

A grayscale photograph of a highway. In the foreground, a signpost has a diamond-shaped sign that says "WRONG WAY". Below it, a smaller sign says "TRUCKS ONLY". The highway is filled with cars, some of which are stopped, suggesting a traffic jam. The background shows a forested hillside.

# **I-70 Reversible Lane Feasibility Support Services**

## ***Phase I Design Support*** **Technical Memorandum**

Prepared by:

**JACOBS™**

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Region 1 of the Colorado Department of Transportation (CDOT) is evaluating the feasibility of an I-70 reversible lane (commonly referred to as a zipper lane) between Georgetown (Milepost 228) and Floyd Hill (Milepost 245). Jacobs Engineering Group (Jacobs) was asked to evaluate the two proposed median crossovers and provide additional, smaller support tasks. This technical memorandum documents the results of the evaluation.

## 1.0 Data Collection / Surveying

Jacobs performed the following data collection tasks:

### 1.1 Sketch Plan Base Maps

Jacobs obtained base aerial photographs from available sources and imported these photographs into a Geographic Information System (GIS) database. Although these aerial photographs are not at sufficient resolution to allow for preliminary design, they have been used for planning efforts, such as creation of corridor maps, definition of features along the corridor, and tracking of design issues that will need to be addressed in subsequent work phases. The overall study area is presented in **Figure 1** using this imagery.

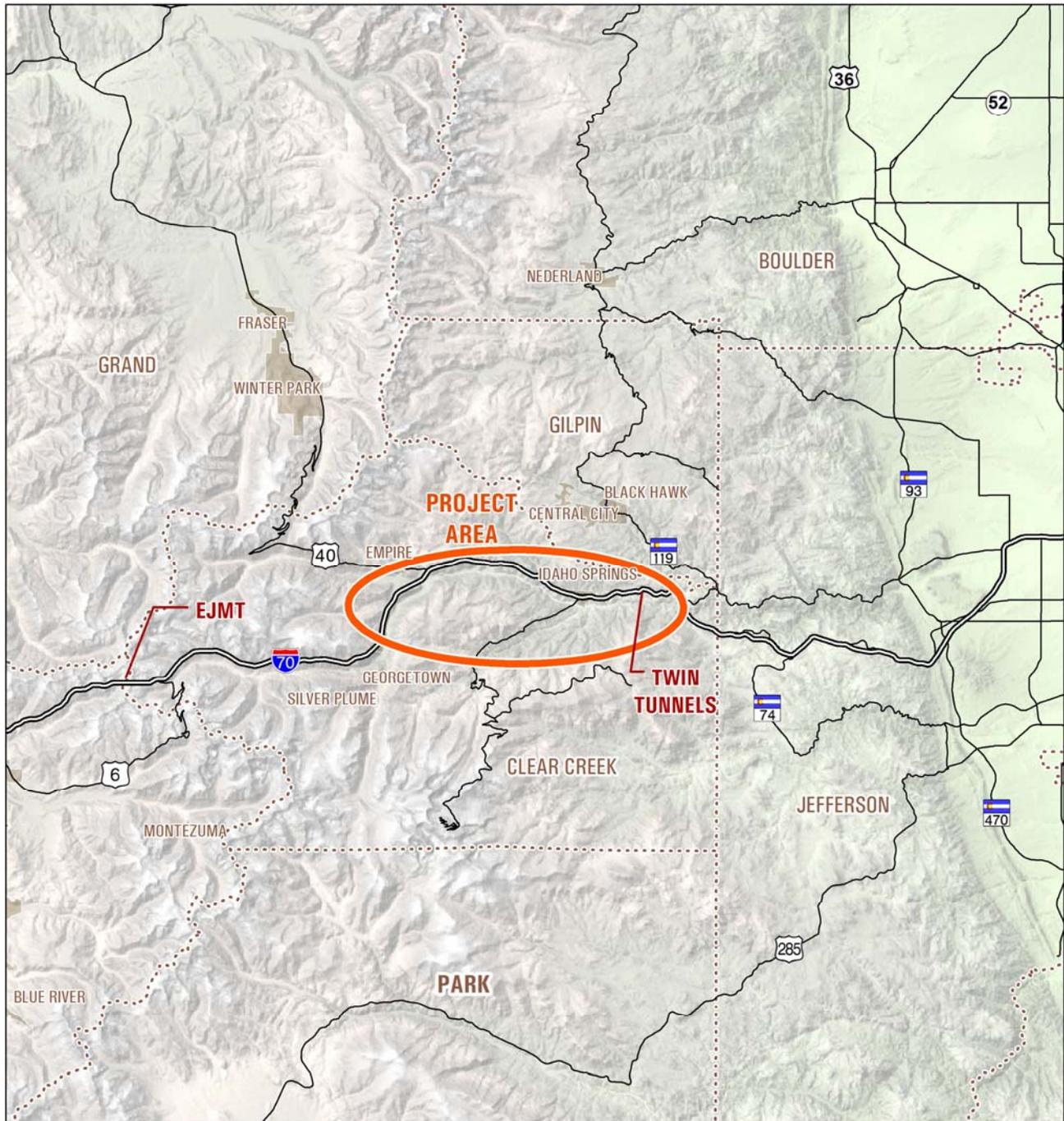
### 1.2 Site Video

Jacobs collected continuous geo-referenced video of the entire corridor (both directions), resulting in four continuous video streams of the corridor. Two videos were taken in the forward travel direction (one eastbound and one westbound). Two videos were taken from the rear window of the vehicle (one eastbound and one westbound), to capture the perspective of a motorist driving in a potential reversible lane.

Based on the videos, Jacobs prepared GIS mapping identifying key issues that could affect reversible lane implementation. This mapping is presented in **Appendix A-1**. The data contained in the mapping is summarized below:

- There were three blunt ends identified. At these locations, additional construction would be required to protect the blunt ends from eastbound traffic in the leftmost westbound (reversible) lane. This work could include impact attenuators, connections to existing barriers, or other site-specific modifications.
- Six median crossovers were identified. These crossovers would not function as they do today if the continuous movable barrier were placed across them. It is not expected that the crossovers could be retained with the movable barrier in place.
- There are five segments of the corridor with an existing concrete median barrier. The longest segment is through Idaho Springs; shorter segments are in Georgetown, Dumont, Hidden Valley, and at the base of Floyd Hill. Remaining segments of the corridor typically have sloped grass medians with either a w-section or cable guardrail.

Figure 1: Study Area Map



- Three segments were identified that have steeply sloped medians. The longest is the area between Idaho Springs and Dumont, where the westbound roadway is generally higher than the eastbound roadway. The other two segments are at the east end of the corridor, at the Twin Tunnels and at the base of Floyd Hill.

### 1.3 Photogrammetry

The I-70 corridor from the C-470 interchange to the Eisenhower/Johnson Memorial Tunnel was survey-controlled and flown with aerial photography in October 2009 by Woolpert. Under the direction of CDOT Region 1, Woolpert acquired the aerial photography at a sufficient photo scale to produce orthophotography at a .25-foot pixel resolution and 2-foot contour mapping anywhere along the corridor. The nominal photo scale for the photography is 1:7700. The imagery was scanned at a resolution of 14 microns. Survey control for the imagery was based on Colorado State Plane Coordinates, Central Zone, NAD83 US Feet.

Two critical crossovers required mapping and orthophotography. They are:

- Hidden Valley: approximately 1.25 miles between the Clear Creek overpass at the base of Floyd Hill and the Clear Creek overpass at Hidden Valley. Woolpert forwarded 2 flight lines and 28 exposures to Jacobs for mapping and orthophoto generation.
- Georgetown: approximately 3.25 miles between the Clear Creek overpass near the CR 308 bridge (west end of Empire Junction) and the 15th Street overpass at the Georgetown interchange. Woolpert forwarded 2 flight lines and 41 exposures to Jacobs for mapping and orthophoto generation.

In each of these areas, Jacobs produced 2-foot contour, planimetric mapping, and DTM mapping with 2-foot contours using Region 1 MicroStation standards and .25-foot orthophotography from the available aerial photography. All Georgetown and Hidden Valley mapping data was transformed to CDOT project coordinates per CDOT requirements.

### 1.4 Field Survey

Several key pinch points were identified. The Jacobs survey team performed a field survey to collect roadway and shoulder width data at the following points:

- CR 312 overpass on I-70 westbound at Downieville, MP 235.00 +/-.
- SH 103 (Mt Evans Road) overpass on I-70 westbound at Idaho Springs, MP 239.65 +/-.
- Colorado Boulevard overpass on I-70 westbound at Idaho Springs, MP 241.10 +/-.
- Colorado Boulevard entrance ramp to I-70 westbound at Idaho Springs (west), MP 238.70 +/-.

These locations are shown in more detail in **Appendix A-2**. Since no photogrammetric survey was performed in the pinch point areas, there were insufficient ties for these data at this stage of the study. The electronic data are included on the CD accompanying this technical memorandum for use in subsequent phases of work.

The team also collected a High-Definition Survey/Laser Scan at the westbound Twin Tunnel. The scan included both approaches and a complete 3-D pavement surface, wall, and roof model of the entire 750-foot tunnel. This process provided X Y Z values to 0.5-centimeter accuracies of all surfaces, allowing

sections to be modeled at any point within the tunnel for clearance and obstructions. That data also located all the lights, conduits, and other physical features within the tunnel. These data are included on CD accompanying this report.

## 1.5 Field Operations Study

During the Phase I Feasibility Study timeframe, CDOT performed emergency repairs on the westbound I-70 overpass of Clear Creek / US 6 at the base of Floyd Hill. Jacobs was asked to collect travel time and queue length data during the lane closures associated with these repairs, since they would be somewhat similar to the westbound lane closure required to operate the reversible lanes. At the same time, CDOT collected traffic volume and speed data from nearby permanent traffic count stations. All Traffic Data (ATD) also collected volumes and speeds at the closure point.

Jacobs collected eight travel time runs during the closure. Data from each run (with relevant count data from CDOT and ATD) are presented in **Appendix A-3**. The following bullets summarize the data collected:

- The lane closure generally operated without queuing during the early runs (between 8:00 AM and 8:45 AM), although speed reductions were noted. These runs occurred with a volume of approximately 1,000 to 1,200 vehicles per hour (vph).
- As the demand began to grow through the morning, delays began to increase and a queue began to form. The volume rose to approximately 1,400 vph by late morning. The maximum observed queue was 3.8 miles in lane and occurred between 10:30 AM and 11:00 AM.
- Between about 11:15 AM and 11:45 AM, the work crews changed the left lane closure to a right lane closure. The change in traffic control resulted in two-lane operations for a short time period that cleared the queues out of the area.
- After the right lane closure was in place, queues began to build again, with a 0.7-mile queue observed at approximately 1,285 vph around 12:30 PM.

From these data, it was determined that westbound single-lane flows greater than approximately 1,100 vph to 1,300 vph could be expected to generate queuing during a reversible lane operation.

## 2.0 Concept Advancement

Based on available aerial photography, Jacobs developed a series of potential typical crossing-sections for the corridor and crossover options at each end of the reversible lane. These are described in more detail in the following sections.

### 2.1 Cross Sections

The reversible lane requires the installation of 1.5-foot-wide concrete barrier in the corridor for the length of the reversible lane. The width of this barrier would take away from the existing westbound

roadway width (either shoulders or lanes). In addition, the barrier could only be moved a distance of up to 16-feet in a single pass of the barrier moving machine. This could limit the available shoulder widths during reversible lane operation.

Typical cross-sections for the reversible lane were developed based on AASHTO guidelines, CDOT standards, and field conditions. Based on the video inventory and CDOT's Straight Line Digrams, much of the corridor has a 3-foot-wide inside (left) shoulder. If a 1.5-foot movable barrier were to be stored on this shoulder, the shoulder would drop below the AASHTO minimum of 2 feet. Hence, it was proposed that the inside shoulder be widened from 3.0 feet to 3.5 feet to create a 2-foot shoulder during barrier storage. During operation, the 1.5-foot movable barrier would be centered on the stripe between the two westbound lanes, and would narrow each lane by 0.75 foot. Therefore, it was proposed that during normal operations, the inside lane be striped to 12.5 feet, and the outside lane be striped at 13 feet. Hence, all lane lines would need to be restriped, resulting in a 2-foot reduction of the existing outside shoulder. All of these typical sections were presented to CDOT and discussed in a workshop setting. Minor changes made at the workshop were incorporated into the sections presented below. The resulting cross-sections are shown in **Figure 2**.

A special case for the cross-section is the westbound Twin Tunnel, just east of Idaho Springs. The westbound tunnel is about 29 feet wide from face of barrier to face of barrier. In the tunnel, slightly different restriping resulting in narrower shoulders would be required. Refer to **Figure 3**.

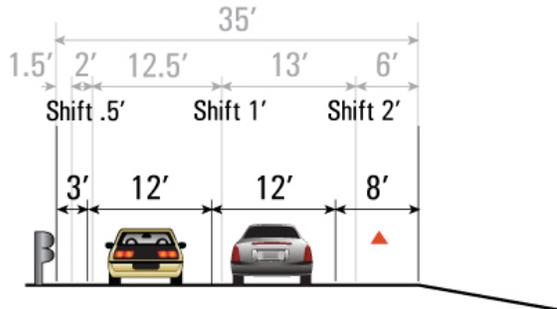
There would be one issue in the Twin Tunnel with the available vertical clearance when traffic shifts to the outside of the tunnel, especially when the reversible lane is in operation. The tunnel survey found actual vertical clearances in the tunnel are as shown in **Table 1** and **Figure 3**.

Table 1: Actual Vertical Clearances at Westbound Twin Tunnel

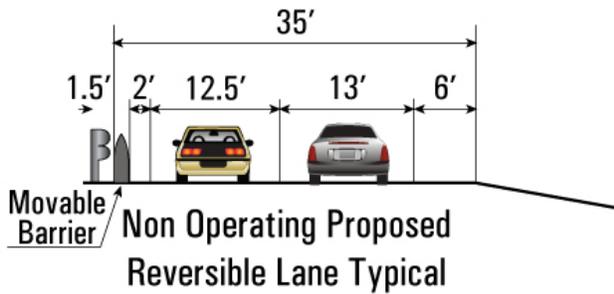
	Left Side of Tunnel	Right Side of Tunnel
<b>At existing barrier</b>	13.1 feet	14.6 feet
<b>1 foot inside existing barrier</b>	15.3 feet	16.4 feet
<b>2 feet inside existing barrier</b>	16.5 feet	17.7 feet

During normal operations, the tunnel clearances would be equivalent to what exists now, and would be at least 16.5 feet at the two outside stripe lines. But with the median barrier in place during reversible lane operations, natural shy distances from the middle barrier would tend to push traffic in both directions across the solid stripe lines to the outside of the tunnel. For eastbound reversible traffic, this would be a major concern, and truck restrictions would be recommended.

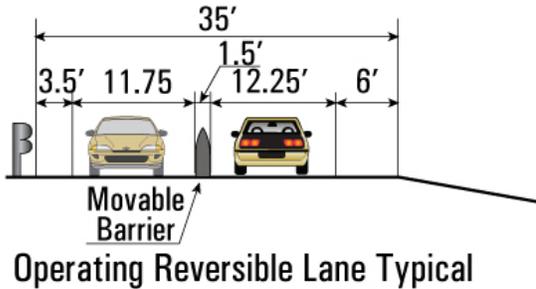
Figure 2: Typical Westbound Roadway Sections



▲ Outside shoulder to be field verified  
Existing Typical/Roadway Width  
with Future Striping Offset

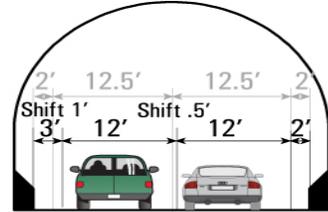


Non Operating Proposed  
Reversible Lane Typical

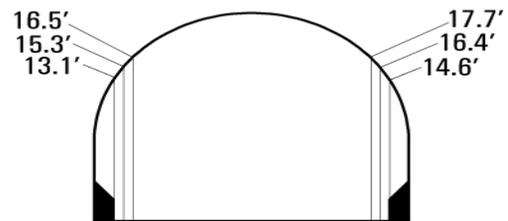


Operating Reversible Lane Typical

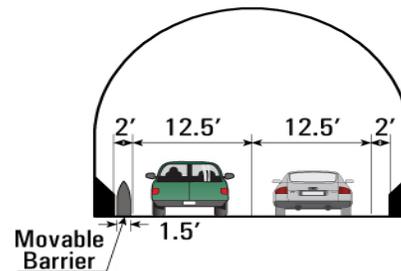
Figure 3: Typical Westbound Tunnel Sections



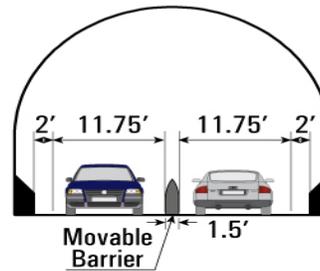
Existing Typical  
with Future Striping Offset



Tunnel Height



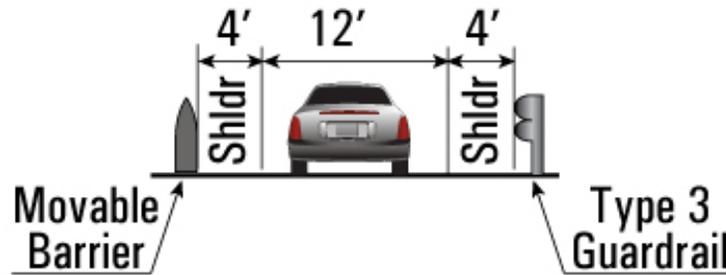
Non Operating Proposed  
Reversible Lane Typical



Operating Reversible Lane  
Typical

Minimum cross-sections for each crossover were also defined. These were also based on AASHTO guidelines and CDOT standards. In general, the crossover lane consists of a single 12-foot lane with 4-foot shoulders on each side. Refer to **Figure 4**. Since the reversible lane is not planned to carry trucks, the overall 20 feet of width would allow a disabled car to pull to one side of the roadway, and other vehicles could pass during an incident.

Figure 4: Typical Crossover Section



The amount of restriping and the issues associated with running reversible lane traffic on an interstate led the team to conclude that an overlay of the westbound lanes would be preferred over grinding off existing pavement markings and restriping the existing roadway surface.

## 2.2 Crossovers

Crossovers are required at each end of a reversible lane to move traffic between the eastbound lanes and the reversible lane. The crossovers must be adequately designed so that they do not hinder reversible lane traffic operations, and allow the reversible lane traffic to travel at reasonable speeds. Two crossover areas were defined for the I-70 reversible lane concept. The east crossover was targeted for the base of Floyd Hill (where I-70 eastbound widens from two lanes to three lanes), and the west crossover was targeted for the Georgetown/ Empire Junction area (where the existing eastbound congestion begins).

In a separate analysis, CDOT confirmed that these two locations would benefit overall traffic operations. It was then left to Jacobs to develop conceptual designs for each crossover to demonstrate that the crossovers could be designed and built in a safe and operationally acceptable manner.

### 2.2.1 East Crossover (base of Floyd Hill)

Jacobs evaluated the existing horizontal and vertical alignment in the area between Floyd Hill and Hidden Valley with the following constraints in mind:

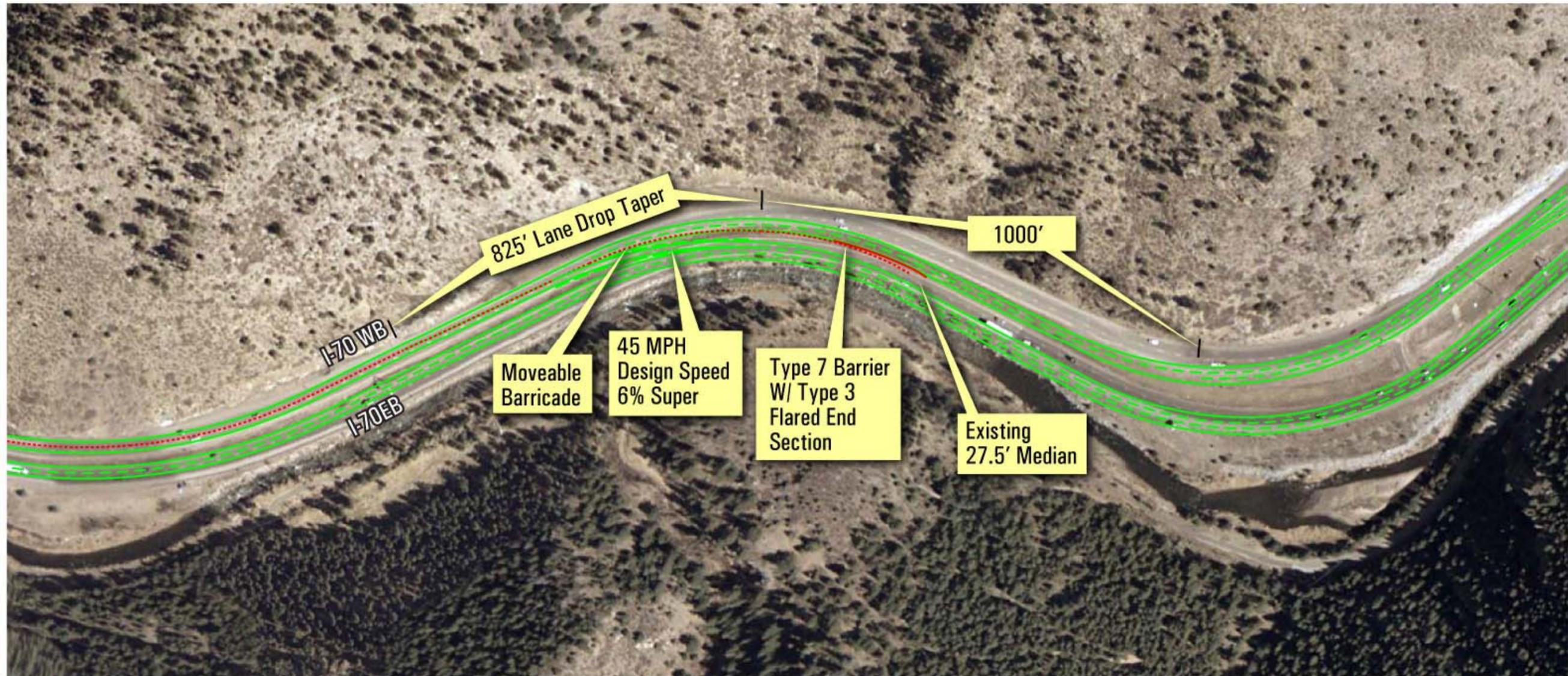
- The eastbound reversible lane must tie into the third lane that currently exists as part of the US 6 left-side exit ramp. The US 6 exit ramp gore could then be restriped to provide three continuous lanes from the end of the reversible lane onto Floyd Hill, where a permanent third lane already exists.

- As part of the connection to the left-side US 6 exit ramp, the length of the newly created weaving section should be maximized.
- There is considerable vertical separation between the eastbound and westbound I-70 lanes at the base of Floyd Hill; this separation decreases to the west along I-70.
- There are several tight horizontal curves between Floyd Hill and Hidden Valley. A potential crossover should take advantage of these curves if possible, and should avoid conflicting with these curves (reverse curves, superelevation rollover, etc.).
- The westbound US 6 on-ramp merges with I-70 just west of the base of Floyd Hill. The distance between the westbound lane drop for the reversible lane and this ramp merge should be maximized.
- The crossover needs to occur in a location where the vertical differences between the eastbound and westbound lanes can be accommodated within the length of the crossover, without unreasonable grades on the crossover.

Given the constraints above and both AASHTO and CDOT guidelines, a concept for a crossover at Floyd Hill was developed. Refer to **Figure 5**. Key elements include:

- A crossover too close to the Hidden Valley interchange would require considerable construction to tie the east end of the crossover into the US 6 exit / third lane.
- A crossover too close to Floyd Hill would have considerable operational impacts on westbound operations since the merge distance from three, to two, to one lane would be too short. Further, a crossover much further east of the proposed location would begin to be constrained by the vertical differences between the eastbound and westbound lanes in relation to the width of the median.
- A 45 mph design speed and 6% superelevation was used, which is consistent with the constrained horizontal alignment in this area.
- A 55 mph design was considered, but would not fit within the existing horizontal curves on I-70, which are posted at 55 mph but actually have a design speed of 45 mph.

Figure 5: Crossover at Floyd Hill



- Maintain at least 1,000 feet to allow the westbound US 6 on-ramp to merge onto I-70 westbound, followed by an 825-foot lane drop taper to go from two westbound lanes to one.
- The movable barrier could be terminated in the grass median behind the westbound guardrail to prevent a blunt end situation.
- A widened and relatively flat area at the east end of the crossover along the inside edge of the existing I-70 eastbound lanes could be paved to allow the barrier machine to be unloaded and loaded onto a truck and removed from the interstate for storage. The truck could use the new extended third lane for the US 6 exit ramp to avoid merging into I-70 traffic and climbing Floyd Hill.

### 2.2.2 West Crossover (Georgetown/Empire Junction)

Jacobs evaluated the existing horizontal and vertical alignment in the area between the Georgetown interchange and the Empire Junction interchange with the following constraints in mind:

- The eastbound reversible lane must be fully developed before it reaches the Empire Junction interchange.
- The crossover must not conflict within the existing chain stations east of Georgetown.
- Adequate distances between the Georgetown interchange ramps and the reversible lane crossover must be provided to accommodate weaving movements from the ramp to the reversible lane.

Given the constraints above and both AASHTO and CDOT guidelines, concepts for two crossovers into the reversible lane were developed. Refer to **Figure 6** and **Figure 7**. Key elements include:

- Both crossovers could be developed at a 60 mph design speed with 6% superelevation.
- The crossover at Empire Junction results in an operational reversible lane that is about one mile shorter than if the crossover were placed east of Georgetown.
- The crossover at Empire Junction avoids conflicts with the existing truck chain stations.
- The crossover at Empire Junction avoids several CDOT maintenance crossovers in the existing median.
- The movable barrier could be terminated in the grass median. Several hundred feet of permanent barrier would have to be constructed to protect both the barrier machine and the end of the movable barrier at either Georgetown or Floyd Hill.
- Only the Empire Junction location allows for a relative flat area at the west end of the crossover along the inside edge of the westbound lanes that could be paved to allow the barrier machine to be stored in this location during active reversible lane operations.

Figure 6: Georgetown Crossover

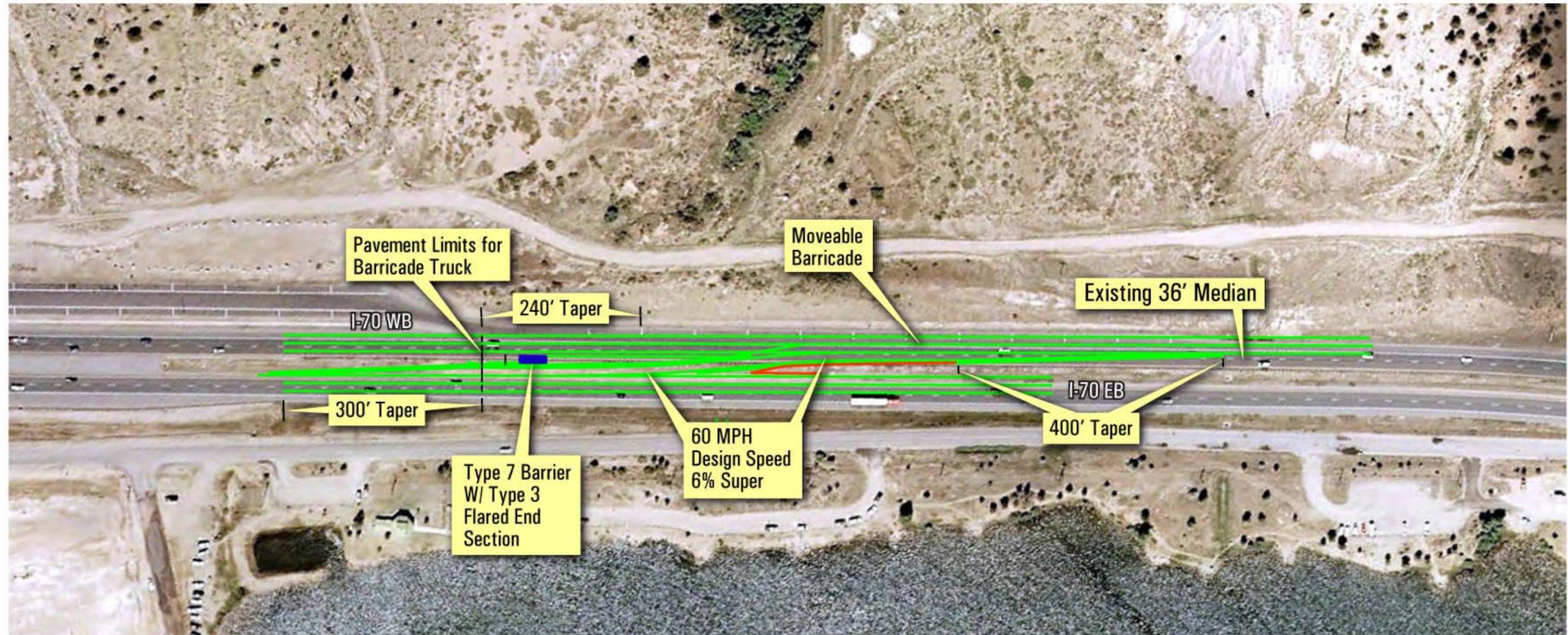
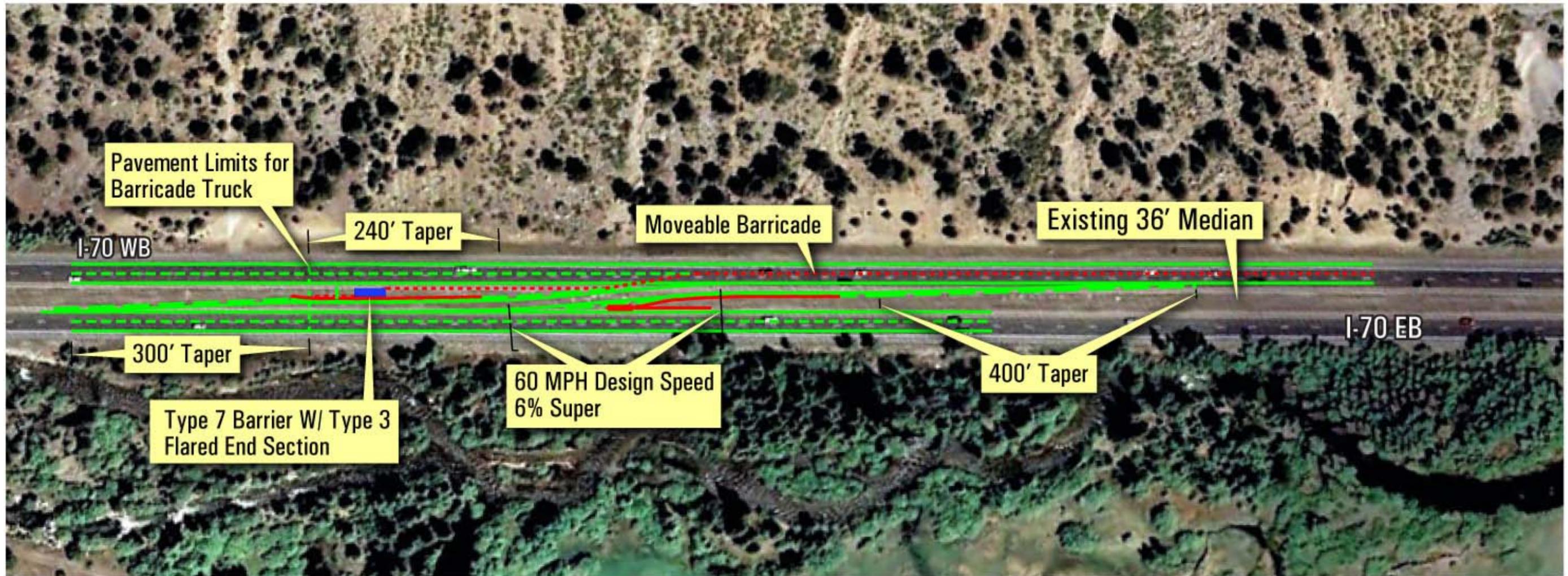


Figure 7: Empire Junction Crossover



- At Georgetown, the crossover had to be moved west closer to the interchange to avoid high grade differences between the westbound and eastbound lanes. Moving the location west resulted in the crossover being located at the existing truck chain stations, and resulted in inadequate weave distances from the eastbound Georgetown on-ramp to the reversible lane.
- Gating for the entrance to the reversible lane (when it is not in use) would be required to prevent wrong-way traffic from entering westbound I-70. There are several gate systems on the market that would work in this application. CDOT Region 6 is currently using one of these systems on the North I-25 Express Toll lanes in the Denver area, so this technology has been proven in Colorado.

### **2.3 Fatal Flaw Workshop #1 and Site Visit**

Jacobs held a workshop with CDOT staff at the Hidden Valley Maintenance Yard to review these sketch plans and discuss comments. The workshop was attended by two CDOT project team members and three Jacobs team members. After the workshop was completed, a field visit was conducted to examine each potential crossover location and identify pinch points. No major changes to the crossover plans were identified; minor changes were incorporated into the plans as appropriate. The results of these discussions to guided project development for concept level (15%) plans.

## **3.0 Design Feasibility**

Based on the design analyses presented above, it was determined that the reversible lane concept would work from a design perspective. The feasibility of each of the reversible lane design elements is described below. Potential future feasibility elements and other supporting information developed are also presented.

### **3.1 Design Feasibility Conclusions**

The Jacobs design team evaluated the design of the reversible lanes in two key areas – crossovers and cross-sections. The feasibility for each is discussed below.

#### **3.1.1 Crossovers**

The East Crossover (at Floyd Hill) could be constructed with a 50 mph design speed. Based on traffic analysis conducted by the University of Arizona (U of A) and the University of Colorado at Denver (UCD), the eastbound weave between the end of the reversible lane and the US 6 exit ramp would operate acceptably. Westbound queuing from Floyd Hill into the proposed lane drop would occur. Based on these findings, this crossover was determined to be feasible if appropriate mitigation measures for the westbound queuing could be developed.

The West Crossover (at Empire Junction) could be constructed with a 60 mph design speed. Based on traffic analysis conducted by U of A and UCD, no operational issues were identified. Several scenarios

for gating the entrance were discussed; one scenario is currently in use on the I-25 North Express Toll lanes in Denver. Based on these findings, this crossover was determined to be feasible.

### **3.1.2 Shoulders (including Twin Tunnels)**

It is expected that 2-foot shoulders could be maintained with implementation of the reversible lane system, except as noted below.

- During reversible lane operation, the movable barrier would not have adjacent shoulders.
- Outside of the westbound Twin Tunnel, 2-foot outside shoulders would be provided whether the reversible lane is in operation or at rest.
- In the westbound Twin Tunnel, a 0.5-foot inside shoulder and a 2-foot outside shoulder would be provided in the rest condition. The lanes would be striped as 12.5 feet wide. During reversible lane operations in the tunnel, 2-foot outside shoulders would be provided in both directions. These lanes would be striped as 11.75 feet wide.

## **3.2 Additional Issues**

During the evaluation of the crossovers and shoulders, several additional items were identified that could affect reversible lane implementation. These items should be considered in the next stage of the reversible lane evaluation.

### **3.2.1 Incident Management and Emergency Response**

- Could barrier pins be removed for access? – What tools would be needed?
- By putting in this barrier, maintenance and emergency vehicles would not be able to use existing median openings to cross between eastbound and westbound lanes.
- In this type of environment with high curvature, narrow lanes, and snow, how could accidents that hit the guard rail impact the ability to return it to the shoulder? Should there be a backup plan?

### **3.2.2 Snow Removal**

- Is there a minimum width needed for snowplow blades?
- Assuming snow would need to be moved to the median, are there areas that would not have adequate capacity to store snow?
- Milepost 233 to Milepost 234 (Lawson to Downieville) and Milepost 238.5 to Milepost 241 (Idaho Springs) have no additional median. The existing median is 7 feet to 8 feet wide between inside lanes. When plowing these areas during reversible lane operations, where will they throw snow? Do they have a vehicle that would throw snow over a barrier?
- CDOT would need to plow immediately before moving barriers.

- Headlight glare paddles on the existing concrete median may need to be removed for snow removal.
- The lane might not open during snow if it is too hard to clean between barriers. How would this be signed?

### 3.2.3 Truck Issues

- Depending on the location of the moved barrier, it might rest on the weigh-in-motion scales at Dumont. Would this make it ineffective during hours of operation?
- How do we analyze how access from westbound Dumont Port of Entry would impact flows? Could port of entry be closed during critical times? Closure of the weigh-in-motion scales would require changing signage or masking during reversible lane operation.
- It may be necessary to look at altering the corridorwide striping at this location to maintain the weigh-in-motion station in the outside lane.

### 3.2.4 Design Issues

- Rumble strips may need to be filled, which further supports an overlay.
- Variances may be required for minimal design width.
- Restriping is anticipated throughout the corridor.
- Drainage
  - Need to look at roadway drainage both at crossovers and in areas where concrete barrier currently exists.
  - The areas where there is a concrete median barrier now might cause problems when the new barrier is placed against it where the roadway super is towards the median.
  - Existing grates might be covered, and the water draining through the reversible lane barrier might not get to these inlets.
  - Water quality and detention basins need to be reviewed.
- Lighting
  - Would lighting need to be revised in tunnels? Is the tunnel lighting directional now?
  - How would we light crossovers, and is there room? Do these poles represent a new hazard?
  - Would the introduction of a barrier impact the effectiveness of existing lighting, or create shadows that might adversely impact roadway visibility?
- Striping would need to be completed at regular intervals in crossover areas and the tunnel. Additionally, the entire length of the reversible lane could see impacts where traffic would shy from the barrier towards the stripe lines. Should we use inlaid striping in these areas?

- The project needs to evaluate options to gate or close the eastbound third lane near Empire Junction.
- Guardrail
  - How would improper guard rail terminals be addressed? (Several locations identified).
  - Guard rail protects signs adequately from one direction, but not the other. How would these signs be addressed?
  - How would other opposite direction hazards, such as lights and overhead signs be addressed?
- Would headlight glare be an issue?
- Median turnaround areas would be impacted by continuous barrier.

### 3.2.5 Project Horizon

The reversible lane project is intended as an interim improvement along I-70 corridor. The anticipated lifecycle of the reversible lane will be determined in future analyses. For the purposes of the design evaluation, it is expected that the reversible lane would be removed either before or concurrent with the installation of improvements for this segment of I-70 outlined in the I-70 Mountain Corridor EIS.

### 3.2.6 Stakeholder Concerns / Agency Involvement

- Has FHWA been involved?
  - Would they buy off on substandard designs
  - Would they accept tunnel typical sections
- Has the I-70 Coalition been involved?
  - The I-70 Mountain Corridor CSS Process must be followed for projects in this area.
  - The coalition has begun discussing how they should be involved in interim projects, such as the reversible lane.
- Would the barrier company move the barriers and maintain gates and barrier?
- The CDOT maintenance group should be contacted for their concerns.
- What are Clear Creek County's concerns?
- What are Idaho Springs business owners' concerns?

## 3.3 Feasibility Presentation

Jacobs worked with CDOT Region 1 staff to present the evaluation results to others within CDOT. The concept plans developed for this study were compiled into a PowerPoint presentation for Region 1 use. The presentation is included as **Appendix A-4**.

### 3.4 Development / Implementation Schedule

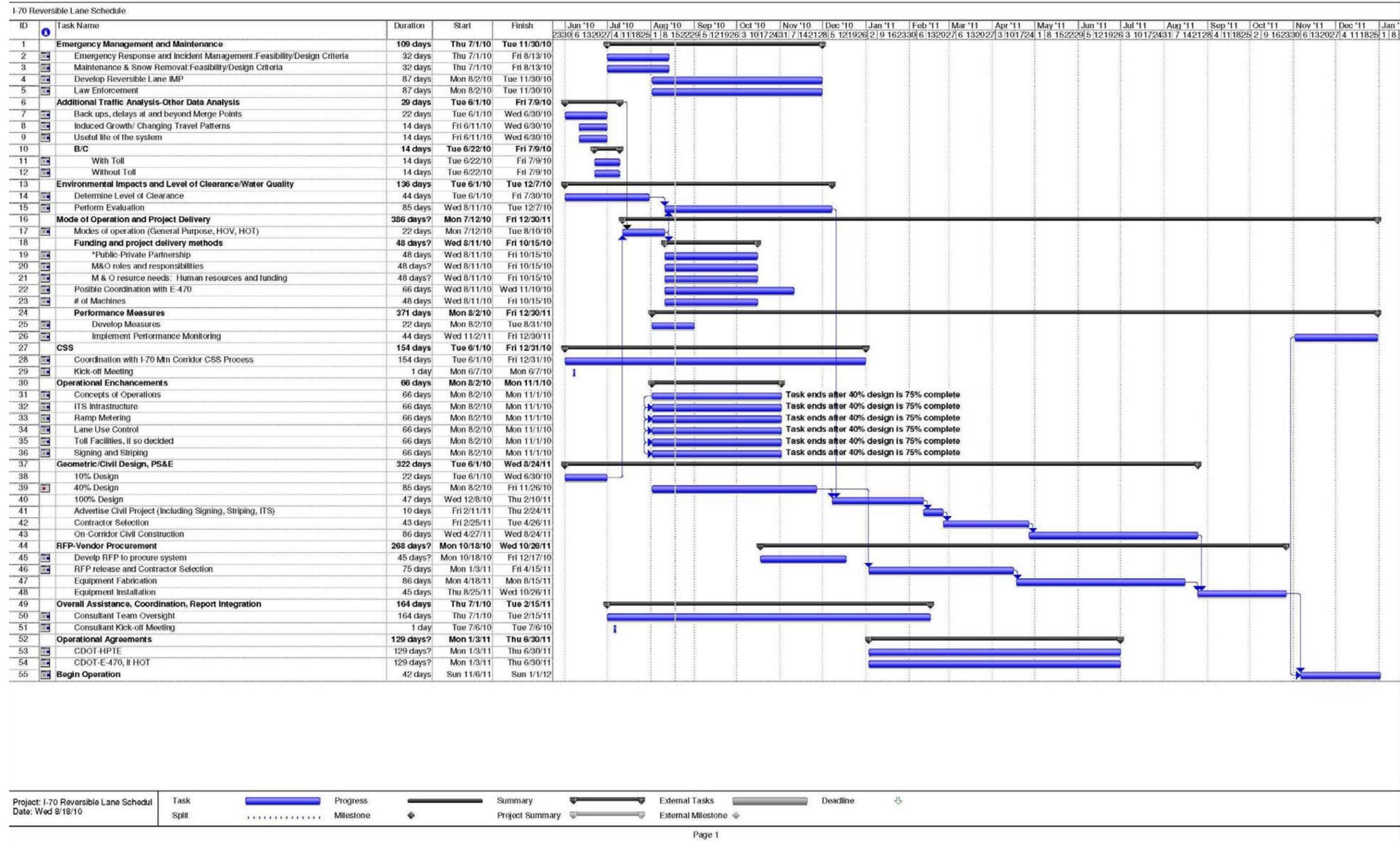
Based on the Phase 1 feasibility study evaluations and the results of separate traffic analyses, CDOT has decided to move forward with further evaluation of project feasibility, design issues, management strategies, and other elements. To this end, Jacobs supported CDOT in developing a preliminary implementation schedule. Refer to **Figure 8**. This schedule calls for the reversible lane to be operational for the 2011-2012 winter tourism (ski) season, with most construction occurring during the summer of 2011.

### 4.0 Concept Plans (15% Design)

Based on the information described above, Jacobs refined the conceptual plans to a 10% to 15% level for future use by CDOT as the reversible lanes concept proceeds into preliminary and final design. These plans in Microstation format are included in **Appendix A-5** and on the CD accompanying this report.

J:\\_Transportation\WVXW3706\I-70 Contraflow Lane\manage\report\Appendices Revised 8\_5-10\Appendix\_A\_ZipperLanes\_TechMemo\_08192010.doc

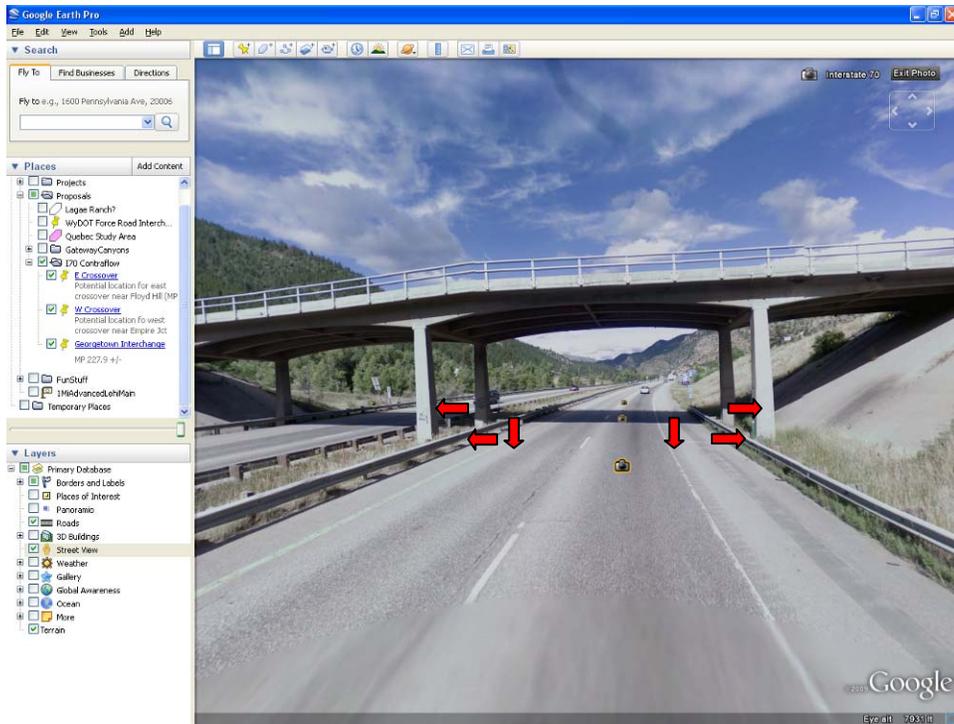
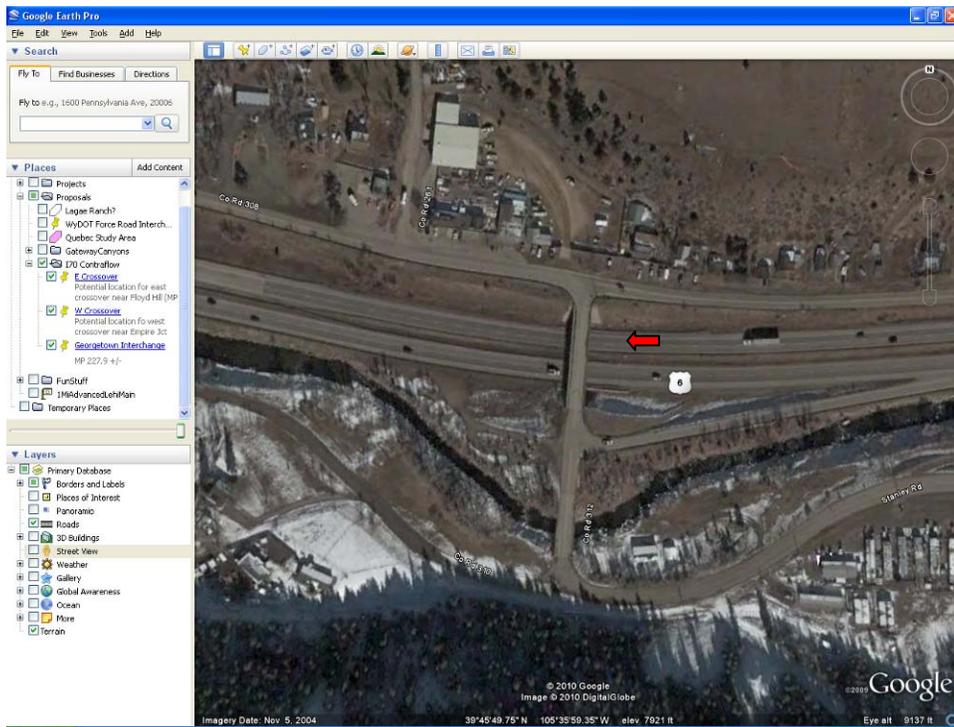
Figure 8: Preliminary Implementation Schedule



## Appendix A-1 Issues Maps

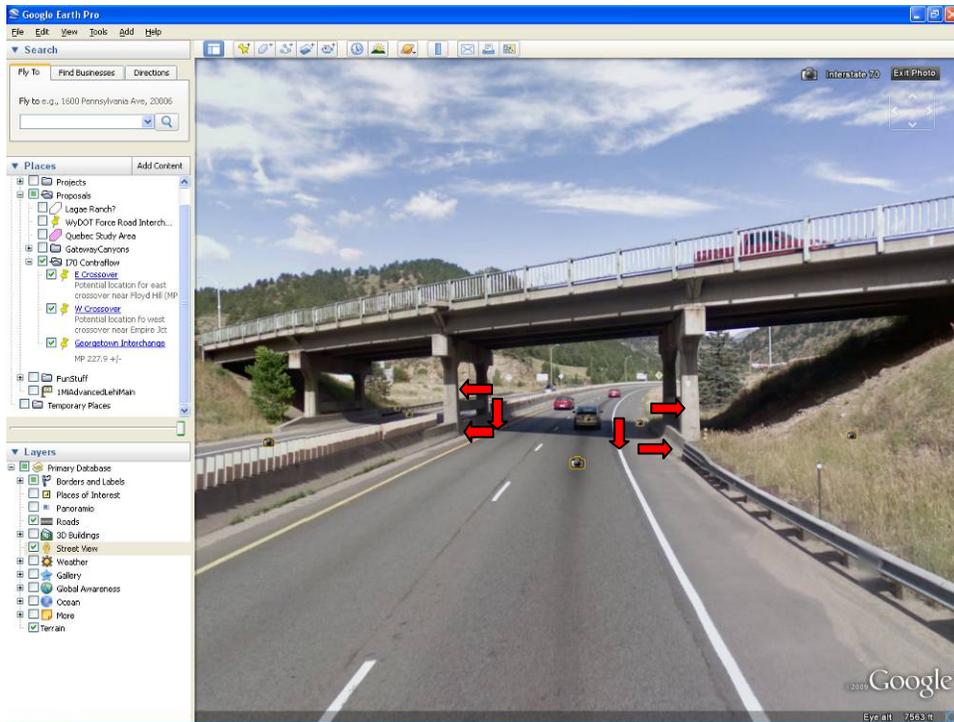
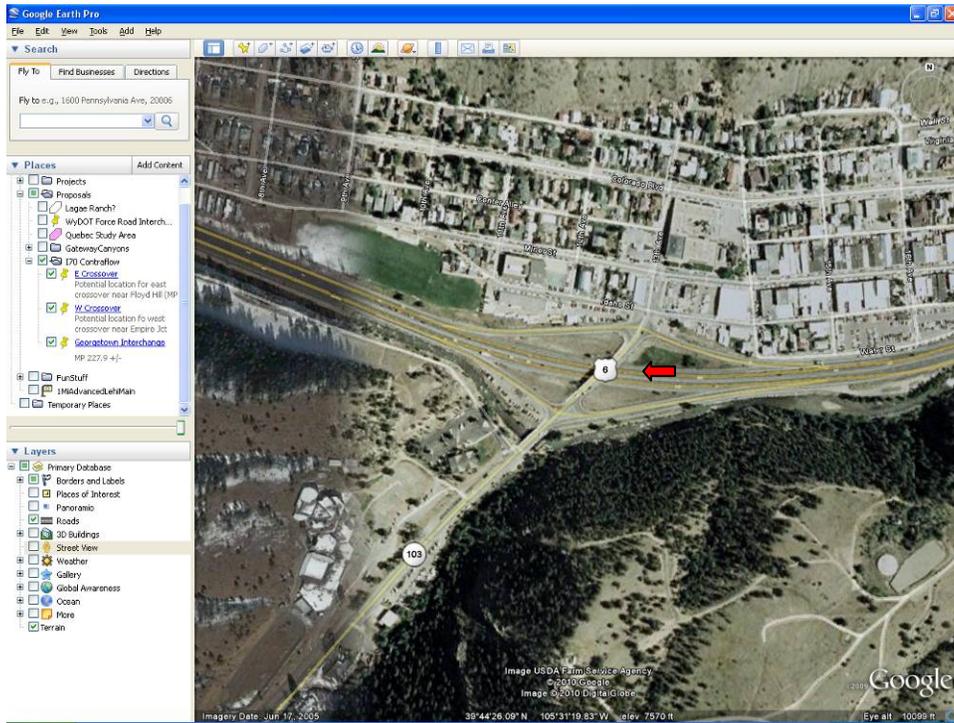
## Appendix A-2 Surveyed Pinch Points

**CR 312 overpass on I-70 WB at Downieville, MP 235.00 +/-**



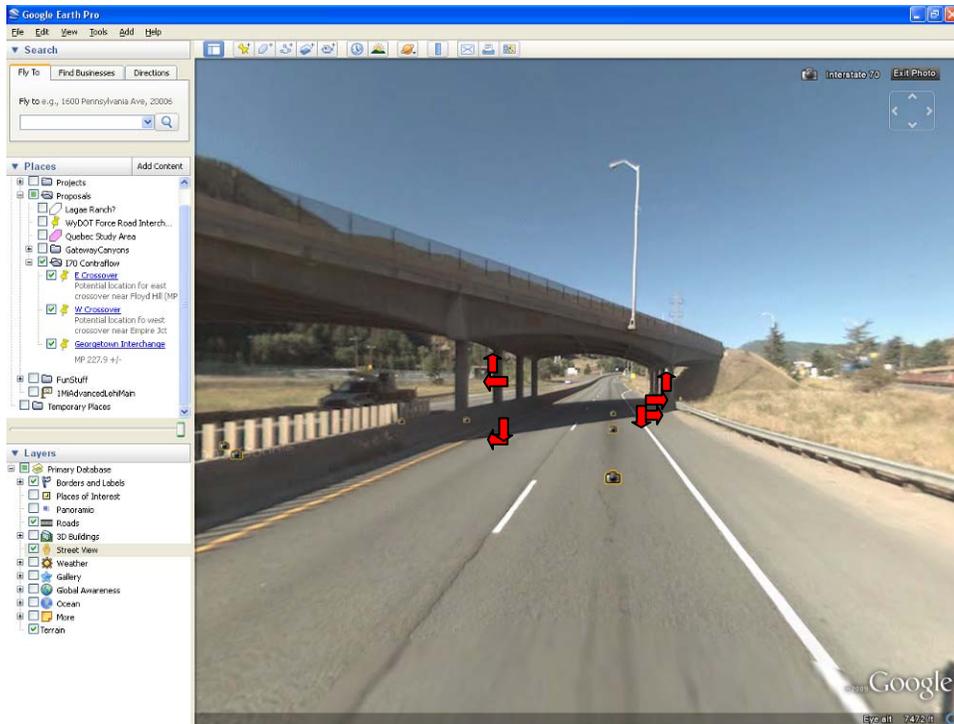
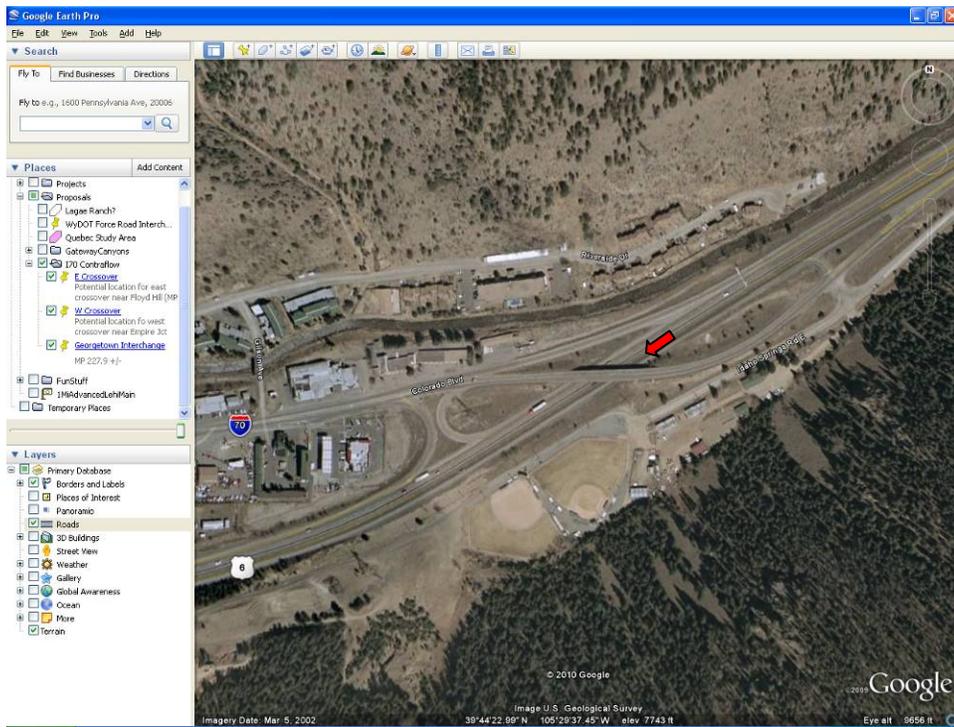
Left face of pier, left face of guardrail, left edge line, right edge line, right face of guardrail, right face of pier.

**SH 103 (Mt Evans Road) overpass on I-70 WB at Idaho Springs, MP 239.65 +/-**



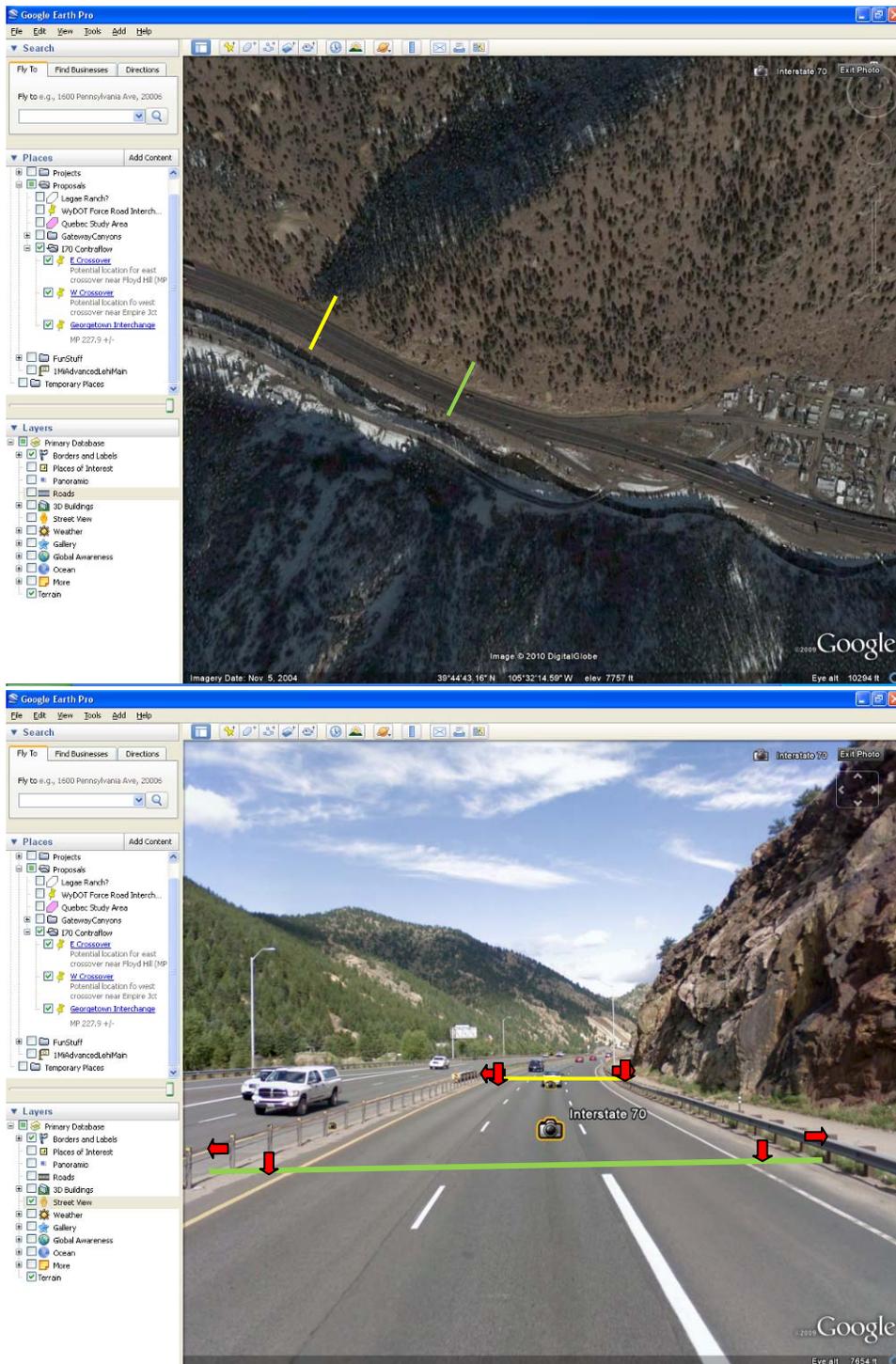
Left face of pier, left toe of barrier, left edge line, right edge line, right toe of barrier, right face of pier.

**Colorado Boulevard overpass on I-70 WB at Idaho Springs, MP 241.10 +/-**



Left vertical clearance (over toe of barrier), left face of pier, left toe of barrier, left edge line, right vertical clearance (over toe of barrier), right edge line, right toe of barrier, right face of pier.

**Colorado Boulevard entrance ramp to I-70 WB at Idaho Springs (west), MP 238.70 +/-**



Two locations – end of the solid white stripe (indicated by green line in photo above) and end of cable guard rail (indicated by yellow line in photo above) – Obtain left face of cable rail / guardrail, left edge line, right edge line, right face of guardrail.

## Appendix A-3 Travel Time Run Data

## Appendix A-4 Feasibility Study PowerPoint

## Appendix A-5 Design Plans