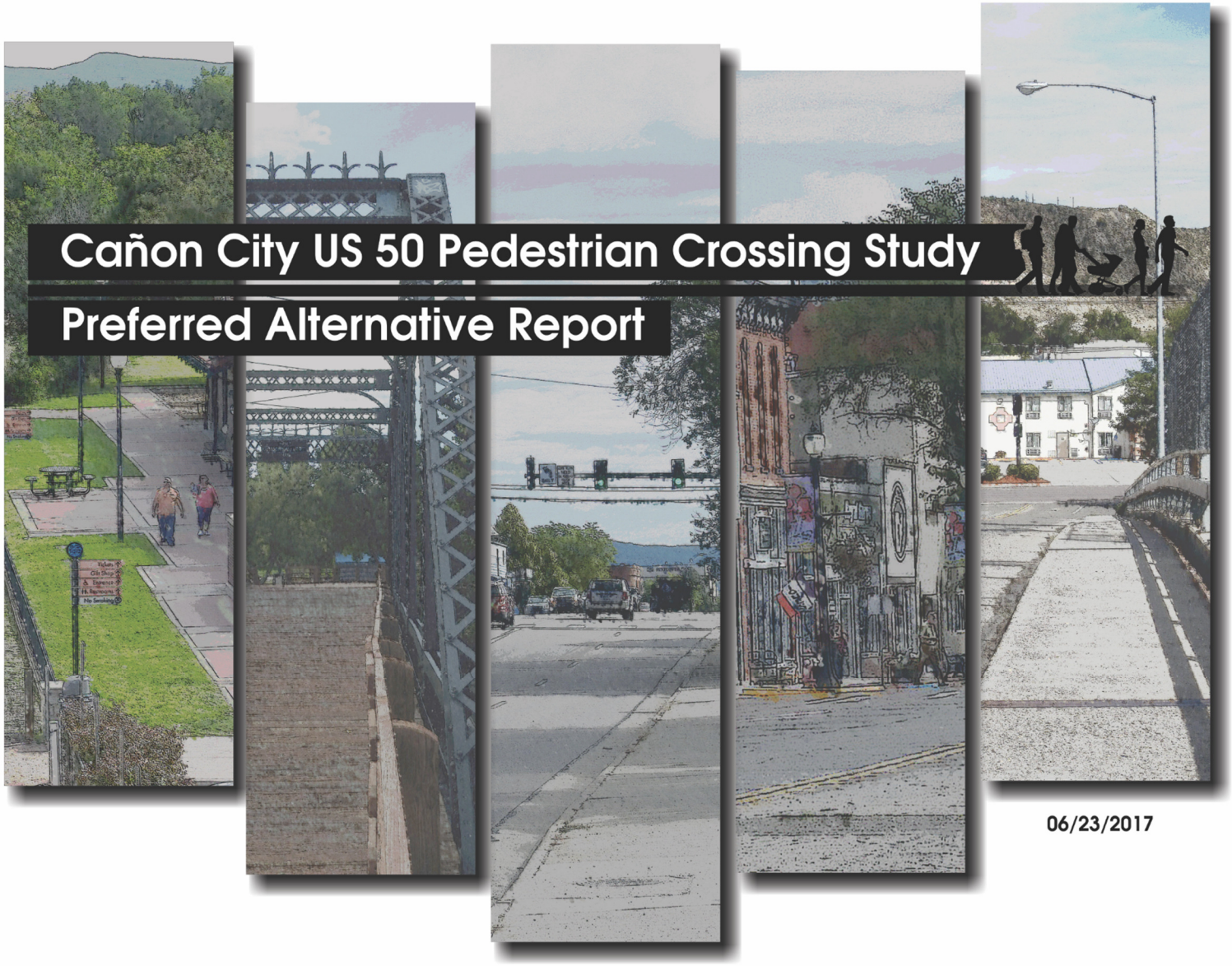

Cañon City US 50 Pedestrian Crossing Study

Preferred Alternative Report

06/23/2017

Prepared for:

City of Cañon City

WILSON & COMPANY

discipline | intensity | collaboration | shared ownership | solutions

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PART 1: PREFERRED ALTERNATIVE

OVERVIEW

This report presents the Preferred Alternative for the US 50 Pedestrian Crossing Study and Design Project. It also documents the process followed to develop the Preferred Alternative and the traffic studies performed in support of this process. The US 50 Pedestrian Crossing Study and Design Project is a City of Cañon City project funded by a grant from the Federal Highway Administration's (FHWA's) Transportation Alternatives Program (TAP) and administered by the Colorado Department of Transportation (CDOT). The project represents an initial step toward addressing the desire and need for improved connectivity across US 50 in Cañon City's downtown area that was identified in recent studies, including the US 50 Corridor Plan (2015) and the Downtown Cañon City Strategic Plan (2012). The project focuses on an area surrounding US 50 (also called Royal Gorge Boulevard) from First Street on the west to Ninth Street on the east and from Main Street, one block north of US 50, south to the Arkansas River. Refer to **Figure 1-1** for the project area and context.

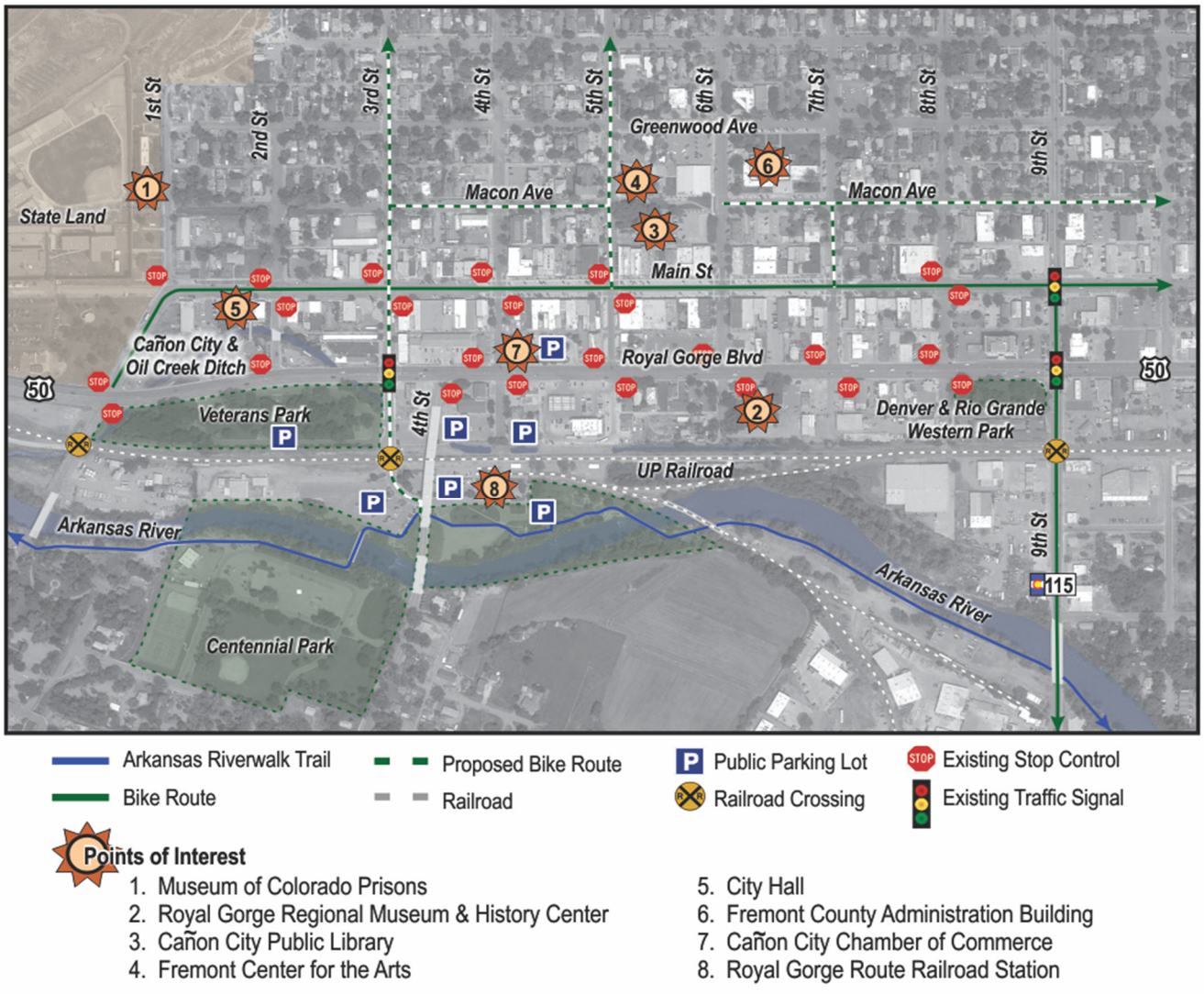


Figure 1-1. US 50 Pedestrian Crossing Study Project Area and Context

PREFERRED ALTERNATIVE

The Preferred Alternative is depicted in **Figures 1-2 and 1-3**. It represents a hybrid of several alternative concepts evaluated by the Citizen Committee and contains five main features:

1. The roadway width (curb to curb) will remain as currently exists.
2. Intersection pedestrian ramps, driveway accesses, and sidewalks will be repaired or replaced as needed to conform to Americans with Disabilities Act (ADA) requirements.
3. Up to four crosswalks will be installed across US 50 between First Street and Ninth Street. Actual crosswalk locations will be determined based on the results of engineering analyses that address safety, traffic flow, and access considerations. Several methods of traffic control at crosswalks are available, and the final method will be determined after an additional engineering analysis. The existing crosswalks at the Third Street and Ninth Street traffic signals will remain.
4. Raised medians will be installed to provide a safe refuge for pedestrians at the crosswalk locations. The length of the medians along US 50 will be determined by an in-depth engineering analysis to balance the goals of maximizing the length while minimizing the impact to property access driveways.
5. New development along US 50 will be required to dedicate a public use easement along the US 50 Right-of-Way (ROW) and construct a detached sidewalk with an amenity zone.

Although the current project funding is inadequate to include a grade-separated pedestrian and bicycle structure, the Preferred Alternative includes a preferred option for a future grade-separated crossing. The preferred option, an overpass between Second and Third Streets, is based on information that was available to the Committee at the time of review. However, there are several additional community planning efforts underway (particularly, the Arkansas River Central Corridor Plan) that may illuminate an option better suited to a broader community vision. Any future grade-separated crossing projects need to consider these efforts. **Appendix 1-1** contains the adopted City Council resolution that concludes this phase of the project.

NEXT STEPS

Pending approval of the Preferred Alternative, the following ten steps are required before construction of the project may begin:

1. Collect ROW and property ownership information.
2. Develop an Access Management Plan.
3. Revise and approve changes to development code.
4. Complete the final traffic analysis.
5. Prepare ROW Plans to obtain right-of-entry permissions and construction easements.
6. Identify required environmental clearances and complete environmental documentation.
7. Complete a topographic survey and engineering investigations.
8. Design project and develop preliminary plans, specifications, and cost estimates.
9. Submit final construction plans, specifications, and cost estimates.
10. Advertise project for construction.

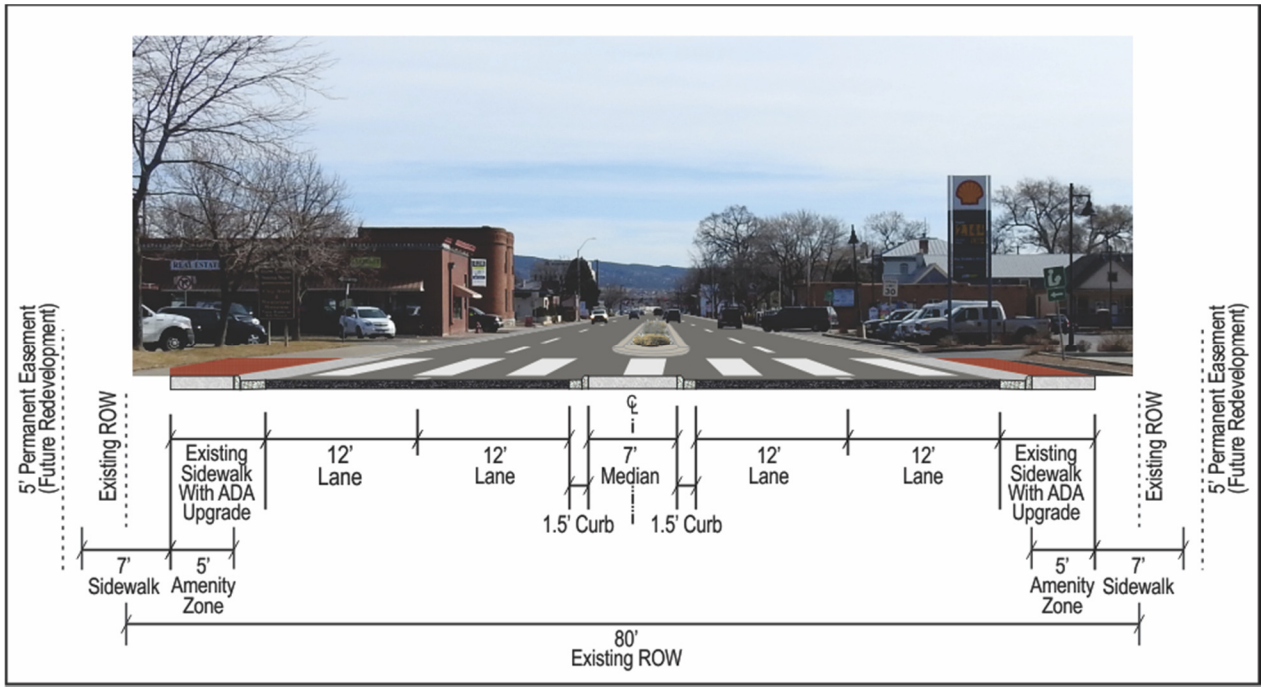


Figure 1-2. US 50 Pedestrian Crossing Study Preferred Alternative Typical Section

Figure 1-3. US 50 Pedestrian Crossing Study Preferred Alternative Plan View

PART 2: ALTERNATIVES DEVELOPMENT AND EVALUATION

STUDY AREA

As shown in **Figure 2-1**, the study area for this analysis extends 0.58 miles from Second Street to Ninth Street and includes the existing US 50 signalized intersections at Third Street and Ninth Street. The area includes both sides of US 50, north to Main Street and south to the Arkansas River.

US 50 PROJECT CORRIDOR SETTING

US 50 is the major arterial road in central Cañon City and a major regional route into the Rocky Mountains. It is the main route in the city's commercial core and central business district. This corridor is busy at all times for motorists, and it experiences especially heavy volume during the summer tourist season as it separates the downtown area from the riverfront recreation area, serving both areas as a primary access route.

Reduced speed limits increase non-motorist safety and although US 50 has a 30 miles-per-hour (mph) posted speed limit in the study area section, pedestrians attempting to cross the roadway still face busy two-way traffic in five lanes. Crossing the approximately 60 feet of pavement under these conditions is challenging and presents safety concerns for pedestrians, bicyclists, and motorists alike.

A typical view within this segment of US 50 is provided in **Figure 2-2**, looking eastbound at Third Street. The highway has two thru lanes in each direction and a center left-turn lane with no median. Sidewalks are present on each side of the highway. The CDOT ROW width is 80 feet with approximately 73 feet being paved from back of sidewalk to back of sidewalk.

INVOLVEMENT OF THE COLORADO DEPARTMENT OF TRANSPORTATION

US 50 is under the jurisdiction of CDOT. CDOT has participated in this study as a key stakeholder, along with the City and various affected parties. CDOT administers TAP grant funds from the FHWA, for which the US 50 pedestrian improvements are an eligible project use.

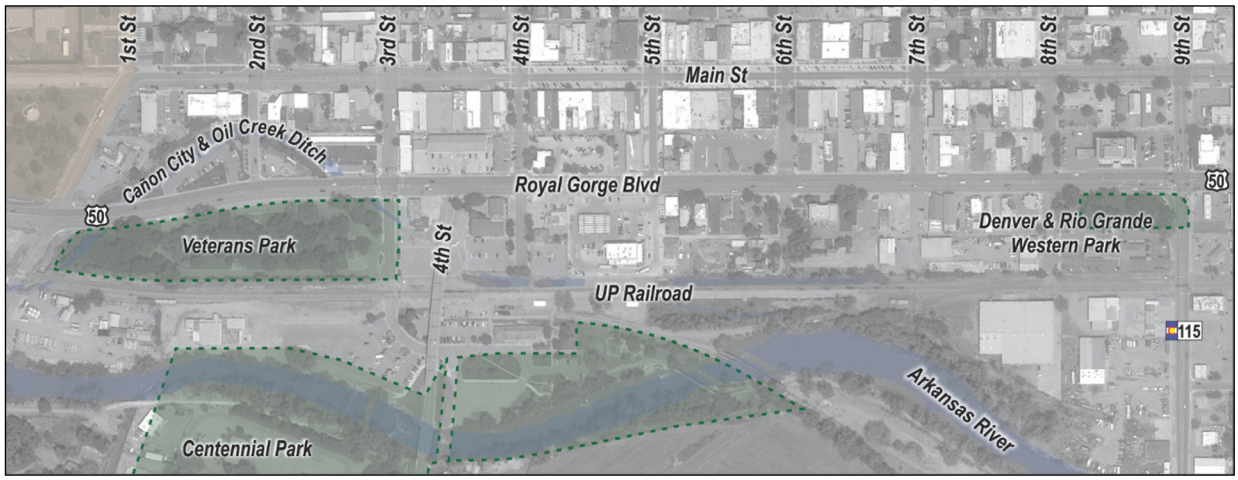


Figure 2-1. Study Area Limits

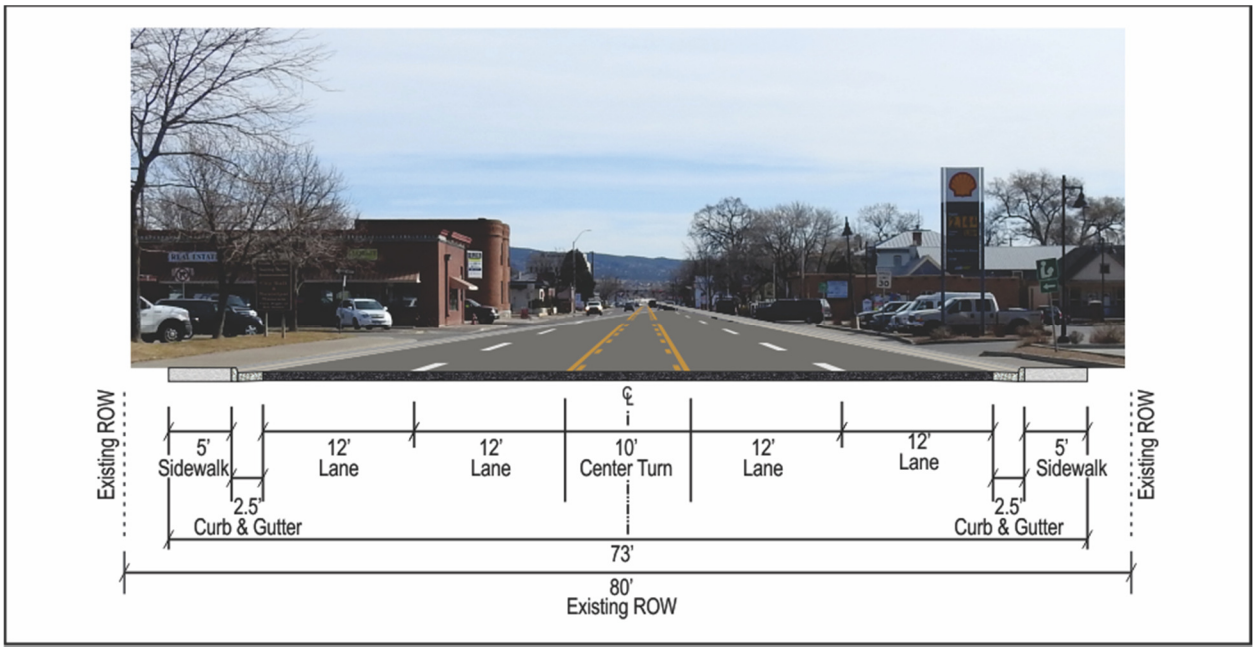


Figure 2-2. Existing US 50 Project Corridor Cross Section

PROJECT BACKGROUND

The Request for Proposals was advertised on May 23, 2016, with proposals due on June 24, 2016. The project was awarded to Wilson & Company on July 15, 2016, with Notice to Proceed issued on August 2, 2016. Traffic counts were initiated immediately to capture the summer tourist traffic volumes prior to Labor Day. On August 18, 2016, stakeholders attended the project kick-off meeting and assessed preliminary traffic data. On October 11, 2016, and November 2, 2016, stakeholders met to review refined traffic analyses, further analyze alternatives suggested in previous studies, and develop new alternatives for consideration. A draft report was published on December 28, 2016.

After further discussion, Cañon City's City Council and City Administration determined that a more robust public process was desirable. City Council directed the creation of a US Highway 50 Crossing Committee to consider alternatives and recommend a course of action. Wilson & Company developed and disseminated a packet containing the previous planning studies and the draft report (including traffic data and analysis) developed earlier in this project to the Committee members.

CITIZEN COMMITTEE MISSION STATEMENT AND MEETING SCHEDULE

CITY OF CAÑON CITY
US HIGHWAY 50 CROSSING COMMITTEE
Mission Statement

The mission of the US 50 Pedestrian Crossing is to consider the goals, costs, and benefits of various at grade, below grade and above grade safety improvement between 1st Street and 9th Street. The group will provide information for a Public Open House to solicit public input on a preferred pedestrian crossing solution and a final recommendation for CDOT and City Council consideration. The Committee will be scheduled to meet at the following dates and time at City Hall.

Guided by the Mission Statement, the Citizen Committee provided information for a Public Open House to solicit public input on a preferred pedestrian crossing solution and provided the Preferred Alternative as the final recommendation for CDOT and City Council consideration.

Following are the dates, times, and goals of the of the Citizen Committee meetings, which took place at City Hall. Full documentation of the meetings is contained in **Appendix 2-1**.

- Meeting 1—Develop Purpose of Project: Tuesday February 14, 2017, from 4:00 p.m. to 6:00 p.m.
- Meeting 2— Develop Goals, Strategies, and Alternatives: Tuesday February 21, 2017, from 4:00 p.m. to 6:00 p.m.
- Meeting 3— Evaluate Alternatives: Tuesday March 21, 2017, from 4:00 p.m. to 6:00 p.m.
- Meeting 4— Refine Alternatives and Recommend Preferred Alternative: Tuesday April 4, 2017, from 4:00 p.m. to 6:00 p.m.
- Public Open House— Invite Feedback: Tuesday April 11, 2017, from 4:00 p.m. to 8:00 p.m.
- Meeting 5— Complete Preferred Alternative: Tuesday April 18, 2017, from 4:00 p.m. to 6:00 p.m.

CITIZEN COMMITTEE MEMBERS

Table 2-1. Citizen Committee Members

City of Cañon City	
Kathy Schumacher	City Council Member
Scott Eckstrom	City Council Member
Tony O'Rourke	City Administrator
Adam Lancaster	City Engineer
Brian LeDoux	City Planning Commission Member
Terri Bernath	City Planner
Colorado Department of Transportation	
Dave Watt	Resident Engineer
Scott Schnake	Project Manager
Rob Frei	Region Planning & Environmental Manager
Fremont County	
Dwayne McFall	County Commissioner
Community Representatives	
Ed Adamic	Resident
Dan Branson	Business Owner: Royal Gorge Route
Gary Clark	Resident
Gloria Stultz	Downtown Merchant Association
Jeri Fry	Business Owner: Cup & Cone
Justin Kurth	Resident
Kim Smith	Business Owner: First Stitches
Lisa Hyams	Chamber of Commerce Director
Rick Harrmann	Resident
Rob Gilkerson	Resident/Rocky Mountain ADA Center (retired)
Roy Hughes	Resident
Shirley Squier	Resident
Ted Adamic	Resident
Wilson & Company – Consultant Team	
Scott Asher	Operations Manager
Maureen Paz de Araujo	Senior Transportation Planner/Project Manager
Marcus Kochis	Project Engineer
Tiffany Haugh	GIS/Graphics

GOALS OF THE STUDY

The goals of the pedestrian crossing study and improvements, as identified by the City of Cañon City and further refined by the Citizen Committee, are presented in Table 2-2.

Table 2-2. Goals of the Study

Enhance Safety
Pedestrian Safety
Vehicular Safety
Bicycle Safety
Emergency Operations
Security: Discourage Vagrancy
Security: Open Feel
Increase Bicycling and/or Walking Activity
Maximize Investment/ Network Connectivity
Immediate Benefit to Public
Improve State and Regional Economy
Economic Development/Redevelopment
Active Use of Both Sides of Highway
Easy Vehicular Access to Businesses
Better or More Access to Parking
Positive Impact on Businesses
Expand Recreational Opportunities
Enhance Quality of Life
Optimize Aesthetics
Create Highly Visible Gateway
Maximally Incorporate Highway into Fabric of the City
Incorporate State of the Art Elements
Enhance Adjacent Building Aesthetics
Improve Public Health
Provide Transportation Equity
ADA Compatibility
Minimize Impact of Traffic Flow
Calm Traffic to Meet 30 MPH Speed Limit
Create Project Readiness
Compatibility with Funding

Table 2-2 (continued)

Integrate with Plans and Community Support
US 50 Corridor Plan
Downtown Strategic Plan
Draft Arkansas River Central Corridor Plan
Eastern Fremont County Trails, Open Space & River Corridor Master Plan
Uniformity with Downtown (Content and Placemaking)
Compatibility with Railroad Crossings (At-Grade or Grade-Separated Connection to Depot)
Future Needs
Incorporate Engineering Considerations
Minimize ROW Impacts
Minimize Construction Impacts
Minimize Natural/Cultural Resource Impacts
Minimize Utility Impacts/Relocations
Minimize Maintenance Requirements

STRATEGIES FOR ACCOMPLISHING THE GOALS

Three basic strategies emerged from the project goals to address the pedestrian crossing issue:

1. Install at-grade crossings distributed between First and Ninth Streets.
2. Install grade-separated crossings to provide a free-flow movement of pedestrians and bicycles across US 50.
3. Anticipate and prepare for future improvements beyond US 50; for example, the railroad is another formidable barrier to the free-flow movement of pedestrians and bicycles between downtown and the Arkansas River recreational facilities.

SUMMARY OF ALTERNATIVES CONSIDERED BY CITIZEN COMMITTEE

Alternatives developed and evaluated by the Citizen Committee were divided into two main categories: roadway concepts and grade-separated concepts. The Citizen Committee discussed the long-range concepts for crossing the railroad insofar as they relate to crossing US 50 to ensure that the two would complement each other by providing a seamless route in the future.

Roadway Concepts

No-Build

- Reconstruct certain pedestrian ramps that were incorrectly installed in a recent CDOT paving project

Base Improvements (**Figure 2-3**)

- Reconstruct all ADA noncompliant features through sidewalk repairs, intersection pedestrian ramp replacement, and driveway replacements
- Install pedestrian crosswalks (across US 50) at all intersections (except when the base improvements are combined with enhanced midblock crosswalks outlined in Concepts RD-A through RD-E)

Concept RD-A (**Figures 2-4 and 2-5**)

- Base Improvements: Replace or install new pedestrian ramps at intersections and new

ADA-compliant driveways along the entire length of US 50

- Maintain US 50's current configuration
- Add downtown streetscaping bump-outs north of US 50 at Fourth, Sixth, Seventh, and Eighth Streets (two-way configuration)
- Install three at-grade, midblock pedestrian crossings using either Rectangular Rapid Flashing Beacons (RRFB) or High-Intensity Activated Crosswalk (HAWK) with median refuge islands where accesses allow between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets

Concept RD-B (**Figures 2-6 and 2-7**)

- Base Improvements: Replace or install new pedestrian ramps at intersections and new ADA-compliant driveways along the entire length of US 50
- Eliminate US 50 center turn lane to provide a buffer or "amenity zone" between the sidewalk and roadway
- Maintain left-turn channelization (wider roadway) at Third Street, Fourth Street Viaduct, and Ninth Street intersections
- Add downtown streetscaping bump-outs north of US 50 at Fourth, Sixth, Seventh, and Eighth Streets (two-way configuration)
- Install three at-grade, midblock pedestrian crossings (either RRFB or HAWK) installed where accesses allow between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets

Concept RD-C (**Figures 2-8 and 2-9**)

- Base Improvements: Replace or install new pedestrian ramps at intersections and new ADA-compliant driveways along the entire length of US 50
- Narrow US 50 lanes and eliminate the center turn lane to provide a buffer or "amenity zone" between the sidewalk and roadway
- Shift US 50 lanes to provide an extra-wide sidewalk on one side for café seating (the shift shown allows for the café zone on the north side but it could be either side)
- Maintain left-turn channelization (wider roadway) at Third Street, Fourth Street Viaduct, and Ninth Street intersections
- Add downtown streetscaping bump-outs north of US 50 at Fourth, Sixth, Seventh, and Eighth Streets (two-way configuration)
- Install three at-grade, midblock pedestrian crossings (either RRFB or HAWK) installed where accesses allow between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets

Concept RD-D (**Figures 2-10 and 2-11**)

- Base Improvements: Replace or install new pedestrian ramps at intersections and new ADA-compliant driveways along the entire length of US 50
- Add medians to the existing US 50 cross section (closing the existing two-way center turn lane) with intersection left-turn lanes maintained at all cross streets
- Remove widening along westbound curb line between Eighth and Ninth Streets
- Add downtown streetscaping bump-outs north of US 50 at Fourth, Sixth, Seventh, and Eighth Streets (two-way configuration)
- Install three at-grade, midblock pedestrian crossings (either RRFB or HAWK) installed where accesses allow between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets

Concept RD-E (**Figures 2-12 and 2-13**)

- Base Improvements: Replace or install new pedestrian ramps at intersections and new

ADA-compliant driveways along the entire length of US 50

- Add medians to the existing US 50 cross section (closing the existing two-way center turn lane) with dedicated intersection left-turn lanes at Third Street, Fourth Street Viaduct, Fifth Street, Seventh Street, and Ninth Street
- Fourth Street north of US 50: two-way, right-in/right-out configuration
- Fourth Street south of US 50: two-way, right-in/right-out configuration
- Sixth Street north of US 50: one-way northbound (right-in only) with downtown streetscaping bump-outs added at US 50 intersection
- Sixth Street south of US 50: two-way, right-in/right-out configuration
- Seventh Street north of US 50: two-way with downtown streetscaping bump-outs added at US 50 intersection
- Eighth Street north of US 50: one-way southbound (right-out only) with downtown streetscaping bump-outs added at US 50 intersection
- Eighth Street south of US 50: two-way, right-in/right-out configuration
- Remove widening along westbound curb line between Eighth and Ninth Streets
- Install three at-grade pedestrian crossings (either RRFB or HAWK) with median refuge installed at the closed full-movement intersections: Fourth Street, Sixth Street, and Eighth St

Figure 2-3. Roadway Base Improvements

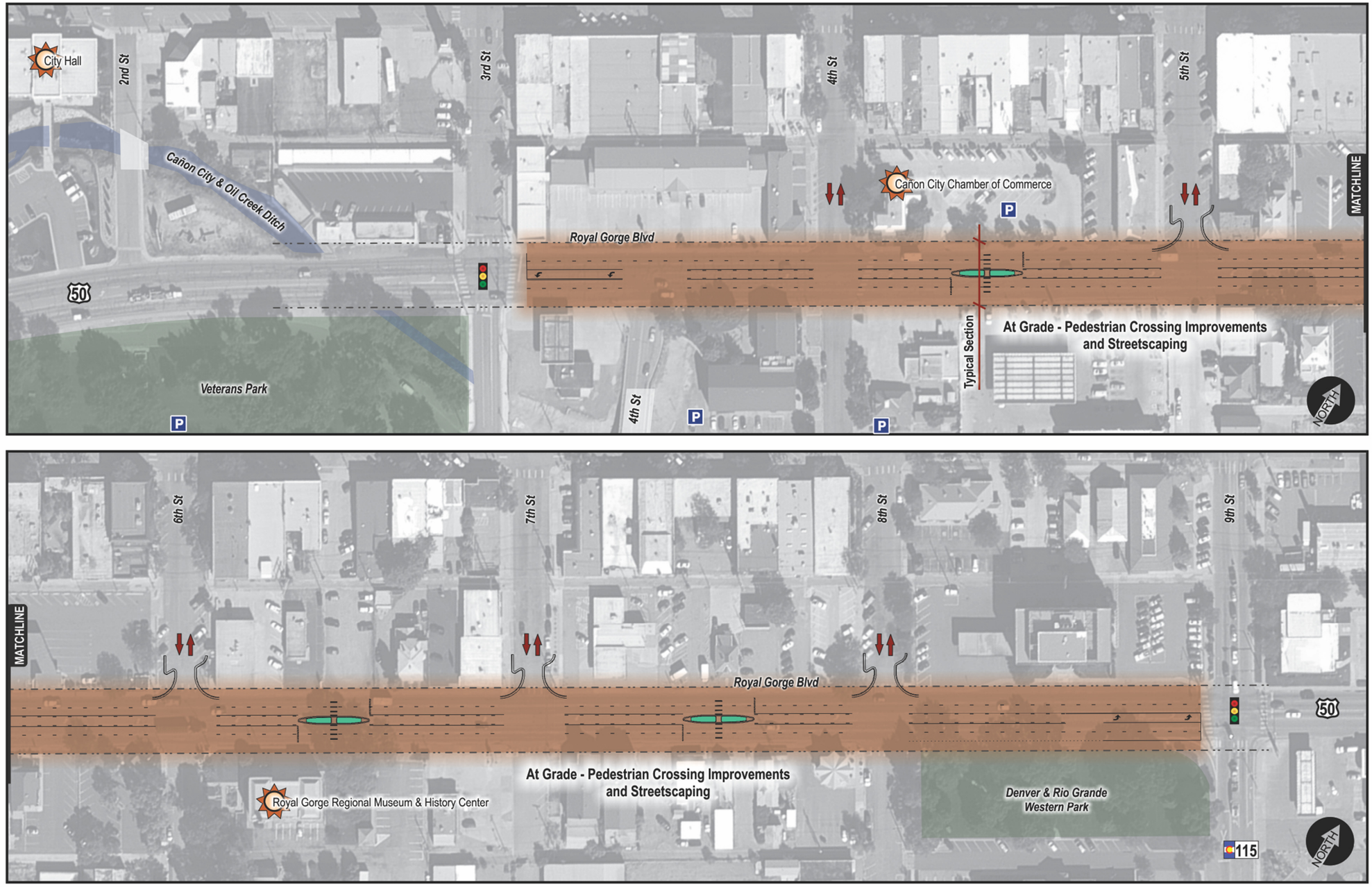


Figure 2-4. Roadway Concept RD-A

Figure 2-5. Roadway Concept RD-A

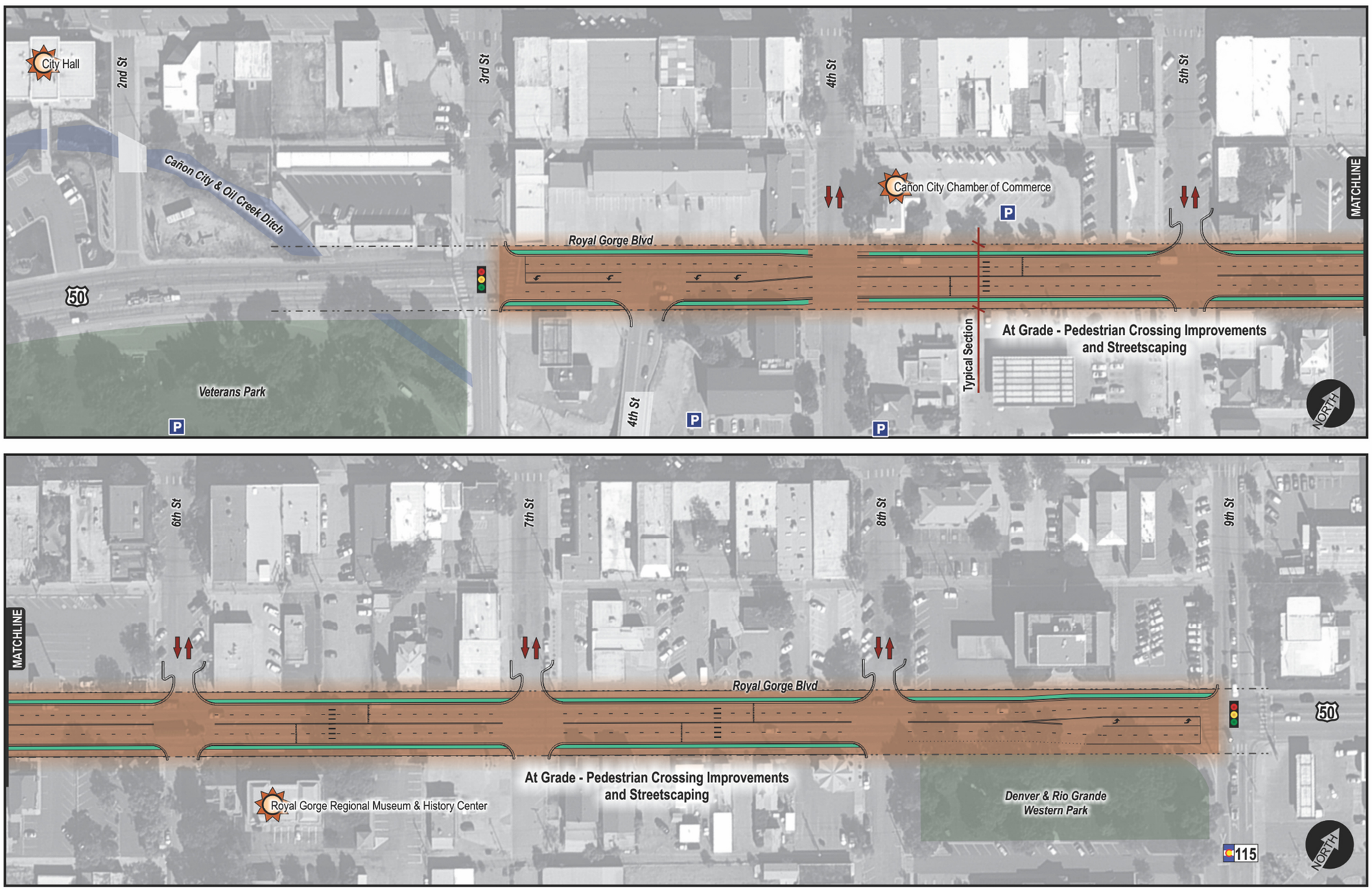


Figure 2-6. Roadway Concept RD-B

Figure 2-7. Roadway Concept RD-B

Figure 2-8. Roadway Concept RD-C

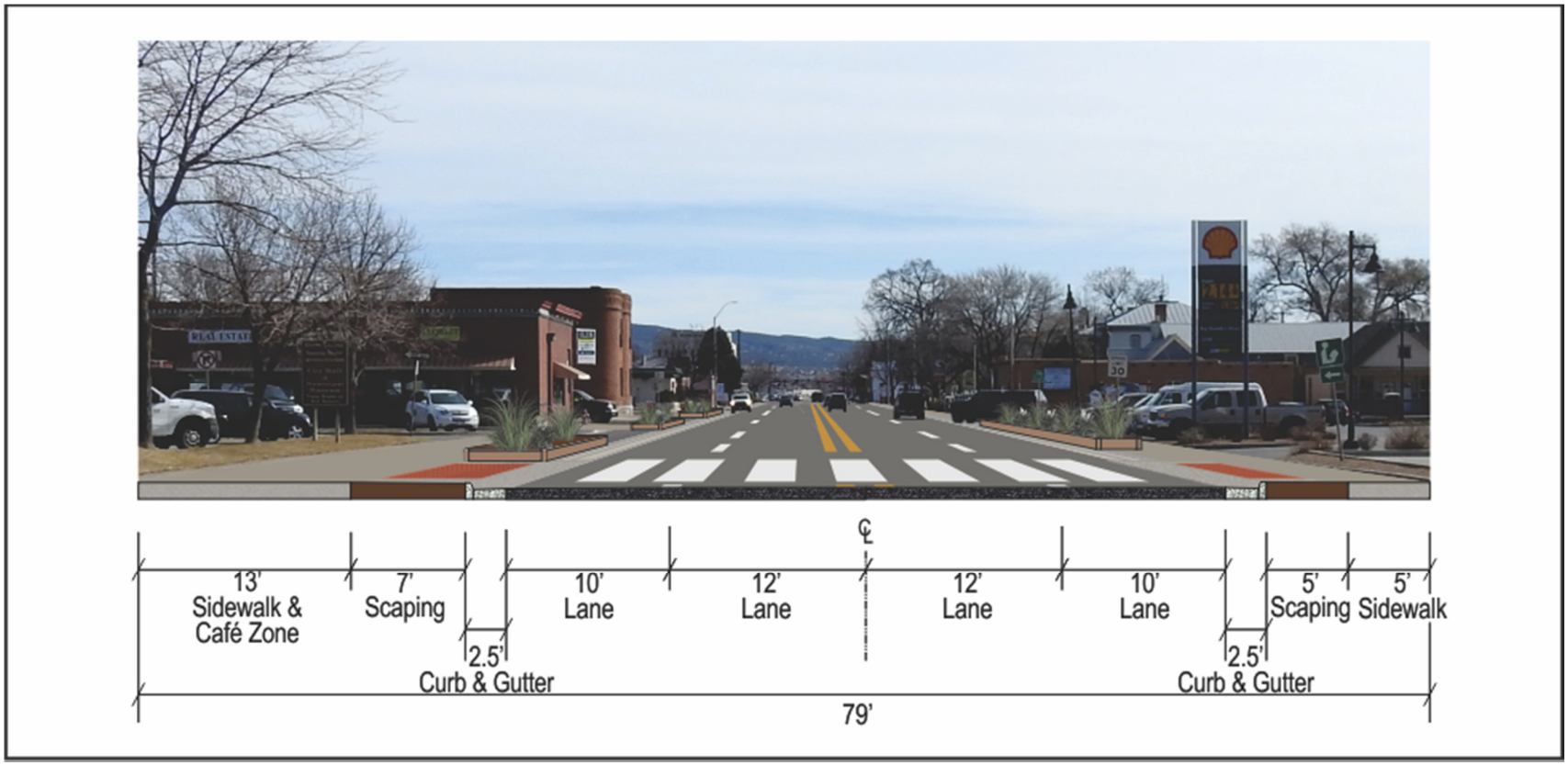


Figure 2-9. Roadway Concept RD-C

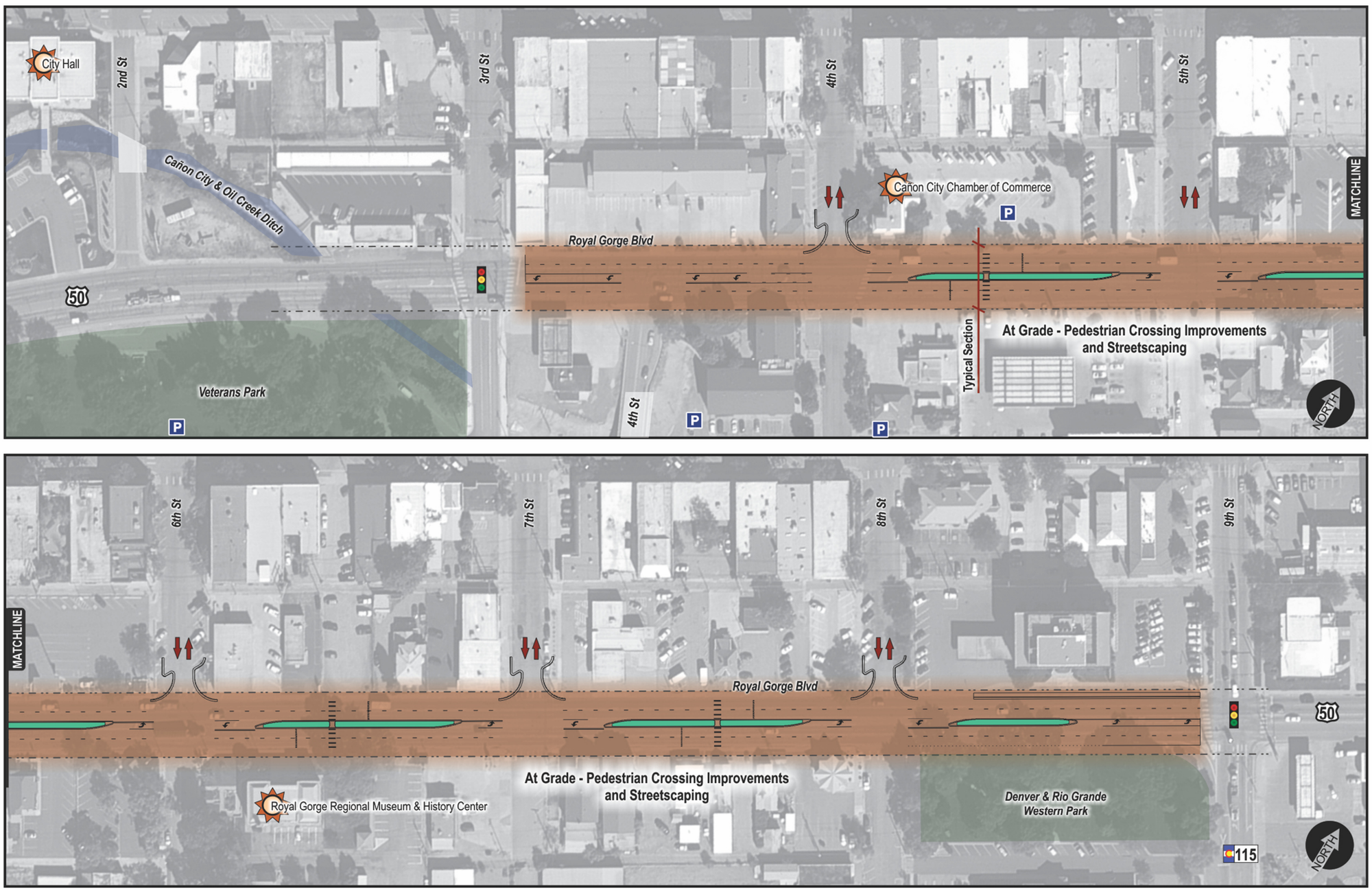


Figure 2-10. Roadway Concept RD-D

Figure 2-11. Roadway Concept RD-D

Figure 2-12. Roadway Concept RD-E

Figure 2-13. Roadway Concept RD-E

Grade-Separated Concepts

Concept GS-1 (**Figure 2-14**)

- Connect to Main Street adjacent to City Hall
- Bridge over Cañon City & Oil Creek Ditch parallel to Second Street bridge
- Diagonally cross US 50 using piers to frame Veteran's Park fountain
- Bridge over Cañon City & Oil Creek Ditch parallel to US 50 bridge
- Connect to sidewalk at Third Street intersection
- City of Cañon City and park land required for ramp structures

Concept GS-2 (**Figure 2-15**)

- Place the pedestrian ramp structures in NW and SW corners of Third Street intersection
- Bridge over US 50 west of Third Street
- Motel and park land required for ramp structures

Concept GS-3 (**Figure 2-16**)

- Place the north side pedestrian ramp structure in NE corner of Third Street intersection
- Bridge over US 50 east of Third Street
- Place the south side pedestrian ramp parallel to Third Street, turning east across the back of the rafting company property, passing under the Fourth Street Viaduct, turning parallel to the Fourth Street Viaduct, connecting to the SE corner of US 50 and the Fourth Street Viaduct, and providing a direct connection to the sidewalk on the Fourth Street Viaduct
- Pawn shop, rafting company, and Royal Gorge Route land required for ramp structures
- Close Fourth Street from Main Street to railroad for pedestrian mall with wide at-grade pedestrian crossing (either RRFB or HAWK) at US 50

Figure 2-14. Grade-Separated Concept GS-1

Figure 2-15. Grade-Separated Concept GS-2

Figure 2-16. Grade-Separated Concept GS-3

Concept GS-4 (**Figure 2-17**)

- Close Fourth Street from Main Street to railroad for pedestrian mall
- Upgrade alley between Fourth and Fifth Streets for pedestrian use
- Place the north side pedestrian ramp structure within Fourth Street ROW between Main Street and alley
- Bridge over Fourth Street pedestrian mall and US 50 between alley and south side of US 50
- Place the south side pedestrian ramp structure in SE corner of Fourth Street
- Bridge access stairs north and south of US 50 (alternate to pedestrian ramps)
- Pedestrian ramp and access stairs from Fourth Street Viaduct sidewalk to parking lot adjacent to Royal Gorge Route depot building
- GOAL Academy and Royal Gorge Route land required for ramp structures

Figure 2-17. Grade-Separated Concept GS-4

Concept GS-5 (**Figure 2-18**)

- Close Fourth Street from alley south of Main Street to parking lots south of US 50 for pedestrian mall and underpass grading
- Provide a pedestrian underpass of US 50 using a bridge or concrete box culvert
- North of US 50, provide a switchback ADA ramp with cul-de-sac at alley
- South of US 50, a potential walk-out configuration may be possible with a cul-de-sac at the city parking lot
- Maintain Fourth Street adjacent to city parking lot with access easement through Royal Gorge Route parking lot to Third Street

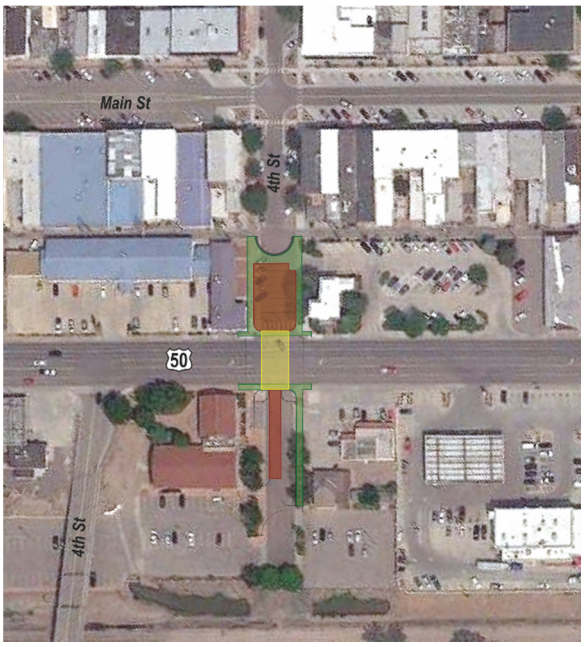


Figure 2-18. Grade-Separated Concept GS-5

Future Grade-Separated Concepts

Concept RR-1 (**Figure 2-19**)

- Connect to sidewalk at SW corner of US 50 and Third Street intersection
- Bridge over Cañon City & Oil Creek Ditch parallel to Third Street
- Bridge over Veteran's Park access
- Bridge over railroad
- Bridge over parking lot entrances and Arkansas Riverwalk Trail
- Touch down on Fourth Street Viaduct embankment and ramp down to join the Arkansas Riverwalk Trail near the historic truss bridge crossing the river into Centennial Park

Concept RR-2 (**Figure 2-20**)

- Improve sidewalk (replace and widen if possible) and ADA pedestrian ramps along US 50 from Third Street to the Fourth Street Viaduct
- Improve pedestrian accommodation on Fourth Street Viaduct by widening sidewalk (if possible) and installing new pedestrian railing and lighting
- Install switchback ADA ramp on Fourth Street Viaduct embankment to make a direct connection to the Arkansas Riverwalk Trail

Figure 2-19. Future Railroad Crossing Concept RR-1

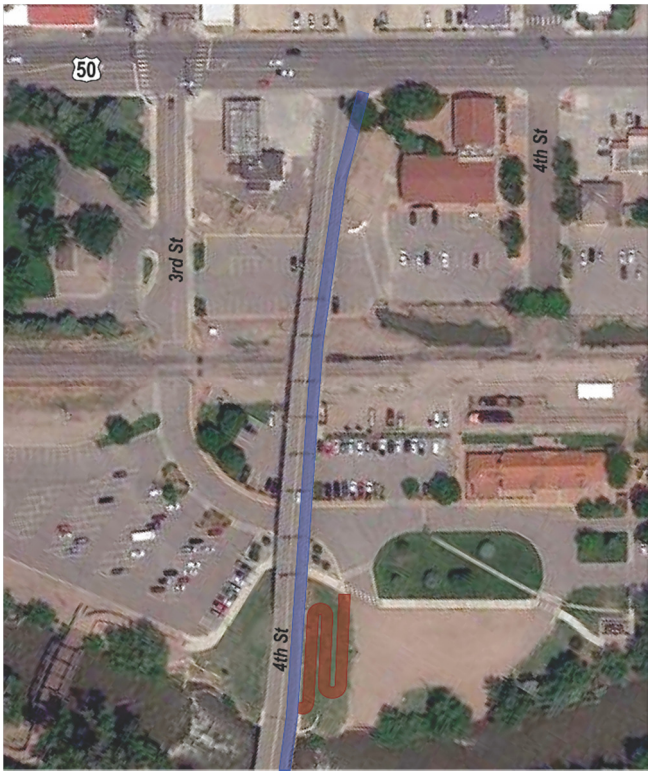


Figure 2-20. Future Railroad Crossing Concept RR-2

SUMMARY OF ALTERNATIVE EVALUATIONS

The project goals established by the City of Cañon City and further refined by the Citizen Committee were used as the basis of evaluating the various alternatives that were developed. In a workshop at the March 21 meeting, the Citizen Committee divided into three groups to complete evaluations of several alternatives assigned to them using an evaluation matrix that was built from the project goals. The results are shown in **Figure 2-21**. This evaluation was shared at the Public Open House. In addition, each Committee member was asked to individually evaluate each alternative. A compilation of these evaluations is shown in **Figure 2-22**. Finally, the engineering consultant team completed the evaluation shown in **Figure 2-23**.

Although no alternative stood out as a clear choice, the Citizen Committee discussed the merits of each, which coalesced into the Preferred Alternative—a hybrid of the Base Improvements, Alternative RD-A, Alternative RD-D, Alternative GS-1 and Alternative GS-5. In addition, the Arkansas River Central Corridor Plan working group indicated that as part of their efforts, Third Street was being considered as a pedestrian connection between Centennial Park (south of the Arkansas River) and Main Street.

SUMMARY OF PUBLIC OPEN HOUSE

The Public Open House was held on Tuesday April 11, 2017, from 4:00 p.m. to 8:00 p.m. at the City Hall of the City of Cañon City. There were 18 members of the Citizen Committee present to discuss the Preferred Alternative and the process for developing it. The Public Open House was attended by 39 visitors. **Appendix 2-2** contains copies of the display boards that were available for viewing at the open house, attendance sheets, a summary of written comments received, and verbatim comments.

General themes expressed by attendees to the Public Open House include:

- Concern about access for businesses on US 50 (particularly, Big Daddy's Diner/Gas Station)
- Dislike for the underpass option (GS-5) due to perceived security issues and impact to businesses on Fourth Street
- Desire for an aesthetically interesting overpass

CITY COUNCIL VISIONING WORKSHOP

The City Council held a visioning workshop on Wednesday May 17, 2017, from 4:00 p.m. to 6:00 p.m. in the Council Chambers at City Hall. The purpose of the workshop was to review the process undertaken by the Citizen Committee and the alternatives considered, review the preferred alternative, ask questions of the design team and listen to public comment. This was in preparation for adoption of a resolution in June to proceed with preliminary and final design of the preferred alternative. **Appendix 2-3** contains documentation of this workshop.

Benefit Rating System:

- 1 Not Supportive of Goal
- 2 Somewhat Supportive of Goal
- 3 Supportive of Goal
- 4 Highly Supportive of Goal
- 5 Very Highly Supportive of Goal

Alternatives:	US 50 Roadway Modifications								Grade Separations						
Evaluation Criteria:	No Build Repair Pedestrian Ramps	Base Pedestrian Improvements ADA Compliant Crossings	Concept RD-A : Five Lanes Medians at Crosswlks Only	Concept RD-B : Four Lanes Crosswalks, Landscaped Edges	Concept RD-C : Narrow Four-Lane Crosswalks, Offset Café Zone One Side	Concept RD-D : Four Lanes Crosswalks, Full Median	Concept RD-E : Four Lanes Crosswalks, Full Median, One-way Pair		Concept GS-1 Overpass at 2nd Street	Concept GS-2 Overpass at 3rd Street (West)	Concept GS-3 Overpass at 3rd Street (East)	Concept GS-4 Overpass at 4th Street	Concept GS-5 Underpass at 4th Street		Concept RR-1 3rd Street Ped Overpass over RR	Concept RR-2 4th St Bridge Ramps to Riverwalk
Address identified project goals:															
Enhance Safety	2	2	4	4	2	3	2		4	5	5	5	4		
Pedestrian Safety	2	2	4	4	2	4	4		5	5	5	5	5		
Vehicular Safety	1	2	4	3	2	3	2		5	5	5	5	5		
Bicycle Safety	1	2	4	3	2	3	3		5	5	5	5	5		
Emergency Operations	3	4	4	3	2	3	1		5	5	5	5	5		
Security: Discourage Vagrancy	1	1	2	5	3	3	3		4	5	5	5	1		
Security: Open Feel	5	1	4	5	2	3	1		4	5	5	5	1		
Increase Bicycling and/or Walking Activity	3	3	3	4	1	3	3		3	3	3	3	4		
Maximize Investment/ Network Connectivity	3	5	5	5	0	2	2		3	3	3	3	3		
Immediate Benefit to Public	3	5	5	5	0	2	2		3	3	3	3	3		
Improve State and Regional Economy	3	4	4	3	1	2	2		2	3	3	3	2		
Economic Development/Redevelopment	1	4	4	4	1	2	2		3	3	3	3	1		
Active Use of Both Sides of Highway	2	5	4	5	1	2	2		2	4	4	4	4		
Easy Vehicular Access to Businesses	5	5	4	2	1	1	1		3	3	3	5	5		
Better or more access to parking	3	5	5	2	0	1	1		2	4	2	1	1		
Positive Impact on Businesses	3	3	4	2	1	1	2		1	3	2	2	2		
Expand Recreational Opportunities	1	2	3	3	0	3	2		2	2	2	2	1		
Enhance Quality of Life	1	1	4	5	2	3	3		4	4	4	4	2		
Aesthetics	1	1	4	5	1	3	2		5	5	5	5	1		
Gateway (Highly Visible)	1	1	4	5	3	4	4		5	5	5	5	1		
Incorporate Highway into Fabric of the City as much as possible	1	1	3	4	1	3	3		5	4	4	4	1		
State of the Art	1	1	4	5	1	2	2		5	5	5	5	2		
Adjacent Building Aesthetics	1	1	4	5	2	3	2		1	1	1	1	1		
Improve Public Health	2	3	3	3	1	3	3		3	3	3	3	3		
Provide Transportation Equity	2	4	4	4	2	3	2		4	3	3	2	2		
ADA Compatibility	3	5	5	5	2	3	3		5	3	1	3	3		
Minimize Impact of Traffic Flow	3	1	2	3	0	2	0		5	5	5	1	1		
Calm Traffic to Meet 30 MPH Speed Limit	1	5	5	5	3	3	2		2	2	2	1	1		
Create Project Readiness	3	5	5	5	2	3	2		1	1	1	1	1		
Compatibility with Funding	3	5	5	5	2	3	2		1	1	1	1	1		
Integration with Plans and Community Support	2	2	2	3	4	4	4		3	3	3	3	3		
US 50 Corridor Plan	2	3	3	5	5	5	5		5	5	5	5	5		
Downtown Strategic Plan	2	3	3	5	4	4	4		4	4	4	4	4		
Draft Arkansas River Central Corridor Plan	1	1	1	1	3	3	3		3	3	3	3	2		
Eastern Fremont County Trails, Open Space & River Corridor Master Plan	1	1	1	1	3	3	3		3	3	3	3	3		
Uniformity with Downtown (content & placemaking)	3	3	1	4	4	4	4		4	4	4	1	1		
Compatibility with Railroad Crossings (At-Grade or Grade Separated Connection to Depot)	1	1	1	1	3	3	3		1	1	1	1	1		
Future Needs	2	1	2	5	3	3	3		3	3	3	3	3		
Consider engineering design constraints/costs:															
Engineering Considerations	5	5	5	4	4	4	4		3	4	4	4	4		
Right-of-Way Impacts	5	5	5	5	5	5	5		2	5	5	5	5		
Minimize Construction Impacts	5	5	4	2	3	3	3		4	4	4	4	5		
Minimize Natural/Cultural Resource Impacts	5	5	5	5	5	5	5		4	4	4	1	1		
Minimize Utility Impacts/Relocations	5	5	5	5	3	3	3		4	4	4	5	5		
Maintenance Considerations	5	5	4	3	3	2	2		3	3	3	5	4		
Overall Evaluation:															
Overall Evaluation	3	4	4	4	2	3	2		3	3	3	3	2		

Figure 2-21. Evaluation Matrix—Committee Breakout Groups

Benefit Rating System:

1 Not Supportive of Goal
2 Somewhat Supportive of Goal
3 Supportive of Goal
4 Highly Supportive of Goal
5 Very Highly Supportive of Goal

Evaluation Criteria:	Alternatives: US 50 Roadway Modifications								Grade Separations							
	No Build Repair Pedestrian Ramps	Base Pedestrian Improvements ADA Compliant Crossings	Concept RD-A : Five Lanes Medians at Crosswlks Only	Concept RD-B : Four Lanes Crosswalks, Landscaped Edges	Concept RD-C : Narrow Four-Lane Crosswalks, Offset Café Zone One Side	Concept RD-D : Four Lanes Crosswalks, Full Median	Concept RD-E : Four Lanes Crosswalks, Full Median, One-way Pair		Concept GS-1 Overpass at 2nd Street	Concept GS-2 Overpass at 3rd Street (West)	Concept GS-3 Overpass at 3rd Street (East)	Concept GS-4 Overpass at 4th Street	Concept GS-5 Underpass at 4th Street		Concept RR-1 3rd Street Ped Overpass over RR	Concept RR-2 4th St Bridge Ramps to Riverwalk
Address identified project goals:																
Enhance Safety	2	3	4	3	3	4	3		4	4	4	4	4		3	4
Pedestrian Safety	2	4	4	3	3	4	4		5	5	5	5	4		4	5
Vehicular Safety	1	2	4	3	3	4	3		5	5	5	5	4		4	4
Bicycle Safety	3	3	3	3	3	3	3		4	4	4	4	4		4	4
Emergency Operations	1	1	4	2	2	3	3		4	4	4	4	3		3	3
Security: Discourage Vagrancy	1	1	3	3	3	3	3		3	3	3	3	2		3	4
Security: Open Feel	3	3	4	4	4	4	4		4	4	4	4	3		3	4
Increase Bicycling and/or Walking Activity	2	4	4	4	4	4	3		4	4	4	4	4		4	4
Maximize Investment/ Network Connectivity	4	4	4	4	4	4	3		3	3	3	3	3		2	3
Immediate Benefit to Public	4	4	4	4	4	4	3		3	3	3	3	3		2	3
Improve State and Regional Economy	2	3	3	3	3	3	2		3	3	3	3	3		3	3
Economic Development/Redevelopment	2	2	3	4	4	3	3		3	3	3	3	4		3	3
Active Use of Both Sides of Highway	2	3	4	4	3	3	3		4	3	3	4	4		2	3
Easy Vehicular Access to Businesses	2	2	3	2	2	3	2		4	4	4	3	3		3	4
Better or more access to parking	2	2	3	2	2	2	2		3	4	4	3	3		3	3
Positive Impact on Businesses	2	2	3	3	3	3	3		3	3	3	3	3		2	3
Expand Recreational Opportunities	3	3	3	3	3	3	3		4	4	4	3	3		4	4
Enhance Quality of Life	2	2	3	4	4	3	3		4	4	4	4	4		2	3
Aesthetics	2	3	3	4	4	4	3		4	3	3	4	3		3	4
Gateway (Highly Visible)	2	3	3	4	4	4	3		5	5	5	5	2		3	3
Incorporate Highway into Fabric of the City as much as possible	3	3	3	4	4	4	3		3	4	4	4	2		1	3
State of the Art	2	2	2	3	3	4	3		4	4	4	5	4		3	3
Adjacent Building Aesthetics	2	2	2	4	4	3	3		3	3	3	3	2		1	3
Improve Public Health	2	2	3	3	3	3	3		4	4	3	3	3		3	4
Provide Transportation Equity	3	4	4	3	3	4	4		4	4	3	3	3		3	3
ADA Compatibility	3	5	4	4	4	4	4		4	4	3	4	4		4	4
Minimize Impact of Traffic Flow	3	4	4	3	3	3	3		4	4	4	4	4		3	4
Calm Traffic to Meet 30 MPH Speed Limit	2	2	4	4	4	3	3		3	3	3	3	2		2	2
Create Project Readiness	4	4	4	4	4	4	4		2	2	2	2	2		1	2
Compatibility with Funding	4	4	4	4	4	4	4		2	2	2	2	2		1	2
Integration with Plans and Community Support	3	3	3	3	3	3	3		3	3	3	3	3		3	3
US 50 Corridor Plan	3	3	4	4	4	4	4		4	4	4	4	3		3	3
Downtown Strategic Plan	3	3	3	3	3	3	3		3	3	3	3	3		2	3
Draft Arkansas River Central Corridor Plan	3	3	3	3	3	3	3		3	3	3	3	3		3	3
Eastern Fremont County Trails, Open Space & River Corridor Master Plan	3	3	3	3	3	2	2		3	3	3	3	3		4	4
Uniformity with Downtown (content & placemaking)	3	3	3	4	4	3	2		3	3	3	4	3		2	3
Compatibility with Railroad Crossings (At-Grade or Grade Separated Connection to Depot)	3	3	3	3	3	3	3		3	3	3	3	3		4	4
Future Needs	3	3	3	3	3	3	3		4	4	4	4	3		3	4
Consider engineering design constraints/costs:																
Engineering Considerations	4	4	4	4	4	4	4		3	3	3	3	3		3	4
Right-of-Way Impacts	4	4	4	3	3	3	3		3	2	3	3	4		3	4
Minimize Construction Impacts	4	4	4	3	3	3	3		3	3	3	3	2		3	4
Minimize Natural/Cultural Resource Impacts	4	4	4	4	4	4	4		3	3	3	3	3		3	4
Minimize Utility Impacts/Relocations	4	4	4	4	4	4	4		4	4	4	4	2		4	4
Maintenance Considerations	4	4	4	3	3	4	4		4	3	3	3	3		3	4
Overall Evaluation:																
Overall Evaluation	3	3	4	3	3	3	3		3	3	3	3	3		3	3

Figure 2-22. Evaluation Matrix—Compilation of Individual Committee Member Reviews

Benefit Rating System:

- 1 Not Supportive of Goal
- 2 Somewhat Supportive of Goal
- 3 Supportive of Goal
- 4 Highly Supportive of Goal
- 5 Very Highly Supportive of Goal

Alternatives:	US 50 Roadway Modifications								Grade Separations						
Evaluation Criteria:	No Build Repair Pedestrian Ramps	Base Pedestrian Improvements ADA Compliant Crossings	Concept RD-A : Five Lanes Medians at Crosswlks Only	Concept RD-B : Four Lanes Crosswalks, Landscaped Edges	Concept RD-C : Narrow Four-Lane Crosswalks, Offset Café Zone One Side	Concept RD-D : Four Lanes Crosswalks, Full Median	Concept RD-E : Four Lanes Crosswalks, Full Median, One-way Pair		Concept GS-1 Overpass at 2nd Street	Concept GS-2 Overpass at 3rd Street (West)	Concept GS-3 Overpass at 3rd Street (East)	Concept GS-4 Overpass at 4th Street	Concept GS-5 Underpass at 4th Street		Concept RR-1 3rd Street Ped Overpass over RR	Concept RR-2 4th St Bridge Ramps to Riverwalk
Address identified project goals:															
Enhance Safety	1	2	3	3	3	3	3		4	4	4	4	3		
Pedestrian Safety	2	2	4	4	4	4	4		5	5	5	5	5		
Vehicular Safety	1	2	3	2	2	3	3		3	3	3	3	3		
Bicycle Safety	1	2	3	3	3	3	3		5	5	5	5	5		
Emergency Operations	1	2	3	4	4	3	3		3	3	3	3	3		
Security: Discourage Vagrancy	1	1	3	3	3	3	3		3	3	3	3	1		
Security: Open Feel	3	3	4	4	4	4	4		4	2	2	2	1		
Increase Bicycling and/or Walking Activity	1	2	4	4	4	4	4		4	4	4	4	4		
Maximize Investment/ Network Connectivity	3	3	4	4	4	4	4		2	2	2	2	1		
Immediate Benefit to Public	3	3	4	4	4	4	4		2	2	2	2	1		
Improve State and Regional Economy	3	3	3	3	3	3	3		3	2	2	2	2		
Economic Development/Redevelopment	2	3	4	4	4	4	4		3	3	3	3	3		
Active Use of Both Sides of Highway	2	3	4	4	4	4	4		2	2	2	2	2		
Easy Vehicular Access to Businesses	3	3	2	3	3	2	2		3	2	3	1	1		
Better or more access to parking	3	3	2	3	3	2	2		3	1	2	1	1		
Positive Impact on Businesses	3	3	3	3	3	3	3		3	1	1	1	1		
Expand Recreational Opportunities	2	3	3	3	3	3	3		3	3	3	3	3		
Enhance Quality of Life	2	2	3	4	4	4	4		3	3	3	3	3		
Aesthetics	2	2	3	4	4	4	4		4	3	3	3	3		
Gateway (Highly Visible)	1	2	4	4	4	4	4		4	3	3	3	3		
Incorporate Highway into Fabric of the City as much as possible	2	2	3	4	5	4	4		2	2	2	2	2		
State of the Art	1	1	3	3	3	3	3		3	3	3	3	3		
Adjacent Building Aesthetics	1	1	3	4	4	3	3		3	2	2	2	3		
Improve Public Health	2	2	3	4	4	3	3		3	2	2	2	2		
Provide Transportation Equity	3	4	4	4	4	3	3		4	4	4	4	4		
ADA Compatibility	4	4	4	5	5	4	4		5	5	5	5	5		
Minimize Impact of Traffic Flow	5	5	4	3	3	2	2		5	5	5	5	5		
Calm Traffic to Meet 30 MPH Speed Limit	1	2	3	3	3	4	4		1	1	1	1	1		
Create Project Readiness	5	5	5	3	3	4	3		1	1	1	1	1		
Compatibility with Funding	5	5	5	3	3	4	3		1	1	1	1	1		
Integration with Plans and Community Support	2	2	3	4	4	4	3		3	3	3	2	2		
US 50 Corridor Plan	2	2	4	5	5	5	4		2	2	2	2	2		
Downtown Strategic Plan	2	2	4	4	4	4	4		3	3	3	3	3		
Draft Arkansas River Central Corridor Plan	2	2	3	3	3	3	3		3	3	3	2	2		
Eastern Fremont County Trails, Open Space & River Corridor Master Plan	2	2	3	3	3	3	3		2	3	3	2	2		
Uniformity with Downtown (content & placemaking)	2	2	4	4	4	4	4		3	3	3	3	3		
Compatibility with Railroad Crossings (At-Grade or Grade Separated Connection to Depot)	3	3	3	3	3	3	3		4	4	4	2	2		
Future Needs	3	3	3	3	4	3	3		2	2	2	2	2		
Consider engineering design constraints/costs:															
Engineering Considerations	5	5	4	3	3	3	3		3	2	2	2	2		
Right-of-Way Impacts	4	4	4	4	4	4	4		2	1	1	2	2		
Minimize Construction Impacts	5	5	4	3	3	3	3		4	2	2	2	1		
Minimize Natural/Cultural Resource Impacts	5	5	4	4	4	4	4		2	2	2	2	2		
Minimize Utility Impacts/Relocations	5	5	4	3	3	3	3		3	3	3	3	1		
Maintenance Considerations	5	5	4	3	3	3	3		3	3	3	3	2		
Overall Evaluation:															
Overall Evaluation	**3**	**3**	**4**	**4**	**4**	**4**	**3**		**3**	**2**	**3**	**2**	**2**		

Figure 2-23. Evaluation Matrix—Engineering Opinion

PART 3: TRAFFIC ANALYSIS

TRAFFIC ANALYSIS METHODOLOGY

Traffic operations performance for the US 50 project corridor was assessed for unsignalized and signalized intersections. Multilane highway segment capacity was also assessed to evaluate the feasibility of a road diet concept that would narrow the project segment to two thru lanes, one in each direction, with a two-way center turn lane.

Procedures and methodologies contained in the Transportation Research Board's *HCM2010: Highway Capacity Manual* were applied to evaluation of the US 50 mainline and eight intersections. Synchro signal progression analysis tools were also applied to evaluate US 50 corridor signal progression efficiency for existing and future scenarios. The methodologies that were used for each component analysis are consistent with requirements identified by CDOT's Traffic Impact Study guidelines.

Intersection Analysis Methodology

Study intersection operations were evaluated using *HCM2010*-based Levels of Service (LOS) calculations as analyzed in the Synchro software version 9. The HCM2010 utilizes measures including operating speed and delay to characterize roadway operations, and it uses letter codes ranging from "A" (excellent, free flow) to "F" (failing, interrupted flow). Descriptions of conditions associated with each of the individual LOS, by control and or facility type are summarized below.

Signalized Intersections

At signalized intersections, traffic conditions were evaluated using procedures and methodologies contained in *HCM2010*. The operation analysis uses various intersection characteristics (such as traffic volumes, lane geometry, and signal phasing) to estimate the intersection's volume-to-capacity (v/c) ratio. For signalized intersections, *HCM2010* defines the LOS as the average delay per vehicle (veh) for the overall intersection. **Table 3-1** summarizes the relationship between delay and LOS for signalized intersections.

Table 3-1. LOS Criteria for Signalized Intersections

Levels of Service	Interpretation	Control Delay (sec/veh)
A	Progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may contribute to low delay.	≤10
B	Good progression or short cycle lengths or both. More vehicles stop than with LOS A.	>10 and ≤20
C	Fair progression or longer cycle lengths or both. The number of vehicles stopping is significant, though many still pass through without stopping.	>20 and ≤35
D	Longer delays result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop.	>35 and ≤55
E	High delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.	>55 and ≤80
F	This level often occurs with oversaturation when arrival flow rates exceed the capacity of the intersection. Poor progression and long cycle lengths may be major contributing factors to such delays.	>80

Source: Transportation Research Board, *HCM2010: Highway Capacity Manual* (Washington DC, 2010), 19-2.

Unsignalized Intersections

Traffic operations for the proposed improvements were evaluated with respect to highway traffic congestion as represented by Level of Service (LOS) as defined by *HCM2010*. For unsignalized (all-way stop-controlled and side-street stop-controlled) intersections, the Transportation Research Board's *HCM2000: Highway Capacity Manual* methodology for unsignalized intersections was utilized. With this methodology, operations are defined by the average control delay per vehicle (measured in seconds) for each stop-controlled movement. The method incorporates delay associated with deceleration, acceleration, stopping, and moving up in the queue. For all-way stop-controlled intersections, *HCM2000* defines the level of service as the average delay per vehicle for the overall intersection. For side street stop-controlled intersections, LOS is reported for the worst approach. **Table 3-2** summarizes the relationship between delay and LOS for unsignalized intersections.

Table 3-2. LOS Criteria for Side-Street Stop-Controlled Intersections

Level of Service	Interpretation	Control Delay (sec/veh)
a	Little or no delay	0–10
b	Short traffic delays	>10–15
c	Average traffic delays	>15–25
d	Long traffic delays	>25–35
e	Very long traffic delays	>25–50
f	When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing that may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improving the intersection.	>50

Note: For two-way stop controlled (TWSC) intersections, level of service is determined by the control delay for each minor movement, LOS is not defined for the intersection as a whole. Source: *HCM2010*, 18.6.

ADT and Hourly Lane Capacity

Identifying a threshold service flow volume as a threshold indicator of the need for four lanes is complex for a principal arterial facility such as the US Highway 50 project corridor. Factors including posted speed, lane width, grade, adjacent land use, and spacing of access points have a profound impact on capacity. Several sources provide guidance to support establishing a two-lane and four-lane Average Daily Traffic (ADT) threshold capacity volumes for the US 50 project corridor. These sources include: inferred guidance from *HCM2010*; calculated capacity thresholds based on speed-flow curve; the *Road Diet Handbook: Setting Trends for Livable Streets*; and various planning level applied criteria (e.g., the Hays County (Austin, Texas) Transportation Plan Roadway Capacity Table). Together these resources suggest a two- to four-lane threshold ADT volume between 15,000 ADT and 20,000 ADT. For purposes of this analysis we have adopted 9,100 ADT per lane, yielding 18,200 ADT and the threshold at which four travel lanes would be required, and 36,400 ADT as the threshold for widening to six lanes.

Significance Criteria

Minimum Acceptable LOS

In accordance with accepted standards all county roads must maintain an overall LOS C while intersections should operate at an overall LOS D or better. CDOT minimum design criteria indicate intersections operate at an overall LOS D or better.

Significant Impact Criteria

A project typically is considered to have a significant impact at a study intersection when one of the following criteria is satisfied:

For Signalized Intersections:
The added project traffic causes an intersection to exceed the LOS standard or the background traffic conditions (without project traffic) exceed the established LOS standards, and the project traffic causes more than a 20 percent increase in the intersection delay.

For Unsignalized Intersections:
Queuing of traffic to adjacent intersections creates impeded traffic flows or excessive delays are determined to create potential safety problems. It is typical for an unsignalized intersection to notice delays higher than 35 seconds (LOS E) for a single approach without meeting signal warrants. Therefore LOS E or better for a single movement at an unsignalized intersection is typically tolerated.

TRAFFIC VOLUMES

ADT Traffic Volumes

Current traffic volume counts, including ADT summary counts and short-term hourly directional counts, were obtained from the CDOT Online Traffic Information System (OTIS) database. As shown in **Figure 3-1**, most of the corridor could serve existing traffic volumes with two lanes; however, 2040 forecast traffic, also obtained from the CDOT OTIS, would outstrip two-lane capacity east of Fourth Street. As shown in **Figure 3-2**, traffic is currently distributed throughout the day without strong morning or evening peaking. All supporting count data can be found in **Appendix 3-1**.

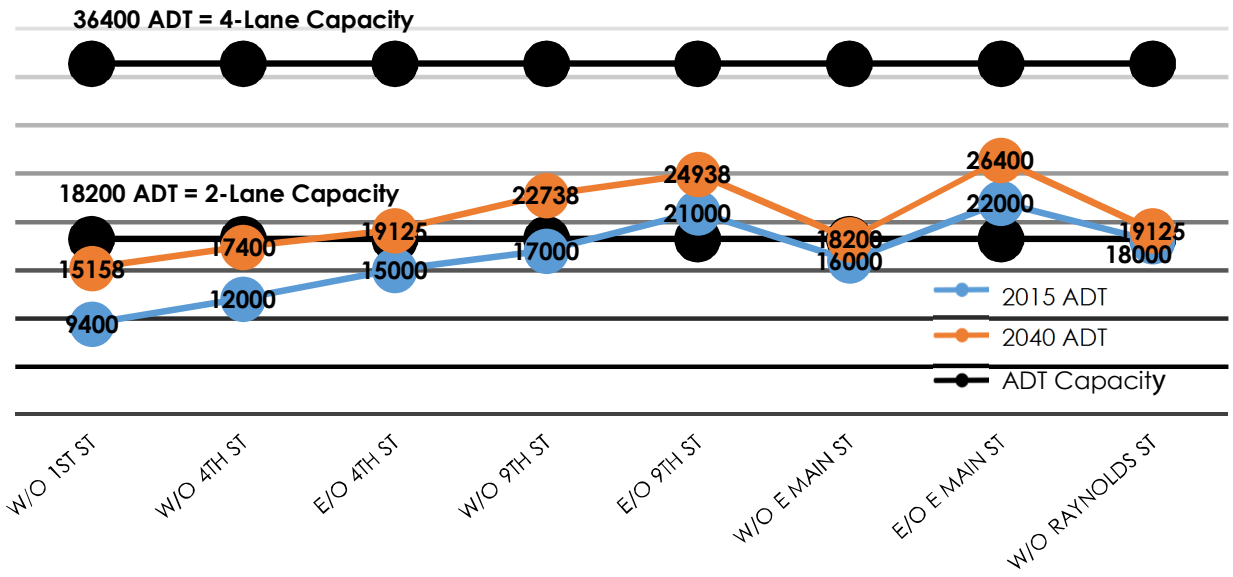


Figure 3-1. US 50 Daily Traffic Volumes—2015, 2040, and Capacity (2-Lane, 4-Lane)

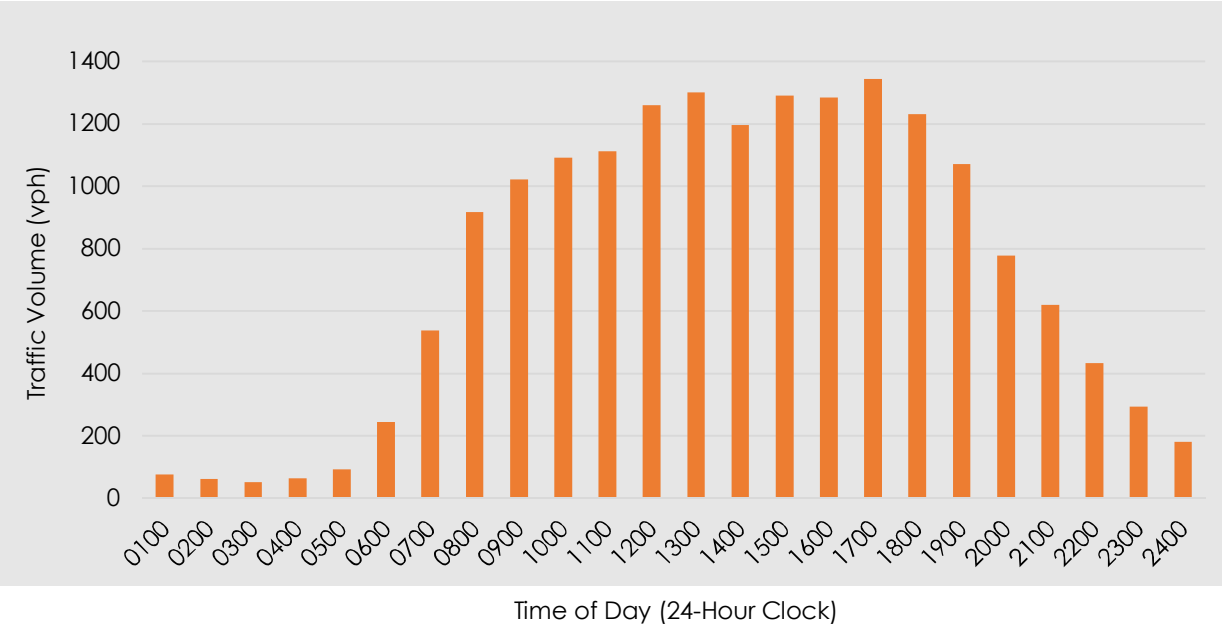


Figure 3-2. US 50 2015 Daily Traffic Volumes—Distribution of Traffic by Time of Day

Peak Hour Turning Movement Counts

Existing traffic turning movement counts and pedestrian crossing counts were conducted in August 2016 by All Traffic Data for the AM and PM weekday peak hours and for the Saturday midday peak hour. Turning movement counts were collected for eight study area intersections.

This data was supplemented with Automated Traffic Count Recorder and short-term count data obtained from the CDOT OTIS database. This data was used to establish the diurnal distribution traffic flows by time- of- day.

Appendix 3-1 contains the unadjusted traffic count data.

CDOT OTIS Traffic Forecasts

The US 50 (Royal Gorge Boulevard) project corridor is a U.S. route and state highway. As such, CDOT tracks traffic flows on US 50 and maintains forecasts of future growth in traffic levels on OTIS. The CDOT OTIS database currently shows an average 20-year growth factor of 1.28, with a range of 1.27 (west of Fourth Street) to 1.36 (west of Ninth Street). Per CDOT Traffic Impact Study guidance, growth factors calculated from CDOT OTIS 2040 forecasted traffic estimates for the project corridor were used to estimate 2040 peak hour traffic volumes used for traffic operations analysis.

Memorial Day Holiday Traffic Counts

Additional traffic count, pedestrian count and potential hotspot video recording data was collected by All Traffic Data in May 2017, over the Memorial Day weekend and the full week following Memorial Day. The new data was collected to characterize peak patronage period for the Royal Gorge Railroad and to ensure consideration of highest volumes, worst case conditions would be factored in to traffic analysis.

Peak Hour Turning Movement Counts

Weekday peak hour and weekend midday turning movement counts were collected at the US 50/Ninth Street intersection. The weekend midday count was conducted on Saturday, May 27, 2017, during the Memorial Day weekend. The weekday peak hour counts were conducted on Wednesday, May 31, 2017, following Memorial Day.

Comparison of the 2016 non-holiday counts to 2017 Memorial Day week counts shows moderate (+/-10% or less) variations between the two count data sets. For weekend conditions, traffic volumes at the Ninth Street intersection were approximately 10% higher for 2017 holiday conditions versus 2016 non-holiday conditions. For weekday peak hour conditions, traffic volume at the Ninth Street intersection were approximately 1% lower for the AM peak hour and 9% lower for the PM peak hour for 2017 holiday conditions versus 2016 non-holiday conditions. This differences would be consistent with increased holiday weekend non-local tourist traffic and reduced holiday week local non-tourism related business traffic.

US 50 7-Day Hourly, Directional Count

A US 50 mainline hourly, directional count, located to the east of Fifth Street was collected for the full holiday week, beginning on Friday, May 26, 2017 and continuing through Thursday, June 1, 2017.

Comparison of hourly traffic volume and distribution average weekday for the corridor obtained from the CDOT OTIS database, as shown in **Figure 3-3**, shows consistency between the CDOT weekday traffic levels and distribution and the Memorial Day weekday traffic levels and distribution. As observed or the intersection TMC comparison, the Memorial Day weekend traffic levels were distributed similarly to the weekday traffic volumes but were consistently higher that the observed weekday traffic levels.

Hotspot Traffic Flow Video Recordings

Traffic flow video recordings were conducted for the Memorial Day holiday weekend beginning on Friday, May 26, 2017 and continuing through Thursday, June 1, 2017. Three cameras were employed to capture traffic flow and queuing upstream of the Third Street/US 50 intersection, downstream of the Sixth Street/US 50 intersection, upstream of the Fifth Street/US 50 intersection.

Focused review of the Third Street video was conducted for the 90-minute periods prior to each scheduled train departure and maximum westbound left-turn queue lengths of two vehicles were observed. Broader review of video recordings centered on Fifth and Sixth Streets video was used to confirm that both the US 50 mainline (driveways) and cross streets are used to access adjacent businesses and that queuing is not significant in this stretch of the corridor.

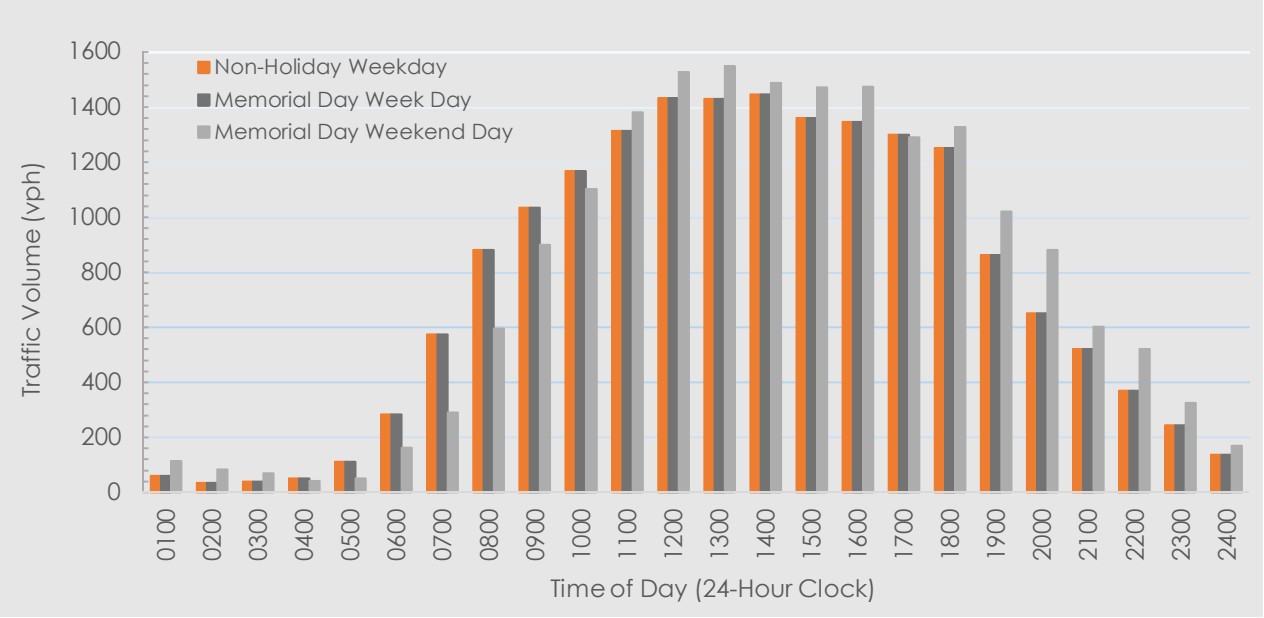


Figure 3-3. US 50 2015 Daily Traffic Volume Distribution—Holiday v. Non-Holiday

TRAFFIC ANALYSIS

Existing and future traffic operations without the signalized (HAWK signals) midblock crosswalks were assessed as a baseline against which future traffic operations with signalized crosswalks could be compared. CDOT signal timing was obtained from CDOT and used directly for baseline analysis. Future traffic operations impacts of implementing three HAWK signals within the US 50 study corridor, between Second and Ninth Streets, were assessed for a 2040 planning horizon with signal progression optimized.

The analysis was conducted based upon CDOT criteria using the existing roadway access and functional categories, and included intersection LOS and signal progression analysis. For the baseline conditions analysis, nine intersections were analyzed for weekday AM and PM peak hours, and for the weekend peak conditions (Saturday midday), as follows:

- US 50 at Second Street (T-intersection)
- US 50 at Third Street
- US 50 at Fourth Street Viaduct (T-intersection)
- US 50 at Fourth Street (T-intersection)
- US 50 at Fifth Street
- US 50 at Sixth Street
- US 50 at Seventh Street
- US 50 at Eighth Street
- US 50 at Ninth Street

Existing Conditions Analysis

A summary of baseline analysis for 2016 existing conditions traffic operations analysis for the nine existing intersections in the study corridor is provided in **Table 3-3**, below. **Figure 3-4**, **Figure 3-5**, **Figure 3-6** and **Figure 3-7**, found at the end of the "HAWK Signal Analysis" subsection, provide graphic representation of intersection LOS evaluation, with LOS by lane/movement, and associated turning movement volumes. Input assumptions and analysis results for 2016 Existing Conditions, 2040 No-Build Conditions and 2040 Conditions with Midblock HAWK pedestrian signals are shown side-by-side to facilitate comparisons among the three scenarios. Scenario-specific graphics depict lane utilization, intersection control, and peak hour turn movement volumes that were utilized for the analysis, as well as LOS results.

Full analysis results, including pedestrian LOS, intersection LOS summaries, and signalized intersection/crosswalk queuing reports are included in **Appendix 3-2**.

2040 No-Build Analysis

A summary of baseline analysis for the 2040 No-Build scenario is provided in **Table 3-4**, below. **Figure 3-4**, **Figure 3-5**, **Figure 3-6** and **Figure 3-7**, found at the end of the "HAWK Signal Analysis" subsection, provide graphic representation of lane utilization, intersection control, and peak hour turn movement volumes that were utilized for the analysis of the 2040 No-Build scenario, as well as LOS results.

These graphics also include 2016 Existing Conditions and 2040 Build Conditions with three midblock crossing under HAWK beacon control shown side-by-side to facilitate comparison of the three scenarios.

Full analysis results for the 2040 No-Build scenario, including pedestrian LOS, intersection LOS summaries, and signalized intersection/crosswalk queuing reports are included in **Appendix 3-2**.

Table 3-3. Level of Service Analysis for 2016 Existing Conditions

Control	Intersection	LOS/Delay [in seconds/vehicle] (Critical Movement)		
		AM Peak Hour	PM Peak Hour	Saturday Midday
STOP	US 50 at 2nd Street	b / 12.9 (SB approach)	b / 10.2 (SB approach)	b / 14.3 (SB approach)
Signal	US 50 at 3rd Street	A / 2.8	A / 3.5	A / 3.8
STOP	US 50 at 4th Street Viaduct	c / 18.7 (NB left-turn)	d / 32.2 (NB left-turn)	d / 27.8 (NB left-turn)
STOP	US 50 at 4th Street	c / 18.6 (SB approach)	d / 26.3 (SB approach)	d / 25.5 (SB approach)
STOP	US 50 at 5th Street	c / 20.8 (SB approach)	e / 37.8 (SB approach)	e / 41.2 (SB approach)
STOP	US 50 at 6th Street	c / 17.9 (SB approach)	d / 26.8 (SB approach)	e / 36.4 (SB approach)
STOP	US 50 at 7th Street	c / 15.8 (SB approach)	d / 31.4 (SB approach)	d / 30.6 (SB approach)
STOP	US 50 at 8th Street	b / 14.3 (SB approach)	c / 18.9 (NB approach)	d / 32.4 (NB approach)
Signal	US 50 at 9th Street	B / 19.9	C / 28.7	C / 22.1

Notes: 1) The signalized intersection LOS and delay results are reported for the overall intersection. The unsignalized results are reported for the critical (worst case) approach or movement; 2) Delay is reported as the average delay per vehicle in seconds; 3) The 9th Street signalized intersection was evaluated using *HCM2000* because *HCM2010* did not support the CDOT timing plan.

Table 3-4. Level of Service Analysis for 2040 No-Build Conditions

Control	Intersection	LOS/Delay [in seconds/vehicle] (Critical Movement)		
		AM Peak Hour	PM Peak Hour	Saturday Midday
STOP	US 50 at 2nd Street	b / 16.1 (SB approach)	c / 23.8 (SB approach)	c / 16.9 (SB approach)
Signal	US 50 at 3rd Street	A / 3.2	A / 3..9	A / 5.9
STOP	US 50 at 4th Street Viaduct	d / 27.4 (NB left-turn)	e / 41.1 (NB left-turn)	e / 35.5 (NB left-turn)
STOP	US 50 at 4th Street	d / 33.6 (SB approach)	f / 60.8 (SB approach)	f / 54.3 (SB approach)
STOP	US 50 at 5th Street	e / 43.7 (SB approach)	f / 242.9 (SB approach)	f / 211.0 (SB approach)
STOP	US 50 at 6th Street	d / 27.4 (SB approach)	f / 58.5 (SB approach)	f / 88.2 (SB approach)
STOP	US 50 at 7th Street	c / 2.3.0 (SB approach)	f / 83.0 (SB approach)	f / 66.2 (SB approach)
STOP	US 50 at 8th Street	c / 18.9 (SB approach)	d / 28.1 (NB approach)	f / 69.3 (NB approach)
Signal	US 50 at 9th Street	C / 23.4	D / 42.1	C / 27.2

Notes: 1) The signalized intersection LOS and delay results are reported for the overall intersection. The unsignalized results are reported for the critical (worst case) approach or movement; 2) Delay is reported as the average delay per vehicle in seconds; 3) The 9th Street signalized intersection was evaluated using *HCM2000* because *HCM2010* did not support the CDOT timing plan.

HAWK Signal Analysis

Three Midblock Crossings—Option 1

A summary of 2040 analysis for the Option 1 scenario, with three midblock HAWK beacon-controlled crosswalks, is provided in **Table 3-5**, below. **Figure 3-4**, **Figure 3-5**, **Figure 3-6** and **Figure 3-7**, found at the end of this subsection, provide graphic representation of lane utilization, intersection control, and peak hour turn movement volumes that were utilized for the analysis of this 2040 Build scenario, as well as LOS results. These graphics also include 2016 Existing Conditions and 2040 No-Build Conditions side-by-side to facilitate comparison of the three scenarios. Full analysis results generated by Synchro analysis, including delay, LOS, and queue length are included in **Appendix 3-2**.

Table 3-5. 2040 Level of Service Analysis for Midblock Crossings—Option 1

Control	Intersection	LOS/Delay [in seconds/vehicle] (Critical Movement)		
		AM Peak Hour	PM Peak Hour	Saturday Midday
STOP	US 50 at 2nd Street	c / 16.1 (SB approach)	c / 23.8 (SB approach)	c / 16.9 (SB approach)
Signal	US 50 at 3rd Street	A / 4.6	A / 5.1	A / 5.9
STOP	US 50 at 4th Street Viaduct	c / 23.2 (NB left-turn)	e / 41.1 (NB left-turn)	e / 35.5 (NB left-turn)
STOP	US 50 at 4th Street	d / 32.5 (NB approach)	f / 52.5 (NB approach)	e / 49.1 (NB left-turn)
STOP	US 50 at 5th Street	e / 43.7 (SB approach)	f / 209.8 (SB approach)	f / 186.7 (SB approach)
STOP	US 50 at 6th Street	d / 27.2 (SB approach)	f / 56.3 (SB approach)	f / 80.4 (SB approach)
STOP	US 50 at 7th Street	c / 22.5 (SB approach)	f / 73.7 (SB approach)	f / 62.5 (SB approach)
STOP	US 50 at 8th Street	c / 22.5 (NB approach)	d / 28.1 (NB approach)	f / 66.1 (NB approach)
Signal	US 50 at 9th Street	C / 22.1	D / 39.6	C / 27.2

Notes: 1) The signalized intersection LOS and delay results are reported for the overall intersection. The unsignalized results are reported for the critical (worst case) approach or movement; 2) Delay is reported as the average delay per vehicle in seconds; 3) The 9th Street signalized intersection was evaluated using *HCM2000* because *HCM2010* did not support the CDOT timing plan.

Three Midblock Crossings—Option 2

A summary of 2040 analysis for the Option 2 scenario is provided in **Table 3-6**. This scenario has three midblock HAWK beacon-controlled midblock crosswalks, located between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets, as well as a Sixth Street–Eighth Street one-way pair. Access management with the one-way pair improves corridor traffic operations with this alternative. Full analysis results for this scenario, including intersection LOS summaries and signalized intersection queuing reports, are included in **Appendix 3-2**.

Table 3-6. 2040 Level of Service Analysis for Midblock Crossings—Option 2

Control	Intersection	LOS/Delay [in seconds/vehicle] (Critical Movement)		
		AM Peak Hour	PM Peak Hour	Saturday Midday
STOP	US 50 at 2nd Street	c / 16.1 (SB approach)	c / 23.6 (SB approach)	c / 22.7 (SB approach)
Signal	US 50 at 3rd Street	A / 5.0	A / 5.7	A / 6.0
STOP	US 50 at 4th Street Viaduct	c / 23.3 (NB left-turn)	e / 42.3 (NB left-turn)	e / 37.4 (NB left-turn)
STOP	US 50 at 4th Street	b / 11.5 (SB right-turn)	b / 13.2 (NB right-turn)	b / 12.8 (SB right-turn)
STOP	US 50 at 5th Street	e / 43.3 (SB approach)	f / 232.9 (SB approach)	f / 229.2 (SB approach)
STOP	US 50 at 6th Street	b / 11.9 (NB right-turn)	b / 13.3 (NB right-turn)	b / 12.0 (NB right-turn)
STOP	US 50 at 7th Street	c / 23.1 (SB approach)	f / 195.3 (SB approach)	f / 91.2 (SB approach)
STOP	US 50 at 8th Street	b / 12.3 (SB right-turn)	b / 13.8 (NB right-turn)	b / 13.0 (SB right-turn)
Signal	US 50 at 9th Street	C / 22.0	D / 41.8	C / 26.0

Notes: 1) The signalized intersection LOS and delay results are reported for the overall intersection. The unsignalized results are reported for the critical (worst case) approach or movement; 2) Delay is reported as the average delay per vehicle in seconds; 3) The 9th Street signalized intersection was evaluated using *HCM2000* because *HCM2010* did not support the CDOT timing plan.

Four Midblock Crossings—Option 3 (Preferred Alternative)

A summary of 2040 analysis for the Option 2 scenario is provided in **Table 3-7**. This scenario has four midblock HAWK beacon-controlled crosswalks, located between First and Second Streets, Fourth and Fifth Streets, Sixth and Seventh Streets and Seventh and Eighth Streets. Full analysis results for this scenario, including intersection LOS summaries and signalized intersection queuing reports, are included in **Appendix 3-2.**

Table 3-7. 2040 Level of Service Analysis for Midblock Crossings—Option 3 (Preferred Alternative)

Control	Intersection	LOS/Delay [in seconds/vehicle] (Critical Movement)		
		AM Peak Hour	PM Peak Hour	Saturday Midday
STOP	US 50 at 2nd Street	c / 16.1 (SB approach)	c / 23.8 (SB approach)	c / 16.9 (SB approach)
Signal	US 50 at 3rd Street	A / 4.6	A / 2.5	A / 4.3
STOP	US 50 at 4th Street Viaduct	c / 23.2 (NB left-turn)	e / 41.1 (NB left-turn)	e / 35.5 (NB left-turn)
STOP	US 50 at 4th Street	d / 32.5 (NB approach)	f / 52.5 (NB approach)	e / 49.1 (NB left-turn)
STOP	US 50 at 5th Street	e / 43.7 (SB approach)	f / 209.8 (SB approach)	f / 186.7 (SB approach)
STOP	US 50 at 6th Street	d / 27.2 (SB approach)	f / 56.3 (SB approach)	f / 80.4 (SB approach)
STOP	US 50 at 7th Street	c / 22.5 (SB approach)	f / 73.7 (SB approach)	f / 62.5 (SB approach)
STOP	US 50 at 8th Street	c / 22.5 (NB approach)	d / 28.1 (NB approach)	f / 66.1 (NB approach)
Signal	US 50 at 9th Street	B / 17.3	D / 45.9	D / 37.5

Notes: 1) The signalized intersection LOS and delay results are reported for the overall intersection. The unsignalized results are reported for the critical (worst case) approach or movement; 2) Delay is reported as the average delay per vehicle in seconds; 3) The 9th Street signalized intersection was evaluated using *HCM2000* because *HCM2010* did not support the CDOT timing plan.

Queuing, Gap, and Spillback

Traffic operations performance was evaluated for midblock crosswalk scenarios controlled by HAWK beacons. Synchro simulations were used to establish 50th percentile and 90th percentile queue lengths and signal progression efficiency. SIMTraffic simulation/animation was used to evaluate potential spillback effects of the HAWK beacons on traffic flow to and from downstream and upstream intersections.

Nine scenarios were evaluated with four midblock HAWK beacons that were located between First and Second Streets, Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets. Future, estimated 2040 morning peak hour, afternoon peak hour, and Saturday midday peak hour scenarios were evaluated for Three Midblock Crossings—Option 1, with full cross section, and for Three Midblock Crossings—Option 2, with medians and a Sixth Street–Eighth Street cross street one-way pair as well as the Preferred Alternative with four midblock signalized pedestrian crossings and partial medians. In all cases a worst-case, 10 pedestrian calls per hour was assumed; current and forecast demand suggests that this level of pedestrian demand is unlikely.

The results of queue and signal progression analysis were generally favorable. Some single HAWK pedestrian phase vehicle queues extended past the adjacent cross-street intersection; however sustained spillback effects were not observed. Additionally, the HAWK beacon pedestrian phases created gaps for left-turning traffic at downstream cross streets that otherwise experienced LOS F delays without the upstream HAWK beacon-controlled pedestrian crosswalks.

Queuing and progression reports for signalized intersections and crosswalks are included in **Appendix 3-2**.

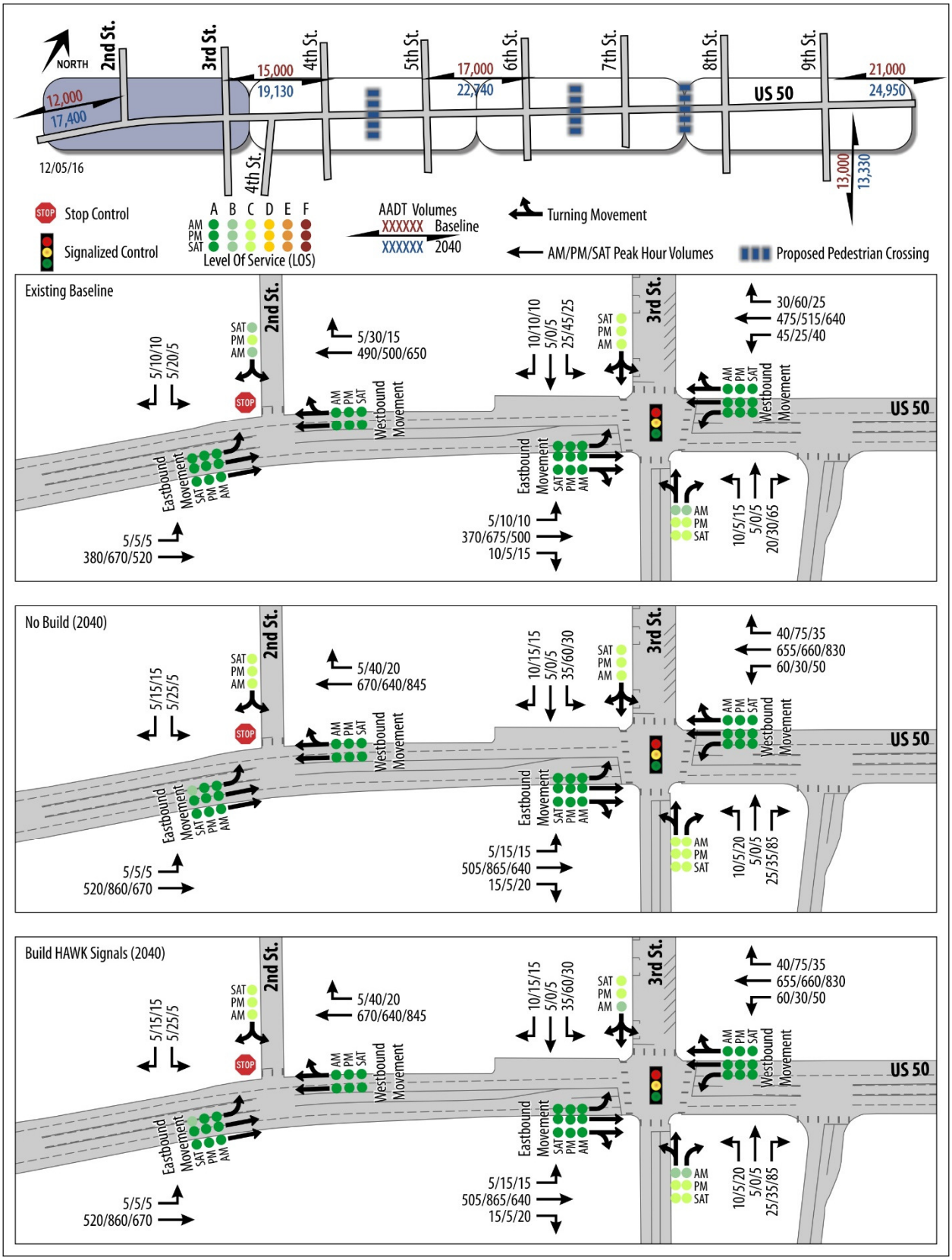


Figure 3-4. US 50 Traffic Volumes and Levels of Service—2nd Street and 3rd Street

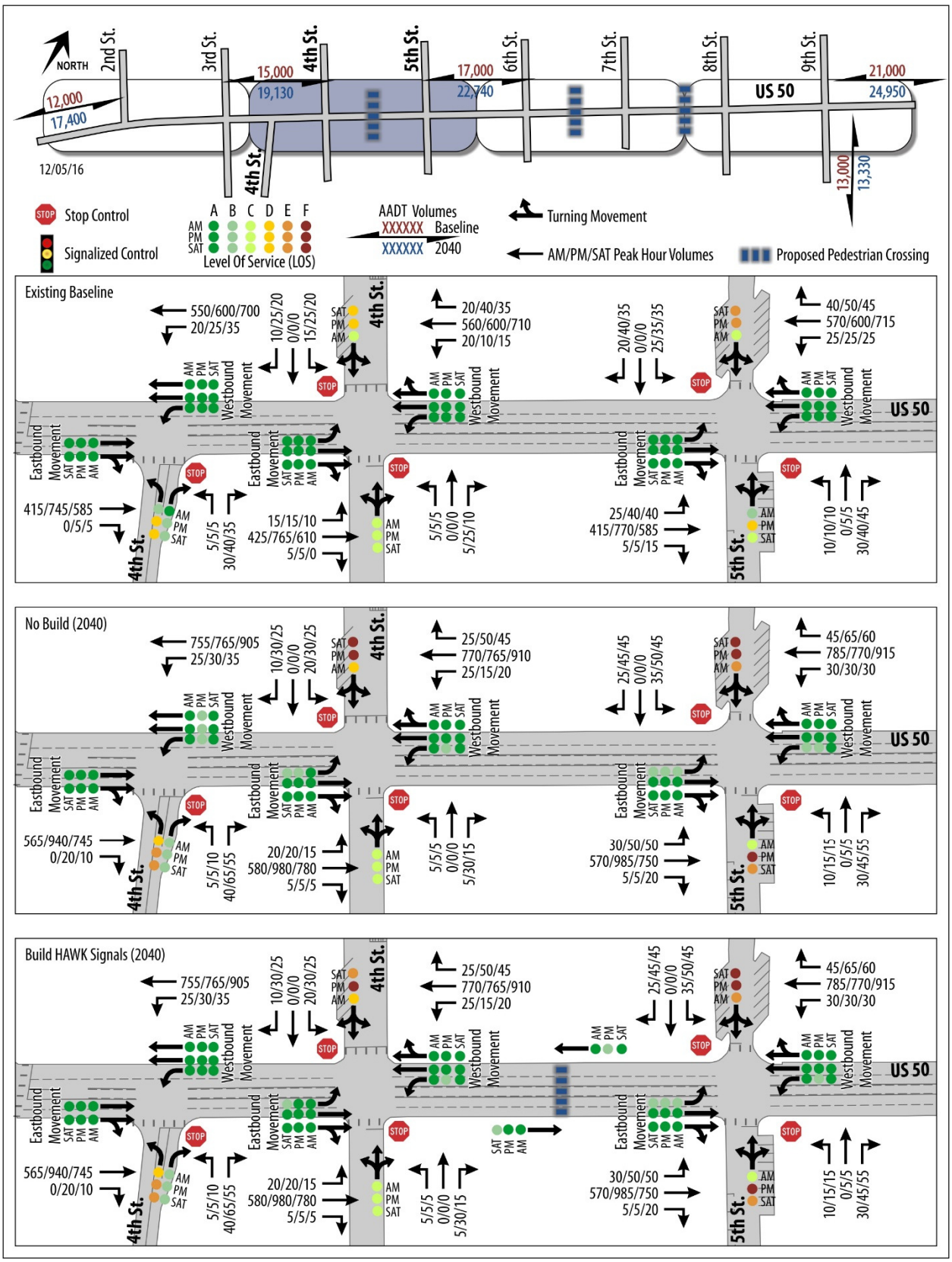


Figure 3-5. US 50 Traffic Volumes and Levels of Service—4th Street and 5th Street

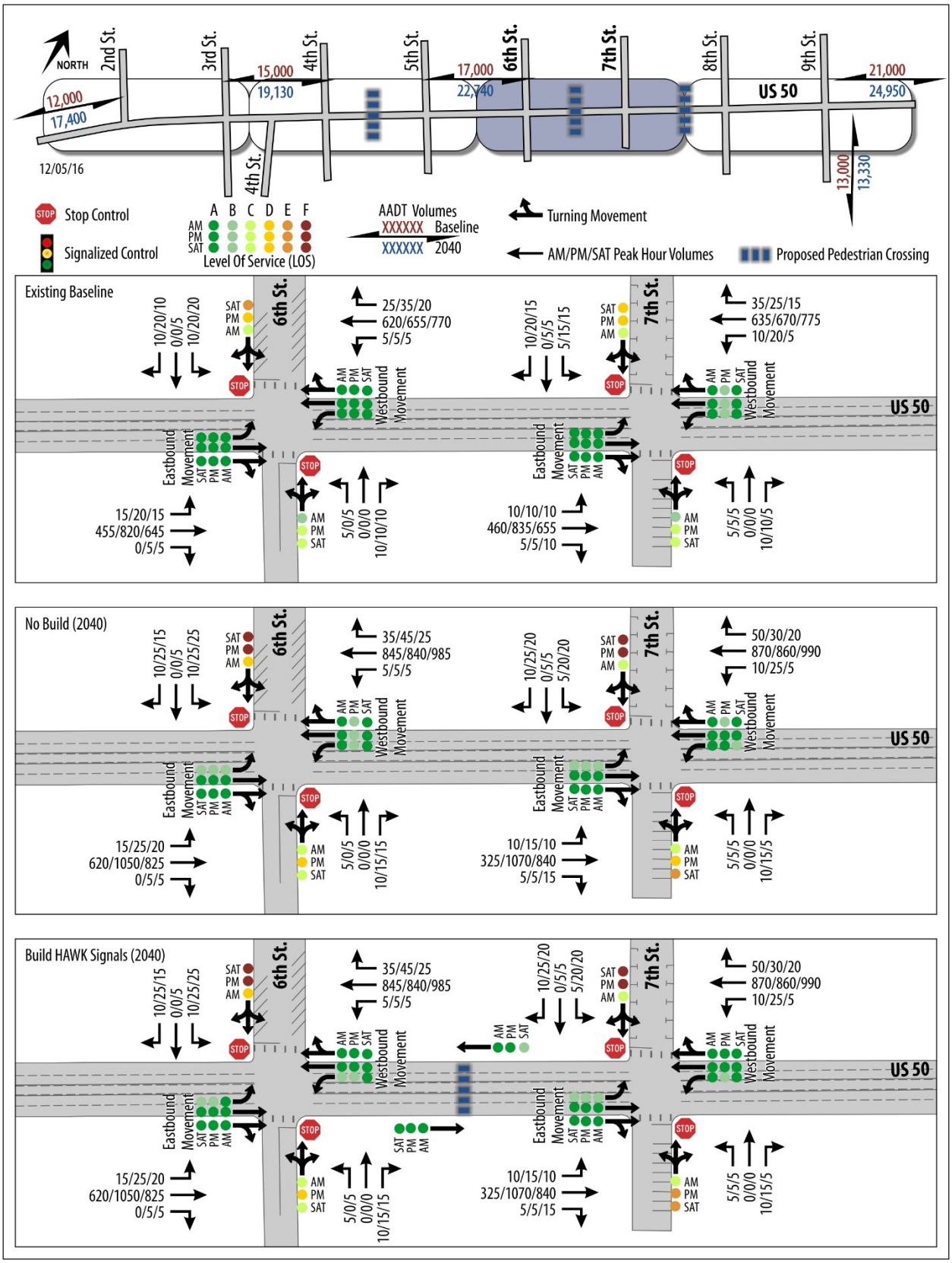


Figure 3-6. US 50 Traffic Volumes and Levels of Service—6th Street and 7th Street

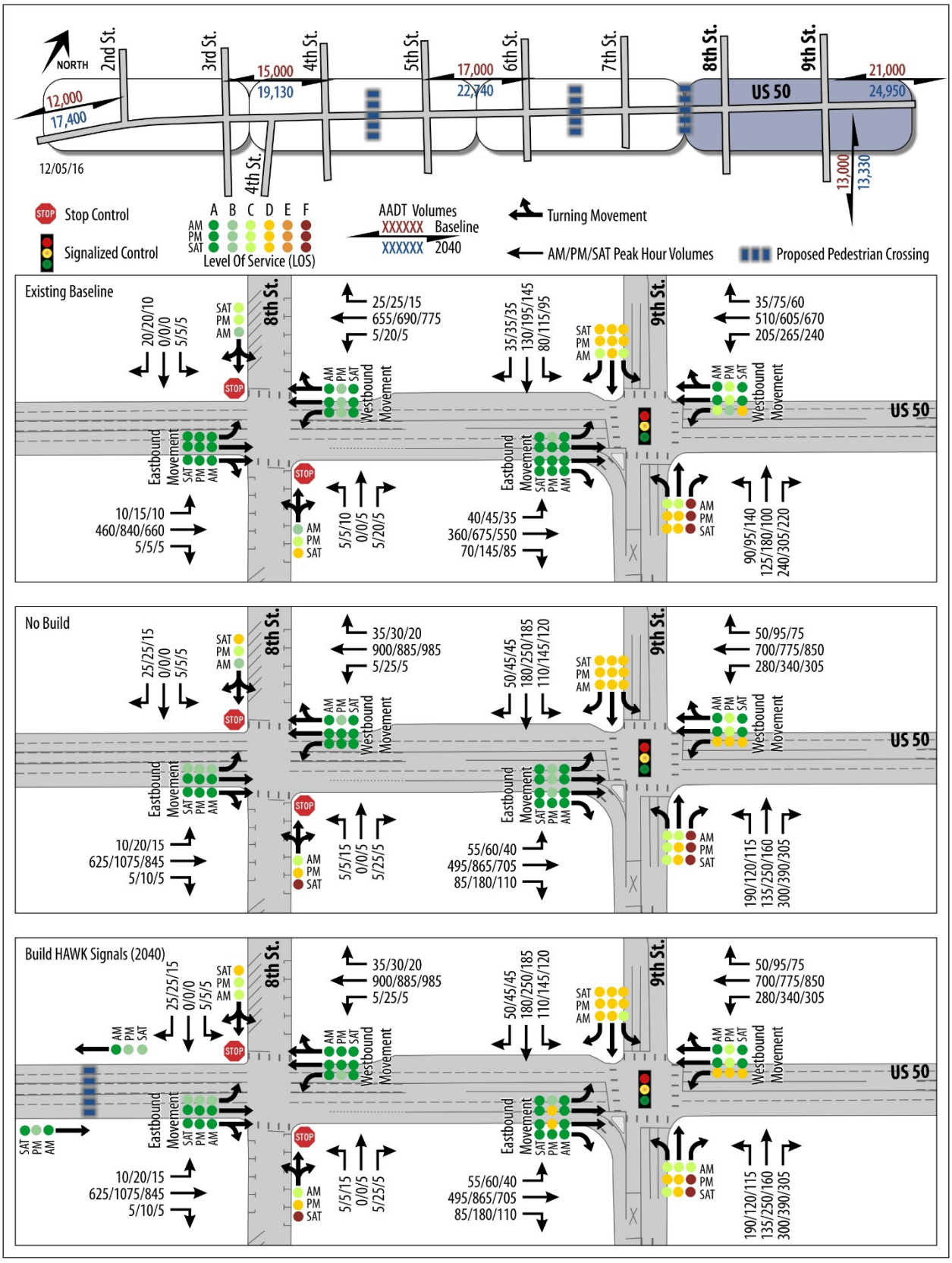


Figure 3-7. US 50 Traffic Volumes and Levels of Service—8th Street and 9th Street

Pedestrian Crossing Options

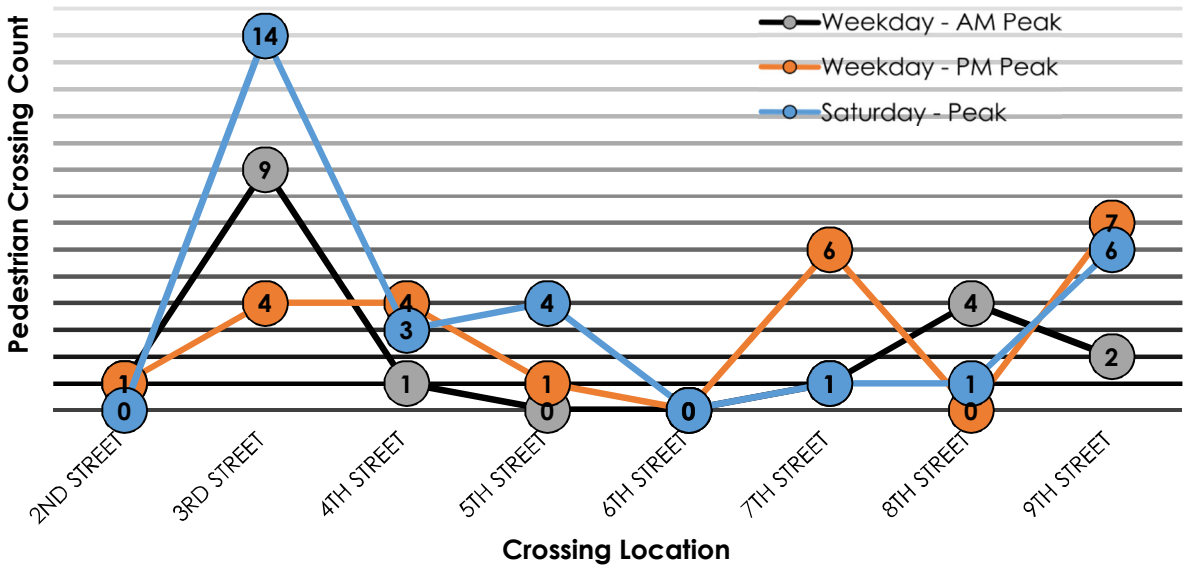
Determining Placement and Types of At-Grade Crossings

Pedestrian Crossing Demand

The highest observed levels of pedestrian crossings of US 50 in the study area are associated with the signalized intersections at Third Street and Ninth Street. However, significant crossing demand levels are observed throughout the six-block-long corridor, including crossings at unsignalized and midblock locations. Further, as shown in **Figure 3-8** below, weekend and weekday demand levels are similar, with moderate weekend peaking at Third Street. These findings point to the need to provide enhanced, safe crossing opportunities throughout the corridor.

At-Grade Crossing Locations

Between the existing signalized intersections on US 50 at Third Street and Ninth Street, which afford pedestrian crossing opportunities, there is a distance of six blocks. Rather than place a standard painted crosswalk at each unsignalized intersection, the project team considered the possibility of establishing enhanced pedestrian crossings at two or three locations. Current pedestrian crossing patterns and demand levels, as well as existing and future connectivity needs, were considered in the identification of optimal enhanced crossing locations. Both at-intersection and midblock locations were considered. Greater emphasis was placed on the eastern end of the corridor given the identification of potential to develop Phase 2 grade-separated crossings at Second Street and/or Fourth Street.



Note: Count data was collected on August 4, 2016, and August 6, 2016, by All Traffic Data; raw data and summaries are included in Appendix 3-1.

Figure 3.8. Peak Hour Pedestrian Crossing Counts by Intersection

Lands Use and Connectivity Considerations
As shown by **Figure 3-9**, a project area site analysis identified seven existing points of interest on the north side of US 50. Two parks, a regional multiuse trail, the Royal Gorge Museum and History Center, the Royal Gorge Railroad Depot, and river edge uses (e.g., rafting portages) were identified as points of interest on the south side of US 50. Relevant planning studies further identified pedestrian routes across US 50/Royal Gorge Boulevard at Third Street, Fifth Street, Sixth, Seventh and Ninth Streets. Defined existing and planned bicycle and pedestrian loop routes additionally utilize US 50 crossings at Second Street, on Third Street, on the viaduct at Fourth Street, and on Ninth Street. Redevelopment of the riverfront area is also contemplated (*Draft Arkansas River Central Corridor Plan*, 2016); planned features include: a "primary gateway" at the reconfigured First Street intersection; a "visitor arrival" area in Veterans Park, between First Street and Second Street; and an overpass at Third Street. Intersection pedestrian crossing counts were collected in late August 2016. The count data identified weekday crossing volumes that were highest in the morning at Third Street and Eighth Street, and highest in the afternoon at Seventh Street and Ninth Street, with significant afternoon crossing demand at Third and Fourth Streets. Weekend crossing counts were highest at Third Street, with significant demand at Fourth Street, Fifth Street and Ninth Street. Midblock crossing is also significant throughout the corridor, pointing to demand that is higher than the counts show.

Access Considerations
Existing driveway access along the project corridor is depicted by **Figure 3-10**. There are a large number of driveway accesses, and some changes in access may be necessary. Introducing medians will limit right-in and right-out driveway access; this impact may be corridor-wide or limited to spot locations at which small pedestrian refuge medians are implemented. A Fourth Street–Fifth Street midblock crossing pedestrian refuge median would have no impact on driveway access within that block. However, driveway accesses coincident with a Sixth Street–Seventh Street or a Seventh Street–Eighth Street midblock crossing would be limited to right-in and right-out access only; however, alley access to all affected parcels would provide alternative left-turn routing.

Crossing Location Recommendations
Based on access, current demand patterns, and land use connectivity considerations, the three preferred midblock crosswalk locations would be between Fourth and Fifth Streets, Sixth and Seventh Streets, and Seventh and Eighth Streets. Concept D and Concept E feature a roadway configuration with crosswalks that cut through a center median. For four-lane, narrowed configurations, such as Concept B and Concept C, shortened crossing distances may offset the need for pedestrian crossing refuge areas. Where a center two-way turn lane is retained, as in Concept A, small-scale raised medians could be built at the crosswalk to provide midblock pedestrian crossing refuge areas.

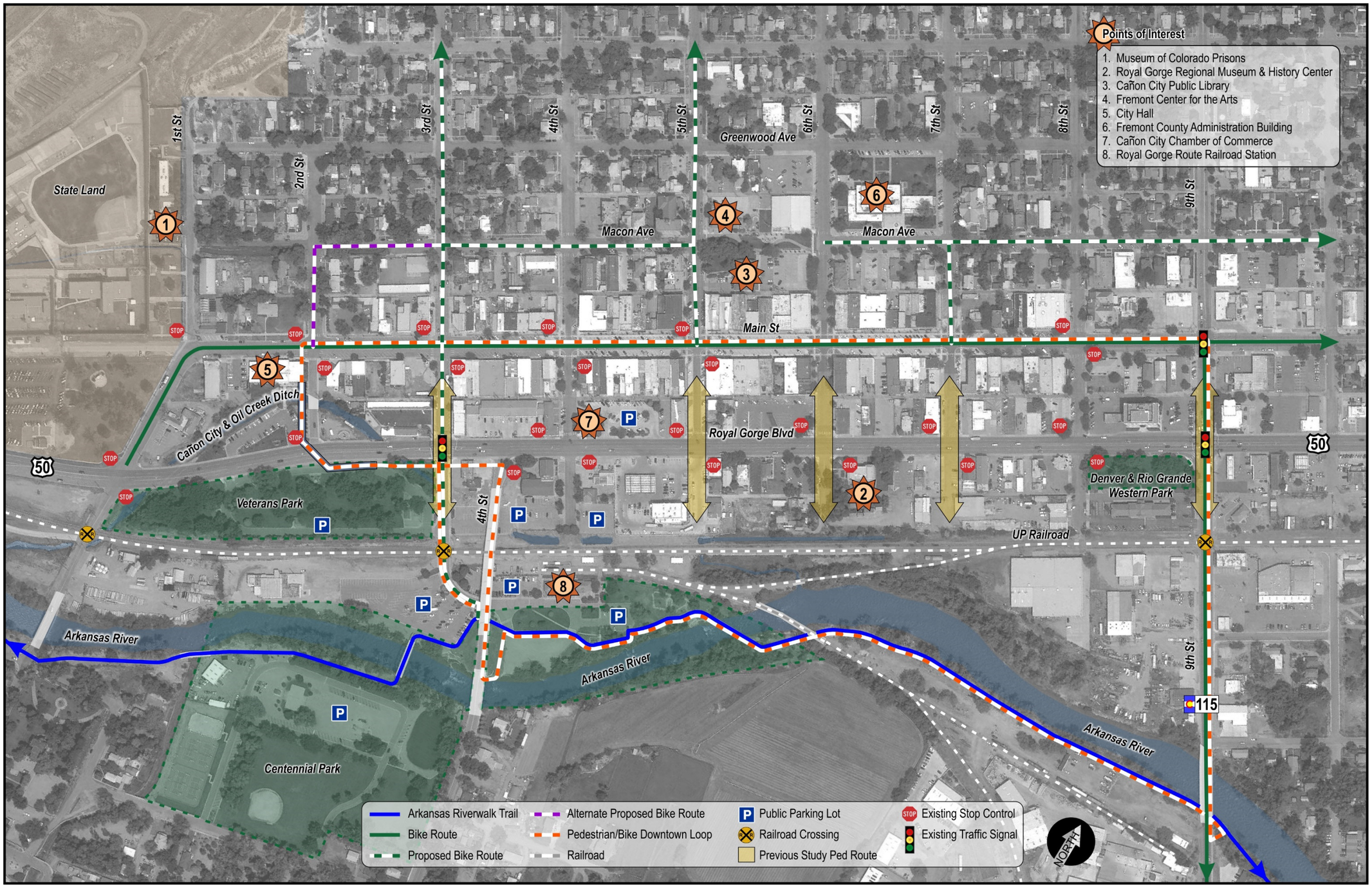


Figure 3-9. Project Area Site Analysis

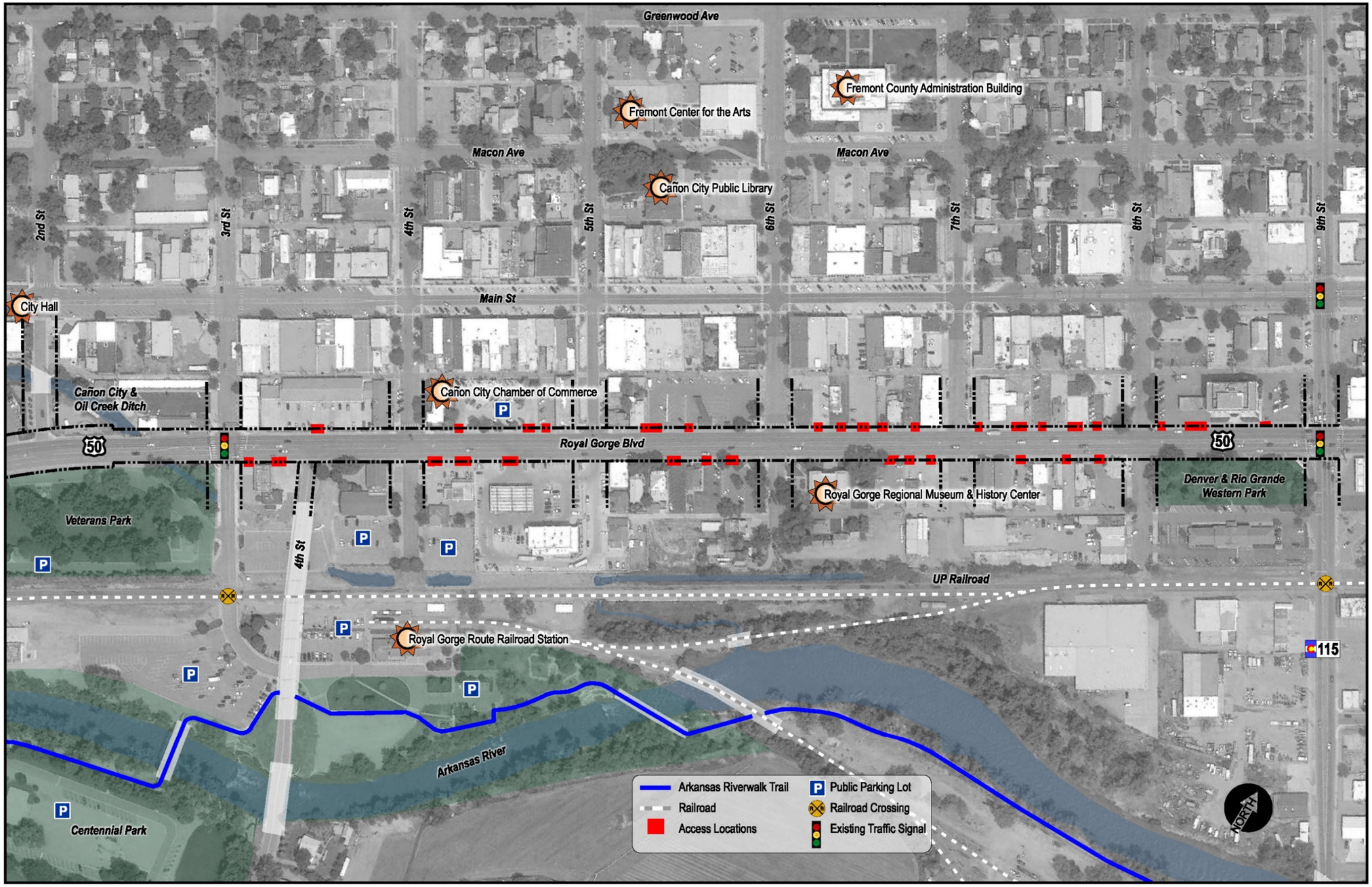


Figure 3-10. US 50/Royal Gorge Boulevard Driveway Access Locations

At-Grade Crossing Types

Crosswalks are present at all signalized intersections and both unsignalized and signalized crosswalks may exist at midblock locations as well. Drivers often fail to yield the right-of-way in marked crosswalks at unsignalized locations. Two types of pedestrian-actuated crosswalk technologies were considered: RRFB and HAWK signals.

Flashing Beacon Equipped Crosswalks

RRFBs have been shown to enhance yielding by vehicles at multilane uncontrolled crosswalks. They serve as visible reminders to motorists to yield to pedestrians in the crosswalk. A basic example of an RRFB application is depicted in **Figure 3-11**. Alternatively, **Figure 3-12** shows a two-stage RRFB crossing, which has a median refuge island and a path offset that forces the pedestrian to look in the direction of oncoming traffic before continuing to cross. In this example, the person wishing to cross the street pushes the button on the sign pole (pedestrian actuation) and waits for the warning lights to start flashing. The warning lights are at either side of the roadway, on the same poles. There is a painted, striped crosswalk.

Figure 3-11. RRFB Crosswalk

Figure 3-12. Two-Stage RRFB Crosswalk with Median Refuge Area

HAWK Signalized Crosswalks

A second type of pedestrian-actuated crossing technology, a HAWK, is shown in **Figure 3-13**. In this example, as in the two RRFB examples, the HAWK signal is actuated by the pedestrian pushing the button on the pole, although video detection of pedestrian presence could also be used. Distinct from the RRFB system, the HAWK system employs overhead stop signals for each lane and each direction of traffic. Due in part to the cost of additional signals, the overhead mast arms, and stronger poles, HAWK signals are more expensive than the RRFB alternative. However, national studies suggest that the rate of driver compliance is much higher for the HAWK than for the RRFB, so the additional expense does yield improved safety.

Figure 3-14 depicts a HAWK application with a median refuge area.

Figure 3-13. Example of a HAWK Beacon

Figure 3-14. Example of a HAWK Beacon with Median Refuge Area

Crossing Type Selection Criteria

The overarching goal of this study and design project is the identification and implementation of pedestrian crossing improvements along the US 50 project corridor to improve safety and enhance connectivity to the historic downtown. At previously noted, at-grade, midblock options include: pedestrian signals, HAWK signals, RRFBs, and unsignalized midblock crosswalks.

National standards are clear regarding warrants for installation of traditional pedestrian signals, which may be considered for application at high-volume pedestrian crossings based on engineering judgment. The *Manual on Uniform Traffic Control Devices* (*MUTCD*) contains warranting procedures for conventional pedestrian traffic signals based on vehicle traffic volumes to help determine if a pedestrian signal is appropriate. These signals are typically considered when there are over 130 pedestrians an hour crossing a roadway. Current and anticipated US 50 pedestrian crossing volumes do not meet the minimum threshold. National standards provide less clear guidance for the installation of alternative marked crosswalks and treatments such HAWK beacons and RRFB applications, particularly at midblock locations.

MUTCD warranting guidelines for HAWK beacons utilize automobile traffic, pedestrian traffic, automobile speeds, and pedestrian crossing distance. Per the guidance, HAWK beacons may be installed where the crossing volume is as low as 20 pedestrians per hour, depending on the crossing distance, automobile traffic volume, and engineering judgment.[1]

The decision nomograph, as shown below in **Figure 3-15**, was developed by the City of Boulder based on the *MUTCD* and FHWA guidance.

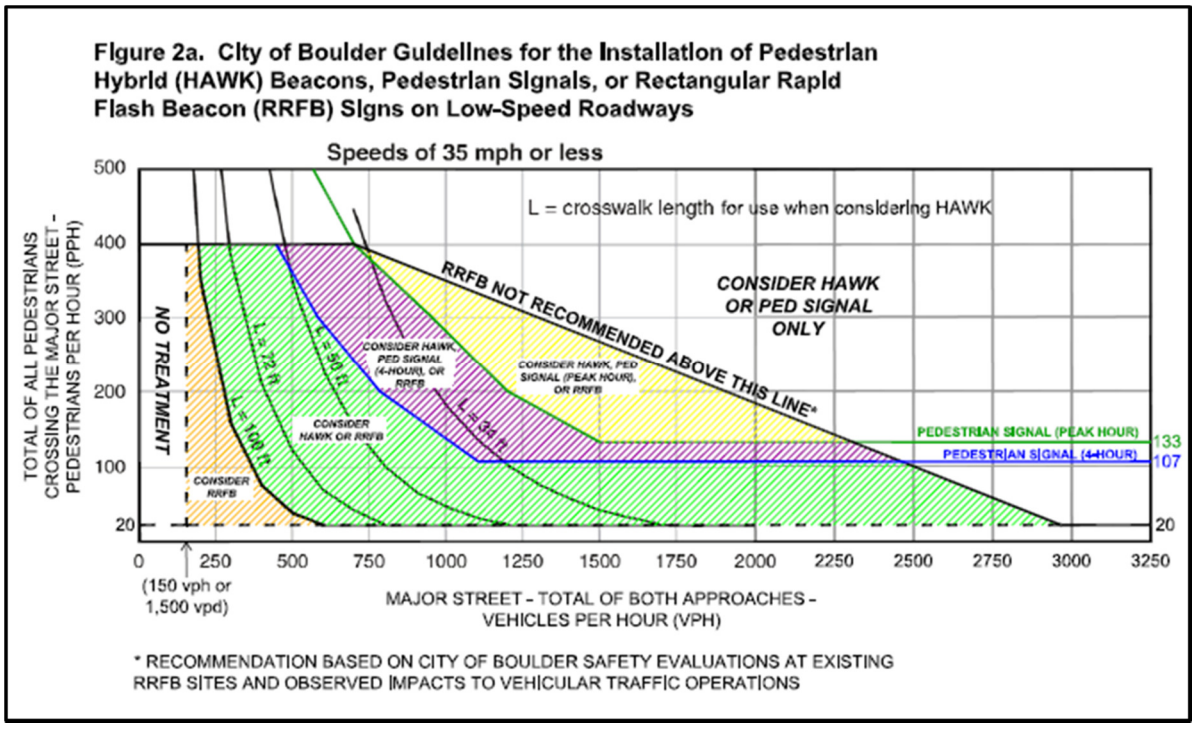


Figure 3-15. Low Volume Road HAWK and RRFB Crosswalk Control Installation Guidelines

[1] USDOT, FHWA, *Manual on Uniform Traffic Control Devices* (2009), 510, fig. 4F-1, https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part4.pdf.

The nomograph chart and the *City of Boulder Pedestrian Crossing Treatment Installation Guidelines* in which it is published,[2] provide useful references that could be used to select the appropriate crossing type(s) to be used by Cañon City on US 50/Royal Gorge Boulevard. Information required to apply these tools and guidance includes: posted speed, length of the crossing, hourly vehicular traffic volume, and hourly pedestrian crossing volume.

The US 50 project corridor posted speed is 30 mph and the combined eastbound and westbound hourly traffic volume exceeds 1,000 vehicles per hour for 11 hours of a typical weekday. The current peak hour number of pedestrians crossing US 50, a crossing distance of 73 feet, is 20 to 30 pedestrians per hour, a number that is likely depressed due to the difficultly and length of the crossing. Although the US 50 pedestrian crossing volume falls far below the 130 crossing per hour threshold for a traditional pedestrian signal, this level of pedestrian activity, together with length of crossing and volume of vehicular traffic, places the project corridor within the minimum threshold for either the RRFB or the HAWK beacon-controlled pedestrian crossing options.

Signal Progression and Traffic Operational Considerations

Installation of RRFBs, HAWK beacons, or pedestrian traffic signals can all have a significant impact on the automobile traffic operation in a corridor. The automobile and pedestrian crossing volumes, the spacing to the adjacent signalized intersections, the type of pedestrian population (elementary students, elderly, secondary and college students, tourists, locals, people with disabilities) should all be considered when selecting the crossing treatment type and how it will be operated. Where practical, HAWK beacons and pedestrian traffic signals should be coordinated with the signal progression in the corridor to minimize the impact of the new traffic signal on corridor traffic flow. However, coordinated signals may be less responsive to pedestrian actuation, and the delay in pedestrian service may result in some pedestrians crossing against the signal rather than waiting. Not coordinating the pedestrian crossing signals may result in unacceptable increases in automobile congestion and delay.

Effects of Differential Queue Lengths on Pedestrian Safety

A pedestrian crossing of a roadway with two or more lanes in a single direction has the potential for "multiple-threat" accidents. A multiple-threat accident is when one lane of traffic stops for a pedestrian and obscures the view of the crossing pedestrian to a motorist in the adjacent travel lane. In this case, there is potential for a pedestrian to step in front of a vehicle that is approaching too fast to stop. If the queue in one lane backs into the crossing and is much longer than the queue in the adjacent lane, a motorist would commonly assume that the stopped traffic in one lane is the result of the queuing. If a vehicle in one lane stops for a pedestrian, instead of the queue, there is an even greater chance for a multiple-threat accident. It is important for the engineer to be aware of the formation of queues to and across the pedestrian crossing from a downstream intersection, as well as routine occurrences of one queue being longer than the other. Either condition may weigh against the appropriateness of implementation of midblock crosswalks, particularly when unsignalized or with RRFB warning type control.

Median Pedestrian Refuge Areas

Median pedestrian refuge areas are useful in increasing the safety and efficiency of a pedestrian crossing. The presence or absence of a median refuge influences the type of

[2] City of Boulder Transportation Division, *City of Boulder Pedestrian Crossing Treatment Installation Guidelines* (November 2011), https://www-static.bouldercolorado.gov/docs/pedestrian-crossing-treamtment-installation-guidelines-1-201307011719.pdf.

pedestrian crossing treatment that can be considered. In this context a pedestrian refuge median is defined as a location in the middle of a pedestrian crossing where a pedestrian can take refuge, thereby separating their crossing into two steps, across each direction of approaching traffic separately. Separating the crossing into two directional crossings greatly increases the number of acceptable gaps for pedestrians to safely cross a roadway.

The City of Boulder provides the following specific guidance with respect to median refuge areas:

- A painted center median or painted turn lane cannot be considered a pedestrian refuge; greater hazard than no median.
- A raised median nose at an intersection can only be considered a pedestrian refuge for the adjacent crosswalk if the median is at least 4 feet wide AND the left turn volume is less than 20 vehicles per hour.
- A raised median at a mid-block pedestrian crossing can only be considered as a refuge if it is at least 6 feet wide (preferably 8 feet wide) and includes curb ramps or a walkway at grade through the median.[3]

HAWK Beacon versus RRFB Cost Considerations

The unit cost for a HAWK beacon installation is approximately $25,000 per system, with full crosswalk installation costs ranging from $21,440 to $128,000 and an average cost of $58,000 per crossing.

The unit cost for an RRFB is less than that for a HAWK beacon installation. A minimum of two RRFB sets are required for each crosswalk installation, one on either side of the crossing, a quantity that would typically be doubled for a phased or median configured crossing. The cost per set is $12,000. Compliance can also be improved with additional, relatively low-cost advance signage.

Additional At-Grade Improvements to Consider

Streetscaping bump-outs have been recommended for Sixth, Seventh and Eighth Streets for all alternatives. The bump-outs are designed for two-way traffic, accommodating diagonal on-street parking. The jagged curb and gutter geometry shown at the cross-street intersections in **Figure 2-4**, **Figure 2-6**, **Figure 2-8**, **Figure 2-10** and **Figure 2-12** accommodates southbound parking while the smoother curb and gutter geometry on the right side accommodates northbound parking.

The cost for additional at-grade improvements would be variable, with lowest costs associated with alternative Concept RD-A (**Figure 2-4**), Concept RD-D (**Figure 2-10**), and Concept RD-E (**Figure 2-12**), each of which would maintain the existing curb lines thus avoiding costly roadway reconstruction.

CDOT's Safety Analysis supports Concept RD-E shown in **Figure 2-12**. Concept RD-E includes converting Sixth Street and Eighth Street to a pair of one-way streets, leaving Seventh Street unchanged between them. This would result in different bump-outs for each street—both sides smooth for northbound Sixth Street and both sides jagged for southbound Eighth Street.

[3] Ibid., 9-10.

SAFETY ANALYSIS

Five-Year Crash History (2011–2015)

Recent, five-year crash data (2011–2015) for the US 50 corridor within Cañon City was used by CDOT to conduct a safety analysis for the project corridor. There were a total of 169 reported crashes during this five-year period. There were 133 Property Damage Only (PDO) crashes, which accounted for the majority of total crashes. Of the remaining 36 crashes, 8 involved pedestrians. Six of the crashes, including 1 of the 8 pedestrian-involved crashes, involved impairment (alcohol or drugs) of either the driver or the pedestrian. Fortunately, perhaps due to the 30 mph posted speed limit within the corridor, associated injuries with both vehicular and pedestrian-involved crashes were reported as unknown/not reported (meaning not apparent) or minor.

A summary of crashes by year and severity is provided as **Table 3-8**, below. **Figure 3-16**, **Figure 3-17**, **Figure 3-18,** and **Figure 3-19**, below, provide additional detail. The full safety study, with additional detail, is included in **Appendix 3-3**.

Table 3-8. Crash History (2011–2015) from US 50 Milepost 278.00 to Milepost 278.80

Year	PDO Crashes	Injury Crashes	Injuries	Fatal Crashes	Fatalities	Total
1/11-12-11	21	5	6	0	0	26
1/12-12/12	30	5	5	0	0	35
1/13-12/13	21	10	11	0	0	31
1/14-12-14	31	10	14	0	0	41
1/15-12-15	30	6	8	0	0	36
Total	133	36	44	0	0	169
Average/Year	26.6	7.2	8.8	0	0	33.8

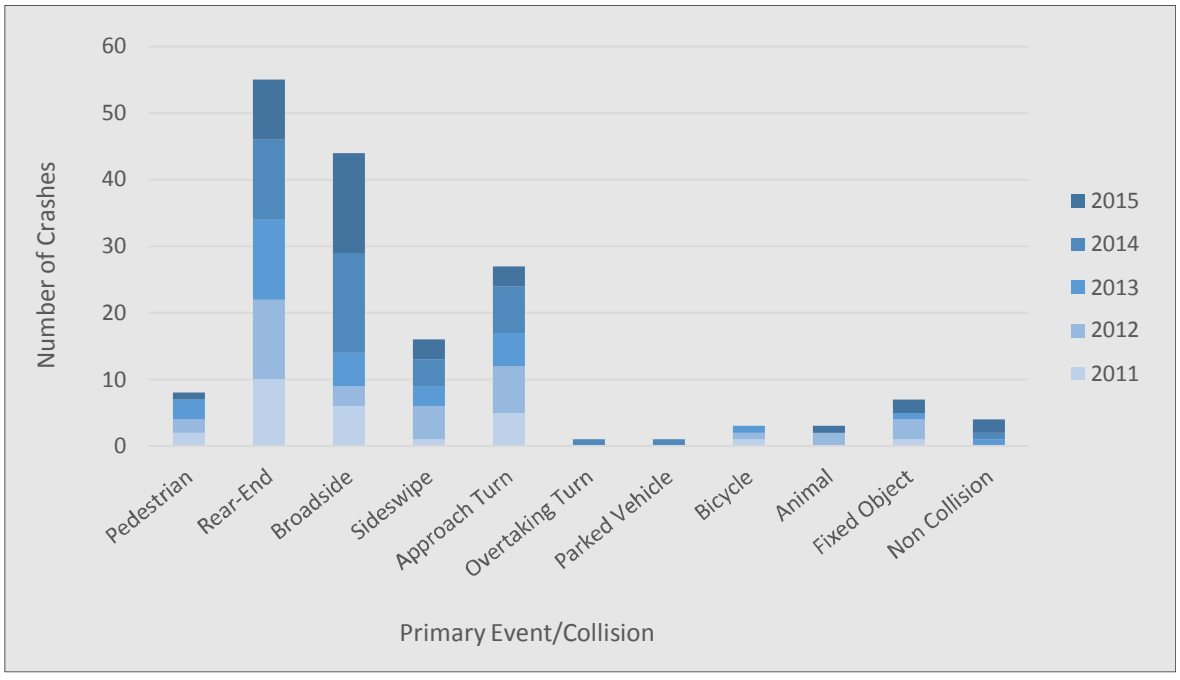


Figure 3-16. Five-Year Crash History (2011–2015)—Crashes by Primary Event

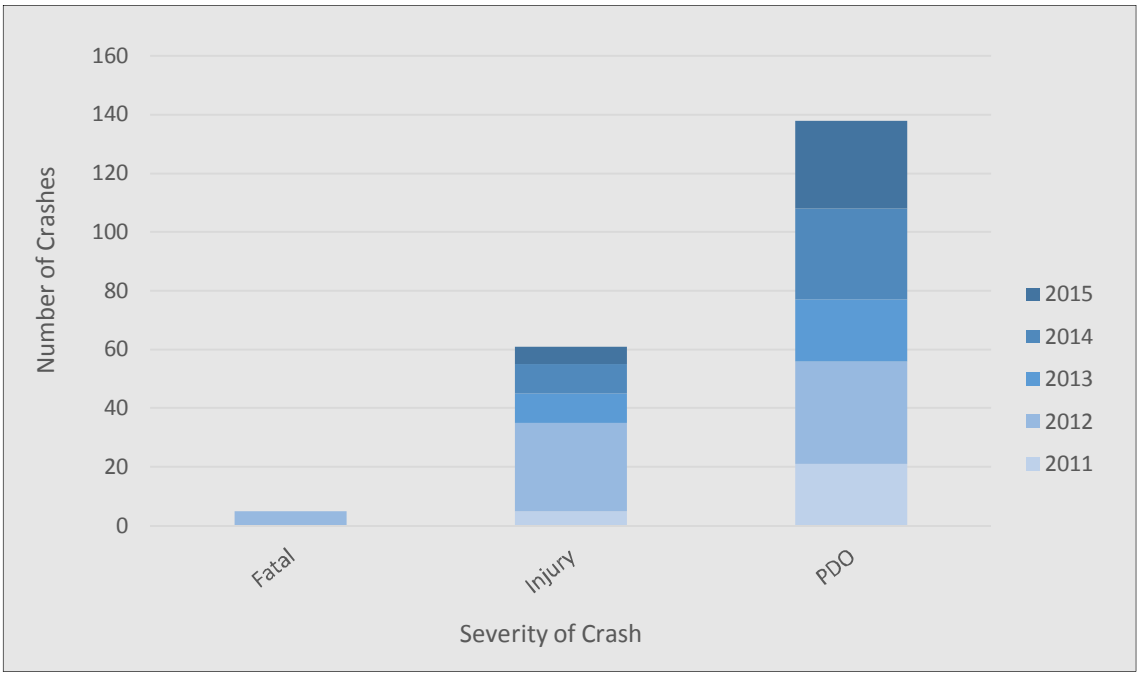


Figure 3-17. Five-Year Crash History (2011–2015)—Crashes by Severity

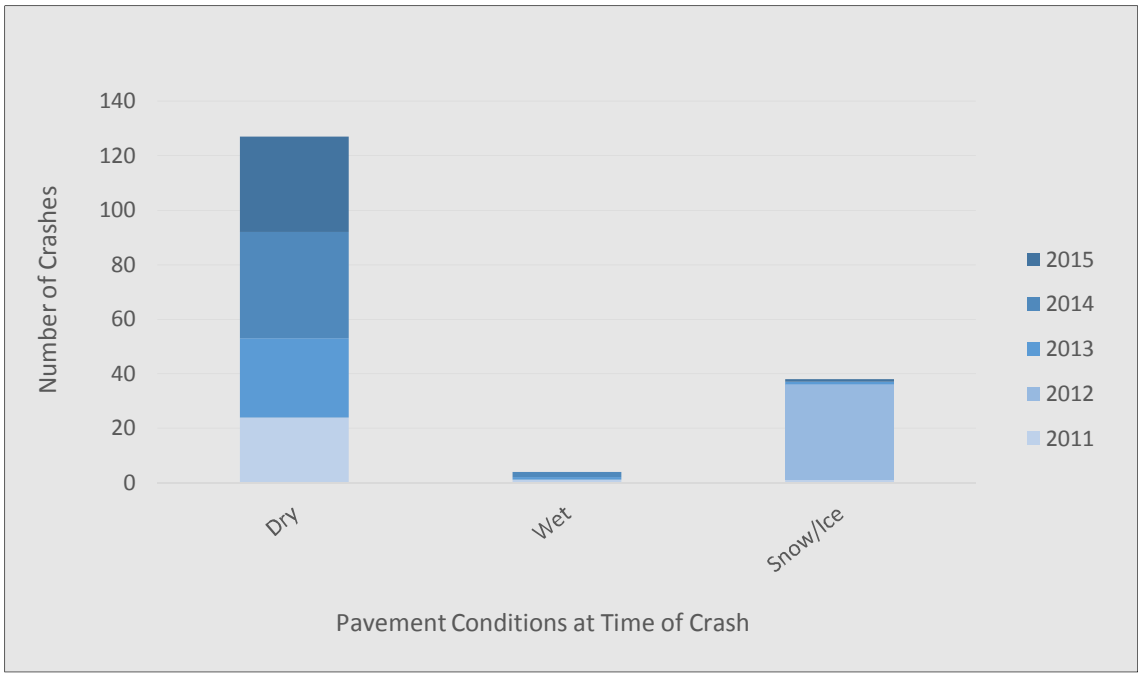


Figure 3-18. Five-Year Crash History (2011–2015)—Crashes by Pavement Condition

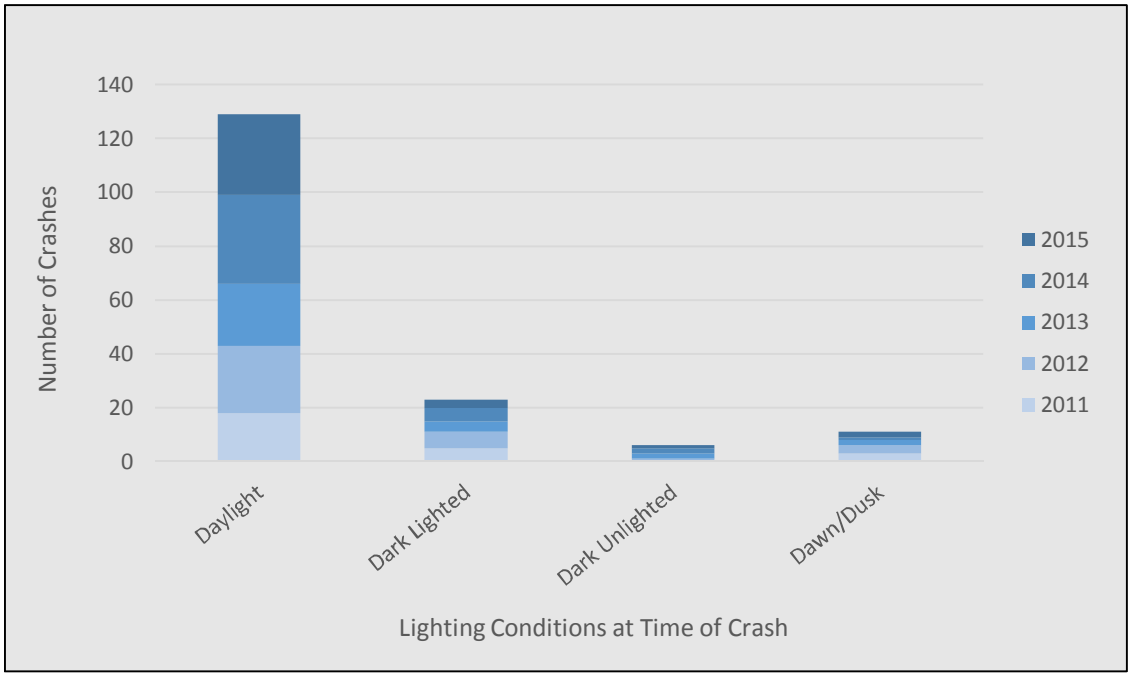


Figure 3-19. Five-Year Crash History (2011–2015)—Crashes by Lighting Condition

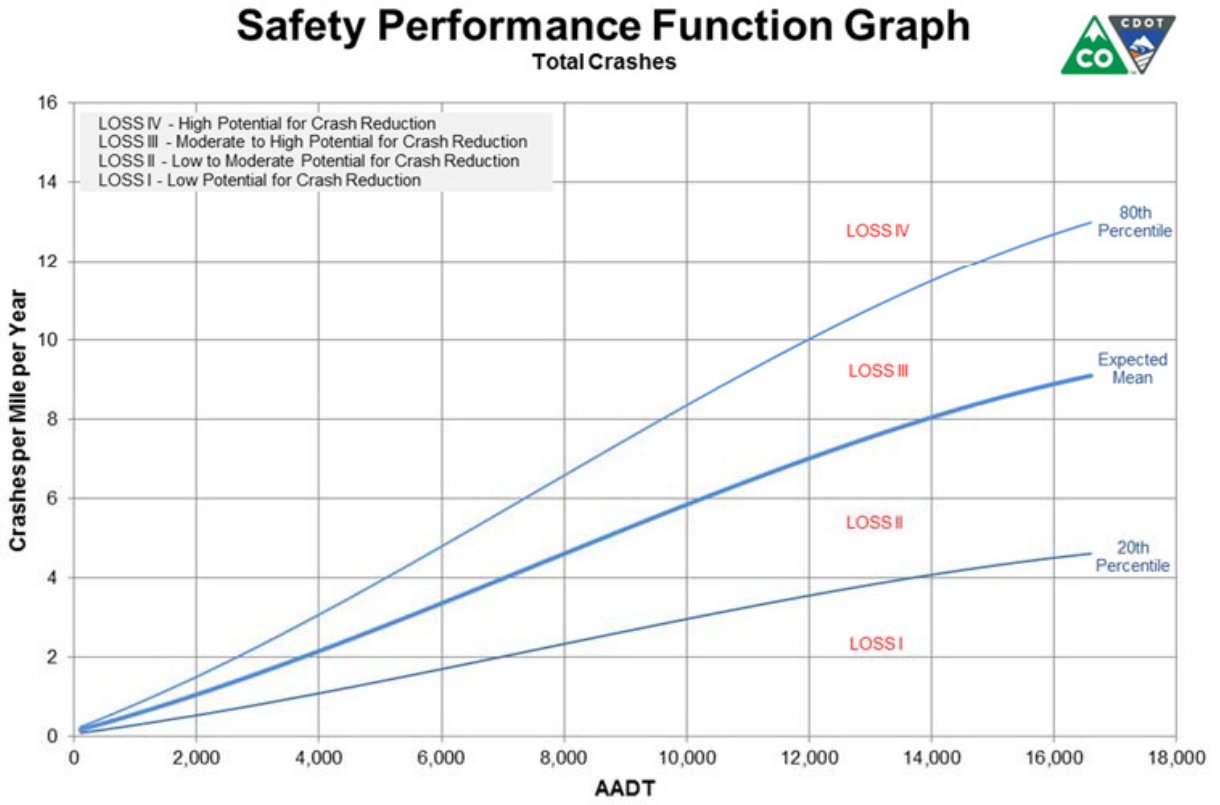
Safety Performance

CDOT has refined assessment of safety problems through the use of Safety Performance Functions (SPFs). The SPF metric recognizes the complex relationship between traffic exposures, expressed as ADT, and crash counts measured in accidents per year. The SPF model provides an estimate of the normal or expected accident frequency and severity for a range of ADT usage level among similar facilities.

The SPF metric forms the basis for calculation of a Level of Service of Safety (LOSS), a key metric used by CDOT for the safety analysis. The concept of LOSS uses qualitative measures that characterize safety of an intersection in relation to its expected performance. If the level of safety predicted by the SPF represents a normal or expected number of accidents at a specific level of ADT, selected percentiles within the frequency distribution can be stratified to represent specific levels of safety as follow:

- LOSS I—Below 20th Percentile
  LOSS I indicates a low potential for crash reduction.
- LOSS II—20th Percentile to Mean
  LOSS II indicates a low to moderate potential for crash reduction.
- LOSS III—Mean to 80th Percentile
  LOSS III indicates a moderate to high potential for crash reduction.
- LOSS IV—Above 80th Percentile
  LOSS IV indicates a high potential for crash reductions.

Figure 3-20 illustrates the LOSS concept.



Source: Colorado Department of Transportation Safety and Traffic Engineering Branch
Note: APMPY=Accidents Per Mile Per Year

Figure 3-20. CDOT Safety Performance Function Graph

Intersection Collision Analysis

Roads intersecting with the US 50 project corridor were examined and reviewed using the SPF analysis. Crashes that can be attributed to intersections accounted for 74 percent (125 of 169) of all those observed on US 50 between MP 278.00 and MP 278.80. **Table 3-9**, below, provides the crash history and LOSS (total and injury/fatality) by location for the intersections that experienced crashes. Those intersections that did not experience crashes within the study period are assumed to have a LOSS I with a low potential for crash reduction. CDOT crash pattern analysis recommends continuing review of the Sixth Street location and potential conversion to right-in/right-out operation.

Pedestrian Analysis

Pedestrian crashes accounted for 5 percent (8 of 169) of all crashes observed on the US 50 project corridor, with 7 of the 8 crashes resulting in injury. None of the crashes took place in the same location. A breakdown of pedestrian crash experience showed that lighting, or lack thereof, was only a contributing factor in 1 of the crashes. Crashes involving pedestrians crossing the highway (rather than the side street) occurred between the existing signals at Third Street and Ninth Street. The half-mile spacing between these controlled locations may be too long to adequately serve pedestrian crossing needs. However, because the pedestrian crashes were not concentrated at any particular location, the data is inconclusive with regard to identifying the most promising locations for improved pedestrian crossing treatments.[4]

Table 3-9. Crash History (2011–2015)—Intersection Collisions by Location

MP	Description	Number of Crashes				LOSS (Total)	LOSS (Inj + Fat)
		Property Damage Only	Injury Crashes	Fatal Crashes	Total		
278.02	1st Street	3	2	0	5	II	II
278.10	2nd Street	0	1	0	1	II	II
278.22	3rd Street	4	2	0	6	II	II
278.25	W 4th Street	6	1	0	7	III	II
278.28	E 4th Street	2	2	0	4	II	II
278.38	5th Street	8	1	0	9	II	II
278.46	6th Street	5	2	0	7	II	II
278.54	7th Street	2	2	0	4	II	II
278.62	8th Street	4	3	0	7	II	II
278.70	9th Street	57	10	0	67	IV	II
278.79	10th Street	5	1	0	6	II	I

[4] SH-50A: MP 278.00 to MP 278.80 Safety Improvement Project, January 2017; CDOT Safety and Traffic Engineering Branch

At-Grade Crossing Safety Performance

Uncontrolled Multilane Crosswalk

Colorado law is specific in safeguarding the rights of pedestrians. Red-and-yellow signs spell it out: "STATE LAW – YIELD to pedestrians in crosswalk." However, driver compliance with the law in the absence of signalized (pedestrian phase at signalized intersections or HAWK beacons at midblock crosswalks) enhanced warning (RRFB) control is low, with a 17-percent level reported by Loveland, Colorado.

Rectangular Rapid Flashing Beacon

Rectangular RRFBs are less effective than pedestrian signals and midblock HAWK beacon applications. National compliance with RRFB applications averages 41 percent and can be enhanced with advance signage. Compliance varies by functional class and speed limit, but it can be expected to be at the high end on the US 50 project corridor with a relatively low, 30-mph posted speed limit within a commercial setting adjacent to the Central Business District.

High-Intensity Activated Crosswalk

Studies show 90-percent driver compliance at HAWK beacon-controlled crosswalks. Before and after studies show significant reduction in pedestrian-involved crashes as well; a 69% reduction was reported by Tucson, Arizona. Durango, Colorado's, application (US 550/Camino Del Rio) also increases pedestrian activity and crossing, an outcome desired by Cañon City.

Grade-Separated Crossing Safety Performance

Pedestrian Overpasses

An overpass offers full separation of pedestrian and vehicular traffic. From a security perspective, the design should incorporate barriers to prevent objects from falling on the roadway. A downside from a safety perspective is that the overpass will only be used if it makes the desired connection; pedestrians will still cross at other, non-separated locations.

Pedestrian Underpasses

Like overpasses, underpasses offer full separation of pedestrian and vehicular traffic. Security may be an issue due to "hidden" nature, and lighting and openness are critical to counteract this potential risk. A downside from a safety perspective, like with the overpass, is that the underpass will only be used if it makes the desired connection; pedestrians will still cross at other, non-separated locations.

LIST OF ACRONYMS AND DEFINITIONS

Average Daily Traffic (ADT)
The amount of vehicular traffic that crosses an imaginary line across a roadway in a 24-hour period. ADT information typically includes both directions of vehicle travel (if on a two-way street).

Controlled Pedestrian Crossing
A pedestrian crossing where motorists are required to stop by either a stop sign or traffic signal (including a HAWK beacon).

Crosswalk Lighting
Street lighting applied at a pedestrian crossing to help approaching motorists see a crossing pedestrian. Crosswalk lighting is at a "vehicular scale" like normal street lighting rather than a "pedestrian scale" that is often used along a sidewalk.

Curb Bump-Outs / Extensions / Neckdowns
A roadway edge treatment where a curb line is bumped out toward the middle of the roadway to narrow the width of the street. Curb extensions are sometimes called "neckdowns" and are often used at the location of a pedestrian crosswalk to minimize the distance and time that a crossing pedestrian must be in the roadway.

Differential Vehicle Queuing
See also Vehicle Queue. A condition on a roadway with two or more travel lanes in a single direction where the line of stopped traffic in one travel lane is significantly longer than the line of stopped traffic in the adjacent travel lane. Differential vehicle queuing across a pedestrian crosswalk can cause a significant safety concern as it increases the potential for multiple-threat pedestrian accidents.

Gap in Traffic
A gap in traffic is the space between vehicles approaching the pedestrian crossing. Gaps are typically measured in seconds, not distance, as a pedestrian must be able to cross within the length of the gap in time. A directional gap is the gap between vehicles approaching in a single direction. A directional gap can be measured between vehicles in a single lane or between vehicles approaching in the same direction but in different lanes on a multilane approach. If there is no median refuge at the crossing, a pedestrian needs to find an acceptable gap in traffic approaching from two directions at once. This is much more challenging than finding a gap in each approach direction separately.

HAWK Beacon
A pedestrian hybrid beacon is a relatively new type of crossing treatment used to both warn and control traffic at a pedestrian crossing. It is actuated by a pedestrian push button and uses a combination of circular yellow and red traffic signal displays to first warn motorists of a pedestrian that is about to cross the street, then requires the motorist to stop for the pedestrian crossing, and then release the motorist to proceed once the pedestrian has cleared the crossing. The HAWK beacon is a hybrid between a pedestrian traffic signal and a stop sign.

Lane
A portion of the roadway surface designated for motor vehicle travel, typically in a single direction, that is delineated by pavement marking stripes. Types of lanes include: thru lanes for travel along the length of the roadway, often through intersections; turn lanes, which are typically on intersection approaches and provide space for left or right turning motorists; and bike lanes, which are designated for bicycle travel in the same direction as the automobile travel, are typically narrower than vehicle lanes, and are usually located along the outside edges of the roadway.

Marked Crosswalk
A pedestrian crossing that is delineated by white crosswalk pavement markings. Marked crosswalks typically also are delineated by a variety of traffic signs. Marked crosswalks also have curb ramps if there are curb and gutter in an area.

Median Refuge
An area in the middle of a roadway where a crossing pedestrian can take shelter from approaching traffic in either direction. In the context of these guidelines, the median refuge must include a raised median of some width. A median refuge allows a pedestrian to cross each direction of approaching traffic in a separate step. By using the refuge, the pedestrian must find an acceptable gap in traffic for only one approach direction at a time.

Minimum Pedestrian Volume Threshold
The minimum amount of pedestrian crossing traffic (typically in a one-hour period) that must be present to warrant the installation of a pedestrian crossing treatment.

Motorist Compliance Data
Observations made and recorded at a pedestrian crossing where it is determined if the approaching motorist complied with their legal requirement to yield to a crossing pedestrian who is in or about to enter the crosswalk.

Multiple-Threat Accidents
A type of pedestrian accident that occurs on a roadway with two or more lanes in the same direction. A motorist that stops for a crossing pedestrian can obscure the view of the pedestrian from another motorist approaching in the adjacent travel lane. If the second motorist does not slow down it creates the potential for a crossing pedestrian to step out in front of a high-speed approach vehicle with potentially dire consequences.

Multiuse Path Crossing
A location where a sidewalk designated as a multiuse path intersects a roadway at-grade, and the path extends on both sides of the roadway.

Pedestrian Traffic Signal
A conventional traffic signal with circular red, yellow, and green displays for motorists and Walk/Don't Walk signals for pedestrians that is applied at a pedestrian crossing. Typically, a pedestrian traffic signal is applied in a midblock location because it would be considered an ordinary intersection-related traffic signal if it were to be applied at an intersection.

Raised Median
An area in the middle of a roadway, commonly separating vehicles traveling in opposite directions, that is surrounded by curb and gutter and is physically raised above the surrounding pavement where vehicles travel. Raised medians often contain landscaped areas. See also Median Refuge.

Rectangular Rapid Flash Beacons (RRFBs)
RRFBs are small rectangular yellow flashing lights that are deployed with pedestrian crossing warning signs. They are typically actuated by a pedestrian push button and flash for a predetermined amount of time to allow a pedestrian to cross the roadway before going dark. RRFBs are warning devices and do not themselves create a legal requirement for a vehicle to stop when they are flashing.

School Crossing
A crossing location with appropriate signing where ten or more student pedestrians per hour cross.

Uncontrolled Pedestrian Crossing
An established pedestrian crossing that does not include a traffic signal, a HAWK beacon, or a stop sign that requires motor vehicles to stop before entering the crosswalk. For example, RRFBs are considered uncontrolled.

Vehicle Queue
A line of stopped vehicles in a single travel lane, commonly caused by traffic control at an intersection.

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