two emergency pullouts: just west of the Dumont interchange bridge (MP 235.0) and just east of an underpass (MP 236.3) mid-way between the Dumont and Fall River Road interchanges. These would be supplemented in the Enhanced Program with emergency pullouts at MP 233.2 (east of the Lawson exit), at MP 236.7 (between the Dumont and Fall River Road interchanges), at MP 237.3 (between the Dumont and Fall River Road interchanges), and at MP 238.1 (between the Fall River Road and west Idaho Springs interchanges). It should be remembered that the four exit ramps in the HSR segment are also available for vehicles to get out of the stream of traffic.

Figure 11 Typical HSR Lane Control Signals



4.3.1.4 Reversible Lane Entrance Area (Near Idaho Springs)

The reversible lane entrance area would be located just west of the partial diamond interchange (Exit 239) on the western end of Idaho Springs. The location and schematic layout of the entrance area are illustrated on **Figure 12**.

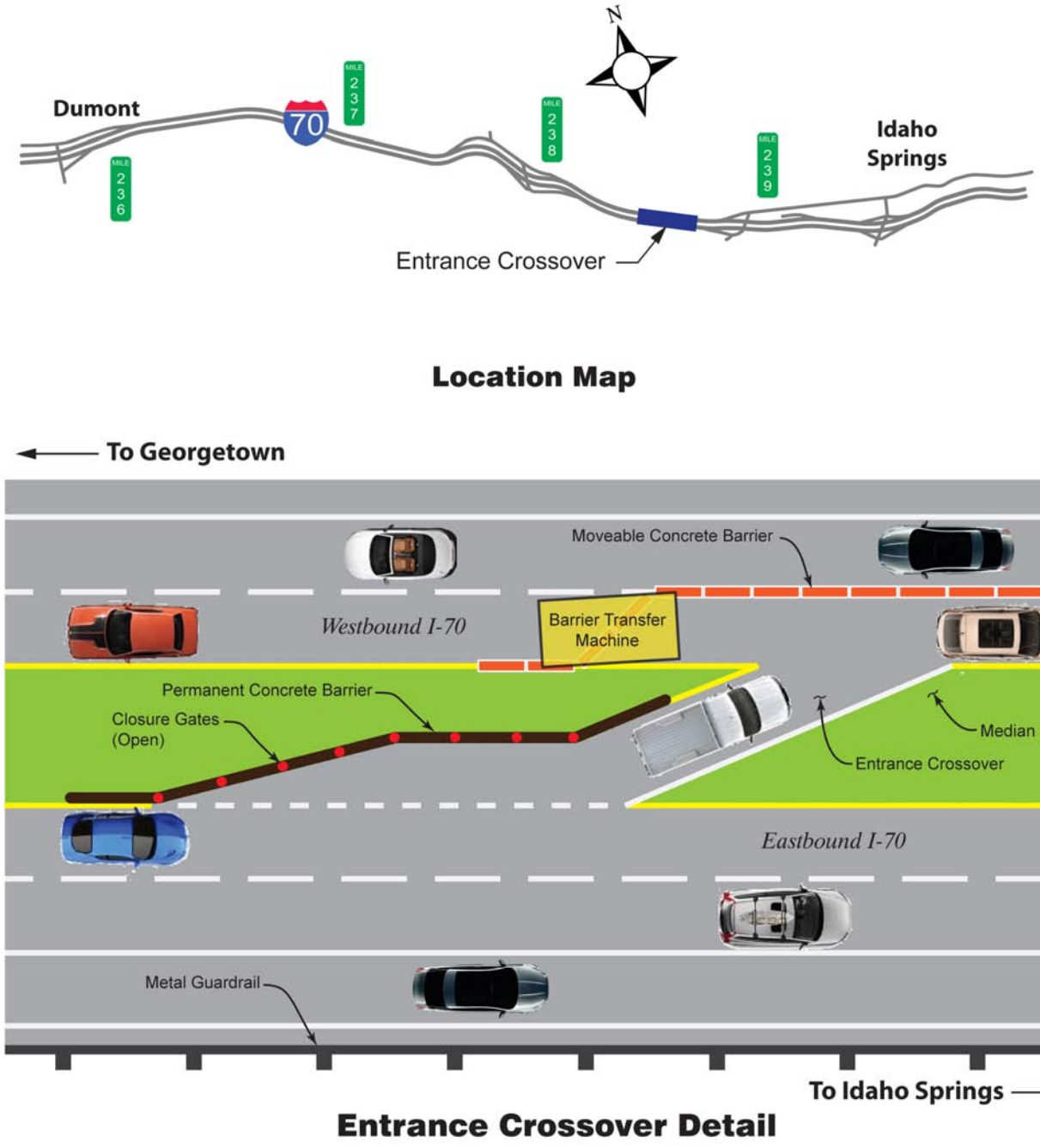
There are two locations west of the Twin Tunnels where the entrance crossover could be located; both were analyzed in detail and evaluated in the field. The one that is preferred is west of the west interchange (Exit 239) for Idaho Springs (referred to as the "West location" in the following discussion). The other one immediately west of the Twin Tunnels is not as suitable (referred to as the "Tunnel location" in the following discussion). Although the Tunnel location would require a shorter length for the moveable barrier and thus would reduce barrier costs, it is not preferred for the following reasons:

- The West location is separated from the upstream Fall River Road interchange (Exit 238) by a greater distance than the Tunnel location is separated from the east Idaho Springs interchange (Exit 241). The approach to the West crossover is relatively straight while there are reverse curves between the east Idaho Springs interchange and the Tunnel location. The West location gives drivers more sight distance to see the advanced signing for the reversible lane and make their decision about which lane to use.
- The Fall River Road interchange has very low volumes while the east Idaho Springs interchange has relatively high volumes. The West location would have very little merging into through traffic upstream of the crossover. On the other hand, the Tunnel location would have a higher volume of cars from Idaho Springs merging onto I-70 at the same time that through traffic is making decisions about whether to use the reversible lane and which is the appropriate lane to use.
- There must be also be sufficient distance downstream of the crossover to allow traffic to transition from the three-lane HSR roadway section to the normal two-lane section for eastbound I-70. The West location can take advantage of the approximately one-mile distance to the SH 103 interchange (Exit 340) to make this transition. There is less than 500 feet between the Tunnel crossover and the Twin Tunnels to accomplish this transition.
- A truck chain-up area for eastbound I-70 traffic approaching Floyd Hill is located just west of the Twin Tunnels.
- There is a solid concrete barrier (Type 7) in the median for much of the distance between the west and east Idaho Springs interchanges. Safety and capacity (due to limited shy distance) for eastbound I-70 traffic could be compromised by extending the HSR through Idaho Springs as the inside shoulder would be two feet wide next to this tall, solid barrier.
- There is a 10 mph off-ramp for eastbound traffic at the east Idaho Springs interchange (Exit 341). Although the cost would be relatively minor, this ramp (and the adjacent on-ramp) would need to be reconstructed to provide adequate deceleration and turning radius since it would be unsafe for exiting traffic to slow down to 10 mph in the HSR lane.

Thus, the decision to recommend the West location for the crossover is based on many factors. Unfortunately, there is too much going on between the east Idaho Springs interchange and the Twin Tunnels for the Tunnel location to be as safe and effective as the West location.

To implement the reversible lane, several changes would be required for the West location. Crossover pavement would need to be added to the I-70 median in order to allow eastbound drivers to cross the median from the inside eastbound lane to the reversible lane. Guardrail in this area would need to be modified to a configuration that is safe and effective both when the reversible lane is and is not in operation. Automatic gates would be installed in the taper area of the crossover to ensure that eastbound vehicles could not enter the crossover when the reversible lane is closed.

Figure 12 Hybrid Alternative - Reversible Lane Entrance Area



4.3.1.5 Differences Between the Pilot and Enhanced Programs – Hybrid Alternative

As previously mentioned, the Pilot Program with associated risks and reduced cost would allow this innovative idea to be tested. After two years, the Pilot Program would be evaluated to determine if it should be continued. An Enhanced Program could be implemented with appropriate additional features that would improve its performance and facilitate longer-term operations. **Table 9** summarizes the different features of the Pilot and Enhanced Programs.

Table 9 Pilot vs. Enhanced Program Features – Hybrid Alternative

Element	Pilot Program	Enhancement Program
Twin Tunnels (Westbound direction)	• Add supplemental lighting at west entrance only, standard (non-LED) lighting	• Add directional, LED tunnel lighting
Emergency Pullouts	• Two locations	• Six locations
Staged assets for emergency response	• Local agencies responsible for ambulance and fire response,	• Stage additional emergency response vehicles along the reversible lane corridor
Intelligent Transportation System (ITS) components	• Portable variable message signs. • Overhead lane control signals	• Replace portable variable message signs (VMS) with overhead VMS signs. • Implement traffic monitoring equipment and additional ramp metering provided for westbound traffic • Complete Closed Circuit Television (CCTV) coverage
Incident Response services	• CDOT only contracts for courtesy patrol and heavy tow services.	• Provide incident command, dedicated operator/dispatcher, and specialized response services

4.3.1.6 Deployment Decision

As discussed in **Section 4.1.2.4**, CDOT will work with area stakeholders to develop a formal Deployment Decision Plan for the Hybrid Alternative. The decision to deploy the Reversible Lane will be made each time based on several factors. Some initial considerations for the deployment decision factors are summarized in **Table 3**. The final decision plan will be made with local input.

4.3.2 Evaluation

4.3.2.1 TRAFFIC OPERATIONS

The same methodology and models that were used to evaluate congestion and travel time savings for the Reversible Lane Only Alternative were also used for the Hybrid Alternative (as discussed previously in **Section 4.2.2.1 Traffic Operations**). Likewise, the same growth assumptions for future traffic over the five to 10 year time horizon were used. The projected westbound queues that are provided in Table 3 would be the same for the Hybrid Alternative since the situation east of the Twin Tunnels would be identical.

As shown in **Table 10**, HSR is projected to save significant time (approximately 16 minutes) in the westbound direction. This results from having two westbound lanes available west of Idaho Springs. Two-lane capacity and the ability to pass slower moving vehicles would allow faster speed and reduced travel time. The travel times reported by the model for eastbound traffic are essentially the same (and within the fluctuations inherent in the computer model).

Table 10 Travel Times – Hybrid and Reversible Lane Only Alternatives

Scenario	Eastbound Travel Time (min)	Westbound Travel Time (min)	Person Hours of Travel Saved[1,2]
2010 Traffic Volumes			
Without Reversible Lane[3]	79	34	—
Reversible Lane Only Alt.[3]	41	69	11,866
Hybrid Alternative	45	54	12,101
Future Traffic Volumes			
Without Reversible Lane (baseline 10% growth)	111	34	—
Reversible Lane Only Alt. (with additional 5% induced eastbound)	68	97	2,626
Hybrid Alt. (with additional 5% induced eastbound)	65	80	5,321

[1]Reported person hours of travel savings does not account for delays to eastbound and westbound travelers due to crashes.
[2]Based on Average Vehicle Occupancy of 2.6.
[3]From Phase I Feasibility Study.

4.3.2.2 SAFETY

4.3.2.2.1 Hard Shoulder Running (HSR) Safety Research

The following safety information has been summarized from the recent FHWA report to Congress entitled *Efficient Use of Highway Capacity Summary*, November 2010. Transportation agencies in the United States have been experimenting with using freeway shoulders to increase capacity since the late 1970's. While American deployments have been limited, experience has been positive, though safety benefits have not been conclusive. Four case studies from the United States found no evidence of a significant effect on crash frequency during peak hours resulting from shoulder use.

Europe has had more experience with temporary shoulder use during congested periods when queues begin to build at bottlenecks in the system. This treatment is almost always deployed in conjunction with dynamic lane control signing and speed harmonization. European agencies have realized both safety and mobility benefits as a result of these projects.

Safety impacts of narrow lanes and shoulder use in the U.S. has also been studied since the late 1970's. Typically the results of these two treatments have been documented concurrently. Shoulder use has been applied and studied as a full time and part time applications as well as a HOV and bus-only treatment. NCHRP Report 369 (*Use of Shoulders and Narrow Lanes to Increase Freeway Capacity*, Transportation Research Board, 1995) reviewed facilities in Virginia, Washington, California, and Georgia. Statistical analysis indicates that in aggregate across the study corridors, there was no significant difference between altered and unaltered segments. However, I-5 in California indicated a significant increase in crashes (up to 36 percent more) for one specific alteration: where a combination of use-of-shoulders and narrow lanes for greater than one mile in length.

Four case studies from the United States found no evidence of a significant effect on crash frequency during peak hours resulting from shoulder use. Research conducted for the I-70 Hybrid Alternative confirmed these previous finding in that conclusions on the safety impacts are varied, and in some cases contradictory. These contradictions are primarily related to differences in analytical methodology but might also be correlated to differences in the nature of the facilities examined.

4.3.2.2.2 Projected Crashes Within the Hybrid Alternative Corridor

Based on the research just discussed, the safety effects of the Hybrid Alternative were analyzed to determine differences that might be projected from the Reversible Lane Only Alternative (see Table 5). The Hybrid Alternative corridor was separated into the respective lengths for the different components and crash rates proportioned (see **Table 11**). Safety for the HSR portion was assumed to range between remaining the same to an increase in crashes by 36 percent, based on the experience of I-5 in California.

Table 11 Historic and Predicted Crash Data – Hybrid Alternative

	2 Eastbound General Purpose Lanes	2 Westbound General Purpose Lanes	3 Eastbound Lanes (HSR)	1 Westbound General Purpose Lane and Reversible Lane	Estimated Total Number of Crashes
HSR Segment (6.2 miles)					
Historic average number of crashes[1]	3.0	3.0	---------	---------	6.0
Projected number of crashes during reversible lane operation	---------	3.0	3.0 to 4.1	---------	6.0 to 7.1
Net change		0.0	0.0 to +1.1		0.0 to +1.1
Reversible Lane Segment (5.2 miles)					
Historic average number of crashes[1]	2.1	2.1	---------	---------	4.2
Projected number of crashes during reversible lane operation	1.4	---------	---------	3.9	5.3
Net change	-0.7			+1.8	+1.1
Total Corridor (12.7 Miles)					
Historic average number of crashes[1]	5.1	5.1	---------	---------	10.2
Projected number of crashes during reversible lane operation	1.4	3.0	3.0 to 4.1	3.9	11.3 to 12.4
Net change					+1.1 to +2.2

[1]Total crashes annually during winter Sundays.

The results of this analysis of safety reveal that the number of crashes is projected to rise with the Hybrid Alternative (compared to existing conditions) but the increase would be less than projected for the Reversible Lane Only Alternative. The increase in crashes would be 11 to 22 percent for the Hybrid Alternative versus 26 percent for the Reversible Lane Only Alternative. Based on European experience with more robust deployment of ATM infrastructure, implementation of the Enhanced Program might be expected to improve the crash experience for the HSR segment of the corridor.

From the perspective of crash severity (injury and fatal crashes), the corridor's safety performance (when the HSR is in operation) is projected to remain the same as current conditions. Approximately 20 percent of crashes result in an injury while the remaining 80 percent result in property damage only (PDO). Fatal crashes occur very infrequently.

4.3.2.2.3 Crashes on Floyd Hill

The crash experience on Floyd Hill for westbound traffic for the Hybrid Alternative would be the same as for the Reversible Lane Only Alternative (as discussed in Section **4.2.2.2.3**). The estimated number of Sunday afternoon rear-end crashes during the Pilot Program is projected to rise from approximately 1.2 annually during the 17-day winter period to 4.2 when the reversible lane is in operation.

As before, the net safety effect of the Enhanced Program on Floyd Hill (assuming the installation of queue detection and variable message signs) would be neutral.

4.3.2.2.4 Emergency Response to Incidents

Emergency response, using just Courtesy Patrol and Heavy Tow is not optimal for the Hybrid Alternative. Since three lanes will be filled with traffic in the HSR segment of the project, courtesy patrol, heavy tow, and emergency responders will use uninvolved lanes to pass traffic to the incident site or will need to approach an eastbound incident from the west since a shoulder will not be available. Inability to pass stopped traffic may increase response time. There would be three staged teams for the Hybrid Pilot Program due to access limitations, which is the same as for the Reversible Lane Only Alternative. Law Enforcement will operate essentially the same for either Pilot Program since both programs result in significant constraints for the full length of operation. The Pilot Programs are cost neutral between the two advanced alternatives.

4.3.2.3 Summary of Traffic and Operations Impacts

This alternative would satisfy the purpose and need in that it would add a third eastbound lane and provide additional capacity while foregoing a more extensive construction project. The decrease in westbound travel times would not be as much as with the Reversible Lane Only Alternative.

This alternative has a number of traffic impacts:

- It would remove a westbound lane and decrease westbound capacity; traffic congestion is forecasted as a result. However, overall travel time savings would be positive.
- Travelers in the reversible lane would have no access to exits within the reversible lane segment of the corridor.
- Incident response and emergency services would be more complicated.

- CDOT would have to manage the new logistical and operational needs resulting from deployment of the barrier, normal maintenance responsibilities, and snowplowing through the Reversible Lane Corridor.
- Incidents would impact the travel-time benefits of the project when they occur, and weather-related operational issues could reduce the number of days that the moveable barrier can be deployed.

4.3.2.4 Social Impacts

4.3.2.4.1 Impact of a Reversible Lane on Business and Economic Conditions

From an economic perspective, there are some differences between the two advanced alternatives that could make the Hybrid Alternative more beneficial to Clear Creek County communities. However, it is the judgment of the economists on the study team that these do not substantially change the findings of their Reversible Lane Only Alternative largely because access to the three Idaho Springs exits from the reversible lane is still restricted under the Hybrid Alternative.

The major changes under the Hybrid Alternative and their potential impacts are summarized in **Table 12**. First, the Hybrid Alternative would create a restricted eastbound lane for only 5.2 miles, compared to 12.7 miles under the Reversible Lane Only Alternative. The reversible lane, separated from westbound traffic by a moveable concrete barrier, would begin approximately 22 miles from the EJMT whereas the Reversible Lane Only Alternative would begin approximately 15.5 miles from the EJMT. Because the additional distance will bring drivers closer to the first Idaho Springs exit, the lack of access from the reversible lane may be less significant. Drivers from all three lanes of eastbound traffic (HSR) will reach the vicinity of Idaho Springs and, based on signage, should be able to shift lanes to exit if they wish to do so. The increased distance to the crossover also provides more opportunities for signage to inform drivers of these options which could be more beneficial to Idaho Springs businesses.

Under the Hybrid Alternative, the access to Idaho Springs from the reversible lane would be restricted in the same manner as the Reversible Lane Only Alternative, as described in **Table 12**. Idaho Springs would still be accessible from the eastbound and westbound general purpose lanes, and the net result is essentially the same set of conditions as the Reversible Lane Only Alternative.

The Hybrid Alternative may be more beneficial than the Reversible Lane Only Alternative to the small Downieville business district as there would be no change in access to these businesses. They could also potentially intercept some traffic before it reaches the reversible lane segment near Idaho Springs. However, the number of businesses in Downieville is much smaller than in Idaho Springs. Idaho Springs is a stronger dining and shopping destination with a larger number and more diverse mix of businesses, making it a more competitive destination than Downieville.

Table 12 Economic Comparison of Alternatives

Characteristic	Reversible Lane Only Alternative	Hybrid Alternative	Economic Considerations: Hybrid vs. Reversible Lane Only
Miles of restricted lane	12.7	5.2	• RL begins further from EJMT. More opportunities for signage describing business access. • More time for drivers to make a decision to exit the highway to visit businesses.
Exits unavailable from eastbound RL	All from Empire Junction to Hidden Valley	Four more available: Empire Junction, Lawson, Downieville, Dumont	• More opportunities to exit in Clear Creek County • Idaho Springs exits remain restricted.
Business Districts along the impacted corridor	Downieville, Idaho Springs	Idaho Springs	• RL begins immediately west of Exit 239 (west Idaho Springs • Small Downieville business district will have no change in access • All eastbound Idaho Springs exits are restricted from the RL • Access from general purpose lanes is possible • No discernible difference in access and impacts to Idaho Springs from the Reversible Lane Only Alternative
Eastbound Future Travel Times (Sunday Afternoons)	No Significant Difference	No Significant Difference	• There are differing views on the effects of travel time on drivers' propensity to exit the highway to visit businesses. • No differences between these alternatives, as both create savings of 35 to 40 minutes above current conditions.
Westbound Future Travel Times (Sunday Afternoons)	69 minutes	54 minutes	• Improved westbound travel time, but still more than twice current levels. • Minimal difference in business impacts. Westbound morning and eastbound afternoon travelers (skiers) are the majority of customers during the winter.

Finally, there is no significant difference in eastbound travel times between the two accepted alternatives. A potential concern would be that additional reductions in congestion (decreases in travel time) would further deter drivers from taking a break in Idaho Springs. Since there is no difference in travel time between the advanced alternatives, the congestion effects on business would be the same under both alternatives. Although westbound travel times improve, westbound Sunday afternoon travelers are a small portion of overall business volume in comparison to eastbound travelers. The decrease in westbound travel times is not projected to change business conditions significantly.

In summary, the Hybrid Alternative could be slightly better from an economic perspective than the Reversible Lane Only Alternative for the two reasons:

- It gives drivers more time to decide to exit in Idaho Springs.
- There would be no change in access to Downieville businesses, giving them an opportunity to intercept some Idaho Springs-bound traffic before it enters the reversible lane.

4.3.2.4.2 Input from Project Leadership Team (PLT)

Local stakeholders (through the PLT) have not had an opportunity to express an opinion about whether they are more comfortable with the Hybrid Alternative than they are with Reversible Lane Only Alternative.

4.3.2.5 Environmental Impacts

The following environmental resources have been evaluated for the Hybrid Alternative Pilot and Enhanced Programs and in the same manner as the Reversible Lane Only Alternative. To avoid redundancy within this report existing conditions information is presented only under the Reversible Lane Only Alternative discussion.

4.3.2.5.1 Visual and Aesthetics

The visual and aesthetic impacts from the Hybrid Alternative would be the same as for the Reversible Lane Only Alternative. Impacts from the implementation of the Pilot Program would be less than from the Enhanced Program because more mobile VMS (lower to the ground and placed on the edge of the road) would be utilized, thereby decreasing the visual intrusion.

To minimize and mitigate for the visual intrusion of the new signage placement, the project should adhere to the aesthetic guidelines prepared as a part of the *I-70 Mountain Corridor Context Sensitive Solutions* (CSS) program, including the Mountain Mineral Belt Aesthetic Guidance.

4.3.2.5.2 Traffic Noise

For both the Pilot and Enhanced Programs of the Hybrid Alternative, the entire project corridor would be considered a Type 1 project because of the addition of a third eastbound lane through much of the corridor during reversible lane deployment along with the added auxiliary lane at the east end of the corridor. Compared to the Reversible Lane Only Alternative, the Hybrid Alternative would have similar eastbound traffic speeds and volumes (no noise change) but higher westbound traffic volumes and speeds (higher noise levels).

While the noise analyses would be expected to be included in the Documented CatEx, some qualitative observations can be presented here. Data from the Draft PEIS indicate that several residences in the project corridor currently are impacted by traffic noise from I-70. The congested traffic periods when the reversible lane would be deployed are not likely to be the corridor's peak noise periods, but impacts from traffic noise during barrier deployment are likely. Assuming noise impacts are identified, noise abatement options for the affected areas will need to be evaluated for feasibility and reasonableness.

In traffic noise terms, there would be little difference between the Pilot program and Enhanced Program for the Hybrid Alternative.

4.3.2.5.3 Biological Resources

The primary vegetation in the median and existing right-of-way are grass species, such as smooth brome (*Bromus inermis*), downy brome (*Bromus tectorum*), western wheatgrass (*Pascopyrum smithii*), and various weedy species. Impacts to vegetation from the Hybrid Alternative would be very similar to the Reversible Lane Only Alternative. However under the Hybrid Alternative, slightly more pavement would be needed for the median and shoulders of I-70 to accommodate the third eastbound lane through three interchanges. These additions would be relatively minor and would not substantially affect the overall project impacts.

There is no known terrestrial threatened or endangered species habitat present in the immediate vicinity of the Reversible Lane Project Area. However, portions of Clear Creek have been identified as potential greenback cutthroat trout (a state threatened species) habitat. Clear Creek is adjacent to the project area. Impacts to Clear Creek from the project would result from increased sedimentation from the addition of an impermeable surface; however, best management practices for water quality will be incorporated to mitigate for any sedimentation. Therefore, there are no expected impacts to threatened or endangered species as a result of the project.

Impacts to wildlife from the Hybrid Alternative are expected to be less than the Reversible Lane Only Alternative. Even though the Hybrid Alternative would have an additional lane of traffic, the moveable barrier would extend for a much shorter distance. The same barrier mitigation actions would be available for the Hybrid Alternative.

Impacts to wildlife and vegetation would be similar under both the Pilot Program and Enhanced Program. The analysis of animal vehicle collisions during the Pilot Program may lead to an adjusted mitigation approach for the Enhanced Program.

4.3.2.5.4 Wetlands

Wetland impacts under the Hybrid Alternative are expected to be more than the Reversible Lane Only Alternative because three areas have been preliminarily identified as potential locations for water quality ponds (as opposed to two under the Reversible Lane Only): two at the east end crossover (MP 244.0) and one area has been conceptually identified as a location at the west end crossover (MP 238.8). Wetland impacts will ultimately be determined by the placement of water quality ponds, associated outlet structures, and rip-rap. The wetland impacts with the Hybrid Program are expected to be approximately 450 square feet of impact area (0.01 acres) compared to 300 square feet of impacts under the Reversible Lane Only Alternative.

Impacts should be covered under a Nationwide Section 404 Permit. The mitigation may be through on-site creation of wetlands or the use of a wetland mitigation bank (such as the Warm Springs Wetland Mitigation Bank). Because the project would not be within a primary service area for any USACE-approved wetland mitigation bank, credits could be purchased, but likely greater than a 1:1 ratio, at the discretion of the USACE.

Impacts would be the same under the Pilot and Enhanced Programs.

4.3.2.5.5 Water Resources

Any impacts to water resources from the Hybrid Alternative would be the same as for the Reversible Lane Only Alternative. Impacts would be the same under the Pilot and Enhanced Programs.

4.3.2.5.6 Geologic Hazards

The conditions regarding geologic hazards for the Hybrid Alternative would be the same as for the Reversible Lane Only Alternative. Impacts would be the same under either the Pilot or Enhanced Programs.

4.3.2.5.7 Regulated Materials and Historic Mining

The Hybrid Alternative could be affected by regulated materials in the same manner as under the Reversible Lane Only Alternative. The particular locations of impact may differ between the two alternatives based on the exact placement of signs and excavation depth, which will be

determined during final design. Impact under the Pilot Program would be expected to be diminished compared to the Enhanced Program because VMS are expected to be portable instead of permanently installed as overhead cantilevers.

4.3.2.5.8 Historic Properties

Impacts to historic resources would be the same under the Hybrid Alternative as under the Reversible Lane Only Alternative. These impacts are limited to the Twin Tunnels, which are historically significant. However, differences would vary between the Pilot Program and the Enhanced Program of the both alternatives. The Pilot Program proposes to install temporary directional lighting within the tunnel, whereas, the Enhanced Program proposes to replace the existing lighting with new LED lighting.

4.3.2.5.9 Other Resources

Information about other resources that would likely not require mitigation is provided in **Table 13**.

Table 13 Resources with No Recommended Mitigation Measures under the Pilot Program and Enhanced Program

Resource	
Air Quality	Compared to existing conditions, the Hybrid Alternative would have the net effect of increasing the existing very low eastbound vehicle speeds and decreasing the existing relatively high westbound vehicle speeds during hours of currently high eastbound congestion. Both of these speed changes are expected to correlate to reductions in tailpipe emissions. There may be some added emissions from westbound traffic queuing to enter the reversible lane segment. Therefore, with no major changes on overall corridor traffic volumes, the Hybrid Alternative is expected to reduce overall tailpipe emissions and to improve modestly the air quality situation.
Land Use	The Hybrid Alternative would not directly impact existing land use in Clear Creek County. Indirect impacts, such as growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate are not expected to occur as a result of the Hybrid Alternative.
Environmental Justice	Pockets of minority and low-income residents are distributed throughout communities adjacent to the project area. No disproportionate impacts are anticipated to low-income and minority populations within the project area as positive and negative impacts are expected to be shared equally between the general public and minority and low-income residents.
Energy	Compared to existing conditions, the Hybrid Alternative would have the net effect of reducing overall energy usage in the project area. The expected reductions in automobile fuel consumption due to overall improved traffic operations would more than outweigh the additional electricity would be used to power additional electronic devices.
Recreation and Section 6(f)	Section 6(f) properties are those that have been funded by Land and Water Conservation Funds. Recreational travel is the predominant contributor to peak I-70 traffic, especially during summer and winter weekends. Existing traffic during the ski season is characterized by congestion that noticeably affects travel within the project area, and affects the tourism economy. The eastward bound skier experience would be improved in terms of travel time and gridlock relief. No physical impacts are anticipated to recreational facilities. No impacts are anticipated to 6(f) properties as a result of implementing the Reversible Lane.
Paleontology	The project area traverses an area of Pre-Cambrian metamorphic rocks, which do not contain fossils, so paleontological resources are not anticipated to be a concern for this project.

4.3.2.6 Logistical/Operation Complexity

The storage and deployment of the barrier transfer machine would be the same for both advanced alternatives. Due to the reduced length of reversible lane contemplated under the Hybrid Alternative, the barrier transfer machine would take approximately 45 minutes instead of the 90 minutes anticipated for the Reversible Lane Only Alternative. This would allow operation flexibility in responding to actual traffic conditions when determining the time to initiate the deployment process.

Snowplowing for the Hybrid Pilot Program would require additional effort over the Reversible Lane Only Pilot Program. The Hybrid Pilot Program increases eastbound travel lanes from two to three (or more lanes) without reducing westbound travel lanes within the HSR segment of the project. Currently, CDOT maintains the paved shoulders but does not make an equivalent effort to apply surface treatments or make additional passes to shoulder areas in the same condition as the travel lanes. As a result, converting the shoulder into a travel lane will require application of additional materials (liquid and solid de-icers) and additional passes on the roadway to keep snow accumulation completely off of the roadway and into a storage area.

Additional cost associated with materials and additional passes is expected to be within the contingency tolerance of the conceptual opinions of cost developed for the Reversible Lane Only Pilot Program; so the difference is relatively cost neutral.

Snowplowing and routine maintenance for the Hybrid Enhanced Program would be the same as the Hybrid Pilot Program.

4.3.3 Legal Implications

FHWA approval is needed for this action. Restricting I-70 to one westbound lane constitutes a federal action, consistent with 23 CFR 658.11. Reducing the Interstate to one lane outside of a construction project with a reversible lane system has not been done anywhere in the nation with positive results. As such, FHWA has requested an evaluation and screening of possible alternatives to solve congestion in addition to a reversible lane for the entire corridor.

There are no Colorado statues that would prohibit this action.

4.3.4 Costs for Hybrid Alternative

The costs of the Hybrid Alternative project (as shown in **Table 14**) are a significant challenge. There are three major cost elements, and each has differing cost implications depending on whether the Pilot or Enhanced Program is considered, as follows:

- Roadway-related Improvements - including crossovers, passing lanes, the eastbound lane extension from the east crossover to the US 6 exit, ITS equipment (including permanent VMS and lane use control signals and signs), snowplow blade modifications, etc. As previously described, the improvements are more extensive for the Enhanced Program when compared to the initial, Pilot Program. These costs are higher than for the Reversible Lane Only Alternative due to the more extensive roadway improvements required between Empire Junction and west Idaho Springs to accommodate HSR.

- Moveable Barrier – Again, the barrier and transfer machine would be supplied by BSI. The barrier costs are less for the Hybrid Alternative than for the Reversible Lane Only Alternative since the barrier would be 5.2 miles in length instead of 12.7 miles. BSI has provided proposals to CDOT for different leasing and purchase options for the shorter

barrier. The Pilot Program would involve the leasing of the barrier and transfer machine for two years. At the end of that time if the decision were made to proceed with the Enhanced Program, CDOT would have the option to purchase the equipment. The costs for the lease/purchase option shown in **Table 14** are the total for both Pilot and Enhanced Programs. The final option that BSI has provided a proposal for would be for CDOT to purchase the equipment required for the Enhance Program initially. CDOT does not favor this approach to implementing the reversible lane, but the costs are also shown in **Table 14** for comparison purposes.

- Annual Costs – These costs would include personnel and equipment costs each year for deploying the barrier and emergency response services on the 17 Sunday afternoons during the winter. Again, the Enhance Program is more comprehensive than the Pilot Program.

Table 14 Hybrid Alternative Costs

	Pilot Program (2 year lease)	Enhanced Program (2 yr lease + purchase)	Enhanced Program (initial purchase)
Roadway	$8,100,000	$16,800,000	$16,800,000
Barrier Systems (estimated based on RLO Alternative)	$6,700,000[1]	$ 13,100,000	$ 11,100,000
Total One-Time Capital Costs	*$14,800,000*	*$29,900,000*	*$27,900,000*
Operations	$130,000	$540,000	$540,000
Emergency Response	$580,000	$1,230,000	$1,220,000
Total Annual Costs	*$710,000*	*$1,770,000*	*$1,770,000*
[1]Two-year equipment lease			

A comparison with the costs for the two advanced alternatives reveals significant overall savings in one-time capital costs. While the roadway costs would increase for the Hybrid Alternative due to more extensive roadway and ITS costs, the cost for the moveable barrier would be substantially less. The final challenge of funding the project would still remain, although the savings in capital costs of $7.5 million for the Pilot Program and $14.0 million for the Enhanced Program would make funding the Hybrid Alternative that much more attainable.

4.3.5 Conclusion

This alternative satisfies the purpose and need. When compared to the Reversible Lane Only Alternative, there are many advantages to the Hybrid Alternative. For the following reasons, the Hybrid Alternative is the favored alternative for implementation:

- Better travel times for westbound traffic translate into more overall time savings.
- Shorter barrier length gives more flexibility for eastbound I-70 travelers to stop at local destinations and more two-lane capacity for westbound traffic.

- Safety is projected to be slightly improved relative to the Reversible Lane Only Alternative.
- Lower cost for the moveable barrier more than offsets the minor increase in roadway construction costs. These savings amount to $7.4 million for the Pilot Program and $13.1 million for the Enhanced Program.
- The inclusion of HSR in the Hybrid Alternative and the moveable barrier both provide a permanent "tool" that can be used at other times and for other purposes (emergencies, crashes, construction, maintenance etc.).

5.0 APPROVAL REQUEST

CDOT is requesting the FHWA review and approve the concept of the Hybrid Alternative including one lane for westbound I-70 traffic, as required under 23 CFR 658.11(d). Additional NEPA approval will be needed prior to project implementation. This report has analyzed a reasonable range of alternatives as required. The two alternatives that were advanced for further consideration both meet the purpose and need for the project, but the Hybrid Alternative has clear advantages over the Reversible Lane Only Alternative. The benefits of implementing short-term improvements on I-70 and the advantages of the Hybrid Alternative include:

- Both alternatives will result in overall time savings in the short-term (five to ten years). The Hybrid Alternative has better travel times for westbound traffic which translates into more overall time savings.
- The Hybrid Alternative's shorter barrier length gives more flexibility for eastbound I-70 travelers to stop at local destinations and more two-lane capacity for westbound traffic.
- Safety for the Hybrid Alternative is projected to be slightly improved relative to the Reversible Lane Only Alternative.
- The lower cost of the shorter moveable barrier for the Hybrid Alterative more than offsets the minor increase in roadway construction costs when compared to the Reversible Lane Only Alternative. These savings amount to $7.4 million for the Pilot Program and $13.1 million for the Enhanced Program.
- The inclusion of HSR in the Hybrid Alternative and the moveable barrier both provide a permanent "tool" that can be used at other times and for other purposes (emergencies, crashes, construction, maintenance, etc.).