

# WestConnect Coalition Planning and Environmental Linkages (PEL) Study

## FINAL ALTERNATIVES REPORT

JANUARY 2018



WestConnect Coalition PEL



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AND ASSOCIATES INC.







WestConnect Coalition PEL

# WESTCONNECT COALITION

## PLANNING AND ENVIRONMENTAL LINKAGES (PEL) STUDY

**Final Alternatives Report**

**January 2018**

**Submitted to**



**COLORADO**  
Department of Transportation

Colorado Department of Transportation, Region 1

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WestConnect Coalition PEL

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# LIST OF ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
CDOT	Colorado Department of Transportation
CFI	Continuous flow intersection
Coalition	WestConnect Corridor Coalition
CO	Colorado State Highway (CO 58, CO 93, CO 170)
CPW	Colorado Parks and Wildlife
C-470	Colorado Highway 470
DEA	David Evans and Associates, Inc.
DG	Design Guide
DRCOG	Denver Regional Council of Governments
EB	Eastbound
E-X	Expressway access category
FHWA	Federal Highway Administration
ft	feet
F-W	Freeway facilities access category
ITS	Intelligent transportation system
JPPHA	Jefferson Parkway Public Highway Authority
LOS	Level of Service
LTS	Level of Traffic Stress
MOU	Memorandum of Understanding
MP	Milepost
MPH	Miles per hour
NB	Northbound
NEPA	National Environmental Policy Act
NWR	National Wildlife Refuge
OTIS	Online Transportation Information System
PEL	Planning and Environmental Linkages Study
PGDHS	A Policy on Geometric Design of Highways and Streets
PMJM	Preble meadow jumping mouse
PMT	Project Management Team
R-A	Regional highway access category
ROW	Right-of-way
RRFB	Rectangular Rapid Flash Beacon
RTD	Regional Transportation District
SB	Southbound
TDM	Travel Demand Management
TOC	Traffic Operations Center
TSP	Transit Signal Priority



TTI	Travel Time Index
TWG	Technical Working Group
UPRR	Union Pacific Railroad
US	United States Highway (US 6, US 285)
V/C	Volume-to-capacity
VMS	Variable Message Sign
vph	Vehicles per hour
WB	Westbound
WVC	Wildlife Vehicle Collisions



# INTRODUCTION

In response to increasing traffic operations, safety and mobility challenges and concerns along the C-470/United States Highway (US) 6/Colorado State Highway 93 (CO 93) corridor, local agency stakeholders came together to create the WestConnect Corridor Coalition (Coalition). Coalition members understand the importance of the highway facility, the potential opportunities and impacts related to other area projects. The Coalition worked with the Colorado Department of Transportation (CDOT) to initiate this Planning and Environmental Linkages (PEL) study. As a group, the Coalition serves as the primary stakeholder providing input, comment, and direction for the PEL study.

The PEL study will provide the framework and process for CDOT to work with the Coalition agencies to build a tailored program of discrete projects that can then move into National Environmental Policy Act (NEPA), design, and construction. The study is an opportunity to leverage the benefits of the PEL process by clearly documenting strategic project decisions regarding short- and long-term improvements to this highly important corridor in the western Denver Metropolitan area.

This Alternatives Report documents the alternatives development and screening process.

## Study Area

The study area for the WestConnect Coalition PEL Study is defined as C-470 from Kipling to I-70/US 6 in south Jefferson County, US 6 from C-470 to CO 58/CO 93 in Golden, and CO 93 from Golden to Marshall Road (CO 170) in Boulder County, illustrated in **Figure 1**. The 32-mile WestConnect corridor varies greatly in functional classification, surrounding character, and use, which creates differing issues in the various segments of this regional travel corridor. To effectively focus on improvements that could address the local transportation issues as well as needs of the overall corridor, the following three corridor segments were identified based on functional classification, adjacent land uses, and physical and operational characteristics:

- C-470 Segment – Kipling to I-70/US 6
- Golden Segment – US 6 – C-470 to CO 58/CO 93 and CO 93 – CO 58 to 64<sup>th</sup> Parkway
- CO 93 Segment – 64<sup>th</sup> Parkway to Marshall Road (CO 170)

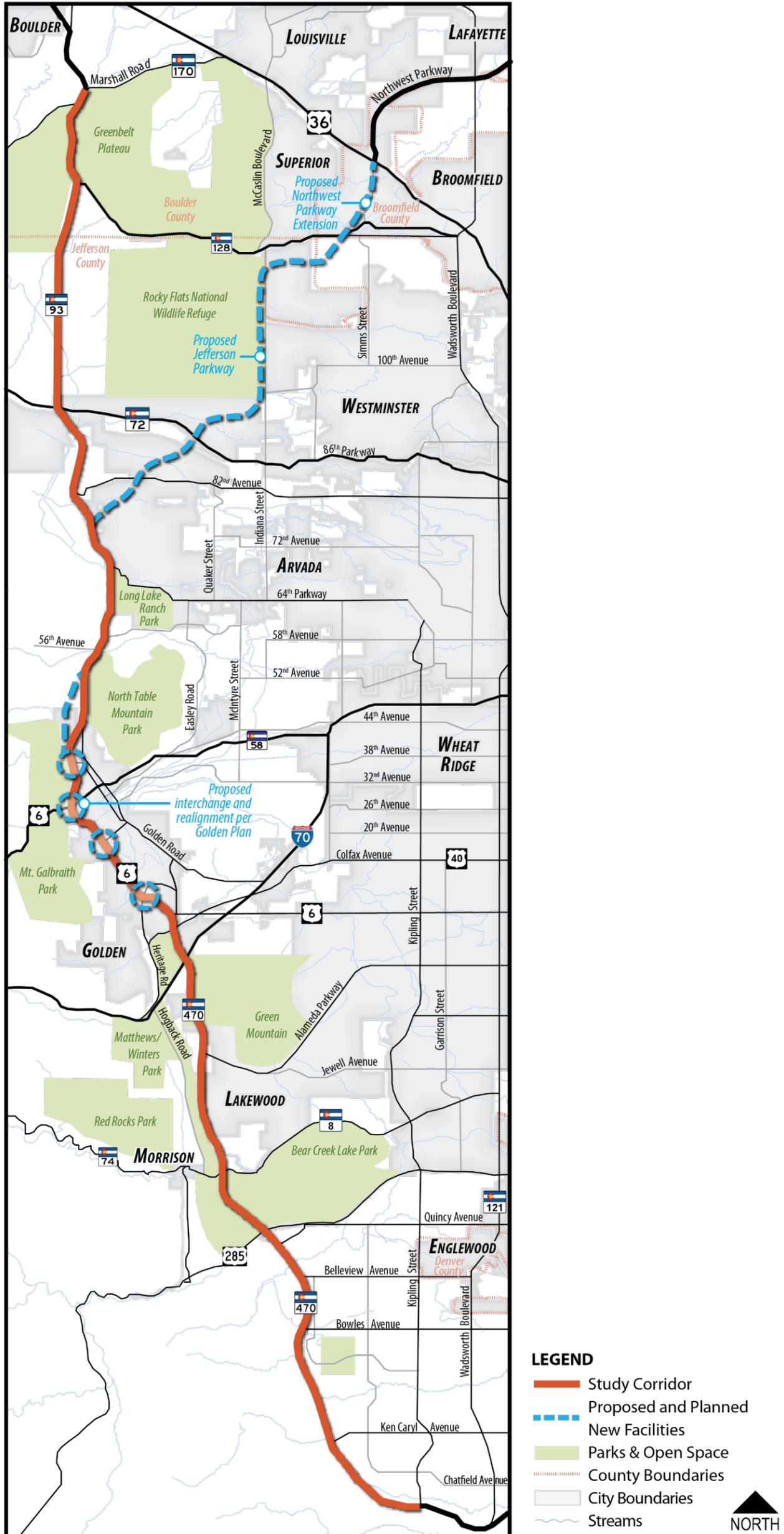
## Related Planning Efforts

Individual local jurisdictions and regional agencies along the corridor have previously completed planning and design efforts for selected improvements within their communities and jurisdiction. The PEL study will respect the existing plans of the Coalition agencies within their respective jurisdictional boundaries. Specifically, the City of Golden’s plan for US 6 and CO 93 through Golden (“The Golden Plan”) has previously completed a comprehensive planning process and alternatives will not be developed and screened for that area. A summary of the Golden Plan is provided in **Appendix A**.



The previous Northwest Corridor Study process was a precursor to the ongoing Jefferson Parkway planning effort, which is separate from this PEL study. The PEL study will not analyze or recommend alternatives to the Jefferson Parkway and its physical connection to CO 93. The Jefferson Parkway project will be considered in a separate process from the PEL study. In order to ensure a comprehensive study, however, the PEL study will still consider the potential traffic implications and impacts to the WestConnect corridor highways with and without the Jefferson Parkway. The PEL Study will not study or make recommendations regarding Jefferson Parkway design or funding.

Figure 1. WestConnect Study Area





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## PURPOSE AND NEED

This Purpose and Need statement was developed in coordination with agency stakeholders with review by the general public. The specific needs, summarized below, are based on the analysis and findings documented in this report and in separate documents prepared as part of this project, including the Corridor Conditions Report (April 2017). Thorough documentation of the process and recommendations is a critical element of the PEL process so the decisions can be used in future NEPA process(es).

The WestConnect corridor is an important regional highway corridor, providing transportation connectivity between southern Jefferson County and Boulder County. The WestConnect corridor provides regional mobility for the growing suburban communities and serves as an important connection for recreational travel and commuter route for area residents and business centers.

### Purpose

The purpose of recommendations from this study is to improve safety for all users, reduce recurring congestion, and improve existing and future operational performance while reflecting the local community context along the WestConnect corridor from C-470 at Kipling Street, along US 6 through Golden, to CO 93 at CO 170.

### Need

Transportation improvements are needed to address:

- **Safety Concerns:** There are safety concerns with higher than expected crashes along several segments along the WestConnect corridor. Significant crash types along the corridor are related to congestion, wild animal movements, and adverse weather conditions.
- **Recurring Congestion:** Drivers along the WestConnect corridor experience substantial delays and queues during peak weekday commuting and weekend recreational travel periods. Congestion is expected to worsen by 2040 with longer recurring peak periods of delay and slower speeds, as well as new areas of congestion as traffic volumes are expected to increase due to local and regional population and employment growth.
- **Poor Operational Performance:** Varying geometric characteristics along the WestConnect corridor create traffic disruptions, particularly weaving and merging conflicts due to lane drops and intersection/interchange configurations, as well as variable free flow speeds due to grades, adverse weather, and limited passing opportunities on two-lane segments. Pedestrian and bicyclist conditions create multimodal conflicts and operational issues. Transit service between population and employment centers along the corridor is limited in times and headways.



## Safety Concerns

- There is a higher than expected number of crashes along the WestConnect corridor, particularly along US 6 between C-470 and CO 58/CO 93 and along CO 93 from US 6/CO 58 to CO 128. There are also more severe than expected crashes along CO 93 north of CO 72.
- C-470 – Kipling Street to US 6
  - » Along C-470, significant crash types are rear end, wild animal, and weather-related crashes. Adverse road conditions, particularly icy conditions, contribute substantially to crashes along the C-470 extension from I-70 to US 6.
- US 6 – C-470 to CO 58/CO 93
  - » Along US 6 through Golden, wild animal crashes are the most significant crash type, concentrated in the area adjacent to the Fossil Trace Golf Course where there is a wildlife crossing with active detection warning signs.
- CO 93 – US 6/CO 58 to Marshall Road (CO 170)
  - » Rear end crashes along the CO 93 corridor are highly concentrated during the peak commuting periods at the signalized intersections of US 6/CO 58, CO 72, and CO 128, likely due to congestion, queuing, and lack of driver expectancy of stopped traffic.
  - » Sideswipe same direction crashes occur along CO 93 in the first mile north of the US 6/CO 58 intersection as a result of the merge condition with the northbound lane drop.
  - » Adverse weather conditions along CO 93 from CO 72 to CO 128, particularly during snow/icy conditions, result in a significant number of head on, overturning, and fixed object crashes.
  - » Wild animal crashes along CO 93 are clustered north of Pine Ridge Drive, north of 68<sup>th</sup> Avenue, near Westgate Drive, and south of CO 128, where there are areas of tree cover and water sources.
  - » Head on crashes are a significant crash type along CO 93 south of CO 128. Aggressive driving and misjudging gaps during passing maneuvers appear to be contributing factors.

## Recurring Congestion

- Drivers along the WestConnect corridor experience substantial delays and queues during commuter peak periods, particularly along C-470 between US 285 and I-70, along US 6 through Golden, and along CO 93 north of Golden and at the CO 72 intersection.
- Congestion along the WestConnect corridor is expected to worsen by 2040 with longer recurring peak periods of delay and slower speeds, as well as new areas of congestion as traffic volumes are expected to increase by up to 60% due to local and regional population and employment growth.



- C-470 – Kipling Street to US 6
  - » Along C-470, merging and weaving conflicts between the US 285 and Morrison Road interchanges cause significant speed reduction and congestion, frequently creating backups for westbound traffic extending to Bowles Avenue during the AM peak commuting period.
  - » The lane drop on eastbound C-470 at Morrison Road creates merging conflicts and lane changing maneuvers that causes significant speed reduction with queues typically reaching past Alameda Parkway during the PM peak commuting period.
  - » Along the C-470 corridor, congestion adds approximately five minutes of travel time during the weekday AM commute and almost 15 minutes of travel time during the weekday PM commute.
- US 6 – C-470 to CO 58/CO 93
  - » Through Golden, congestion and queuing occurs during the peak weekday commuting travel periods, as well as mid-day school travel peaks, at the signalized intersections along US 6, including Heritage Road.
  - » The grade-separated interchange improvements recently completed at the US 6/19<sup>th</sup> Street intersection are expected to result in longer queues and greater delays at the US 6/Heritage Road traffic signal as the bottleneck at 19<sup>th</sup> Street has been relieved.
- CO 93 – US 6/CO 58 to Marshall Road (CO 170)
  - » Congestion and queuing occurs during the peak weekday commuting and weekend recreational travel periods at the signalized intersections along CO 93, including US 6/CO 58, Washington Avenue, CO 72, CO 128, and CO 170.
  - » During the weekday PM peak commuting period, reduced speeds and queuing occurs along southbound CO 93 approaching US 6/CO 58, typically backing up to Golden Gate Canyon Road with reduced speeds starting at 64<sup>th</sup> Parkway.

### **Poor Operational Performance**

- Varying geometric characteristics along the WestConnect corridor create traffic disruptions, particularly weaving conflicts between interchanges along C-470 and the lane drops on eastbound C-470 at Morrison Road and on northbound CO 93 north of US 6/CO 58.
- There is no transit service along the C-470 corridor from south of Golden to Boulder and limited and directional transit service south of Golden provides service to downtown Denver only during peak periods with 30- and 60-minute headways.
- C-470 – Kipling Street to US 6
  - » Grades on C-470 north of US 285 lead to variable speeds in both directions that cause lane changing maneuvers and other driver behaviors frequently disrupting traffic flow.



- » Along C-470, the popular bikeway crosses high-volume free-right turn movements at the Kipling Street, Ken Caryl Avenue, and Bowles Avenue interchanges, introducing multimodal conflict.
- US 6 – C-470 to CO 58/CO 93
  - » Transit service between Golden and Boulder along US 6 and CO 93 is limited to weekday peak commute hours with 30- and 60-minute headways.
- CO 93 – US 6/CO 58 to Marshall Road (CO 170)
  - » Along CO 93, variable free flow speeds due to grades, adverse weather, and limited passing opportunities contribute to congestion as well as aggressive driver behavior.
  - » Multimodal operations and bicyclist comfort and safety are impacted when drivers must slow down and shift over into the other lane to pass bicyclists on CO 93 due to the lack of adequate shoulders for bicycle travel.
  - » The relatively high volume of bicyclists and pedestrians crossing CO 93 at the CO 128 traffic signal (High Plains Trail) delays vehicular traffic with pedestrian push button activation.
  - » Lack of sidewalks and pedestrian crossing opportunities contribute to multimodal conflicts and operational issues at bus stops along CO 93.

## Project Goals

Additional goals of the transportation improvements for the WestConnect study corridor are to:

- Enhance multimodal mobility options to serve travel demand for all users
- Support local and regional planning efforts
- Provide effective connections with identified corridor projects
- Avoid or minimize environmental impacts
- Balance local access and regional mobility
- Accelerate project delivery with realistic funding opportunities
- Complement local community surroundings and context
- Recognize emerging technology



# ALTERNATIVES EVALUATION PROCESS

The proposed alternatives development and evaluation process includes developing evaluation criteria based on the Purpose and Need and goals for the project, developing a reasonable range of improvement concepts, and narrowing options and alternatives through a multi-tiered screening process (see **Figure 2**).

As part of the study process, public, environmental, and resource concerns and opportunities in the corridor were identified and used to develop concepts, options and alternatives to address safety concerns, capacity restrictions, and operational performance. Local jurisdictions and regional agencies provided input and review at each step in the evaluation process. Further detail on the agency and public review process is provided in the following Agency and Public Coordination section of this chapter.

## Initial Alternatives Development

The intent of the alternatives development and evaluation process is to identify and screen a broad range of reasonable improvement concepts, options and alternatives for the WestConnect corridor that recognize the diverse elements of the C-470, US 6, and CO 93 roadways and surrounding environment. The screening process will identify transportation projects that will be more fully evaluated through future NEPA documentation during further project development.

The initial concepts were developed from reasonable options focused on addressing the project's Purpose and Need and issues identified in the evaluation of existing conditions with input from the Technical Working Group (TWG) and general public. The concepts are categorized by:

- highway;
- intersections/interchanges;
- multimodal elements;
- corridor management; and
- technology.

The concepts respond to the 2040 traffic volumes as developed in the travel demand forecasting. The No Action alternative will be carried forward through the entire screening analysis as a baseline for comparison, even if it does not address the project Purpose and Need.

## Level 1 (Purpose and Need) Screening

The purpose of the Level 1 screening is to eliminate the fatally flawed concepts or concepts that do not meet the project Purpose and Need. Level 1 screening was supported by the baseline data collected for the study. During the Level 1 screening, concepts were evaluated qualitatively, primarily using professional judgment of the project engineering and planning staff.

Figure 2: Screening Process





Corridor concepts were evaluated with a “Yes” or “No” answer to the following questions to demonstrate each alternative concept’s ability to meet the project Purpose and Need.

- Safety Concerns
  - » Does the alternative provide safety improvements along the WestConnect corridor?
- Recurring Congestion
  - » Does the alternative reduce current and future delays and queuing experienced along the WestConnect corridor?
- Operational Performance
  - » Does the alternative improve geometric characteristics that create traffic disruptions?
  - » Does the alternative improve existing and future multimodal operations along the WestConnect corridor?
  - » Does the alternative reduce multimodal conflicts and disruptions?

An alternative concept that had a “No” answer to any of the above questions was considered to not fully meet the project Purpose and Need. If a concept should be evaluated quantitatively and with more criteria in order to make an informed decision for recommendation, it was carried forward to Level 2 screening for further evaluation. In order to identify the best solution possible, favorable attributes of concepts were retained as elements to consider with alternatives that are carried forward to Level 2 screening.

## Level 2 Screening

The Level 2 screening is intended to establish a means for estimating and comparing how well corridor options perform in meeting the project Purpose and Need and project goals in a cost-effective and least environmentally harmful manner. The Level 2 screening expanded measures for each criterion from Level 1 screening and provided additional screening criteria based on the project goals.

For Level 2 screening, the evaluation criteria focused on elements responding to the project Purpose and Need and project goals: safety, traffic operations, multimodal connectivity, community, environmental resources, and implementability. The alternatives were compared to determine how well each concept meets the evaluation criteria.

The Level 2 screening was applied to alternatives over two stages of evaluation. Concepts carried forward for further evaluation from Level 1 Purpose and Need screening were evaluated at specific locations along each segment of the WestConnect corridor for comparative Level 2A evaluation specific to each location and improvement category. The screened Level 2A options were combined into corridor alternatives by segment to assess the benefits and impacts to the overall corridor goals in a Level 2B evaluation.



### Level 3 Evaluation

The Level 3 evaluation will be presented in the PEL study report. The “carried forward” elements of the Level 2B alternatives were defined as the Draft Recommendations. Along CO 93, the higher capacity roadway segment improvements were packaged with lower capacity intersection improvements, and conversely, the higher capacity intersection improvements were packaged with lower capacity roadway segment improvements. No further screening will be made, but a complete corridor wide evaluation of traffic operations with the draft recommendations will be conducted. Conceptual layouts and cost estimates will be developed to facilitate future project development phases.

### Agency and Public Coordination

Understanding the ideas, perspectives, and needs of key stakeholders along the corridor is critical to building broadly supported decisions and solutions. Throughout the alternatives development and evaluation process, stakeholder involvement was emphasized and feedback was solicited from local agency and public partners at key decision points to foster acceptance of study recommendations.

A Project Management Team (PMT), consisting of CDOT and consultant Project Management, Planning, Traffic, Environmental, and Communications staff, and the Coalition Facilitator met monthly throughout the project duration to discuss project progress and prepare for upcoming agency committee meetings.

A TWG was formed to serve as the primary mechanism to directly interact and engage the corridor communities and stakeholders. The PMT coordinated with the TWG to determine the proper level of involvement and engagement required for elected officials and other associated stakeholder groups. The TWG reviewed and provided comments on development and analysis of improvement concepts, options and alternatives at key points in the study progress.

The following agencies were represented by their technical staff on the TWG:

- CDOT Region 1
- CDOT Headquarters – Environmental Programs Branch
- City of Arvada
- Boulder County
- City of Boulder
- City and County of Broomfield
- City of Golden
- Jefferson County
- Jefferson Parkway Public Highway Authority (JPPHA)
- City of Lakewood
- Town of Morrison
- Town of Superior
- City of Westminster
- Federal Highway Administration (FHWA)
- Denver Regional Council of Governments (DRCOG)

The WestConnect Coalition Steering Committee, comprised of elected officials and other decision-makers, directed the Coalition’s efforts. During the PEL process, the PMT presented PEL study information to the Coalition’s Steering Committee prior to presentation to the public.



Resource agencies were contacted to introduce the study and establish communications, and to present existing conditions, draft alternatives screening and draft study recommendations for comment. Information was gathered regarding necessary next steps related to environmental impact mitigation or next steps that would be required in NEPA clearance.

The following resource agencies were contacted:

- Colorado Department of Public Health and Environment – Air Quality/Air Pollution Control Division
- Colorado Department of Public Health and Environment – Hazardous Materials and Waste Management Division
- Colorado Department of Public Health and Environment – Water Quality Control Division
- Colorado Historical Society/State Historic Preservation Office
- US Environmental Protection Agency Region 8
- US Army Corps of Engineers
- US Fish and Wildlife Service – Colorado Field Office
- Colorado Parks and Wildlife
- Jefferson County Historical Society
- Jefferson County Health Department

## General Public Meetings

In an effort to gain as much community input as possible, two general public meetings are planned for the study.

The first public meetings were held November 15, 16 and 17, 2016 to educate the public on the PEL process and to collect input about the vision for the highway corridors and associated concerns.

The second round of public meetings are planned in January 2018 to present the alternatives development and screening results, including the draft recommended improvements. Input will be gathered regarding potential refinements for consideration by the project team as study recommendations and identified projects are finalized.

## Project Webpage

A webpage on the CDOT website was created, <https://www.codot.gov/library/studies/westconnect-coalition-pel-study>. The webpage included study background information, and described the purpose for the project, study objectives, and information on the study area, schedule, and frequently asked questions. Final reports were also posted online. The webpage included an opportunity to comment and ask questions about the study and input received via all avenues was summarized.



## **Telephone Town Hall and On-line Meetings**

Telephone town hall and on-line meetings were conducted to provide an additional forum for outreach and involvement. Two telephone town halls were organized, conducted and summarized by the project team. The first telephone town hall was conducted November 9, 2016 and the second on May 22, 2017.

Concurrent to the telephone town halls, videos were posted on the project website illustrating and explaining the need for improvements, study process and concepts being considered.

# LEVEL 1 SCREENING

The initial improvement concepts were developed from reasonable options focused on addressing the project Purpose and Need and issues identified in the evaluation of existing conditions, with input from the TWG and general public. The initial concepts addressed safety concerns, recurring congestion, geometric characteristics that effect operational performance, and multimodal operations, conflicts and disruptions. The concepts are categorized by highway, intersections/interchanges, multimodal elements, corridor management, and technology. The initial concepts were intended to be potential components to a comprehensive solution for each corridor segment.

## Level 1 Concepts

Considering the study area constraints and the project Purpose and Need, the following improvement concepts, in addition to the No Action alternative, were considered in the Level 1 screening.

### C-470 Segment – Kipling to I-70/US 6

#### *No Action*

The No Action alternative is included as a baseline for comparison to the improvement concepts and subsequent alternatives. Under the No Action alternative, only programmed improvements that are planned and funded by CDOT, the Counties, or cities would be completed, as described in the Corridor Conditions Report and summarized in **Appendix B**.

#### *Highway*

##### Six General Purpose Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of widening C-470 to provide three through travel lanes in each direction with barrier separated median and shoulders, similar to the section of C-470 north of Morrison Road. The concept includes ramp/intersection improvements and auxiliary lanes between interchanges, as warranted.

##### Four/Six General Purpose Lanes with Managed Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of widening C-470 to provide two general purpose through lanes plus one or two managed lanes in each direction, generally consistent with the planned improvements to C-470 Segment 1 from I-25 to Wadsworth Boulevard. The concept includes ramp/intersection improvements and auxiliary lanes between interchanges, as warranted.



#### Four/Six Lanes with Bus-on-Shoulder Lanes

This concept was considered because it may address recurring congestion and multimodal operational performance. The concept consists of provisions for bus use of shoulders as a travel lane during peak traffic periods, which may require shoulder widening, clear zone modifications and on and off ramp merge/diverge adjustments.

#### Four/Six Lanes with Peak Period Shoulders Lanes

This concept was considered because it may address recurring congestion. The concept consists of provisions for general purpose traffic use of shoulders as a travel lane during peak traffic periods, which may require shoulder widening, clear zone modifications and on and off ramp merge/diverge adjustments.

#### Auxiliary Lanes between Interchanges

This concept was considered because it may address safety concerns, and operational performance. The concept consists of widening to provide an additional lane connection between on ramps and off ramps.

#### Increased Capacity/Operational Improvements on Local Roadways

This concept was considered because it may address recurring congestion. The concept consists of widening and other operational improvements to increase capacity of local roadways such as Kipling Parkway, Indiana Street and Rooney Road.

### ***Intersections/Interchanges***

#### Lane Modifications at Ramp Intersections

This concept was considered because it may address recurring congestion and safety concerns at ramp intersections. The concept considers additional turn lanes and traffic control modifications.

#### Braided Ramps

The concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of grade separation of large volume weaving movements between closely spaced on and off ramps.

#### Diverging Diamond Interchange (Double Crossover Diamond)

This concept was considered because it may address safety concerns and recurring traffic congestion. The concept consists of modifications to the interchange for traffic to cross to the opposite side of the arterial intersecting road, allowing for vehicles to have unimpeded movement onto the freeway ramps. Left turn lanes are eliminated and vehicles turning left onto or off ramps do not conflict with other vehicles. Pedestrians can be accommodated in the center median of the arterial between the ramp junctions.



### Roundabouts Interchange (Diamond with Roundabouts at Ramps)

This concept was considered because it may address safety concerns and recurring traffic congestion. The concept consists of a new interchange configuration with multilane roundabouts at Diamond ramp intersections with arterial roads.

### Ramp Reconfiguration

This concept was considered because it may address safety concerns and recurring congestion. The concept consists of ramp modifications such as increasing off ramp capacity by addition of an optional off ramp lane, or peak period use of on ramp shoulders for additional queued vehicle storage at ramp meters. Ramp reconfiguration may include realigning or moving existing slip ramps or incorporating existing ramps into a collector-distributor road.

## Multimodal Elements

### Pedestrian/Bicyclist Grade Separations

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of overpass or underpass separation of the C-470 Trail at C-470 interchanges and intersecting arterial streets.

### Improved Crossings for Pedestrians/Bicyclists

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of the installation of traffic controls and/or high visibility crosswalk treatments to increase driver awareness of potential pedestrian crossing movements. This may include colored pavement, textured markings, and pedestrian warning lights.

### Improved C-470 Trail Connections to Neighborhoods

This concept was considered because it may address multimodal operations along the corridor. The concept would consist of additional or improved paths from adjacent neighborhoods to the C-470 Trail.

### Improved C-470 Trail Continuity through Bear Creek Lake Park

This concept was considered because it may address multimodal operations. The concept would consist of a new more direct path for the trail through Bear Creek Lake Park from US 285 to Morrison Road.

### C-470 Trail/Signage/Wayfinding Improvements

This concept was considered because it may address multimodal operations. The concept consists of completing missing trail connections, improved trail width, on-street pavement markings, and route and wayfinding signage leading to and along the C-470 Trail.

### New/Improved Park-n-Ride Facilities

This concept was considered because it may address multimodal operations. The concept would consist of additional park-n-ride locations and improved facilities at existing park-n-ride lots.



### Improved Transit Service

This concept was considered because it may address multimodal operations. The concept would consist of such improvement as increased service frequency, potential new or modified routes, and additional, relocated or improved stops.

## ***Corridor Management***

### Travel Demand Management Strategies

This concept was considered because it may address recurring congestion and operational performance. The concept consists of strategies that encourage corridor users to utilize the existing infrastructure in different ways and/or at different times of the day, rather than driving alone in the peak traffic periods. Possible strategies include incentive programs such as EcoPasses, bike sharing and bike parking, subsidy for first/last mile by car share services, and car pools and van pools.

### Incident Management

This concept was considered because it may address safety concerns and operational performance. The concept consists of a system to continuously monitor the roadway for incidents to provide efficient response to remove incidents from the roadway to prevent further incidents or crashes. This management approach can reduce damage, recovery time and cost.

### Event Traffic Management

This concept was considered because it may address safety and congestion during events. The concept may consist of traveler information and dynamic routing using variable message signs, travel time indicators and dynamic lane use controls.

### Wildlife Crossings

This concept was considered because it may address safety concerns. The concept may consist of overpasses or underpasses of the highway for unobstructed wildlife movement, with fencing to direct wildlife to the safe crossing location.

### Snow Fence

This concept was considered because it may address safety concerns and improve characteristics that create traffic disruptions. The concept consists of fencing designed to the geographic conditions along the highway to reduce blowing snow across the highway pavement.

## ***Technology***

### Autonomous Vehicle Lanes

This concept was considered because it may address recurring congestion, safety concerns and operational performance. The concept consists of a dedicated lane for autonomous vehicles, vehicles that can sense the environment around them and navigate without human input. A dedicated lane for



such vehicles could potentially be narrower than a general purpose lane and provide greater capacity with reduced vehicle headways.

#### Variable Speed Limits

This concept was considered because it may address safety and recurring congestion. The concept consists of dynamically adjusted speed limits to maintain safe travel speeds based on traffic, weather or other roadway conditions. The speed limits can be regulatory and enforceable or they can be recommended speed advisories.

#### Dynamic Lane Use

This concept was considered because it may address safety concerns, recurring congestion and multimodal operational performance. This concept involves dynamically closing or opening individual traffic lanes or allowable movements by use of advanced warning or lane use control signs in order to improve traffic operations and respond to traffic congestion or incidents based on real time data.

#### Queue Warnings

This concept was considered because it may address corridor safety concerns. The concept uses real time information to alert motorists of downstream stopped traffic by use of warning signs and flashing lights, thereby reducing rear-end crashes associated with stop and go traffic patterns.

#### Ramp Metering

This alternative was considered because it may address safety concerns, recurring congestion and operational performance. This concept uses traffic signals and traffic detection systems on interchange on ramps to monitor freeway and ramp traffic and manage the flow of on ramp traffic to minimize impact to freeway traffic speed.

#### Wildlife Detection and Alert Systems

This concept was considered because it may address safety concerns. This concept consists of wildlife detection systems and roadway markings and signage with activated flashing warning beacons installed along the roadway at known wildlife movement locations.

#### Enhanced Communications Infrastructure

This concept was considered because it may address safety concerns and recurring traffic congestion. This concept consists of fiber optic communications infrastructure “backbone” to support data transmission from ITS devices and vehicle to roadway technology.

#### Improved Traveler Information Signs

This concept was considered because it may address safety concerns and recurring congestion. This concept consists of electronic display signs used to notify motorists of upcoming roadway, incident, weather and traffic-related conditions.



### Enhanced Lane Markings

This concept was considered because it may address safety concerns or geometric conditions that disrupt operational performance. The concept may consist of pavement markings, reflectors, or lights to enhance driver recognition of roadway geometry and laneage, and other new technology to support driverless vehicle recognition of geometry and laneage.

## Golden Segment – US 6 from C-470 to CO 58 and CO 93 from CO 58 to 64<sup>th</sup> Parkway

### *No Action*

The No Action alternative is included as a baseline for comparison to the improvement concepts and subsequent alternatives. Under the No Action alternative, only programmed improvements that are planned and funded by CDOT, the Counties, or cities would be completed, as described in the Corridor Conditions Report and summarized in **Appendix B**.

### *Highway*

#### Four Lanes with Raised Medians and Widened Shoulders

This concept was considered because it may address safety concerns and operational performance. The concept consists of widening substandard shoulders to provide refuge for vehicles with mechanical trouble or for emergency responders for incidents. Widened shoulders can also provide for accommodation of bicyclists. The Golden Plan proposes a raised, landscaped median with painted shoulders that will separate opposing traffic flows. A raised or painted median would also extend north of Golden to 64<sup>th</sup> Parkway.

#### Six General Purpose Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. This concept consists of corridor widening to provide three through travel lanes in each direction with raised or barrier-separated median and shoulders. This concept may be applicable along US 6 east of C-470 or within constraints of the volume threshold identified in the Golden Plan Memorandum of Understanding.

#### Four General Purpose Lanes with Managed Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of corridor widening to provide two general purpose travel lanes plus one managed lane in each direction, within the constraints of the volume threshold identified in the Golden Plan Memorandum of Understanding.



#### Four Lanes with Bus-on-Shoulder Lanes

This concept was considered because it may address recurring congestion and multimodal operational performance. The concept consists of provisions for bus use of shoulders as a travel lane during peak traffic periods, which may require shoulder widening, clear zone modifications, or intersection turn lane modifications.

#### New Alignment with Additional Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. This concept consists of realignment of CO 93 from Washington Street to north of Pine Ridge Road, consistent with The Golden Plan, moving the highway away from nearby residences and allowing the existing roadway to serve as a local residential collector street. The concept includes grade separation at Golden Gate Canyon Road and grade separation or cul-de-sac of Pine Ridge Road.

### *Intersections/Interchanges*

#### At-Grade Intersection Improvements

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of separating right turning traffic from through/right lanes by adding a right turn lane, or adding a second (or third) right or left turn lane to accommodate high turning traffic movements. This may also include adding or lengthening acceleration/deceleration lanes and tapers at intersections.

#### Grade-Separated Interchanges

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of modifying an at-grade intersection by depressing under or raising the highway over the intersecting roadway, with connecting ramps to serve traffic turning onto or off of the highway corridor. Interchange ramp configurations vary to accommodate traffic demand and surrounding topography and other physical and environmental constraints.

#### Frontage Road Connections

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of local street connections between intersections or interchanges to provide an alternative, supplemental route for short trips.

#### Light Rail Grade Separation at Intersection

This concept was considered because it may address safety concerns, recurring traffic congestion and operational performance. The concept consists of modifying roadway and/or track elevation to eliminate the at-grade light rail transit crossing at Johnson Road.



### Roundabout

This concept was considered because it may address safety concerns, recurring congestion and operational performance at intersections. The concept consists of a circular intersection where drivers travel counterclockwise around a center island. There are no traffic signals or stop signs, drivers yield at entry to traffic in the roundabout, then enter the intersection and exit at their desired street.

## ***Multimodal Elements***

### Pedestrian/Bicyclist Grade Separations

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of overpass or underpass separation for pedestrians and bicyclists crossing the highway corridor, replacing at-grade crossings or as supplemental crossing opportunities.

### Improved Crossings for Pedestrians/Bicyclists

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of the installation of traffic controls and/or high visibility crosswalk treatments to increase driver awareness of potential pedestrian crossing movements. This may include colored pavement, textured markings, and pedestrian warning lights.

### Separated Trail Improvements/Extension

This concept was considered because it may address safety concerns and multimodal operations along the corridor. The concept would consist of additional or improved separated trail facilities.

### Improved Transit Service

This concept was considered because it may address multimodal operations. The concept would consist of such improvement as increased service frequency, potential new or modified routes, and additional, relocated or improved stops.

### Bus Queue Jump Lanes

This concept was considered because it may address recurring congestion and multimodal operational performance. The concept provides a separate lane at intersections to allow buses to pass traffic queues, so buses move forward as the first vehicle to proceed when the next green signal occurs.

## ***Corridor Management***

### Travel Demand Management Strategies

This concept was considered because it may address recurring congestion and multimodal operations. The concept consists of strategies that encourage corridor users to utilize the existing infrastructure in different ways and/or at different times of the day, rather than driving alone in the peak traffic periods.



Possible strategies include incentive programs such as EcoPasses, bike sharing and bike parking, subsidy for first/last mile by car share services, and car pools and van pools.

#### Enhanced Maintenance and Operations Program

This concept was considered because it may address safety concerns and recurring congestion. The concept consists of efficient snow removal and icing prevention, effective pavement management, incident or weather-triggered street sweeping, and efficient upkeep of signs, pavement marking, guardrail, impact attenuators, and signals using advanced technological alert and scheduling programs.

#### Access Management Plan

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of proactive management of vehicular access points along the highway corridor, which may consider access spacing, adding, removing or combining accesses, improving grades and sight distance at driveways, safe turning movements/lanes and median treatments to maintain overall mobility and the functional integrity and safety along the highway corridor.

#### Incident Management

This concept was considered because it may address safety concerns and operational performance. The concept consists of a system to continuously monitor the roadway for incidents to provide efficient response to remove incidents from the roadway to prevent further incidents or crashes. This management approach can reduce damage, recovery time and cost.

#### Wildlife Crossings

This concept was considered because it may address safety concerns. The concept may consist of overpasses or underpasses of the highway for unobstructed wildlife movement, with fencing to direct wildlife to the safe crossing location.

### *Technology*

#### Adaptive Traffic Signals

This concept was considered because it may address recurring congestion and operational performance. The concept consists of traffic signal control technology in which traffic signal timing changes, based on actual traffic demand to accommodate variable traffic patterns.

#### Variable Speed Limits

This concept was considered because it may address safety and recurring congestion. The concept consists of dynamically adjusted speed limits to maintain safe travel speeds based on traffic, weather or other roadway conditions. The speed limits can be regulatory and enforceable or they can be recommended speed advisories.



### Queue Warnings

This concept was considered because it may address corridor safety concerns. This concept uses real time information to alert motorists of downstream stopped traffic by use of warning signs and flashing lights, thereby reducing rear-end crashes associated with stop and go traffic patterns.

### Wildlife Detection and Alert Systems

This concept was considered because it may address safety concerns. This concept consists of wildlife detection systems and roadway markings and signage with activated flashing warning beacons installed along the roadway at known wildlife movement locations.

### Enhanced Communications Infrastructure

This concept was considered because it may address safety concerns and recurring traffic congestion. This concept consists of fiber optic communications infrastructure “backbone” to support data transmission from vehicle detection systems, closed circuit television cameras, and other ITS devices and vehicle to roadway technology.

### Improved Traveler Information Signs

This concept was considered because it may address safety concerns and recurring congestion. This concept consists of electronic display signs used to notify motorists of upcoming roadway, incident, weather and traffic-related conditions.

## CO 93 Segment – 64<sup>th</sup> Parkway to Marshall Rd

### *No Action*

The No Action alternative is included as a baseline for comparison to the improvement concepts and subsequent alternatives. Under the No Action alternative, only programmed improvements that are planned and funded by CDOT, the Counties, or cities would be completed, as described in the Corridor Conditions Report and summarized in **Appendix B**.

### *Highway*

#### Four General Purpose Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of widening CO 93 to provide two general purpose lanes in each direction with median and shoulders.

#### Two Lanes with Bus-on-Shoulder Lanes

This concept was considered because it may address recurring congestion and multimodal operational performance. The concept consists of provisions for bus use of shoulders as a travel lane during peak traffic periods, which may require shoulder widening, clear zone modifications, or intersection turn lane modifications.



### Two Lanes with Additional Passing Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of extended and/or additional passing lanes to provide additional passing opportunities along the two lane highway corridor.

### New Split Alignment with Additional Lanes

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept would consider topographic conditions along the highway corridor that may be best accommodated by a split alignment, both vertically and horizontally, providing physical separation between opposing traffic flows.

### Widened Shoulders

This concept was considered because it may address safety concerns and multimodal operational performance. The concept consists of widening substandard shoulders to provide refuge for vehicles with mechanical trouble or for emergency responders for incidents. Widened shoulders can also provide for accommodation of bicyclists.

### Increased Capacity/Operational Improvements on Local Roadways

This concept was considered because it may address recurring congestion. The concept would focus improvement to other parallel roadways such as Indiana Street or McIntyre Street.

## ***Intersections/Interchanges***

### At-Grade Intersection Improvements

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of separating right turning traffic from through/right lanes by adding a right turn lane, or adding a second (or third) right or left turn lane to accommodate high turning traffic movements. This may also include adding or lengthening acceleration/deceleration lanes and tapers at intersections.

### Grade-Separated Interchange

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of modifying an at-grade intersection by depressing under or raising the highway over the intersecting roadway, with connecting ramps to serve traffic turning onto or off of the highway corridor. Interchange ramp configurations vary to accommodate traffic demand and surrounding topography and other physical and environmental constraints.

### Roundabout

This concept was considered because it may address safety concerns, recurring congestion and operational performance at intersections. The concept consists of a circular intersection where drivers



travel counterclockwise around a center island. There are no traffic signals or stop signs, drivers yield at entry to traffic in the roundabout, then enter the intersection and exit at their desired street.

#### Channelized T Intersection

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept provides free flowing traffic for one direction of travel on the highway with median separation of left turning traffic from the intersecting cross street, providing a dedicated auxiliary lane that allows traffic to merge into the left lane of the free flowing highway movement.

#### Median U-Turn Intersection

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept requires drivers on the highway wishing to turn left at the cross street to first drive through the cross street intersection, execute a U-turn at the first median opening, then turn right at the cross street intersection. The median opening for the U-turn movement could be signalized or unsignalized depending on traffic volume.

#### Continuous Flow Intersection (CFI)

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The CFI design allows left turn and through movements to progress through the signal at the same time. Left turning traffic is directed across the opposing travel lanes to a left turn bay before the main intersection. This eliminates the need for a separate left turn signal at the intersection.

#### Grade-Separated Turning Movement

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of structurally elevating or depressing the lane(s) for a high volume turning movement, above or below the highway.

#### Pedestrian/Bicyclist Grade Separations

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of overpass or underpass separation for pedestrians and bicyclists crossing the highway corridor, replacing at-grade crossings or as supplemental crossing opportunities.

#### Improved Crossings for Pedestrians/Bicyclists

This concept was considered because it may address safety concerns and multimodal operational performance and conflicts. The concept consists of the installation of traffic controls and/or high visibility crosswalk treatments to increase driver awareness of potential pedestrian crossing movements. This may include colored pavement, textured markings, and pedestrian warning lights.



### Separated Trail

This concept was considered because it may address safety concerns and multimodal operations along the corridor. The concept consists of a separate trail along the highway.

### Improved Pedestrian/Bicyclist Connections to Other Trails

This concept was considered because it may address multimodal operations. The concept would consist of additional trail improvement to connect to intersecting trails and paths into adjacent neighborhoods.

### Improved Transit Service

This concept was considered because it may address multimodal operations. The concept would consist of such improvement as increased service frequency, potential new or modified routes, and additional, relocated or improved stops.

### Bus Queue Jump Lanes

This concept was considered because it may address recurring congestion and multimodal operational performance. The concept provides a separate lane at intersections to allow buses to pass traffic queues, so buses move forward as the first vehicle to proceed when the next green signal occurs.

### Improved Bus Stop Facilities

This concept was considered because it may address safety concerns and multimodal operations. The concept may consist of improved sidewalk connections, bench or shelter, lighting or other amenities.

### New/Improved Park-n-Ride Facilities

This concept was considered because it may address multimodal operations. The concept would consist of additional park-n-ride locations and improved facilities at existing park-n-ride lots.

## ***Corridor Management***

### Travel Demand Management Strategies

This concept was considered because it may address recurring congestion and multimodal operations. The concept consists of strategies that encourage corridor users to utilize the existing infrastructure in different ways and/or at different times of the day, rather than driving alone in the peak traffic periods. Possible strategies include incentive programs such as EcoPasses, bike sharing and bike parking, subsidy for first/last mile by car share services, and car pools and van pools.

### Enhanced Maintenance and Operations Program

This concept was considered because it may address safety concerns and recurring congestion. The concept consists of efficient snow removal and icing prevention, effective pavement management, incident or weather-triggered street sweeping, and efficient upkeep of signs, pavement marking, guardrail, impact attenuators, and signals using advanced technological alert and scheduling programs.



### Access Management Plan

This concept was considered because it may address safety concerns, recurring congestion and operational performance. The concept consists of proactive management of vehicular access points along the highway corridor, which may consider access spacing, adding, removing or combining accesses, improving grades and sight distance at driveways, safe turning movements/lanes and median treatments to maintain overall mobility and the functional integrity and safety along the highway corridor.

### Incident Management

This concept was considered because it may address safety concerns and operational performance. The concept consists of a system to continuously monitor the roadway for incidents to provide efficient response to remove incidents from the roadway to prevent further incidents or crashes. This management approach can reduce damage, recovery time and cost.

### Wildlife Crossings

This concept was considered because it may address safety concerns. The concept may consist of overpasses or underpasses of the highway for unobstructed wildlife movement, with fencing to direct wildlife to the safe crossing location.

### Additional Snow Fence

This concept was considered because it may address safety concerns and improve characteristics that create traffic disruptions. The concept consists of fencing designed to the geographic conditions along the highway to reduce blowing snow across the highway pavement.

## *Technology*

### Advanced Signal Warning Flashers

This concept was considered because it may address safety concerns and operational performance. The concept consists of signs with flashing beacons that are activated when the signal ahead is going to turn from green to yellow, and then stay flashing through the red signal phase.

### Adaptive Traffic Signals

This concept was considered because it may address recurring congestion and operational performance. The concept consists of traffic signal control technology in which traffic signal timing changes, or adapts, based on actual traffic demand to accommodate variable traffic patterns and reduce traffic congestion.

### Variable Speed Limits

This concept was considered because it may address safety and recurring congestion. The concept consists of dynamically adjusted speed limits to maintain safe travel speeds based on traffic, weather or other roadway conditions. The speed limits can be regulatory and enforceable or they can be recommended speed advisories.



### Queue Warnings

This concept was considered because it may address corridor safety concerns. This concept uses real time information to alert motorists of downstream stopped traffic by use of warning signs and flashing lights, thereby reducing rear-end crashes associated with stop and go traffic patterns.

### Wildlife Detection and Alert Systems

This concept was considered because it may address safety concerns. This concept consists of wildlife detection systems and roadway markings and signage with activated flashing warning beacons installed along the roadway at known wildlife movement locations.

### Enhanced Communications Infrastructure

This concept was considered because it may address safety concerns and recurring traffic congestion. This concept consists of fiber optic communications infrastructure “backbone” to support data transmission from vehicle detection systems, closed circuit television cameras, and other ITS devices and vehicle to roadway technology.

### Improved Traveler Information Signs

This concept was considered because it may address safety concerns and recurring congestion. This concept consists of electronic display signs used to notify motorists of upcoming roadway, incident, weather and traffic-related conditions.

### Enhanced Lane Markings

This concept was considered because it may address safety concerns or geometric conditions that disrupt operational performance. The concept may consist of pavement markings, reflectors, or lights to enhance driver recognition of roadway geometry and laneage and other new technology to support driverless vehicle recognition of geometry and laneage.

### Road/Weather Information Systems

This concept was considered because it may address safety concerns and operational performance. The concept consists of technologies and strategies for improved surveillance, monitoring and prediction, information dissemination and decision support during adverse weather conditions.

## Level 1 Screening

The purpose of the Level 1 screening is to eliminate fatally flawed concepts or concepts that do not meet the project Purpose and Need. Concepts were evaluated with a “Yes” or “No” answer to the following questions to demonstrate each concept’s ability to meet the three main components of the project Purpose and Need:

- Safety Concerns
  - » Does the concept provide safety improvements along the WestConnect corridor?



- Recurring Congestion
  - » Does the concept reduce current and future delays and queuing experienced along the WestConnect corridor?
- Operational Performance
  - » Does the concept improve geometric characteristics that create traffic disruptions?
  - » Does the concept improve existing and future multimodal operations along the WestConnect corridor?
  - » Does the concept reduce multimodal conflicts and disruptions?

If a concept could not meet any of the criteria (that is, all “No” responses), it was eliminated from further consideration. However, if a concept was able to meet a portion of the needs, it was retained for further consideration in Level 2 screening.

The Level 1 Screening Matrix is shown in **Table 1**. The evaluation matrix summarizes the evaluation for each concept as follows:

- **RETAINED** – Concept will be evaluated further as a stand-alone option at specific locations along the corridor segments.
- **RETAINED AS AN ELEMENT** – Concept will be evaluated as a packaged element of larger-scale options.
- **ELIMINATED** – Concept does not meet the Purpose and Need established with this study.

Table 1: Level 1 – Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>C-470 Segment – Kipling to I-70/US 6</b>							
No Action	No	No	No	No	No	Retained	Retained to evaluate as baseline condition for comparison
<b>CONCEPTS CONTRIBUTING TO INFRASTRUCTURE ALTERNATIVES</b>							
<b>HIGHWAY</b>							
Six General Purpose Lanes	Yes	Yes	Yes	No	No	Retained	
Four/Six General Purpose Lanes with Managed Lanes	Yes	Yes	Yes	No	No	Retained	
Four/Six Lanes with Bus-on-Shoulder Lanes	No	No	No	No	No	Eliminated	No existing transit route on the highway segment and minimal potential for future service.
Four/Six Lanes with Peak Period Shoulder Lanes	No	Yes	No	No	No	Retained as an element	Retained as an element to reduce congestion during peak hours
Auxiliary Lanes between Interchanges	Yes	Yes	Yes	No	No	Retained	
Increased Capacity/Operational Improvements on Local Roadways	No	No	No	No	No	Eliminated	Does not provide additional capacity or safety or operational improvements along C-470
<b>INTERSECTIONS/INTERCHANGES</b>							
Lane Modifications at Ramp Intersections	Yes	Yes	Yes	No	No	Retained	
Braided Ramps	Yes	Yes	Yes	No	No	Retained	
Diverging Diamond Interchange	Yes	Yes	Yes	No	No	Retained	
Roundabouts Interchange	Yes	Yes	Yes	Yes	No	Retained	
Ramp Reconfiguration	Yes	Yes	Yes	No	No	Retained	
<b>MULTIMODAL ELEMENTS</b>							
Pedestrian/Bicyclist Grade Separation	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Improved Crossings for Pedestrians/Bicyclists	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Improved C-470 Trail Connections to Neighborhoods	No	No	No	No	No	Eliminated	Does not provide additional capacity or safety or operational improvements along C-470
Improved C-470 Trail Continuity through Bear Creek Lake Park	No	No	No	No	No	Eliminated	Major infrastructure with substantial impacts that does not provide additional capacity or safety improvements along C-470
C-470 Trail Signage/Wayfinding Improvements	No	No	No	Yes	No	Retained as an element	Retained as an element to enhance multimodal operations along the C-470 Trail
New/Improved Park-n-Ride Facilities	No	No	No	Yes	No	Retained as an element	Retained as an element to increase transit use and carpooling along the corridor
Improved Transit Service	No	Yes	No	Yes	No	Retained as an element	Retained as an element to increase transit use and to reduce volumes on C-470

Table 1 (cont.): Level 1 – Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>CONCEPTS CONTRIBUTING TO SYSTEM/PROGRAM ALTERNATIVES</b>							
<b>CORRIDOR MANAGEMENT</b>							
Travel Demand Management Strategies	No	Yes	No	Yes	No	Retained as an element	Retained as a system management element to reduce congestion and enhance operations
Incident Management	Yes	No	No	Yes	No	Retained as an element	Retained as a system management element to enhance safety and operations during freeway incidents
Event Traffic Management	Yes	No	No	No	No	Retained as an element	Retained as a system management element to enhance safety and reduce congestion during events that create increased traffic on C-470
Wildlife Crossings	Yes	No	No	No	No	Retained as an element	Retained as an element to mitigate crashes related to wildlife crossings
Snow Fence	Yes	No	Yes	No	No	Retained as an element	Retained as an element to mitigate crashes and issues related to blowing, drifting snow
<b>TECHNOLOGY</b>							
Autonomous Vehicle Lanes	Yes	Yes	Yes	No	No	Retained	Retained as future technology to improve safety, reduce freeway congestion, and enhance operations along C-470
Variable Speed Limits	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to improve safety and reduce congestion related to speed
Dynamic Lane Use	Yes	Yes	Yes	No	No	Retained	
Queue Warnings	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate rear end crashes related to unexpected queues
Ramp Metering	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and operations at ramp merge areas
Wildlife Detection and Alert Systems	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate crashes related to wildlife crossings
Enhanced Communications Infrastructure	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
Improved Traveler Information Signs	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
Enhanced Lane Markings	Yes	No	Yes	No	No	Retained as an element	Retained as a technology element to mitigate crashes related to distracted driving and lane visibility

Table 1 (cont.): Level 1 – Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>Golden Segment – US 6 from C-470 to CO 58 and CO 93 from CO 58 to 64<sup>th</sup> Parkway</b>							
No Action	No	No	No	No	No	Retained	Retained to evaluate as baseline condition for comparison
<b>CONCEPTS CONTRIBUTING TO INFRASTRUCTURE ALTERNATIVES</b>							
<b>HIGHWAY</b>							
Four Lanes with Raised Medians and Widened Shoulders	Yes	No	Yes	Yes	Yes	Retained as an element	Retained as a design element to enhance safety, operations, and multimodal conflicts
Six General Purpose Lanes	Yes	Yes	Yes	No	No	Retained	Retained within constraints of the volume threshold identified in the <i>Golden Plan Memorandum of Understanding</i>
Four General Purpose Lanes with Managed Lanes	Yes	Yes	Yes	No	No	Retained	Retained within constraints of the volume threshold identified in the <i>Golden Plan Memorandum of Understanding</i>
Four Lanes with Bus-on-Shoulder Lanes	No	No	No	No	No	Eliminated	No existing or proposed transit route on the highway segment
New Alignment with Additional Lanes	Yes	Yes	Yes	Yes	Yes	Retained	Retained as identified in the <i>Golden Plan</i>
<b>INTERSECTIONS/INTERCHANGES</b>							
At-Grade Intersection Improvements	Yes	Yes	Yes	No	No	Retained	
Grade-Separated Interchange	Yes	Yes	Yes	Yes	Yes	Retained	Retained as identified in the <i>Golden Plan</i>
Frontage Road Connections	Yes	Yes	Yes	No	Yes	Retained	Retained as identified in the <i>Golden Plan</i>
Light Rail Grade Separation at Intersection	Yes	Yes	Yes	Yes	Yes	Retained	Retained for consideration at Johnson Road light rail crossing
Roundabout	Yes	Yes	Yes	Yes	No	Retained	
<b>MULTIMODAL ELEMENTS</b>							
Pedestrian/Bicyclist Grade Separations	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Improved Crossings for Pedestrians/Bicyclists	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Separated Trail Improvements/Extension	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to improve multimodal safety and operational improvements
Improved Transit Service	No	Yes	No	Yes	No	Retained as an element	Retained as an element to increase transit use and to reduce volumes on US 6/CO 93
Bus Queue Jump Lanes	No	Yes	Yes	No	No	Retained as an element	Retained as an element to enhance improved transit service

Table 1 (cont.): Level 1 – Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>CONCEPTS CONTRIBUTING TO SYSTEM/PROGRAM ALTERNATIVES</b>							
<b>CORRIDOR MANAGEMENT</b>							
Travel Demand Management Strategies	No	Yes	No	No	No	Retained as an element	Retained as a system management element to reduce congestion and enhance operations
Enhanced Maintenance and Operations Program	Yes	Yes	No	No	No	Retained as an element	Retained as a system management element to enhance safety and operations
Access Management	Yes	Yes	Yes	No	No	Retained	
Incident Management	Yes	No	No	No	No	Retained as an element	Retained as a system management element to enhance safety and operations during highway incidents
Wildlife Crossings	Yes	No	No	No	No	Retained as an element	Retained as an element to mitigate crashes related to wildlife crossings
<b>TECHNOLOGY</b>							
Adaptive Traffic Signals	No	Yes	Yes	No	No	Retained as an element	Retained as an element to enhance traffic signal operations
Variable Speed Limits	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to improve safety and reduce congestion related to speed
Queue Warnings	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate rear end crashes related to unexpected queues
Wildlife Detection and Alert Systems	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate crashes related to wildlife crossings
Enhanced Communications Infrastructure	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
Improved Traveler Information Signs	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
<b>CO 93 Segment – 64<sup>th</sup> Parkway to Marshall Road (CO 170)</b>							
No Action	No	No	No	No	No	Retained	Retained to evaluate as baseline condition for comparison
<b>CONCEPTS CONTRIBUTING TO INFRASTRUCTURE ALTERNATIVES</b>							
<b>HIGHWAY</b>							
Four General Purpose Lanes	Yes	Yes	Yes	Yes	Yes	Retained	
Two Lanes with Bus-on-Shoulder Lanes	No	Yes	No	Yes	No	Retained as an element	Retained as an element to enhance improved transit service
Two Lanes with Additional Passing Lanes	Yes	Yes	Yes	No	No	Retained	
New Split Alignment with Additional Lanes	Yes	Yes	Yes	Yes	Yes	Retained	
Widened Shoulders	Yes	No	Yes	Yes	Yes	Retained as an element	Retained as a design element to enhance safety, operations, and multimodal conflicts
Increased Capacity/Operational Improvements on Local Roadways	No	No	No	No	No	Eliminated	Does not provide additional capacity or safety or multimodal operational improvements along CO 93

Table 1 (cont.): Level 1 – Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>INTERSECTIONS/INTERCHANGES</b>							
At-Grade Intersection Improvements	Yes	Yes	Yes	No	No	Retained	
Grade-Separated Interchange	Yes	Yes	Yes	Yes	Yes	Retained	
Roundabout	Yes	Yes	Yes	Yes	No	Retained	
Channelized T Intersection	Yes	Yes	Yes	No	No	Retained	
Median U-Turn Intersection	Yes	Yes	Yes	No	No	Retained	
Continuous Flow Intersection	Yes	Yes	Yes	No	No	Retained	
Grade-Separated Turning Movement	Yes	Yes	Yes	Yes	Yes	Retained	
<b>MULTIMODAL ELEMENTS</b>							
Pedestrian/Bicyclist Grade Separations	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Improved Crossings for Pedestrians/Bicyclists	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to enhance multimodal safety and operational improvements
Separated Trail	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to improve multimodal safety and operational improvements
Improved Pedestrian/Bicyclist Connections to Other Trails	No	No	No	No	No	Eliminated	Does not provide additional capacity or safety or multimodal operational improvements along CO 93
Improved Transit Service	No	Yes	No	Yes	No	Retained as an element	Retained as an element to increase transit use and to reduce vehicle volumes on CO 93
Bus Queue Jump Lanes	No	Yes	Yes	No	No	Retained as an element	Retained as an element to enhance improved transit service
Improved Bus Stop Facilities	Yes	No	No	Yes	Yes	Retained as an element	Retained as an element to increase transit use along the corridor and improve safety at bus stop locations
New/Improved Park-n-Ride Facilities	No	No	No	Yes	No	Retained as an element	Retained as an element to increase transit use and carpooling along the corridor
<b>CONCEPTS CONTRIBUTING TO SYSTEM/PROGRAM ALTERNATIVES</b>							
<b>CORRIDOR MANAGEMENT</b>							
Travel Demand Management Strategies	No	Yes	No	No	No	Retained as an element	Retained as a system management concept to reduce congestion and enhance operations
Enhanced Maintenance and Operations Program	Yes	Yes	No	No	No	Retained as an element	Retained as a system management concept to enhance safety and operations
Access Management	Yes	Yes	Yes	No	No	Retained	
Incident Management	Yes	No	No	No	No	Retained as an element	Retained as a system management concept to enhance safety and operations during highway incidents
Wildlife Crossings	Yes	No	No	No	No	Retained as an element	Retained as an element to mitigate crashes related to wildlife crossings
Additional Snow Fence	Yes	No	Yes	No	No	Retained as an element	Retained as an element to mitigate crashes and issues related to blowing, drifting snow

Table 1 (cont.): Level 1 Screening Matrix

CONCEPTS	SAFETY CONCERNS	RECURRING CONGESTION	OPERATIONAL PERFORMANCE			SUMMARY OF RESULTS	ADDITIONAL COMMENTS
	DOES THE CONCEPT PROVIDE SAFETY IMPROVEMENTS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE CURRENT AND FUTURE DELAYS AND QUEUING EXPERIENCED ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT IMPROVE GEOMETRIC CHARACTERISTICS THAT CREATE TRAFFIC DISRUPTIONS?	DOES THE CONCEPT IMPROVE EXISTING AND FUTURE MULTIMODAL OPERATIONS ALONG THE WESTCONNECT CORRIDOR?	DOES THE CONCEPT REDUCE MULTIMODAL CONFLICTS AND DISRUPTIONS?		
<b>TECHNOLOGY</b>							
Advanced Signal Warning Flashers	Yes	No	Yes	No	No	Retained as an element	Retained as an element to mitigate crashes related to unexpected traffic signals
Adaptive Traffic Signals	No	Yes	Yes	No	No	Retained as an element	Retained as an element to enhance traffic signal operations
Variable Speed Limits	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to improve safety and reduce congestion related to speed
Queue Warnings	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate rear end crashes related to unexpected queues
Wildlife Detection and Alert Systems	Yes	No	No	No	No	Retained as an element	Retained as a technology element to mitigate crashes related to wildlife crossings
Enhanced Communications Infrastructure	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
Improved Traveler Information Signs	Yes	Yes	No	No	No	Retained as an element	Retained as a technology element to enhance safety and reduce congestion
Enhanced Lane Markings	Yes	No	Yes	No	No	Retained as an element	Retained as an element to mitigate crashes related to distracted driving and lane visibility
Road/Weather Information Systems	Yes	No	Yes	No	No	Retained as an element	Retained as technology element to mitigate crashes and operational issues related to weather conditions



## Level 1 Screening Results

Several concepts were eliminated from further consideration because they do not meet the project Purpose and Need. The eliminated concepts were:

### C-470 Segment

#### Highway

- Four/Six Lanes with Bus on-Shoulder Lanes – Eliminated because there is no existing transit route on the highway segment and minimal potential for future service
- Increased Capacity/Operational Improvements on Local Roadways – Eliminated because it does not provide additional capacity or safety or operational improvements along C-470

#### Multimodal Elements

- Improved C-470 Trail Connections to Neighborhoods – Eliminated because it does not provide additional capacity or safety or operational improvements along C-470
- Improved C-470 Trail Continuity through Bear Creek Lake Park – Eliminated because it would require major infrastructure with substantial impacts and it does not provide additional capacity or safety improvements along C-470

### Golden Segment

#### Highway

- Four Lanes with Bus on-Shoulder Lanes – Eliminated because there is no existing or proposed transit route on the highway segment

### CO 93 Segment

#### Highway

- Increased Capacity/Operational Improvements on Local Roadways – Eliminated because it does not provide additional capacity or safety or multimodal operational improvements along CO 93

#### Multimodal Elements

- Improved Pedestrian/Bicyclist Connections to Other Trails – Eliminated because it does not provide additional capacity or safety or multimodal operational improvements along CO 93

All other concepts were carried forward for further evaluation in Level 2 screening, either as a stand-alone option or packaged as elements of larger-scale options.

# LEVEL 2A SCREENING

## Level 2A Options

The transportation improvement concepts that were retained from Level 1 screening moved into Level 2A Screening. In this level of screening, options were developed for specific locations within each segment. The improvement options were applied at locations to respond to the forecasted 2040 transportation conditions. The options considered the capacity, safety, and operational needs of critical traffic movements, and multimodal travel demand, considering the geometric conditions at locations along the study corridor. Concepts were considered at locations appropriate to meet the traffic demand and adapt to physical features in order to develop the most appropriate Level 2A options.

Transit, technology, and corridor management options considered are also listed with each study segment. **Appendix C** describes the transit options considered for each segment in more detail. The technology and corridor management options are described in more detail in **Appendices D** and **E**, respectively.

The No Action Alternative option was carried forward through the analysis as a baseline for comparison, even when it does not address the project Purpose and Need.

## C-470 Segment – Kipling to I-70/US 6

**Figure 3** illustrates the Level 2A Comparative Screening options developed for the C-470 Segment, which extends from Kipling Parkway north to US 6, and includes eight interchanges.

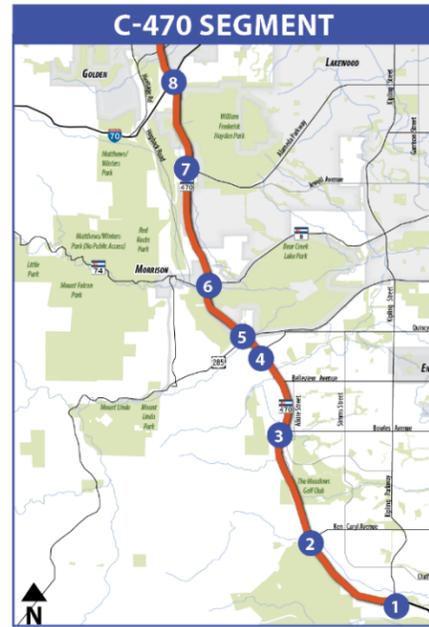
### *Highway Options*

The highway options are shown by their typical cross-section which illustrates the number of travel lanes and the shoulder and median configuration.

Highway improvement options for C-470 include:

- No Action (existing number of lanes along the highway)
- Six General Purpose Lanes
- Four/Six General Purpose Lanes with Managed Lanes
- Auxiliary Lanes between Interchanges
- Four/Six Lanes with Peak Period Shoulders Lanes

Figure 3: Level 2A Options – C-470 Segment

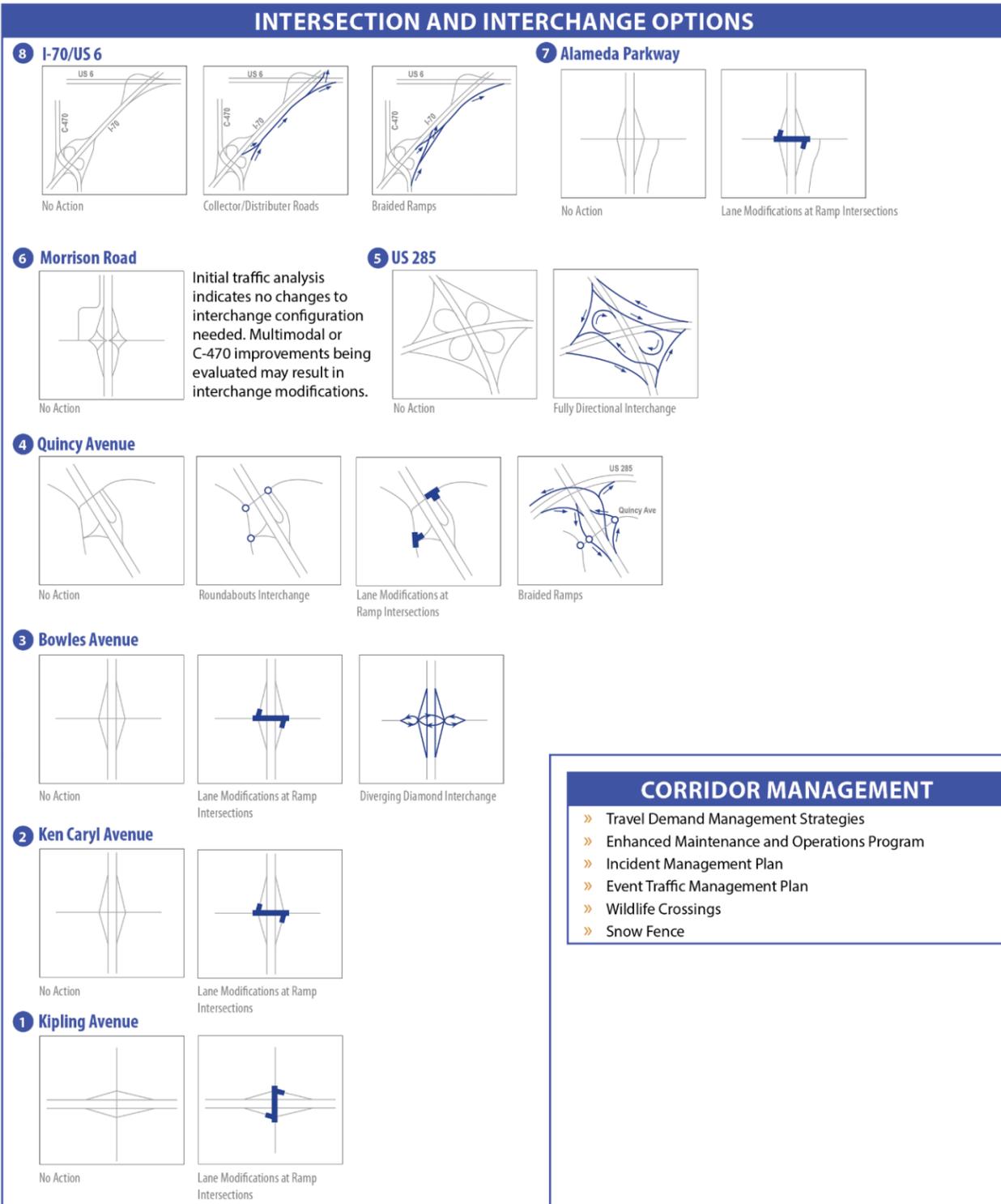
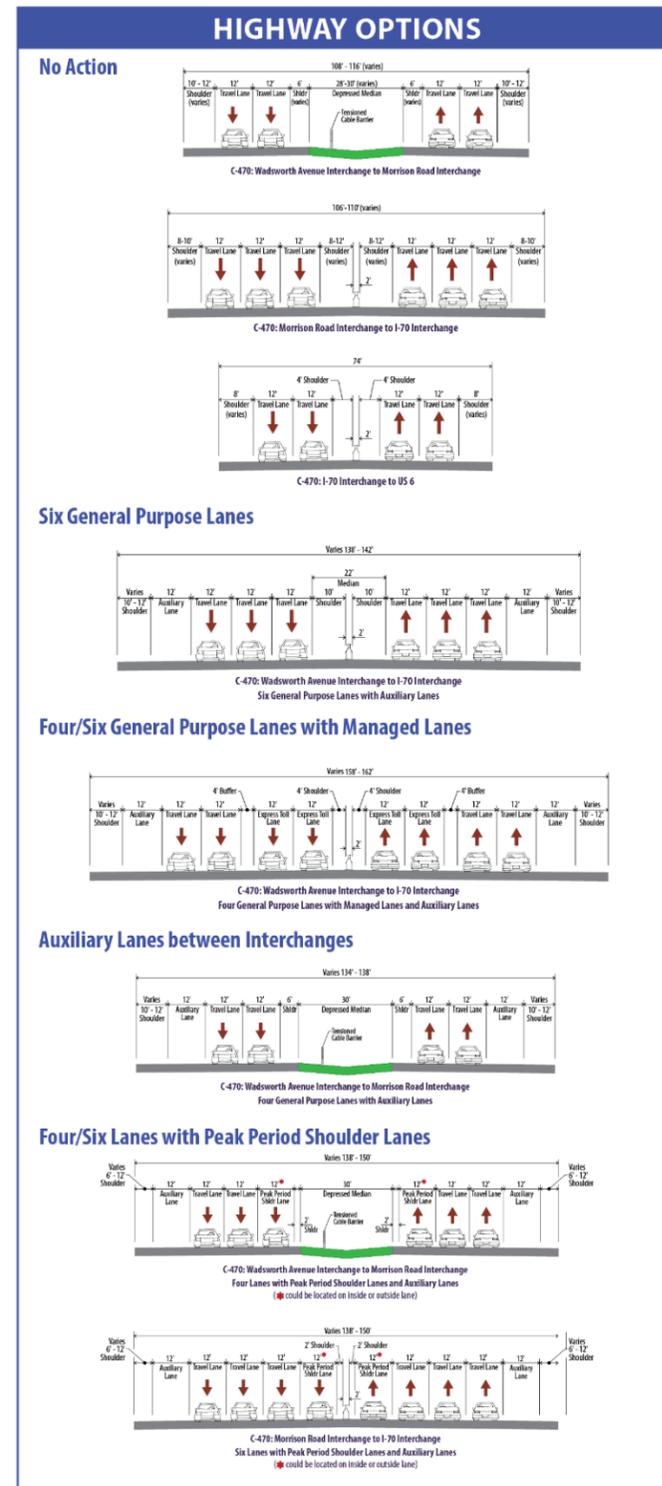


**TECHNOLOGY**

- » Road/Weather Information Systems
- » Dynamic Lane Use
- » Ramp Metering
- » Variable Speed Limits
- » Queue Warnings
- » Wildlife Detection and Alert Systems
- » Enhanced Communications Infrastructure
- » Improved Traveler Information Signs
- » Enhanced Lane Markings
- » Autonomous Vehicle Lanes

**MULTIMODAL INFRASTRUCTURE**

- » New Express Service - Ken Caryl to Downtown Denver
  - » Increased 116X Frequency
- |   |   |
|---|---|
| <p><b>C-470 Trail</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Signage/Wayfinding Improvements</li> </ul> <p><b>Kipling Parkway</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Pedestrian/Bicyclist Grade Separation</li> <li>» Improved Crossing for Pedestrians/Bicyclists</li> </ul> <p><b>Ken Caryl Avenue</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Improved Crossing for Pedestrians/Bicyclists</li> <li>» Improved Park-n-Ride Facilities</li> </ul> | <p><b>Bowles Avenue</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Pedestrian/Bicyclist Grade Separation</li> <li>» Improved Crossing for Pedestrians/Bicyclists</li> </ul> <p><b>Quincy Avenue</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Improved Crossing for Pedestrians/Bicyclists (Quincy Ave &amp; Belview Ave)</li> <li>» Improved Park-n-Ride Facilities</li> </ul> <p><b>Morrison Road</b></p> <ul style="list-style-type: none"> <li>» No Action</li> <li>» Improved Crossing for Pedestrians/Bicyclists</li> <li>» Improved Park-n-Ride Facilities</li> </ul> |
|---|---|



**CORRIDOR MANAGEMENT**

- » Travel Demand Management Strategies
- » Enhanced Maintenance and Operations Program
- » Incident Management Plan
- » Event Traffic Management Plan
- » Wildlife Crossings
- » Snow Fence



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### ***Interchange Options***

Interchange improvement options are illustrated in Figure 3. At the Kipling and Ken Caryl Interchanges, lane modifications at the ramp intersections were considered. At the Bowles Avenue Interchange, lane modifications at the ramp intersections and a Diverging Diamond configuration were considered. At the Quincy Avenue Interchange, lane modifications and traffic signals or roundabouts were considered at the ramp intersections. Braided ramps were also considered in conjunction with potential improvements at US 285.

At US 285, directional ramps were considered to replace the loop ramps in the northwest and southwest quadrants. The Morrison Road interchange is anticipated to operate well in its current configuration. At the Alameda Interchange, lane modifications at the ramp intersections were considered. Improvements were considered at I-70 to address the weave of traffic entering I-70 eastbound from C-470 with traffic exiting to eastbound US 6, including collector/distributor road or braided ramps options.

### ***Multimodal, Technology, and Corridor Management Options***

Multimodal options considered for the C-470 segment include:

- Signage and wayfinding Improvements along the C-470 trail
- Improved crossings for pedestrian and bicyclists across the local streets and ramps
- Improved park-n-ride facilities at Ken Caryl, Quincy and Morrison Road
- Pedestrian/bicyclist grade separations at the Kipling and Bowles interchanges
- New express bus service from Ken Caryl to Downtown Denver
- Increased 116X frequency

Technology options considered:

- Variable speed limits
- Queue warnings
- Dynamic lane use
- Enhanced communications infrastructure
- Enhanced lane markings
- Ramp metering
- Wildlife detection and alert systems
- Improved traveler information signs
- Road/weather information systems
- Opportunities to enhance future autonomous vehicle operations

Corridor Management options considered for the C-470 Segment include:

- Travel Demand Management Strategies
- Enhanced maintenance and operations program
- Incident Management Plan
- Event Traffic Management Plan (with congestion from event traffic at the Morrison interchange)
- Wildlife crossings
- Snow fencing

### Golden Segment – US 6 and Johnson Rd, and CO 93 from south of 56<sup>th</sup> Ave to 64<sup>th</sup> Parkway

Figure 4 illustrates the Level 2A Comparative Screening options developed for the Golden Segment east and north of the limits of The Golden Plan. The PEL study assumes that highway and interchange improvements along US 6 west of C-470 and along CO 93 to north of Golden Gate Canyon Road will be consistent with improvements previously developed, evaluated, and documented in The Golden Plan and as established in The Golden Plan Memorandum of Understanding between CDOT and the City of Golden. No evaluation of alternatives to The Golden Plan was included in the PEL study. (See **Appendix A** for background and history regarding development of The Golden Plan.)

#### Highway Options

Highway improvement options for the segment include:

- No Action
- Four General Purpose Lanes
- Two Lanes with Bus on Shoulder Lanes

#### Intersections/Interchanges

At the US 6/C-470 Ramps/Johnson Road intersection, additional lanes at the intersection were considered. A Light Rail grade separation was also considered to understand the general feasibility of modifying the rail crossing.

Improvement options considered at 58<sup>th</sup> Avenue include additional lanes and a traffic signal at the at-grade intersection, a Channelized T intersection, which would allow southbound through traffic to operate without stopping at the traffic signal while westbound to southbound left turns merge into the southbound traffic flows, and a roundabout option.

At 64<sup>th</sup> Parkway, improvement options considered include intersection lane and traffic signal improvements, a Channelized T intersection, grade separation of westbound to southbound traffic, and a roundabout option.

Figure 4: Level 2A Options – Golden Segment



Improvements within Golden are consistent with The Golden Plan (2013) Memorandum of Understanding agreement between CDOT and the City of Golden.

### CORRIDOR MANAGEMENT

- » Travel Demand Management Strategies
- » Enhanced Maintenance and Operations Program
- » Incident Management Plan
- » Event Traffic Management Plan
- » Access Management Plan
- » Wildlife Crossings

### TECHNOLOGY

- » Road/Weather Information Systems
- » Adaptive Traffic Signals
- » Transit Signal Priority
- » Variable Speed Limits
- » Queue Warnings
- » Wildlife Detection and Alert Systems
- » Enhanced Communications Infrastructure
- » Improved Traveler Information Signs
- » Enhanced Lane Markings

### MULTIMODAL INFRASTRUCTURE

- » Express service from Ken Caryl Park-n-Ride to Golden
- » Separated Trail along CO 93 north of Pine Ridge Road to 64th Parkway

#### US 6/C-470/Johnson Road

- » No Action
- » Improved Crossing for Pedestrians/Bicyclists

#### 64th Avenue

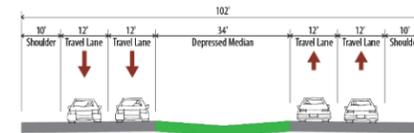
- » No Action
- » Improved Crossing for Pedestrians/Bicyclists

#### 58th Avenue

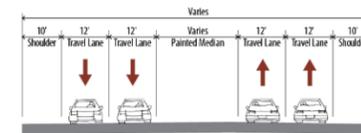
- » No Action
- » Improved Crossing for Pedestrians/Bicyclists

### HIGHWAY OPTIONS

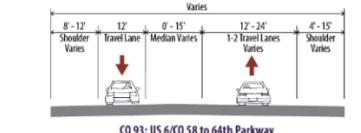
#### No Action



US 6: Johnson Road to 19th Street

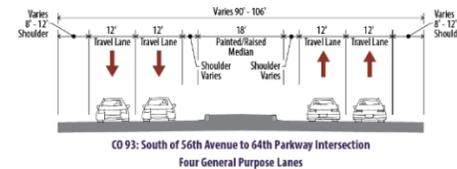


US 6: 19th Street to US 6/CO 58



CO 93: US 6/CO 58 to 64th Parkway

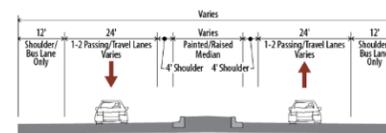
#### Four General Purpose Lanes



CO 93: South of 56th Avenue to 64th Parkway Intersection

Four General Purpose Lanes

#### Two Lanes with Bus on Shoulder Lanes



CO 93: South of 56th Avenue to 64th Parkway Intersection

with Bus on Shoulder without Auxiliary Lanes

Note: Highway improvements from Heritage Road to south of 56th Avenue are consistent with The Golden Plan.

### INTERSECTION AND INTERCHANGE OPTIONS

#### 3 64th Parkway



No Action, At-Grade Intersection Improvements, Channelized-T Intersection, Grade Separated Turning Movement, Roundabout

#### 2 58th Avenue



No Action, At-Grade Intersection Improvements, Channelized-T Intersection, Roundabout

#### Golden Plan Area

Note: Intersections improvements from Heritage Road to south of 56th Avenue are consistent with The Golden Plan (see next page).

#### 1 US 6/C-470/Johnson Road



No Action, At-Grade Intersection Improvements, Light Rail Grade Separation of Intersection



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### ***Multimodal, Technology, and Corridor Management***

Multimodal options considered for the Golden segment include improved intersection crossings for pedestrians and bicyclists at intersections, and separated trail along CO 93 north to 64<sup>th</sup> Parkway.

Technology options considered:

- Adaptive traffic signals
- Variable speed limits
- Enhanced communications infrastructure
- Enhanced lane markings
- Queue warnings
- Wildlife detection and alert systems
- Improved traveler information signs
- Road/weather information systems
- Transit signal priority

Corridor Management options considered for the Golden Segment include:

- Travel Demand Management strategies
- Enhanced maintenance and operations program
- Event traffic management program
- Access management plan
- Incident Management Plan
- Wildlife crossings

### **CO 93 Segment – 64<sup>th</sup> Parkway to Marshall Rd**

Figure 5 illustrates and describes the Level 2A Screening options developed for the CO 93 Segment.

#### ***Highway Options***

Options considered for highway improvement include:

- No Action
- Four General Purpose Lanes
- Two Lanes with Bus on Shoulder Lanes
- Two Lanes with Additional Passing Lanes
- New Split Alignment with Additional Lanes
- Two Lanes with Widened Shoulders

#### ***Intersections/Interchanges Options***

The configuration of the future intersection of Jefferson Parkway at CO 93 is being evaluated by the JPPHA as part of their access approval process.



At 82<sup>nd</sup> Avenue, options considered include lane modifications, a Channelized T intersection, a Median U-turn intersection, and a roundabout. At the intersection with CO 72, improvement options considered include lane modifications at the at-grade intersection, a continuous flow intersection, a roundabout, and a grade separated interchange that would eliminate the signalized stop at CO 72.

At Westgate Road, the road serving the Rocky Flats Wildlife Refuge, options included at-grade intersection improvements and a Channelized T intersection. At CO 128, options considered include at-grade intersection improvements, grade separation of the southbound to eastbound left turn, a roundabout intersection, and a channelized T intersection. At the CO 170/Marshall Road intersection, options considered were at-grade intersection improvements and a roundabout intersection.

**Multimodal, Technology, and Corridor Management**

Multimodal infrastructure options considered for this segment include:

- Improved intersection crossings for pedestrians and bicyclists at intersections
- Improved park-n-ride at CO 72
- Pedestrian/bicyclist grade separation of CO 93 north of CO 128
- Separated trail along CO 93 from Golden to CO 170
- Increased service of the GS bus route from Golden to Boulder
- Queue jump lanes for buses at signalized intersections along CO 93

**Technology and Corridor Management**

Technology options considered:

- |   |  |
|---|--|
| ■ Advanced signal warning flashers      | ■ Enhanced lane markings               |
| ■ Adaptive traffic signals              | ■ Queue warnings                       |
| ■ Variable speed limits                 | ■ Wildlife detection and alert systems |
| ■ Enhanced communication infrastructure | ■ Road/weather information systems     |
| ■ Improved traveler information signs   | ■ Transit signal priority              |

Corridor Management options considered for the CO 93 Segment include:

- Travel Demand Management Strategies
- Access management
- Incident management
- Wildlife crossings
- Additional snow fence
- Enhanced Maintenance and Operations Program

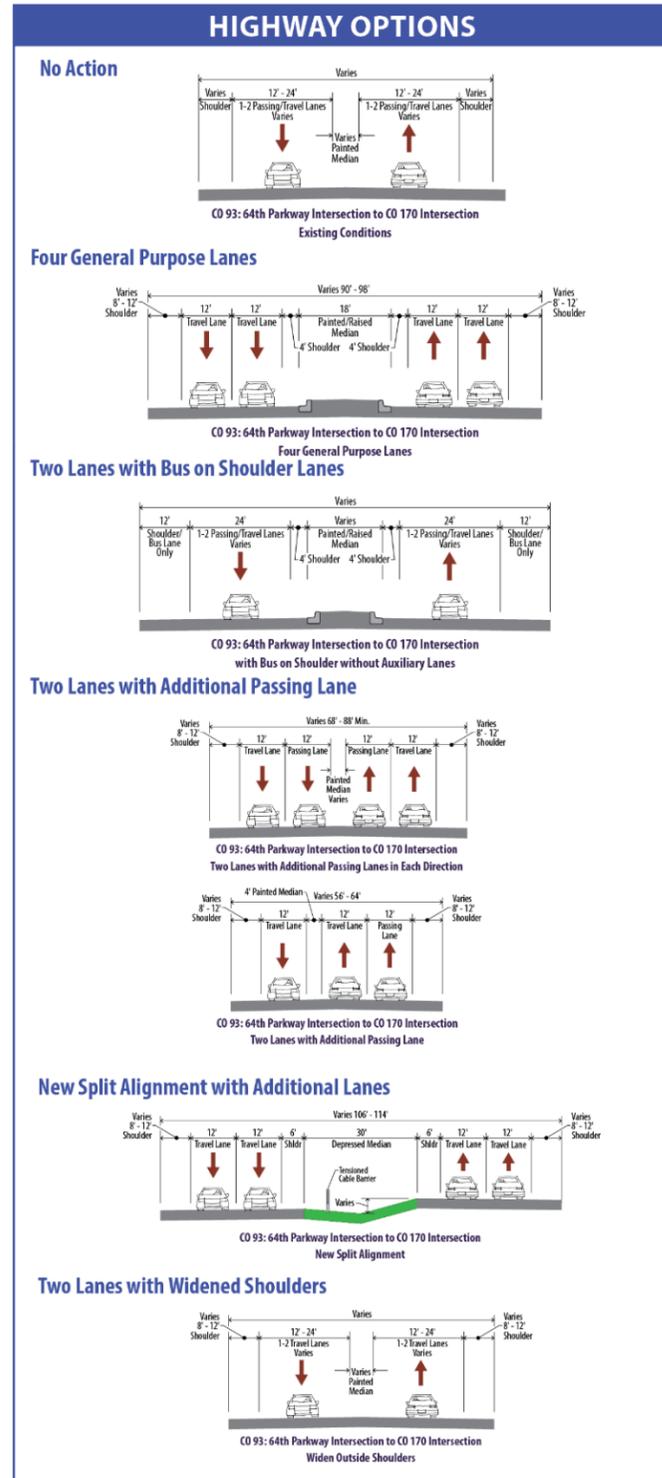
Figure 5: Level 2A – Options, CO 93 Segment



- ### CORRIDOR MANAGEMENT
- » Travel Demand Management Strategies
  - » Enhanced Maintenance and Operations Program
  - » Incident Management Plan
  - » Access Management Plan
  - » Wildlife Crossings
  - » Additional Snow Fence

- ### TECHNOLOGY
- » Road/Weather Warning Systems
  - » Adaptive Traffic Signals
  - » Advanced Signal Warning Flashers
  - » Transit Signal Priority
  - » Variable Speed Limits
  - » Queue Warnings
  - » Wildlife Detection and Alert Systems
  - » Enhanced Communications Infrastructure
  - » Improved Traveler Information Signs
  - » Enhanced Lane Markings

- ### MULTIMODAL INFRASTRUCTURE
- » Pedestrian/Bicyclist Grade Separation of CO 93 at CO 128
  - » Separated Trail along CO 93 from 64th Parkway to CO 170
  - » More GS Service and Queue Jumps along CO 93
- |  |  |  |
|--|--|--|
| <b>CO 72</b>                                   | <b>CO 128</b>                                  | <b>CO 170</b>                                  |
| » No Action                                    | » No Action                                    | » No Action                                    |
| » Improved Crossing for Pedestrians/Bicyclists | » Improved Crossing for Pedestrians/Bicyclists | » Improved Crossing for Pedestrians/Bicyclists |
| » Improved Park-n-Ride Facilities              |  |  |



### INTERSECTION AND INTERCHANGE OPTIONS

**5 CO 170, Marshall Road**

**4 CO 128**

**3 Westgate Road**

**2 CO 72**

**1 82nd Avenue**

**Future Jefferson Parkway**  
Future Jefferson Parkway intersection with CO 93 being evaluated by Jefferson Parkway Public Highway Authority.



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## Level 2A Evaluation Criteria

The technology and system management options were valued and screened separately, as summarized in **Appendices D** and **E**.

Evaluation criteria were developed to compare how well each highway, interchange/intersection, and multimodal option in Level 2A screening meets the Purpose and Need and goals of the project (see **Table 2**). The performance measures are a mix of qualitative and quantitative assessments, based on the criteria and the data available at this stage of development.

**Table 2: Level 2A – Evaluation Criteria and Performance Measures**

CATEGORY	CRITERIA	PERFORMANCE MEASURE
Safety	Ability to address identified unsafe physical or operational conditions	Qualitative assessment of expected change in frequency and severity of crashes at locations identified in Safety Assessment Report
	Potential multimodal conflict points	Vehicular, pedestrian, and bicyclist conflict points at intersections Qualitative assessment of pedestrian and bicyclist perception of comfort and safety
Traffic Operations	Roadway capacity related to 2040 travel demand	Volume-to-capacity (V/C) ratio for the highway options for 2040 daily traffic volumes
	Intersection delay during 2040 peak hours	Overall intersection Level of Service (LOS) for 2040 AM and PM peak hours
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	New infrastructure and/or wayfinding provided for pedestrians and bicyclists
	Enhanced transit options	Additional routes, frequency, and/or stop enhancements
Community	Design and operational context related to local community surroundings	Qualitative assessment of consistency of infrastructure and operations with existing and future local surroundings
	Impacts on existing properties	Number of properties that may be impacted based on conceptual layout Acres of properties that may be impacted based on conceptual layout
	Support of local and regional planning efforts	Noted consistencies and inconsistencies with recommendations within documented plans as identified in Corridor Conditions Report
Environmental Resources	Impacts on environmental resources within the built and natural environment	Qualitative and quantitative assessment of notable benefits and/or impacts to environmental resources based on existing conditions identified in Environmental Scan Report
Implementability	Construction costs	Assessment of conceptual-level probable construction costs (low, moderate, high, very high)
	Ease and cost of maintenance	Assessment of ease and accessibility for maintenance and conceptual-level probable maintenance costs (low, moderate, high, very high)

The color ratings shown with the performance measures in the Level 2A screening matrices were used as a visual indication of the comparative characteristics of a criterion between options. The colors are not used as an indication of a decision (i.e., an option with many “red” ratings was not automatically rendered unreasonable). The colors are a general indication of the following:

- Green = Comparatively beneficial and/or minor impacts
- Black = Comparatively neutral benefits and/or moderate impacts
- Red = Comparatively negative and/or major impacts

The color ratings for each criterion used in the options screening are defined below.

## Safety

### *Ability to address unsafe conditions*

- Green = potential for substantial crash reduction
- Black = no change to moderate crash reduction expected
- Red = increased safety concern or conflict

### *Multimodal conflict points*

- Green = 20% or more reduction compared to No Action condition
- Black = less than 20% reduction compared to No Action condition
- Red = increased number of conflict points

## Traffic Operations

### *2040 Daily roadway capacity related to daily travel demand*

- Green = V/C less than 0.9
- Black = V/C of 0.9
- Red = V/C of 1.0 or higher

### *2040 Peak hour intersection level of service*

- Green = LOS C or better during both the AM and PM peak hours
- Black = LOS D during both the AM and PM peak hours
- Red = LOS E or F during the AM or PM peak hour



## Multimodal Operations and Connectivity

### *Enhanced regional biking and walking options*

- Green = Substantial improvement in regional biking and walking opportunities
- Black = Minor to moderate improvement in regional biking and walking opportunities
- Red = No improvement in regional biking and walking opportunities

### *Enhanced transit options*

- Green = Substantial improvement in transit service or facilities
- Black = Minor to moderate improvement in transit service or facilities
- Red = No improvement in transit service or facilities

## Community

### *Design and operational context*

- Green = Consistent with surrounding design and operational context
- Red = Inconsistent with surrounding design and operational context

### *Impacts on existing properties*

- Green = Minor to no properties impacted; Less than one acre of impacts expected
- Black = Moderate number of properties or acres of impacts expected
- Red = Twice or more the number of properties or acres impacted than other options

### *Support of local and regional plans*

- Green = Consistent with relevant established plans
- Red = Inconsistent with relevant established plans

## Environmental Resources

### *Impacts on environmental resources*

- Green = Minor to no impacts to surrounding built or natural environment
- Black = Relatively moderate impacts to surrounding built or natural environment
- Red = Relatively major impacts to surrounding built or natural environment



## Implementability

### *Construction costs*

- Green = Relative low costs
- Black = Relative moderate costs
- Red = Relative high/very high costs

### *Ease and cost of maintenance*

- Green = Reduced and/or typical infrastructure or services with relatively easy maintenance access
- Black = Typical infrastructure or services with some increase in maintenance
- Red = Major increase in infrastructure or services with potential for high maintenance need

## Level 2A Screening

The evaluation matrices presented in **Tables 3** through **11** summarize the recommendation for each option as follows:

- **CARRIED FORWARD** – Option will be evaluated further as part of corridor alternative with further definition and conceptual design
- **NOT RECOMMENDED** – Option will not be evaluated further in the study due to comparatively negligible benefits and higher impacts than other options
- **ELIMINATED** – Option does not meet the Purpose and Need established with this study or the option is unreasonable due to impacts and/or infeasibility

Table 3: Level 2A – C-470: Highway Options

CATEGORY	EVALUATION CRITERIA	NO ACTION	AUXILIARY LANES BETWEEN INTERCHANGES	SIX GENERAL PURPOSE LANES	FOUR/SIX GENERAL PURPOSE LANES WITH FOUR MANAGED LANES	FOUR/SIX LANES WITH PEAK PERIOD SHOULDER LANES
Safety	Ability to address identified safety problems	Rear end and side swipe crash types likely to increase with traffic volume growth	Congestion related crashes likely to increase with traffic volume growth	Potential crash reduction with reduced congestion and improved merge/diverge areas	Potential crash reduction with reduced congestion Additional merge and diverge movements with managed lanes may introduce new conflict areas and potential crashes	Reduced shoulder width introduces new potential crash issues and increases potential conflicts and queues near incidents
Traffic Operations	Roadway capacity related to 2040 travel demand (V/C ratio)	Kipling to Morrison: V/C = 1.2 Morrison to I-70: V/C = 1.1	Kipling to Morrison: V/C = 1.0 Morrison to I-70: V/C = 1.1	Kipling to Morrison: V/C = 0.7 Morrison to I-70: V/C = 0.9	Kipling to Morrison: V/C = 0.7 Morrison to I-70: V/C = 1.0	Kipling to Morrison: V/C = 1.0 Morrison to I-70: V/C = 1.0
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists				
	Enhanced transit options	No additional transit service provided				
Community	Design and operational context	C-470 alignment and design elements blend well with unique natural surroundings along Dakota Hogback but with recurring peak period congestion	Widened corridor generally consistent with corridor natural and built surroundings	Widened corridor generally consistent with corridor natural and built surroundings	Substantial widening and infrastructure and sign structures for managed lane operations somewhat inconsistent with corridor natural surroundings but consistent with improvements underway in Segment 1 east of Wadsworth to I-25	Widened corridor generally consistent with corridor natural and built surroundings
	Impacts on existing properties	None	4 properties < 1 acre	4 properties < 1 acre	8 properties 1 acre	5 properties < 1 acre
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans identifying roadway capacity projects along C-470	Consistent with Jefferson County plans identifying roadway capacity projects along C-470	Consistent with Jefferson County plans identifying roadway capacity projects along C-470	Consistent with Jefferson County plans identifying roadway capacity projects along C-470	Consistent with Jefferson County plans identifying roadway capacity projects along C-470
Environmental Resources	Impacts on environmental resources	No impacts	~ 1,400 LF of potential trail impacts 13 historic sites 9 100-year floodplain areas 10 water bodies 9 parks and open space properties	~ 1,400 LF of potential trail impacts 14 historic sites 9 100-year floodplain areas 10 water bodies 9 parks and open space properties	~ 5,400 LF potential trail realignment 14 historic sites 9 100-year floodplain areas 10 water bodies 9 parks and open space properties	~ 1,700 LF of potential trail impacts 14 historic sites 9 100-year floodplain areas 10 water bodies 9 parks and open space properties
Implementability	Construction costs (low, moderate, high, very high)	None	Low	Moderate	Very High	High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Low	Moderate	Very High	High
Summary of Results		<b>CARRIED FORWARD</b>	<b>ELIMINATED</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>ELIMINATED</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options	Does not meet the Purpose and Need related to safety and operational improvements due to increased safety concerns and insufficient capacity Option may be applicable for short term phased implementation			Does not meet the Purpose and Need related to safety and operational improvements due to increased safety concerns and insufficient capacity Option may be applicable for short term phased implementation

Table 4: Level 2A – C-470: Interchange Options

CATEGORY	EVALUATION CRITERIA	KIPLING PARKWAY		KEN CARYL AVENUE		BOWLES AVENUE		
		NO ACTION	LANE MODIFICATIONS AT RAMP INTERSECTIONS <sup>(1)</sup>	NO ACTION	LANE MODIFICATIONS AT RAMP INTERSECTIONS <sup>(1)</sup>	NO ACTION	LANE MODIFICATIONS AT RAMP INTERSECTIONS <sup>(1)</sup>	DIVERGING DIAMOND INTERCHANGE
Safety	Ability to address identified safety problems	Rear end and side swipe crash types likely to increase with traffic volume growth	Additional capacity may address congestion-related crashes	Rear end and side swipe crash types likely to increase with traffic volume growth	Additional capacity may address congestion-related crashes	Rear-end and side swipe crash types likely to increase with traffic volume growth	Additional capacity may address congestion-related crashes	Substantial safety benefits with no left turn conflicts at ramps
	Potential multimodal conflict points (pts)	30 vehicular pts 13 ped/bike pts	30 vehicular pts 13 ped/bike pts	30 vehicular pts 8 ped/bike pts	30 vehicular pts 8 ped/bike pts	30 vehicular pts 8 ped/bike pts	30 vehicular pts 8 ped/bike pts	14 vehicular pts 6 - 12 ped/bike pts
Traffic Operations	2040 peak hour intersection delay (AM/PM)	EB Ramps: LOS C/C WB Ramps: LOS C/C	EB Ramps: LOS B/C WB Ramps: LOS C/C	EB Ramps: LOS E/C WB Ramps: LOS C/C	EB Ramps: LOS C/C WB Ramps: LOS C/C	EB Ramps: LOS D/D WB Ramps: LOS F/A	EB Ramps: LOS D/D WB Ramps: LOS B/A	EB Ramps: LOS A/A WB Ramps: LOS B/B
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists						
	Enhanced transit options	No additional transit service provided						
Community	Design and operational context	Interchange design consistent with other area interchanges and adjacent surroundings	Minor modifications consistent with other area interchanges and adjacent surroundings	Interchange design consistent with other area interchanges and adjacent surroundings	Minor modifications consistent with other area interchanges and adjacent surroundings	Interchange design consistent with other area interchanges and adjacent surroundings	Minor modifications consistent with other area interchanges and adjacent surroundings	Unique interchange layout along corridor but generally consistent with surrounding character
	Impacts on existing properties	None	2 properties < 1 acre	None	6 properties < 1 acre	None	3 properties < 1 acre	9 properties < 1 acre
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans identifying interchange capacity projects along C-470	Consistent with Jefferson County plans identifying interchange capacity projects along C-470	Inconsistent with Jefferson County plans identifying interchange capacity projects along C-470	Consistent with Jefferson County plans identifying interchange capacity projects along C-470	Inconsistent with Jefferson County plans identifying interchange capacity projects along C-470	Consistent with Jefferson County plans identifying interchange capacity projects along C-470	Consistent with Jefferson County plans identifying interchange capacity projects along C-470
Environmental Resources	Impacts on environmental resources	No impacts	~ 1,700 LF of potential trail impacts Minimal impacts expected on other resources	No impacts	< 100 LF of potential trail impacts Minimal impacts expected on other resources	No impacts	~ 200 LF of potential trail impacts Minimal impacts expected on other resources	~ 700 LF of potential trail impacts Potential moderate impacts to cultural sites, historic sites, noise sensitive areas, and parks and open space properties
Implementability	Construction costs (low, moderate, high, very high)	None	Moderate	None	Moderate	None	Moderate	High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options		The No Action option is carried forward for comparison to the benefits and impacts of action options		The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to adequate operational benefits with lower cost lane modifications.

<sup>(1)</sup> See lane configurations page for summary of lane modifications.

Table 4 (cont.): Level 2A – C-470: Interchange Options

CATEGORY	EVALUATION CRITERIA	QUINCY AVENUE				US 285		ALAMEDA PARKWAY		I-70/US 6		
		NO ACTION	LANE MODIFICATIONS AT RAMP INTERSECTIONS <sup>(1)</sup>	ROUNDBABOUTS INTERCHANGE	BRAIDED RAMPS	NO ACTION	FULLY DIRECTIONAL INTERCHANGE	NO ACTION	LANE MODIFICATIONS AT RAMP INTERSECTIONS <sup>(1)</sup>	NO ACTION	COLLECTOR/DISTRIBUTOR ROADS	BRAIDED RAMPS
Safety	Ability to address identified safety problems	Broadside crash pattern likely to increase with traffic volume growth	Crash reduction from changes to traffic control	Crash reduction for frequency and severity, particularly broadside crash pattern	Potential crash reduction with reduced weaving conflicts	Rear end and side swipe crash types likely to increase with traffic volume growth	Potential crash reduction with reduced weaving conflicts	Minimal crash history/low volume	Additional capacity may address congestion-related crashes	Rear end and side swipe crash types likely to increase with traffic volume growth	Potential crash reduction with reduced weaving conflicts	Potential crash reduction with reduced weaving conflicts
	Potential multimodal conflict points (pts)	27 vehicular pts No ped/bike pts	27 vehicular pts No ped/bike pts	18 vehicular pts No ped/bike pts	26 vehicular pts No ped/bike pts	16 vehicular pts No ped/bike pts	13 vehicular pts No ped/bike pts	26 vehicular pts 2 ped/bike pts	26 vehicular pts 2 ped/bike pts	16 vehicular pts No ped/bike pts	17 vehicular pts No ped/bike pts	18 vehicular pts No ped/bike pts
Traffic Operations	2040 peak hour intersection delay (AM/PM)	EB Ramps: LOS F/F WB Ramps: LOS E/E	EB Ramps: LOS E/D WB Ramps: LOS C/C	EB Ramps: LOS B/B WB Ramps: LOS A/A	EB Ramps: LOS B/B WB Ramps: LOS A/A	Low speed loop ramps, and AM on ramp congestion when C-470 congested	Improved ramp speed and operations	EB Ramps: LOS C/B WB Ramps: LOS A/A	EB Ramps: LOS C/B WB Ramps: LOS A/A	Low speed resulting from weaving movements affects mainline I-70	Separated C/D road maintains speed and operations on I-70	Braided ramps eliminates weaving
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists										
	Enhanced transit options	No additional transit service provided										
Community	Design and operational context	Interchange design consistent with adjacent surroundings	Modifications consistent with adjacent surroundings	Modifications consistent with adjacent surroundings	Modifications consistent with adjacent surroundings	Recurring congestion inconsistent in unique natural surroundings	Design consistent with major highway interchange	Interchange design is consistent with other area interchanges and adjacent surroundings	Minor modifications consistent with other area interchanges and adjacent surroundings	Interchange design consistent with adjacent surroundings	Modifications consistent with adjacent surroundings	Design consistent with major highway interchange
	Impacts on existing properties	None	0 properties 0 acres	2 properties < 1 acre	3 properties 2 acres	None	0 properties 0 acres	None	1 property < 1 acre	None	Minimal property impacts likely	Minimal property impacts likely
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Inconsistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges	Inconsistent with Jefferson County plans for C-470 interchanges	Consistent with Jefferson County plans for C-470 interchanges
Environmental Resources	Impacts on environmental resources	No impacts	No trail impacts expected Minimal impacts expected on other resources	No trail impacts expected 1 historic site	270 LF of potential trail impacts 1 historic site	No impacts	No trail impacts expected Minimal impacts expected on other resources	No impacts	No trail impacts expected Minimal impacts expected on other resources	No impacts	Widened highway may increase noise to residential area	Raised roadway profile may increase noise to residential area
Implementability	Construction costs (low, moderate, high, very high)	None	Moderate	High	Very High	None	Very High	None	Moderate	None	High	Very High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Moderate	Very High	Moderate	Very High	Moderate	Moderate	Moderate	High	Very High
Summary of Results		CARRIED FORWARD	NOT RECOMMENDED	CARRIED FORWARD	NOT RECOMMENDED	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	NOT RECOMMENDED	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options	Not recommended because option does not provide acceptable operations and has moderate costs		Not recommended due to similar operational benefits with lower-cost options May be considered with US 285 interchange improvements to optimize operations	The No Action option is carried forward for comparison to the benefits and impacts of action options		The No Action option is carried forward for comparison to the benefits and impacts of action options	Not recommended because No Action option provides acceptable operations and safety with less impacts and cost	The No Action option is carried forward for comparison to the benefits and impacts of action options		

<sup>(1)</sup> See lane configurations page for summary of lane modifications.

Table 5: Level 2A – C-470: Multimodal Options

CATEGORY	EVALUATION CRITERIA	CORRIDOR-WIDE				KIPLING PARKWAY			KEN CARYL AVENUE		
		NO ACTION	NEW EXPRESS SERVICE KEN CARYL TO DOWNTOWN DENVER	INCREASED 116X FREQUENCY	C-470 TRAIL SIGNAGE/ WAYFINDING IMPROVEMENTS	NO ACTION	PEDESTRIAN/ BICYCLIST GRADE SEPARATION	IMPROVED CROSSINGS FOR PEDESTRIAN/ BICYCLISTS	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS	IMPROVED PARK-N-RIDE FACILITIES
Safety	Ability to enhance safety across travel modes	No change to existing multimodal operations	Minimal potential safety benefit from mode shift away from single occupancy vehicle	Minimal potential safety benefit from mode shift away from single occupancy vehicle	Potential safety benefit	No change to existing physical conditions	Potential substantial safety benefit	Potential safety benefit	No change to existing physical conditions	Potential safety benefit	No safety concerns with existing Park-n-Ride
	Potential multimodal conflict points	Minimal conflict points along C-470 Trail	No change from No Action	No change from No Action	No change from No Action	C-470 Trail crosses Kipling Pkwy with sidewalk on both sides of Kipling Pkwy and marked crosswalks	Substantially reduced conflict points with grade separation	Potential reduced conflict and improvement in perception of comfort/safety	C-470 Trail crosses Ken Caryl Ave with sidewalk on south side of Ken Caryl Ave and marked crosswalks	Potential reduced conflict and improvement in perception of comfort/safety	Minimal conflict points with existing Park-n-Ride access
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	New and improved wayfinding	No new infrastructure and/or wayfinding	New grade separation substantially enhances opportunities	Crossing improvements enhance opportunities	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	New wayfinding to lot for pedestrians and bicyclists
	Enhanced transit options	Existing transit service with ridership of 67 daily boardings	New service to Downtown Denver with estimated ridership of 150 daily boardings	Increased frequency to Downtown Denver with estimated ridership of 100 daily boardings	No additional transit service	No additional transit service	No change from No Action	No change from No Action	No additional transit service	Potential improvements for transit connections	Existing Park-n-Ride with 6% utilization accommodates demand
Community	Design and operational context	Limited transit service common along C-470 corridor	Improvements desirable in support of local community	Improvements desirable in support of local community	Improvements desirable in support of local community	High volume/high speed crossings undesirable in local community	Improvements desirable in support of local community and trail users	Improvements desirable in support of local community and trail users	High volume/high speed crossings undesirable in local community	Improvements desirable in support of local community	Existing Park-n-Ride fits within design and operational context
	Impacts on existing properties	None	None	None	None	None	1 property < 1 acre	Minimal impacts expected	None	Minimal impacts expected	1 property 1 acre
	Support of local and regional planning efforts (consistent or inconsistent)	Inconsistent with Jefferson County and Lakewood plans supporting transit improvements	Consistent with Jefferson County and City of Lakewood plans supporting transit improvements	Consistent with Jefferson County and City of Lakewood plans supporting transit improvements	Consistent with Jefferson County plans to develop a wayfinding system	Inconsistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Inconsistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans supporting transit improvements
Environmental Resources	Impacts on environmental resources	No impacts	No impacts	No impacts	Minimal impacts expected	No impacts	~ 300 LF of potential trail impacts Moderate impacts dependent on design	Minimal impacts expected	No impacts	Minimal impacts expected	Moderate impacts dependent on size and design
Implementability	Construction costs (low, moderate, high, very high)	None	Very High	Moderate	Low	None	High	Low	None	Low	Moderate
	Ease and cost of maintenance (low, moderate, high, very high)	Low	High	Moderate	Low	Low	High	Low	Low	Low	Moderate
Summary of Results		CARRIED FORWARD	NOT RECOMMENDED	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	NOT RECOMMENDED
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options	Not recommended due to relatively low ridership increase and very high cost			The No Action option is carried forward for comparison to the benefits and impacts of action options			The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to minimal safety, operational, and multimodal benefits and moderate cost

Table 5 (cont.): Level 2A – C-470: Multimodal Options

CATEGORY	EVALUATION CRITERIA	BOWLES AVENUE			QUINCY AVENUE			MORRISON ROAD		
		NO ACTION	PEDESTRIAN/ BICYCLIST GRADE SEPARATION	IMPROVED CROSSINGS FOR PEDESTRIAN/ BICYCLISTS	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIAN/ BICYCLISTS	IMPROVED PARK-N-RIDE FACILITIES	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS	IMPROVED SHARED RIDE FACILITIES
Safety	Ability to enhance safety across travel modes	No change to existing physical conditions	Potential substantial safety benefit	Potential safety benefit	No change to existing physical conditions	Potential safety benefit	Potential safety benefit of formal Park-n-Ride versus on street parking	No change to existing physical conditions	Potential safety benefit	Potential safety benefit of formalized parking lot
	Potential multimodal conflict points	C-470 Trail crosses Bowles Ave east of C-470 with sidewalk on south side of Bowles Ave with marked crosswalks	Substantially reduced conflict points with grade separation	Potential reduced conflict and improvement in perception of comfort/safety	No crossings or continuous pedestrian/bicyclist facilities at ramp intersections	Intersection crossings would require added sidewalks/paths throughout interchange area	Potential reduced conflict with changes to Park-n-Ride access	C-470 Trail crosses Morrison Rd at unsignalized and unmarked crossing	Potential reduced conflict and improvement in perception of comfort/safety	Potential reduced conflict with changes to Park-n-Ride access
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	New grade separation enhances opportunities	Crossing improvements enhance opportunities	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	Potential improvements for walking and biking connections	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	Potential substantial improvements for walking and biking connections
	Enhanced transit options	No additional transit service	Potential improvements for transit connections	Potential improvements for transit connections	No additional transit service	Potential improvements for transit connections	Improved transit facility	No additional transit service	Potential improvements for transit connections	Improved carpool and cyclist parking facility
Community	Design and operational context	High volume/high speed crossings undesirable in local community	Improvements desirable in support of local community and trail users	Improvements desirable in support of local community and trail users	Uncontrolled ped/bike crossings undesirable in local community	Improvements desirable in support of local community and trail users	Improvements desirable in support of local community	High volume/high speed crossings undesirable in local community	Improvement desirable in support of local community and trail users	Improvements desirable in support of local community
	Impacts on existing properties	None	Minimal impacts expected	Minimal impacts expected	None	Minimal impacts expected	1 property 1 acre	None	Minimal impacts expected	Minimal impacts expected
	Support of local and regional planning efforts (consistent or inconsistent)	Inconsistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Inconsistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans supporting transit improvements	Inconsistent with Jefferson County and Town of Morrison plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County and Town of Morrison plans to improve pedestrian and bicyclist infrastructure	Consistent with Jefferson County plans supporting mode shift and bicyclist improvements
Environmental Resources	Impacts on environmental resources	No impacts	~ 400 LF of potential trail impacts Minimal impacts expected on other resources	Minimal impacts expected	No impacts	Minimal impacts expected	Moderate impacts dependent on size and design	No impacts	Minimal impacts expected	Moderate impacts dependent on size and design
Implementability	Construction costs (low, moderate, high, very high)	None	High	Low	None	Moderate	High	None	Low	Low
	Ease and cost of maintenance (low, moderate, high, very high)	Low	High	Low	Low	Moderate	High	Low	Low	Low
Summary of Results		CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options			The No Action option is carried forward for comparison to the benefits and impacts of action options			The No Action option is carried forward for comparison to the benefits and impacts of action options		

**Table 6: Level 2A – Golden: Highway Options (from south of 56<sup>th</sup> Avenue to 64<sup>th</sup> Parkway)**

Highway improvements along US 6/CO 93 from Heritage Road to south of 56<sup>th</sup> Avenue are consistent with The Golden Plan and alternatives through that section were not evaluated.

CATEGORY	EVALUATION CRITERIA	NO ACTION	FOUR GENERAL PURPOSE LANES	TWO LANES WITH BUS ON SHOULDER LANES
Safety	Ability to address identified safety problems	Wild animal, guard rail and rear-end crash patterns likely to increase with traffic volume growth.	Wild animal crashes likely to increase with traffic volume growth. Potential rear end and side swipe crash reduction with added capacity	Wild animal, guard rail and rear-end crash patterns likely to increase with traffic volume growth. Increased safety concerns with bicyclist and bus sharing shoulder
Traffic Operations	Roadway capacity related to 2040 travel demand (V/C ratio)	<u>with Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 1.4 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 1.1 <u>without Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 1.3 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 0.9	<u>with Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 0.7 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 0.8 <u>without Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 0.7 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 0.7	<u>with Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 1.4 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 1.1 <u>without Jeff Pkwy</u> CO 58 to 58 <sup>th</sup> Ave: V/C = 1.3 58 <sup>th</sup> Ave to 64 <sup>th</sup> Pkwy: V/C = 0.9
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding	Widened shoulders allow more space for bicyclists	Bus on shoulder service would negatively impact bicyclists on shoulder if no separate facility provided
	Enhanced transit options	No additional transit service	No additional transit service	Bus on shoulder improves service
Community	Design and operational context	Recurring AM and PM congestion and delay inconsistent with local community	Reduced congestion generally consistent with local community	Improved transit experience and reduced delay generally consistent with local community
	Impacts on existing properties	None	25 properties 4 acres	16 properties 2 acres
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans for improvements along CO 93	Consistent with Jefferson County plans for four lanes from Golden to County line	Inconsistent with Jefferson County plans for four lanes from Golden to County line
Environmental Resources	Impacts on environmental resources	No impacts	1 trail crossing 3 known cultural sites 1 historic sites 4 noise sensitive areas 1 freshwater wetland 1 100-year floodplain 1 water body	1 trail crossing 3 known cultural sites 1 historic sites 4 noise sensitive areas 1 freshwater wetland 1 100-year floodplain 1 water body
Implementability	Construction costs (low, moderate, high, very high)	None	High	Low
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Low
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>ELIMINATED</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options		Does not meet the Purpose and Need related to safety and operational improvements due to increased safety concerns and insufficient capacity

**Table 7: Level 2A – Golden: Intersection Options**

Intersection improvements along US 6/CO 93 from Heritage Road to south of 56<sup>th</sup> Avenue are consistent with The Golden Plan and alternatives through that section were not evaluated.

CATEGORY	EVALUATION CRITERIA	US 6/C-470/JOHNSON ROAD			58 <sup>TH</sup> AVENUE				64 <sup>TH</sup> PARKWAY				
		NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	LIGHT RAIL GRADE SEPARATION OF INTERSECTION	NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	CHANNELIZED-T INTERSECTION	ROUNDBABOUT	NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	CHANNELIZED-T INTERSECTION	GRADE SEPARATED TURNING MOVEMENT	ROUNDBABOUT
Safety	Ability to address identified safety problems	Rear end and side swipe crashes likely to increase with traffic growth	Additional capacity may address congestion-related crashes	Crash reduction with reduced congestion and removal of rail conflicts	Rear end and side swipe crashes likely to increase with traffic growth	Additional capacity may address congestion-related crashes	Additional capacity may address congestion-related crashes	Crash reduction for frequency and severity	Rear end and side swipe crashes likely to increase with traffic growth	Additional capacity may address congestion-related crashes	Additional capacity may address congestion-related crashes	Potential crash reduction with reduced conflict	Crash reduction for frequency and severity
	Potential multimodal conflict points (pts)	36 vehicular pts 10 ped pts 6 bike pts	36 vehicular pts 10 ped pts 6 bike pts	32 vehicular pts 8 ped pts 4 bike pts	9 vehicular pts 6 ped pts 10 bike pts	9 vehicular pts 6 ped pts 10 bike pts	9 vehicular pts 6 ped pts 10 bike pts	6 vehicular pts 6 ped/bike pts	9 vehicular pts 6 ped pts 10 bike pts	9 vehicular pts 6 ped pts 10 bike pts	9 vehicular pts 6 ped pts 10 bike pts	8 vehicular pts 5 ped pts 9 bike pts	6 vehicular pts 6 ped/bike pts
Traffic Operations	2040 peak hour intersection delay (AM/PM)	LOS E/D (with and without Jeff Pkwy)	LOS D/C (with and without Jeff Pkwy)	LOS D/C (with and without Jeff Pkwy)	w/Jeff Pkwy: LOS D/C w/o Jeff Pkwy: LOS C/B	w/Jeff Pkwy: LOS B/A w/o Jeff Pkwy: LOS B/A	w/Jeff Pkwy: LOS B/A w/o Jeff Pkwy: LOS B/A SB CO 93 free flow	w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS E/F	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS C/D	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS C/D SB CO 93 free flow	w/Jeff Pkwy: LOS A/A w/o Jeff Pkwy: LOS A/A	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS B/B
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Grade separation for pedestrians and bicyclists	Pedestrian and bicyclist improvements
	Enhanced transit options	No additional transit service	No additional transit service	No additional transit service	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay	Minor reduction in transit delay
Community	Design and operational context	Recurring AM and PM congestion inconsistent with local community	Improvements desirable in support of local community	Light rail access impacts inconsistent with current ease of use	At grade intersection compatible with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Generally consistent with local community surroundings	At grade intersection compatible with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Magnitude of infrastructure generally inconsistent with local surroundings	Generally consistent with local community surroundings
	Impacts on existing properties	None	0 properties 0 acres	Moderate property impacts likely	None	3 properties < 1 acre	3 properties < 1 acre	3 properties < 1 acre	None	4 properties 2 acres	4 properties 2 acres	5 properties 3 acres	5 properties 3 acres
	Support of local and regional plans (consistent or inconsistent)	Generally inconsistent with City of Golden plans along US 6	Generally consistent with City of Golden plans along US 6	Generally inconsistent with City of Golden plans along US 6	Inconsistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Inconsistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93
Environmental Resources	Impacts on environmental resources	No impacts	Minimal to no impact	1 trail crossing 1 known cultural site 2 historic sites	No impacts	1 noise sensitive area	1 noise sensitive area	2 noise sensitive areas	No impacts	2 parks and open spaces	1 parks and open space	2 parks and open spaces	2 parks and open spaces
Implementability	Construction costs (low, moderate, high, very high)	None	Moderate	Very High	None	Moderate	Moderate	Moderate	None	Moderate	Moderate	Very High	High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Very High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Very High	High
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to similar safety and operational benefits as other option with high impacts and very high cost	The No Action option is carried forward for comparison to the benefits and impacts of action options				The No Action option is carried forward for comparison to the benefits and impacts of action options				Not recommended due to similar operations as other lower-cost options

<sup>(1)</sup> See lane configurations page for summary of lane modifications.

**Table 8: Level 2A – Golden: Multimodal Options**

Multimodal improvements along US 6/CO 93 from Heritage Road to south of 56<sup>th</sup> Avenue are consistent with The Golden Plan and alternatives through that section were not evaluated.

CATEGORY	EVALUATION CRITERIA	CORRIDOR-WIDE			US 6/C-470/JOHNSON ROAD		58 <sup>TH</sup> AVENUE		64 <sup>TH</sup> PARKWAY	
		NO ACTION	SEPARATED TRAIL ALONG CO 93 NORTH OF PINE RIDGE RD TO 64 <sup>TH</sup> PKWY	TRANSIT SERVICE FROM KEN CARYL PARK-N-RIDE TO GOLDEN	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS
Safety	Ability to enhance safety across travel modes	No change to existing multimodal operations	Potential safety benefit	Potential for safety benefit from mode shift away from single occupancy vehicle	No change to existing physical conditions	Potential safety benefit	No change to existing physical conditions	Potential safety benefit	No change to existing physical conditions	Potential safety benefit
	Potential multimodal conflict points	Potential conflict points with pedestrians and bicyclists at intersections and along highway shoulder	Reduced conflict along highway with pedestrians and bicyclists due to separated trail	No change from No Action	Conflict points with pedestrians and bicyclists at intersection	Potential reduced conflict and improvement in perception of comfort/safety	Conflict points with pedestrians and bicyclists at intersection	Potential reduced conflict and improvement in perception of comfort/safety	Conflict points with pedestrians and bicyclists at intersection	Potential reduced conflict and improvement in perception of comfort/safety
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	Pedestrians and bicyclists separated from traffic substantially enhances opportunities	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities
	Enhanced transit options	No additional transit service	No additional transit service	New transit service from Ken Caryl Park-n-Ride to Golden with estimated ridership of 30 boardings	No additional transit service	No additional transit service	No additional transit service	No additional transit service	No additional transit service	No additional transit service
Community	Design and operational context	Lack of separated trail inconsistent with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Crossing of high volume/high speed corridor undesirable in local community	Improvements desirable in support of local community	Intersection crossing somewhat undesirable in local community	Improvements desirable in support of local community	Intersection crossing somewhat undesirable in local community	Improvements desirable in support of local community
	Impacts on existing properties	None	28 properties 13 acres	Minimal impacts expected	None	Minimal impacts expected	None	Minimal impacts expected	None	Minimal impacts expected
	Support of local and regional planning efforts (consistent or inconsistent)	Inconsistent with Jefferson County plans for new trails and transit improvements	Consistent with Jefferson County plans for new trails	Consistent with Jefferson County plans for transit improvements	Inconsistent with City of Golden plans for pedestrian and bicyclist improvements	Consistent with City of Golden plans for pedestrian and bicyclist improvements	Inconsistent with Jefferson County plans for pedestrian and bicyclist improvements	Consistent with Jefferson County plans for pedestrian and bicyclist improvements	Inconsistent with Jefferson County plans for pedestrian and bicyclist improvements	Consistent with Jefferson County plans for pedestrian and bicyclist improvements
Environmental Resources	Impacts on environmental resources	No impacts	1 trail crossing 4 cultural sites 3 historic sites 3 noise sensitive areas 1 potential prairie dog colony 1 freshwater wetland 1 100-year floodplain 1 parks and open space 1 water body	No impacts	No impacts	Minimal impacts expected	No impacts	Minimal impacts expected	No impacts	Minimal impacts expected
Implementability	Construction costs (low, moderate, high, very high)	None	High	Very High	None	Low	None	Low	None	Low
	Ease and cost of maintenance (low, moderate, high, very high)	Low	High	Very High	Low	Low	Low	Low	Low	Low
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to relatively low ridership and very high cost	The No Action option is carried forward for comparison to the benefits and impacts of action options		The No Action option is carried forward for comparison to the benefits and impacts of action options		The No Action option is carried forward for comparison to the benefits and impacts of action options	

Table 9: Level 2A – CO 93: Highway Options

CATEGORY	EVALUATION CRITERIA	NO ACTION	FOUR GENERAL PURPOSE LANES	TWO LANES WITH BUS ON SHOULDER LANES	TWO LANES WITH ADDITIONAL PASSING LANES	NEW SPLIT ALIGNMENT WITH ADDITIONAL LANES	TWO LANES WITH WIDENED SHOULDERS																																																
Safety	Ability to address identified safety problems	Crash history with weather-related, wild animal, rear end, head-on and overturning vehicle crash patterns likely to increase with traffic volume growth	Substantial crash reduction with congestion and safety mitigation to address identified crash patterns, particularly head-on crashes	Increased safety concerns with bicyclist and bus sharing shoulder	Crash reduction with congestion and safety mitigation to address identified crash patterns	Substantial crash reduction with congestion and safety mitigation to address identified crash patterns, particularly head-on crashes	Minimal crash reduction to address identified crash patterns																																																
Traffic Operations	Roadway capacity related to 2040 travel demand (V/C ratio)	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.9</td> <td>64<sup>th</sup>-CO 72: V/C = 1.0</td> </tr> <tr> <td>CO 72-CO 128: V/C = 1.1</td> <td>CO 72-CO 128: V/C = 1.2</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.9</td> <td>CO 128-CO 170: V/C = 0.9</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.9	64 <sup>th</sup> -CO 72: V/C = 1.0	CO 72-CO 128: V/C = 1.1	CO 72-CO 128: V/C = 1.2	CO 128-CO 170: V/C = 0.9	CO 128-CO 170: V/C = 0.9	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.7</td> <td>64<sup>th</sup>-CO 72: V/C = 0.7</td> </tr> <tr> <td>CO 72-CO 128: V/C = 0.6</td> <td>CO 72-CO 128: V/C = 0.7</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.7</td> <td>CO 128-CO 170: V/C = 0.7</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.7	64 <sup>th</sup> -CO 72: V/C = 0.7	CO 72-CO 128: V/C = 0.6	CO 72-CO 128: V/C = 0.7	CO 128-CO 170: V/C = 0.7	CO 128-CO 170: V/C = 0.7	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.9</td> <td>64<sup>th</sup>-CO 72: V/C = 1.0</td> </tr> <tr> <td>CO 72-CO 128: V/C = 1.1</td> <td>CO 72-CO 128: V/C = 1.2</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.9</td> <td>CO 128-CO 170: V/C = 0.9</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.9	64 <sup>th</sup> -CO 72: V/C = 1.0	CO 72-CO 128: V/C = 1.1	CO 72-CO 128: V/C = 1.2	CO 128-CO 170: V/C = 0.9	CO 128-CO 170: V/C = 0.9	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.8</td> <td>64<sup>th</sup>-CO 72: V/C = 0.8</td> </tr> <tr> <td>CO 72-CO 128: V/C = 0.9</td> <td>CO 72-CO 128: V/C = 1.0</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.7</td> <td>CO 128-CO 170: V/C = 0.8</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.8	64 <sup>th</sup> -CO 72: V/C = 0.8	CO 72-CO 128: V/C = 0.9	CO 72-CO 128: V/C = 1.0	CO 128-CO 170: V/C = 0.7	CO 128-CO 170: V/C = 0.8	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.6</td> <td>64<sup>th</sup>-CO 72: V/C = 0.7</td> </tr> <tr> <td>CO 72-CO 128: V/C = 0.6</td> <td>CO 72-CO 128: V/C = 0.7</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.6</td> <td>CO 128-CO 170: V/C = 0.6</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.6	64 <sup>th</sup> -CO 72: V/C = 0.7	CO 72-CO 128: V/C = 0.6	CO 72-CO 128: V/C = 0.7	CO 128-CO 170: V/C = 0.6	CO 128-CO 170: V/C = 0.6	<table border="0"> <tr> <td>with Jeff Pkwy</td> <td>without Jeff Pkwy</td> </tr> <tr> <td>64<sup>th</sup>-CO 72: V/C = 0.9</td> <td>64<sup>th</sup>-CO 72: V/C = 1.0</td> </tr> <tr> <td>CO 72-CO 128: V/C = 1.1</td> <td>CO 72-CO 128: V/C = 1.2</td> </tr> <tr> <td>CO 128-CO 170: V/C = 0.9</td> <td>CO 128-CO 170: V/C = 0.9</td> </tr> </table>	with Jeff Pkwy	without Jeff Pkwy	64 <sup>th</sup> -CO 72: V/C = 0.9	64 <sup>th</sup> -CO 72: V/C = 1.0	CO 72-CO 128: V/C = 1.1	CO 72-CO 128: V/C = 1.2	CO 128-CO 170: V/C = 0.9	CO 128-CO 170: V/C = 0.9
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CO 128-CO 170: V/C = 0.9	CO 128-CO 170: V/C = 0.9																																																						
Multimodal Operations and Connectivity	Enhanced regional walking and biking options	No new infrastructure and/or wayfinding	Widened shoulders allows more space for bicyclists	Bus on shoulder service would negatively impact bicyclists on shoulder	Widened shoulders allows more space for bicyclists	Widened shoulders allows more space for bicyclists	Widened shoulders allows more space for bicyclists																																																
	Enhanced transit options	No additional transit service	No additional transit service	Bus on shoulder improves service	No additional transit service	No additional transit service	No additional transit service																																																
Community	Design and operational context	Recurring AM and PM congestion and limited shoulders inconsistent with local community and surroundings	Reduced congestion consistent with local community, but increased roadway width inconsistent with natural surroundings	Improved transit experience and reduced delay generally consistent with local community	Reduced congestion generally consistent with local community and minimal roadway width consistent with natural surroundings	Reduced congestion generally consistent with local community surroundings, and alignment conforming to and consistent with natural surroundings	Recurring AM and PM congestion inconsistent with local community																																																
	Impacts on existing properties	None	35 properties 19 acres	27 properties 16 acres	22 properties 12 acres	47 properties 31 acres	25 properties 6 acres																																																
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County and Boulder County plans for improvements along CO 93	Consistent with Jefferson County plans for four lanes from Golden to County line, but inconsistent with Boulder County vision	Inconsistent with Jefferson County plans for four lanes from Golden to County line, but consistent with Boulder County vision	Inconsistent with Jefferson County plans for four lanes from Golden to County line, but consistent with Boulder County vision	Consistent with Jefferson County plans for four lanes from Golden to County line, but inconsistent with Boulder County vision	Inconsistent with Jefferson County plans for four lanes from Golden to County line, but consistent with Boulder County vision																																																
Environmental Resources	Impacts on environmental resources	No impacts	< 100 LF of potential trail impacts 2 potential hazardous material site/regions 14 known cultural sites 4 noise sensitive areas 1 potential prairie dog colony 6 potential PMJM habitats 3 freshwater wetlands 7 parks and open space properties	< 100 LF of potential trail impacts 2 potential hazardous material site/regions 13 known cultural sites 2 noise sensitive areas 1 potential prairie dog colony 5 potential PMJM habitats 3 freshwater wetlands 8 parks and open space properties	< 100 LF of potential trail impacts 2 potential hazardous material site/regions 10 known cultural sites 1 noise sensitive areas 2 potential prairie dog colonies 5 potential PMJM habitats 3 freshwater wetlands 8 parks and open space properties	< 100 LF of potential trail impacts 3 potential hazardous material site/regions 11 known cultural sites 1 noise sensitive areas 2 potential prairie dog colony 5 potential PMJM habitats 3 freshwater wetlands 9 parks and open space properties	< 100 LF of potential trail impacts 1 potential hazardous material site/regions 10 known cultural sites 1 noise sensitive areas 1 potential prairie dog colony 4 potential PMJM habitats 1 freshwater wetlands 7 parks and open space properties																																																
Implementability	Construction costs (low, moderate, high, very high)	None	High	Low	Moderate	Very High	Low																																																
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Low	Moderate	High	Low																																																
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>ELIMINATED</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>	<b>ELIMINATED</b>																																																
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options		Does not meet the Purpose and Need related to safety and operational improvements due to increased safety concerns without a separate trail for bicyclists and insufficient capacity		Not recommended due to similar safety and operational benefits to other options with substantially higher property impacts and very high costs Option may be applicable for sections of overall highway design	Does not meet the Purpose and Need related to safety and operational improvements due to insufficient capacity Option may be applicable for short term phased implementation																																																

Table 10: Level 2A – CO 93: Intersection Options

CATEGORY	EVALUATION CRITERIA	82ND AVENUE					CO 72				
		NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup> (SIGNALIZED)	CHANNELIZED-T INTERSECTION (SIGNALIZED)	MEDIAN U-TURN INTERSECTION (UNSIGNALIZED)	ROUNDBABOUT	NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	CONTINUOUS FLOW INTERSECTION	ROUNDBABOUT	GRADE-SEPARATED INTERCHANGE
Safety	Ability to address identified safety problems	Rear end and side swipe crashes likely to increase with traffic growth	Potential intersection crash reduction for identified crash patterns, but potential new crashes with signal	Potential intersection crash reduction	Potential intersection crash reduction, , but increased safety concerns with u-turns and high speeds	Crash reduction for frequency and severity	Rear end and side swipe crash pattern may increase with traffic growth	Additional capacity may address congestion-related crashes	Additional capacity may address congestion-related crashes	Crash reduction for frequency and severity	Potential substantial crash reduction with CO 93 grade separation
	Potential multimodal conflict points (pts)	32 vehicular pts 12 bike pts	32 vehicular pts 12 bike pts	11 vehicular pts 12 bike pts	16 vehicular pts 14 bike pts	8 vehicular pts 8 bike pts	32 vehicular pts 10 ped pts 32 bike pts	32 vehicular pts 10 ped pts 32 bike pts	30 vehicular pts 8 ped pts 32 bike pts	8 vehicular pts 4 ped pts 8 bike pts	Eliminates vehicular, pedestrian, and bicyclist conflicts with high volumes of CO 93 traffic
Traffic Operations	2040 peak hour intersection delay (AM/PM)	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS F/F	w/Jeff Pkwy: LOS A/A w/o Jeff Pkwy: LOS A/A	w/Jeff Pkwy: LOS A/A w/o Jeff Pkwy: LOS A/A SB CO 93 free flow	w/Jeff Pkwy: LOS C/E w/o Jeff Pkwy: LOS D/E	w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B	w/Jeff Pkwy: LOS D/E w/o Jeff Pkwy: LOS E/D	w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B	w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B	w/Jeff Pkwy: LOS B/D w/o Jeff Pkwy: LOS C/C	CO 72 Ramps: w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	Grade separation for pedestrians and bicyclists
	Enhanced transit options	No additional transit service	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay	Substantial reduction in transit delay
Community	Design and operational context	Recurring AM and PM congestion inconsistent with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Generally consistent with local community surroundings	Recurring AM and PM congestion inconsistent with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Generally consistent with local community surroundings	Design consistent with interchange of two state highways
	Impacts on existing properties	None	2 properties < 1 acre	2 properties < 1 acre	2 properties < 1 acre	3 properties < 1 acre	None	3 properties < 1 acre	4 properties < 1 acre	3 properties < 1 acre	5 properties 3 acres
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Inconsistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93	Consistent with Jefferson County plans for CO 93
Environmental Resources	Impacts on environmental resources	No impacts	2 historic sites 1 noise sensitive area 1 water body	4 historic sites 2 water bodies	1 known cultural site 4 historic sites 2 water bodies	4 historic sites 2 water bodies	No impacts	3 crossings of proposed Colorado Front Range Trail 5 historic sites	1 crossing of proposed Colorado Front Range Trail 3 historic sites	3 historic sites	2 crossings of proposed Colorado Front Range Trail 5 historic sites 1 freshwater wetland
Implementability	Construction costs (low, moderate, high, very high)	None	Moderate	Moderate	Moderate	Moderate	None	Moderate	High	Moderate	Very High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Very High
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>ELIMINATED</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>	<b>NOT RECOMMENDED</b>	<b>CARRIED FORWARD</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options			Does not meet the Purpose and Need related to safety and operational improvements		The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to similar safety and operational benefits as other lower-cost options	Not recommended due to less operational benefits than other options with similar costs	

<sup>(1)</sup> See lane configurations page for summary of lane modifications.

Table 10 (cont.): Level 2A – CO 93: Intersection Options

CATEGORY	EVALUATION CRITERIA	WESTGATE ROAD			CO 128					CO 170		
		NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup> (UN SIGNALIZED)	CHANNELIZED-T INTERSECTION	NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	GRADE SEPARATED TURNING MOVEMENT	ROUNABOUT	CHANNELIZED-T INTERSECTION	NO ACTION	AT-GRADE INTERSECTION IMPROVEMENTS <sup>(1)</sup>	ROUNABOUT
Safety	Ability to address identified safety problems	Crashes likely to increase with traffic volume	Turning traffic crashes likely to increase with signal removal	Additional capacity may address congestion-related crashes	Rear end and side swipe crashes likely to increase with traffic volume	Additional capacity may address congestion-related crashes	Additional capacity may address congestion-related crashes	Crash reduction for frequency and severity	Additional capacity may address congestion-related crashes	Rear end and side swipe crashes likely to increase with traffic volume	Additional capacity may address congestion-related crashes	Crash reduction for frequency and severity
	Potential multimodal conflict points (pts)	9 vehicular pts 4 ped pts 10 bike pts	9 vehicular pts 4 ped pts 10 bike pts	9 vehicular pts 4 ped pts 10 bike pts	9 vehicular pts 3 ped pts 10 bike pts	9 vehicular pts 3 ped pts 10 bike pts	7 vehicular pts 3 ped pts 9 bike pts	6 vehicular pts 2 ped pts 10 bike pts	9 vehicular pts 3 ped pts 10 bike pts	32 vehicular pts 16 ped pts 40 bike pts	32 vehicular pts 16 ped pts 40 bike pts	8 vehicular pts 8 ped/bike pts
Traffic Operations	2040 peak hour intersection delay (AM/PM)	w/Jeff Pkwy: LOS C/D w/o Jeff Pkwy: LOS E/E	w/Jeff Pkwy: LOS E/D w/o Jeff Pkwy: LOS F/D	w/Jeff Pkwy: LOS A/A w/o Jeff Pkwy: LOS A/A SB CO 93 free flow	w/Jeff Pkwy: LOS C/D w/o Jeff Pkwy: LOS D/D	w/Jeff Pkwy: LOS A/B w/o Jeff Pkwy: LOS A/B	w/Jeff Pkwy: LOS A/A w/o Jeff Pkwy: LOS A/B	w/Jeff Pkwy: LOS B/B w/o Jeff Pkwy: LOS B/B	w/Jeff Pkwy: LOS A/B w/o Jeff Pkwy: LOS A/B SB CO 93 free flow	w/Jeff Pkwy: LOS F/F w/o Jeff Pkwy: LOS F/D	w/Jeff Pkwy: LOS C/C w/o Jeff Pkwy: LOS C/C	w/Jeff Pkwy: LOS B/F w/o Jeff Pkwy: LOS B/F
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Grade separation for pedestrians and bicyclists	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements	No new infrastructure and/or wayfinding	Pedestrian and bicyclist improvements	Pedestrian and bicyclist improvements
	Enhanced transit options	No additional transit service	No additional transit service	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay	Minor reduction in transit delay	No additional transit service	No additional transit service	No additional transit service	Minor reduction in transit delay
Community	Design and operational context	At grade intersection compatible with local surroundings	Improvements desirable in support of local community	Improvements desirable in support of local community	At grade intersection compatible with local surroundings	Improvements desirable in support of local community	Improvements desirable in support of local community	Generally consistent with local community surroundings	Improvements desirable in support of local community	Recurring AM and PM congestion inconsistent with local community	Improvements desirable in support of local community	Generally consistent with local community surroundings
	Impacts on existing properties	None	1 property < 1 acre	0 properties 0 acres	None	2 properties < 1 acre	1 property < 1 acre	3 properties < 1 acre	2 properties < 1 acre	None	1 property < 1 acre	1 property 2 acres
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Consistent with Jefferson County plans along CO 93	Inconsistent with Boulder County plans along CO 93	Consistent with Boulder County plans along CO 93	Relatively inconsistent with Boulder County plans along CO 93	Consistent with Boulder County plans along CO 93	Consistent with Boulder County plans along CO 93	Inconsistent with Boulder County plans along CO 93	Consistent with Boulder County plans along CO 93	Consistent with Boulder County plans along CO 93
Environmental Resources	Impacts on environmental resources	No impacts	2 known cultural sites	3 known cultural sites	No impacts	1 water well 3 historic sites 1 potential prairie dog colony 1 parks and open space	1 crossing of Proposed Colorado Front Range Trail 1 known cultural site 3 historic sites 1 prairie dog colony 2 parks and open space	3 historic sites 2 parks and open space	4 historic sites 1 potential prairie dog colony 2 parks and open space	No impacts	1 crossing of Proposed Colorado Front Range Trail	2 crossings of Proposed Colorado Front Range Trail 1 potential prairie dog colony
Implementability	Construction costs (low, moderate, high, very high)	None	Low	Moderate	None	Moderate	Very High	Moderate	Moderate	None	Moderate	High
	Ease and cost of maintenance (low, moderate, high, very high)	Moderate	Low	Moderate	Moderate	Moderate	Very High	Moderate	Moderate	Moderate	Moderate	High
Summary of Results		CARRIED FORWARD	ELIMINATED	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	NOT RECOMMENDED	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	CARRIED FORWARD	NOT RECOMMENDED
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options	Does not meet Purpose and Need related to safety and operational improvements		The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended due to similar safety and operational benefits as other lower-cost options			The No Action option is carried forward for comparison to the benefits and impacts of action options		Not recommended because option does not provide acceptable operations and has high costs

<sup>(1)</sup> See lane configurations page for summary of lane modifications

Table 11: Level 2A – CO 93: Multimodal Options

CATEGORY	EVALUATION CRITERIA	CORRIDOR WIDE					CO 72		
		NO ACTION	SEPARATED TRAIL ALONG CO 93 FROM 64 <sup>TH</sup> PARKWAY TO CO 170	BUS STOP IMPROVEMENTS ALONG CO 93	BUS QUEUE JUMP LANES AT TRAFFIC SIGNALS	IMPROVED GS SERVICE	NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/ BICYCLISTS	IMPROVED PARK-N-RIDE FACILITIES
Safety	Ability to enhance safety across travel modes	No change to existing multimodal operations	Potential for substantial safety benefit	Potential for safety benefit	Potential for safety benefit	Minimal potential for safety benefit from mode shift away from single occupancy vehicle	No change to existing physical conditions	Potential for safety benefit	Minimal potential for safety benefit from mode shift away from single occupancy vehicle
	Potential multimodal conflict points	Conflict points with pedestrians and bicyclists along corridor	Bicyclists separated from traffic	Conflict points with pedestrians and bicyclists along corridor	Minor increase in conflict with additional lanes	Conflict points with pedestrians and bicyclists along corridor	No change from No Action	Potential reduced conflict and improvement in perception of comfort/safety	Potential reduced conflict with changes to access points
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	Improved safety and comfort for pedestrians and bicyclists separated from traffic	Stop improvements enhance opportunities	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	Potential substantial improvements for walking and biking connections
	Enhanced transit options	Existing transit service with ridership of 626 daily boardings	No additional transit service	Improved transit facilities	Improved GS service reliability with estimated ridership of 1,550 daily boardings (with improved service)	Improved GS service with estimated ridership of 1,500 daily boardings	No additional transit service	No additional transit service	Improved transit facility
Community	Design and operational context	Lack of separated trail is inconsistent with local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Improvements desirable in support of local community	Crossing of high volume/high speed corridor undesirable in local community	Improvements desirable in support of local community	Improvements desirable in support of local community
	Impacts on existing properties	None	29 properties 36-52 acres	Minimal impacts expected	1 property < 1 acre	Minimal impacts expected	None	Minimal impacts expected	1 property 2 acres
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Jefferson County and City of Arvada plans for new trails and transit improvements	Consistent with Jefferson County and City of Arvada plans for new trails	Consistent with Boulder County plans for transit improvements	Consistent with Boulder County plans for transit improvements	Consistent with Jefferson County and Boulder County plans for transit improvements	Inconsistent with Jefferson County and City of Arvada plans for pedestrian, bicyclist, and transit improvements	Consistent with Jefferson County and City of Arvada plans for pedestrian, bicyclist, and transit improvements	Consistent with Jefferson County and City of Arvada plans for pedestrian, bicyclist, and transit improvements
Environmental Resources	Impacts on environmental resources	No impacts	5 - 7 crossings with trails 4 crossings with proposed Colorado Front Range Trail 18 - 21 known cultural sites 13 - 14 historic sites 2 - 3 noise sensitive areas 4 - 5 potential PMJM habitats 2 freshwater wetlands 5 - 6 parks and open space 4 water bodies	Minimal impacts expected	Minimal impacts expected	No impacts	No impacts	Minimal impacts expected	Minimal impacts expected
Implementability	Construction costs (low, moderate, high, very high)	None	Moderate	Low	Low	Moderate	None	Low	High
	Ease and cost of maintenance (low, moderate, high, very high)	Low	Moderate	Low	Low	Moderate	Low	Low	High
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options							

Table 11 (cont.): Level 2A – CO 93: Multimodal Options

CATEGORY	EVALUATION CRITERIA	CO 128			CO 170		
		NO ACTION	IMPROVED CROSSINGS FOR PEDESTRIANS/BICYCLISTS	PEDESTRIAN BICYCLIST GRADE SEPARATION	NO ACTION	IMPROVED PARK-N-RIDE FACILITIES	IMPROVED CROSSINGS FOR PEDESTRIAN/BICYCLISTS
Safety	Ability to enhance safety across travel modes	No change to existing physical conditions	Potential for safety benefit	Potential substantial safety benefit from reduced conflict	No change to existing physical conditions	Minimal potential for safety benefit from mode shift away from single occupancy vehicle	Potential for safety benefit
	Potential multimodal conflict points	Conflict points with pedestrians and bicyclists at intersection	Potential reduced conflict and improvement in perception of comfort/safety	Reduced conflict and major improvement in pedestrian and bicyclist perception of comfort and safety	Conflict points with pedestrians and bicyclists at intersection	Potential reduced conflict with changes to access points	Potential reduced conflict and improvement in perception of comfort/safety
Multimodal Operations and Connectivity	Enhanced regional biking and walking options	No new infrastructure and/or wayfinding	Crossing improvements enhance opportunities	Major enhancement with grade separation	No new infrastructure and/or wayfinding	Potential substantial improvements for walking and biking connections	Crossing improvements enhance opportunities
	Enhanced transit options	No additional transit service			No additional transit service	Improved transit facility	No additional transit service
Community	Design and operational context	Crossing of high volume/high speed corridor undesirable in local community	Improvements desirable in support of local community	An overpass would be visually out of character in the corridor	Crossing of high volume/high speed corridor undesirable in local community	Improvements desirable in support of local community	Improvements desirable in support of local community
	Impacts on existing properties	None	Minimal impacts expected	3 properties < 1 acre	None	Minimal impacts expected	Minimal impacts expected
	Support of local and regional plans (consistent or inconsistent)	Inconsistent with Boulder County plans for pedestrian and bicyclist improvements	Consistent with Boulder County plans for pedestrian and bicyclist improvements	Consistent with Boulder County plans for pedestrian and bicyclist improvements	Inconsistent with Boulder County plans for pedestrian and bicyclist improvements	Consistent with Boulder County plans for pedestrian, bicyclist, and transit improvements	Consistent with Boulder County plans for pedestrian and bicyclist improvements
Environmental Resources	Impacts on environmental resources	No impacts	Minimal impacts expected	Trail connection and potential 4(f) impacts	No impacts	Minimal impacts expected	Minimal impacts expected
Implementability	Construction costs (low, moderate, high, very high)	None	Low	High	None	Moderate	Low
	Ease and cost of maintenance (low, moderate, high, very high)	Low	Low	High	Low	Moderate	Low
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>
Notes		The No Action option is carried forward for comparison to the benefits and impacts of action options			The No Action option is carried forward for comparison to the benefits and impacts of action options		



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## Level 2A Screening Results

### Eliminated Options

In the Level 2A screening, the following infrastructure options were eliminated from further consideration by this study because they do not meet the project Purpose and Need.

#### C-470 Segment – Highway Cross-Section Options

- Auxiliary Lanes between Interchanges – Eliminated because it does not meet the Purpose and Need due to safety concerns and insufficient capacity.
- Four/Six Lanes with Peak Period Shoulder Lanes – Eliminated because it does not meet the Purpose and Need due to increased safety concerns and insufficient capacity

#### Golden Segment – Highway Cross-Section Options

- Two Lanes with Bus on Shoulder Lanes – Eliminated because it does not meet the Purpose and Need due to increased safety concerns and insufficient capacity

#### CO 93 – Highway Cross-Section Options

- Two Lanes with Bus on Shoulder Lanes – Eliminated because it does not meet the Purpose and Need due to increased safety concerns without a separate trail for bicyclists and insufficient capacity
- Two Lanes with Widened Shoulders – Eliminated because it does not meet the Purpose and Need due to insufficient capacity.

#### CO 93 – Intersection Options

- Median U-turn Intersection (unsignalized) at 82<sup>nd</sup> Avenue – Eliminated because it does not meet the Purpose and Need related to safety and operational improvements
- At-grade Intersection Improvement at Westgate Road – Eliminated because it does not meet Purpose and Need related to safety and operational improvements

### Not Recommended Options

The following options were not recommended for further study due to comparatively negligible benefits and higher impacts than other options:

#### C-470 Segment – Interchange Options

- Diverging Diamond at Bowles Avenue – Not recommended due to similar operational benefits with lower cost lane modifications



- Braided Ramps at Quincy Avenue – Not recommended due to similar operational benefits with lower-cost options, option may be combined with US 285 interchange improvements to optimize operations
- Lane Modifications at Ramp Intersections at Quincy Avenue and at Alameda Parkway – Not recommended because No Action option provides acceptable operations and safety with less impacts and cost

#### C-470 Multimodal Infrastructure and Services Options

- New Express Service – Ken Caryl to Downtown Denver – Not recommended due to relatively low ridership increase and very high cost

#### Golden Segment – Intersection Options

- Light rail Grade Separation of Intersection at Johnson Road – Not recommended due to similar safety and operational benefits as other option with high impacts and very high cost
- Roundabout at 64<sup>th</sup> Parkway – Not recommended due to similar operations as other lower-cost options

#### Golden Segment Multimodal Infrastructure and Services Options

- Transit Service from Ken Caryl Park-n-Ride to Golden – Not recommended due to relatively low ridership and very high cost

#### CO 93 Segment – Highway Cross-Section Options

- New Split Alignment with Additional Lanes – Not recommended due to similar safety and operational benefits as other options with substantially higher property impacts and very high costs, but option may be applicable for sections of overall highway design

#### CO 93 Intersection Options

- Continuous Flow Intersection at CO 72 – Not recommended due to similar safety and operational benefits as other lower-cost options
- Roundabout at CO 72 – Not recommended due to less operational benefits than other options with similar costs
- Grade Separated Turning Movement at CO 128 – Not recommended due to similar safety and operational benefits as other lower-cost options
- Roundabout at CO 170 – Not recommended because option does not provide acceptable operations and has high costs



## LEVEL 2B SCREENING

Infrastructure options from the Level 2A screening that were recommended for further evaluation were combined and applied to locations along each corridor segment to create corridor alternatives and to provide information to evaluate potential benefits and impacts. Capacity, safety and operational needs of critical traffic movements and multimodal travel demand were considered, along with geometric and physical conditions at locations along the corridor to identify appropriate corridor alternatives. Not every combination of concepts was considered, but only those most applicable to develop uniquely different alternatives that respond to the project goals and objectives.

The purpose of the Level 2B screening was to complete additional analysis to compare how well each alternative meets the Purpose and Need, compare how well each alternative would perform, and identify what general impacts each alternative would have. The results of the Level 2B screening identified alternatives that are most practical or feasible to carry forward as study recommendations.

Due to the difference in type and magnitude of benefits and impacts, corridor management alternatives and technology alternatives were evaluated separately from the alternatives consisting of infrastructure options.

### Alternative Conceptual Design

In order to compare the impacts of alternatives through the Level 2B screening process, cross-sections with right-of-way (ROW) assumptions were developed for each alternative based on appropriate design criteria for the assumed roadway classification and multimodal elements. The design criteria for the corridor segments are included in **Appendix F**. The cross-sections developed for each alternative are included in the illustrations of the alternatives. The ROW assumed for each alternative was intended to provide width for vehicular travel, as well as utilities and roadside improvements (e.g., grading, drainage). The opportunity to modify the ROW width to mitigate specific property impacts or optimize operations and/or safety may be considered during subsequent project NEPA and design. Wildlife crossings were also included in the alternatives conceptual design and costs as described in **Appendix G**. Further consideration in collaboration with wildlife biologists and design engineers will be necessary to develop all of the wildlife crossing alternatives and determine optimal locations.

### Level 2B Alternatives

The following corridor infrastructure alternatives were developed from the concepts carried from Level 2A screening. Illustrations summarizing the elements of the alternatives are shown in **Figures 6** through **12**.



## C-470 Segment

Alternatives 1 and 2 include lane modifications at ramp intersections, roundabouts at the Quincy Avenue ramp intersections, and fully directional ramp improvements at US 285. Also included are trail and transit enhancements, including pedestrian/bicyclist grade separations at Kipling Parkway and at Bowles Avenue.

### *Alternative 1*

This alternative consists of three general purpose lanes plus auxiliary lanes in each direction. Alternative 1A includes pedestrian grade separations at Kipling and at Bowles, a braided on-ramp from Quincy with off-ramp to US 285, a continuous auxiliary lane from US 285 to I-70 (total of four lanes south and four lanes north), and an EB I-70 collector/distributor road to US 6. Alternative 1B is the same as Alternative 1A, except it includes braided ramps at C-470/I-70.

### *Alternative 2*

This alternative consists of one/two managed lanes plus two general purpose lanes and auxiliary lanes in each direction. Alternative 2A includes one managed lane and two general purpose lanes in each direction starting at Wadsworth, an auxiliary lane between Wadsworth and Kipling with an ingress lane, an auxiliary lane between Kipling and Ken Caryl, egress between Ken Caryl and Bowles, two managed lanes from just south of Belleview to north of Morrison, a continuous auxiliary lane between Morrison and I-70, and a collector/distributor road along EB I-70 from C-470 to US 6. Alternative 2B is the same as Alternative 2A except it includes braided ramps at C-470/I-70.

## Golden Segment

Both alternatives assume The Golden Plan implementation through Golden on US 6 and CO 93, and include additional lanes on US 6 at Johnson Road, a separated trail, transit service enhancement, queue jump at signalized intersections, as applicable.

### *Alternative 1*

This alternative consists of four lanes with signalized intersection improvements at 58<sup>th</sup> Avenue and 64<sup>th</sup> Parkway, and an option for grade separated turning movements at 64<sup>th</sup> Parkway (Alternative 1B).

### *Alternative 2*

This alternative consists of four lanes with channelized T intersection improvements at 58<sup>th</sup> Avenue and 64<sup>th</sup> Parkway, and an option for a roundabout at 58<sup>th</sup> Avenue (Alternative 2B).



## **CO 93 Segment**

All three alternatives include a separated trail, transit service enhancements, queue jump at signalized intersections, as applicable.

### ***Alternative 1***

This alternative consists of four lanes with signalized intersection improvements and channelized T intersection improvements at Westgate Road.

### ***Alternative 2***

This alternative includes two lanes with additional/extended passing lanes and channelized T intersection improvements at 82<sup>nd</sup> Avenue, Westgate Road, and CO 128, signalized intersection improvements at CO 170, and an interchange at CO 72.

### ***Alternative 3***

This alternative consists of two lanes with roundabout intersections at 82<sup>nd</sup> Avenue and CO 128, channelized T intersection improvements at Westgate Road, and signalized intersection improvements at CO 72 and CO 170.



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Figure 6: Level 2B – C-470 Segment, Alternative 1

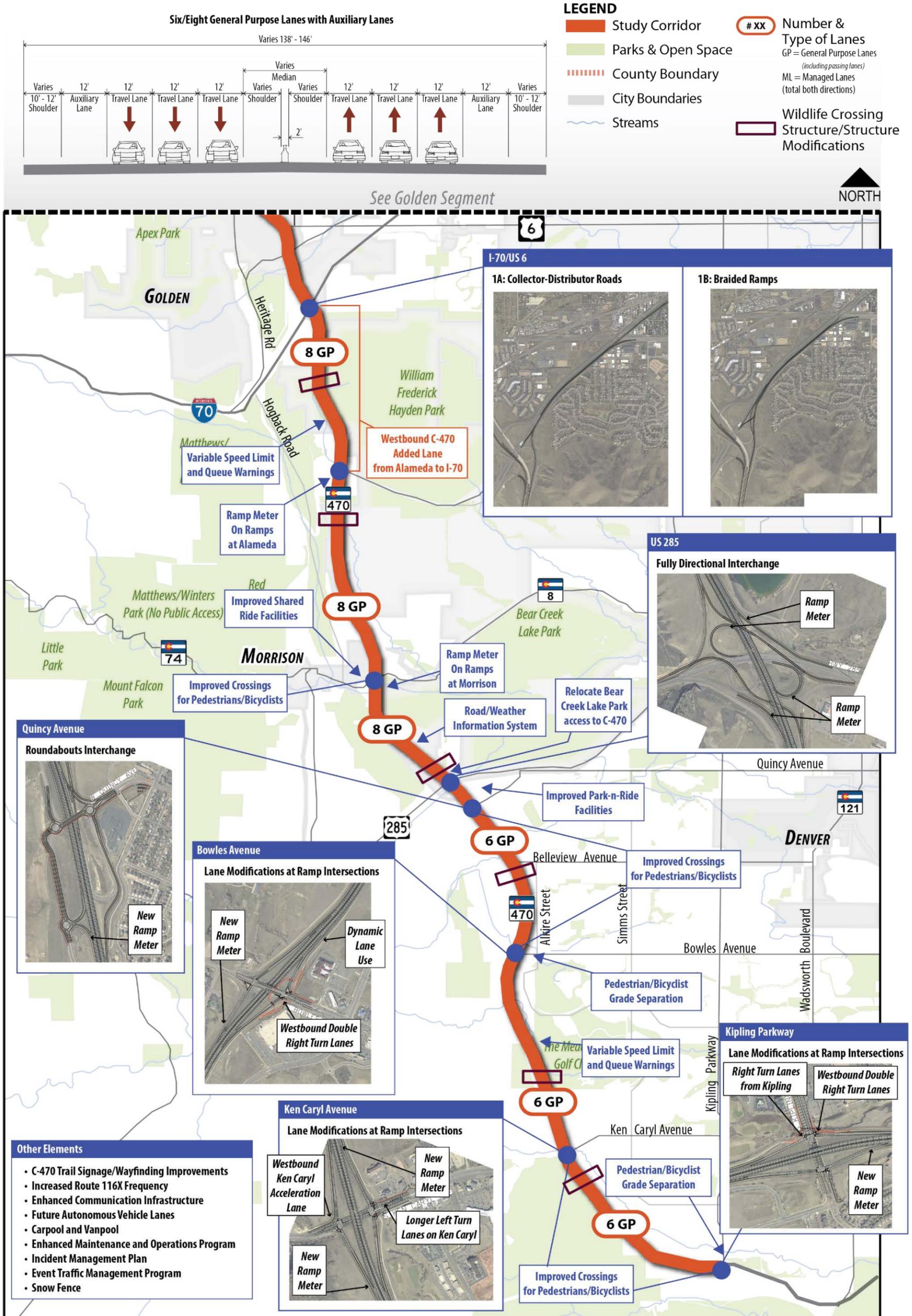




Figure 8: Level 2B – Golden Segment, Alternative 1

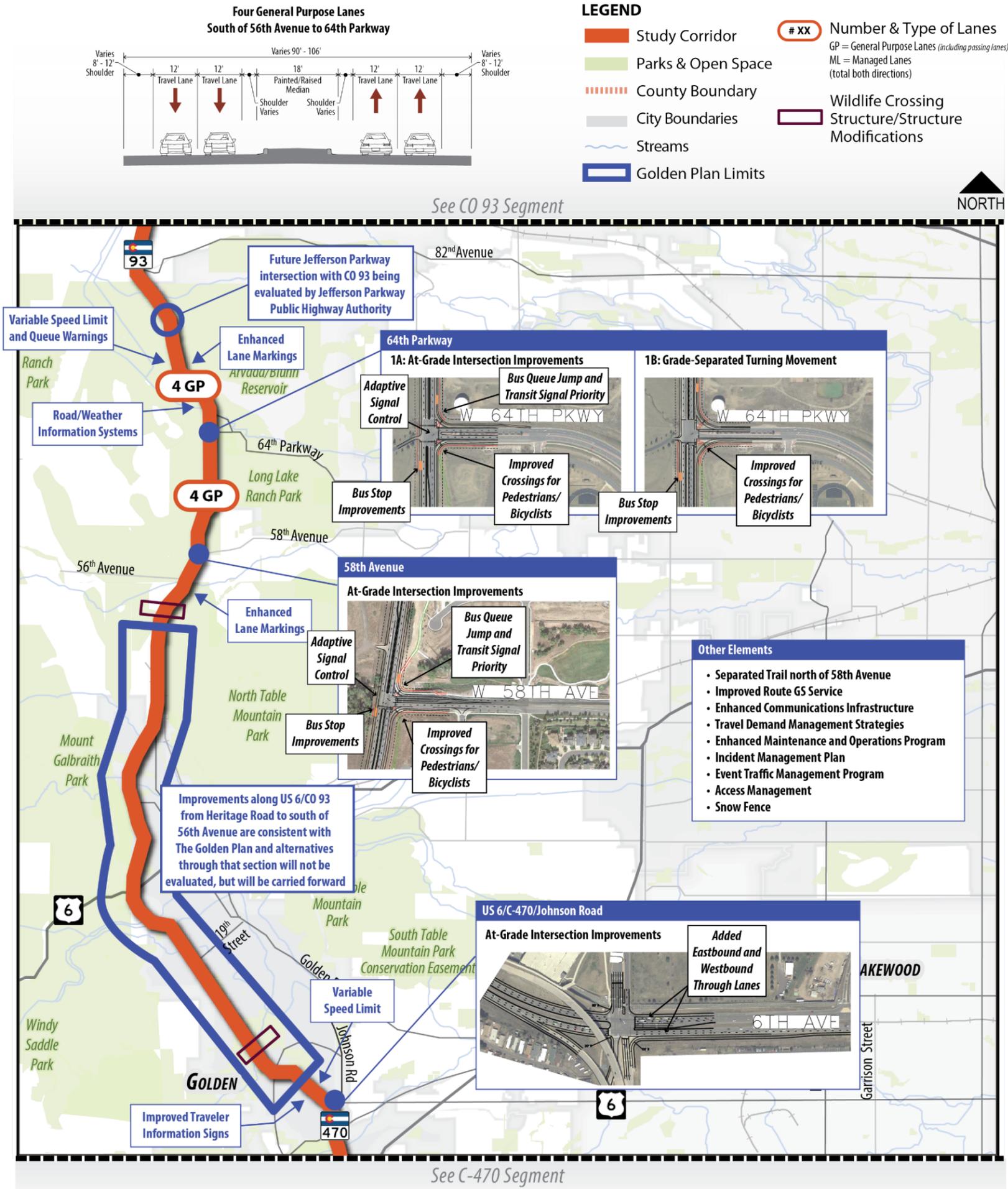


Figure 9: Level 2B – Golden Segment, Alternative 2

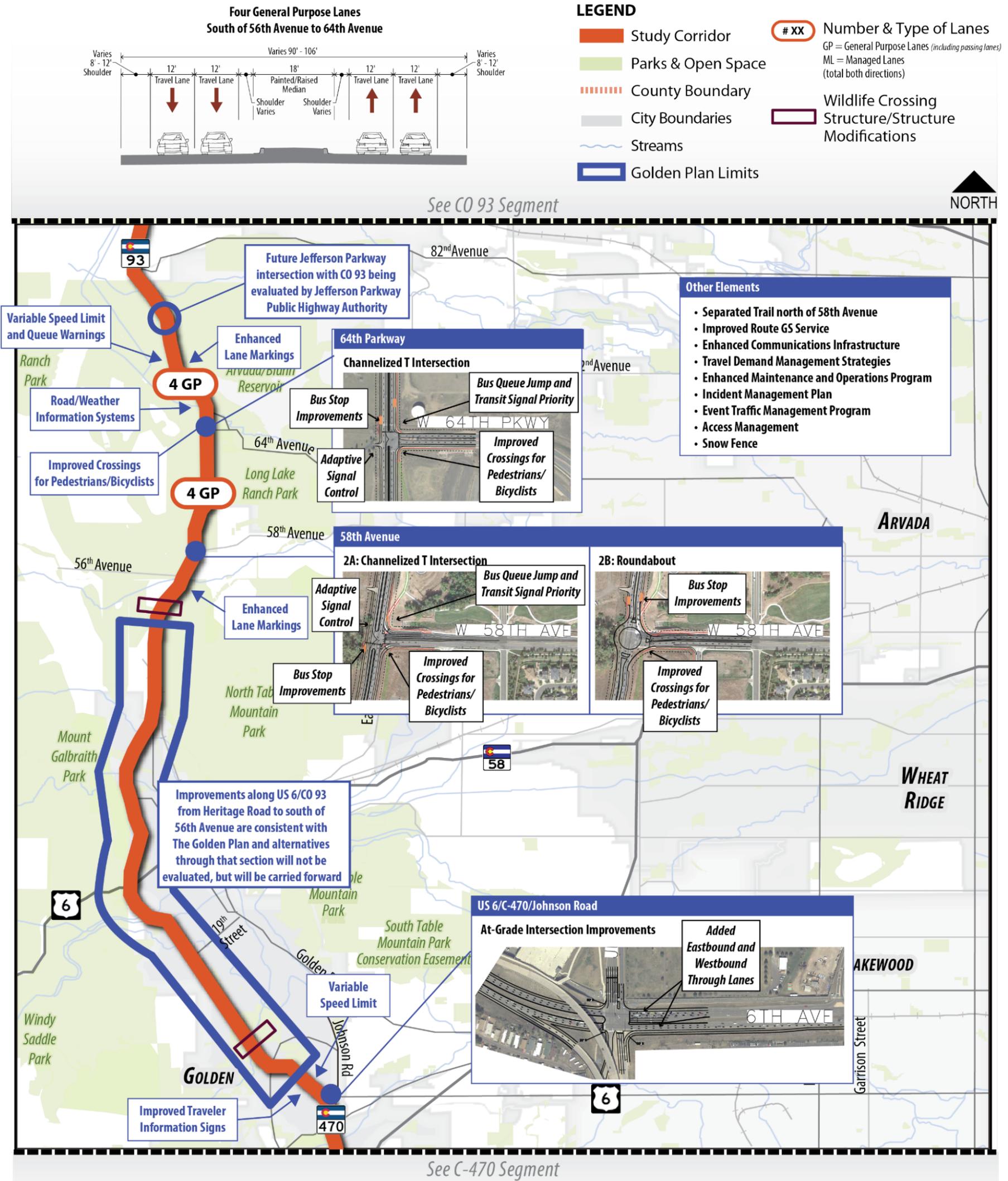
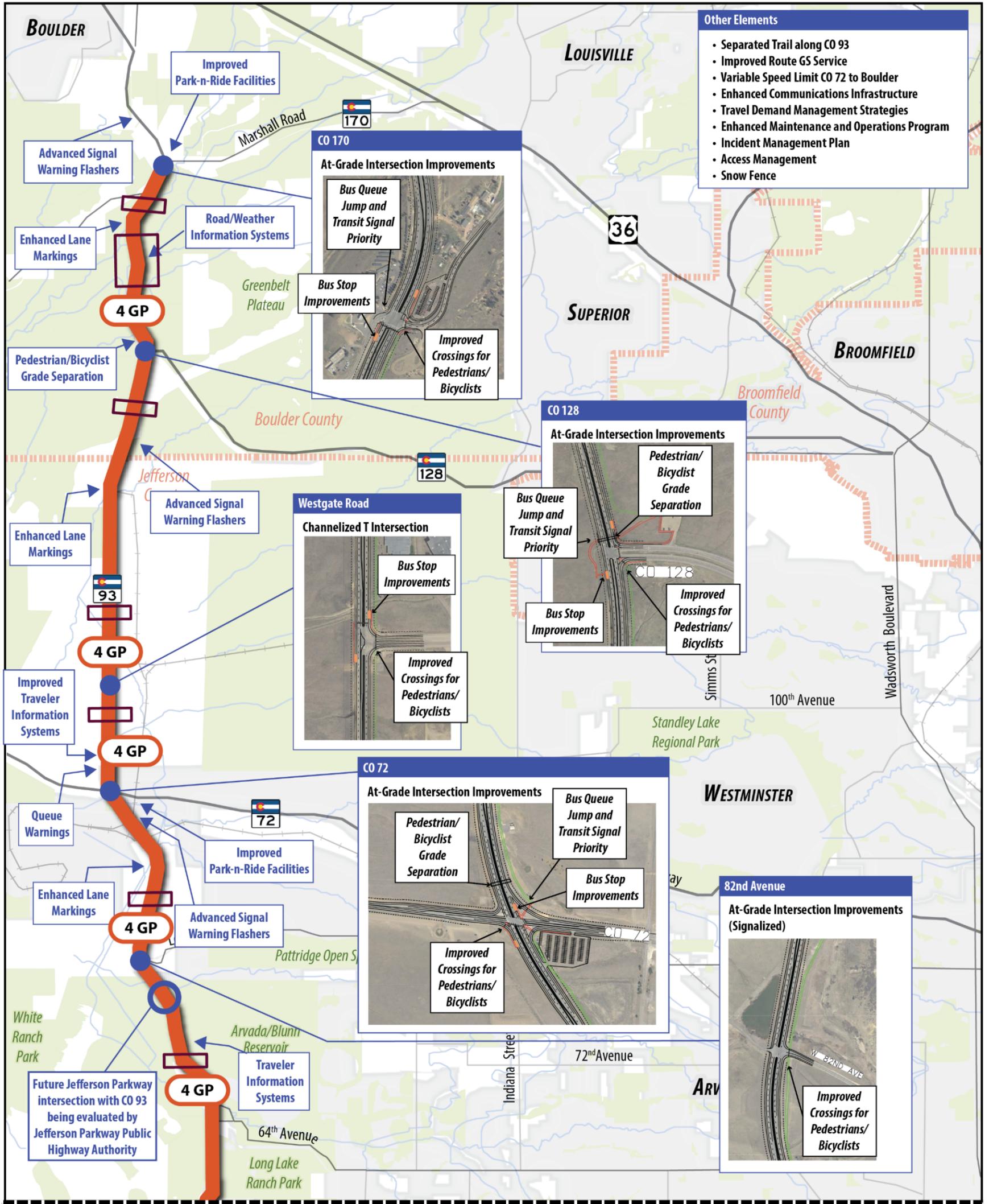


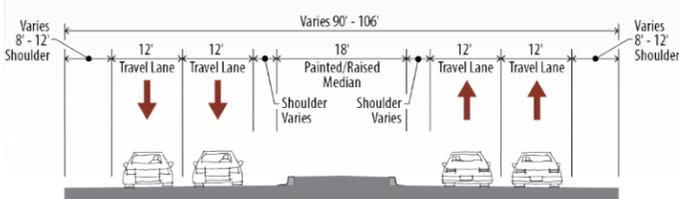
Figure 10: Level 2B – CO 93 Segment, Alternative 1



See Golden Segment



**Four General Purpose Lanes  
64th Parkway to CO 170**



**LEGEND**

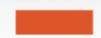
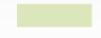
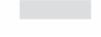
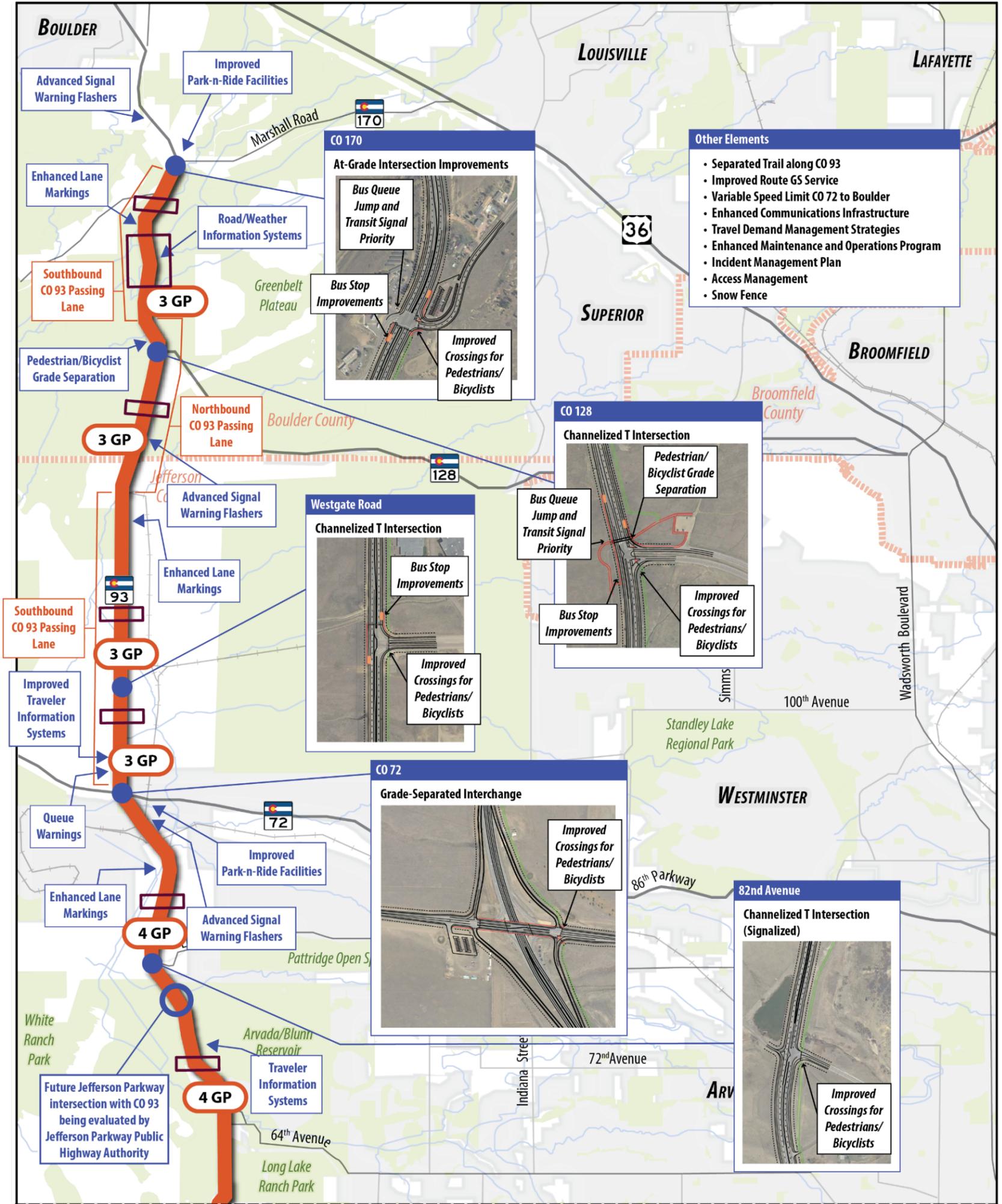
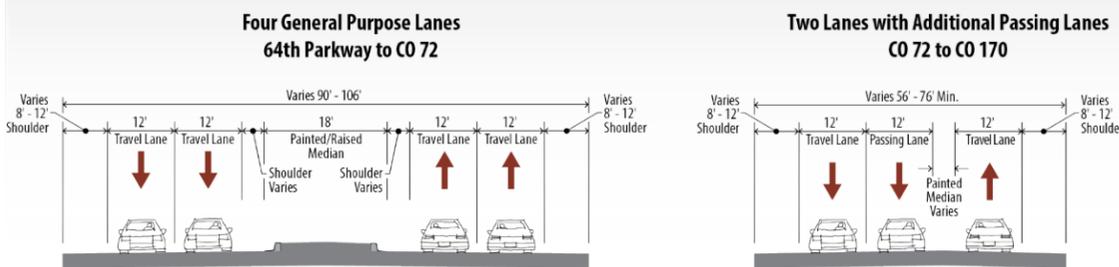
-  Study Corridor
-  Parks & Open Space
-  County Boundary
-  City Boundaries
-  Streams
-  # XX Number & Type of Lanes  
GP = General Purpose Lanes (including passing lanes)  
ML = Managed Lanes (total both directions)
-  Wildlife Crossing Structure/Structure Modifications

Figure 11: Level 2B – CO 93 Segment, Alternative 2



See Golden Segment

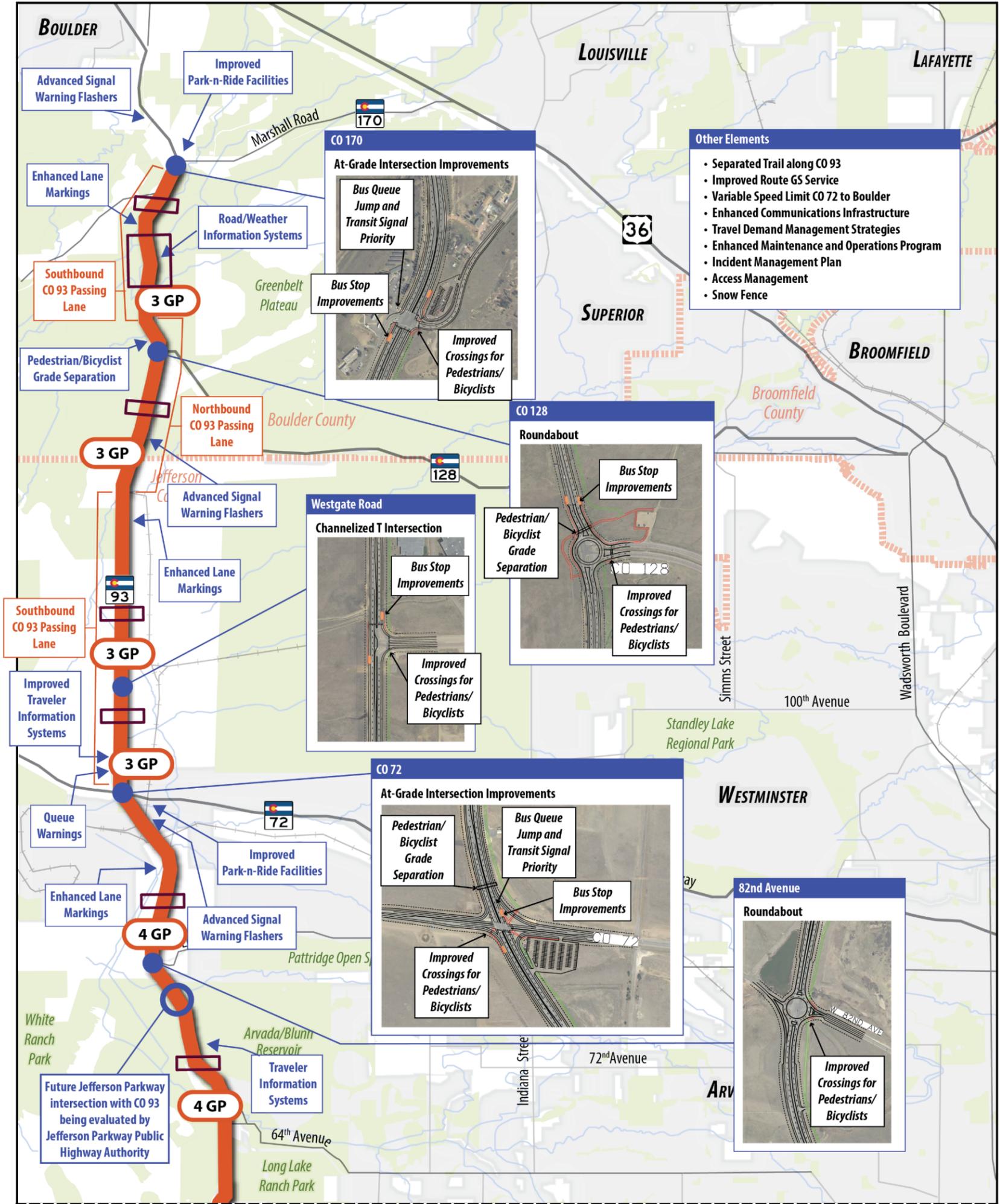


**LEGEND**

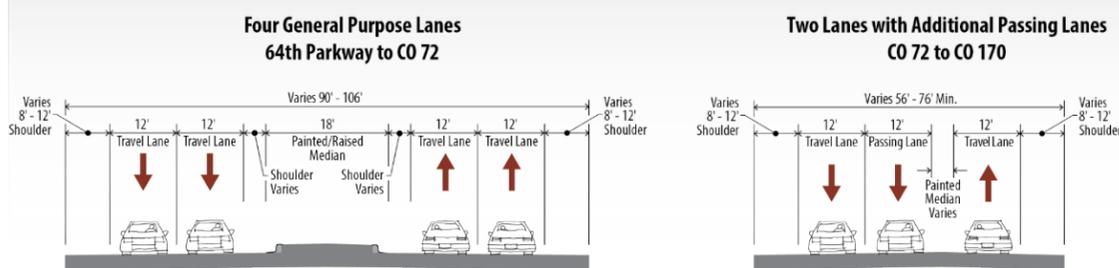
- Study Corridor
- Parks & Open Space
- County Boundary
- City Boundaries
- Streams
- # XX Number & Type of Lanes  
 GP = General Purpose Lanes (including passing lanes)  
 ML = Managed Lanes (total both directions)
- Wildlife Crossing Structure/Structure Modifications

**NORTH**

Figure 12: Level 2B – CO 93 Segment, Alternative 3



See Golden Segment



LEGEND

- Study Corridor
- Parks & Open Space
- County Boundary
- City Boundaries
- Streams
- # XX Number & Type of Lanes  
 GP = General Purpose Lanes (including passing lanes)  
 ML = Managed Lanes (total both directions)
- Wildlife Crossing Structure/Structure Modifications





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## Level 2B Evaluation Criteria

The following evaluation criteria were developed to compare how well corridor segment alternatives meet the Purpose and Need and goals of the project (see **Table 12**). The performance measures are a mix of qualitative and quantitative assessments, based on the criteria and the data available at this stage of development.

**Table 12: Level 2B – Evaluation Criteria and Performance Measures**

CATEGORY	CRITERIA	PERFORMANCE MEASURE
Safety	Ability to address identified unsafe physical or operational conditions	Expected crash reduction for identified predominant crash types and patterns
	Expected crash frequency	Expected crash frequency along corridor segments
	Pedestrian and bicycle comfort and safety	Pedestrian and bicycle level of traffic stress (LTS)
Traffic Operations	Intersection delay during 2040 peak hours	Intersection Level of Service (LOS) for 2040 AM and PM peak hours
	Future (2040) vehicular travel time	2040 vehicular travel time index along corridor segments
Multimodal Operations and Connectivity	Enhanced regional biking and walking transportation options	New regional infrastructure and/or wayfinding provided for pedestrians and bicyclists consistent with the biking and walking vision of corridor agencies
	Enhanced regional transit options	Additional routes, frequency, and/or stop enhancements
	Local multimodal connections	New infrastructure provided for multimodal connections consistent with established local plans
Community	Design and operational context related to local community surroundings	Qualitative assessment of consistency of infrastructure and operations with existing local surroundings
	Access management	Local access provided compatible with the functional characteristics of the transportation system
	Impacts on existing properties	Acres of residential, business, and public properties that may be impacted based on conceptual layout
	Support of local and regional planning efforts	Noted consistencies and inconsistencies with recommendations within documented plans as identified in Corridor Conditions Report
Environmental Resources	Impacts on environmental resources within the built and natural environment	Qualitative and quantitative (if readily available) assessment of notable benefits and/or impacts to environmental resources based on existing conditions identified in Environmental Scan Report
Implementability	Construction and maintenance costs	Assessment of conceptual-level probable construction and maintenance costs on a scale of low, moderate, high, very high
	Ability to proceed independently with phased projects	Assessment of ability to construct useful portions of the improvements as separate projects over a phased implementation period on a scale of easy, moderate, difficult
	Effective connections with identified corridor projects	Reasonable connection provided to established planned corridor projects
	Ability to incorporate technology that can be used to optimize safety and operations	Assessment of ease to include advanced technology on an overall scale of low, moderate, high, very high

The color ratings shown with the performance measures in the Level 2B screening matrices were used as a visual indication of the comparative characteristics of a criterion between options. The colors are not used as an indication of a decision (i.e., an option with many “red” ratings was not automatically rendered unreasonable). The colors are a general indication of the following:

- Green = Comparatively beneficial and/or minor impacts
- Black = Comparatively neutral benefits and/or moderate impacts
- Red = Comparatively negative and/or major impacts

The color ratings for each criterion used in the options screening are defined below.

## Safety

### *Ability to address unsafe conditions*

- Green = potential for substantial crash reduction
- Black = no change to moderate crash reduction expected
- Red = increased safety concern or conflict

### *Expected crash frequency*

- Green = 20% or more reduction compared to No Action condition
- Black = less than 20% reduction compared to No Action condition
- Red = increased crashes expected compared to No Action condition

### *Pedestrian and bicycle level of traffic stress (LTS)*

- Green = LTS 1
- Black = LTS 2 or LTS 3
- Red = LTS 4

### *Pedestrian and bicycle level of comfort and safety at intersections*

- Green = alternative generally feels comfortable for pedestrian and bicycle crossings
- Black = one key characteristic (crossing width, uncontrolled movements, vehicular speeds) makes the alternative feel uncomfortable or intimidating to cross
- Red = several key characteristics (crossing width, uncontrolled movements, vehicular speeds) makes the alternative feel uncomfortable or intimidating to cross

## Traffic Operations

### *2040 Peak hour intersection level of service (LOS)*

- Green = LOS C or better during both the AM and PM peak hours
- Black = LOS D during both the AM and PM peak hours
- Red = LOS E or F during the AM or PM peak hour

### *2040 Vehicular travel time index (TTI)*

- Green = TTI less than 1.3
- Black = TTI between 1.3 and 1.5
- Red = TTI greater than 1.5

## Multimodal Operations and Connectivity

### *Enhanced regional biking and walking options*

- Green = Substantial improvement in regional biking and walking opportunities
- Black = Minor to moderate improvement in regional biking and walking opportunities
- Red = No improvement in regional biking and walking opportunities

### *Enhanced transit options*

- Green = Substantial improvement in transit service or facilities
- Black = Minor to moderate improvement in transit service or facilities
- Red = No improvement in transit service or facilities

### *Local multimodal connections*

- Green = Substantial new/improved connections to existing or planned local facilities
- Black = Minor/moderate improvement in connections to existing or planned local facilities
- Red = No new or improved connections to existing or planned local facilities

## Community

### *Design and operational context*

- Green = Consistent with surrounding design and operational context
- Red = Inconsistent with surrounding design and operational context

### ***Access management***

- Green = Local access compatible with functional characteristics of transportation system
- Red = Local access that is not compatible with functional characteristics of transportation system

### ***Impacts on existing properties***

- Green = Minor to no properties impacted; Less than five acres of total impacts expected
- Black = Moderate number of properties or acres of impacts expected
- Red = Twice or more the number of properties or acres impacted than other options

### ***Support of local and regional plans***

- Green = Consistent with relevant established plans
- Red = Inconsistent with relevant established plans

## **Environmental Resources**

### ***Impacts on environmental resources***

- Green = Minor to no impacts to surrounding built or natural environment
- Black = Relatively moderate impacts to surrounding built or natural environment
- Red = Relatively major impacts to surrounding built or natural environment

## **Implementability**

### ***Construction and maintenance costs***

- Green = Relative low costs
- Black = Relative moderate costs
- Red = Relative high/very high costs

### ***Ability to proceed independently with phased projects***

- Green = Easy: Substantial opportunities for useful portions to be implemented separately
- Black = Moderate: Opportunities for implementation of useful portions as separate projects, but with limited sequence to provide benefits or potential issues with costs/processes
- Red = Difficult: Useful portions difficult to implement in pieces due to large costs/processes

### ***Effective connections with other corridor projects***

- Green = Alternative provides consistent design and operations with adjacent corridor projects
- Red = Alternative inconsistent in design or operations with adjacent corridor projects



### *Ability to incorporate technology*

- Green = High: Substantial opportunities to incorporate advanced technologies to optimize safety and operations
- Black = Moderate: Notable opportunities to incorporate advanced technologies to optimize safety and operations
- Red = Low: Limited opportunities to incorporate advanced technologies to optimize safety and operations

### Level 2B Screening

The Level 2B evaluation matrix (see **Table 13**) summarizes the recommendation for each alternative as follows:

- **RECOMMENDED** – Alternative is reasonable and feasible and recommended for consideration as the Preferred Alternative during subsequent NEPA process and project development
- **CARRIED FORWARD** – Alternative is reasonable and feasible and may be considered for further evaluation during subsequent NEPA process and project development
- **NOT RECOMMENDED** – Alternative is not recommended for further evaluation during subsequent NEPA process and project development due to comparatively negligible benefits and higher impacts than other alternatives
- **ELIMINATED** – Alternative does not meet the Purpose and Need established with this study or the option is unreasonable due to impacts and/or infeasibility



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Table 13: Level 2B – C-470 Segment – Kipling to I-70/US 6

CATEGORY	EVALUATION CRITERIA	NO ACTION	ALTERNATIVE 1: SIX/EIGHT GENERAL PURPOSE LANES WITH AUXILIARY LANES	ALTERNATIVE 2: GENERAL PURPOSE LANES WITH TWO/FOUR MANAGED LANES AND AUXILIARY LANES
Safety	Ability to address identified unsafe physical or operational conditions	No change	<p><u>Mainline</u>: Increased capacity of the mainline with the additional lanes and auxiliary lanes would reduce crashes. Dual lane exits at multiple locations would reduce congestion and ramp crashes.</p> <p><u>Quincy</u>: Roundabouts reduce severe crashes such as broadside and approach turn</p> <p><u>US 285</u>: Flyover ramps remove the tight curves of loop ramps, reducing off road crashes</p>	<p><u>Mainline</u>: Increased capacity of the mainline with the auxiliary lanes would reduce crashes. Dual lane exits at multiple locations would reduce congestion and ramp crashes.</p> <p><u>Quincy</u>: Roundabouts reduce severe crashes such as broadside and approach turn</p> <p><u>US 285</u>: Flyover ramps remove the tight curves of loop ramps, reducing off road crashes</p>
	Expected crash frequency (crashes/year)	<p>C-470: 213 total; 41 severe</p> <p>Kipling: 27 total, 9 severe</p> <p>Ken Caryl: 73 total, 22 severe</p> <p>Bowles: 44 total, 15 severe</p> <p>Quincy: 34 total, 16 severe</p> <p>Morrison: 17 total, 2 severe</p> <p>Alameda: 21 total, 5 severe</p>	<p>C-470: 149 total; 29 severe</p> <p>Kipling: 27 total, 9 severe</p> <p>Ken Caryl: 73 total, 22 severe</p> <p>Bowles: 40 total, 11 severe</p> <p>Quincy: 19-25 total, 9-12 severe</p> <p>Morrison: 17 total, 2 severe</p> <p>Alameda: 21 total, 5 severe</p>	<p>C-470: 149 total; 29 severe</p> <p>Although capacity of managed lanes may reduce crashes, congestion in general purpose lanes may increase crashes. Overall crash frequency expected to be similar to Alternative 1</p> <p>Kipling: 27 total, 9 severe</p> <p>Ken Caryl: 73 total, 22 severe</p> <p>Bowles: 40 total, 11 severe</p> <p>Quincy: 19- 25 total, 9-12 severe</p> <p>Morrison: 17 total, 2 severe</p> <p>Alameda: 21 total, 5 severe</p>
	Pedestrian and bicycle comfort and safety (level of traffic stress – LTS)	<p>Along C-470: LTS 1</p> <p>Kipling: Free right turn lanes at ramps</p> <p>Bowles: Free right turn lanes at ramps</p> <p>Quincy: No crossings or pedestrian facilities</p>	<p>Along C-470: LTS 1</p> <p>Grade separation at Kipling and Bowles would substantially improve comfort and safety</p> <p>Kipling: Double right turn lanes increase crossing distance</p> <p>Bowles: Double right turn lanes increase crossing distance</p> <p>Quincy: Crossing of multi-lane free-flow movements</p>	<p>Along C-470: LTS 1</p> <p>Grade separation at Kipling and Bowles would substantially improve comfort and safety</p> <p>Kipling: Double right turn lanes increase crossing distance</p> <p>Bowles: Double right turn lanes increase crossing distance</p> <p>Quincy: Crossing of multi-lane free-flow movements</p>
Traffic Operations	2040 peak hour intersection delay (AM/PM)	<p>Kipling EB Ramps: LOS F / LOS C</p> <p>Kipling WB Ramps: LOS D / LOS B</p> <p>Ken Caryl EB Ramps: LOS F / LOS C</p> <p>Ken Caryl WB Ramps: LOS C / LOS C</p> <p>Bowles EB Ramps: LOS C / LOS D</p> <p>Bowles WB Ramps: LOS F / LOS A</p> <p>Quincy EB Ramps: LOS F / LOS A</p> <p>Quincy WB Ramps: LOS F / LOS A</p> <p>Morrison Ramps: LOS C / LOS D</p> <p>Alameda EB Ramps: LOS C / LOS B</p> <p>Alameda WB Ramps: LOS A / LOS A</p>	<p>Kipling EB Ramps: LOS B / LOS C</p> <p>Kipling WB Ramps: LOS C / LOS C</p> <p>Ken Caryl EB Ramps: LOS C / LOS D</p> <p>Ken Caryl WB Ramps: LOS C / LOS C</p> <p>Bowles EB Ramps: LOS C / LOS D</p> <p>Bowles WB Ramps: LOS B / LOS B</p> <p>Quincy EB Ramps: LOS A / LOS A</p> <p>Quincy WB Ramps: LOS C / LOS A</p> <p>Morrison Ramps: LOS C / LOS E</p> <p>Alameda EB Ramps: LOS C / LOS C</p> <p>Alameda WB Ramps: LOS A / LOS A</p>	<p>Kipling EB Ramps: LOS C / LOS D</p> <p>Kipling WB Ramps: LOS C / LOS D</p> <p>Ken Caryl EB Ramps: LOS C / LOS C</p> <p>Ken Caryl WB Ramps: LOS C / LOS D</p> <p>Bowles EB Ramps: LOS D / LOS C</p> <p>Bowles WB Ramps: LOS B / LOS A</p> <p>Quincy EB Ramps: LOS A / LOS A</p> <p>Quincy WB Ramps: LOS C / LOS A</p> <p>Morrison Ramps: LOS C / LOS D</p> <p>Alameda EB Ramps: LOS C / LOS D</p> <p>Alameda WB Ramps: LOS B / LOS C</p>
	2040 vehicular peak hour travel time index (AM/PM)	<p>EB: 2.6 / 6.6</p> <p>WB: 10.3 / 3.9</p>	<p>EB: 1.3 / 1.3</p> <p>WB: 1.9 / 1.4</p>	<p>EB: General Purpose = 1.3 / 1.4; Managed Lanes = 1.2 / 1.2</p> <p>WB: General Purpose = 1.6 / 1.0; Managed Lanes = 1.0 / 1.0</p>
Multimodal Operations and Connectivity	Enhanced regional biking and walking transportation options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists	Improved sidewalks and crossings at almost all interchanges Wayfinding improvements between Bowles and Quincy	Improved sidewalks and crossings at almost all interchanges Wayfinding improvements between Bowles and Quincy
	Enhanced regional transit options	No additional transit service provided	Increased 116X frequency and formalized park and ride facility at Quincy Avenue	Increased 116X frequency and formalized park and ride facility at Quincy Avenue
	Local multimodal connections	No new or improved connections	Improved parking facilities at Quincy and Morrison	Improved parking facilities at Quincy and Morrison

Table 13 (cont.): Level 2B – C-470 Segment – Kipling to I-70/US 6

CATEGORY	EVALUATION CRITERIA	NO ACTION	ALTERNATIVE 1: SIX/EIGHT GENERAL PURPOSE LANES WITH AUXILIARY LANES		ALTERNATIVE 2: GENERAL PURPOSE LANES WITH TWO/FOUR MANAGED LANES AND AUXILIARY LANES	
Community	Design and operational context related to local community surroundings	C-470 alignment and design elements blend well with unique natural surroundings along Dakota Hogback but with recurring peak period congestion	Widened corridor generally consistent with corridor natural and built surroundings		Substantial widening and infrastructure and sign structures for managed lane operations somewhat inconsistent with corridor natural surroundings	
	Access management	Interchange spacing and configurations appropriate for freeway access, except low-speed access to Bear Creek Lake Park north of US 285	Interchange spacing and configurations appropriate for freeway access with relocation of low-speed access to Bear Creek Lake Park north of US 285		Interchange spacing and configurations appropriate for freeway access with relocation of low-speed access to Bear Creek Lake Park north of US 285	
	Impacts on existing properties	None	<u>Alternative 1A (with I-70 C/D Road)</u> Residential: < 1 acre (2 parcels) Business/Other: < 1 acre (2 parcels) Public: < 1 acre (5 parcels)	<u>Alternative 1B (with I-70 Braided Ramp)</u> Residential: < 1 acre (2 parcels) Business/Other: < 1 acre (2 parcels) Public: < 1 acre (5 parcels)	<u>Alternative 2A (with I-70 C/D Road)</u> Residential: < 1 acre (2 parcels) Business/Other: < 1 acre (3 parcels) Public: 1 acre (5 parcels)	<u>Alternative 2B (with I-70 Braided Ramp)</u> Residential: < 1 acre (2 parcels) Business/Other: < 1 acre (3 parcels) Public: 1 acre (5 parcels)
	Support of local and regional planning efforts	Inconsistent with Jefferson County plans identifying interchange capacity projects along C-470	Consistent with Jefferson County plans identifying interchange capacity projects along C-470		Consistent with Jefferson County plans identifying interchange capacity projects along C-470	
Environmental Resources	Impacts on environmental resources within the built and natural environment	Impacts to air quality and noise are likely with increase in traffic volumes and congestion	<u>Alternative 1A</u> 9 100-year floodplains with approximately 618,000 square foot area of impact 32 cultural surveys and known sites 5 parks and open spaces impacted 5 wetlands impacted 7 stream and/or water bodies 1 Section 6(f) property 7 potential hazardous material site/regions 3 potential noise analysis areas in neighborhoods between Kipling and Ken Caryl; just south of Bowles; and between Bowles and US 285	<u>Alternative 1B</u> 8 100-year floodplains with approximately 621,000 square foot area impact 32 cultural surveys and known sites 5 parks and open spaces impacted 5 wetlands impacted 7 stream and/or water bodies 1 Section 6(f) property 7 potential hazardous material site/regions 3 potential noise analysis areas in neighborhoods between Kipling and Ken Caryl; just south of Bowles; and between Bowles and US 285	<u>Alternative 2A</u> 9 100-year floodplains with approximately 534,000 square foot area of impact 30 cultural surveys and known sites 7 parks and open spaces impacted 5 wetlands impacted 7 stream and/or water bodies 1 Section 6(f) property 7 potential hazardous material site/regions 3 potential noise analysis areas in neighborhoods between Kipling and Ken Caryl; just south of Bowles; and between Bowles and US 285	<u>Alternative 2B</u> 8 100-year floodplains with approximately 534,000 square foot area of impact 30 cultural surveys and known sites 7 parks and open spaces impacted 5 wetlands impacted 7 stream and/or water bodies 1 Section 6(f) property 7 potential hazardous material site/regions 3 potential noise analysis areas in neighborhoods between Kipling and Ken Caryl; just south of Bowles; and between Bowles and US 285
Implementability	Construction and maintenance costs	Construction: None Operations & Maintenance: > \$1.7M/yr (deferred costs)	Construction: \$325M - \$400M Operations & Maintenance: \$2.3M/yr	Construction: \$320M - \$390M Operations & Maintenance: \$2.3M/yr	Construction: \$370M - \$450M Operations & Maintenance: \$2.6M/yr	Construction: \$355M - \$435M Operations & Maintenance: \$2.6M/yr
	Ability to proceed independently with phased projects	N/A	Easy Mainline improvements could be constructed in useful phases to address current congestion Interchange improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements		Moderate Managed lane implementation required as one project Interchange improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements	
	Effective connections with identified corridor projects	No changes to connect with adjacent corridor projects	Provides additional capacity for the segment, but inconsistent with managed lanes currently under construction from Wadsworth to I-25		Managed lanes provide regional connection to managed lanes currently under construction from Wadsworth to I-25	
	Ability to incorporate technology that can be used to optimize safety and operations	Low	Moderate Opportunities for corridor operations enhancements with improvements		High Opportunities for corridor operations enhancements with improvements and potential repurposing for autonomous vehicle lanes	
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>		<b>CARRIED FORWARD</b>	
Notes		Further analysis required as the No Action Alternative in NEPA process for comparison to action alternatives.	This alternative is carried forward to future NEPA processes because the alternative provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources.  This alternative would be easier to independently proceed than Alternative 2, but is relatively inconsistent with the managed lanes currently under construction east of study corridor.		This alternative is carried forward to future NEPA processes because the alternative provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources.  This alternative provides better travel time reliability than Alternative 1 with higher speeds maintained in managed lanes, but with some congestion in the general purpose lanes.	

**GREEN** = Comparatively beneficial and/or minor impacts.  
**BLACK** = Comparatively neutral benefits and/or moderate impacts.  
**RED** = Comparatively minor benefits and/or major impacts.

Table 14: Level 2B – Golden Segment – US 6 and Johnson Rd and CO 93 56<sup>th</sup> Ave to 64<sup>th</sup> Pkwy

CATEGORY	EVALUATION CRITERIA	NO ACTION		ALTERNATIVE 1: FOUR GENERAL PURPOSE LANES AND INTERSECTION IMPROVEMENTS		ALTERNATIVE 2: FOUR GENERAL PURPOSE LANES WITH FREE FLOW SOUTHBOUND CO 93	
Safety	Ability to address identified unsafe physical or operational conditions	No change		<p><u>Mainline</u>: Increased capacity with additional lanes would reduce crashes. Wider median also helps to reduce crashes</p> <p>58<sup>th</sup>: Channelized northbound right reduce crashes related to this movement</p> <p>64<sup>th</sup> (Alt 1A: at-grade): Channelized right turns reduce crashes related to right turns</p> <p>64<sup>th</sup> (Alt 1B: grade-separated): Crashes related to northbound through vehicles significantly reduced</p> <p>68<sup>th</sup> (Alt 1B: grade-separated): Closing this movement eliminates crashes related to intersection</p>		<p><u>Mainline</u>: Increased capacity with additional lanes would reduce crashes. Wider median also helps to reduce crashes</p> <p>58<sup>th</sup> (Alt 2A: channelized-T): Channelized T significantly reduces crashes related to southbound through movement</p> <p>58<sup>th</sup> (Alt 2B: roundabout): Roundabouts reduce severe crashes by reducing broadside and approach turn type crashes</p> <p>64<sup>th</sup>: Channelized T significantly reduces crashes related to southbound through movement</p>	
	Expected crash frequency and severity (crashes/year)	US 6/CO 93: 7 total; 2 severe Johnson: 84 total, 20 severe 58 <sup>th</sup> : 16 total, 6 severe 64 <sup>th</sup> : 11 total, 1 severe		US 6/CO 93: 6 total; 1 severe Johnson (at-grade): 84 total, 20 severe 58 <sup>th</sup> (at-grade): 15 total, 6 severe 64 <sup>th</sup> (Alt 1A: at-grade): 10 total, 1 severe 64 <sup>th</sup> (Alt 1B: grade-separated): 8 total, 1 severe		US 6/CO 93: 6 total; 1 severe Johnson (at-grade): 84 total, 20 severe 58 <sup>th</sup> (Alt 2A: channelized T): 13 crashes, 4 severe 58 <sup>th</sup> (Alt 2B: roundabout): 5-15 total, 2-5 severe 64 <sup>th</sup> : 7 total, 1 severe	
	Pedestrian and bicycle comfort and safety (level of traffic stress – LTS)	Along CO 93: LTS 3		<p>Along CO 93: LTS 1</p> <p>Johnson (at-grade): Increased crossing width</p> <p>58<sup>th</sup> (at-grade): Added free rights and increased width</p> <p>64<sup>th</sup> (Alt 1A: at-grade): Added free rights and increased width</p> <p>64<sup>th</sup> (Alt 1B: grade-separated): Added free rights, but grade separation of NB CO 93</p>		<p>Along CO 93: LTS 1</p> <p>Johnson (at-grade): Increased crossing width</p> <p>58<sup>th</sup> (Alt 2A: channelized-T): Increased width</p> <p>58<sup>th</sup> (Alt 2B: roundabout): Crossing of multi-lane free-flow movements</p> <p>64<sup>th</sup> (channelized-T): Increased width</p>	
Traffic Operations	2040 peak hour intersection delay (AM/PM) *LOS F for CO 93 through movement	<u>With Jefferson Pkwy</u> Johnson: LOS C / LOS F 58 <sup>th</sup> : LOS D / LOS C 64 <sup>th</sup> : LOS F* / LOS F*	<u>Without Jefferson Pkwy</u> Johnson: LOS C / LOS F 58 <sup>th</sup> : LOS C / LOS B 64 <sup>th</sup> : LOS E / LOS F*	<u>With Jefferson Pkwy</u> Johnson (at-grade): LOS D / LOS C 58 <sup>th</sup> (at-grade): LOS B / LOS B 64 <sup>th</sup> (Alt 1A: at-grade): LOS D / LOS E 64 <sup>th</sup> (Alt 1B: grade-separated): LOS B / LOS B	<u>Without Jefferson Pkwy</u> Johnson (at-grade): LOS D / LOS C 58 <sup>th</sup> (at-grade): LOS B / LOS B 64 <sup>th</sup> (Alt 1A: at-grade): LOS C / LOS B 64 <sup>th</sup> (Alt 1B: grade-separated): LOS B / LOS B	<u>With Jefferson Pkwy</u> Johnson (at-grade): LOS D / LOS C 58 <sup>th</sup> (Alt 2A: channelized-T): LOS D* / LOS C* 58 <sup>th</sup> (Alt 2B: roundabout): LOS F* / LOS F* 64 <sup>th</sup> (channelized-T): LOS E / LOS F*	<u>Without Jefferson Pkwy</u> Johnson (at-grade): LOS D / LOS C 58 <sup>th</sup> (Alt 2A: channelized-T): LOS C / LOS B 58 <sup>th</sup> (Alt 2B: roundabout): LOS D / LOS D 64 <sup>th</sup> (channelized-T): LOS D / LOS E
	2040 vehicular peak hour travel time (AM/PM)	<u>With Jefferson Pkwy</u> NB: 2.4 / 1.4 SB: 1.1 / 1.0	<u>Without Jefferson Pkwy</u> NB: 1.9 / 1.3 SB: 1.3 / 1.1	<u>With Jefferson Pkwy</u> Alt 1A: NB: 5.3 / 3.9 SB: 1.2 / 1.4 Alt 1B: 1.4 / 1.2 SB: 1.2 / 1.3	<u>Without Jefferson Pkwy</u> Alt 1A: NB: 1.7 / 1.5 SB: 1.2 / 1.2 Alt 1B: NB: 1.2 / 1.2 SB: 1.2 / 1.2	<u>With Jefferson Pkwy</u> Alt 2A: NB: 2.8 / 2.0 SB: 1.1 / 1.1 Alt 2B: NB: 2.8 / 3.2 SB: 1.4 / 1.5	<u>Without Jefferson Pkwy</u> Alt 2A: NB: 1.5 / 1.4 SB: 1.2 / 1.2 Alt 2B: NB: 1.5 / 1.5 SB: 1.3 / 1.3
Multimodal Operations and Connectivity	Enhanced regional biking and walking transportation options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists		Improved sidewalks and crossings at all intersections		Improved sidewalks and crossings at all intersections	
	Enhanced regional transit options	No additional transit service provided		<p>Alt 1A: Queue jumps northbound at 58<sup>th</sup> and 64<sup>th</sup></p> <p>Alt 1B: Queue jump lane at 58<sup>th</sup> and NB grade separated at 64<sup>th</sup>, but bus stops moved away from intersection</p>		<p>Alt 2A: Queue jumps northbound at 58<sup>th</sup> and 64<sup>th</sup></p> <p>Alt 2B: Roundabout facilitates NB movement at 58<sup>th</sup> and queue jump lane at 64<sup>th</sup></p>	
	Local multimodal connections	No new or improved connections		Improved multimodal connections to bus stops at 64 <sup>th</sup> intersection		Improved multimodal connections to bus stops at 64 <sup>th</sup> intersection	
Community	Design and operational context related to local community surroundings	Recurring AM and PM congestion and delay inconsistent with local community		Reduced congestion and arterial corridor generally consistent with local community		Reduced congestion and arterial corridor generally consistent with local community	
	Access management	Intersection spacing appropriate for highway, but driveway access limits highway mobility		Intersection spacing and configurations improve highway mobility		Intersection spacing and configurations improve highway mobility	
	Impacts on existing properties	None		<p><u>Alternative 1A</u></p> <p>Residential: 1 acre (3 parcels) Business/Other: &lt; 1 acre (4 parcels) Public: &lt; 1 acre (4 parcels)</p>	<p><u>Alternative 1B</u></p> <p>Residential: 1 acre (3 parcels) Business/Other: &lt; 1 acre (4 parcels) Public: &lt; 1 acre (4 parcels)</p>	<p><u>Alternative 2A</u></p> <p>Residential: 1 acre (3 parcels) Business/Other: &lt; 1 acre (4 parcels) Public: &lt; 1 acre (4 parcels)</p>	<p><u>Alternative 2B</u></p> <p>Residential: 1 acre (4 parcels) Business/Other: &lt; 1 acre (3 parcels) Public: &lt; 1 acre (2 parcels)</p>
	Support of local and regional planning efforts	Inconsistent with Jefferson County plans for improvements along CO 93		Consistent with Jefferson County plans for four lanes from Golden to County line		Consistent with Jefferson County plans for four lanes from Golden to County line	

Table 14 (cont.): Level 2B – Golden Segment – US 6 and Johnson Rd and CO 93 56<sup>th</sup> Ave to 64<sup>th</sup> Pkwy

CATEGORY	EVALUATION CRITERIA	NO ACTION	ALTERNATIVE 1: FOUR GENERAL PURPOSE LANES AND INTERSECTION IMPROVEMENTS		ALTERNATIVE 2: FOUR GENERAL PURPOSE LANES WITH FREE FLOW SOUTHBOUND CO 93	
			Alternative 1A	Alternative 1B	Alternative 2A	Alternative 2B
Environmental Resources	Impacts on environmental resources within the built and natural environment	Impacts to air quality and noise are likely with increase in traffic volumes and congestion	<p><u>Alternative 1A</u></p> 3 100-year floodplains with approximately 126,000 square foot area of impact 48 cultural surveys and known sites 12 parks and open spaces impacted 6 wetlands impacted 3 potential/critical PMJM habitats 7 stream and/or water bodies 2 potential noise analysis areas in neighborhoods between Johnson and the Jefferson County Sheriff's Office and between 56 <sup>th</sup> and 62 <sup>nd</sup>	<p><u>Alternative 1B</u></p> 3 100-year floodplains with approximately 90,000 square foot area of impact 48 cultural surveys and known sites 12 parks and open spaces impacted 6 wetlands impacted 3 potential/critical PMJM habitats 7 stream and/or water bodies 2 potential noise analysis areas in neighborhoods between Johnson and the Jefferson County Sheriff's Office and between 56 <sup>th</sup> and 62 <sup>nd</sup>	<p><u>Alternative 2A</u></p> 3 100-year floodplains with approximately 115,000 square foot area of impact 46 cultural surveys and known sites 12 parks and open spaces impacted 6 wetlands impacted 3 potential/critical PMJM habitats 7 stream and/or water bodies 2 potential noise analysis areas in neighborhoods between Johnson and the Jefferson County Sheriff's Office and between 56 <sup>th</sup> and 62 <sup>nd</sup>	<p><u>Alternative 2B</u></p> 3 100-year floodplains with approximately 159,000 square foot area of impact 46 cultural surveys and known sites 12 parks and open spaces impacted 6 wetlands impacted 3 potential/critical PMJM habitats 7 stream and/or water bodies 2 potential noise analysis areas in neighborhoods between Johnson and the Jefferson County Sheriff's Office and between 56 <sup>th</sup> and 62 <sup>nd</sup>
Implementability	Construction and maintenance costs	Construction: <b>None</b> Operations & Maintenance: > \$110K/yr (deferred costs)	Construction: \$33M - \$40M Operations & Maintenance: \$195K/yr	Construction: \$37M - \$46M Operations & Maintenance: \$195K/yr	Construction: \$34M - \$41M Operations & Maintenance: \$195K/yr	Construction: \$33M - \$41M Operations & Maintenance: \$195K/yr
	Ability to proceed independently with phased projects	N/A	<p style="text-align: center;">Easy</p> CO 93 improvements could be constructed in useful phases to address congestion Intersection improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements		<p style="text-align: center;">Easy</p> CO 93 improvements could be constructed in useful phases to address congestion Intersection improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements	
	Effective connections with identified corridor projects	No changes to connect with adjacent corridor projects	Provides additional capacity for the segment consistent with the improvements in the Golden Plan		Free flow southbound flow at intersections more consistent with the Golden Plan	
	Ability to incorporate technology that can be used to optimize safety and operations	Low	<p style="text-align: center;">Moderate</p> Opportunities for corridor operations enhancements with improvements		<p style="text-align: center;">Moderate</p> Opportunities for corridor operations enhancements with improvements	
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>		<b>CARRIED FORWARD</b>	
Notes		Further analysis required as the No Action Alternative in NEPA process for comparison to action alternatives.	<p>These elements of the alternative are Not Recommended:</p> <ul style="list-style-type: none"> <li>- 64<sup>th</sup> at-grade intersection due to unacceptable level of service and increased delays along the corridor</li> </ul> <p>The grade separation at 64<sup>th</sup> Parkway is carried forward to future NEPA processes because the improvement provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources.</p> <p>The at-grade intersection improvement at 58<sup>th</sup> Avenue may be considered a short-term improvement to the long-term channelized T intersection improvement included in Alternative 2.</p>		<p>These elements of the alternative are Not Recommended:</p> <ul style="list-style-type: none"> <li>- 64<sup>th</sup> channelized-T intersection due to unacceptable level of service and increased delays along the corridor, although this configuration may be considered as a short-term improvement to the long-term grade-separated intersection</li> <li>- 58<sup>th</sup> roundabout due to unacceptable level of service and increased delays along the corridor</li> </ul> <p>The channelized T intersection at 58<sup>th</sup> Avenue is carried forward to future NEPA processes because the improvement provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources.</p> <p>The at-grade intersection improvement at 58<sup>th</sup> Avenue included in Alternative 1 may be considered a short-term improvement to the long-term channelized T intersection.</p>	

**GREEN** = Comparatively beneficial and/or minor impacts.  
**BLACK** = Comparatively neutral benefits and/or moderate impacts.  
**RED** = Comparatively minor benefits and/or major impacts.

Table 15: Level 2B – CO 93 Segment – 64<sup>th</sup> Pkwy to Marshall Rd

CATEGORY	EVALUATION CRITERIA	NO ACTION		ALTERNATIVE 1: FOUR GENERAL PURPOSE LANES WITH AT-GRADE INTERSECTION IMPROVEMENTS		ALTERNATIVE 2: COMBINATION OF FOUR LANES SOUTH OF CO 72 AND TWO LANES WITH PASSING LANES AND FREE FLOW SOUTHBOUND CO 93		ALTERNATIVE 3: COMBINATION OF FOUR LANES AND TWO LANES WITH PASSING LANES, ROUNDABOUTS AND AT-GRADE INTERSECTION IMPROVEMENTS	
Safety	Ability to address identified unsafe physical or operational conditions	No change		<p><u>Mainline</u>: Increased capacity with additional lanes would reduce crashes. Median with wider outside shoulders also helps to reduce crashes.</p> <p><u>Westgate</u>: Channelized T significantly reduces crashes related to southbound through movement.</p>		<p><u>Mainline</u>: Increased capacity with additional lanes reduces crashes. Median with wider outside shoulders also helps to reduce crashes.</p> <p><u>82nd</u>: Signalized channelized T significantly reduces crashes related to southbound through movement.</p> <p><u>CO 72</u>: Interchange significantly reduces crashes related to northbound/southbound through movements.</p> <p><u>Westgate</u>: Channelized T significantly reduces crashes related to southbound through movement.</p> <p><u>CO 128</u>: Channelized T significantly reduces crashes related to southbound through movement.</p>		<p><u>Mainline</u>: Increased capacity with additional lanes reduces crashes. Median with wider outside shoulders also helps to reduce crashes.</p> <p><u>82nd</u>: Roundabout reduces severe crashes by reducing broadside and approach turn type crashes.</p> <p><u>Westgate</u>: Channelized T significantly reduces crashes related to southbound through movement.</p> <p><u>CO 128</u>: Roundabout reduces severe crashes by reducing broadside and approach turn type crashes.</p>	
	Expected crash frequency and severity (crashes/year)	CO 93: 56 total; 17 severe 82nd: 4 total, 3 severe CO 72: 21 total, 4 severe Westgate: 5 total, 3 severe CO 128: 12 total, 4 severe CO 170: 18 total, 10 severe		CO 93: 37 total; 11 severe 82nd (at-grade): 3-5 total, 2-3 severe CO 72 (at-grade): 21 total, 4 severe Westgate (channelized-T): 2 total, 2 severe CO 128 (at-grade): 12 total, 4 severe CO 170 (at-grade): 18 total, 10 severe		CO 93: 41 total; 12 severe 82nd (channelized-T): 1-2 total, 1-2 severe CO 72 (interchange): 12 total, 2 severe Westgate (channelized-T): 2 total, 2 severe CO 128 (channelized-T): 8 total, 3 severe CO 170 (at-grade): 18 total, 10 severe		CO 93: 41 total; 12 severe 82nd (roundabout): 1-3 total, 1-2 severe CO 72 (at-grade): 21 total, 4 severe Westgate (channelized-T): 2 total, 2 severe CO 128 (roundabout): 4-11 total, 1-4 severe CO 170 (at-grade): 18 total, 10 severe	
	Pedestrian and bicycle comfort and safety (level of traffic stress – LTS)	Along CO 93: LTS 3 82nd: stop-controlled crossing of 82nd CO 72: signalized but no pedestrian facilities Westgate: signalized but no pedestrian facilities CO 128: signalized but no pedestrian facilities CO 170: signalized but no pedestrian facilities		Along CO 93: LTS 1 Grade separation of CO 93 at CO 72 and CO 128 82nd (at-grade): signalized crossing of 82nd CO 72 (at-grade): increased crossing width Westgate (at-grade): increased crossing width CO 128 (at-grade): no change to CO 128 crossing CO 170 (at-grade): Added free right and increased width		Along CO 93: LTS 1 Grade separation of CO 93 at CO 72 and CO 128 82nd (channelized-T): signalized crossing of 82nd CO 72 (interchange): reduced crossing width on CO 72 Westgate (channelized-T): increased crossing width CO 128 (channelized-T): no change to CO 128 crossing CO 170 (at-grade): Added free right and increased width		Along CO 93: LTS 1 Grade separation of CO 93 at CO 72 and CO 128 82nd (roundabout): Crossing of free-flow movements CO 72 (at-grade): increased crossing width Westgate (channelized-T): increased crossing width CO 128 (roundabout): Crossing of multi-lane free-flow movements CO 170 (at-grade): Added free right and increased width	
Traffic Operations	2040 peak hour intersection delay (AM/PM) *LOS F for CO 93 through movement	<u>With Jefferson Pkwy</u> 82nd: LOS F / LOS F CO 72: LOS D / LOS E Westgate: LOS C / LOS D CO 128: LOS C / LOS D CO 170: LOS F* / LOS F*	<u>Without Jefferson Pkwy</u> 82nd: LOS F / LOS F CO 72: LOS E / LOS D Westgate: LOS E / LOS E CO 128: LOS D / LOS D CO 170: LOS F* / LOS D	<u>With Jefferson Pkwy</u> 82nd (at-grade): LOS B / LOS A CO 72 (at-grade): LOS C / LOS D Westgate (channelized-T): LOS B / LOS B CO 128 (at-grade): LOS A / LOS B CO 170 (at-grade): LOS C / LOS D	<u>Without Jefferson Pkwy</u> 82nd (at-grade): LOS C / LOS B CO 72 (at-grade): LOS D / LOS D Westgate (channelized-T): LOS C / LOS B CO 128 (at-grade): LOS C / LOS C CO 170 (at-grade): LOS D / LOS F*	<u>With Jefferson Pkwy</u> 82nd (channelized-T): LOS B / LOS B CO 72 (interchange): LOS A / LOS B Westgate (channelized-T): LOS B / LOS B CO 128 (channelized-T): LOS B / LOS C CO 170 (at-grade): LOS C / LOS C	<u>Without Jefferson Pkwy</u> 82nd (channelized-T): LOS C / LOS B CO 72 (interchange): LOS A / LOS B Westgate (channelized-T): LOS B / LOS B CO 128 (channelized-T): LOS B / LOS B CO 170 (at-grade): LOS B / LOS D	<u>With Jefferson Pkwy</u> 82nd (roundabout): LOS B / LOS C CO 72 (at-grade): LOS C / LOS D Westgate (channelized-T): LOS B / LOS B CO 128 (roundabout): LOS C / LOS D CO 170 (at-grade): LOS C / LOS C	<u>Without Jefferson Pkwy</u> 82nd (roundabout): LOS C / LOS D CO 72 (at-grade): LOS D / LOS D Westgate (channelized-T): LOS B / LOS B CO 128 (roundabout): LOS C / LOS E* CO 170 (at-grade): LOS B / LOS D
	2040 vehicular peak hour travel time index (AM/PM)	<u>With Jefferson Pkwy</u> NB: 1.6 / 1.5 SB: 7.2 / 20.5	<u>Without Jefferson Pkwy</u> NB: 1.7 / 1.4 SB: 1.6 / 2.2	<u>With Jefferson Pkwy</u> NB: 1.2 / 1.3 SB: 1.2 / 1.4	<u>Without Jefferson Pkwy</u> NB: 1.3 / 1.2 SB: 1.2 / 1.4	<u>With Jefferson Pkwy</u> NB: 1.3 / 1.2 SB: 1.1 / 1.3	<u>Without Jefferson Pkwy</u> NB: 1.2 / 1.2 SB: 1.1 / 1.4	<u>With Jefferson Pkwy</u> NB: 1.3 / 1.2 SB: 1.1 / 2.6	<u>Without Jefferson Pkwy</u> NB: 1.3 / 1.2 SB: 1.1 / 2.6
Multimodal Operations and Connectivity	Enhanced regional biking and walking transportation options	No new infrastructure and/or wayfinding provided for pedestrians and bicyclists		Separated trail along CO 93. Improved crossings for pedestrians/bicyclists at CO 72 and CO 170		Separated trail along CO 93. Improved crossings for pedestrians/bicyclists at CO 170		Separated trail along CO 93. Improved crossings for pedestrians/bicyclists at CO 72 and CO 170	
	Enhanced regional transit options	No additional transit service provided		Increased GS service between Boulder and Golden		Increased GS service between Boulder and Golden		Increased GS service between Boulder and Golden	
	Local multimodal connections	None		Improved and expanded park and ride facility on southeast corner at CO 72		Improved and expanded park and ride facility on southwest corner at CO 72		Improved and expanded park and ride facility on southeast corner at CO 72	

Table 15 (cont.): Level 2B – CO 93 Segment – 64<sup>th</sup> Pkwy to Marshall Rd

CATEGORY	EVALUATION CRITERIA	NO ACTION	ALTERNATIVE 1: FOUR GENERAL PURPOSE LANES WITH AT-GRADE INTERSECTION IMPROVEMENTS	ALTERNATIVE 2: COMBINATION OF FOUR LANES SOUTH OF CO 72 AND TWO LANES WITH PASSING LANES AND FREE FLOW SOUTHBOUND CO 93	ALTERNATIVE 3: COMBINATION OF FOUR LANES AND TWO LANES WITH PASSING LANES, ROUNDABOUTS AND AT-GRADE INTERSECTION IMPROVEMENTS
Community	Design and operational context related to local community surroundings	Recurring AM and PM congestion and limited shoulders inconsistent with local community and surroundings	Reduced congestion consistent with local community, but increased roadway width inconsistent with natural surroundings	Reduced congestion generally consistent with local community and minimal roadway width consistent with natural surroundings	Reduced congestion generally consistent with local community and minimal roadway width consistent with natural surroundings
	Access management	Intersection spacing appropriate for highway, but driveway access limits highway mobility	Intersection spacing and configurations improve highway mobility	Intersection spacing and configurations improve highway mobility Improved access for CO 93 at CO 72	Intersection spacing and configurations improve highway mobility
	Impacts on existing properties	None	Residential: 2 acres (3 parcels) Business/Other: 12 acres (24 parcels) Public: 34 acre (28 parcels)	Residential: 2 acres (3 parcels) Business/Other: 12 acres (23 parcels) Public: 37 acre (24 parcels)	Residential: 2 acres (3 parcels) Business/Other: 11 acres (21 parcels) Public: 34 acre (25 parcels)
	Support of local and regional planning efforts	Inconsistent with Jefferson County and Boulder County plans for improvements along CO 93	Consistent with Jefferson County plans for four lanes from Golden to County line, but inconsistent with Boulder County vision	Consistent with Jefferson County plans for four lanes from Golden to County line and consistent with Boulder County vision	Consistent with Jefferson County plans for four lanes from Golden to County line and consistent with Boulder County vision
Environmental Resources	Impacts on environmental resources within the built and natural environment	Impacts to air quality and noise are likely with increase in traffic volumes and congestion	49 cultural surveys and known sites 20 parks and open spaces 12 existing trails 5 wetlands impacted 5 potential/critical PMJM habitat 7 stream and/or water bodies 3 potential hazardous material site/regions 1 potential noise analysis area in neighborhoods between 80th and Coal Creek Canyon Road	49 cultural surveys and known sites 19 parks and open spaces 12 existing trails 6 wetlands impacted 5 potential/critical PMJM habitat 8 stream and/or water bodies 3 potential hazardous material site/regions 1 potential noise analysis area in neighborhoods between 80th and Coal Creek Canyon Road	49 cultural surveys and known sites 19 parks and open spaces 12 existing trails 5 wetlands impacted 5 potential/critical PMJM habitat 8 stream and/or water bodies 3 potential hazardous material site/regions 1 potential noise analysis area in neighborhoods between 80th and Coal Creek Canyon Road
Implementability	Construction and maintenance costs	Construction: None Operations & Maintenance: > \$450K/yr (deferred cost)	Construction: \$195M - \$240M Operations & Maintenance: \$990K/ yr	Construction: \$185M - \$225M Operations & Maintenance: \$915K/yr	Construction: \$175M - \$215M Operations & Maintenance: \$915K/yr
	Ability to proceed independently with phased projects	N/A	Easy CO 93 improvements could be constructed in useful phases to address congestion Intersection improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements	Easy CO 93 improvements could be constructed in useful phases to address congestion Intersection improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements	Easy CO 93 improvements could be constructed in useful phases to address congestion Intersection improvements could be implemented as independent projects with mobility and safety benefits independent of mainline improvements
	Effective connections with identified corridor projects	No changes to connect with adjacent corridor projects	Provides additional capacity for the segment consistent with the improvements in the Golden Plan	Free flow southbound flow at intersections more consistent with the Golden Plan	Less consistent with improvements in the Golden Plan than other alternatives
	Ability to incorporate technology that can be used to optimize safety and operations	Low	Moderate Opportunities for corridor operations enhancements with improvements	Moderate Opportunities for corridor operations enhancements with improvements	Moderate Opportunities for corridor operations enhancements with improvements
Summary of Results		<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>CARRIED FORWARD</b>	<b>NOT RECOMMENDED</b>
Notes		Further analysis required as the No Action Alternative in NEPA process for comparison to action alternatives.	This alternative is carried forward to future NEPA processes because the alternative provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources.	This alternative is carried forward to future NEPA processes because the alternative provides reasonable safety and mobility benefits related to recurring congestion and operational conditions and enhances multimodal mobility options, while minimizing impacts to the community and environmental resources. This alternative provides similar CO 93 travel speeds, and greater safety benefits, and is more consistent with the Boulder County vision compared to Alternative 1.	These elements of the alternative are Not Recommended: - CO 128 roundabout due to unacceptable level of service and increased delays along the corridor - 82nd roundabout as only roundabout along corridor due to concerns with CO 93 speeds and dark conditions The remaining alternative highway and intersection elements are contained within Alternatives 1 and 2 and, therefore, are carried forward with those alternatives.

**GREEN** = Comparatively beneficial and/or minor impacts.  
**BLACK** = Comparatively neutral benefits and/or moderate impacts.  
**RED** = Comparatively minor benefits and/or major impacts.

## Evaluation of Technology Options

This Level 2 evaluation is intended to compare how well the technology options perform in meeting the Purpose and Need and goals of the project. The evaluation focuses on the criteria developed for the overall Level 2 evaluation: safety, traffic operations, multimodal operations and connectivity, community, environmental resources, and implementability.

The technology options remaining after this Level 2 screening will be combined with the corridor infrastructure improvements and further considered with the corridor Level 3 evaluation of final recommendations, including specific locations for technology applications related to each corridor segment. A summary evaluation of the general benefits and considerations/constraints associated with the identified technology options is provided in **Table 16**.

**Table 16: Technology Options Level 2 Evaluation**

CONCEPT	EVALUATION CRITERIA					
	SAFETY	TRAFFIC OPERATIONS	MULTIMODAL OPERATIONS AND CONNECTIVITY	COMMUNITY	ENVIRONMENTAL RESOURCES	IMPLEMENTABILITY
Advanced Signal Warning Flashers	<ul style="list-style-type: none"> <li>Potential for reduced rear end crashes</li> </ul>	<ul style="list-style-type: none"> <li>Minimal reduction in traffic congestion</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low cost for communication and power</li> </ul>
Adaptive Traffic Signals	<ul style="list-style-type: none"> <li>Potential for reduced crashes related to congestion</li> </ul>	<ul style="list-style-type: none"> <li>Reduced congestion and delay</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively high cost with required signal upgrades and system development and monitoring</li> </ul>
Variable Speed Limits	<ul style="list-style-type: none"> <li>Potential for reduced crashes</li> </ul>	<ul style="list-style-type: none"> <li>Delayed onset of congestion</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low cost for communication and power</li> </ul>
Dynamic Lane Use	<ul style="list-style-type: none"> <li>Potential for reduced congestion-related crashes</li> </ul>	<ul style="list-style-type: none"> <li>Reduced congestion and delay</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate high cost with potential for needed infrastructure reconstruction (e.g., shoulder width expansion, clear zone improvements)</li> </ul>
Queue Warnings	<ul style="list-style-type: none"> <li>Potential for reduced rear-end crashes</li> </ul>	<ul style="list-style-type: none"> <li>Minimal reduction in traffic congestion</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost for additional detection devices, communication, and power</li> </ul>

Table 16 (cont.): Technology Options Level 2 Evaluation

CONCEPT	EVALUATION CRITERIA					
	SAFETY	TRAFFIC OPERATIONS	MULTIMODAL OPERATIONS AND CONNECTIVITY	COMMUNITY	ENVIRONMENTAL RESOURCES	IMPLEMENTABILITY
Ramp Metering	<ul style="list-style-type: none"> <li>Potential for reduced freeway rear-end and sideswipe crashes</li> </ul>	<ul style="list-style-type: none"> <li>Delayed onset of congestion on freeway</li> <li>Limited ramp capacity may result in queues extending into cross-street/ramp intersection</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Queues may impact arterial road operations within communities</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost for ramp capacity improvements</li> </ul>
Wildlife Detection and Alert Systems	<ul style="list-style-type: none"> <li>Limited potential for reduced crashes with wild animals with existing technology</li> </ul>	<ul style="list-style-type: none"> <li>Limited operational benefits with high traffic volumes, speed and multi-lane roadways where driver responsiveness is reduced</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Most applicable beyond local communities</li> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential wildlife benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate cost for animal detection and warning beacon interconnect system</li> </ul>
Enhanced Communication Infrastructure	<ul style="list-style-type: none"> <li>Potential for reduced crashes by providing support for multiple information systems</li> </ul>	<ul style="list-style-type: none"> <li>Operational benefits with connectivity to numerous technologies and devices</li> </ul>	<ul style="list-style-type: none"> <li>Potential for multimodal operational enhancements</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to moderate property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate cost for significant fiber enhancements</li> </ul>
Improved Traveler Information Signs	<ul style="list-style-type: none"> <li>Potential for reduced congestion- and weather-related crashes</li> </ul>	<ul style="list-style-type: none"> <li>Reduced congestion if vehicles take suggested alternate routes, predictable travel time</li> </ul>	<ul style="list-style-type: none"> <li>Potential for multimodal operational enhancements</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost for communication and power to signs</li> </ul>
Enhanced Lane Markings	<ul style="list-style-type: none"> <li>Potential for reduced crashes</li> </ul>	<ul style="list-style-type: none"> <li>Operational benefits related to highway geometrics, lighting, and adverse weather</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost for materials and maintenance</li> </ul>
Road/Weather Information Systems	<ul style="list-style-type: none"> <li>Potential for reduced weather-related crashes</li> </ul>	<ul style="list-style-type: none"> <li>Reduced congestion during inclement weather</li> </ul>	<ul style="list-style-type: none"> <li>Enhances transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate to high cost for system equipment, communication, maintenance, and monitoring</li> </ul>

Table 16 (cont.): Technology Options Level 2 Evaluation

CONCEPT	EVALUATION CRITERIA					
	SAFETY	TRAFFIC OPERATIONS	MULTIMODAL OPERATIONS AND CONNECTIVITY	COMMUNITY	ENVIRONMENTAL RESOURCES	IMPLEMENTABILITY
Transit Signal Priority (TSP)	<ul style="list-style-type: none"> <li>Limited safety benefit</li> </ul>	<ul style="list-style-type: none"> <li>Potential for increased delay for general vehicular traffic</li> </ul>	<ul style="list-style-type: none"> <li>Reduced delay/improved travel time for transit operations</li> <li>Minimal pedestrian/bicyclist benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Limited potential for air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate to high cost for traffic signal and bus equipment upgrades and lane widening to accommodate bus priority</li> </ul>
Autonomous Vehicle Lanes (Future Technology)	<ul style="list-style-type: none"> <li>Potential for safety benefit with autonomous vehicles</li> </ul>	<ul style="list-style-type: none"> <li>May provide improved travel speed for autonomous vehicles</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>May be consistent with future corridor context</li> <li>Minimal to moderate property impacts, based on widening for separate lane</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively high cost for reconfiguration of lanes, signage and ITS devices, and vehicle/infrastructure communications</li> </ul>

### Evaluation of System Management Options

This Level 2 evaluation is intended to compare how well the system management options perform in meeting the Purpose and Need and goals of the project. The evaluation focuses on the criteria developed for the overall Level 2 evaluation: safety, traffic operations, multimodal operations and connectivity, community, environmental resources, and implementability.

The system management options remaining after this Level 2 screening will be combined with the corridor infrastructure improvements and further considered with the Level 3 evaluation of final recommendations for implementation. A summary evaluation of the general benefits and considerations/constraints associated with the identified corridor management options is provided in **Table 17**.

Table 17: System Management Options Evaluation

CONCEPT	EVALUATION CRITERIA					
	SAFETY	TRAFFIC OPERATIONS	MULTIMODAL OPERATIONS AND CONNECTIVITY	COMMUNITY	ENVIRONMENTAL RESOURCES	IMPLEMENTABILITY
Travel Demand Management Strategies	<ul style="list-style-type: none"> <li>Limited safety benefit</li> </ul>	<ul style="list-style-type: none"> <li>Reduced recurring congestion</li> </ul>	<ul style="list-style-type: none"> <li>Enhances multimodal options</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate cost with financial incentives</li> </ul>
Enhanced Maintenance and Operations Program	<ul style="list-style-type: none"> <li>Limited potential for reduced crashes with enhanced maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Minimal operational benefits</li> </ul>	<ul style="list-style-type: none"> <li>Minimal transit benefits</li> <li>Enhanced pedestrian/bicyclist options with improved infrastructure maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Limited potential for air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost with request based system</li> </ul>
Access Management Plan	<ul style="list-style-type: none"> <li>Potential for reduced intersection-related crashes</li> </ul>	<ul style="list-style-type: none"> <li>Improved corridor operational performance</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Moderate property impacts with changes to access</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost depending on property impacts</li> </ul>
Incident Management Plan	<ul style="list-style-type: none"> <li>Potential for reduced crashes subsequent to incidents</li> </ul>	<ul style="list-style-type: none"> <li>Improved emergency response time and operational benefits during incidents</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low cost if utilized with available communications and ITS devices</li> </ul>
Event Traffic Management Program	<ul style="list-style-type: none"> <li>Potential for reduced crashes during events</li> </ul>	<ul style="list-style-type: none"> <li>Reduced congestion during events</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to no property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential air quality benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low cost if utilized with available communications and ITS devices</li> </ul>
Wildlife Crossings	<ul style="list-style-type: none"> <li>Potential for reduced crashes with wild animals</li> </ul>	<ul style="list-style-type: none"> <li>Improved corridor operational performance</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to moderate property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential wildlife benefits</li> </ul>	<ul style="list-style-type: none"> <li>Relatively moderate to high cost depending on the type of treatment</li> </ul>
Snow Fence	<ul style="list-style-type: none"> <li>Potential for reduced crashes during snow weather events</li> </ul>	<ul style="list-style-type: none"> <li>Improved operations during snow weather events</li> </ul>	<ul style="list-style-type: none"> <li>Minimal multimodal benefits</li> </ul>	<ul style="list-style-type: none"> <li>Consistent with corridor context</li> <li>Minimal to moderate property impacts</li> </ul>	<ul style="list-style-type: none"> <li>Potential impacts to wildlife corridors</li> </ul>	<ul style="list-style-type: none"> <li>Relatively low to moderate cost</li> </ul>

## Level 2B Screening Results

### Elements of Alternatives Not Recommended

The following elements of the Level 2B alternatives were not recommended for further consideration due to unreasonable impacts or lack of benefits when compared to other reasonable alternatives.

#### *Golden Segment*

- 58<sup>th</sup> Avenue – A roundabout intersection was not recommended due to unacceptable level of service and increased delays along the CO 93 corridor.
- 64<sup>th</sup> Parkway – The at-grade intersection and channelized-T intersection were not recommended due to unacceptable level of service and increased delays along the CO 93 corridor. But, the channelized-T intersection may be considered as a short-term improvement.

#### *CO 93 Segment*

- 82<sup>nd</sup> Avenue – A roundabout intersection was not recommended since it would be the only roundabout along the CO 93 corridor (all others were not recommended due to poor operational performance) and due to concerns with CO 93 off-peak speeds and dark conditions.
- CO 128 Intersection – A roundabout intersection was not recommended due to unacceptable level of service and increased delays along the CO 93 corridor.

### Alternatives Carried Forward

The following alternatives were carried forward for further consideration in future NEPA.

#### *C-470 Segment*

- Alternative 1 – Six/Eight General Purpose Lanes with Auxiliary Lanes
- Alternative 2 – General Purpose Lanes with Two/Four Managed Lanes and Auxiliary Lanes

Under either alternative, both a collector/distributor road and a braided ramp concept would be considered along eastbound I-70 between C-470 and US 6.

Technology elements include:

- Corridor Wide
  - » Enhanced communications infrastructure
  - » Autonomous vehicle lanes (flexibility for possible future implementation)
  - » Ramp metering at all on-ramps



- Bowles Avenue
  - » Variable speed limits (WB C-470 approaching Bowles)
  - » Dynamic lane use (use of WB on-ramp shoulder in peak periods for additional storage of queued vehicles)
  - » Queue warnings (WB C-470 approaching Bowles)
- Morrison Road
  - » Road/weather information systems
- Alameda Parkway
  - » Variable speed limits (EB C-470 approaching Alameda)
  - » Queue warnings (EB C-470 approaching Alameda)

Corridor management elements include:

- Travel Demand Management (TDM): Carpool and vanpool
- Enhanced maintenance and operations program
- Incident management plan: Courtesy patrol program, Coordination plan between state and local agencies and enforcement agencies for incident response
- Event traffic management program: Messages on variable message sign (VMS)
- Wildlife crossings – Collaboration with wildlife biologists and design engineers needed to determine optimal locations and prioritization of improvements
- Snow fence – Further study needed to determine potential locations for installation, effectiveness and impacts

### ***Golden Segment***

- Combination of Alternative 1 and Alternative 2 – Four General Purpose Lanes with Free Flowing Southbound CO 93
  - » 58<sup>th</sup> Avenue – An at-grade intersection may be considered as a short-term improvement to a long-term channelized-T intersection.
  - » 64<sup>th</sup> Parkway – A channelized-T intersection may be considered as a short-term improvement to a long-term grade separated intersection.

Technology elements include:

- Corridor Wide
  - » Enhanced communications infrastructure



- Johnson Road
  - » Improved traveler information signs (US 6 approaching C-470)
- Heritage Road
  - » Variable speed limits (US 6 approaching Heritage Road)
- 58<sup>th</sup> Avenue
  - » Adaptive traffic signal control
  - » Enhanced lane markings
  - » Transit Signal Priority
- 64<sup>th</sup> Parkway
  - » Adaptive traffic signal control
  - » Variable speed limits (SB CO 93 approaching 64<sup>th</sup> Parkway)
  - » Queue warnings (SB CO 93 approaching 64<sup>th</sup> Parkway)
  - » Enhanced lane markings
  - » Road/weather information systems
  - » Transit Signal Priority

Corridor management elements include:

- TDM: Carpool and vanpool, Flextime and telecommute policy at businesses, EcoPass program, Stationless bike share system
- Enhanced maintenance and operations program
- Incident management plan: Closed circuit cameras to monitor incidents and traffic conditions, Permanent VMS to provide traveler information in advance of alternate routes and decision points during an incident, Public transit vehicles equipped to provide information regarding the incident location, severity and clearance duration to the Traffic Operations Center (TOC), Emergency vehicle signal pre-emption, Coordination plan between state and local agencies and enforcement agencies for incident response
- Event traffic management program: Messages on VMS
- Wildlife crossings – Collaboration with wildlife biologists and design engineers needed to determine optimal locations and prioritization of improvements
- Access management – Specific locations to be identified with corridor improvement recommendations
- Snow fence – Further study needed to determine potential locations for installation, effectiveness and impacts



## CO 93 Segment

- Alternative 1 – Four General Purpose Lanes with At-Grade Intersection Improvements
- Alternative 2 – Combination of Four Lanes south of CO 72 and Two Lanes with Passing Lanes north of CO 72 and Free Flowing Southbound CO 93
  - » CO 72 at-grade intersection may be considered as a short-term improvement to a long-term grade separated interchange.

Technology elements include:

- Corridor wide
  - » Variable speed limits (CO 93 between Boulder and CO 72)
  - » Enhanced communications infrastructure
- Proposed Jefferson Parkway
  - » Traveler information signs
- CO 72
  - » Advanced signal warning flashers (south of intersection higher priority)
  - » Queue warnings (CO 93 approaching CO 72)
  - » Improved traveler information signs
  - » Enhanced lane markings
  - » Transit Signal Priority
- CO 128
  - » Advanced signal warning flashers (CO 93 approaching CO 128)
  - » Enhanced lane markings
  - » Transit Signal Priority
- CO 170
  - » Advanced signal warning flashers (north of intersection higher priority and convert signal warning flasher to advanced signal warning flasher)
  - » Enhanced lane markings
  - » Road/weather information systems
  - » Transit Signal Priority



Corridor management elements include:

- TDM: Carpool and vanpool, EcoPass program
- Enhanced maintenance and operations program
- Incident management plan: Emergency pullouts for disabled motorists, Access points and turnarounds for response vehicles, Closed circuit cameras to monitor incidents and traffic conditions, Permanent VMS to provide traveler information in advance of alternate routes and decision points during an incident, Public transit vehicles equipped to provide information regarding the incident location, severity and clearance duration to the TOC, Emergency vehicle signal pre-emption, Coordination plan between state and local agencies and enforcement agencies for incident response
- Access management – Specific locations need to be identified with corridor improvement recommendations
- Wildlife crossings – Collaboration with wildlife biologists and design engineers needed to determine optimal locations and prioritization of improvements
- Snow fence – Further study needed to determine potential locations for installation, effectiveness and impacts



## LEVEL 3 EVALUATION

The alternatives carried forward are being evaluated to provide more information on the benefits and impacts of the potential study recommendations, including more information for conceptual cost estimates and potential right-of-way impacts. This third level of evaluation will be described with the study recommendations in the PEL Study Report. The recommendations will include large-scale improvements, such as interchange reconstruction, and short-term improvements, such as bus queue jump lanes. Long-term recommendations will likely have short-term project elements.



# APPENDIX A: GOLDEN PLAN HISTORY



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# THE GOLDEN PLAN

## Background/History

The Golden Plan was developed after a very long and often contentious history of highway planning along the US 6 and CO 93 corridor. Planning for a regional beltway dates back as far as the 1960s (see **Figure A-1**). The City of Golden became seriously involved about the corridor in the 1980s, during the planning and construction on C-470 from I-70 to 1-25. This state highway was initially planned as an interstate freeway, but was stopped by former Governor Dick Lamm in the 1970s. Golden had unsuccessfully asked that the highway start slightly to the north at US 6 to alleviate traffic that was using Heritage Road. An extension of C-470 from I-70 north to US 6 was eventually completed in the late 1990s.

An initiative to complete a high speed highway through Golden occurred in the late 1980s with the W-470 toll road project. This road was to “complete the beltway” from C-470 north and east to 1-25. The project considered a \$10 annual vehicle registration fee in the corridor to help fund construction, operations and maintenance. This fee was part of an election in 1989 which lost 4 to 1.

After the defeat of W-470 there was an effort led through Jefferson County to include the highway in the mid 1998 update of the Jefferson County Transportation Plan. However, the Policy Committee was not able to reach consensus on the need, the routing or the design of the proposed Northwest Parkway. This led to Jefferson County, the cities of Arvada, Lakewood, Wheat Ridge, Golden and Westminster, along with DRCOG and CDOT, to launch the Northwest Corridor Transportation study.

## Northwest Corridor Transportation Study Alternatives

There are three roadway corridors that provide paths from the vicinity of US 36 and the Northwest Parkway on the north to the vicinity of CO 58, I-70 and C-470 on the south:

- CO 93
- the Indiana Street/McIntyre Street/Ward Road corridor, and
- Wadsworth Boulevard.

The Northwest Corridor study concluded that each of these routes have connectivity and functionality constraints that limit their ability to efficiently serve the regional and inter-regional travel demands in and through the Northwest Corridor. Therefore, improvement alternatives were developed and analyzed for a route connecting the Northwest Parkway with CO 93. This included a new curvilinear route south and east of Rocky Flats Wildlife Refuge as Freeway and Tollway alternatives, a Regional Arterial alternative that followed the Indiana Street and CO 72 alignments, and a Combined Alternative, which was the study’s recommendation.



The Combined Alternative (Recommended Alternative) included two major regional arterial portions along its alignment, CO 93 south of 58<sup>th</sup> Avenue and the far northern portion along Interlocken Loop north of CO 128, and a new high speed, access-controlled facility from CO 93 to CO 128. Signalized intersections in the northern and southern arterial portions of the Combined Alternative would reduce travel speeds compatible with community visions. The nearly two year study, completed in January 2001, included five public workshops and monthly meetings of the management and technical committees.

## The Golden Plan

The City of Golden, with substantial community input, used the recommendations from the Northwest Corridor Transportation Study to develop a highway plan through Golden that was sufficient for traffic, but able to mitigate the highway’s impacts. This resulted in the Golden Plan, first published in 2003 (see **Figure A-1**). This plan has slower speeds, 45 mph to mitigate noise and four lanes instead of six. The plan included interchanges at Heritage Road, 19<sup>th</sup> Street, CO 58 and Washington Avenue, re-alignment of CO 93 from Washington Avenue north to the city limit, Iowa and Golden Gate Canyon Road grade separation with no access to CO 93, and the old CO 93 alignment was kept to provide service road access to Golden Gate Canyon and Pine Ridge Road. The plan also included a covered section approximately 550 feet long adjacent to Mitchell Elementary School.

While Golden was working on developing the Golden Plan, regional leaders still believed that the completion of the beltway was critical. An 11-mile section from I-25 to almost US 36 was built as a public toll road: the Northwest Parkway which opened in 2003. This highway was later privatized through a 99-year lease to a private operator.

In 2002, Arvada and Jefferson County created the Jefferson Parkway Authority to build the beltway segment from CO 128 to CO 93. The authority put its efforts on hold in 2003 when CDOT’s Colorado Tolling Enterprise funded an Environmental Impact Study to complete the beltway from the Northwest Parkway to C-470.

Golden participated in that effort, and was opposed to the recommended findings: a six-lane 70 mph highway through Golden along the US 6 and CO 93 corridor. This effort was shelved in 2008 by the state when environmental approvals could not be obtained and there was no highway funding.

When the state effort ended, the Jefferson Parkway Authority picked up its effort to complete the section from CO 128 to CO 93, and continued to look at developing a private-public partnership that could complete the highway.

## Memorandum of Understanding

In 2012, Golden began discussions with the state concerning bringing a highway through the community. A compromise was found that limited the highway to existing speeds, 45 and 55 mph through Golden and limited the number of lanes to four unless traffic volumes or congestion triggers were reached. It also addressed expanded intersections, a covered section and a realigned section to help mitigate noise



impacts and to prevent the highway from becoming a barrier. In addition, the agreement stipulated that existing free highway lanes remain free, while any new lanes could be tolled under a managed lane program.

The City held a series of public meetings around the proposed compromise which led to an update of the Golden Plan in 2013 and a Memorandum of Understanding (MOU) with the Colorado Department of Transportation (CDOT) that defined regional highway improvement designs through Golden. The Golden Plan as amended was readopted by City Council in January of 2013, and the MOU with CDOT was approved by Resolution 2273 adopted on July 11, 2013. The Plan is depicted in the following graphic illustration.

### **Initial Construction**

In late 2013, Golden applied for and received a \$20 million grant from CDOT to complete an interchange at US 6 and 19<sup>th</sup> Street. The grant required a 20 percent match, with Golden pledging \$4 million to the project, and the Colorado School of Mines added the additional \$1 million. In May of 2014, Golden signed an agreement with CDOT for the grant, and began project design, and environmental clearances. The interchange construction was completed in the fall of 2017.



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# APPENDIX B: NO ACTION ALTERNATIVE



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## NO ACTION ALTERNATIVE

Under the No Action Alternative, the general existing conditions of the highway segments, intersections and interchanges, and multimodal elements will remain throughout the corridor. Funded or programmed improvements identified by CDOT, Boulder and Jefferson Counties or the local municipalities are included.

The following relevant projects have been identified within the No Action Alternative:

- **US 6 shared-use path:** This project will construct an 8-foot wide detached multi-use path along the north side of US 6 between Colfax Avenue and Johnson Road. Americans with Disabilities Act (ADA)/American Association of State Highway and Transportation (AASHTO) compliant lighting and wayfinding signage with destination and distance information will be included.
- **Washington Avenue complete streets:** This project reconstructs Washington Avenue from CO 93 to 10<sup>th</sup> Street to include a curb-separated 4-foot wide bike facility and 8 foot wide sidewalk, where permitted. Intersection safety improvements, ADA/AASHTO compliant lighting, transit supporting amenities, and wayfinding signage with destination and distance information will be included.
- **C-470 managed toll express lanes from Wadsworth Boulevard east to I-25:** The eastbound segment will have one managed lane from approximately Santa Fe Drive to I-25. The westbound segment will have one managed lane from Colorado Boulevard to Wadsworth Boulevard, and two managed lanes from I-25 to Colorado Boulevard.
- **CO 93 Golden to Boulder ITS installation:** This project will install fiber optic cable on CO 93, from Golden to Boulder. This will accommodate future implementation of intelligent transportation system (ITS) components, which may include elements useful for autonomous vehicles.
- **McIntyre Street improvements:** The second phase of the McIntyre roadway improvements will include widening of the road to four lanes with a raised center median, adding bike lanes, and placing curb, gutter, sidewalk, and storm sewer from West 52<sup>nd</sup> Avenue to West 60<sup>th</sup> Avenue. Two new box culverts will be installed where the Farmer’s Highline Canal crosses McIntyre Street. A new bridge will also be installed at the Van Bibber Creek crossing that will include pedestrian access under McIntyre.
- **Eldorado Road shoulders:** Shoulders on Eldorado Road.
- **Leyden Road improvements:** Leyden Road connection at 82<sup>nd</sup> Avenue between CO 93 and Indiana Street to safely accommodate the increased traffic and bring road in compliance with the City’s major collector street standard.



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WestConnect Coalition PEL

*FINAL ALTERNATIVES REPORT – APPENDIX C*

*JANUARY 2018*

# APPENDIX C: TRANSIT OPTIONS



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# TRANSIT OPTIONS

## Bus Stop Improvements

Bus stop improvements enhance access for riders and encourage the use of bus service. A number of possible improvements as detailed below improve infrastructure connections for people walking and bicycling to bus stops. Other bus stop improvements include programmatic elements that improve the transit rider experience. **Table C-1** identifies recommended improvements by stop.

## Sidewalk Connections

Many bus stops along the CO 93 corridor do not have sidewalk connections to existing stops. This means bicyclists and pedestrians often have a difficult time accessing the stop in a safe manner. People with disabilities may have even greater difficulty accessing the stops without a formal sidewalk connection due to uneven terrain or walking/biking in the roadway.

## Bike Parking

None of the stops along CO 93 provide bike parking infrastructure. Bike parking provides another transportation option to combine transit use and bicycling along the corridor. Due to the rural nature of the corridor and low ridership, short term parking options like the inverted-U rack will be the primary type of infrastructure considered. Long-term parking solutions like bike lockers and restricted access cages are more appropriate in urban areas with high bicycle usage.

## Bus Stoppers

Given the rural nature of the CO 93 corridor, transit riders may feel uncomfortable waiting at stops in the dark. Bus stoppers are reflective/light units that allow riders waiting for the bus to make themselves more visible to bus drivers to ensure they stop. These are currently in use to improve safety on the BOLT route along CO 119 in between Boulder and Longmont.

## Solar Lights

Installing solar lights at bus stops would be another means of providing a safe waiting environment for riders waiting in the dark. Many of the stops are located away from intersections and/or other buildings that would provide ambient lighting. This would provide another layer of comfort for riders who wait for the bus during times of the day without daylight, and would be especially important in the winter when overall daylight is reduced.

## Standard Crosswalks

Crosswalks are typically used at signalized intersections on every leg of the intersection, unless pedestrians are prohibited from a section of the roadway, and at midblock crossings with high



pedestrian or bicycle volumes. Crosswalks are important near bus stops to allow people to cross the roadway. On roadways without bicycle infrastructure, crosswalks will likely also be used by bicyclists.

### **Rectangular Rapid Flash Beacon (RRFB)**

This type of treatment is installed at unsignalized intersections or at mid-block locations. After being user activated, rapid flashes alert drivers about the presence of a pedestrian or bicyclists crossing the roadway. Rapid flash beacons usually work best in locations with good visibility and where a traditional traffic signal is not necessary based on traffic volumes but people are still interested in crossing the roadway.

### **Stop Platform**

The platform where riders board, alight and wait for the bus needs to provide a safe and comfortable space for people. Many of the current bus stops do not have any platforms or are located immediately on the roadway, providing virtually no separation from vehicles.

### **Fare Payment**

To improve the experience of boarding and alighting at all stops, improvements can be made to the fare collection process. The newly introduced MyRide card allows riders to load money onto a pre-loaded fare card, which provides a convenient and fast way to pay the fare. Employers can have these available for purchase to reduce the barrier people may feel in obtaining the card from Regional Transportation District (RTD).



Table C-1: Recommended Bus Stop Improvements

ROUTE	STOP	LOCATION	SIDEWALK CONNECTION	BIKE PARKING	BUS STOPPERS	SOLAR LIGHTS	STANDARD CROSSWALKS	RRFB	STOP PLATFORM
GS	CO 93 & Pine Ridge Rd	N/A	On east side of the intersection, providing a connection from Pine Ridge Road.	Inverted U racks needed at northbound and southbound stops.	Bus stoppers would be beneficial to both northbound and southbound stops due to the absence of streetlights.	Solar lights would improve comfort and safety at both northbound and southbound stops.	Crosswalk needed with use of the RRFB on the south leg of the intersection across CO 93 and on the east leg of the intersection across Pine Ridge Road.	South leg of the intersection (due to bus stop locations and limited visibility from the hill)	Needed at northbound and southbound stops.
GS	CO 93 & 58 <sup>th</sup> Ave	Shift northbound and southbound stops to be farside of the intersection at 58 <sup>th</sup> Avenue (northbound just north of connection with sidewalk and southbound just south of end of guardrail)	Connection will be needed to connect the platform to the sidewalk (northbound) while the southbound stop will not need a sidewalk connection because people will have to cross to the east side of the intersection for access to locations.	Inverted U racks needed at northbound and southbound stops.	Since stops are located at a major intersection with streetlights, this is not as critical.	Since stops are located at a major intersection with streetlights, this is not as critical.	Move crosswalk at the north leg of the intersection to the south leg of the intersection.	N/A (Stops located at intersection with traffic signal.)	Needed at northbound and southbound stops.
GS	CO 93 & 68 <sup>th</sup> Ave – Current Location	N/A	There is currently not a sidewalk connection from the northbound stop to the informal park-n-ride on the south side of 68 <sup>th</sup> Avenue.	Inverted U racks needed at northbound and southbound stops.	Bus stoppers would be beneficial to both northbound and southbound stops due to the absence of streetlights.	Bus stoppers would be beneficial to both northbound and southbound stops due to the absence of streetlights.	N/A (Stops not located at intersection with traffic signal.)	South leg of the intersection (due to the bus stop locations and limited visibility from the hill).	Needed at northbound and southbound stops.



Table C-1 (cont.): Recommended Bus Stop Improvements

ROUTE	STOP	LOCATION	SIDEWALK CONNECTION	BIKE PARKING	BUS STOPPERS	SOLAR LIGHTS	STANDARD CROSSWALKS	RRFB	STOP PLATFORM
GS	CO 93 & 64 <sup>th</sup> (New Location)	Northbound and southbound stops are located farside of 64 <sup>th</sup> Parkway (northbound just north of the crosswalk across CO 93 and southbound just south of the intersection.	Either need to add a sidewalk connection north to existing crosswalk or add crosswalk on the south leg of the intersection.	Given the bike facility on 64 <sup>th</sup> Parkway, it will be important to provide ample bike parking to allow people the option to store their bike at this location.	Since stops are located at a major intersection with streetlights, this is not as critical.	Since stops are located at a major intersection with streetlights, this is not as critical.	Either need to add a sidewalk connection north to existing crosswalk or add crosswalk on the south leg of the intersection.	N/A (Stops located at intersection with traffic signal.)	Needed at northbound and southbound stops.
GS	CO 93 & CO 72	Shift northbound and southbound stops to be farside of the intersection at CO 72. Many of the details will depend on recommended alternatives for the intersection and the location of the park-n-ride.	There needs to be a sidewalk connection from the park-n-ride providing access to the intersection.	The park-n-ride should provide some bike parking facilities.	Since stops are located at a major intersection with streetlights, this is not as critical.	Since stops are located at a major intersection with streetlights, this is not as critical.	If the park-n-ride remains in the same location, a crosswalk on the east side of the intersection is necessary. Crosswalks also need to be added to the free rights to guide where people cross that lane of traffic.	N/A (Stops located at intersection with traffic signal.)	Needed at northbound and southbound stops.
GS	CO 93 & Milepost 9, 10 and 11	These stops experience low rider activity and do not create much delay because very few riders actually use the stop. These stops should have bus stoppers added to them, because it is a low-cost improvement to increase safety and visibility along the corridor for riders. It provides a backup to bicyclists who are riding but need a ride back to Golden or Boulder. These stops should be removed or not receive any further improvements due to low usage / very little surrounding destinations.							



Table C-1 (cont.): Recommended Bus Stop Improvements

ROUTE	STOP	LOCATION	SIDEWALK CONNECTION	BIKE PARKING	BUS STOPPERS	SOLAR LIGHTS	STANDARD CROSSWALKS	RRFB	STOP PLATFORM
GS	CO 93 & CO 128	Shift northbound slightly south just north of the Greenbelt Connector.	Provide a connection between both bus stops and the Greenbelt Connector.	Inverted U racks needed at northbound and southbound stops given the close proximity to the Greenbelt Connector.	Bus stoppers would be beneficial to both northbound and southbound stops due to the limited streetlights at this intersection.	Solar lights would improve comfort and safety at both northbound and southbound stops.	Additional crosswalk on the east leg of the intersection to allow people to access the shoulder of eastbound CO 128.	N/A (Stops located at intersection with traffic signal.)	Needed at northbound and southbound stops.
GS	CO 93 & Eldorado Springs Rd	N/A	Sidewalk connections needed for both bus stops to the intersection as well as along Eldorado Springs Drive to the parking lot on the northeast corner of the intersection.	Inverted U racks needed at northbound and southbound stops.	Since stops are located at a major intersection with streetlights, this is not as critical.	Solar lights would improve comfort and safety at both northbound and southbound stops.	N/A (Crosswalks are present at all legs of the intersection.)	N/A (Stops located at intersection with traffic signal.)	Needed at northbound and southbound stops.



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## Bus Queue Jump Lanes

Bus queue jump lanes provide a short transit only lane at intersection approaches to allow buses to circumvent any queues present. Depending on the type of intersection, these can be integrated with transit signal priority to allow even greater savings for the bus.

- CO 93/Washington Avenue
- CO 93/Golden Gate Canyon Road
- CO 93/58<sup>th</sup> Avenue
- CO 93/64<sup>th</sup> Parkway
- CO 93/CO 72
- CO 93/CO 128
- CO 93/CO 170

## Improved Park-n-Ride Facilities

### Quincy Avenue

RTD does not provide an official park-n-ride facility at this location. Northbound, it is the last stop before the 116X travels along C-470 and southbound it is the first stop after exiting C-470. This bus service provides a more direct route for people traveling within the Ken Caryl area but do not want to ride the bus from the Ken Caryl Park-n-Ride.

### CO 72

The park-n-ride at CO 72 is actually owned by CDOT and is not an official RTD park-n-ride, although it is still included in RTD's information, and utilization information is collected every month. Although the parking lot is not paved and striped, RTD estimates there are 14 parking spaces and the utilization memo used for the RTD existing conditions report claimed a 93 percent utilization over the past 12 months.

### CO 170

After inquiring about this park-n-ride at a meeting with RTD in December 2016, there are no plans to create a shared parking facility at the Marshall Mesa Trailhead at CO 170. RTD does have a history of renting spaces at other park-n-rides to provide some designated spaces for RTD riders.

## Improved Shared Ride Facilities

### Morrison Road

This park-n-ride is owned by CDOT and bus service to this park-n-ride was discontinued in 2013 when the W Line opened. This park-n-ride is currently used for carpoolers as well as bicyclists who want to ride in the area.

## Service Improvements

### Increased 116X Frequency

This service would increase the existing 116X service to provide 30-minute frequency from 6:00 – 9:00 AM northbound in the morning and 3:00 – 7:00 PM southbound in the evening. **Table C-2** describes current and increased service for the 116X.

**Table C-2: Summary of Current Service and Increased 116X Frequency**

	CURRENT			INCREASED 116X SERVICE		
	TRIPS	SERVICE SPAN	HEADWAY	TRIPS	SERVICE SPAN	HEADWAY
<b>Northbound</b>			30 minutes with last bus about 40 minutes after previous trip			30 minutes
AM	4	5:30 AM – 7:00 AM		7	6:00 AM – 9:00 AM	
Midday	N/A			N/A		
PM	N/A			N/A		
<b>Southbound</b>						
AM	N/A			N/A		
Midday	N/A		N/A			
PM	4	3:30 PM – 6:00 PM	9	3:00 PM – 7:00 PM		

After running the COMPASS transit ridership forecast model for this scenario, 116X daily boardings increased 48 percent from 67 to 99 riders. This accounts for less than 0.01 percent in growth across the transportation system that was included for this model run. The results are shown in **Table C-3**.

**Table C-3: Modeling Results for Increased 116X Frequency**

	2035 BASE	2035 OPTION 4	RAW GROWTH	% GROWTH
116X	67	99	32	48%
System-wide Linked Trips	336,340	336,367	27	0.008%

### Improved GS Service

This will be an increase in peak period and creation of midday GS service. For the peak period, there will be a headway of every 15 minutes instead of roughly 30 minutes, with the last trip approximately 60 minutes after the previous trip. This option will change the headway to every 15 minutes within the current starting time of service and with an extension of the service from 6:30 to 7:00 PM. The creation of midday GS service during the day with 6 runs in each direction to provide midday service at 60-minute headways. These trips would provide access for people that do not have start or end times for a particular trip within the peak period. Current and improved GS service is described in **Table C-4**.

The approximately 19-mile-long stretch from Boulder (Table Mesa Drive and Broadway) and Golden (Washington Avenue and 10<sup>th</sup> Street) takes the bus approximately 30 minutes, based on time points in the schedule. Studies show that queue jumps can result in a reduction in travel times from 5 to 15 percent (with transit signal priority treatments) or about 1.5-4.5 minutes. Queue jump lanes could be



constructed at approximately seven intersections. Given that this would save the bus 30-90 seconds at each signalized intersection, this would result in approximately 3.5-10.5 minutes of savings in travel time. For a conservative estimate, a 5-minute reduction in travel time was assumed with queue jump lanes starting at CO 170 to Washington Street.

**Table C-4: Summary of Current Service and Improved GS Service**

	Current			Improved GS Service			
	Trips	Service Span	Headway	Trips	Service Span	Headway	
<b>Northbound</b>			30 minutes, with last trip 60 minutes after previous bus				
AM	5	5:30 AM – 8:30 AM		13	5:30 AM – 8:30 AM	15 minutes peak period and 60 minutes during midday	
Midday	N/A			8	8:30 AM – 4:00 PM		
PM	5	4:00 PM – 6:30 PM		15	4:00 PM – 7:00 PM		
<b>Southbound</b>							
AM	6	5:00 AM – 8:30 AM		13	5:00 AM – 8:30 AM		
Midday	N/A			6	8:30 AM – 2:00 PM		
PM	6	2:00 PM – 6:30 PM	21	2:00 PM – 7:00 PM			

After running the COMPASS transit ridership forecast model for this scenario, GS daily boardings increased 135 percent from 626 to 1,472 riders. This accounts for a total of nearly 0.1 percent in growth across the transportation system that was included for this model run. The results are shown in **Table C-5** (without queue jumps) and **Table C-6** (with queue jumps).

**Table C-5: Modeling Results without Queue Jumps**

	2035 BASE	2035 OPTION 1	RAW GROWTH	% GROWTH
GS Boardings	626	1,472	846	135%
System-wide Linked Trips	336,340	336,628	288	0.086%

After including time savings assumptions from queue jump lanes, the model found an additional 50 boardings using the GS service.

**Table C-6: Modeling Results with Queue Jumps**

	2035 BASE	2035 OPTION 1.2	RAW GROWTH	% GROWTH
GS Boardings	626	1,525	899	144%
System-wide Linked Trips	336,340	336,660	320	0.095%



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# APPENDIX D: TECHNOLOGY OPTIONS – LEVEL 2 EVALUATION



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# TECHNOLOGY OPTIONS – LEVEL 2A EVALUATION

This document describes the technology options considered in the Level 2 screening for the WestConnect Coalition PEL Study. As noted in the Level 1 screening analysis, technology options will supplement the safety and operational performance of corridor infrastructure improvements, but alone would be insufficient to meet project Purpose and Need. These options will be combined with corridor infrastructure improvements to identify project recommendations that will optimize safety and operational benefits.

Potential options that were evaluated in this Level 2A screening are listed by segment in **Table D-1**. These are options carried forward from the previous Level 1 screening.

**Table D-1: Level 2A Screening Technology Options – by Segment**

CONCEPT	C-470 SEGMENT	GOLDEN SEGMENT	CO 93 SEGMENT
Advanced Signal Warning Flashers			■
Adaptive Traffic Signals		■	■
Variable Speed Limits	■	■	■
Dynamic Lane Use	■		
Queue Warnings	■	■	■
Ramp Metering	■		
Wildlife Detection and Alert Systems	■	■	■
Enhanced Communications Infrastructure	■	■	■
Improved Traveler Information Signs	■	■	■
Enhanced Lane Markings	■	■	■
Road/Weather Information Systems	■	■	■
Transit Signal Priority		■	■
Autonomous Vehicle Lanes	■		



## Technology Options

### Advanced Signal Warning Flashers

This concept was considered because it may address safety concerns with traffic signals on high-speed corridors. The concept consists of signs with flashing beacons that are activated when the signal is going to turn from green to yellow, and then stay flashing through the red signal phase. Advanced signal warning flashers alert motorists before they arrive at a roadway condition to reduce potential conflicts.

Flashers need to be placed strategically where the greatest benefits will likely be captured (possibly from reduced number of rear end crashes). If flashers are placed with too much frequency or have a low threshold to trigger the flashing phase, drivers may stop paying attention to them because they do not alert drivers to different conditions.

Locations where this concept may be applicable include:

- CO 93/CO 72 intersection (south of intersection higher priority)
- CO 93/CO 128 intersection (both directions)
- CO 93/CO 170 intersection (north of intersection higher priority and convert existing signal warning flasher to advanced signal warning flasher)

### Adaptive Traffic Signals

This concept was considered because it may address congestion and operational performance. The concept consists of traffic signal control technology in which traffic signal timing changes are based on actual traffic demand to accommodate variable traffic patterns and reduce traffic congestion. Ideally, a number of traffic signals would be connected to provide the most efficient signal timing among multiple traffic signals.

Oftentimes, a traffic signal will be activated for a cross street because cars have started queuing. To minimize delay to traffic, the adaptive traffic signals could communicate to coordinate cross traffic at the same time. This would reduce the likelihood of drivers to stop at multiple traffic signals for traffic on cross streets.

The traffic signals along CO 93 are candidates for adaptive control.

### Variable Speed Limits

This concept was considered because it may address safety and recurring congestion. The concept consists of dynamically adjusted speed limits to maintain safe travel speeds based on traffic, weather or other roadway conditions. The speed limits can be regulatory and enforceable or they can be recommended speed advisories.

The main benefits that would result from the implementation of variable speed limits are improving safety by increasing uniform behavior of motorists and delaying onset of congestion. Variable speed



limits may be applicable throughout all segments but especially where congested traffic conditions and/or weather conditions result in slow speed. Potential locations to address existing conditions may include:

- C-470 westbound approaching Bowles Avenue and eastbound approaching Alameda Avenue
- US 6 eastbound and westbound approaching Heritage Road
- CO 93 southbound approaching 64<sup>th</sup> Parkway
- CO 93 from Boulder to CO 72 where high winds and blowing snow frequently impact highway travel

### Dynamic Lane Use

This concept was considered because it may address safety concerns, recurring congestion and multimodal operational performance. This concept involves dynamically closing or opening individual traffic lanes or allowable movements by use of advanced warning or lane use control signs in order to improve traffic operations and respond to traffic congestion or incidents. Changing lane assignments based on roadway conditions and peak period conditions maximizes the capacity of the existing roadway.

There are a number of ways this can be integrated into the roadway system: reversing lane direction, diverting traffic to another lane, changing a through lane to a shared turn lane, and moving traffic to the shoulder or a peak period lane. High volume on- and off-ramps along C-470 may utilize dynamic lane use technology.

### Queue Warnings

This concept was considered because it may address corridor safety concerns. The concept uses real-time information to alert motorists of downstream stopped traffic by use of warning signs and flashing lights, thereby reducing rear-end crashes. The queue warnings need to be located in the correct locations to alert drivers to upcoming queues without being activated all the time so drivers will pay attention to the warnings and respond accordingly.

The following describes the potential locations for consideration with corridor alternatives in Level 2B screening:

- C-470 westbound approaching Bowles Avenue and eastbound approaching Alameda Avenue.
- CO 93 southbound approaching 64<sup>th</sup> Parkway
- CO 93 approaching CO 72



## Ramp Metering

This alternative was considered because it may address safety concerns and recurring traffic congestion. This concept uses traffic signals and detection systems on interchange on-ramps to monitor freeway and ramp traffic and manage the flow of on-ramp traffic to minimize impact to freeway traffic speed. In areas where the roadway congestion occurs consistently, a ramp meter may be on all the time. In other cases, ramp metering may turn on when a certain threshold is triggered, often during peak period times.

Managing the flow of traffic requires enough storage on the ramps entering the highway to not create gridlock on the local street system. Sometimes, the queuing on the ramps can overflow on the cross street providing access to the highway and the meter releases vehicles more quickly to clear the queue from blocking cross street traffic. A RoadX program is underway along I-25 South that is focused on ramp meter timing and queue management, and that program could be expanded to the C-470 corridor. If implemented along the C-470 corridor, the RoadX program would recommend that every entrance ramp be metered.

Accordingly, the following interchanges along C-470 would be considered for metering with corridor alternatives in Level 2B screening:

- C-470/Kipling Avenue interchange – WB on-ramp (EB on-ramp already metered)
- C-470/Ken Caryl Avenue interchange – EB and WB on-ramps
- C-470/Bowles Avenue interchange – EB on-ramp (WB on-ramp already metered)
- C-470/Quincy Avenue interchange – EB on-ramp (WB on-ramp already metered)
- C-470/US 285 interchange – EB and WB on-ramps
- C-470/Morrison Road interchange – EB and WB on-ramps
- C-470/Alameda Parkway interchange – EB and WB on-ramps

## Wildlife Detection and Alert Systems

This concept was considered because it may address safety concerns with reduced crashes resulting from collisions with wild animals. This concept consists of wildlife detection systems and roadway markings and signage with activated flashing warning beacons installed along the roadway at known wildlife movement locations. The alert systems are most effective when the animals are directed to the crossing, whether that is with fencing, foliage or topography. The alert systems need to be sensitive enough to pick up a wide variety within the species as well as other species that may start using the crossing. However, if the alert system is too sensitive, the alert systems will be activated when there are no animals present and motorists will become desensitized from the alert constantly being active.

Wildlife detection systems are not recommended for any locations within this study. The existing technology is currently not sufficiently reliable, although newer systems are currently being tested and may hold future promise. Also, traffic volumes, speeds, and the varying multi-lane sections through the corridor are not suited to this type of system that depends on appropriate responses from drivers in order to be effective.



## Enhanced Communications Infrastructure

This concept was considered because it may address safety concerns and recurring traffic congestion. This concept consists of enhanced fiber optic communication infrastructure to support data transmission from vehicle detection systems, closed circuit television cameras, and other technology devices and vehicle-to-roadway technology. Enhanced communications infrastructure can provide many benefits in the form of coordination with multiple information systems.

This alternative would be considered throughout all segments in consultation with CDOT ITS staff regarding gaps in current communications and need for upgrades.

## Improved Traveler Information Signs

This concept was considered because it may address safety issues and recurring congestion. This concept consists of electronic display signs used to notify motorists of upcoming roadway, incident, weather, and traffic-related conditions. Traveler information signs should be placed in locations with high visibility that will not distract drivers and will provide useful information about the road conditions ahead.

The signs can display informational text based on real-time conditions. The signs are side mounted or mounted overhead of the roadway on a cantilever, sign bridge or other structure. Traveler information signs can work well in combination or independently from other real-time warning and alert systems. The flexibility of traveler information signs can provide general information.

Locations for implementation could be prioritized along the corridor with the highest volumes to maximize exposure. The following describes the locations recommended for consideration with corridor alternatives in Level 2B screening:

- US 6 approaching C-470
- CO 93/Proposed Jefferson Parkway
- CO 93/CO 72

## Enhanced Lane Markings

This concept was considered because it may address safety concerns or geometric conditions that disrupt operational performance. The concept may consist of pavement markings, reflectors, or lights to enhance driver recognition of roadway geometry and laneage, and other new technology to support driverless vehicle recognition of geometry and laneage.

Enhanced lane markings would require maintenance plans for paint markings and lighting, and ambient lighting sensors. The following describes the locations recommended for consideration with corridor alternatives in Level 2B screening:

- CO 93/58<sup>th</sup> Avenue
- CO 93/64<sup>th</sup> Parkway



- CO 93/CO 72
- CO 93/CO 128
- CO 93/CO 170

### Road/Weather Information Systems

This concept was considered because it may address safety concerns and operational performance. The concept consists of technologies and strategies for improved monitoring and prediction, information dissemination, and decision support during adverse weather conditions.

Based on observed weather-related roadway conditions, the following describes the locations recommended for consideration with corridor alternatives in Level 2B screening:

- C-470 westbound at Morrison Road
- CO 93 northbound at 64<sup>th</sup> Parkway
- CO 93 southbound at CO 170

### Transit Signal Priority (TSP)

This future technology concept was considered to provide an improved transit experience by reducing the delay that occurs at signals along the Golden and CO 93 segments. Buses are equipped with technology to communicate with traffic signals when they are within close range to modify the signal timing to reduce delay for the transit vehicle. The modification usually changes the length of the green or red phase based on the distance away from the signal.

The most direct benefit of TSP is the reduction in transit vehicle delay at intersections and the increase in reliability for transit service. Since the signals react to the buses, TSP may affect queuing on cross streets as well as affect the network of signals if the signals are connected and communicate with one another. Signal controller cabinets and bus technology may need to be updated. This technology is most effective at intersections that have farside bus stops or no stop because it is much easier to anticipate transit running time than dwell time.

This concept is best applied on corridors with long distances between signals or cycle phases. This is most relevant along the CO 93 signalized intersections:

- CO 93/58<sup>th</sup> Avenue
- CO 93/64<sup>th</sup> Parkway
- CO 93/CO 72
- CO 93/CO 128
- CO 93/CO 170



### Autonomous Vehicle Lanes

This future technology concept was considered because it may address recurring congestion, safety concerns, and operational performance. The concept consists of a dedicated lane for autonomous vehicles, vehicles that can sense the environment around them and navigate without human input. A dedicated lane for such vehicles could potentially be narrower than a general purpose lane and provide greater capacity with reduced vehicle headways. Although there are still unknowns associated with autonomous vehicles, this concept assumes vehicle technology will continue to evolve that would allow vehicles to travel in a specified lane to maximize the technological benefits of autonomous vehicles. To allow flexibility in the timing and implementation, the future autonomous vehicle lane could initially be utilized as a general purpose lane, or managed lane, then repurposed as the percentage of autonomous vehicles in the overall vehicle mix reaches an appropriate level. Implementation may be applicable along C-470, and ultimately on the other corridor segments.

### Integration with Existing ITS Infrastructure

The placement of new technology elements will need to properly integrate with existing ITS infrastructure. The ITS infrastructure currently located along the study corridor is summarized in **Table D-2**, and illustrated in **Figure D-1**.

Table D-2: Existing ITS Infrastructure

LOCATION	MP	LOCATION ON ROADWAY	STRUCTURE	FIBER	VMS	RTMS	CCTV/CAMERA	RWIS	AVI	RAMP METER
Kipling EB on ramp	12.59									■
East of Kipling	12.5	Center	Separate pole				■		■	
Kipling to Ken Caryl	12 to 10.19	East/North		■						
	11.68	West/South	Separate pole				■			
South of Ken Caryl	10.22	East/North	Sign structure						■	
North of Ken Caryl	10.17	West/South	Sign structure				■		■	
Ken Caryl to Bowles	10.19 to 7.9	East/North		■						
	8.86	Center	Sign structure			NB and SB				
	8.74	East/North	Separate pole				■			
Bowles to Quincy	7.9 to 6.13	East/North		■						
Bowles NB (WB) on ramp	7.77	East/North								■
South of Quincy	6.95	East/North	VMS structure		■		■		■	
	6.95	West/South	Separate pole						■	
	6.41	East/North	Separate pole			■				
Quincy NB (WB) on ramp	6.4	East/North								■
Quincy to Morrison Rd	6.13 to 4.25	West/South		■						
North of US 285	5.66	East/North	Separate pole				■		■	
	5.66	West/South	Separate pole						■	
	5.17	Center	Sign structure						■	wireless
Morrison Rd to Alameda	4.25 to 1.88	West/South		■						



Table D-2 (cont.): Existing ITS Infrastructure

LOCATION	MP	LOCATION ON ROADWAY	STRUCTURE	FIBER	VMS	RTMS	CCTV/CAMERA	RWIS	AVI	RAMP METER
North of Morrison Rd	4.16	Center	Separate pole				■		■	
	3.5	West/South	Sign structure			■				
	2.7	West/South	Separate pole				■		■	
Alameda to south of I-70	1.88 to 0.26	West/South		■						
South of Ped bridge	1.19	West/South	Separate pole				■			
North of Ped bridge	1.14	West/South	VMS structure		■		■		■	
	0.96	Center	Sign structure						■	
	0.39	West/South	Sign structure				■			
South of I-70 to I-70	0.26 to 0	East/North		■						
North of I-70	0	Center	Separate pole					■		
Johnson Road to CO 58/Golden Fwy	274.24 to 0	South/West		■						
	272.96	East	VMS sign		■					
	272.96	East	Separate pole					■		
	272.96	West	VMS sign		■					
	272.96	West	Separate pole					■		
CO 58/Golden Fwy to Iowa Dr	0 to 0.54	West		■						
Iowa Dr to Washington St	0.54 to 0.82	East		■						
Washington St to Pine Ridge Dr	0.82 to 1.59	West		■						
Pine Ridge Dr to Hog Back Dr	1.59 to 1.81	East		■						
Hog Back Dr to RR	1.81 to 7.33	West		■						
South of Asphalt Paving Co access	3.73	East			■					
RR to Coal Creek (CO 72)	7.33 to 7.38	East		■						
Coal Creek (CO 72) to south of Community Ditch	7.38 to 12.58	West		■						
North of CO 128*	12	East					■			
North of CO 128	12.05	West	VMS sign		■					
South of Community Ditch to CO 170	12.58	East		■						

\* Shown on KMZ file provided by CDOT but could not verify via Google Earth.

VMS – Variable Message Sign

RTMS – Remote Traffic Microwave Sensor

RWIS – Road Weather Information System

AVI – Automatic Vehicle Identification

Figure D-1: Existing ITS Infrastructure





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# APPENDIX E: SYSTEM MANAGEMENT OPTIONS – LEVEL 2 EVALUATION



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# SYSTEM MANAGEMENT OPTIONS – LEVEL 2A EVALUATION

This document describes the system management options considered for the WestConnect Coalition PEL Study.

The following options were carried forward from the Level 1 screening:

- Travel demand management strategies
- Enhanced maintenance and operations program
- Access management plan
- Incident management plan
- Event traffic management program
- Wildlife crossings
- Snow fence

Options carried forward from this Level 2 evaluation will be combined with corridor infrastructure improvements to identify project recommendations that will optimize safety and operational benefits.

## System Management Options

### Travel Demand Management (TDM) Strategies

This concept was considered because it may address recurring congestion and improve multimodal operations. The concept consists of strategies that encourage corridor users to utilize the existing infrastructure in different ways and/or at different times of the day, rather than driving alone in the peak traffic periods. TDM strategies are programs and financial incentives that encourage people to use multimodal transportation. Possible strategies include incentive programs that make it more convenient and less expensive than driving. DRCOG's Way to Go program supports employers and commuters to find non-driving alone options. It is primarily an informational service provided through DRCOG, but also operates the vanpool program, provides opportunities to find a carpool, and Bike to Work Day.

EcoPasses provide an unlimited and unrestricted transit pass to ride all RTD services in the metro Denver area. These are primarily employer-based and the pricing for this pass is based on total number of employees and category of RTD service. While the employer often pays for the entire pass, the pass program can be paid by the employees or it can be shared between the employer and employees. This pass program also provides the Guaranteed Ride Home program, which provides a free taxi ride home



when unplanned and emergency events occur. This is part of the EcoPass program, but can also be purchased as a separate service through DRCOG to provide employees a backup option.

Bike sharing provides a flexible and convenient mode of transportation for people traveling short distances. The traditional bike sharing structure is based on a number of stations with docking portals for individual bikes. A variation of the traditional bike share system are individual bikes with a locking mechanism that allow users to park the bike within a specific service area. This type of system is a better fit for low-density areas where a large concentration of stations would not be cost effective. The area within this study area outside of Golden would be better suited for the bike-based bike share opposed to the station-based bike share.

Carpooling matching programs and vanpooling programs provide an alternative for people who prefer traveling in a semi-private vehicle and in low-density areas where transit service may not be available. Carpool matching programs are more flexible and riders tend to determine the details associated with car usage, gas, frequency and any parking issues. For commuters looking for a bit more structure and reliable service, vanpool is a better fit than casual carpooling. Commuters can join or create a new vanpool route and DRCOG provides the van, insurance, maintenance and gas. Vanpools provide shared transportation for commutes of 5 to 12 people where the riders pay a low monthly fare. The monthly fee covers the cost of the vehicle, fuel, maintenance and insurance. Vanpools allow flexibility among the group to determine the logistics of pick-up and drop-off locations and times. The easiest and fastest vanpool groups start at a common location for pick-up and drop-off all passengers at the same location. It helps if the passengers live in the same neighborhood and work at the same employer or office complex.

The morning and evening peak periods experience higher volumes and congestion because workers are traveling to and from traditional work positions that generally start between 8 AM-9 AM and end between 4 PM-5 PM. Flextime and telecommuting policies remove commuters from the peak periods without changing the total amount of work time or place of work. Flextime allows more variation in the work day by allowing staggered start/end times determined either through formal or informal policies. Many policies set parameters on the variability of schedules by addressing work times within a specific time range (e.g. 6 AM-7 PM) and setting a span of hours that must be worked, regardless of work schedule (e.g. 10 AM-2 PM). While flextime shifts the time commuters are traveling, telecommuting avoids the commuter from traveling altogether.

TDM strategies vary in their levels of effectiveness for changing behavior. The most successful strategies tend to be cost effective (free services, subsidized/free transit pass, paid parking) and convenient (frequent service, allow flexibility in doing different transportation over the course of the week).



The following strategies have been identified for the different segments:

- C-470 Segment – Carpool and vanpool
- Golden Segment – Carpool and vanpool, flextime and telecommute policy at businesses, EcoPass program, and stationless bike share system
- CO 93 – Carpool and vanpool and EcoPass program

### Enhanced Maintenance and Operations Program

This concept was considered because it may address safety concerns and incident/event congestion. The concept consists of efficient snow removal and icing prevention, effective pavement management, incident or weather-triggered street sweeping, and efficient upkeep of signs, pavement markings, guardrail, impact attenuators, and signals using an advanced technological alert and scheduling program. Over time, CDOT will be able to track patterns to better anticipate maintenance needs.

While CDOT maintenance provides these services along the corridor currently, the goal would be to provide these services more efficiently given the limited funds available. CDOT currently uses a number of electronic information systems to disseminate information, but not a straightforward way to note issues and/or to request service. The CDOT website provides a place to identify issues and request service, but it is not an easy-to-find location. A straightforward option to note issues and/or to request service would make it easier for corridor users to give geographic information with issues along the corridor. The contact information would be displayed on signs and potential messaging on dynamic message signs along the corridor.

Enhanced maintenance and operations program improvements may be applicable along the entire WestConnect corridor, especially considering the unique weather conditions along the Front Range Foothills.

### Access Management Plan

This concept was considered because it may address safety concerns and operational performance. The concept consists of proactive management of vehicular access points along the corridor, which may consider access spacing, adding, removing or combining accesses, improving geometry at driveways, and median treatments to maintain overall mobility and the functional integrity along the highway corridor.

### C-470 Segment

C-470 is currently classified as Interstate System, Freeway Facilities. Any additional interchanges or changes to existing ramp connections and spacing must go through the CDOT 1601 approval process and meet the strict access management documented for that classification in the *CDOT State Highway Access Code*.



### Golden Segment

Accesses along US 6/CO 93 through Golden are primarily signalized intersections. Opportunities to improve safety and traffic flow along the corridor through access modifications at unsignalized intersections/accesses are listed in **Table E-1**. Consideration of access within The Golden Plan area may need to be revisited as interchange and realignment plans are finalized.

**Table E-1: Golden Segment Access Management Considerations**

APPROXIMATE MILEPOST	LOCATION	POTENTIAL RECOMMENDATION
271.7	Clear Creek Lane/US 6	Convert to ¾ turn with raised median island
1.1	Copper Bucket Lane	Remove access on CO 93 and provide connection to Golden Gate Canyon Road, or Restrict to right in/right out with raised island and/or median
1.7	Hog Back Drive	Define right in/right movements with raised island and/or median
1.7 – 2.9	Residential accesses between Hog Back Drive and 56 <sup>th</sup> Avenue	Restrict to right in /right out accesses with raised island and/or median
2.0	Table Loop Trailhead access	Better define ¾ movements with raised island and/or median
3.6	Pet Camp Boarding Kennels access	Restrict to right in/right out with raised island and/or median
3.9	Ralston Quarry/Asphalt Paving Company access	Restrict to right in/right out with raised island and/or median
4.0	Residential access south of 64 <sup>th</sup> Parkway	Define right in/right out movements with raised island and/or median

### CO 93

Accesses along CO 93 north of Golden are a mix of unsignalized minor roads, business, recreation, and field/ditch accesses with primary cross street intersections being signalized.

Opportunities to improve safety and traffic flow along the corridor through access modifications at unsignalized intersections/accesses are identified in **Table E-2**.



**Table E-2: CO 93 Segment Access Management Considerations**

APPROXIMATE MILEPOST	LOCATION	POTENTIAL RECOMMENDATION
4.2	68 <sup>th</sup> Avenue west leg	Restrict to right in/right out with raised island and/or median
4.3	Ralston Reservoir/Denver Water Department access	Convert to unsignalized channelized T intersection
4.6	Blunn Reservoir access	Define/convert to unsignalized channelized T intersection
4.9	East side of CO 93 south of Pioneer Sand Company access	Close field/trail access
5.2	Pioneer Sand Company access	Provide northbound and southbound left turn lanes
6.8	Republic Services Foothills Landfill access	Define unsignalized channelized T intersection with raised island/median
6.8 – 7.6	Field/ditch accesses between Republic Services Foothills Landfill access and CO 72	Consolidate, restrict to right in/right out, or close accesses
7.7	Shed access north of CO 72	Restrict to right in/right out with raised island/median
8.4	Ditch access south of Westgate Road	Restrict to right in/right out with raised island/median
8.4 – 11.5	Home/business accesses between Ditch access and Flatirons Vista trailhead	Consolidate and/or restrict to right in/right out
11.5	Flatirons Vista trailhead	Convert to unsignalized channelized T intersection
13.0	Community Ditch/Greenbelt Plateau access	Restrict to right in/right out with raised island/median
13.0 – 13.6	Field/ditch accesses between Community Ditch/Greenbelt Plateau access and CO 170	Restrict to right in/right out or close

### Incident Management Plan

This concept was considered because it may address safety concerns and operational performance during incidents. The concept consists of a plan to continuously monitor the corridor for incidents to provide efficient response to prevent further incidents or crashes. This management approach can reduce damage, recovery time, and cost.

### C-470 Segment

With approximately 100,000 vehicles traveling through the C-470 corridor daily, traffic congestion and delays are inherent problems for commuters. The ability to effectively identify and clear incidents will minimize impacts to motorists. Additional measures that would be implemented throughout the C-470 corridor include:



- Courtesy patrol program
- Coordination plan between state and local agencies and enforcement agencies for incident response

### *Golden Segment*

Incident management on US 6/CO 93 is naturally constrained by the City of Golden area geography and limited number of accesses to US 6/CO 93. Therefore, a major traffic incident on US 6/CO 93 will inevitably exacerbate resulting congestion. These constraints also can slow response times from local agencies and towing vehicles, and provide few options for detour routes when incidents occur on US 6/CO 93. There are existing incident management plans for US 6 east of I-70 and west of CO 93, but there is a gap within the WestConnect study corridor. Measures that could be implemented throughout the US 6/CO 93 corridor include:

- Closed circuit cameras to monitor incidents and traffic conditions
- Public transit vehicles equipped to provide information regarding the incident location, severity and clearance duration to the CDOT TOC
- Emergency vehicle signal pre-emption
- Coordination plan between state and local agencies and enforcement agencies for incident response

### *CO 93*

As noted for the Golden Segment, a major traffic incident on CO 93 will inevitably exacerbate resulting congestion. Measures that could be implemented throughout the CO 93 corridor include:

- Emergency pullouts for disabled motorists
- Access points and turnarounds for response vehicles
- Closed circuit cameras to monitor incidents and traffic conditions
- Public transit vehicles equipped to provide information regarding the incident location, severity and clearance duration to the CDOT TOC
- Emergency vehicle signal pre-emption
- Coordination plan between state and local agencies and enforcement agencies for incident response



## Event Traffic Management Program

This concept was considered because it may address safety and congestion during events contributing to high volume along the corridor. The concept may consist of traffic signal synchronization, transit signal priority, CCTV systems, traveler information and dynamic routing using variable message signs, travel time indicators, and dynamic lane use controls.

- C-470 Segment
  - » Events occurring along the C-470 Segment include:
    - Bandimere Speedway (just north of Morrison Road and west of C-470)
      - Approximately 70 events currently in the 2017 schedule, with the majority of events occurring May-September. Events start in April and continue to the beginning of October.
    - Red Rocks Amphitheatre (accessed from Morrison Road interchange)
      - Approximately 13 day events, 136 evening events, and 9 graduations scheduled in 2017
  - » Additional study would be needed to determine the magnitude of event traffic impacts and specific traffic management elements that could be used to address the traffic impacts. Possible traffic management elements include:
    - CCTV monitoring
    - Traveler information (i.e. Highway Advisory radio [HAR])
    - Messages on VMS
- Golden Segment
  - » Events along this segment include:
    - Clear Creek Athletic Complex (School of Mines athletic fields)
      - Football (Saturday afternoons): 5 games
      - Soccer (Fridays evenings and Sundays afternoons): 17
      - Softball (Monday, Friday, Saturday and Sunday afternoons): 18
      - Baseball (Mostly on Fridays, Saturday and Sunday afternoons, some on Monday, Tuesday and Thursday): 23
      - Track and Field (Mostly Saturday and Sunday, some on Thursday and Friday): 13
    - North Area Athletic Complex
      - Games almost every day of the week from March until mid-May. In the fall, games occur Thursdays, Fridays and some Saturdays. Games generally start at 4 and end at 9, although football tends to go longer. Football games on Saturdays usually start at noon.



- » Additional study would be needed to determine the magnitude of event traffic impacts and specific traffic management elements that would be used to address the traffic impacts. Possible traffic management elements include:
  - CCTV monitoring
  - Traffic signal synchronization
  - Transit Signal Priority
  - Messages on VMS

### Snow Fence

This concept was considered because it may address safety concerns and improve weather conditions that create traffic disruptions especially with the high winds that are typical along this corridor. The concept consists of fencing designed to the geographic conditions along the highway to reduce blowing snow across the highway pavement. A number of factors need to be considered before installing a snow fence: location, windbreaks, fence ending, installation, maintenance and interference with animal migratory paths.

A living snow fence can also provide the benefits of an artificial snow fence. Exact locations will need to be determined by a future study. Benefits provided by an effectively designed snow fence include potential crash reduction, greater reliability for safe travel during inclement weather, and less hours/days of road closure during storm events.



# APPENDIX F: DESIGN CRITERIA



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Table F-1: PEL Design Criteria – C-470

STANDARD APPLIED		CDOT/FHWA	CDOT/FHWA	DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		C-470 FROM WADSWORTH TO I-70	C-470, I-70 TO US 6	
<b>General</b>				
Roadway Functional Classification		State Highway, Principal Arterial – Fwys and Expwys	State Highway, Principal Arterial – Fwys and Expwys	OTIS - CDOT Website. A small segment of C-470 from I-70 to US 6 was noted as minor arterial, but since a majority of the segment was considered Principal Arterial, this was listed.
Access Control Classification		Interstate System, Freeway Facilities (F-W)	Interstate System, Freeway Facilities (F-W)	OTIS - CDOT Website
Type of Terrain		Rolling	Rolling	OTIS - CDOT Website
Design Speed				
	Minimum (MPH)	70	60	5 MPH over Posted Speed. Coordinated with CDOT on 7-19-16.
Posted Speed Limit Minimum (MPH)		65	55	OTIS - CDOT Website
Truck Route		National	National	OTIS - CDOT Website
Design Vehicle		WB-67	WB-67	AASHTO PGDHS 2011 Ch 2, p.2-5, Surface Transportation Assistance Act of 1982
<b>Horizontal Alignment Criteria</b>				
Superelevation ( $e_{max}$ )		6%	6%	AASHTO PGDHS 2011 Ch 3, p. 3-31 (1st Paragraph) Also considering snow and ice conditions in the mountains.
Curve Radius For Design Speed Minimum (Ft.) @ $e_{max}$		2040	1330	AASHTO PGDHS 2011 p. 3-45, Table 3-9
Max. Degree of Curve - Design Speed Min. (Calculated)		2.80	4.30	Degree of Curve = $5729.6/R$
Cross-Slope		2%	2%	CDOT 2005 DG Sec. 4.1.2, p.4-2 & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8
Maximum Algebraic Difference at Crossover Line (%) @ 35mph or greater		4 to 5	4 to 5	AASHTO PGDHS 2011 pg.9-121 , Table 9-20; CDOT 2005 DG Sec. 10.6.5, pg. 10-29.
Clear Zone on Tangent (Foreslope/Backslope)				AASHTO Roadside DG 2011 pp. 3-1 to 3-3, Table 3.1
	Minimum (Ft.)	30 - 34 / 28 - 30	30 - 32 / 26 - 28	6:1 sideslopes, over 6000 ADT
Clear Zone on Curve				AASHTO Roadside DG 2011 p. 3-4, Table 3.2
	Kcz, Adjustment Factor	1.2 to 1.5	1.2 to 1.5	Dependent on radius
No. of Lanes (In each direction) (Existing Condition)		2-3	1-2	OTIS - CDOT Website
Lane Width Minimum (Ft.)		12'	12'	CDOT 2005 DG Sec. 4.2, p.4-3; Table 4-1, p. 4-6; & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8 (4-lane divided); Fig. 4-4 (HMA and Concrete), p. 4-10 (4-lane Urban).CDOT 2005 DG Sec. 7.2.1.11.3 p. 7-10.
Shoulder Widths				
	Left Inside (Ft.)	4' - 10'	4' - 10'	CDOT 2005 DG Sec. 4.3, p.4-3 to 4-4; Table 4-1, p. 4-6; & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8 . DHV is less than 250 for no 12' shoulders. 4' for 4 lanes and 10' for 6 lanes.
	Right Outside (Ft.)	10'	10'	CDOT 2005 DG Sec. 4.3, p.4-3 to 4-6; Table 4-1, p. 4-6; & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8. DHV is less than 250 for no 12' shoulders.

Table F-1 (cont.): PEL Design Criteria – C-470

STANDARD APPLIED DESIGN ELEMENT		CDOT/FHWA	CDOT/FHWA	DESIGN CRITERIA REFERENCE
		C-470 FROM WADSWORTH TO I-70	C-470, I-70 TO US 6	
Curb and Gutter Type		N/A	N/A	CDOT 2005 DG Sec. 4.6, pp.4-12 to 4-13;
	Inside Medians (Ft.)			
	Outside (Ft.)			
	Islands			
Side Ditches				
	Cut Slope	≥ 3:1	≥ 3:1	CDOT 2005 DG Sec.4.7.4, p. 4-15
Rolling	Fill Slope	4:1(H<10 Ft.) 3:1(H>10 Ft.)	4:1(H<10 Ft.) 3:1(H>10 Ft.)	CDOT 2005 DG Sec.4.7.5, p. 4-15 & Table 4-2, p. 4-16
	Z-slope (6:1 Slope) (Ft.)	12'	12'	CDOT 2005 DG Sec. 4.4, p.4-5 & Fig. 4-1 (HMA), pg. 4-7; Fig. 4-2 (Concrete), p. 4-8
Clear from Cut/Fill Slope Catch Point to ROW				CDOT 2005 DG Sec.4.7.6, p. 4-16
	Minimum (Ft.)	10'	10'	
	Desirable (Ft.)	20'	20'	
Median Width Minimum (Ft.)				
	Depressed Median	42'	N/A	AASHTO Roadside DG 2011 pp. 6-1 to 6-3, Figure 6-1. This includes 6' inside shoulders and a 30' wide depressed median. This includes a median barrier on a high-speed, fully controlled-access roadway where the median is 30' or less and average daily traffic greater than 20,000 vph. This was coordinated with CDOT on 7-19-16.
	Flush Median with Barrier	22'	10'	AASHTO PGDHS 2011 pg.8-10, Section 8.4.2. Min. median for 4-lane urban freeway should be 10', which provides for two, 4' shoulders and a 2' median barrier. For freeways with 6 or more lanes, min. median width should be 22' and preferably 26' if the DDHV for truck traffic exceeds 250 vph (for a wider median shoulder to accommodate a truck). This was coordinated with CDOT on 7-19-16.
	Redirect Taper (Ft.)	65:1	55:1	State Highway Access Code Table 4-9, p. 57 of 62
	Left Turn Deceleration Length (Ft.)	=(25*12)+600+storage	=(18.5*12)+600+storage	State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62. For E-X, Taper+decel length+storage
	Right Turn Deceleration Length (Ft.)	1100	600	State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62. For E-X, Taper+decel length
	Acceleration Length (Ft.)	1680	1182	State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62. For E-X, Taper+accel length
Transition Taper for Accel/Decel Lanes		25:1	18.5:1	State Highway Access Code Table 4-6 p. 55 of 62
<b>Intersection Design Criteria</b>				
Minimum Intersection Radii		N/A	N/A	
Minimum Access Radii		N/A	N/A	
Minimum Access Width		N/A	N/A	

Table F-1 (cont.): PEL Design Criteria – C-470

STANDARD APPLIED		CDOT/FHWA	CDOT/FHWA	DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		C-470 FROM WADSWORTH TO I-70	C-470, I-70 TO US 6	
<b>Vertical Alignment Criteria</b>				
Maximum Grade		4%	4%	(AASHTO PGDHS 2011 p. 3-119; p. 7-3 to 7-4, table 7-2; p. 7-28 to 7-29, Table 7-4); (AASHTO PGDHS 2011 Pg. 8-3 to 8-4, Table 8-1). CDOT 2005 DG Sec. 3.3.3, pp. 3-32 to 3-33
Minimum Grade		0.5%	0.5%	AASHTO PGDHS 2011 p. 3-119, 0.3% could be used for high type pavement. CDOT 2005 DG Sec. 3.3.3, pp. 3-32 to 3-33
Max. Vertical Grade Break without a Curve		0.20%	0.20%	CDOT 2005 DG Sec. 3.3.4, p. 3-35
Min. Vertical Curve Length (Ft.)		210	180	AASHTO PGDHS 2011, p. 3-153 (Lmin. = 3V)
K-Value Ranges (Based on Stopping Sight Distance)				
	Crest VC (Min)	247	151	AASHTO PGDHS 2011 p. 3-155, Table 3-34;
	Sag VC (Min)	181	136	AASHTO PGDHS 2011 p. 3-157 to 3-161, Table 3-36.
<b>Sight Distances</b>				
Min. Stopping Sight Distance (Ft.)				
	Level	730	570	AASHTO PGDHS 2011 pp. 3-2 to 3-4, Table 3-1, p. 3-161, Table 3-36
	3% (6%) Downgrade	771 (825)	598 (638)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
	3% (6%) Upgrade	690 (658)	538 (515)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
<b>Structure Clearance Criteria</b>				
Highway Underpass Vertical (Ft.) (Min.)		16.5	16.5	AASHTO PGDHS 2011 p. 10-21, CDOT 2005 DG p. 3-31, Table 3-3. Resurfacing and ice and snow conditions were considered in setting criteria.
Railroad (Ft.)(Min.)		23.5	23.5	CDOT 2005 DG p. 3-31, Table 3-3. Measured from top of rail to bottom of structure. UPRR Industry Track Agreement is 23 feet from top of rails.
Overhead Wires (Ft.) (Min.)*		20.5+	20.5+	CDOT 2005 DG p. 3-31, Table 3-3. *Depends on volts...see Table 3-3
Sign Structures and Pedestrian Structures(Ft.) (Min.)		17.5	17.5	FHWA Website 17' - CDOT 2005 DG p. 3-31, Table 3-3. – footnote

AASHTO – American Association of State Highway and Transportation Officials

CDOT – Colorado Department of Transportation

DG – Design Guide

FHWA – Federal Highway Administration

OTIS – Online Transportation Information System

PGDHS – A Policy on Geometric Design of Highways and Streets

UPRR – Union Pacific Railroad

**Table F-2: PEL Design Criteria – Golden**

Design Criteria Based on Golden’s Plan from City of Golden, Highway 6 & 93 Corridor, dated 7/1/2014.

DESIGN ELEMENT	CDOT			DESIGN CRITERIA REFERENCE	REMARKS
	US 6	US 6	CO 93		
	EAST OF 19TH ST	WEST OF 19TH ST			
<b>General</b>					
<b>Roadway Classification</b>	Principal Arterial	Principal Arterial	Principal Arterial	CDOT Website	
<b>Access Control Classification</b>	E-X: Expressway	E-X: Expressway	E-X: Expressway	CDOT Website	
<b>Terrain</b>	Rolling	Rolling	Rolling	CDOT Website	
<b>Posted Speed Limit (MPH)</b>	55	45	45	CDOT Website	
<b>Design Speed</b>					
Minimum (MPH)	55	45	45		
Desirable (MPH)	60	50		CDOT 2005, 3.5.1, pg. 8-1	
<b>Design Vehicle</b>	WB-67	WB-67	WB-67	PGDHS 2004, pg. 18	
<b>HCL Location</b>	at Centerline	at Centerline	at Centerline		
<b>Profile Location</b>	inside EOT	inside EOT	inside EOT		
<b>Superelevation Rotation Point</b>	inside EOT	inside EOT	inside EOT		
<b>Horizontal Alignment Criteria</b>					
<b>Curve Radius (Feet)</b>					
Minimum (Feet)	1060	643	643	PGDHS 2004, Exhibit 3-15, pg. 147	
Desirable (Feet)	1330	833		PGDHS 2004, Exhibit 3-15, pg. 147	

Table F-2 (cont.): PEL Design Criteria – Golden

DESIGN ELEMENT	CDOT			DESIGN CRITERIA REFERENCE	REMARKS
	US 6	US 6	CO 93		
	EAST OF 19TH ST	WEST OF 19TH ST			
<b>Superelevation (e<sub>max</sub>)</b>	6%	6%	6%	PGDHS 2004, pg. 145	
<b>Superelevation Transition Location</b>	60/40	60/40	60/40	CDOT M&S Standards, M-203-11	Superelevation Diagram for Divided Highways Shoulder Pivot. Superelevation transition assuming 2 lanes.
<b>Algebraic Difference at Gore Cross Over Line Ramps</b>					
Desirable	4.0	4.0	4.0	PGDHS 2004, Exhibit 9-49, pg. 648	
Maximum	5.0	5.0	5.0	PGDHS 2004, Exhibit 9-49, pg. 648	
<b>Clear Zone</b>					
Minimum (Feet)	30	20	20	Roadside Design Guide 2011, Table 3-1, pg. 3-3	6:1 Z-Slope
Desirable (Feet)	32	22	22	Roadside Design Guide 2011, Table 3-1, pg. 3-3	6:1 Z-Slope
<b>Cross Slope</b>	2%	2%	2%	CDOT 2005, 4.1.2, pg. 4-2	
<b>Number of Lanes</b>	4	4	4	CDOT 2005, Table 4-1, pg. 4-6	
<b>Lane Widths (Feet)</b>	12	12	12	CDOT 2005, Table 4-1, pg. 4-6	
<b>Median Width (Feet) (Minimum)</b>	22	18	18	CDOT 2005, 8.3.1, pg. 8-5,6	Use only sloping curb on median (CDOT 2005, 4.6)
<b>Shoulder Widths</b>					
Left Inside (Feet)	4	N/A	N/A	CDOT 2005, Table 4-1, pg. 4-6	
Right Outside (Feet)	10	10	6 with C&G II-B	CDOT 2005, Table 4-1, pg. 4-6	
<b>Side Slopes</b>					
Cut Slope	≥ 3:1	≥ 3:1	≥ 3:1	CDOT 2005, 4.7.4, pg. 4-15	
Fill Slope (Minimum)	4:1 (H≤10) 3:1 (H>10)	4:1 (H≤10) 3:1 (H>10)	4:1 (H≤10) 3:1 (H>10)	CDOT 2005, Table 4-2, pg. 4-16	
Fill Slope (Desirable)	4:1	4:1	4:1		
Z-slope (6:1 Slope) (Feet)	12	12	12	CDOT 2005, Figure 4-1, pg. 4-7	
<b>Redirect Taper</b>					
Minimum	55:1	45:1	45:1	CDOT 2005, 9.18.5.1, pg. 9-30	
Desirable	60:1	50:1		CDOT 2005, 9.18.5.1, pg. 9-30	

Table F-2 (cont.): PEL Design Criteria – Golden

DESIGN ELEMENT	CDOT			DESIGN CRITERIA REFERENCE	REMARKS
	US 6	US 6	CO 93		
	EAST OF 19TH ST	WEST OF 19TH ST			
<b>Vertical Alignment Criteria</b>					
<b>K-Values of Vertical Curves</b>					
Crest Vertical Curve					
Minimum	114	61	61	CDOT 2005, Table 3-1, pg. 3-2	
Desirable	151	84		CDOT 2005, Table 3-1, pg. 3-2	
Sag Vertical Curve					
Minimum	115	79	79	CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	
Desirable	136	96		CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	
<b>Maximum Grade Break (Without Using a Vertical Curve)</b>	0.2%	0.2%	0.2%	CDOT 2005, 3.3.4, pg. 3-35	
<b>Stopping Sight Distance</b>					
Crest Vertical Curve					
Minimum	495	360	360	CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	Use grade adjustment factors if necessary
Desirable	570	425		CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	Use grade adjustment factors if necessary
Sag Vertical Curve					
Minimum	495	360	360	CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	Use grade adjustment factors if necessary
Desirable	570	425		CDOT 2005, 3.1.2 Table 3-1, pg. 3-2	Use grade adjustment factors if necessary
<b>Grade</b>					
Maximum (Minimum criteria)	5.0%	7.0%	7.0%	CDOT 2005, Table 3-4, pg. 3-33	Rolling Terrain for Urban Arterials
Maximum (Desirable)	4.0%	5.0%	5.0%	CDOT 2005, Table 3-4, pg. 3-33	Rolling Terrain for Urban Freeways
Minimum	0.5%	0.5%	0.5%	CDOT 2005, 3.3.3, pg. 3-32	CDOT minimum grade on bridges and sumps is 0.5%. Any area flatter than 0.5% must be evaluated for drainage
<b>Minimum Vertical Clearance at Structures</b>					
Highways/Streets (Feet)	16.5	16.5	16.5	CDOT 2005, Table 3-3, pg. 3-31	
Overhead Wires (Feet)	21.5	21.5	21.5	CDOT 2005, Table 3-3, pg. 3-31	
Pedestrian/Sign Structures (Feet)	17.5	17.5	17.5	CDOT 2005, Table 3-3, pg. 3-31	

Table F-3: PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
<b>General</b>				
Roadway Functional Classification		State Highway, Principal Arterial	State Highway, Principal Arterial	
Access Control Classification		Expressway, Major Bypass (E-X)	Regional Highway (R-A)	OTIS - CDOT Website (different classifications)
Type of Terrain		Rolling	Rolling	OTIS - CDOT Terrain Classification Information on website
Design Speed				
	Minimum (MPH)	50 - 60	50 - 60	5 MPH over Posted Speed. Coordinated with CDOT on 7-19-16.
Posted Speed Limit Minimum (MPH)		45 - 55	45 - 55	OTIS - CDOT Website
Truck Route		National	National	OTIS - CDOT Website
Design Vehicle		WB-67	WB-67	AASHTO PGDHS 2011 Ch 2, p.2-5, Surface Transportation Assistance Act of 1982
<b>Horizontal Alignment Criteria</b>				
Superelevation ( $e_{max}$ )		6%	6%	AASHTO PGDHS 2011 Ch 3, p. 3-31 (1st Paragraph) Also considering snow and ice conditions in the mountains.
Curve Radius For Design Speed Minimum (Ft.) @ $e_{max}$				AASHTO PGDHS 2011 p. 3-45, Table 3-9
	50 mph	833	833	
	55 mph	1060	1060	
	60 mph	1330	1330	
Max. Degree of Curve - Design Speed Min. (Calculated)				Degree of Curve = 5729.6/R
	50 mph	6.90	6.90	
	55 mph	5.40	5.40	
	60 mph	4.30	4.30	
Cross-Slope		2%	2%	CDOT 2005 DG Sec. 4.1.2, p.4-2 & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8 (4-lane divided); Fig. 4-4 (HMA and Concrete), p. 4-10 (4-lane Urban)
Maximum Algebraic Difference at Crossover Line (%) @ 35mph or greater		4 to 5	4 to 5	AASHTO PGDHS 2011 pg.9-121 , Table 9-20; CDOT 2005 DG Sec. 10.6.5, pg. 10-29.

AASHTO – American Association of State Highway and Transportation Officials

CDOT – Colorado Department of Transportation

OTIS – Online Transportation Information System

PGDHS – A Policy on Geometric Design of Highways and Streets

Table F-3 (cont.): PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
Clear Zone on Tangent (Foreslope/Backslope)				AASHTO Roadside DG 2011 pp. 3-1 to 3-3, Table 3.1, 6:1 sideslopes, over 6000 ADT
	Minimum (Ft.) 45-50 mph	20' - 22' / 20' - 22'	20' - 22' / 20' - 22'	
	Minimum (Ft.) 55 mph	22' - 24' / 22' - 24'	22' - 24' / 22' - 24'	
	Minimum (Ft.) 60 mph	30' - 32' / 26' - 28'	30' - 32' / 26' - 28'	
Clear Zone on Curve				AASHTO Roadside DG 2011 p. 3-4, Table 3.2
	Kcz, Adjustment Factor	1.1 to 1.5	1.1 to 1.5	Dependent on radius
No. of Lanes (In each direction)		1 - 2	1 - 2	OTIS - CDOT Website
Lane Width Minimum (Ft.)		12'	12'	CDOT 2005 DG Sec. 4.2, p.4-3; Table 4-1, p. 4-6; & Fig. 4-1 (HMA), p. 4-7; Fig. 4-2 (Concrete), p. 4-8 (4-lane divided); Fig. 4-4 (HMA and Concrete), p. 4-10 (4-lane Urban). CDOT 2005 DG Sec. 7.2.1.11.3 p. 7-10.
Shoulder Widths				
	Left Inside (Ft.)	N/A	N/A	The highway is either undivided or has a painted median
	Right Outside (Ft.)	8'	8'	CDOT 2005 DG Table 4-1, pg. 4-6; Fig. 4-5 (Type B), p. 4-11
Curb and Gutter Type		N/A	N/A	CDOT 2005 DG Sec. 4.6, pp.4-12 to 4-13; & Figure 4-4, p. 4-10 (4-lane Urban). CDOT M & S Standards 2012, pp. 126 to 129, M-609-1.
	Inside Medians (Ft.)			
	Outside (Ft.)			
	Islands			
Side Ditches				
	Cut Slope	3:1	3:1	CDOT 2005 DG Sec.4.7.4, p. 4-15
Rolling	Fill Slope	4:1(H<10 Ft.) 3:1(H>10 Ft.)	4:1(H<10 Ft.) 3:1(H>10 Ft.)	CDOT 2005 DG Sec.4.7.5, p. 4-15 & Table 4-2, p. 4-16
	Z-slope (6:1 Slope) (Ft.)	12	12	CDOT 2005 DG Table 4-1, pg. 4-6; Fig. 4-5 (Type B), p. 4-11
Clear from Cut/Fill Slope Catch Point to ROW				CDOT 2005 DG Sec.4.7.6, p. 4-16
	Minimum (Ft.)	10	10	
	Desirable (Ft.)	20	20	

Table F-3 (cont.): PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
Median Width Minimum (Ft.)		12' to 30'	12' to 30'	CDOT 2005 DG Sec.4.10, pp. 4-23 to 4-24; Sec.7.1.3.3, p.7-6. AASHTO PGDHS 2011 Pg. 7-14. 4' to 6' is the minimum and used under very restricted conditions. This is subject to change based on Technical Team input.
Redirect Taper (Ft.)				State Highway Access Code Table 4-9, p. 57 of 62
Posted Speed	45 mph	45:1	45:1	
Posted Speed	50 mph	50:1	50:1	
Posted Speed	55 mph	55:1	55:1	
Left Turn Deceleration Length (Ft.)				State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62.
Posted Speed	45 mph	= $(13.5 \times 12) + 435 + \text{storage}$	435+storage	For E-X, Taper+decel length+storage; for R-A, Decel Length +storage
Posted Speed	50 mph	= $(15 \times 12) + 500 + \text{storage}$	500+storage	For E-X, Taper+decel length+storage; for R-A, Decel Length +storage
Posted Speed	55 mph	= $(18.5 \times 12) + 600 + \text{storage}$	600+storage	For E-X, Taper+decel length+storage; for R-A, Decel Length +storage
Right Turn Deceleration Length (Ft.)				State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62.
Posted Speed	45 mph	597	435	
Posted Speed	50 mph	680	500	
Posted Speed	55 mph	822	600	
Acceleration Length (Ft.)				State Highway Access Code Table 4-6 p. 55 of 62 (Also use Table 4-7 for Grade Adjustment Factors). Subject to change based on traffic analysis. See Table 4-5 for speed change lane length on p. 54 of 62.
Posted Speed	45 mph	712	550	
Posted Speed	50 mph	940	760	
Posted Speed	55 mph	1182	960	

Table F-3 (cont.): PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
Transition Taper for Accel/Decel Lanes				State Highway Access Code Table 4-6 p. 55 of 62
Posted Speed	45 mph	13.5:1	13.5:1	
Posted Speed	50 mph	15:1	15:1	
Posted Speed	55 mph	18.5:1	18.5:1	
<b>Intersection Design Criteria</b>				
Minimum Intersection Radii		40'	40'	CDOT 2005 DG Sec.9.5.2.2, p.9-11
Minimum Access Radii		20'	20'	State Highway Access Code p. 51
Minimum Access Width		16' - 40'	16' - 40'	State Highway Access Code p. 51
<b>Vertical Alignment Criteria</b>				
Maximum Grade		4% - 5%	4% - 5%	(AASHTO PGDHS 2011 p. 3-119; p. 7-3 to 7-4, table 7-2; (AASHTO PGDHS 2011 Pg. 8-3 to 8-4, Table 8-1). For CO 93 used Rural Arterial criteria. Grades based on coordination with CDOT on 7-19-16.
Minimum Grade		0.5%	0.5%	AASHTO PGDHS 2011 p. 3-119, 0.3% could be used for rural sections but it is difficult for a contractor to achieve during construction therefore a minimum of 0.5% has been set.
Max. Vertical Grade Break without a Curve		0.20%	0.20%	CDOT 2005 DG Sec. 3.3.4, pp. 3-33 to 3-35
Min. Vertical Curve Length (Ft.)		150' - 180'	150' - 180'	AASHTO PGDHS 2011, p. 3-153 (Lmin. = 3V)
K-Value Ranges (Based on Stopping Sight Distance)				
	Crest VC (Min)			AASHTO PGDHS 2011 p. 3-155, Table 3-34;
	50 mph	84	84	
	55 mph	114	114	
	60 mph	151	151	
	Sag VC (Min)			AASHTO PGDHS 2011 p. 3-157 to 3-161, Table 3-36.
	50 mph	96	96	
	55 mph	115	115	
	60 mph	136	136	



Table F-3 (cont.): PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
<b>Sight Distances</b>				
Intersection Sight Distance		1st vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.	1st vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.	
Min. Stopping Sight Distance (Ft.)				
	Traffic Signals	1st vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.	1st vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches.	AASHTO PGDHS 2011 p. 9-51, Case D. See additional criteria.
55 mph	Level	495	495	AASHTO PGDHS 2011 pp. 3-2 to 3-4, Table 3-1, p. 3-161, Table 3-36
	3% (6%) Downgrade	520 (553)	520 (553)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
	3% (6%) Upgrade	469 (450)	469 (450)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
60 mph	Level	570	570	AASHTO PGDHS 2011 pp. 3-2 to 3-4, Table 3-1, p. 3-161, Table 3-36
	3% (6%) Downgrade	598 (638)	598 (638)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
	3% (6%) Upgrade	538 (515)	538 (515)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
65 mph	Level	645	645	AASHTO PGDHS 2011 pp. 3-2 to 3-4, Table 3-1, p. 3-161, Table 3-36
	3% (6%) Downgrade	682 (728)	682 (728)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
	3% (6%) Upgrade	612 (584)	612 (584)	AASHTO PGDHS 2011 p. 3-5, Table 3-2
<b>Structure Clearance Criteria</b>				
Highway Underpass Vertical (Ft.) (Min.)		16.5	16.5	AASHTO PGDHS 2011 p. 10-21, CDOT 2005 DG p. 3-31, Table 3-3. Resurfacing and ice and snow conditions were considered in setting criteria.
Railroad (Ft.)(Min.)		23.5	23.5	CDOT 2005 DG p. 3-31, Table 3-3. Measured from top of rail to bottom of structure. UPRR Industry Track Agreement is 23 feet from top of rails.

Table F-3 (cont.): PEL Design Criteria – CO 93

STANDARDS APPLIED		CDOT/FHWA		DESIGN CRITERIA REFERENCE
DESIGN ELEMENT		CO 93 SEGMENT US 6 TO MP 7 NORTH OF COAL CREEK CANYON RD (CO 72) TO BOULDER COUNTY LINE	CO 93 SEGMENT MP 7 TO NORTH OF COAL CREEK CANYON RD (CO 72) BOULDER COUNTY LINE TO MARSHALL RD (CO 170)	
Overhead Wires (Ft.) (Min.)*		20.5+	20.5+	CDOT 2005 DG p. 3-31, Table 3-3. *Depends on volts...see Table 3-3
Sign Structures and Pedestrian Structures(Ft.) (Min.)		17.5	17.5	FHWA Website 17' - CDOT 2005 DG p. 3-31, Table 3-3 footnote

Table F-4: PEL Design Criteria – Bicycle/Pedestrian/Trails

BICYCLE/PEDESTRIAN/TRAILS DESIGN ELEMENT	DESIGN CRITERIA	DESIGN CRITERIA REFERENCE
<b>On-Street Bicycle Facility: Protected Bike Lane</b>		
One-way protected bike lane width (from edge of gutter) (Ft.)	7	FHWA Separated Bike Lane Planning and Design Guide Ch 5
One-way protected bike lane buffer width (Ft.)	3	FHWA Separated Bike Lane Planning and Design Guide Ch 5
Two-way protected bike lane width (from edge of gutter) (Ft.)	12	FHWA Separated Bike Lane Planning and Design Guide Ch 5
Two-way protected bike lane buffer width (Ft.)	3	FHWA Separated Bike Lane Planning and Design Guide Ch 5
Protected bike lane intersection design	treatments vary by intersection type	FHWA Separated Bike Lane Planning and Design Guide (Ch. 5) & NACTO Urban Bikeway Design Guide (Cycle Tracks Section)
<b>Shared Use Path General</b>		
Width (Ft.)	10-14 (dependent on volumes, users)	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-3; CDOT Roadway Design Guide Ch. 14, p. 14-57
Design Speed (mph)	18; 30 in locations where 4% grades are required for more than 300'	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-13; CDOT Roadway Design Guide Ch. 14, p.14-50
Separation between side path and street (from edge of paved shoulder) (Ft.)	5*	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-11. *Unless barrier provided. CDOT Roadway Design Guide Ch. 14, p. 14-85
Clearance to obstructions (Ft.)	3 on each side, max cross slope 6:1*	CDOT Roadway Design Guide Ch. 14, p. 14-60; *exceptions are provided for constrained conditions
Intersections between Shared Use Paths and Roadways	Sight Distance, Sight Triangles, Traffic Control	CDOT Roadway Design Guide Ch. 14, Section 14.2.9, p. 14-64 through 14-76
<b>Shared Use Path</b>		
Curve Radius For Design Speed Minimum (Ft.)	60 (79)	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-14; (CDOT Roadway Design Guide Ch. 14, p. 14-62 [assumes 0% superelevation])
Cross-Slope	1-2%	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-15
Grade Maximum	5%**	AASHTO Guide for the Development of Bicycle Facilities, Ch 5, p. 5-16. **Or grade of adjacent roadway.

AASHTO - American Association of State Highway and Transportation Officials

NACTO - National Association of City Transportation Officials

CDOT - Colorado Department of Transportation

FHWA - Federal Highway Administration



WestConnect Coalition PEL

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# APPENDIX G: WILDLIFE CROSSINGS



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# WILDLIFE CROSSING STRUCTURES RECOMMENDATIONS AND PRIORITIES<sup>1</sup>

A stakeholder meeting was held on August 30, 2017 to review a preliminary list of wildlife crossing structure recommendations in the WestConnect corridor. The following list of revised recommendations is the result of stakeholder input at this meeting and in follow-up email conversations. Additional revisions and refinements will be required as specific transportation projects are developed, and should be conducted in coordination with Colorado Parks and Wildlife (CPW) staff and other land managers with responsibility in the corridor. Notably, depending on the road footprint of the final design, recommended crossing structure types and dimensions may need to be adjusted to account for greater road widths. Wildlife crossings mitigation is recommended as the most effective mitigation strategy for reducing the safety hazard of wildlife-vehicle collisions (WVC) for motorists and providing safe passages for wildlife, such as elk, mule deer and, where relevant, Preble’s meadow jumping mouse. Deer and elk act as umbrella species for other species’ movement needs in this area, including moose, black bear, mountain lion, bobcat, fox, coyote and other fauna. Where connectivity for Preble’s meadow jumping mouse is needed, it will be important to integrate riparian habitat connectivity into the structure design. The suburban nature of this corridor and its situation along the western edge of the Denver Metropolitan Area preclude landscape connectivity at a broader scale (i.e., mountains to plains); however, multiple open space parks and the National Wildlife Refuge continue to provide some wildlife habitat east of the transportation corridor. The objective of the wildlife crossing opportunities presented herein is to provide connections between these open space habitats and the foothills to the west. In some segments, barriers to wildlife movement may be recommended where the likelihood of wildlife-human conflict is greater than the value of connectivity for wildlife.

**Tables G-1 through G-3** list the recommended wildlife-highway mitigation along each roadway in the corridor, respectively, CO 93, US 6 and C-470. Locations prioritized for mitigation will require further development, including specific structure dimensions and features, and wildlife fencing length and alignment. Fence designs should include end treatments, wildlife escape ramps, and deer guards at driveways and interchanges to prevent incursions into the fenced right-of-way. In addition to large crossing structures, intermittent small culverts may also be warranted in any fenced segments of roadway to provide greater passage opportunities for smaller fauna with smaller home ranges. Drainage culverts that may also function as small fauna passages should be incorporated into the wildlife fencing design.

Alternative mitigations (e.g., vegetation treatments, wildlife deterrents, dynamic signage and public awareness campaigns) may also be considered where structural mitigation is not feasible; however, the effectiveness of these strategies is substantially less than crossing structures mitigation, both in reducing

<sup>1</sup> Prepared by Julia Kintsch, ECO-resolutions LLC, October 2017.



WVC and promoting connectivity for wildlife. Where appropriate, multiple mitigation strategies may also be combined, for example, dynamic signage and vegetation deterrents at the end of a wildlife fence. Opportunities to complement wildlife crossings with supplementary mitigation strategies should be discussed during project development.

**Table G-1: Wildlife crossing structure opportunities across CO 93 (south to north)**

MP*	SITE NAME	SPECIES POTENTIAL	CROSSING STRUCTURE RECOMMENDATION	PRIORITY
0.5	Iowa St. Tunnel	Mule deer, bobcat, coyote, fox	Land bridge over CO 93 proposed in Golden Plan ( <a href="http://www.getthefactsgolden.org">www.getthefactsgolden.org</a> ). Consider adding wildlife barrier fencing along the west side of CO 93 from the US 6 junction to the land bridge to reduce WVC, which occur with a high frequency in this segment. Note, CPW has concerns regarding potential moose activity and access into Golden over the land bridge; however, keeping moose off the highway is an important driver safety concern.	Low – opportunistic when tunnel constructed
1.9	North Table Mountain	Mule deer, bobcat, coyote, fox	Arch or box culvert. However, mitigation at this location will need to be developed in coordination with the new alignment for CO 93 to the west of this location, as described in the Golden Plan. Lower speeds and less traffic on the current (old) alignment may mean that this segment of road would be suitable for an animal-detection system, dynamic signage, or other non-structural mitigation, provided wildlife are provided a corresponding wildlife crossing structure under the new alignment.	Low
2.6	North of proposed old/new CO 93 interchange	Mule deer, bobcat, coyote, fox	Small fill in medium WVC segment. Install large arch culvert suitable for deer. Best location for connection to North Table Mountain, assuming US 93 alignment is moved west. Otherwise, locations south of here may also be considered.	Medium



**Table G-1 (cont.): Wildlife crossing structure opportunities across CO 93 (south to north)**

MP*	SITE NAME	SPECIES POTENTIAL	CROSSING STRUCTURE RECOMMENDATION	PRIORITY
4.8	Ralston Creek	Mule deer, mountain lion, black bear, bobcat, coyote, fox, Preble’s meadow jumping mouse	<p>Large fill across wide drainage, riparian zone, flood plain. This location requires balancing multiple interests, e.g., restoring riparian habitat for Preble’s mouse (present upstream) under US 93 while discouraging elk and moose from crossing east of the highway.</p> <p>Replace double box culvert with a single-chamber 3-sided box or arch culvert, minimum 24', preferably 44' wide.</p> <p>Upsize Ralston Creek pipe culvert to oversized culvert with a small animal shelf (and cover objects every 30') when culvert is replaced. Reduce culvert skew under highway to decrease culvert length.</p> <p>Explore the possibility of realigning the creek channel west of US 93 into the dry channel that feeds into the box culvert to create a single creek and wildlife crossing for deer, Preble’s and other wildlife.</p>	Medium
6.3	Leyden Gulch	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Use the opportunity of structure replacement to improve the riparian corridor; however, there is limited habitat on the east side of CO 93 (lands already developed or proposed highway development).	Low
8.4	Woman Creek	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	<p>Replace existing pipe culverts with a low bridge underpass suitable for elk and spanning the riparian zone. Woman Creek is potential habitat for Preble’s jumping mouse (but not designated critical habitat).</p> <p>Wildlife movement across CO 93 is a concern in this area; however, CPW is concerned about elk activity moving into the Candelas development. The alignment for proposed bike path on east side of CO 93 is still being determined and will require additional coordination.</p>	Medium-High
9 – 9.8	Rocky Flats NWR	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	<p>Coordinate with engineering team and stakeholders to identify at least one suitable wildlife crossing location in this segment for elk. Flat terrain suggests wildlife overpass as best option for a structure across CO 93.</p> <p>A conservation easement will be needed to protect private lands on the east side of the overpass location between the highway and the Refuge. Note alignment for proposed bike path on east side of CO 93 is still being determined and will require additional coordination.</p>	High



**Table G-1: Wildlife crossing structure opportunities across CO 93 (south to north)**

MP*	SITE NAME	SPECIES POTENTIAL	CROSSING STRUCTURE RECOMMENDATION	PRIORITY
10.9	Coal Creek	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox, Preble’s meadow jumping mouse, northern leopard frog	Existing box culvert is undersized for 100-year flood. Replace with a low, wide bridge spanning riparian corridor and floodplain. Bridge should be suitable for elk, deer and other large fauna. In addition, restore riparian habitat under the bridge to provide movement habitat for Preble’s meadow jumping mouse and northern leopard frog.	High
12.2, 12.4 & 12.6	Rudd Open Space	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Three potential overpass locations. Coordinate with engineers, land owners and biologists to determine which is the best location for an overpass. Note, cattle grazing occurs on most of these open space lands, but wildlife-friendly fencing would allow wildlife to access the overpass.	Medium-High
13.7	Eldorado Springs	Elk, mule deer, bobcat, coyote, fox	Wildlife overpass. Topography relative to roadbed is suited for an overpass structure.	Medium

Notes:

\*Milepost locations are approximate.

**Table G-2: Wildlife crossing structure opportunities across US 6 (north to south)**

MP*	SITE NAME	SPECIES POTENTIAL	CROSSING STRUCTURE RECOMMENDATION	PRIORITY
271.1	Clear Creek Bridge	Raccoon, fox, coyote	Create a pathway for wildlife through the riprap on the south bank through the existing bridge structure. CPW does not want to encourage deer movement into Golden at this location.	Medium (low hanging fruit for medium-sized fauna)
272	Chimney Gulch	Mule deer, bobcat, coyote, fox	Maintain as is for incidental passage by small and medium-sized fauna. If structure is to be replaced, replace with wider multi-use box culvert.	Medium
273	Wildlife Crosswalk	Elk, deer, bobcat, coyote fox	Remove and replace with wildlife fencing. Install additional escape ramps. These actions should be concurrent with the installation of a crossing structure at MP 273.5.	High – in conjunction with crossing structure at MP 273.5
273.5	Kinney Run	Elk, deer, bobcat, coyote, fox	Replace existing box culvert with a multi-use bridge. The segment of US 6 from 19 <sup>th</sup> Street to Heritage Road has the highest WVC rate in this corridor (8 WVC/mile/year). Improve fence end at Heritage Road to deter end-arounds.	High

Notes:

\*Milepost locations are approximate.



**Table G-3: Wildlife crossing structure opportunities across C-470 (north to south)**

MP*	SITE NAME	SPECIES POTENTIAL	CROSSING STRUCTURE RECOMMENDATION	PRIORITY
0.7	Green Mountain	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Replace existing bike path culvert with multi-use wildlife crossing structure, e.g., large arch culvert suitable for deer. North-south movement between Green Mountain and Bear Creek Lake Park has decreased with the development of Soltera, and these deer populations are increasingly isolated. Occasional movements across C-470 are needed to minimize isolation. A small resident elk herd has established on Green Mountain, but further population growth is not encouraged. Extend existing wildlife barrier fence to south, on both sides of the highway.	High
2.5	Rooney Gulch	Mule deer, mountain lion, black bear, bobcat, coyote, fox	Tall, narrow gulch. Replace existing concrete box culvert with a low bridge or large culvert suitable for deer and other smaller wildlife. As development increases on the east side of C-470, encourage open space protection of the broader riparian corridor as it connects into Bear Creek Lake Park.	Medium
4.3	Bear Creek Bridge	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Maintain habitat under span bridges. Add wildlife fencing from south end of bridge to US 285 interchange to reduce WVC in this segment.	High
5.8	US 285 Interchange	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Incorporate wildlife passage into the design of a new interchange, so that wildlife may cross east-west into and out of Bear Creek Lake Park, on the north side of US 285. Integrate the wildlife crossing with Turkey Creek, if possible.	High
6.2	Wildlife Barrier Fence	n/a	Maintain existing wildlife barrier fence. This location marks the northern extent of the fencing on the west side of C-470, south of Quincy Avenue.	n/a
8.4	Dutch Creek	Elk, mule deer, mountain lion, black bear, bobcat, coyote, fox	Retrofit for wildlife passage and wildlife fence added on east side of C-470 from Dutch Creek to Ken Caryl in 2017. Escape ramps added to fencing on east and west sides of highway. No additional mitigation needed.	n/a
9.3	Meadows Golf Club	Mule deer, mountain lion, black bear, bobcat, coyote, fox	Replace existing pipe culvert with large arch underpass. Tie into existing wildlife fence. This is a lower priority location for a wildlife crossing due to the potential for new development on the golf course property and shrinking habitat for wildlife.	Medium-Low
10.2 – 12.4	Ken Caryl to Kipling	n/a	Maintain wildlife barrier fence on the west side of C-470. Replace one-way gates with wildlife escape ramps. Consider habitat improvements on west side to divert wildlife from roadway. Maintain existing smaller culverts to support incidental movements by non-ungulate species.	Medium-High (low hanging fruit)
10.4	Massey Draw	Mule deer, bobcat, coyote, fox	If this structure is to be replaced, replace with a large box underpass suitable for deer.	Low

Notes:

\*Milepost locations are approximate.

Figures G-1 thru G-3 have been appended to illustrate the crossing locations.