I-25/Arapahoe Interchange

Environmental Assessment

FINAL
Interchange and Supplemental I-25 Crossing Alternatives Technical Report

August 2011

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I-25/Arapahoe Road Interchange and Supplemental I-25 Crossing Alternatives Technical Report

This technical report describes the range of alternatives considered for improvements to the I-25/Arapahoe Road interchange and for supplemental crossings of I-25, the comparative analysis, summary of findings and recommendations.

1 Introduction and Need for Improvements

This technical memorandum documents the range of alternatives, analysis process, findings and recommendations for improvements to the I-25/Arapahoe Road (SH 88) interchange. Alternatives for interchange ramp configuration and capacity improvements have been analyzed along with physical and operational modifications to improve through traffic on Arapahoe Road.

Additional opportunities for a crossing of I-25 that would supplement the capacity for east-west travel in the vicinity of the I-25/Arapahoe Road interchange have also been explored. An alternative crossing of I-25 would provide an opportunity to travel east-west without traveling through the busy interchange complex. The Yosemite Street overpass north of Arapahoe Road provides this similar opportunity, focused on north-south traffic crossing I-25. Previous interchange improvement analyses with the Arapahoe/I-25 System Level Feasibility Study have concluded that interchange improvements alone may be insufficient to accommodate forecasted interchange traffic volumes.

Approximately 100,000 vehicles per day enter the interchange complex from either Arapahoe Road or the I-25 ramps as measured by traffic counts collected in 2010. Existing average daily traffic (ADT) on Arapahoe Road east of the interchange complex is approximately 57,800 vehicles while west of the interchange the ADT is about 44,700 vehicles. The traffic entering the interchange is projected to increase by 2035 to over 130,000 vehicles per day. By comparison, traffic volumes on Arapahoe Road at I-25 are nearly double the existing and forecasted traffic volumes on Orchard and Dry Creek Roads at I-25. Specific movements with critical operations and capacity needs are:

- Southbound I-25 to eastbound Arapahoe Road
- East-west travel on Arapahoe Road
- Eastbound approach to Yosemite Road
- Westbound Arapahoe to northbound I-25

Following improvements in the mid 1980's, travel lanes on Arapahoe Road under I-25 were split by bridge piers as traffic bound for the I-25 on-ramps was placed outside the piers with through traffic lanes inside between the bridge piers. The Transportation Expansion (T-REX) project added lanes to I-25, improved ramp acceleration and deceleration lanes, and provided lane balance along the freeway, which substantially reduced congestion on I-25. The freeway segments and merge/diverges currently operate at LOS D or better during the peak hours, except

the diamond northbound and southbound entrance ramp merges, which operate at LOS F due to heavy freeway volumes. All four I-25 on ramps are controlled with ramp meters during the AM and PM peak hours. Although queues do not consistently back up to Arapahoe Road, the queues do fully utilize the ramps for storage.

Interim improvements completed in the summer of 2010 have resulted in two through travel lanes in each direction between the bridge piers and one through travel lane in each direction on the outside of the bridge piers in addition to a lane leading to the I-25 cloverleaf on-ramps. Due to the geometric design constraints of the narrow two eastbound "inside" through lanes on Arapahoe Road with no shoulders under the I-25 bridge, vehicular traffic (especially large trucks) slowly negotiate the southbound I-25 to eastbound Arapahoe Road double left turn, resulting in lengthy vehicle queuing on the southbound off-ramp that backs up onto I-25 in peak periods. The close spacing and high turning traffic volumes at the Yosemite Street and Boston/Clinton Street intersections adds to traffic congestion and delays within the interchange area. These conditions cause drivers to slow their speeds through the interchange area, which further limits the capacity of the interchange and adversely affects through traffic on Arapahoe Road.

Although recent (2010) interim lane improvements have improved traffic movements through the interchange and reduced queues along the Southbound I-25 off-ramp, significant queuing continues along Arapahoe Road at the Boston/Clinton and Yosemite Street intersections for traffic entering the interchange area and on the southbound off-ramp. The slightest increase in volume or any traffic incident can create gridlock conditions on Arapahoe Road and the freeway ramps.

2 Purpose of the Proposed Action and Project Objectives

The purpose of the project is to reduce congestion and improve functional deficiencies and traffic operations and safety for the traveling public within the I-25 and Arapahoe Road interchange complex, extending along Arapahoe Road from west of the Yosemite Street intersection to east of the Boston/Clinton Street intersection.

The objectives of the improvements should:

- Improve functional deficiencies and operational efficiency of the interchange complex and meet future traffic demands
- Improve safety for motorists, pedestrians and bicyclists
- Accommodate multimodal connections
- Be sensitive to and preserve the residential and business community character of the area through Context Sensitive Solutions (CSS)
- Mitigate adverse impacts
- Consider the economic importance of the interchange at the local and regional levels
- Create the best value, considering benefits, anticipated construction costs, life cycle costs, and potential for funding

2.1 Alternatives Assessment Process

This report includes documentation of the reconsideration of previously considered alternatives from the Arapahoe Road Corridor Study and System Level Feasibility Study, and evaluation of newly suggested reasonable alternatives. Following the project's first public meeting held in April 2010, the project team received a tremendous amount of comments and roadway improvement suggestions from community members and local agency representatives. In keeping with the requirements of NEPA, all reasonably feasible alternatives for the I-25/Arapahoe Road interchange are being investigated. Among the new suggestions for interchange improvements are concepts to keep necessary roadway improvements on Arapahoe Road, including lower cost short- to mid-term improvements that could be constructed prior to fully rebuilding the I-25 interchange.

A tiered alternatives screening process was used to evaluate alternatives and options moving forward in this NEPA process. Evaluation is based on the purpose and need for improvements and project objectives, and includes investigation of traffic, community and environmental impacts.

Level 1 screening is at a qualitative assessment level of detail considering physical feasibility and consistency of the improvement alternative with the purpose for the proposed action and project objectives. Alternatives that meet these basic tests are then refined and quantitatively assessed at a greater level of detail and compared and contrasted. The goal of the Level 2 analysis is to identify a single action alternative for assessment in the Environmental Assessment.

3 Previously Considered Interchange Alternatives

Since the current analysis is meant to reconfirm and build on previous analysis, it is important to summarize the extensive work of the relevant prior studies of the I-25/Arapahoe interchange.

In 2005, Arapahoe County, CDOT, Greenwood Village, and Centennial sponsored the Arapahoe Road Corridor Study, which included the evaluation of initial configuration options for the Arapahoe/I-25 interchange. The corridor study included a comprehensive stakeholder engagement process. The study Technical Advisory Committee (TAC) and Executive Committee (EC) were comprised of engineers, planners, and stakeholder agency representatives that reviewed and guided the study process. Public input was received through public open house meetings, focus groups, small group meetings and one-on-one conversations. The corridor study evaluation effort led to the selection of the interchange alternatives examined in the System Level Feasibility Study report completed in June 2008 and approved by the Colorado Transportation Commission in December 2008.

The Arapahoe Road Corridor Study considered a range of options for improvements to the Arapahoe/I-25 interchange. The initial options considered, shown in **Figure 1**, included improvements to the existing cloverleaf type interchange, concepts with improved ramp intersection operations, and three level interchange concepts.

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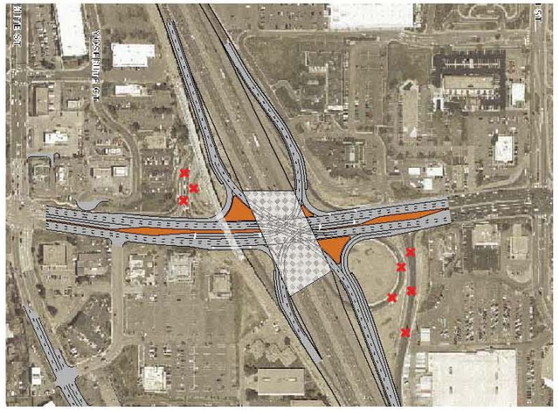
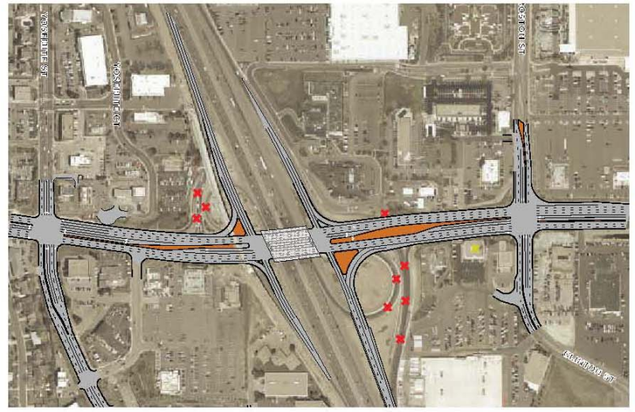
Figure 1. Preliminary Interchange Layouts

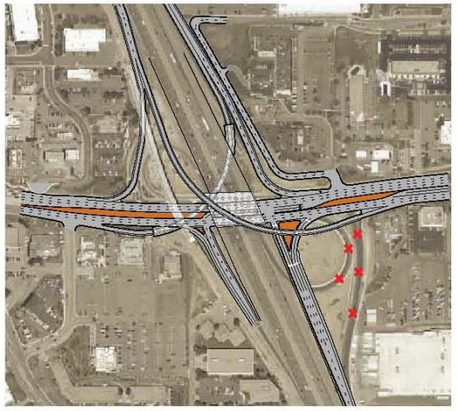
Alt. A - Improved Partial Cloverleaf



Alt. B - Single Point Urban Interchange

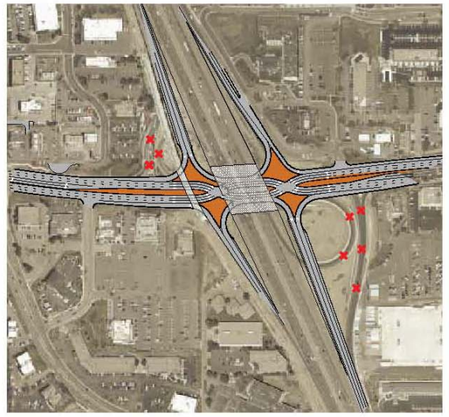


Alt. C - Tight Urban Diamond Interchange

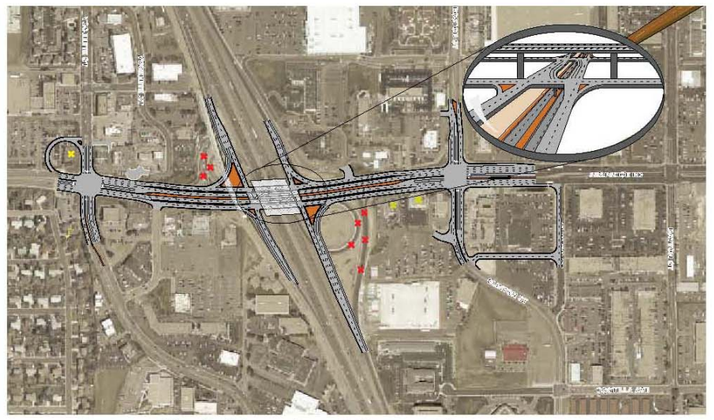


Alt. D - Directional Ramps Interchange

Alt. E - Tunnel Interchange



Alt. F - Diverging Diamond Interchange



Alt. G - Three Level Diamond Interchange

Alt. H - Costilla Connection

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Alternative A - Improved Partial Cloverleaf: Conceptual design options were considered for improving the existing partial cloverleaf interchange design geometry. The concept included increasing the loop ramp radius for the loop within the northwest quadrant. Realignment of the southbound off-ramp would require crossing under the adjacent LRT tracks.

Alternative B - Single Point Urban: The single point urban interchange option would replace the existing partial cloverleaf interchange and its two signalized ramp intersections with a single three-phase signalized intersection on Arapahoe Road. Due to the substantial width of the intersection, a long, deep clear span structure would be required, with relatively long clearance intervals at the ramps signalized intersection.

Alternative C - Tight Urban Diamond: The tight urban diamond interchange configuration included two closely-spaced signalized intersections to serve ramp terminal and Arapahoe Road traffic movements. Due to the proximity of the signalized ramp intersections, signal operations of the two intersections would be operated as one signal with four-phase overlap phasing. Much of the Arapahoe Road left turn storage may be provided outside the signalized intersections, with signal timing developed to minimize the number of vehicles stored between the ramp intersections.

Alternative D - Directional Ramps: This option consists of directional ramps to/from north I-25 with diamond configuration ramps to/from south I-25. This interchange option would have significant impacts to I-25 lane alignments due to the widening that would be required for shoulder areas for the grade change-related barriers of the flyover/tunnel ramps. I-25 widening would be all to the east due to the proximity of the light rail bridge to the west. A short weave area would result for southbound I-25 to eastbound Arapahoe Road traffic prior to the Boston/Clinton Street intersection.

Alternative E - Tunnel: With this option, the eastbound to northbound and westbound to southbound ramp movements would be accommodated as tunnels under the interchange. All eastbound and westbound traffic bound for I-25 would be separated from Arapahoe Road west of Yosemite Street and east of Boston/Clinton Street, respectively, with local access to the southwest and northeast quadrants crossing over the on-ramps. Similar to the directional ramp option, the merge of the westbound to southbound ramp would require additional shoulder area along the southbound on-ramp, consequently requiring a shift in the alignment of I-25.

Alternative F - Diverging Diamond: A diverging diamond interchange is a form of diamond interchange in which the two directions of traffic on the intersecting arterial roadway cross to the opposite side on both sides of the bridge at the freeway, allowing simple two-phase traffic signal control of the ramp intersections and ease of merging ramp traffic onto and from Arapahoe Road. The speed limit on Arapahoe Road would need to be reduced through the interchange to be consistent with the lower design speed of the curving intersection approaches without substantial widening of Arapahoe Road to provide wider sweeping approach curves.

Alternative G - Three Level Diamond: The three level diamond option would include an underpass for east/west Arapahoe Road through traffic under the existing level of Arapahoe Road. The underpass would provide two lanes in each direction for through travel on Arapahoe Road. Ramp intersection movements would occur on the existing level of Arapahoe Road, and I-25 would remain the top level of the interchange. Turn accommodations for ramp traffic bound for the adjacent Yosemite Street and Boston/Clinton Street would be made to eliminate weaving traffic movements along Arapahoe Road.

Alternative H - Yosemite to Costilla Connection: With this option, the existing interchange configuration and number of lanes remain, but a new underpass of I-25 south of Arapahoe Road would be constructed to connect Yosemite Street and Costilla Avenue. This would provide an alternate route for east/west through traffic to bypass the interchange area along Arapahoe Road. The new segment of Costilla Avenue would begin at a T-intersection with Yosemite Street west of I-25, cross under the freeway south of the Target property, and connect at the existing Costilla Avenue and Clinton Street intersection. The existing section of Costilla Avenue east of Clinton Street would also be improved to meet the existing five-lane section at Fulton Street. This was the initially considered feasible location for a supplemental I-25 crossing. Additional supplemental I-25 crossing locations are presented in Section 4.0 of this Technical Memorandum.

3.1 Preliminary Evaluation

The initial alternatives were evaluated against evaluation criteria that were established for the System Level Feasibility Study. These criteria were categorized as:

- Traffic Operations/Level of Service (LOS)
- Safety/Crash Potential
- Access to Adjacent Land Uses
- Constructability/Phasing
- Right-of-Way Requirements
- Existing Business Impacts
- Construction/Implementation Cost

Table 1 provides a summary of the evaluation of preliminary alternatives. This evaluation matrix provides a comparative analysis of the alternatives related to the evaluation criteria. The System Level Feasibility Study dated June 2008 provides additional information regarding this preliminary evaluation.

Table 1. Preliminary Evaluation of Interchange Options

Evaluation Criteria	No Build	Alt. A Improved Partial Cloverleaf	Alt. B Single Point Urban	Alt. C Tight Urban Diamond	Alt. D Directional Ramps	Alt. E Tunnel	Alt. F Diverging Diamond	Alt. G Three Level Diamond	Alt. H Yosemite and Costilla Connection
Traffic Operations / LOS	No improvements to existing congestion or queuing.	Four intersections on Arapahoe Rd; No left turns at ramp terminals. Direct connection for EB to NB and WB to SB left turns.	Three intersections on Arapahoe Rd; Reduced capacity of single NB and SB on-ramps; Limited capacity of EB to NB and WB to SB left turns.	Four intersections on Arapahoe Rd; Reduced capacity of single NB and SB on-ramps; Limited capacity of EB to NB and WB to SB left turns.	Four intersections on Arapahoe Rd; High capacity for heavy movements to/from north I-25; Weaving movements for SB to EB ramp traffic to Boston St.	Four intersections on Arapahoe Rd; High capacity for movements to I-25; Complicated movements Yosemite & Boston intersections.	Four intersections on Arapahoe Rd; Two-phase ramp terminal operations; Insufficient capacity of single NB and SB on-ramps; High interchange volumes exceed capacity for unsignalized, free-flowing ramp operations.	Two intersections for thru traffic on Arapahoe Rd; Weaving at Yosemite & Boston intersections; Complex turning and local movements at Yosemite & Boston intersections.	Four intersections on Arapahoe Rd; New signalized intersection on Yosemite north of Alton Way; About 3,000 vpd removed from Araphoe Rd thru interchange.
Safety / Crash Potential	No changes in crash potential.	Arapahoe Rd traffic continues to stop at four intersections; Limits queuing from I-25 on-ramps to outside lanes of Arapahoe.	Single intersection limits conflicting movements; Decreased storage length for I-25 on-ramp queues.	Arapahoe Rd traffic continues to stop at four intersections with increased left turn conflicts.	Arapahoe Rd traffic continues to stop at four intersections; Decreased turn conflicts at ramp terminal intersections: Decreased storage length for SB I-25 on-ramp queues.	Arapahoe Rd traffic continues to stop at four intersections; Decreased conflicts at ramp intersections: Removes Arapahoe queuing from I-25 on-ramps; Weaving issues east & west of interchange.	Driver expectancy safety concern with unusual travel lane configuration thru interchange; Short weaving section along Arapahoe Rd between ramp intersections.	Arapahoe Rd thru traffic grade-separated, limiting conflicting movements; Driver expectancy safety concern with movements required at Yosemite & Boston intersections.	Arapahoe Rd traffic continues to stop at four intersections; Decreased volumes on Arapahoe thru interchange decreases conflicts; Increased conflicts on Yosemite and Costilla Ave.
Access to Adjacent Land Uses	Continuing congestion degrades existing access conditions.	Closes right-in/right-out access to NW quadrant; Potential for added signalized access to SW quadrant across from SB off-ramp (only with CDOT approval).	Closes right-in/right-out access to NW quadrant and signalized access to NE quadrant.	Closes right-in/right-out access to NW quadrant and signalized access to NE quadrant.	Closes right-in/right-out access to NW quadrant; Replaces signalized access to NE quadrant with unsignalized right-in/right-out access.	Closes right-in/right-out access to SW quadrant; Potential for added signalized access to SW quadrant across from SB off-ramp (only with CDOT approval).	Closes right-in/right-out access to NW quadrant; Replaces signalized access to NE quadrant with unsignalized right-in/right-out access.	Closes right-in/right-out access to NW quadrant; Replaces signalized access to NE quadrant with unsignalized right-in/right-out access; Complex movements to provide access at Yosemite & Boston.	Provides additional access opportunities south of interchange with additional traffic on Costilla connection.
Constructability / Phasing	No construction impacts.	Could be built in phases with minimal impacts to existing Arapahoe alignment during construction.	Difficult to build in phases; Requires detours of Arapahoe and multiple construction phases on I-25.	Difficult to build in phases.	Constructability issues with third level bridges and tunnels; Requires realignment of I-25	Constructability issues with tunnel.	Difficult to build in phases.	Constructability issues with lower level for Arapahoe thru traffic; Difficult to build in phases.	Could be built in phases; No impact to Arapahoe interchange during construction.
Right-of-Way Requirements	No ROW impacts.	Minimal ROW required if loop ramps remain within existing interchange footprint.	Least ROW required than other build alternatives.	Minimal, if any, ROW required.	ROW required in all four quadrants for flyover ramps.	ROW required in SW and NE quadrants for tunnel approaches.	Minimal, if any, ROW required.	ROW required along Arapahoe thru interchange and at Yosemite & Boston intersections for roadways for local circulation.	Substantial ROW required along new roadway alignment.
Existing Business Impacts	None.	No impacts if loop ramps remain within existing interchange footprint.	None anticipated.	None anticipated.	Potential building impacts in SW, NE, and SE quadrants for flyover ramps.	Potential for substantial building impacts in SW and NE quadrants for tunnel approaches.	None anticipated.	Potential building impacts in SW and SE quadrants with widening required along Arapahoe Rd.	Major impacts to two buildings with substantial impacts to parking for adjacent properties.
Construction / Implementation Cost	No construction costs.	$50-60 million	$70-80 million	$50-60 million	$120-170 million	$120-170 million	$50-60 million	$100-140 million	$35-45 million

Legend: ○ High compliance with project objectives ◔ Moderate compliance with project objectives ◒ Limited compliance with project objectives ◕ Little compliance with project objectives ● Low level of compliance with project objectives

Note: Construction cost in 2007 dollars

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3.2 Preliminary Screening Summary

3.2.1 Alternatives Eliminated from Further Consideration

Based on the results of the preliminary alternatives evaluation conducted in conjunction with the System Level Feasibility Study, the following alternatives were not forwarded for further detailed evaluation. This evaluation was reconfirmed for the current study. Primary reasons that these alternatives were screened from further consideration are highlighted below.

Alternative C – Tight Urban Diamond: The diamond interchange ramp intersections with Arapahoe Road would not provide sufficient capacity to accommodate future traffic volumes. The eastbound to northbound and westbound to southbound left turn movements would exceed the capacity of double left turn lanes and queues would extend through the interchange. Limited storage length would be provided between the two ramp intersections. Traffic signal progression along Arapahoe Road would be compromised with the additional left turn phases at the ramp signals. Due to the nature of the construction within existing travel areas, there would be some difficulty with building the interchange ramps and intersections in phases.

Alternative D – Directional Ramps: The locations of the eastbound to northbound and southbound to eastbound ramp merges/diverges along Arapahoe Road would result in complex weaving maneuvers at the Boston/Clinton and Yosemite Street intersections. The northbound to westbound and westbound to southbound left turns would require the ramp terminals to remain signalized. The westbound to southbound left turn movement would exceed the capacity of double left turn lanes and queues would extend through the northbound ramp intersection. All traffic headed for Southbound I-25 would travel on one diamond ramp, which results in decreased storage length for queues from the ramp meter or the I-25 merge.

The flyover and tunnel ramps would require complicated construction and realignment of the freeway. Due to the nature of the construction within existing travel lanes, it would be difficult to build in phases. New right-of-way would be required in all four quadrants of the interchange with potential business building impacts in the southwest, northeast, and southeast quadrants.

Alternative E - Tunnel: The locations of the I-25 entrance ramp diverges along eastbound and westbound Arapahoe Road would result in complex lane changing maneuvers east and west of the Boston/Clinton and Yosemite Street intersections. The I-25 exit ramp terminals would remain signalized. The tunnels under Arapahoe Road would require complicated construction. New right-of-way would be required in the southwest and northeast quadrants of the interchange for the approaches to the tunnels with the potential for business building impacts.

Alternative F – Diverging Diamond: All traffic headed for Northbound or Southbound I-25 would travel on single diamond ramps, which would result in decreased storage for queues from the ramp meters prior to the I-25 merge. The high volume of turns on and off the freeway ramps would require merges of multiple lanes and/or signalization, which would substantially impact the benefits of the two-phase signal control and Diverging Diamond configuration. Due to the nature of the construction within existing travel lanes, it would be difficult to build in phases. The unconventional layout with realigned lanes for drivers to travel on the left side of the roadway would create safety and capacity concerns related to driver expectancy, as no other interchange of this type exists in Colorado. The proximity of the Yosemite Street and Boston/Clinton Street intersections to the Diverging Diamond ramp intersections is also a concern.

Alternative G – Three Level Diamond: The decision point between Arapahoe Road through movements and freeway ramp access movements would create weaving movements with the short distance and traffic interactions at the Boston/Clinton and Yosemite Street intersections. Providing local access within the interchange area would be complicated with the grade-separation of Arapahoe Road movements. All traffic headed for Northbound or Southbound I-25 would travel on single diamond ramps, which results in decreased storage length for queues from the ramp meters or the I-25 merge. New right-of-way would be required along Arapahoe Road. The tunnels under Arapahoe Road would require complicated construction and the nature of the construction within existing travel lanes would make it difficult to build in phases. Substantial drainage infrastructure would be needed and long-term maintenance is a concern for local agencies.

Alternative H – Yosemite and Costilla Connection: The travel modeling indicates that the alternate route between Yosemite Street and Clinton Street along Costilla Avenue would decrease the daily traffic traveling along Arapahoe Road through the interchange, with most volume reduction expected during the peak hours. Although a benefit to traffic operations at the ramp terminal intersections, the travel forecasts show that the connection would not divert sufficient traffic to eliminate the need for additional capacity improvements within the immediate interchange area. The connection would be best combined with another action alternative to provide the most benefit from the reduction of traffic volumes through the interchange.

3.2.2 Alternatives for Further Consideration

Based on the results of the preliminary alternatives evaluation, the Improved Partial Cloverleaf (Alternative A) and Single Point Urban (Alternative B) alternatives were forwarded for more detailed evaluation in the System Level Feasibility Study. The Improved Partial Cloverleaf and Single Point Urban interchange configurations were noted as providing the best traffic operations and safety benefits and perform better than the other alternatives in almost all preliminary criteria.

Due to the additional capacity and access benefits identified for the Yosemite and Costilla Connection in the preliminary evaluation, both alternatives moving forward into the detailed alternative assessment were modified to include a new underpass of I-25 south of Arapahoe Road connecting Yosemite Street and Costilla Avenue as a means for east/west through traffic to bypass the interchange area. **Table 2** illustrates the simplified comparison of the preliminary alternatives with the evaluation of the modified alternatives, Improved Partial Cloverleaf with Costilla Connection (Modified Alternative A) and Single Point Urban Interchange with Costilla Connection (Modified Alternative B), related to the preliminary evaluation criteria.

The Costilla Connection could divert traffic from Arapahoe Road, reducing traffic volumes through the interchange and improving interchange traffic operations and safety. The new roadway connection would provide additional access opportunities across I-25 south of the interchange. The construction of the Costilla Connection would not impact traffic through the interchange. The Costilla Connection is also an element of the recommended alternative in the Arapahoe Road Corridor Study.

Adding the Costilla Connection to the alternatives would require additional right-of-way, and impacts existing businesses and character of the area since it is a new roadway alignment through a developed area adjacent to a residential neighborhood.

Table 2. Preliminary Evaluation of Modified Interchange Options

Evaluation Criteria	No Build	Alt. A Improved Partial Cloverleaf	Alt. B Single Point Urban	Alt. C Tight Urban Diamond	Alt. D Directional Ramps	Alt. E Tunnel	Alt. F Diverging Diamond	Alt. G Three Level Diamond	Alt. H Yosemite and Costilla Connection	Mod. Alt. A Improved Partial Cloverleaf with Costilla Connection	Mod. Alt. B Single Point Urban with Costilla Connection
Traffic Operations / LOS	●	◔	◕	◕	◒	◒	◕	◒	◔	○	◔
Safety / Crash Potential		◔	◔	◒	◒	◒	◕	◕	◒	◔	◔
Access to Adjacent Land Uses	●	◔	◒	◒	◒	◔	◒	●	○	○	○
Constructability / Phasing	○	◔	◕	◒	●	●	◒	◕	○	◔	◕
Right-of-Way Requirements	○	◔	○	◔	●	●	◔	●	●	●	●
Existing Business Impacts	○	○	○	○	◕	◕	○	◕	●	●	●
Construction / Implementation Cost	No construction costs ○	$50-60 million ◔	$70-80 million ◒	$50-60 million ◔	$120-170 million ●	$120-170 million ●	$50-60 million ◔	$100-140 million ◕	$35-45 million ◔	$85-105 million ◒	$105-125 million ◕

Legend: ○ High compliance with project objectives; ◔ Moderate Compliance with project objectives; ◒ Limited Compliance with project objectives; ◕ Little compliance with project objectives; ● Low level of compliance with project objectives

Note: Construction cost in 2007 dollars

3.3 Detailed Alternatives Assessment

Based on the preliminary screening of alternatives, the following alternatives were forwarded for more detailed evaluation in the System Level Feasibility Study.

- Modified Alternative A - Improved Partial Cloverleaf with Costilla Connection
- Modified Alternative B - Single Point Urban Interchange with Costilla Connection

The System Level Feasibility Study dated June 2008 provides additional information on this detailed alternative assessment.

3.4 Summary of Previous Detailed Alternatives Evaluation

A summary matrix of the previous detailed alternatives evaluation is provided in **Table 3**. Criteria used in this analysis included:

- Traffic Operations and Safety Performance –Intersection Levels of Service (LOS), delay, and potential queue lengths for critical movements were quantified for each alternative. Crash potential as a result of conflict points and queuing was also considered.
- Design and Construction – Geometric considerations, constructability issues, and potential construction phasing were considered in this evaluation.
- Environmental Issues – These criteria considered community/business impacts, hazardous materials impacts, water resources, noise impacts, as well as air quality impacts.
- Right-of-Way Requirements – Quantification of the required acres of right-of-way for each alternative was calculated.
- Construction Costs – Costs for construction, contingencies, construction engineering, and construction management are included in this analysis. This analysis excluded the cost for right-of-way acquisition.

The more detailed screening identified concerns associated with the Single Point Urban Interchange (SPUI) with Costilla Connection alternative. With the SPUI, all traffic headed for I-25 would travel on one diamond ramp, rather than the diamond ramp and loop ramp with the partial cloverleaf configuration. The 2035 projected northbound on-ramp traffic volume exceeds 2,300 vehicles per hour (vph) which can be accommodated by the two on-ramps of the partial cloverleaf, but not effectively by the single on-ramp of the SPUI. A single on-ramp also results in decreased storage length for queues from the ramp meters at the I-25 merges. Because of the ramp metering and congestion on I-25 during the AM and PM peak hour, the queues on the I-25 entrance ramps would extend through the Arapahoe Road signal. Traffic attempting to turn left onto the freeway ramps would back up into the inside through lanes on Arapahoe Road while traffic attempting to turn right onto the ramps would back up into the outside lanes.

This SPUI requires a long, single span bridge structure to accommodate the left turns to and from the ramps at the Arapahoe Road intersection, which would require deep structural girders. This bridge design would require either lowering Arapahoe Road or raising I-25 to provide adequate vertical clearance, which would result in complex construction phasing and substantial impacts to I-25 and Arapahoe Road traffic during construction. Lowering Arapahoe Road creates construction phasing issues at existing ramp intersections and access points, and the southbound on-ramp would exceed maximum desirable ramp grade. Temporary roadways and multiple

Table 3. Detailed Evaluation of Alternatives

Evaluation Criteria	No Build	Mod. Alt. A Improved Partial Cloverleaf with Costilla Connection	Mod. Alt. B Single Point Urban with Costilla Connection
Traffic Operations	No improvements to congestion and queuing	Improved SB off ramp operations and increased capacity for through traffic on Arapahoe Road	Reduced capacity of NB and SB on ramp movements
Design and Construction	Not applicable	- Standard single span bridge - 2000' of I-25 reconstruction - Construction simplified while maintaining traffic	- Non-standard, deep bridge girders required - 4000' of I-25 reconstruction - Difficult to construct while maintaining traffic - Compromises existing LRT infrastructure
Right-of-Way Requirements	Not applicable	Interchange = 1.1 acres Costilla connection = 5.0 acres Total = approx. 6.1 acres	Interchange = 1.8 acres Costilla connection = 5.0 acres Total = approx. 6.8 acres
Environmental Issues	- As congestion increases, business access will be negatively impacted - As congestion increases, air pollution will increase - No other environmental impacts	- Closes right-in/right-out access to NW quadrant - Positive impact to air quality as traffic operations improved substantially - Minor impacts to wetlands - Potential hazardous material impacts	- Closes right-in/right-out access to NW quadrant and signalized access to NE quadrant - Positive impact to air quality as traffic operations improved substantially - Minor impacts to wetlands - Potential hazardous material impacts
Construction Costs	None	$85 – 105 million [Note: This 2007 cost estimate was updated in 2011 to $122 million]	$105 – 125 million
Summary			

Legend:
- High compliance with project objectives
- Moderate compliance with project objectives
- Limited compliance with project objectives
- Little compliance with project objectives
- Low level of compliance with project objectives

stages of traffic detours would be required to maintain traffic on both Arapahoe Road and I-25 during bridge construction, however, the vertical grades may make this infeasible.

Construction of the west side ramps would need to avoid impacts to the existing light rail bridge, and is particularly critical adjacent to the LRT retaining walls and ballast walls west of I-25**.** Construction of the northbound off-ramp would need to avoid impacts to the Target store since any further impacts to that site could result in acquisition of the Target property. Maintaining the existing eastbound to northbound loop ramp during construction of the new northbound off-ramp would result in severe impacts and possible costly temporary ramp realignments.

The SPUI configuration also requires the closure of the signalized access to the northeast quadrant of the interchange, which would be an economic impact concern to Greenwood Village and the property owners served. A sub-alternative to maintain this traffic movement, and provide a similar southbound off-ramp through traffic movement, could be explored. This would require an additional signal cycle phase to accommodate this unusual traffic movement at a SPUI interchange.

The No Action alternative would not provide the capacity necessary to meet the forecasted travel demand at the interchange, resulting in increased traffic congestion, safety concerns, and air quality impacts.

Based on the results of the alternatives evaluation, the Improved Partial Cloverleaf with and without Costilla Connection are recommended for further evaluation in the subsequent NEPA process for the interchange improvements.

4 Alternatives Evaluation for the Environmental Assessment

4.1 Supplemental I-25 Crossings

The need for additional crossings of I-25 in the south Denver metro area has been a subject of attention for over 25 years. Previous studies to address crossing needs resulted in construction of the Yosemite Street overpass north of Arapahoe Road, and the Union Avenue overpass north of Belleview Avenue.

The concept for a Costilla Avenue crossing was initially developed during the Arapahoe Road Corridor Study as a means to divert traffic from the I-25/Arapahoe interchange, thereby improving interchange traffic operations. The proposed alignment would intersect with Yosemite Street about 500 feet north of the Briarwood Boulevard/Alton Way intersection within an established business area, offset from the Walnut Hills residential neighborhood street network. Alternative intersection design is being considered for the new east-west connection to have continuity with Yosemite Street to the north. The Costilla connection offered advantages over other potential crossing locations since I-25 is slightly elevated at the proposed crossing allowing for an underpass to meet minimum design standards for vertical grade (see Design Criteria, **Appendix A**). Connectivity with Costilla Avenue to the east also provides a nearby parallel east-west route as an alternative to Arapahoe Road.

The City of Greenwood Village also studied the potential for a Peakview Avenue crossing in conjunction with “serpentine road” improvements northeast of the I-25/Arapahoe interchange,

meant to divert traffic off of Arapahoe Road at I-25. That analysis concluded that the physical limitations of Peakview east and west of I-25 would result in a crossing too steep to meet design standards and too disruptive to intersecting streets and adjacent development.

More recently, Greenwood Village considered a Caley Avenue crossing of I-25 in conjunction with proposed development north of the Arapahoe park-n-Ride and LRT station. Although physically feasible, the analysis showed that traffic would be diverted from the Yosemite Street overpass, with little decrease in traffic on Arapahoe Road. The City is now considering an overpass at this location for pedestrians and bicyclists only.

A full range of previously considered and other suggested alternative locations for an I-25 crossing were considered in the analysis. The alternative crossing locations are illustrated in **Figure 2**. The alternatives include Caley and Peakview Avenues north of Arapahoe Road, a depressed third level on Arapahoe Road under the interchange for through traffic, the Costilla Avenue connection (labeled Alternative 1b) and other alternative locations south of Arapahoe Road suggested through public and agency input. Traffic forecasts for alternative I-25 crossings are summarized in **Appendix B**.

4.1.1 Caley Avenue Crossing

The Caley Avenue crossing would extend from Fiddler Green Circle east across I-25 to connect with Caley Avenue west of Yosemite Street. The grade for an overpass or underpass could meet minimum design standards with adjustments to intersection elevation at the westernmost driveway intersection along Fiddler's Green Circle, at the Blinder Way intersection, and at the intersection with Yosemite Street.

Updated 2035 travel forecasts for this study reconfirm that a Caley Avenue crossing would carry approximately 9,000 vehicles per day (vpd), which would divert traffic primarily from the Yosemite Street overpass while diverting less than 500 vpd from the I-25/Arapahoe interchange.

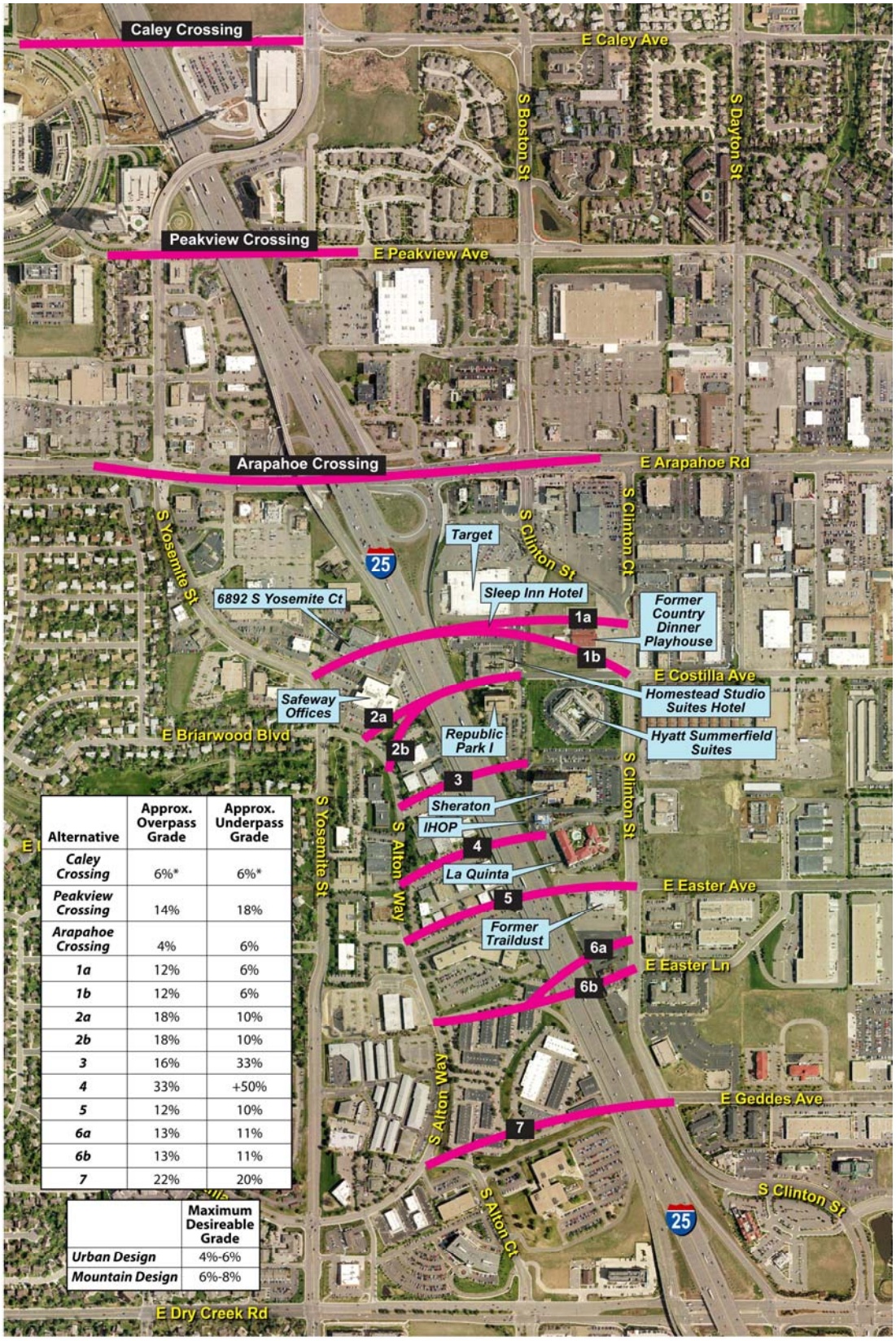
Because of the limited traffic diversion from the interchange and undesirable traffic diversion from the nearby Yosemite Street overpass, the City of Greenwood Village concluded that a Caley Avenue crossing for automobile traffic would be redundant with the Yosemite Street overpass. The City's Village Center plans have now been modified to include a pedestrian/bicycle overpass to serve the developing area and the nearby Arapahoe LRT Station.

4.1.2 Peakview Avenue Crossing

The Peakview Avenue crossing would extend from the Yosemite/Peakview intersection east across I-25 to connect with Peakview Avenue west of Boston Street. Because of the short distance from Yosemite Street to I-25, the crossing would be very steep. Raising or lowering the Yosemite/Peakview intersection to accommodate the steep approach is limited by the nearby approach to the Yosemite Street overpass.

Access to the United Health/Minton building (former Blinder building) and residences on the east side of I-25 would also be impacted. Residences east of I-25 would also experience visual and noise impacts of an elevated crossing. A Peakview connection, if physically possible, would

Figure 2. Other Suggested Alternative Locations for Supplemental Crossings of I-25



Alternative	Approx. Overpass Grade	Approx. Underpass Grade
Caley Crossing	6%*	6%*
Peakview Crossing	14%	18%
Arapahoe Crossing	4%	6%
1a	12%	6%
1b	12%	6%
2a	18%	10%
2b	18%	10%
3	16%	33%
4	33%	+50%
5	12%	10%
6a	13%	11%
6b	13%	11%
7	22%	20%

	Maximum Desireable Grade
Urban Design	4%-6%
Mountain Design	6%-8%

**assuming reconstruction to modify intersecting street elevations*

have continuity as the "serpentine roadway" extends east in a curvilinear fashion to the Arapahoe/Havana intersection. Travel forecasts indicate that it would divert about 3,000 vpd from the I-25/Arapahoe Road interchange, which would only marginally help relieve bottleneck traffic from the congested interchange.

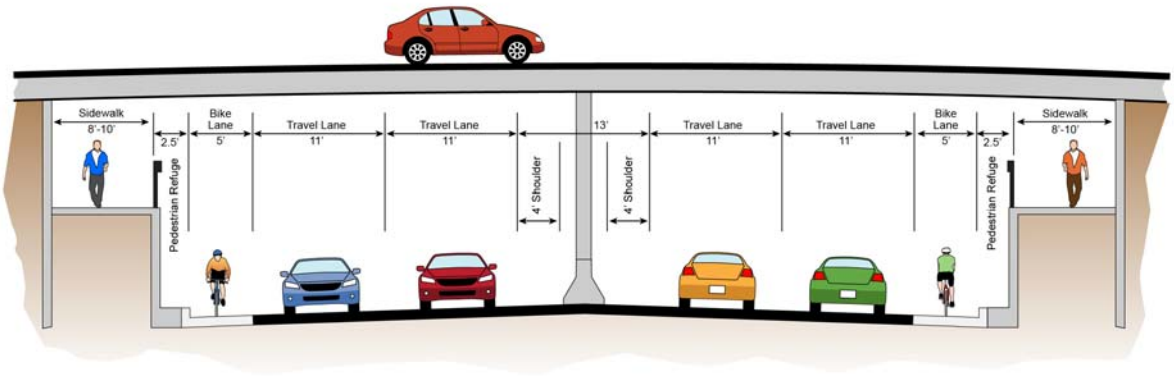
Because of the impacts to intersections and driveways to adjacent residences and businesses, this alternative is not compatible with local/community character.

4.1.3 Costilla Avenue Alternatives 1a and 1b

The Costilla Avenue Alternative 1a is a variation of the previously recommended Costilla Avenue crossing of I-25, Alternative 1b. Both alternatives would have an intersection with Yosemite Street at approximately Yosemite Court, about 500 feet north of the Alton/Briarwood intersection. The new roadway would extend east under I-25, then east to Clinton Street. Alternative 1a would intersect Clinton Street opposite Clinton Court, while Alternative 1b would have continuity with Costilla Avenue east of Clinton Street. Consideration was given to an overpass versus an underpass, but an overpass would be too steep and not meet minimum design criteria because of the existing LRT structure height.

Both alternatives would meet the purpose of diverting sufficient traffic to result in improved I-25/Arapahoe interchange traffic operations and safety, and would provide a safe alternative route for pedestrians and bicyclists wishing to cross I-25 without negotiating across the high volume ramps at the I-25 interchange. Potential pedestrian and bicycle accommodations are illustrated in **Figure 3**. Alternative 1b better meets the evaluation criteria. Due to its continuity with Costilla Avenue, which extends east for about three miles, Alternative 1b would carry about 14,000 vehicles per day and could divert about 6,000 vpd from the I-25 interchange.

Figure 3. Potential Pedestrian and Bicycle Accommodations



Alternatives 1a and 1b are somewhat sensitive to residential areas and community character because the alternative alignment intersects Yosemite Street north of Briarwood in an area surrounded by business and office land uses, and not in alignment with a Walnut Hills residential street. The crossing is consistent with land use illustrations from the City of Centennial Arapahoe Urban Center Sub-Area Plan (October 2007). The design is feasible in that it meets minimum design standards for vertical and horizontal grade and curvature, no significant environmental impacts have been identified and local access can be maintained. As Alternative 1b diverts traffic from the interchange, it addresses the criteria to relieve bottleneck issues that impact regional economic vitality. The alternatives would require acquisition of the 6892 S. Yosemite Court office building and the Sleep Inn Hotel.

4.1.4 Alternatives 2a and 2b

Alternatives 2a and 2b would connect Costilla Avenue with Alton Way. Alternative 2a would have continuity with Alton Way directly opposite Briarwood Boulevard. Alternative 2b would have continuity with Alton Way to the south, with closure of Alton Way opposite Briarwood Boulevard. The proposed alignment would require acquisition of the Homestead Studio Suites Hotel and impact parking for offices along Alton Way.

Due to the shorter crossing distance, the alternatives would be too steep to meet minimum design criteria, or require significantly raising or lowering Alton Way, which would impact driveways to adjacent office buildings. Widening would also be required to accommodate the additional traffic volume on Alton Way. Alternative 2a would divert less traffic from the I-25/Arapahoe interchange than Alternatives 1a or 1b due to additional turns required to access the crossing from Yosemite Street, and Alternative 2b would divert the least traffic due to the long circuitous route required to access the crossing from Yosemite Street.

Alternative 2a is not consistent with community character because the road would directly align with Briarwood Boulevard and increase the potential for cut-through traffic impacts within the Walnut Hills neighborhood. Similarly, Alternative 2b would increase traffic on Alton Way opposite Xanthia Street and may contribute to traffic impacts for the Hunters Hill neighborhood. The increased traffic on Alton Way would impact traffic operations at the numerous business driveways along this collector road through the Kelmore Professional Park.

4.1.5 Alternatives 3 and 4

Alternatives 3 and 4 would extend across I-25 between Clinton Street and Alton Way. Neither alternative would have east/west continuity beyond Clinton and Alton. Alternative 3 would impact parking for the Hyatt Summerfield Suites and Sheraton Hotels on the east and parking for offices along Alton Way to the west. Alternative 4 would impact parking for IHOP and the LaQuinta Hotel and parking for offices along Alton Way. These alternatives also have a short crossing distance and would be extremely steep to cross over or under I-25 and require substantially raising or lowering Alton Way and Clinton Street, which would impact driveways to adjacent businesses. Widening would also be required to accommodate the additional traffic volume on Alton Way. Less traffic would be diverted from the I-25/Arapahoe Road interchange than Alternative 1b due to the greater distance south and the circuitous travel and turns required to access the crossing location from Yosemite Street.

Alternatives 3 and 4 are not consistent with community character since crossing traffic on Alton Way would intersect Yosemite Street directly across from residential neighborhood streets (Briarwood and Xanthia), and the increased traffic on Alton Way would impact business access in the Kelmore Professional Park.

4.1.6 Alternatives 5, 6a/6b and 7

Alternatives 5, 6a/6b and 7 have a similar connection between Alton Way and Clinton Street with impacts to office buildings and parking along Alton Way, and impacts to parking and restaurant properties along Clinton Street. These alternatives have a greater distance between Alton Way and I-25 to accommodate an approach grade that meets minimum design standards. However, these alternatives have a very short distance between I-25 and Clinton Street which would require significantly raising or lowering Clinton Street and the connecting Street (Easter Avenue, Easter Lane or Geddes Avenue, as applicable), which would impact nearby driveway access and

adjacent businesses. Widening would also be required to accommodate the additional traffic volume on Alton Way. The crossings would carry about 15,000 vehicles per day but only divert about 3,000 vpd from the I-25/Arapahoe interchange due to the increased distance from Arapahoe Road, and the circuitous travel and turns required to access the crossing location from Yosemite Street.

Alternatives 5, 6a/6b and 7 are not consistent with community character since crossing traffic on Alton Way would intersect Yosemite Street directly across residential neighborhood streets (Briarwood and Xanthia) and the increased traffic on Alton Way would impact business access in the Kelmore Professional Park.

4.1.7 Arapahoe Road Crossing (Three Level Interchange)

The concept for a third level for through traffic on Arapahoe Road under the I-25/Arapahoe interchange was considered in the Arapahoe Road Corridor Study as part of the Three Level Diamond Interchange alternative. That concept considered a third, lower level for through traffic extending from east of Yosemite Street to west of the Boston/Clinton intersection.

Upon refinement of the conceptual design for the vertical transition to the depressed third level to meet arterial street design standards, and to better serve estimated through traffic volume, the depressed level for this analysis was extended under the Yosemite Street and Boston/Clinton intersections as well. Traffic accessing Yosemite Street, the I-25 ramps and Boston/Clinton Street would continue to operate at the existing level with approximately the same number of lanes as existing, above the depressed through travel lanes. This Arapahoe Road Crossing alternative could be linked with the Improved Partial Cloverleaf interchange alternative so that sufficient on-ramp traffic capacity is provided. Maintaining the existing interchange and I-25 bridge over Arapahoe Road would not provide the accepting lanes to allow a southbound triple left turn from the southbound off-ramp to eastbound Arapahoe Road.

Approximately one-third of the Arapahoe Road forecasted traffic volume, about 28,000 vpd, is "through traffic" that may utilize the depressed through travel lanes. Although the additional capacity may attract more travel to the Arapahoe Road corridor, the through travel priority level would divert about 20,000 vehicles per day from the busy Yosemite Street, I-25 ramp and Boston/Clinton intersections, resulting in improved traffic operations at these busy intersections. About 56,000 vpd are forecast to utilize Arapahoe Road at the interchange ramps in addition to the diverted through traffic noted above.

Substantial right of way impacts would result from the widening required to reconstruct the existing level lanes bound for turns at the I-25 ramps and adjacent intersections that bypass the portals to the depressed third level, east of Uinta/Greenwood Plaza Boulevard and west of Dayton Street. The widening of Arapahoe Road adjacent to the portals would impact residences in Walnut Hills, the Castlewood Library, the shopping center north of Arapahoe Road between Greenwood Plaza Boulevard and Yosemite Street, and the shopping center and businesses between Clinton Court and Dayton Street. The alignment could be shifted to the north to minimize right of way impacts to residential property to the south, but with substantially greater impact to commercial properties along the north side of Arapahoe Road.

Due to insufficient weaving and merging distance from the portals and the Uinta/Greenwood Plaza Boulevard and Dayton Street intersections, turn restrictions would be required resulting in out-of-direction travel to intended destinations. Potential neighborhood cut-through traffic may result within Walnut Hills.

Traffic signals at the Dayton and Uinta/Greenwood Plaza Boulevard intersections, just east and west of the portals, would back up traffic on the uphill approaches to the signals in peak traffic hours, which is a concern regarding air quality, safety and traffic operations, and is a road maintenance concern during inclement weather conditions. Concentration of turning traffic at these intersections may require additional intersection improvements adding to the alternative cost and impacts.

The depressed level could be extended east of Dayton Street, allowing turns to occur at the Dayton Street intersection and taking advantage of the grade change east of Dayton Street to meet the existing grade of Arapahoe Road. However, the additional length of the depressed level would come with substantial additional cost.

Extensive signage would be required to guide Arapahoe Road traffic to the appropriate travel lanes. Signage for traffic bound for four successive intersections would be required to direct traffic to the right lanes and through traffic to left lanes westbound approaching Dayton Street and eastbound approaching Uinta/Greenwood Plaza Boulevard.

Construction of a depressed segment of roadway through the interchange area is limited by the physical constraints of existing I-25, the southeast corridor LRT pier in Arapahoe Road, and adjacent development. Maintaining traffic operations on Arapahoe Road during construction would be very difficult through the confined interchange, resulting in highly congested traffic operations during the lengthy construction period, with substantial economic impact to adjacent businesses.

Major utility modifications, walls, bridges and drainage accommodations would be required along Arapahoe Road and under I-25 for the separated through movements. The approximate 4,000 foot long, covered tunnel section would require life safety infrastructure and ventilation. Emergency providers have expressed concerns regarding emergency access within the depressed section. Long-term maintenance and costs associated with the walls, drainage and ventilation infrastructure elements are also a concern.

Construction cost of this alternative would be substantial. In addition to the tunnel element, Arapahoe Road from west of Uinta/Greenwood Plaza Boulevard to Dayton Street would need to be reconstructed, the I-25 interchange rebuilt, and substantial right of way and property acquired along Arapahoe Road. An estimate of probable construction cost is included in **Appendix C**.

A three-level single point urban interchange was also considered, as summarized in **Section 4.9.1**. This alternative included a shortened segment for the depressed third level with a portal east of Yosemite Street and west of Boston Clinton Street. This configuration would result in inadequate approach grade to the Boston/Clinton Street intersection, and substantial traffic operation issues resulting from westbound turn restrictions at Yosemite Street and eastbound turn restrictions at Boston/Clinton Street. These operational issues include safety, out of direction travel, increased neighborhood cut-through traffic, and traffic operation improvement needs at other nearby intersections.

Consideration for a third level overpass instead of an underpass identified the substantially greater elevation differential to cross over both I-25 and the separated LRT structure west of I-25, with increased distance to meet existing grades east and west of I-25.

4.1.8 Additional Arapahoe Road Crossing Design Options

Several additional design options were explored for the Arapahoe Road Crossing alternative, at the request of the City of Centennial.

The first option incorporates a third level depressed in an open trench for through travel lanes that concentrates on saving the existing I-25 structure and LRT structure. This option would carry two lanes in each direction for Arapahoe Road below the existing street grade, and an additional two lanes in each direction for collection/distribution of ramp traffic and local traffic between Yosemite and Boston/Clinton at grade. Three sub-options were explored considering how best the trench section could fit between the existing bridge piers and/or abutments.

Not replacing the existing I-25 structure would save cost and reduce construction traffic impacts for I-25 motorists, if the option was feasible, and the open trench/depressed lanes would not require tunnel ventilation or cost of a long tunnel structure.

However, the option as proposed will not fit within the existing I-25 structure piers or abutments. The existing piers sit on spread footings which further reduces the available width between piers and to the bridge abutment. In addition, the existing I-25 bridge is functionally obsolete due to inadequate vertical clearance and lateral distance from travel lanes to bridge piers and will ultimately need to be replaced. Further, maintaining the existing bridge would not provide the lanes to allow a southbound triple left turn from the southbound off-ramp to eastbound Arapahoe Road, so the capacity limitation for the southbound left turn would remain.

A second option is an open trench with two lanes in each direction, a collector road system outside of the trench section at grade to handle ramp and local traffic between Yosemite and Boston/Clinton, but assuming replacement of the I-25 structure over Arapahoe. Upon analysis, it was determined that the existing LRT structure would remain in place since no better horizontal alignment would result from relocating the LRT pier. Separation of through traffic from intersecting cross and turning traffic would improve ramp intersection traffic operations. Open trench/depressed lanes would not require tunnel ventilation or cost of a long tunnel structure.

Significant concerns with this option are listed below:

- Congested traffic movements at terminal intersections (minimal distance to weave/merge from beginning/end of grade separation).
- Reduced access to Walnut Hills neighborhood and businesses east and west of the interchange.
- Extensive residential and commercial property acquisition along Arapahoe Road from Greenwood Plaza Boulevard to Dayton Street, and parking/circulation impacts due to widened depressed/trenched lanes.
- Large structures over depressed/trenched lanes and high cost for length of required retaining walls.
- Extensive utility and drainage relocation cost.
- Duplicative storm sewer system for upper and lower level roads, and pump station(s) required with extensive underground drainage.
- Significant traffic impacts during construction.
- Visibility of adjacent business diminished (through traffic below grade).
- Long-term maintenance cost associated with structures, walls and drainage infrastructure

- Snow removal/drainage of open trench adds to maintenance cost.

The third option differs in that the Arapahoe Road through movements would be split to the outside and the collector/distributor system would be located in the middle to accommodate ramp and local traffic. The existing LRT structure would remain in place since no better horizontal alignment would result from relocating the LRT pier. Separation of through traffic from intersecting cross and turning traffic would improve ramp intersection traffic operations. Overall, less structural crossings for intersecting streets and left turn lanes would be required versus a long covered depressed level for through traffic.

The significant concerns with this option include:

- Congested traffic movements at terminal intersections (minimal distance to weave/merge from beginning/end of grade separation).
- Reduced access to Walnut Hills neighborhood and businesses between Syracuse and Galena Streets.
- Cross section is 30' wider than options 1 or 2 resulting in extensive residential and commercial property acquisitions along Arapahoe Road between Greenwood Plaza Boulevard and Dayton Street.
- More ROW required than other alternatives, with substantial residential and business impacts.
- Double open trench would require double the length of retaining walls and double walks for safety/refuge.
- Extensive drainage and utility relocation costs.
- Duplicative storm sewer system for upper and two separated lower level roads, and pump stations required with extensive underground drainage.
- Visibility of adjacent business diminished (through traffic below grade).
- Pedestrian movement/access would be impacted. Duplication of sidewalks for access/crossings and non-standard crossings at corners/ ramps.
- Long-term maintenance cost associated with structures, walls and drainage infrastructure
- Snow removal/drainage of open trench adds to maintenance cost.

5 Suggested Interchange Sub-Alternatives

Several alternatives have been suggested since the System Level Feasibility Study was completed to potentially improve interchange operations.

5.1 Southbound Off-Ramp Left Turn Grade Separation

An option has been suggested for modification of the southbound off-ramp to grade separate the southbound to eastbound left turn movements over the westbound through traffic lanes by depressing the westbound lanes and elevating the left turn lanes. The westbound to southbound lanes leading to the partial cloverleaf loop ramp would need to remain at existing elevation so as not to increase the grade of the loop ramp. The left turn lanes could only be partially elevated because they need to meet the minimum 16’ 6” clearance under the nearby LRT bridge. The elevation of the northbound off-ramp intersection to the east is another limiting factor in the design.

Because the westbound through lanes would be depressed through the southbound off-ramp intersection, they would not meet the existing roadway elevation until just east of Yosemite Street. Therefore, southbound to westbound traffic could not merge with the depressed westbound traffic lanes until just east of Yosemite Street, and traffic on the southbound off-ramp destined to turn left at South Yosemite Street would be unable to weave across the depressed westbound through traffic lanes. Westbound through traffic destined to turn right at Yosemite Street would be unable to weave across the adjacent lanes coming from the southbound off-ramp. Turn restrictions would be required resulting in substantial traffic operations issues, including safety, out of direction travel, and the potential for neighborhood cut-through traffic.

Conceptual design of this modification option has found that the limiting constraints of the LRT bridge abutments alongside of the southbound off-ramp, LRT bridge vertical clearance, maximum ramp grade requirements, restricted merging and weaving movements with the depressed westbound traffic lanes make this option physically and operationally unfeasible. Therefore, no further analysis of this sub-alternative was warranted.

5.2 Southbound Off-Ramp Through Movement Grade Separation

Another southbound off-ramp modification suggestion would accommodate the southbound to westbound ramp traffic destined to turn left at South Yosemite Street by providing a grade separated southbound movement over both westbound and eastbound Arapahoe Road with a new road extending south from the southbound ramp intersection to intersect with South Yosemite Street at about Yosemite Court (see **Figure 4**). Property acquisitions would be required in the southwest quadrant of the interchange, which could facilitate redevelopment consistent with City of Centennial plans.

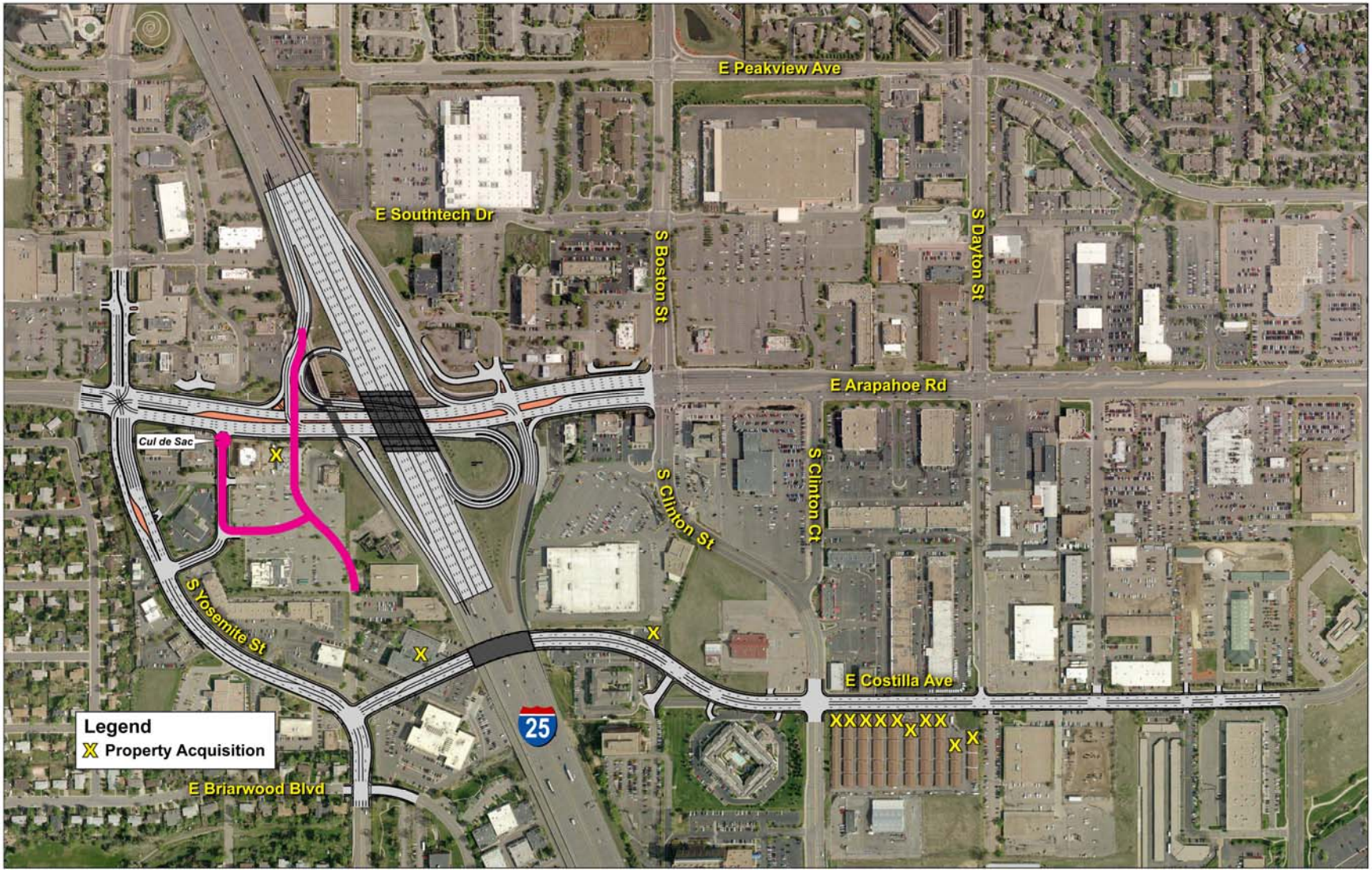
Conceptual design of this modification option has found that the limiting constraints of maximum ramp grade, the LRT bridge vertical clearance and ramp gore geometry to create a vertically separated lane make this option physically and operationally unfeasible. Therefore, no further analysis of this sub-alternative was warranted.

Enhanced local access may be pursued in the future in conjunction with possible redevelopment in the southwest quadrant of the interchange. A new roadway connection could be constructed directly across from the southbound I-25 exit ramp. This enhanced access may benefit interchange operations by reducing the traffic volume making the “Z” movement from the southbound I-25 exit ramp to southbound Yosemite Street. Signal operations, allowable movements, and safety concerns for such an access would need to be studied in detail with development plans and traffic projections considering the redevelopment potential within the southwest quadrant area prior to any access approvals. Similar considerations and analyses should be conducted for the northeast quadrant of the interchange where current access is provided opposite the northbound I-25 exit ramp. The City of Greenwood Village may pursue a more defined north/south circulator road leading from Arapahoe Road north to Southtech Drive.

5.3 Northbound I-25 Collector/Distributor Road

A Northbound I-25 collector/distributor (C/D) road from just north of Arapahoe Road to Orchard Road was explored to address northbound on-ramp capacity. This sub-alternative, if feasible, may allow for reconsideration of a single point urban interchange or other interchange configuration with a single on-ramp due to the increased merging capacity. Modification would

Figure 4. Improved Partial Cloverleaf with Costilla Crossing and Southbound Off-Ramp Through Movement Grade Separation



be required of the Northbound I-25 ramps, creating a northbound off-ramp to Orchard Road diverge just north of Arapahoe Road. This concept would allow weave/merging to be segregated from I-25 traffic on a C/D road, and improve northbound on-ramp storage with ramp metering potentially moved north to the merge point with mainline I-25 at Orchard Road.

Significant concerns with the collector/distributor road include:

- The two lane collector/distributor road would be required to merge to one lane prior to merging with I-25, with insufficient capacity for existing and forecasted traffic volume. A continuous northbound lane would be necessary to accommodate the projected on-ramp volume which would require widening as far north as I-225 due to the successive off and on-ramps for Orchard Road and Belleview Avenue.
- Significant ROW impacts and business acquisitions would be required northeast of Arapahoe and I-25 (La Quinta, Sports Authority, Brothers BBQ).
- Impacts to the Yosemite Street overpass structure (modification/replacement may be required) due to vertical clearance and lack of lateral clearance to pier and abutment.
- Impact to pedestrian bridge over I-25 north of the Yosemite Street bridge.
- Impacts western perimeter access road to Arapahoe park-n-Ride.
- Impacts to frontage road located south of Orchard and impacts adjacent business access.
- Impacts existing parking spaces (approx. 50 spaces) at the United Healthcare/Minton building. A parking structure may be required for mitigation.
- Requires additional drainage infrastructure (double the amount of inlets would be required for a barrier separated system).

5.4 SPUI with Northbound Loop On-ramp

A variation on the SPUI alternative was suggested that would include an eastbound to northbound loop ramp, braided with the northbound off-ramp. Upon review of the vertical profiles of the two ramps, it was determined that the grades of the two crossing ramps would exceed five percent grade and not meet design criteria in this general configuration. The loop ramp would govern the vertical geometry as it must merge with the grade of I-25 just south of Arapahoe Road, requiring the northbound off-ramp to steeply descend after its diverge from northbound I-25 to cross under the suggested loop ramp, then meet grade at the SPUI intersection under the I-25 bridge. Substandard design speed would result for the diverging movement with insufficient vertical clearance at the loop ramp bridge.

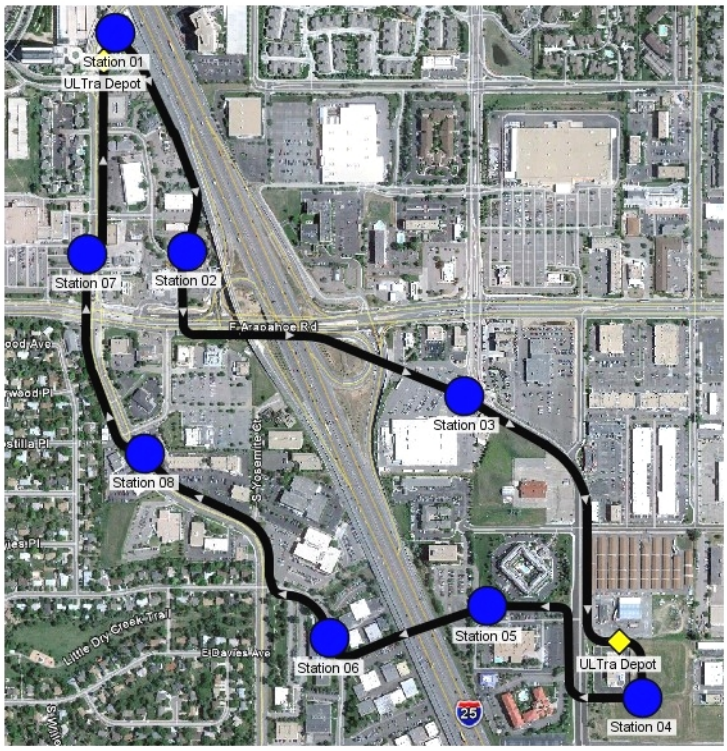
There are safety concerns with the loop ramp configuration and its crossing of the northbound off-ramp right turn to eastbound Arapahoe Road. A separation would be required for the northbound to eastbound off-ramp traffic movement, requiring additional ROW. Splitting the northbound off-ramp traffic would create a ramp terminal (exit to exit) spacing issue, requiring the off-ramp to diverge from I-25 northbound further to the south. This would also affect gore to gore spacing with the on-ramp from Dry Creek Road. There is also a concern that signage could not adequately direct eastbound traffic to the loop ramp without traffic mistakenly using the northbound off-ramp, resulting in wrong way interstate travel.

A similar southbound loop on-ramp with the SPUI configuration would be physically constrained by the LRT bridge, abutment and piers. A single southbound on-ramp cannot be lengthened due to the adjacent LRT tracks, and a single ramp would not accommodate the forecasted 2035 peak hour traffic volume.

6 Suggested Personal Rapid Transit (PRT) Alternative

A personal rapid transit (PRT) alternative has been suggested as a means to relieve interchange traffic congestion. The suggested PRT alternative would travel a 2.5-mile one-way loop connecting the Arapahoe at Village Center LRT Station with a new proposed 800 space park-n-Ride at Clinton Street and Easter Avenue with six other intermediate stations. The feasibility of the system crossing I-25 at Arapahoe Road and again south of Arapahoe Road, as shown in **Figure 5**, and the cost of these crossings of I-25, have not been defined.

Figure 5. Personal Rapid Transit (PRT) Concept



PRT vehicles holding up to four passengers would travel the loop with the ability to bypass intermediate stations. Vehicles would travel on an elevated guideway at a speed of approximately 25 mph, about a 3.5 minute trip from the proposed park-n-Ride to the Arapahoe at Village Center LRT station.

PRT Consulting, the group suggesting the PRT alternative, estimates the system capital construction cost to be $36 M, exclusive of right of way costs, with annual operating and maintenance costs of about $2 to 3M per year. Federal funds could be pursued for construction and operations/maintenance, and a passenger fare could be collected to offset a portion of the costs. PRT Consulting has suggested that the 2.5-mile system could be the beginning of a larger system of PRT service along the Arapahoe Road corridor east to Jordan Road, and north and south along I-25.

Although no estimate of passenger usage has been made, the proponents have identified a benefit in capturing westbound AM peak hour Arapahoe Road traffic bound for the Arapahoe at Village Center LRT station and park-n-Ride, and interchange area traffic throughout the day.

Analysis of factors related to this alternative identified that the 1,585 space Arapahoe at Village Center park-n-Ride is currently only about 25 percent utilized. If the Arapahoe at Village Center park-n-Ride were to be fully utilized in the future, RTD has considered additional park-n-Ride capacity further to the east in the vicinity of Arapahoe and Parker Roads. Due to the relatively low density of residential and commercial development in the immediate vicinity of the I-25/Arapahoe interchange, it is likely that mid-day ridership would be minimal. Therefore, even if the proposed park-n-Ride at Clinton and Easter was fully utilized, total daily ridership of the proposed PRT system would not warrant the capital and operations/maintenance costs of the initial system.

7 Other Suggested Roadway Improvements

Three alternative route improvements were suggested by attendees at the first EA public meeting. It is assumed that the suggested route improvements are meant to increase the amount of traffic that might divert around the I-25/Arapahoe intersection, and thereby result in improved interchange traffic operations.

7.1 Arapahoe LRT Station to Caley Avenue to Boston/Clinton Street to Costilla Avenue

Realignment of the Caley and Boston intersection to create a sweeping curve could be accommodated within City of Greenwood Village owned property should traffic conditions warrant this realignment. Additional turn lanes at intersecting streets along this route will be explored as a means to enhance traffic operations. Greenwood Village has already constructed additional turn lanes on Boston and Clinton at Arapahoe Road.

7.2 Arapahoe LRT Station to Caley Avenue to Boston Street to Peakview Avenue to Havana and Arapahoe

Realignment of the Caley and Boston intersection to create a sweeping curve could be accommodated within City of Greenwood Village owned property should traffic conditions warrant this realignment. The route follows the "Serpentine Road" alignment that was planned specifically to divert traffic from the I-25/Arapahoe interchange. Elements of the serpentine road have been completed and some traffic does use it to avoid travel through the busy interchange. Further widening, signal timing and other modification of the route to encourage greater use will be considered.

7.3 Havana Street from Orchard Avenue to Arapahoe Road

Widening of Havana Street is not identified in the Arapahoe County 2035 Transportation Plan. The roadway has been improved to enhance pedestrian and bicycle travel in lieu of additional vehicular travel lanes, generally consistent with Havana Street north of Orchard Avenue in Greenwood Village. Even if widened for additional vehicular capacity, this north/south roadway improvement would provide marginal benefit to east/west traffic operations through the I-25/Arapahoe interchange. No further consideration will be given to this suggested local street improvement.

8 Level 1 Screening

8.1 Level 1 Screening Criteria

Level 1 screening criteria provide a qualitative assessment of each alternatives' consistency with purpose of the proposed action and project objectives. The Level 1 criteria used in the analysis are listed below by category.

- Capacity/Operations/Safety
  - Does the alternative help address current and future traffic needs of the I-25/Arapahoe Road interchange complex, including the Yosemite and Boston/Clinton intersections?

        - A qualitative assessment of additional capacity provided by new infrastructure or diversion of traffic from Arapahoe Road to other new transportation infrastructure improvements.
    - Does the alternative improve vehicular traffic safety of the interchange complex?
        - Qualitative considerations of reduced congestion, elimination of conflicting traffic movements and simplified traffic operations.
    - Can this alternative enhance safe bicycle and pedestrian travel conditions and future transit route opportunities in the interchange complex?
        - This objective qualitatively considers how the new proposed improvement elements address multimodal options.
- Local/Community Impacts
    - Is the alternative sensitive to residential and business areas and community characteristics?
        - This objective considers potential change in traffic characteristics on local neighborhood streets, access from surrounding arterials, and potential change in surrounding land characteristics and necessary commercial parking.
    - Is the alternative compatible with established local plans and visions?
        - This objective considers the proposed improvements within the context of adopted city and county land use and transportation plans for the interchange area.
- Design
    - Is the alternative feasible from an engineering and constructability perspective?
        - This objective compares the proposed alternative design to established CDOT, city and county design standards, as applicable per jurisdiction within which the improvements would occur.
- Environmental Impacts
    - Can environmental impacts be reasonably mitigated?
        - Are the mitigation measures feasible with respect to cost and benefit provided, and compatible with the character of the area?
- Economic Impacts
    - Does the alternative maintain reasonable local access and local economic vitality?
        - Are current local access routes modified, and are the alternative routes out of direction, create additional travel time, and/or require development modifications to mitigate the access change?
    - Does the alternative address bottleneck issues that impact regional economic vitality?
        - Do the proposed improvements address significant regional traffic needs, or simply aid local mobility?
- Cost
    - Can the alternative be constructed in a cost effective manner?
        - Can the alternative be constructed generally within the $83 M identified for the interchange within the DRCOG RTP?

8.2 Level 1 Screening Summary

Tables 4 through 7 provide a summary of the Level 1 analysis of interchange options and supplemental I-25 crossing options, which were evaluated using the criteria presented in **Section 8.1**. The bullets within the tables represent a comparative analysis across each individual criteria, with no weighting of the criteria.

The Single Point Urban Interchange options reevaluated with and without a northbound collector/distributor road did not meet project objectives and were eliminated due to reduced ramp capacity, physical impacts, constructability impacts and high cost.

The two southbound off-ramp sub-alternatives for grade separation over Arapahoe Road lanes were determined to be physically infeasible. The interchange and LRT bridge and abutments limit any substantial grade changes to the southbound off-ramp.

The suggested Personal Rapid Transit system surrounding the interchange would not meet project Purpose and Need. Estimated PRT ridership, when compared to current LRT and bus ridership of the area, would not be sufficient to preclude improvement to the I-25/Arapahoe Road interchange. An expanded system serving a larger area than simply surrounding the I-25/Arapahoe interchange could be considered by others.

Based on public and agency input, a wide range of alternative supplemental I-25 crossings were analyzed. The analysis first focused on the physical feasibility of construction, meeting minimum design requirements. Further analyses addressed the purpose of the I-25/Arapahoe Road Interchange project to reduce congestion and to improve functional deficiencies and operational and safety for the traveling public. The No Action alternative was used as a basis of comparison in the analysis. Based on this analysis, the Improved Partial Cloverleaf without Costilla Crossing, the Improved Partial Cloverleaf with Costilla Crossing and Arapahoe Crossing (Three Level Partial Cloverleaf) alternatives will be carried forward for Level 2 evaluation. All other supplemental crossing alternatives were either physically infeasible or did not meet project objectives. Graphic illustrations of the improvements and the 2035 traffic volumes and level of service for the Level 2 alternatives are included in **Appendix D and E**, respectively.

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Table 4. Level 1 Screening Results – Alternative Locations for Supplemental Crossings of I-25

Category		Level 1 Screening Criteria	Other Suggested Alternative Locations for Supplemental Crossings of I-25								
			Peakview Crossing	Caley Crossing	Connection to Clinton Court (Crossing 1a) & Connection to Costilla (Crossing 1b)		Costilla to Briarwood (Crossing 2a) & Costilla to Alton Way (Crossing 2b)	S of Costilla to Alton Way (Crossing 3)	N of Easter to Alton Way (Crossing 4)	Easter to Alton Way (Crossing 5)	N of Easter Ln to Alton Way (Crossing 6a) & Easter Ln to Alton Way (Crossing 6b)	Geddes to Alton Way (Crossing 7)
Consistency with Purpose & Need/Project Objectives	Capacity/ Operations/ Safety	Does the alternative help address current and future traffic needs of the Arapahoe Road/I-25 interchange complex?	Minor traffic diversion from I-25/Arapahoe interchange complex. Redundant due to proximity to Yosemite Street overpass.	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Alt 1a - Traffic diverted from I-25/ Arapahoe interchange, but without roadway continuity of Alt. 1b.	Alt 1b - Of all supplemental crossing alternatives, diverts the most traffic from I-25/ Arapahoe interchange	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations
		Does the alternative improve vehicular traffic safety?	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection		Alt 2a -Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Alt 2b - Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection	Based solely on estimated magnitude of traffic volume diverted from I-25/ Arapahoe intersection
		Can this alternative enhance safe bicycle and pedestrian travel conditions and future transit route opportunities?	Minimal traffic volume diverted from I-25/ Arapahoe intersection. Two pedestrian crossings of I-25 between Arapahoe and Orchard already exist.	Pedestrian/bike connection a benefit to future City Center development	Provides alternative route across I-25 for pedestrians and bicyclists, and a potential future local transit route with service along Clinton and/or Costilla		Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way	Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way	Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way	Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way	Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way	Provides alternative route across I-25 for pedestrians and bicyclists, but steep grades may not meet ADA requirements, and less likely for future local transit route due to route circuity via Alton Way
	Local Impacts/ Community Impacts	Is the alternative sensitive to residential/ business areas and community character?	New road through a business/ residential area	New road through a business area	New road through a business/ commercial area, disconnected from continuity with Briarwood, but adding traffic to roads adjacent to residential neighborhoods		New connection to Alton Way, directly leading to Briarwood and Xanthia Street create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.	New connection to Alton Way, directly leading to Briarwood and Xanthia Street, create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.	New connection to Alton Way, directly leading to Briarwood and Xanthia Street, create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.	New connection to Alton Way, directly leading to Briarwood and Xanthia Street, create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.	New connection to Alton Way, directly leading to Briarwood and Xanthia Street, create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.	New connection to Alton Way, directly leading to Briarwood and Xanthia Street, create neighborhood connections that are inconsistent with community character. Alton Way is not designed for the level of traffic resulting from the crossing requiring substantial improvements.

NOTE: Analysis summary continued on next page

Legend: High compliance with project objectives; Moderate Compliance with project objectives; Limited Compliance with project objectives; Little compliance with project objectives; Low level of compliance with project objectives

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Table 4 continued. Level 1 Screening Results – Alternative Locations for Supplemental Crossings of I-25

Category		Level 1 Screening Criteria	Other Suggested Alternative Locations for Supplemental Crossings of I-25								
			Peakview Crossing	Caley Crossing	Connection to Clinton Court (Crossing 1a) & Connection to Costilla (Crossing 1b)	Costilla to Briarwood (Crossing 2a) & Costilla to Alton Way (Crossing 2b)	S of Costilla to Alton Way (Crossing 3)	N of Easter to Alton Way (Crossing 4)	Easter to Alton Way (Crossing 5)	N of Easter Ln to Alton Way (Crossing 6a) & Easter Ln to Alton Way (Crossing 6b)	Geddes to Alton Way (Crossing 7)
Consistency with Purpose & Need/ Project Objectives	Local Impacts/ Community Impacts	Is the alternative compatible with established local plans and visions?	Prior review by Greenwood Village identified crossing would be infeasible due to physical constraints	No longer considered a vehicular crossing due to physical constraints and lack of improvement to I-25/ Arapahoe traffic operations	Alt 1a - The crossing is consistent with land use illustrations from the City of Centennial Arapahoe Urban Center Sub-Area Plan, October, 2007 Alt 1b - The crossing is consistent with land use illustrations from the City of Centennial Arapahoe Urban Center Sub-Area Plan, October, 2007 and concepts in the Arapahoe Road Corridor Study, Nov. 2007	New connection to Alton directly leading to Briarwood and Xanthia Street neighborhood connections is inconsistent with community character	New connection to Alton directly leading to Briarwood and Xanthia Street neighborhood connections is inconsistent with community character	New connection to Alton directly leading to Briarwood and Xanthia Street neighborhood connections is inconsistent with community character	New connection to Alton directly leading to Briarwood and Xanthia Street neighborhood connections is inconsistent with community character	New connection to Alton directly leading to Briarwood and Xanthia Street neighborhood connections is inconsistent with community character
	Design	Is the alternative feasible from an engineering and constructability perspective?	Does not meet minimum design criteria	Yes, but requires grade adjustments to intersecting streets	The design is feasible in that it meets minimum design standards for vertical and horizontal grade and curvature	Neither meet minimum design criteria	Does not meet minimum design criteria	Does not meet minimum design criteria	Does not meet minimum design criteria	Does not meet minimum design criteria	Does not meet minimum design criteria
	Environmental Impacts	Can environmental impacts be reasonably mitigated?	Immediately adjacent residential development	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified	No significant environmental impacts have been identified
	Economic Impacts	Does the alternative maintain reasonable local access and economic vitality?	Impacts local access	Minor impacts to local access	Local access can be maintained	Impacts local access	Impacts local access	Impacts local access	Impacts local access	Impacts local access	Impacts local access
		Does the alternative address bottleneck issues that impact regional economic vitality?	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Alt 1a - Diversion of traffic from interchange Alt 1b - Most diversion of traffic from interchange	Alt 2a - Some diversion of traffic from interchange Alt 2b - Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations	Insufficient traffic diversion to benefit Arapahoe/I-25 traffic operations
	Cost	Can the alternative be constructed in a cost effective manner?	Would require reconstruction of Yosemite/ Peakview intersection and Peakview east of I-25 due to differential grades, with construction cost exceeding available funding	Would require reconstruction of Yosemite Street due to differential grades, with construction cost exceeding available funding	Construction cost would exceed available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding	Would require reconstruction of Alton Way and/or Clinton Street at connections to existing street network due to differential grade, with construction cost exceeding available funding
Summary of Results			**Eliminated**: Could not be constructed without significant impacts to existing streets and intersections, and impacts adjacent residential and business development.	**Eliminated**: Does not meet project objectives. Does little to benefit interchange operations with high cost and impacts.	**1a. Eliminated:** Alt 1b alignment with Costilla east of Clinton provides for better local/regional accessibility. **1b. Carried forward:** Level 2 Evaluation.	**Eliminated:** Although Alt 2a moderately meets project Purpose & Need, it is inconsistent with community character. Alt 2b does not meet project objectives. Does little to benefit interchange operations with high cost and impacts.	**Eliminated:** Does not meet design criteria, and does little to benefit interchange operations with high cost and impacts.	**Eliminated:** Does not meet design criteria, and does little to benefit interchange operations with high cost and impacts.	**Eliminated:** Does not meet design criteria, and does little to benefit interchange operations with high cost and impacts.	**Eliminated:** Does not meet design criteria, and does little to benefit interchange operations with high cost and impacts.	**Eliminated**: Does not meet design criteria, and does little to benefit interchange operations with high cost and impacts.

Legend: ○ High compliance with project objectives ◔ Moderate Compliance with project objectives ◒ Limited Compliance with project objectives ◕ Little compliance with project objectives ● Low level of compliance with project objectives

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Table 5. Level 1 Screening Results – Arapahoe Road Crossings of I-25

Category		Level 1 Screening Criteria	Arapahoe Crossing Alternatives			
			Three Level Construction Without Replacing Existing I-25 Bridge	Through Traffic in Covered Lower Level	Through Traffic in Open, Trenched Lower Level	Separated, Trenched Through Lanes on Outside and Local/Ramp Traffic on Middle Level
Consistency with Purpose & Need/Project Objectives	Capacity/ Operations/ Safety	Does the alternative help address current and future traffic needs of the Arapahoe Road/I-25 interchange complex?	Complicated traffic operations and turn restrictions at portals and the Yosemite and Boston/Clinton intersections, resulting in out-of-direction travel and potential neighborhood cut-through traffic	Complicated traffic operations and turn restrictions at portals and the Yosemite and Boston/Clinton intersections, resulting in out-of-direction travel and potential neighborhood cut-through traffic	Complicated traffic operations and turn restrictions at portals and the Yosemite and Boston/Clinton intersections, resulting in out-of-direction travel and potential neighborhood cut-through traffic	Complicated traffic operations and turn restrictions at portals and the Yosemite and Boston/Clinton intersections, resulting in out-of-direction travel and potential neighborhood cut-through traffic
		Does the alternative improve vehicular traffic safety?	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections, but with weaving and merging issues between portal ends and next intersections requiring turn restrictions	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections, but with weaving and merging issues between portal ends and next intersections requiring turn restrictions	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections, but with weaving and merging issues between portal ends and next intersections requiring turn restrictions	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections, but with weaving and merging issues between portal ends and next intersections requiring turn restrictions
		Can this alternative enhance safe bicycle and pedestrian travel conditions and future transit route opportunities?	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections	Reduced traffic volume at Yosemite, I-25 ramps, and Boston/Clinton intersections
	Local Impacts/ Community Impacts	Is the alternative sensitive to residential/ business areas and community character?	Business and residential property impacts and ROW acquisitions required along Arapahoe Road from Greenwood Plaza Blvd/Uinta to Dayton, changing character of adjacent residential neighborhoods and business properties	Business and residential property impacts and ROW acquisitions required along Arapahoe Road from Greenwood Plaza Blvd/Uinta to Dayton, changing character of adjacent residential neighborhoods and business properties	Business and residential property impacts and ROW acquisitions required along Arapahoe Road from Greenwood Plaza Blvd/Uinta to Dayton, changing character of adjacent residential neighborhoods and business properties. Wider cross section than with covered lower level alternative.	Business and residential property impacts and ROW acquisitions required along Arapahoe Road from Greenwood Plaza Blvd/Uinta to Dayton, changing character of adjacent residential neighborhoods and business properties. Widest cross section of the three depressed alternatives.
		Is the alternative compatible with established local plans and visions?	No, creates expressway-type facility with large sign structures, walled infrastructure, limited turns at portal ends, and attracts more through traffic to the higher capacity corridor	No, creates expressway-type facility with large sign structures, walled infrastructure, limited turns at portal ends, and attracts more through traffic to the higher capacity corridor	No, creates expressway-type facility with large sign structures, walled infrastructure, limited turns at portal ends, and attracts more through traffic to the higher capacity corridor	No, creates expressway-type facility with large sign structures, walled infrastructure, limited turns at portal ends, and attracts more through traffic to the higher capacity corridor
	Design	Is the alternative feasible from an engineering and constructability perspective?	Practically infeasible to construct. Existing I-25 bridge is functionally obsolete due to inadequate vertical clearance and lateral distance from travel lanes to bridge piers. The existing bridge piers are built on spread footings and excavation could undermine existing structural stability.	Complicated construction with utility relocations; severe traffic impacts during extended phases of construction, with months of ramp and intersection closures and detours	Complicated construction with utility relocations; severe traffic impacts during extended phases of construction, with months of ramp and intersection closures and detours	Complicated construction with utility relocations; severe traffic impacts during extended phases of construction, with months of ramp and intersection closures and detours
	Environmental Impacts	Can environmental impacts be reasonably mitigated?	Potential neighborhood and water quality impacts, potential air quality benefit	Potential neighborhood and water quality impacts, potential air quality benefit	Potential neighborhood and water quality impacts, potential air quality benefit	Potential neighborhood and water quality impacts, potential air quality benefit
	Economic Impacts	Does the alternative maintain reasonable local access and economic vitality?	Access restrictions, out of direction travel due to turn limitations at Greenwood Plaza/Uinta and Dayton Street, and potential increased neighborhood cut-through traffic	Access restrictions, out of direction travel due to turn limitations at Greenwood Plaza/Uinta and Dayton Street, and potential increased neighborhood cut-through traffic	Access restrictions, out of direction travel, potential increased neighborhood cut-through traffic	Access restrictions, out of direction travel, potential increased neighborhood cut-through traffic
		Does the alternative address bottleneck issues that impact regional economic vitality?	Yes, at immediate interchange intersections but attracts more traffic to corridor and has complicated operations at portal ends	Yes, at immediate interchange intersections but attracts more traffic to corridor and has complicated operations at portal ends	Yes, at immediate interchange intersections but attracts more traffic to corridor and has complicated operations at portal ends	Yes, at immediate interchange intersections but attracts more traffic to corridor and has complicated operations at portal ends
	Cost	Can the alternative be constructed in a cost effective manner?	High cost for structures and drainage, substantially exceeding identified funding	Highest cost for structures and drainage, substantially exceeding identified funding	High cost for structures and drainage, substantially exceeding identified funding	High cost for structures and drainage, substantially exceeding identified funding
Summary of Results			**Eliminated:** Alternative is practically infeasible to construct, is difficult and costly to maintain, and improvement cost substantially exceeds identified funding.	**Eliminated:** Alternative creates complicated traffic operations at portal ends, is difficult and costly to maintain, and improvement is most costly of the Three Level alternatives, substantially exceeding identified funding.	**Carried Forward:** The less costly of the potentially feasible Three Level alternative design concepts. More analysis is needed to consider the complicated traffic operations at portal ends, and confirm improvement costs versus identified funding.	**Eliminated:** Alternative creates complicated traffic operations at portal ends, is difficult and costly to maintain, and improvement cost substantially exceeds identified funding.

Legend: ○ High compliance with project objectives; ◔ Moderate Compliance with project objectives; ◒ Limited Compliance with project objectives; ◕ Little compliance with project objectives; ● Low level of compliance with project objectives

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Table 6. Level 1 Screening Results – Interchange Design Options

Category		Level 1 Screening Criteria	No Action	Improved Partial Cloverleaf		Single Point Urban Interchange (SPUI)		
				without Costilla Crossing	with Costilla Crossing	With Single Ramp-metered On-Ramp	With 2 Lane C/D From Arapahoe to Orchard	With Eastbound to Northbound Loop Ramp
Consistency with Purpose & Need/Project Objectives	Capacity/ Operations/ Safety	Does the alternative help address current and future traffic needs of the Arapahoe Road/I-25 interchange complex?	No	Improved traffic operations versus No Action	Improved traffic operations versus No Action, but with more traffic drawn to interchange complex	Single on-ramp capacity of SPUI less than No Action	Single on-ramp capacity of SPUI less than No Action, but with greater northbound queue storage at ramp meter	Single southbound on-ramp does not serve future traffic needs
		Does the alternative improve vehicular traffic safety?	No	Widened underpass of I-25 and barriers removed for improved emergency vehicle access	Widened underpass of I-25 and barriers removed for improved emergency vehicle access, plus alternate emergency route provided by new crossing	Reduced number of traffic signals and conflict points at Arapahoe Road, but with high volume merging conflicts at on-ramps	Reduced number of traffic signals and conflict points at Arapahoe Road, but with weaving and merging conflicts along high volume C/D road	Confusing combo of SPUI ramps with loop ramp operation requiring eastbound to northbound ramp traffic to stop at SPUI signal
		Can this alternative enhance safe bicycle and pedestrian travel conditions and future transit route opportunities?	No	Widened sidewalks at interchange	Widened sidewalks at interchange, supplemental crossing for ped/bikes and transit to avoid interchange	All ramp traffic must stop at SPUI signal improves ped/bike crossing safety	All ramp traffic must stop at SPUI signal improves ped/bike crossing safety	All ramp traffic must stop at SPUI signal improves ped/bike crossing safety, but crossing traffic does not stop at loop ramp
	Local Impacts/ Community Impacts	Is the alternative sensitive to residential/ business areas and community character?	No	All improvements at interchange, no change in area character	New traffic routing near residential neighborhood, and business acquisitions required	All improvements at interchange, no change in area character	Substantial business impacts and change in character of existing business corridor	Impacts to businesses in southeast quadrant of interchange
		Is the alternative compatible with established local plans and visions?	No	No change beyond immediate interchange	New traffic routing near residential neighborhood, new route consistent with Centennial sub-area development plan concepts	No change in area character	Business acquisitions and impacts are significant along east side of I-25 from Arapahoe to Orchard	Business impacts in southeast quadrant of interchange
	Design	Is the alternative feasible from an engineering and constructability perspective?	N/A	Yes	Some concern with tunneling under LRT and I-25	Constructability concerns with maintenance of traffic during construction of long span bridge for SPUI	Constructability concerns with maintenance of traffic during construction of long span bridge for SPUI, would require reconstruction or design variances to Yosemite overpass and new pedestrian bridge to north	Cannot meet design criteria given vertical and horizontal geometry of I-25 and Arapahoe Road
	Environmental Impacts	Can environmental impacts be reasonably mitigated?	Air quality impact to increasing traffic congestion	Yes	New ROW required, with related environmental impacts	Yes	New ROW required, with related environmental impacts	New ROW required, with related environmental impacts
	Economic Impacts	Does the alternative maintain reasonable local access and economic vitality?	Decreasing accessibility due to congestion	Minimal change to local access, improved levels of congestion	Local mobility and access enhanced by supplemental crossing of I-25	Requires closure of existing access opposite northbound off-ramp that exists due to previous legal challenge	Requires closure of existing access opposite northbound off-ramp that exists due to previous legal challenge	Requires closure of existing access opposite northbound off-ramp that exists due to previous legal challenge
		Does the alternative address bottleneck issues that impact regional economic vitality?	No	Improved traffic operations on Arapahoe Road, but with some remaining congestion	Improved area mobility, but some remaining congestion on Arapahoe Road due to redirected travel	Reduced on-ramp capacity would impact regional business community	Reduced on-ramp capacity would impact regional business community	Reduced southbound on-ramp capacity would impact regional business community
	Cost	Can the alternative be constructed in a cost effective manner?	N/A	Yes	Not within existing identified funding	Not within existing identified funding	Not within existing identified funding	Not within existing identified funding
Summary of Results			**Carried Forward:** Baseline Comparison	**Carried Forward:** Level 2 Evaluation	**Carried Forward:** Level 2 Evaluation	**Eliminated:** Worse LOS than with ParClo alternative; Reduced capacity of single on-ramps; Constructability impacts; Higher cost	**Eliminated:** Greater physical impacts and cost than other better functioning alternatives; Marginal increased capacity of C/D road; Constructability impacts	**Eliminated:** Does not meet design criteria, with greater ROW required and more constructability impacts than ParClo, and does not address operational needs of southbound on-ramp

Legend: High compliance with project objectives; Moderate Compliance with project objectives; Limited Compliance with project objectives; Little compliance with project objectives; Low level of compliance with project objectives

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Table 7. Level 1 Screening Results – Other Suggestions

Category		Level 1 Screening Criteria	Various Potential Arterial Improvements such as:	Other Arterial Street, Intersection and Operational Improvements Suggested by Public			Personal Rapid Transit (PRT) System Around Interchange Complex
			Auxiliary Lanes on Arapahoe and Approach Roads, Signal Coordination and Timing, Add Pedestrian Grade Separations	From Arapahoe LRT Station to Caley Avenue, to Boston/Clinton Street to Costilla Avenue	From Arapahoe LRT Station to Caley Avenue, to Boston Street, to Peakview Avenue, to Havana and Arapahoe Road	From Orchard Road to Havana Street to Arapahoe Road	
Consistency with Purpose & Need/Project Objectives	Capacity/ Operations/ Safety	Does the alternative help address current and future traffic needs of the Arapahoe Road/I-25 interchange complex?	Improvements to approaches, but not at the immediate interchange and ramp intersections	No, but could be a phased element of ultimate area improvements	No, but could be a phased element of ultimate area improvements	No, minimal traffic diverted from the I-25/ Arapahoe interchange	Marginal improvement, only in peak hours
		Does the alternative improve vehicular traffic safety?	Improvements to approaches, but not at the immediate interchange and ramp intersections	Minimal traffic diversion from interchange	Minimal traffic diversion from interchange	Minimal traffic diversion from interchange	Minimal traffic diversion from interchange
		Can this alternative enhance safe bicycle and pedestrian travel conditions and future transit route opportunities?	Improvements to approaches, roads and intersections, grade separated pedestrian crossing eliminates conflicts, but not at the immediate interchange ramp intersections	Minor traffic diversion from interchange complex	Minor traffic diversion from interchange complex	No, would likely impact bikeway along Havana Street and Orchard Road	Yes
	Local Impacts/ Community Impacts	Is the alternative sensitive to residential/ business areas and community character?	Parking and circulation impacts for adjacent businesses	Route already planned to help area traffic circulation	Route already planned to help area traffic circulation	No, Orchard and Havana at ultimate width	New technology, visual impacts
		Is the alternative compatible with established local plans and visions?	Improvements are focused on Arapahoe Road	Route already planned to help area traffic circulation	Route already planned to help area traffic circulation	No, Orchard and Havana at ultimate width	PRT-type system not addressed in local plans
	Design	Is the alternative feasible from an engineering and constructability perspective?	Improvements are focused on Arapahoe Road	Yes	Yes	May require additional ROW	Requires ROW. Uncertainty of feasible crossings of I-25.
	Environmental Impacts	Can environmental impacts be reasonably mitigated?	Improvements are focused on Arapahoe Road	Yes, ROW exists	Impacts to lower income residential	Neighborhood impacts	Visual impacts of elevated system
	Economic Impacts	Does the alternative maintain reasonable local access and economic vitality?	Access details yet to be determined N/A	Yes	Yes	Yes	Yes
		Does the alternative address bottleneck issues that impact regional economic vitality?	Improvements to approaches, but not at the immediate interchange and ramp intersections	Minor traffic diversion from interchange complex	Minor traffic diversion from interchange complex	Minor traffic diversion from interchange complex	Minor traffic diversion from interchange complex
	Cost	Can the alternative be constructed in a cost effective manner?	Uncertainty of ROW costs	Yes, depending on extent of total improvements	Yes, depending on extent of total improvements	Mitigation adds uncertainty to cost	Uncertainty of ROW costs
Summary of Results			**Carried Forward:** For evaluation and consideration as potential phased element of ultimate improvements.	**Carried Forward:** For evaluation and consideration as potential phased element of ultimate improvements.	**Carried Forward:** For evaluation and consideration as potential phased element of ultimate improvements.	**Eliminated:** Improvements to Havana Street would provide marginal benefit to traffic operations at the I-25/ Arapahoe interchange and are inconsistent with local plans .	**Eliminated:** Marginal benefit to traffic operations at the I-25/Arapahoe interchange, and no committed operator.

Legend: ○ High compliance with project objectives ◔ Moderate Compliance with project objectives ◒ Limited Compliance with project objectives ◕ Little compliance with project objectives ● Low level of compliance with project objectives

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8.3 Arterial Improvements

Arterial street, intersection and ramp improvements that could be completed at lower cost prior to full funding of the I-25 bridge replacement will be evaluated. Although these improvements would not fully satisfy the Purpose and Need for the interchange improvement project, sufficient improvements could further extend the useful life of the recently constructed interim improvements. The identified lower cost improvement elements could also be constructed as early phases of the ultimate project improvements.

8.3.1 Arapahoe Road Corridor

The list of lower cost, potential early action improvements along the Arapahoe Road Corridor could include:

- Auxiliary Lanes:
  - An additional westbound lane extending from Dayton Street to the northbound I-25 on-ramp, to separate right turning traffic bound for the northbound on-ramp from the lanes leading to the southbound on-ramp loop
  - An additional westbound lane on Arapahoe Road extending from Yosemite Street to Greenwood Plaza Boulevard with a right turn arrow northbound at Greenwood Plaza Boulevard, and a short westbound right turn lane on Arapahoe Road at Yosemite Street
  - Convert the eastbound right turn lane on Arapahoe Road at Yosemite Street to a shared through/right lane and extend the lane to the west about 300 feet
  - Modification of southbound Greenwood Plaza Boulevard to increase storage for the southbound double left turn lane
  - A second northbound left turn lane on Yosemite Street at Arapahoe Road with complimentary widening of the north leg of Yosemite Street for lane alignment
  - Create an eastbound auxiliary acceleration/deceleration lane extending from the northbound off-ramp to Clinton Street
- Signal Coordination and Timing – Signal system upgrades for the signalized intersections from Quebec Street to Havana Street. [Note: signal timing improvements with no infrastructure improvements is a separate alternative that FHWA requested. Overall signal timing optimization and progression is part of all alternative improvements.]
- Pedestrian Grade Separation –Pedestrian overpasses of Arapahoe Road at Yosemite Street and at Boston/Clinton Street have been suggested as a means to enhance pedestrian accessibility and safety. Eliminating the pedestrian phase from the signalized intersection timing could also benefit Arapahoe Road vehicular traffic flow, if this was feasible to implement. However, it is unlikely that a grade separation can be designed that would fit in the limited available ROW near these two developed intersections, and all at-grade pedestrian crossing physically controlled. East/west crosswalks would still exist at the intersections and any physical barrier to crossing Arapahoe Road at-grade would need to allow for the east/west crosswalk movement to access the Arapahoe Road sidewalk. Pedestrian count data indicates few pedestrian signal actuations now occur in the peak traffic hours, so the benefit to signal timing is negligible.

  Recent counts at intersections along Arapahoe Road west of I-25 conducted in conjunction with the Walnut Hills neighborhood study included pedestrian count data. The results of those counts, conducted on April 6, 2011 are listed in the following table.

	AM Peak Hour		PM Peak Hour	
	West Crosswalk	East Crosswalk	West Crosswalk	East Crosswalk
Crossing Arapahoe at Yosemite St.	4	2	1	2
Crossing Arapahoe at Uinta/Greenwood Plaza Blvd.	3	4	1	4
Crossing Arapahoe at Spruce St.	0	5	0	2

Although pedestrian count data was not obtained at the Boston/Clinton intersection, very similar levels of pedestrian activity have been observed during observations of intersection traffic operations. The extremely low levels of pedestrian activity indicate that it would be difficult to justify the suggested pedestrian grade separations over Arapahoe Road at Yosemite Street and at Boston/Clinton Street.

8.3.2 Other Area Roadway Improvements

Further consideration will be given to short-term, lower cost improvements to other area roadways. These potential improvements may be considered as complimentary phased construction of the ultimate improvement recommendations that could extend the operational life of the recent interchange improvements by diverting traffic from the interchange. It is not anticipated that these improvements would substitute for the ultimate need for major interchange reconstruction.

The area roadways to be considered for improvement include the realignment of Caley Avenue and Boston Street to create a sweeping curve, consistent with previous plans by Greenwood Village. Additional auxiliary lanes and signal timing or other operational improvements along Caley Avenue, Boston Street, and Peakview Avenue east to the Havana/Arapahoe intersection could also be considered. This is consistent with the "serpentine road" improvements initiated by Greenwood Village. Directional signage for use of Xanthia Street by northbound Yosemite Street to I-25 traffic would also be considered.

9 Level 2 Screening

9.1 Level 2 Screening Criteria

Level 2 screening criteria provide a more qualitative assessment of the remaining alternatives' consistency with purpose and need and project objectives. The Level 2 criteria used in the analysis are listed below by category.

- Capacity/Operations
  - Corridor intersection LOS/overall intersection delay (2035 AM and PM peak hour)
- Safety
  - Turn restrictions, weaving considerations
  - Pedestrian and bicycle accommodations

- Local/Community Impacts
  - Construction impacts (length of construction period and ability to phase)
  - Potential for increase in traffic through Walnut Hills neighborhood
  - Business parking and access impacts
  - Reduced business visibility
- Environmental Impacts
  - Number of partial property impacts
  - Number of full property acquisitions/relocations (residential/business)
  - Number of potential noise sensitive receivers adjacent to improvements (i.e., parks, residences, hotels, medical facilities)
  - Water quality (acres of increased impervious area)
- Cost
  - Construction cost (2010 dollars)
  - Right-of-way costs
  - Total cost
  - Cost within identified funding

9.2 Level 2 Screening Summary

Table 8 provides a summary of the Level 2 analysis of the improvement alternatives forwarded from the Level 1 analysis for further evaluation. The Level 2 evaluation criteria presented in **Section 9.1** was used for this analysis. The No Action alternative was again used as a basis of comparison for each action alternative's ability to reduce congestion, improve functional deficiencies, and improve traffic operations and safety within the interchange complex. The bullets within the tables represent a comparative analysis across each individual criteria, with no weighting of the criteria.

The quantitative Level 2 analysis reconfirmed the operational benefits of the Improved Partial Cloverleaf interchange alternative, and its ability to be constructed in phases with minimal impacts and generally within available funding. **Appendix F** provides information on the construction phasing general approach.

Analysis of both the Improved Partial Cloverleaf with Costilla Crossing and the Three Level Partial Cloverleaf indicates insufficient improvement to traffic operations within the interchange complex to justify the additional impacts to area businesses and residences. Although the Improved Partial Cloverleaf with Costilla Crossing would increase mobility in the area south of I-25, only a small volume of traffic is forecasted to be diverted from Arapahoe Road through the interchange. With the Three Level Partial Cloverleaf, although through traffic would be removed from the Yosemite and Boston/Clinton intersections, a substantial amount of traffic would still travel through the intersections, traveling to/from Yosemite Street, the I-25 ramps and Boston/Clinton Streets. Further, the cost of constructing these two alternatives is substantially beyond the available foreseeable funding identified for the interchange in the 2035 Regional Transportation Plan.

Subsequent to Level 2 analysis, the City of Centennial requested additional analysis of the Diverging Diamond Interchange (DDI) concept. A summary of that analysis is provided in **Appendix G**. The findings of that additional analysis is that the DDI configuration, reconstruction phasing requirements and proposed laneage would be insufficient to serve the

projected traffic demands at the I-25/Arapahoe interchange and be ineffective at substantially reducing overall construction cost.

Based on the analysis of alternative I-25 crossings, other interchange improvements and transit alternatives, the following alternatives are recommended for further analysis through the Environmental Assessment of the I-25/Arapahoe Road interchange:

- No Action
- Partial Cloverleaf improvements focused at the I-25/Arapahoe interchange

Short-term improvements to signal timings, traffic operations, auxiliary turn lane improvements, signing and pavement markings will be examined as potential for phased implementation of the recommended improvements to the interchange complex.

A description of each of these alternatives is provided in the following sections.

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Table 8. Level 2 Evaluation Results

	Category	Level 2 Interchange Evaluation Criteria	No Action	Improved Partial Cloverleaf without Costilla Crossing	Improved Partial Cloverleaf with Costilla Crossing	Three Level Partial Cloverleaf
Consistency with Purpose and Need / Project Objectives	Capacity/ Operations	Corridor intersection LOS*/Overall intersection delay (sec/veh) - 2035 AM Peak Hour**	GPB/Uinta: D / 50.8 Yosemite: E / 69.5 SB Off-ramp: E / 60.9 NB Off-ramp: E / 60.8 Boston/Clinton: C / 24.2 Dayton: C / 32.4	GPB/Uinta: B / 19.1 (+) Yosemite: E / 57.4 (+) SB Off-ramp: C / 27.4 (+) NB Off-ramp: C / 33.5 (+) Boston/Clinton: C / 28.2 (-) Dayton: C / 33.4	GPB/Uinta: C / 21.3 (+) Yosemite: D / 51.8 (+) SB Off-ramp: C / 25.9 (+) NB Off-ramp: C / 28.2 (+) Boston/Clinton: C / 28.2 (-) Dayton: E / 59.5 (-)	GPB/Uinta: C / 26.4 (+) Yosemite: E / 59.3 (+) SB Off-ramp: C / 22.6 (+) NB Off-ramp: D / 44.5 (+) Boston/Clinton: C / 35.0 (-) Dayton: C / 32.3
		Corridor intersection LOS/Overall intersection delay (sec/veh) - 2035 PM Peak Hour**	GPB/Uinta: F / 98.7 Yosemite: F / 181.5 SB Off-ramp: C / 27.9 NB Off-ramp: C / 34.5 Boston/Clinton: D / 48.7 Dayton: D / 42.7	GPB/Uinta: F / 98.9 Yosemite: F / 152.6 (+) SB Off-ramp: C / 22.7 (+) NB Off-ramp: B / 19.5 (+) Boston/Clinton: D / 40.2 (+) Dayton: D / 39.6	GPB/Uinta: F / 110.7 (-) Yosemite: F / 132.5 (+) SB Off-ramp: C / 21.2 (+) NB Off-ramp: B / 18.2 (+) Boston/Clinton: D / 39.1 (+) Dayton: E / 57.7 (-)	GPB/Uinta: E / 69.0 (+) Yosemite: F / 173.0 SB Off-ramp: D / 38.2 (-) NB Off-ramp: D / 37.8 (+) Boston/Clinton: D / 53.2 Dayton: D / 54.5 (-)
		Summary	Over capacity intersection and congested operations due to increasing traffic volumes	Generally improves peak hour congestion versus No Action	Improves ramp delay, but with increased congestion for turning movements at Boston/Clinton and Dayton in peak hours. However, less problematic in off peak.	Limited benefits to peak hour congestion due to redistribution of restricted turning movements and insufficient lanes for ramp and adjacent intersection turning traffic
	Safety	Turn restrictions, weaving considerations	No turn restrictions. Some weaving occurs between SB off-ramp and WB Yosemite left turn.	No turn restrictions. Weave from SB off-ramp to WB Yosemite would remain, but reduced congestion would facilitate movements.	No turn restrictions. Redistribution of some traffic movements due to new I-25 crossing would benefit some traffic movements but impact others.	Turns would be restricted at Uinta/Greenwood Plaza Boulevard, Yosemite and Boston/Clinton, resulting in increased turn volumes at other intersections, within private properties, and u-turn maneuvers.
		Pedestrian and bicycle accommodations	No improvement from existing conditions	Wider sidewalks and/or multi-use trail provided along Arapahoe, but vehicular conflicts at intersections would remain.	Wider sidewalks and/or multi-use trail provided along Arapahoe, but vehicular conflicts at I-25 intersections would remain. Costilla crossing would provide multi-use path and bike lanes for comfortable pedestrian and bicycle travel across I-25 on a corridor with collector-level traffic volumes.	Wider sidewalks and/or multi-use trail provided along Arapahoe on outside at intersection level, but vehicular conflicts at intersections would remain. Depressed level cross-section would be widened for pedestrian refuge/escape during emergencies.
	Local/ Community Impacts	Construction impacts (length of construction period and ability to phase)	N/A	Approximately 18 months. Arterial improvements could be completed as early phase.	Approximately 18 to 24 months. Arterial improvements, including Costilla Crossing, could be completed as early phase, providing a detour route for some traffic during interchange construction.	Approximately 24 months. Difficult to build depressed lanes and maintain Arapahoe Road traffic during construction.

LEGEND: (+) = improved LOS by at least one letter or decreased delay by more than 10% versus No Action
(-) = degraded LOS by at least one letter or increased delay more than 10% versus No Action

○ High compliance with project objectives ◔ Moderate Compliance with project objectives ◒ Limited Compliance with project objectives ◕ Little compliance with project objectives ● Low level of compliance with project objectives

* Note: Level of Service (LOS) is a measure of the quality of traffic flow and level of congestion on a roadway or intersection, measured on a scale from A to F. For signalized intersections, LOS is defined by the average control delay per vehicle. LOS A indicates very low control delay, averaging less than ten seconds per vehicle. LOS F indicates highly congested conditions with control delay in excess of 80 seconds per vehicle at the intersection. LOS D or better is often viewed as the realistic optimal operation for peak hour level of service in urbanized areas.

** Note: Capacity analysis is based on laneage illustrated in Appendix D graphics.

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Table 8 continued. Level 2 Evaluation Results

	Category	Level 2 Interchange Evaluation Criteria	No Action	Improved Partial Cloverleaf without Costilla Crossing	Improved Partial Cloverleaf with Costilla Crossing	Three Level Partial Cloverleaf
Consistency with Purpose and Need / Project Objectives	Local/ Community Impacts	Potential for increase in traffic through Walnut Hills neighborhood	Cut-through travel is not significant, but peak hour cut-through travel may increase between GPB/Uinta to Briarwood/Yosemite as area traffic congestion worsens	Decrease in delay through the interchange may reduce desire of through traffic to cut through neighborhood	Decrease in delay through the interchange may reduce desire of through traffic to cut through neighborhood, but Costilla crossing may increase travel of neighborhood residents through neighborhood to access Yosemite Street	Decrease in delay through the interchange may reduce desire of through traffic to cut through neighborhood, but turn restrictions at Yosemite Street and Uinta/Greenwood Plaza Boulevard may increase travel through the neighborhood
		Business parking and access impacts	Congested operations reduces business accessibility	Parking impacts at 10 businesses, direct access to NW quadrant impacted	Parking impacts at 17 businesses, direct access to NW quadrant impacted	Parking impacts at 16 businesses, access limitations at Clinton Court and Yosemite Court intersections
		Reduced business visibility	No change	No change	Diverted traffic to Costilla crossing on new route, a potential benefit for future redevelopment	Arapahoe Road through traffic in lower level with reduced visibility of adjacent businesses
	Environmental Impacts	# potential property impacts	0	ROW needed from 8 residential and 26 business properties	ROW needed from 8 residential and 35 business properties	ROW needed from 3 residential and 31 business properties
		# full property acquisitions/relocations	0	No full acquisitions anticipated	2 business properties acquired	8 residential and 2 business properties acquired
		# potential noise sensitive receivers adjacent to improvements (i.e., parks, residences, hotels, medical facilities)	0	13 residences and 2 hotels near improvements	16 residences and 4 hotels near improvements	11 residences and 2 hotels near improvements
		Water quality (acres of increased impervious area)	No change	0.7 Acres	1 Acre	7 Acres
	Cost	Construction cost ($ 2010)	N/A	$63 M	$94 M	$172 M
		Right-of-way costs	N/A	$2 M	$26 M	$27 M
		Total cost*	N/A	$65 M	$120 M	$199 M
		Cost within identified funding	N/A	Yes	No	No
Summary of Results			**Carried Forward:** Baseline comparison	**Carried Forward:** Alternative results in improved traffic operations with minimal impacts, and total cost within available funding	**Eliminated:** Insufficient operational improvement benefit to justify impacts, and total cost beyond available funding	**Eliminated:** Insufficient operational improvement benefit to justify impacts, and total cost beyond available funding

LEGEND: (+) = improved LOS by at least one letter or decreased delay by more than 10% versus No Action
(-) = degraded LOS by at least one letter or increased delay more than 10% versus No Action

High compliance with project objectives | Moderate Compliance with project objectives | Limited Compliance with project objectives | Little compliance with project objectives | Low level of compliance with project objectives

* Note: Other complimentary arterial system improvements within the interchange complex have yet to be defined, which will add to the total construction cost for the recommended alternative.

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9.3 No Action

Under the No Action alternative, no further improvements would be made to the I-25/Arapahoe Road interchange. The cities and County may make subsequent modifications to nearby intersecting streets and intersections using local funds, but no improvements would be made to the I-25 bridge, ramps or to Arapahoe Road within the interchange.

9.4 Improved Partial Cloverleaf Interchange Alternative

Components of the conceptual design for the interchange, including local access, major intersection design along Arapahoe Road, and movements to/from I-25, are discussed below.

I-25 Mainline: I-25 will be designed to meet the requirements of the typical section, which includes five twelve-foot through lanes in each direction, ten-foot inside and outside shoulders, a two-foot wide concrete median barrier and twelve-foot acceleration/deceleration lanes, where required. Because the improvements are generally located within the existing interchange footprint, the existing interchange ramp merges and diverges along I-25 will remain in the current locations along I-25 and the existing lane add/drop configurations will not be modified. The alignment of northbound I-25 mainline lanes may need to shift slightly to the east to accommodate phased reconstruction of the I-25 bridge over Arapahoe Road and maintain I-25 traffic lanes during construction.

I-25 Ramps: The interchange ramps will be designed to accommodate the 2035 traffic volume projections discussed earlier in this report. The entrance ramps will provide one lane access to I-25, narrowing from two lanes at the ramp meter locations. The ramps will include a four-foot left shoulder, a fifteen-foot wide lane, and a minimum six-foot right shoulder. The exit ramps will consist of two lanes, diverging I-25 as a drop lane and an option lane approaching the ramp gore. The southbound off-ramp will be modified to allow triple left turns by modification of the right turn median.

Arapahoe Road: Arapahoe Road will be designed to meet the requirements of CDOT and local agency standard specifications. Auxiliary lane improvements will consider the operational benefits versus cost of these potential short-term improvements summarized in **Section 8.3.1**.

The operational benefits and physical impacts of proposed local access modifications will be further assessed, particularly the operational benefits and impacts of modification of the Yosemite Court right-in/right-out access just west of the interchange, and the frontage road alignment and movements at the intersection opposite the northbound off-ramp. Sidewalks along both the north and south sides of Arapahoe Road from Yosemite Street, through the interchange, to the Boston/Clinton Street intersection will be included.

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Appendix A
Design Criteria

Arapahoe & I-25 EA Roadway Design Criteria

11/24/2010

HARTWIG & Associates, Inc.

DESIGN ELEMENT		Standards Applied: I-25	Ramps	Arapahoe Road	Design Criteria Reference
Roadway Classification					
General					
Roadway Classification		Interstate - Urban	Interchange Ramps	Urban Atterial	
Access Control Classification		Interstate (Full)			
Design Speed					
	Minimum (MPH)	70	60/50/35	45	
	Desirable (MPH)	75	65/55/40	45	AASHTO 2004, Exhibit 10-56 / Low Speed Urban Design, Pg. 148
	Loop Ramps (MPH)		25		
Posted Speed Limit Minimum (MPH)		65	n/a	40	Maintaining Existing Conditions
Design Vehicle		WB-67	WB-67	WB-67	AASHTO 2004, Pg. 18
Horizontal Alignment Criteria					
Curve Radius For Design Speed Minimum (Ft.)		2040'	1330'/833'/340'	1040'	AASHTO 2004 Exhibit 3-26, Pg. 168 / Exhibit 3-16 Normal Crown -2%
Curve Radius For Design Speed Desirable (Ft.)		2500'	1660'/1060'/485'	1040'	AASHTO 2004 Exhibit 3-26, Pg. 168 / Exhibit 3-16 Normal Crown -2%
Superelevation (e_{max})		6%	6%	Normal Crown	CDOT 2005 Design Guide Sec. 8.1.6
Max. Degree of Curve - Design Speed Minimum (Calculated)		2.81	4.31	5.51	DC = 5729.6/R
Max. Degree of Curve - Design Speed Desirable (Calculated)		2.29	3.45	5.51	DC = 5729.6/R
Cross Slope - Normal		2%	2%	-2% (Normal Crown)	CDOT 2005 Design Guide Sec. 4.1.2
Maximum Algebraic Difference at Crossover Line (%)		4 to 5%	4 to 5%	4 to 5%	AASHTO 2004 Exhibit 9-49, Pg. 648
Clear Zone (On Tangent)					
	Minimum	30'	20'	14'	AASHTO 2004, table 3.1 pg. 3-6
	Desirable	34'	22'	16'	AASHTO 2004, table 3.1 pg. 3-6
Clear Zone (On Curve)					
	Minimum	39'	28'	17'	AASHTO 2004, table 3.2 pg. 3-7
	Desirable	44'	31'	19'	AASHTO 2004, table 3.2 pg. 3-7
Lane Width (Ft.)		12'	12' (2 lanes) 15' (1 lane)	12	AASHTO 2004 Exhibit 10-67, Pg. 839
Shoulder Widths					
	Left Inside (Ft.)	12'	4'	n/a	
	Right Outside (Ft.)	12'	6'-8'	n/a	AASHTO 2004 Exhibit pg. 838-840
Curb and Gutter Type		n/a	Type 2 (Section I-B, II-B)	Type 2 (Section I-B, II-B)	CDOT M & S Standards, 2006, M-609-1
Side Ditches					
	Z slope (6:1)	12'	12'	2'	CDOT 2005 Design Guide Table 4-2
	Fill Slope	4:1	4:1	4:1	CDOT 2005 Design Guide Table 4-2
	Cut Slope	4:1	4:1	4:1	CDOT 2005 Design Guide Table 4-2
Redirect Taper (Ft.)		65:1 min.	30:1 min.	30:1 min.	State of CO State Highway Access Code Pg.57
Transition Taper for Accel/Decel Lanes		25:1 min.	12:1 min.	12:1 min.	State of CO State Highway Access Code, Table 4-6
Taper Length Roadway Lane Drop		70:1 Desirable 50:1 min.			AASHTO 2004, pg. 818
Vertical Alignment Criteria					
Maximum Grade (Rolling)		4%	5%	6%	CDOT 2005 Design Guide Pg. 3-33, Table 3-4, 10-26, 10.6.4 Ramp Profiles
Minimum Grade		0.5%	0.5%	0.5%	CDOT 2005 Design Guide Pg. 3-32
Min. Vertical Grade Break without a Curve		0.20%	0.20%	0.20%	CDOT 2005 Design Guide Sec. 3.3.4
Min. Vertical Curve Length (Ft.)		300'	120'	120'	CDOT 2005 Design Guide Pg. 3-35, 3x Design Speed
K-Value Ranges					
	Crest VC (Minimum)	247	84	61	AASHTO 2004 Exhibit 3-73, Pg. 272
	Crest VC (Desirable)	312	114	61	AASHTO 2004 Exhibit 3-73, Pg. 272
	Sag VC (Minimum)	181	96	79	AASHTO 2004 Exhibit 3-75, Pg. 277
	Sag VC (Desirable)	206	115	79	AASHTO 2004 Exhibit 3-75, Pg. 277
Sight Distances					
Min. Stopping Sight Distance (Ft.) Minimum					

Arapahoe & I-25 EA Roadway Design Criteria

11/24/2010

HARTWIG & Associates, Inc.

DESIGN ELEMENT	Standards Applied	I-25	Ramps	Arapahoe Road	Design Criteria Reference
Roadway Classification					
	Level	730'	425'	360'	AASHTO 2004 Exhibit 3-1, Pg. 112
	3% Downgrade	771'	446'	378'	AASHTO 2004 Exhibit 3-2, Pg. 115
	3% Upgrade	690'	405'	344'	AASHTO 2004 Exhibit 3-2, Pg. 115
Interchanges Parallel Type Ent./Ex. Terminals					
Taper Length Taper Entrance Terminal (L>1300 Ft.)		between 50:1 & 70:1	n/a	n/a	CDOT 2005 DG Table 10-7 & Figure 10-11A & Figure 10-12
Taper Length Parallel Entrance Terminal (L<1300 Ft.)		300' Minimum	n/a	n/a	CDOT 2005 DG Table 10-7 & Figure 10-11B
Taper Length Parallel Exit Terminal		between 15:1 & 25:1	n/a	n/a	CDOT 2005 Design Guide Figure 10-15
Structure Clearance Criteria					
Highway Underpass Vertical (Ft.)		16.5'	16.5'	16.5'	CDOT 2005 Design Guide Table 3-3
Local Road Underpass Vertical (Ft.)		16.5'	16.5'	16.5'	CDOT 2005 Design Guide Table 3-3
Sign Structures (Ft.)		17.5'	17.5'	17.5'	CDOT 2005 Design Guide Table 3-3
Overhead Power Lines Vertical (Ft.)		20.5 to 21.5	20.5 to 21.5	20.5 to 21.5	CDOT 2005 Design Guide Table 3-3

Appendix B
Travel Forecast and Origin/Destination Analysis

TRAFFIC FORECASTS FOR ALTERNATIVE I-25 CROSSINGS

Alternative Forecasts

The regional travel demand model was used to forecast traffic conditions for new or improved crossings of I-25. All analyses reflect changes to the land use forecasts proposed by the Cities of Centennial and Greenwood Village, and Arapahoe County, and accepted by the Denver Regional Council of Governments (DRCOG). **Table B-1** shows the No Action 2035 daily traffic forecasts on the existing Arapahoe Road, Orchard Road, Yosemite Street, and Dry Creek Road crossings of I-25.

Table B-1. No Action 2035 Traffic Forecasts

I-25 Crossing	Baseline 2035 Daily Traffic Forecast
Arapahoe Road	75,700
Orchard Road	42,600
Yosemite Street	35,100
Dry Creek Road	42,800

Year 2035 model runs were prepared for six alternative new or improved crossings of I-25, including:

1. **Costilla Crossing** – A new 4-lane collector street connecting between Yosemite Street on the west and the Clinton Street intersection with Costilla Avenue on the east.
2. **Orchard Widening** – Widen Orchard Road by one lane in each direction between Quebec Street on the west and DTC Boulevard/Yosemite Street on the east
3. **Caley Crossing** – A new 4-lane collector street connecting between Fiddlers Green Circle on the west and Yosemite Street on the east
4. **Peakview Crossing** – A new 4-lane collector street connecting between Fiddlers Green Circle on the west and Boston Street on the east
5. **Easter Crossing** – A new 4-lane collector street connecting between Yosemite Street via an improved South Alton Way on the west and the Clinton Street intersection with Easter Avenue on the east.
6. **Arapahoe Crossing** – A 4-lane underpass constructed under the Arapahoe Road/I-25 interchange allowing traffic from west of Yosemite Street to east of Boston/Clinton Street (and the reverse movement) to travel underneath Arapahoe Road and bypass the Yosemite Street, Boston/Clinton Street, and I-25 ramp signalized intersections.

The purpose of this forecasting exercise was to evaluate the effects on traffic patterns of different improvement alternatives, particularly with respect to relief of Arapahoe Road. The selection of these alternative crossing locations for testing does not imply that each one has been determined to be a viable alternative; some of the connections would have significant issues with respect to grades and construction or environmental constraints. Multiple design variations to these crossing locations were suggested by public and agency stakeholders. The six locations analyzed with the 2035 model runs are representative of the magnitude of traffic of the similar nearby crossing alternatives.

Table B-2 shows the results of the 2035 forecasts for the six alternatives. The table shows the daily traffic forecast for each of the new and improved connections and the reduction in traffic that is forecast on the existing I-25 crossings as a result of the new or improved connections.

Table B-2. Forecasted Effects of Alternative I-25 Crossings

Alternative	Forecasted Volume	Change in Daily Volume Forecast on Existing Crossings of I-25 Due to Alternative			
		Arapahoe	Orchard	Yosemite	Dry Creek
1. Costilla Crossing	14,000	-5,800	-300	-1,200	-2,500
2. Orchard Widening	47,800	-500	+5,200	-1,500	-300
3. Caley Crossing	9,000	-400	-1,500	-4,900	-100
4. Peakview Crossing	6,600	-2,900	-300	-1,000	-500
5. Easter Crossing	10,000	-2,900	-200	-500	-2,100
6. Arapahoe Crossing	27,600	-19,800	-500	-1,600	-1,200

Following are observations about each of the alternate crossings based on forecasts summarized in Table B-2:

1. **Costilla Crossing** – The connection is forecast to attract 14,000 vehicles per day (vpd). Other than the Arapahoe Bypass alternative, the Costilla Crossing would provide the greatest relief for Arapahoe Road, reducing daily traffic by an estimated 5,800 vpd or about 8%. An alternative model run was performed with the Costilla Crossing upgraded from a collector-level street to a minor arterial and with the movement between Costilla and Yosemite Street to the north being smoothed; this upgraded connection was forecasted to provide approximately an additional 1,000 vpd relief to Arapahoe Road.
2. **Orchard Widening** – Adding lanes to Orchard Road across I-25 is forecast to attract more than 5,000 additional vpd to the road, but it would provide little relief to Arapahoe Road. Since little relief is provided to the I-25/Arapahoe interchange, widening Orchard Road would not meet the Purpose and Need for this project.
3. **Caley Crossing** – A Caley Avenue connection is forecast to carry approximately 9,000 vpd, but most of the relief would be received by Yosemite Street and Orchard Road, with little effect on Arapahoe Road.
4. **Peakview Crossing** – A Peakview Avenue connection is forecast to attract less than half of the traffic and provide approximately half of the relief to Arapahoe Road compared with the Costilla Crossing.
5. **Easter Crossing** – Forecasts for the Easter Connection show that the further south alternate crossings provide decreasing relief to Arapahoe Road and increasing relief to Dry Creek Road.
6. **Arapahoe Crossing** – Approximately one third of the traffic on Arapahoe Road, over 27,000 vpd, is projected to be through traffic that could use the bypass to travel from west of Yosemite Street to east of Boston/Clinton Street. An estimated 56,200 vph would use Arapahoe Road at the interchange at-grade. Most of this bypass traffic would result in a reduction of through traffic on Arapahoe Road through the I-25 interchange; however, some of the bypass traffic would be drawn from other routes to the Arapahoe Road Corridor because of the additional capacity and improved speeds for through traffic.

Costilla Crossing Analysis

Origin-Destination Analysis

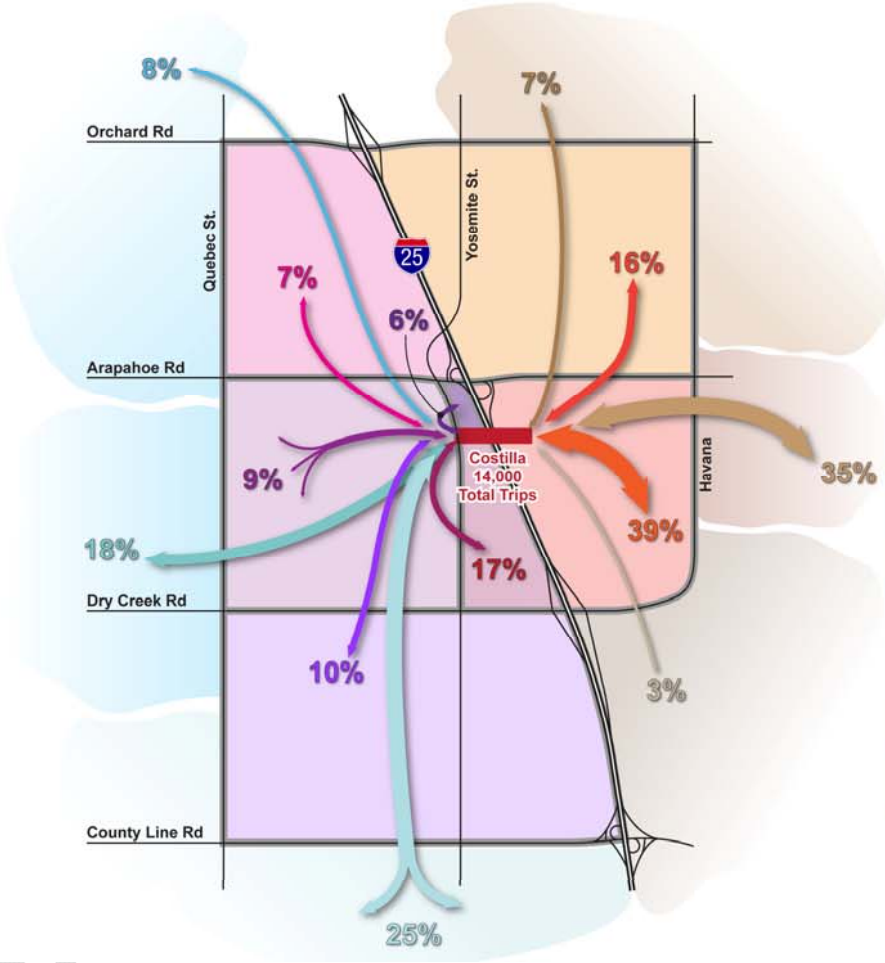
To evaluate the origin and destination patterns of vehicles that would use a Costilla Crossing, a select link analysis was conducted using the 2035 travel demand model. A select link analysis is a modeling tool that looks at a specific roadway segment and determines where trips using that segment would begin and end. **Figure B-1** shows the results of a select link analysis of a Costilla Crossing under I-25. The graphic depicts locations of origins and destinations of trips that are projected to use a Costilla Crossing. The percentages shown on the map, and on the tables on either side of the map, show the estimated proportion of Costilla Crossing trips that would have origins or destinations in each colored area.

Following are highlights of the findings from the analysis:

- On the west end, 49% of the trips using the Costilla Crossing would come from the local areas between Orchard Road, I-25, County Line Road and Quebec Street. This includes 23% to the commercial areas immediately north and south of the crossing, between Yosemite Street and I-25.
- On the east end, 55% of the trips using the Costilla Crossing would come from the local area between I-25, Orchard Road, Havana Street and Dry Creek Road.
- On the west end, of the 51% of trips to and from areas outside of the local area, the most common origins and destinations (25%) would be in the south, including trips to and from C-470 and other southern routes.
- On the east end, of the 45% of trips to and from areas outside of the local area, the most common origins and destinations (35%) would be in the east, including trips to and from Arapahoe Road and Broncos Parkway.

Figure B-1. Costilla Crossing Trip Origins and Destinations

West Side Origins/Destinations of Costilla Crossing Trips	
Area (Boundaries)	**% of Trips**
Immediate North Area (Arapahoe, I-25, Costilla, Yosemite)	6%
Immediate South Area (Costilla, I-25, Dry Creek, Yosemite)	17%
Local Area West (Arapahoe, Yosemite, Dry Creek, Quebec)	9%
Local Area North (Orchard, I-25 Arapahoe, Quebec)	7%
Local Area South (Dry Creek, I-25, County Line, Quebec)	10%
LOCAL AREA SUBTOTAL	*49%*
Other Areas North/Northwest	8%
Other Areas West	18%
Other Areas South/Southwest	25%
TOTAL	*100%*



East Side Origins/Destinations of Costilla Crossing Trips	
Area (Boundaries)	**% of Trips**
Local Area East (Arapahoe, Havana, Dry Creek, I-25)	39%
Local Area North (Orchard, Havana, Arapahoe, I-25)	16%
LOCAL AREA SUBTOTAL	*55%*
Other Areas North/Northeast	7%
Other Areas East	35%
Other Areas South/Southeast	3%
TOTAL	*100%*

Traffic Effects on I-25 Crossings

Based on Level 1 screening, additional analysis was conducted of the Costilla Avenue Crossing alternative. **Table B-3** has been developed to evaluate the effects on Arapahoe Road and other I-25 crossings with the construction of the Costilla Crossing. The table provides the 2035 forecasted daily volume anticipated on the Costilla Crossing as well as the daily net effects to other I-25 crossings north and south of the Arapahoe Road interchange. A greater diversion of traffic would be anticipated in peak traffic hours than in non-peak hours, as traffic would be looking for an alternative route to avoid I-25 interchange congestion.

Table B-3. Forecasted Effects of Costilla Crossing

I-25 Crossing	Change in Daily Volume Forecast on Existing Crossings of I-25 Due to Costilla Crossing	Cumulative Change in Daily Volume Forecast
I-225	-200	North: -1,900
Union	-200	
Belleview	-50	
Orchard	-300	
Yosemite	-1,150	
Arapahoe	-5,800	Arapahoe: -5,800
Costilla	+14,000	Costilla: +14,000
Dry Creek	-2,500	South: -3,450
County Line	-600	
C-470/E-470	-250	
Lincoln	-50	
Ridgegate	-50	

Based on the results summarized in Table B-3, the effects of the Costilla Crossing on Arapahoe Road and other I-25 crossings can be described.

- 14,000 vehicles per day (vpd) are forecasted on the new Costilla Crossing
- 7,700 vpd are forecast to be reduced on I-25 crossings north of the Costilla Crossing, including 5,800 vpd on Arapahoe Road
- 3,450 vpd are forecast to be reduced on I-25 crossings south of the Costilla Crossing
- Of the 14,000 vpd forecast on Costilla, 2,850 vpd are not accounted for in reductions on other routes shown on Table B-3. This estimated 2,850 vpd results from changes in trip patterns due to the Costilla Crossing. For example, prior to the addition of the Costilla Crossing, a resident who lives west of I-25 and is looking for a convenient store may choose to patronize a location on the same side (west) of the interstate, in order to avoid the congestion surrounding the Arapahoe Road interchange. With the addition of the Costilla Crossing, new shopping destinations with the same convenience would be newly available, and the west side resident may now choose to patronize a similar store on the east side of I-25. This type of destination change represents trip pattern change due to shorter travel times afforded by the supplemental crossing.

- A net reduction of 5,800 vpd is forecast on Arapahoe Road due to the Costilla Crossing. The relief to Arapahoe Road provided by the Costilla Crossing would free up some traffic carrying capacity on Arapahoe Road resulting in relief to other routes to the north and south (i.e., traffic backfilling Arapahoe Road).

Effects on North-South Traffic

In addition to relief provided to other east-west roadways including Arapahoe Road, the Costilla Crossing would have some effect on traffic on north-south roadways.

- The forecasted effect of the Costilla Crossing on Yosemite Street traffic is an approximate 5% reduction between Arapahoe Road and Costilla and an approximate 10% increase between Costilla and Dry Creek Road. Reduced traffic volume and improved level of service at the Arapahoe/Yosemite intersection could help reduce PM peak hour cut-through traffic southbound from Uinta to Briarwood.
- On Clinton Street, the Costilla Crossing is projected to cause approximately a 6% reduction in traffic between Costilla and Arapahoe Road and an approximate 9% increase on Clinton Street south of Costilla.
- Traffic volume changes on other north-south streets farther from I-25, including Quebec Street and Havana Street are forecasted to be only in the range of 0% to 5%, with small reductions on Quebec Street and increases on Havana Street.

Arapahoe Crossing Analysis

Effects on East-West Traffic

Forecast daily traffic volumes have been evaluated for the Arapahoe Road corridor along the proposed depressed section. During the modeling of the three level alternative, a four lane depressed section for through traffic was modeled. **Table B-4** provides the forecast vehicles per day (vpd) for the No Action scenario along with the new Three Level Alternative along Arapahoe Road.

Table B-4. Forecasted Effects of Three Level Alternative

Arapahoe Road Location	No Action (vpd)	Three Level Alternative (vpd)
West of Yosemite Street	63,100	67,600
Between I-25 Ramps	75,700	56,200
New Lanes Below I-25 Interchange	NA	27,600
East of Boston/Clinton	66,700	72,000

This analysis suggested that the depressed through travel lanes, starting west of Yosemite Street and ending east of Clinton Street could remove approximately 33% of the Arapahoe Road volume through the interchange. The increased capacity provided by the depressed lanes is forecasted to attract additional traffic to the Arapahoe Road corridor, resulting in estimated increases of 7% on Arapahoe Road west of Yosemite Street and 9% east of Boston/Clinton Street.

Appendix C

Opinion of Probable Cost for Level 2 Alternatives

- **Improved Partial Cloverleaf without Costilla Crossing**
- **Improved Partial Cloverleaf with Costilla Crossing**
- **Costilla Crossing Only (not a stand-alone alternative)**
- **Three Level Partial Cloverleaf**

ARAPAHOE & I-25 IMPROVEMENTS -
IMPROVED PARTIAL CLOVERLEAF WITHOUT COSTILLA CROSSING - ARAPAHOE RD IMPROVEMENTS
OPINION OF PROBABLE CONSTRUCTION COSTS
Conceptual Design Cost Estimate

DATE: 6/1/2011
BY: KJB

	ITEM DESCRIPTION	UNIT	UNIT COST	ARAPAHOE & I-25 IMPROVEMENTS APPROX. QUANTITY	ARAPAHOE & I-25 IMPROVEMENTS ESTIMATED COST
A.	***BID ITEMS****				
	REMOVALS/DEMOLITION (FLATWORK)	SY	$ 12.00	124,088	$ 1,489,054.67
	REMOVAL GUARDRAIL (TYPE 7)	LF	$ 15.00	5,000	$ 75,000.00
	REMOVAL OF BRIDGE	SF	$ 30.00	44,338	$ 1,330,140.00
	CONCRETE PAVEMENT (11 INCH)	SY	$ 60.00	111,453	$ 6,687,180.00
	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF	$ 11.00	8,684	$ 95,524.00
	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF	$ 14.00	12,776	$ 178,864.00
	MEDIAN COVER MATERIAL	SF	$ 5.50	31,500	$ 173,250.00
	SIGNALS PER INTERSECTION	EA	$ 300,000.00	4	$ 1,200,000.00
	GUARDRAIL (TYPE 7)	LF	$ 45.00	7,276	$ 327,420.00
	MSE WALL	SF	$ 50.00	25,000	$ 1,250,000.00
	BRIDGE	SF	$ 150.00	57,000	$ 8,550,000.00
	SIDEWALK	SY	$ 30.00	7,254	$ 217,626.67
	EMBANKMENT MATERIAL (CIP)	CY	$ 10.00	70000	$ 700,000.00
	SUBTOTAL A				**$ 22,274,059**
B.	ITS	(6% of A)			$1,336,444
	Drainage/Utilities	(10% of A)			$2,227,406
	Signing & Striping, Lighting	(5% of A)			$1,113,703
	Construction Signing & Traffic Control	(10% of A)			$2,227,406
	Mobilization	(7% of A)			$1,559,184
	Erosion Control/Water Quality	(12% of A)			$2,672,887
	Removals (Misc.)	(1% of A)			$222,741
	Force Account - Utilities	(15% of A)			$3,341,109
	Force Account - Misc.	(10% of A)			$2,227,406
	SUBTOTAL B				**$16,928,285**
C.	Project Construction Bid Items Contingencies	(30% of A+B)			$11,760,703
	Total Preliminary Engineering	(10% of A+B)			$3,920,234
	Total Construction Engineering	(20% of A+B)			$7,840,469
	SUBTOTAL C				**$23,521,407**
D.	R.O.W Acquisition	Project Dependant			$2,003,793
	SUBTOTAL D				**$2,003,793**
	GRAND TOTALS (A, B, C & D)				**$64,727,544**

* Unit cost estimated using information in 2010 CDOT Cost Data Book
Includes added turn lane west of Yosemite St, and east of Clinton St

ARAPAHOE & I-25 IMPROVEMENTS -
IMPROVED PARTIAL CLOVERLEAF WITH COSTILLA CROSSING IMPROVEMENTS
OPINION OF PROBABLE CONSTRUCTION COSTS
Conceptual Design Cost Estimate

DATE: 6/1/2011
BY: KJB

	ITEM DESCRIPTION	UNIT	UNIT COST	ARAPAHOE & I-25 IMPROVEMENTS APPROX. QUANTITY	ESTIMATED COST
A.	***BID ITEMS****				
	REMOVALS/DEMOLITION (FLATWORK)	SY	$ 12.00	171,353	$ 2,056,237.33
	REMOVAL GUARDRAIL (TYPE 7)	LF	$ 15.00	5,000	$ 75,000.00
	REMOVAL OF BRIDGE	SF	$ 30.00	44,338	$ 1,330,140.00
	CONCRETE PAVEMENT (11 INCH)	SY	$ 60.00	149,747	$ 8,984,820.00
	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF	$ 11.00	8,684	$ 95,524.00
	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF	$ 14.00	23,846	$ 333,844.00
	MEDIAN COVER MATERIAL	SF	$ 5.50	31,500	$ 173,250.00
	SIGNALS PER INTERSECTION	EA	$ 300,000.00	7	$ 2,100,000.00
	GUARDRAIL (TYPE 7)	LF	$ 45.00	7,276	$ 327,420.00
	MSE WALL	SF	$ 50.00	75,852	$ 3,792,600.00
	BRIDGE	SF	$ 150.00	79,794	$ 11,969,100.00
	SIDEWALK	SY	$ 30.00	14,828	$ 444,846.67
	UNCLASSIFIED EXCAVATION (CIP)	CY	$ 10.00	80,000	$ 800,000.00
	SUBTOTAL A				**$ 32,482,782**
B.	ITS	(6% of A)			$1,948,967
	Drainage/Utilities	(10% of A)			$3,248,278
	Signing & Striping, Lighting	(5% of A)			$1,624,139
	Construction Signing & Traffic Control	(Varies)			$4,954,587
	Mobilization	(7% of A)			$2,273,795
	Erosion Control/Water Quality	(12% of A)			$3,897,934
	Removals (Misc.)	(1% of A)			$324,828
	Force Account - Utilities	(15% of A)			$4,872,417
	Force Account - Misc.	(10% of A)			$3,248,278
	SUBTOTAL B				**$26,393,223**
C.	Project Construction Bid Items Contingencies	(30% of A+B)			$17,662,801
	Total Preliminary Engineering	(10% of A+B)			$5,887,600
	Total Construction Engineering	(20% of A+B)			$11,775,201
	SUBTOTAL C				**$35,325,603**
D.	R.O.W Acquisition	Project Dependant			$26,109,645
	SUBTOTAL D				**$26,109,645**
	GRAND TOTALS (A, B, C & D)				**$120,311,253**

* Unit cost estimated using information in 2010 CDOT Cost Data Book

ARAPAHOE & I-25 IMPROVEMENTS -
COSTILLA CROSSING IMPROVEMENTS ONLY (Not a stand-alone alternative)
OPINION OF PROBABLE CONSTRUCTION COSTS
Conceptual Design Cost Estimate

DATE: 6/1/2011
BY: KJB

	ITEM DESCRIPTION	UNIT	UNIT COST	ARAPAHOE & I-25 IMPROVEMENTS APPROX. QUANTITY	ARAPAHOE & I-25 IMPROVEMENTS ESTIMATED COST
A.	***BID ITEMS****				
	REMOVALS/DEMOLITION (FLATWORK)	SY	$ 12.00	47,265	$567,183
	REMOVAL GUARDRAIL (TYPE 7)	LF	$ 15.00	0	$0
	REMOVAL OF BRIDGE	SF	$ 30.00	0	$0
	CONCRETE PAVEMENT	SY	$ 60.00	38,294	$2,297,640
	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF	$ 11.00	0	$0
	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF	$ 14.00	11,070	$154,980
	MEDIAN COVER MATERIAL	SF	$ 5.50	0	$0
	SIGNALS PER INTERSECTION	EA	$ 300,000.00	3	$900,000
	GUARDRAIL (TYPE 7)	LF	$ 45.00	0	$0
	MSE WALL	SF	$ 50.00	50,852	$2,542,600
	BRIDGE	SF	$ 150.00	22,794	$3,419,100
	SIDEWALK	SY	$ 30.00	7,574	$227,220
	UNCLASSIFIED EXCAVATION (CIP)	CY	$ 10.00	80,000	$800,000
	SUBTOTAL A				**$ 10,908,723**
B.	ITS	(6% of A)			$654,523
	Drainage/Utilities	(10% of A)			$1,090,872
	Signing & Striping, Lighting	(5% of A)			$545,436
	Construction Signing & Traffic Control†	(25% of A)			$2,727,181
	Mobilization	(7% of A)			$763,611
	Erosion Control/Water Quality	(12% of A)			$1,309,047
	Removals (Misc.)	(1% of A)			$109,087
	Force Account - Utilities	(15% of A)			$1,636,308
	Force Account - Misc.	(10% of A)			$1,090,872
	SUBTOTAL B				**$9,926,938**
C.	Project Construction Bid Items Contingencies	(30% of A+B)			$6,250,698
	Total Preliminary Engineering	(10% of A+B)			$2,083,566
	Total Construction Engineering	(20% of A+B)			$4,167,132
	SUBTOTAL C				**$12,501,396**
D.	R.O.W Acquisition	Project Dependant			$24,105,852
	SUBTOTAL D				**$24,105,852**
	GRAND TOTALS (A, B, C & D)				**$57,442,908**

* Unit cost estimated using 2010 CDOT Cost Data Book
†25% includes allowance for impacts to light rail (e.g. temp buses, extra CTC).

ARAPAHOE & I-25 IMPROVEMENTS
OPINION OF PROBABLE CONSTRUCTION COSTS
Conceptual Design Cost Estimate

Three Level Partial Cloverleaf Alternative
(Depressed Through Lanes with Replacement of I-25 Structure - Greenwood Plaza Blvd. to Dayton St.)

DATE: 6/29/2011
BY: KJB

	ITEM DESCRIPTION	UNIT	UNIT COST	ARAPAHOE & I-25 IMPROVEMENTS APPROX. QUANTITY	ESTIMATED COST
A.	***BID ITEMS****				
	REMOVALS/DEMOLITION (FLATWORK)	SY	$ 12.00	129,412	$ 1,552,944.00
	REMOVAL GUARDRAIL (TYPE 7)	LF	$ 15.00	5,000	$ 75,000.00
	REMOVAL OF BRIDGE	SF	$ 30.00	44,338	$ 1,330,140.00
	CONCRETE PAVEMENT (11 INCH)	SY	$ 60.00	147,043	$ 8,822,580.00
	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF	$ 11.00	4,750	$ 52,250.00
	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF	$ 14.00	28,165	$ 394,310.00
	MEDIAN COVER MATERIAL	SF	$ 5.50	22,508	$ 123,794.00
	SIGNALS PER INTERSECTION	EA	$ 300,000.00	6	$ 1,800,000.00
	GUARDRAIL (TYPE 7)	LF	$ 45.00	17,188	$ 773,460.00
	MASONARY/MSE WALL	SF	$ 50.00	10,800	$ 540,000.00
	CAISSON WALLS	SF	$ 150.00	125,885	$ 18,882,750.00
	BRIDGE	SF	$ 150.00	145,412	$ 21,811,800.00
	SIDEWALK	SY	$ 30.00	107,250	$ 3,217,500.00
	UNCLASSIFIED EXCAVATION (CIP)	CY	$ 10.00	179,501	$ 1,795,010.00
	SUBTOTAL A				**$ 61,171,538**
B.	ITS	(6% of A)			$3,670,292
	Drainage/Utilities	(10% of A)			$6,117,154
	Signing & Striping, Lighting	(5% of A)			$3,058,577
	Construction Signing & Traffic Control	(10% of A)			$6,117,154
	Mobilization	(7% of A)			$4,282,008
	Erosion Control/Water Quality	(12% of A)			$7,340,585
	Removals (Misc.)	(1% of A)			$611,715
	Force Account - Utilities	(15% of A)			$9,175,731
	Force Account - Misc.	(10% of A)			$6,117,154
	SUBTOTAL B				**$46,490,369**
C.	Project Construction Bid Items Contingencies	(30% of A+B)			$32,298,572
	Total Preliminary Engineering	(10% of A+B)			$10,766,191
	Total Construction Engineering	(20% of A+B)			$21,532,381
	SUBTOTAL C				**$64,597,144**
D.	R.O.W Acquisition	Project Dependant			$26,820,763
	SUBTOTAL D				**$26,820,763**
	GRAND TOTALS (A, B, C & D)				**$199,079,814**

* Unit cost estimated using information in 2010 CDOT Cost Data Book

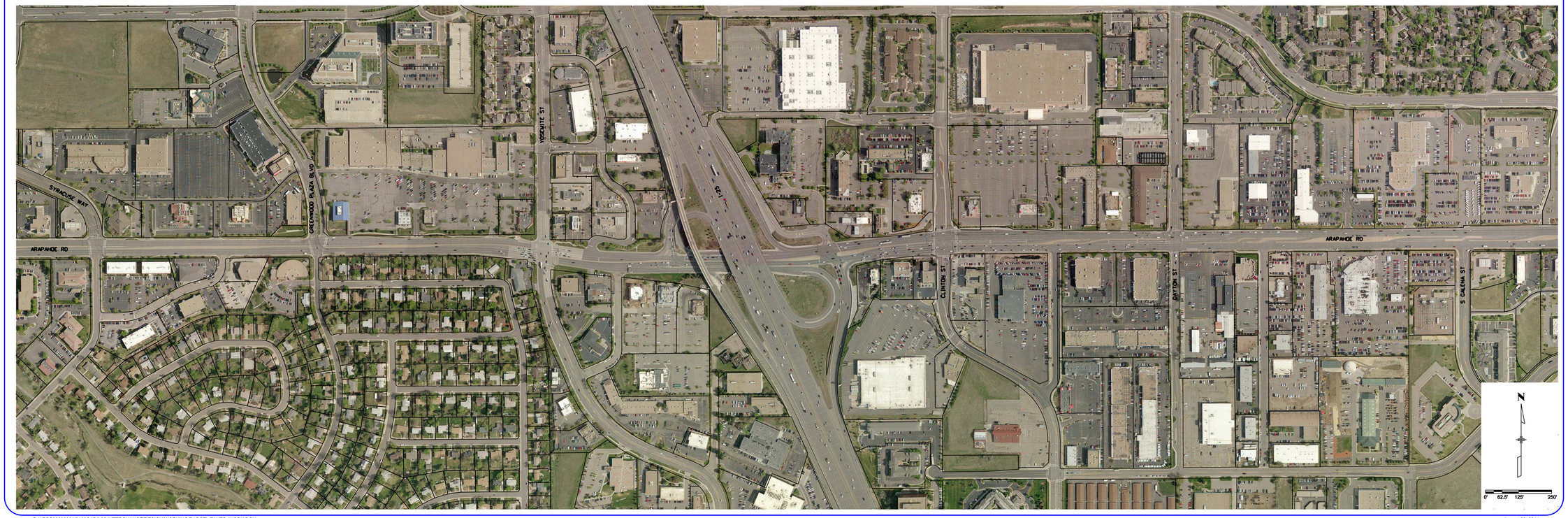
Appendix D

Graphic Illustrations of Level 2 Alternatives:

- **No Action**
- **Improved Partial Cloverleaf without Costilla Crossing**
- **Improved Partial Cloverleaf with Costilla Crossing**
- **Three Level Partial Cloverleaf**

I-25/Arapahoe Interchange
Environmental Assessment

No Action



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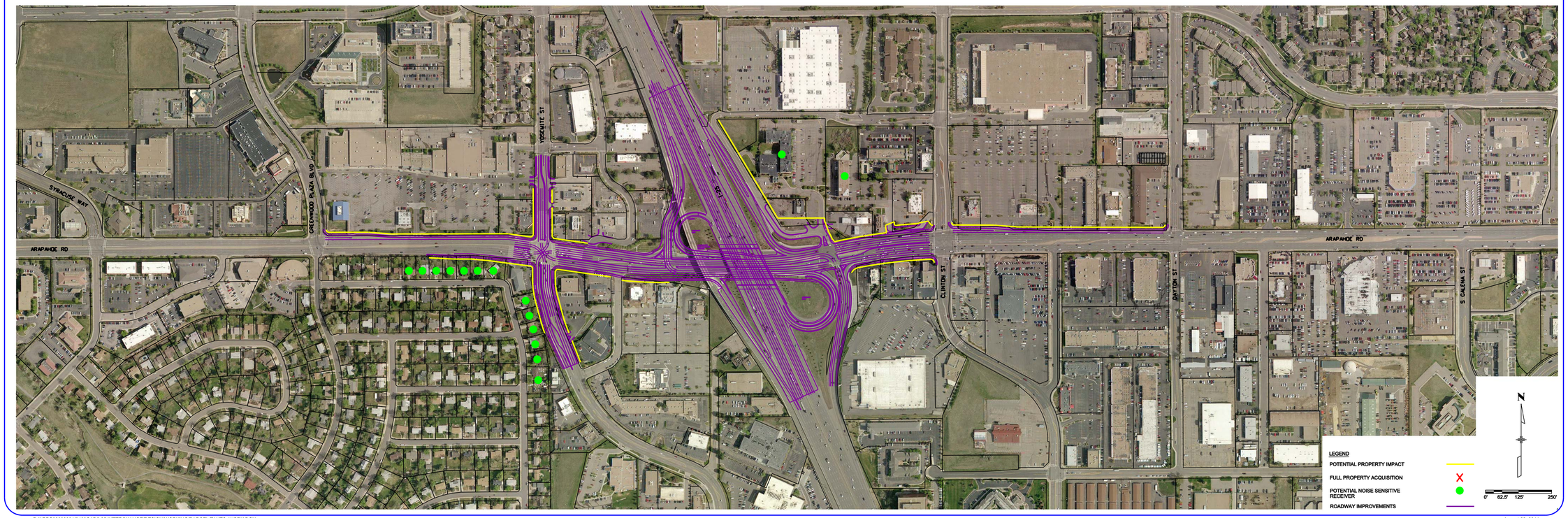
August 22, 2011

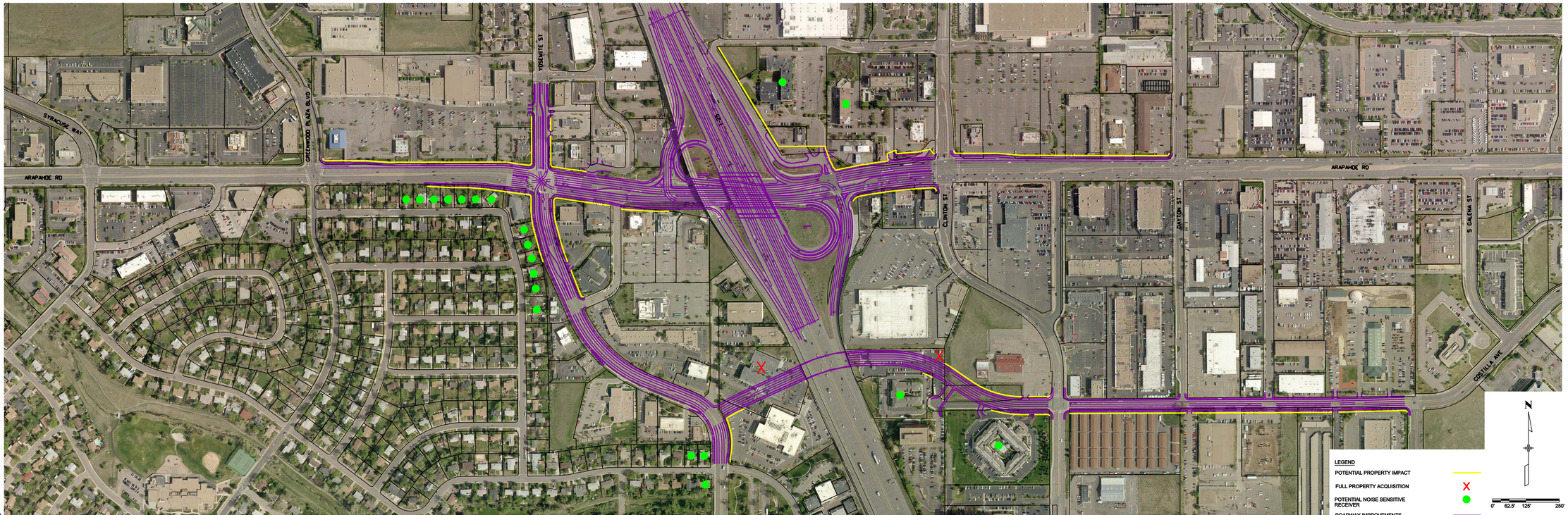
I-25/Arapahoe Interchange
Environmental Assessment

Improved Partial Cloverleaf without Costilla Crossing



I-25/Arapahoe Interchange
Environmental Assessment

Improved Partial Cloverleaf with Costilla Crossing



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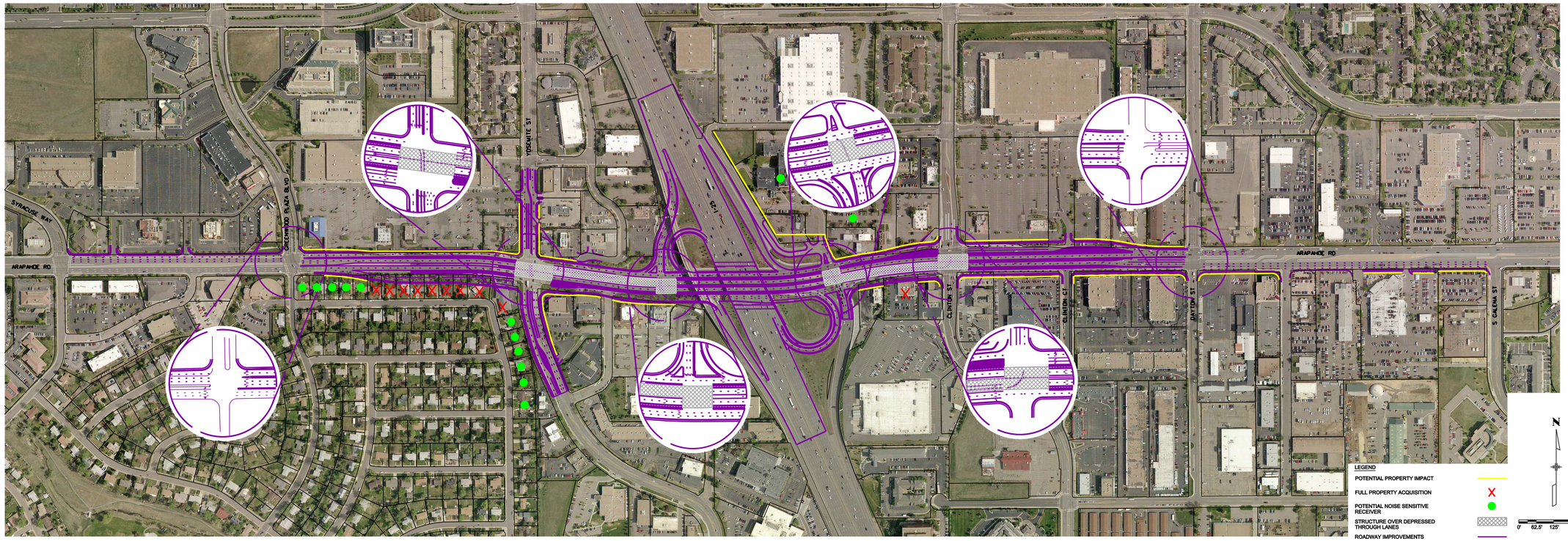
August 22, 2011

I-25/Arapahoe Interchange
Environmental Assessment

Three Level Partial Cloverleaf



Appendix E

2035 Traffic Volumes and Level of Service for Level 2 Alternatives:

- **No Action**
- **Improved Partial Cloverleaf without Costilla Crossing**
- **Improved Partial Cloverleaf with Costilla Crossing**
- **Three Level Partial Cloverleaf**

Figure E-1. 2035 No Action Traffic Volumes and Level of Service

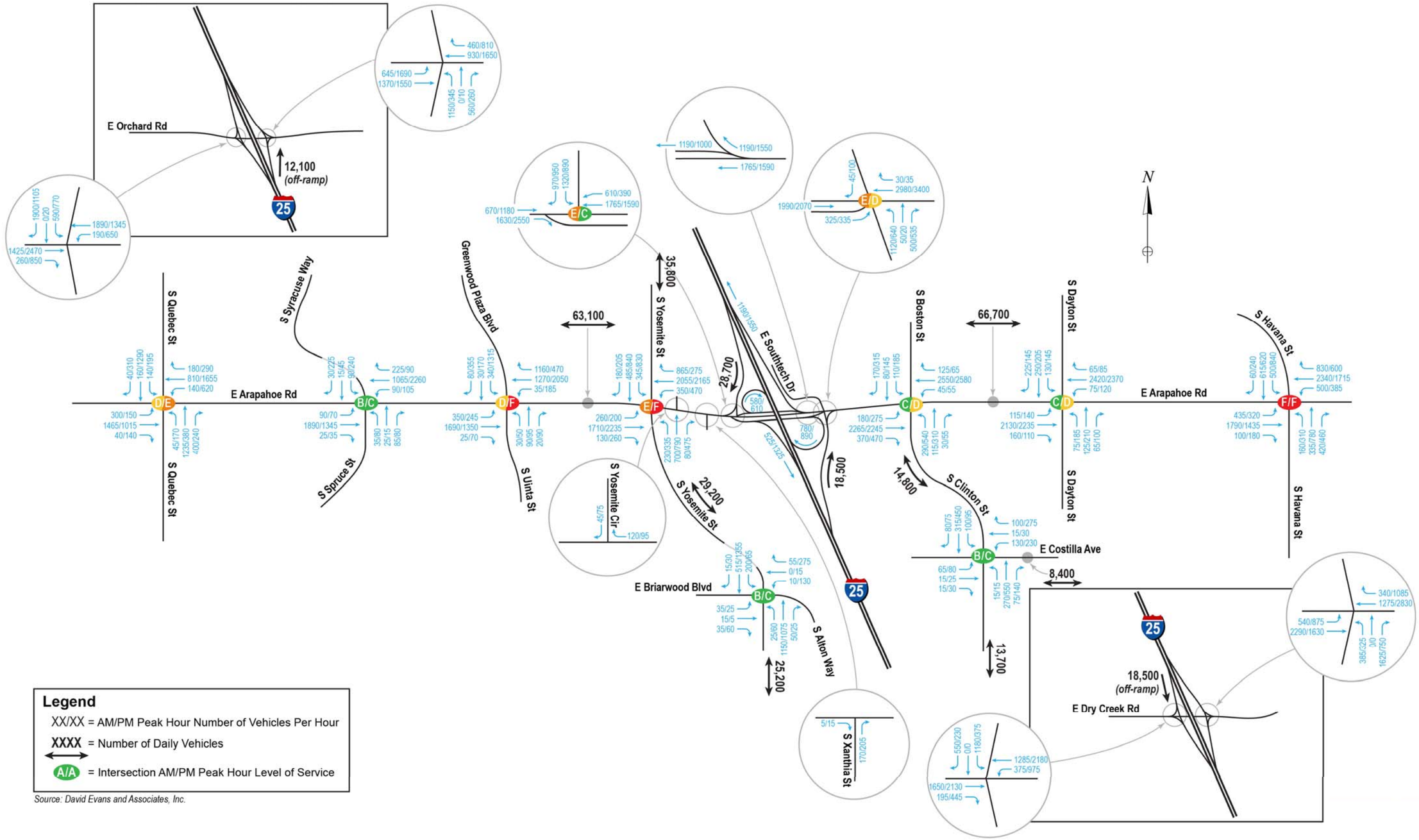


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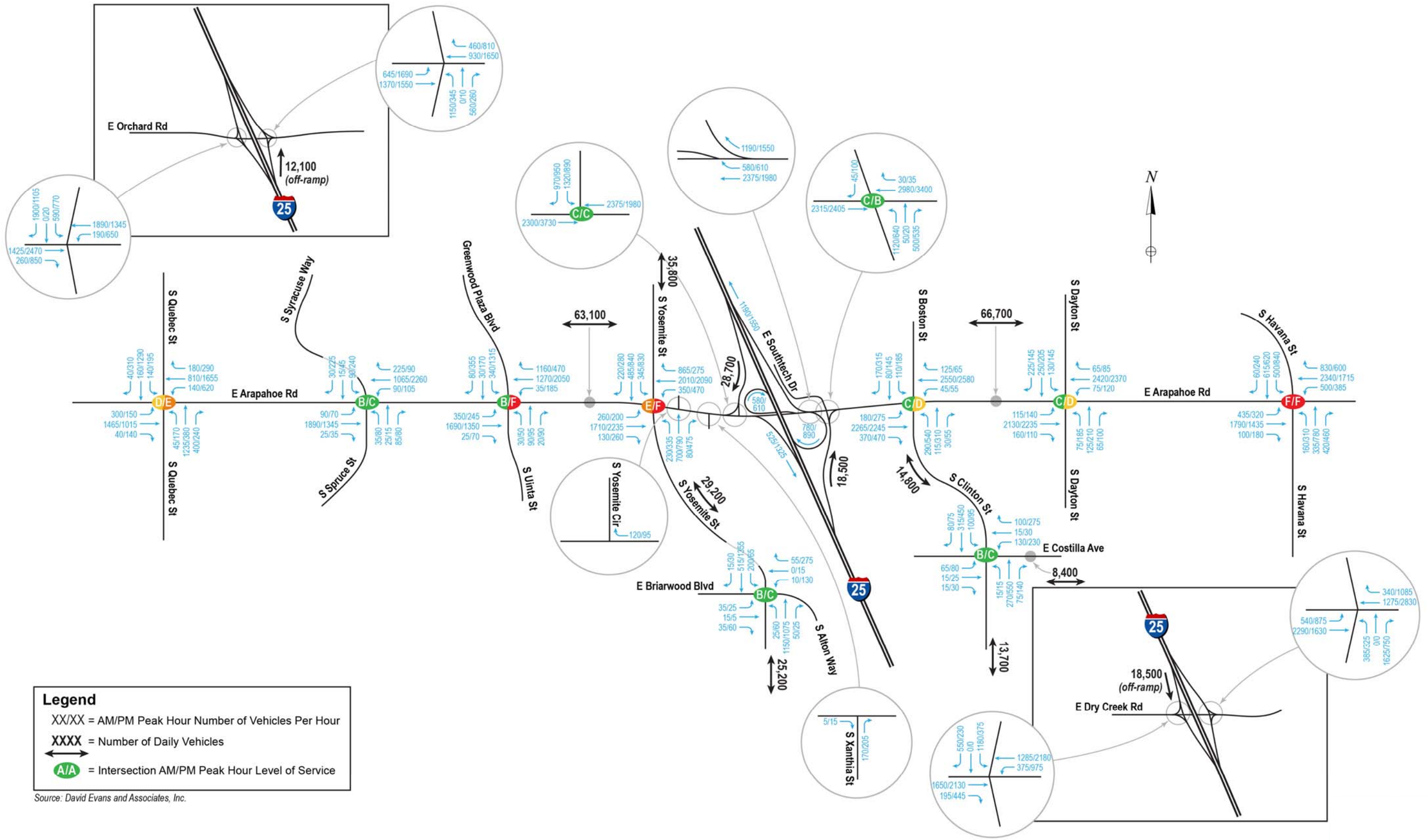
Figure E-2. 2035 Improved Partial Cloverleaf without Costilla Crossing Traffic Volumes and Level of Service



Source: David Evans and Associates, Inc.

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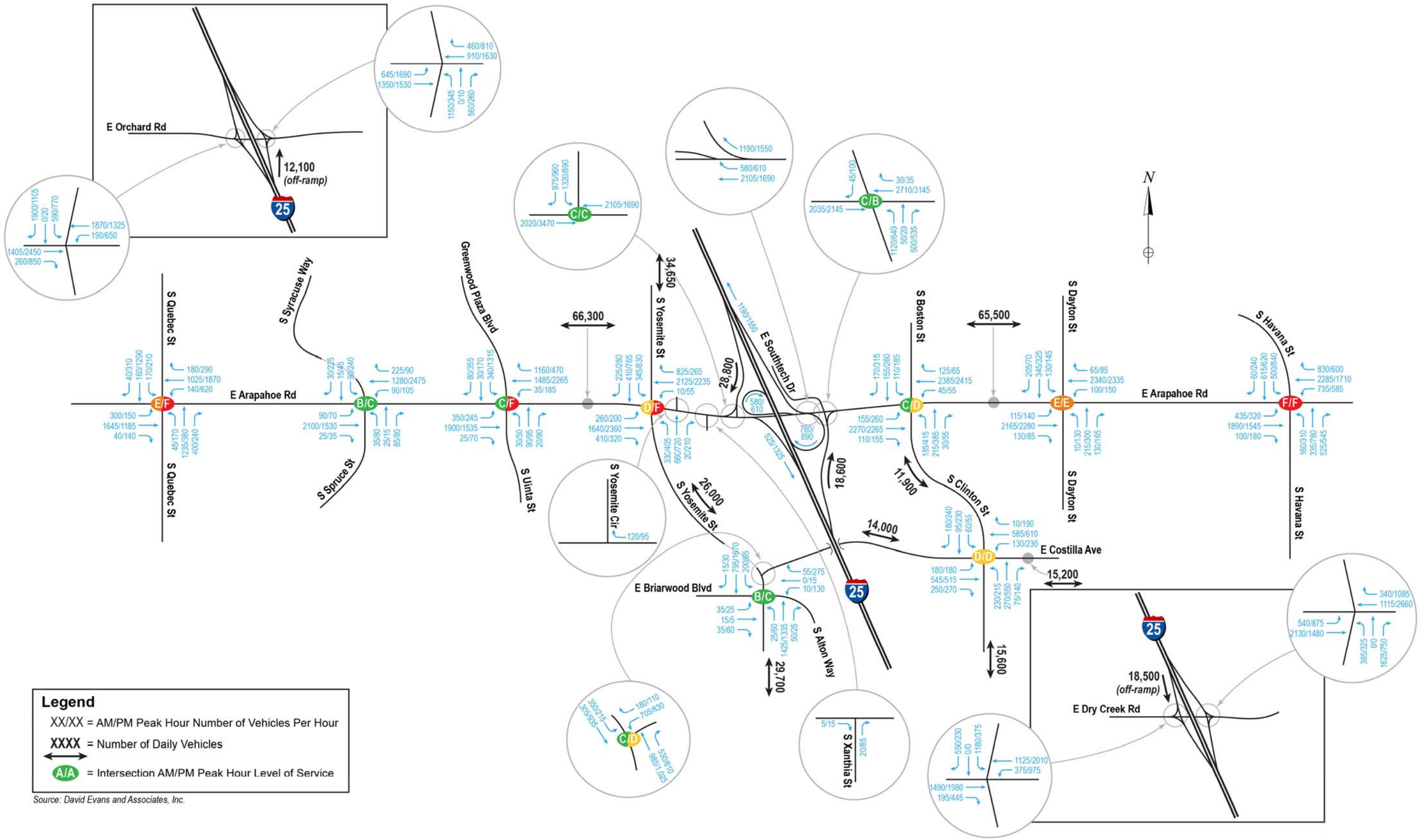
Figure E-3. 2035 Improved Partial Cloverleaf with Costilla Crossing Traffic Volumes and Level of Service



Source: David Evans and Associates, Inc.

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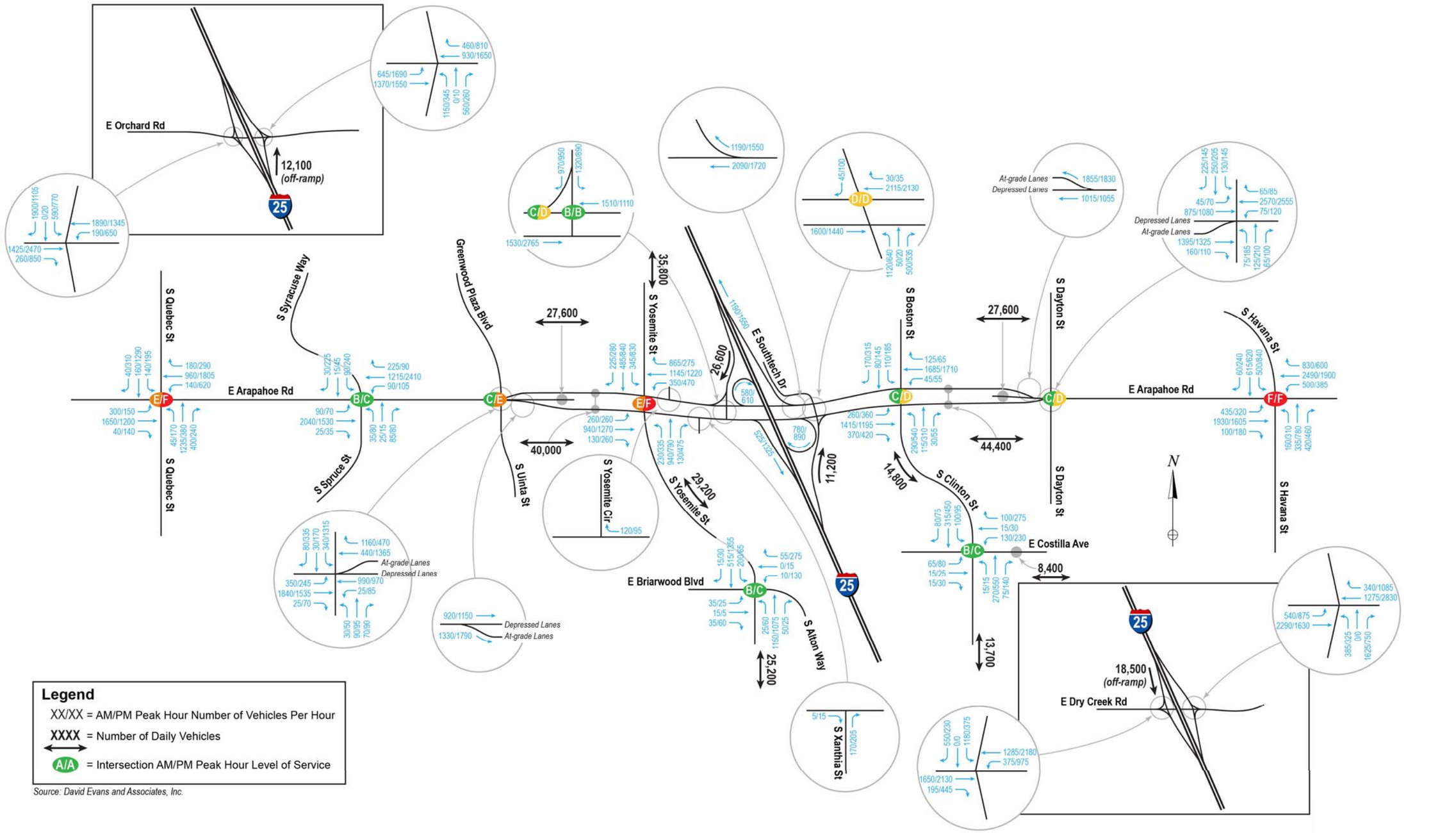
Figure E-4. 2035 Three Level Partial Cloverleaf Traffic Volumes and Level of Service



Source: David Evans and Associates, Inc.

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Appendix F
Construction Phasing Plan

Technical Memorandum – I-25/Arapahoe Interchange Construction Phasing Plan

August 3, 2011

This memorandum details the assumptions and methodology used to develop the conceptual phasing plan for the reconstruction of the I-25/Arapahoe Interchange project. The construction phasing approach focused primarily on the general phasing/constructability for the Partial Cloverleaf (ParClo) interchange alternative. This general approach would be applied to all alternatives.

Our general construction phasing approach, assumptions and findings are summarized as follows:

- Follow CDOT's current lane closure policy. This policy only allows for closures on I-25 and Arapahoe Road during non-peak periods. Therefore we maintained all lanes of traffic on I-25 and Arapahoe Road.

- Traffic would not cross over the existing centerline. The existing bridge consists of several different bridges. There is an elevation difference between the southbound and northbound structures at the centerline. This difference varies from approximately 4 ½ inches to 9 inches.

- The existing structure would not handle any load increase due to temporary pavement required to eliminate this vertical difference.

- Neither the existing northbound or southbound structure is wide enough to handle both directions of I-25 traffic on one side, even if reduced lane widths are used. Therefore, all construction for either direction will need to occur on one side. See Figure 1. This restriction results in approximately 53 feet of additional structure.

- The construction phasing required for replacing the I-25 bridge will occur in a minimum of three phases, with the initial phase starting on the east side of I-25. These phasing concepts are illustrated in Figures 1-3 and are summarized in the following:

    - *Phase 1* –Northbound I-25 traffic will be shifted to the west (towards the median barrier) using reduced lane widths and shoulders, to provide as much room on the east side of I-25 as possible. A portion of the existing northbound I-25 bridge will be removed. The first phase of the bridge construction will include approximately 53 feet of additional structure that is needed to accommodate shifting northbound traffic in Phase 2.
    - *Phase 2* – Northbound traffic is shifted onto a portion of the new northbound bridge (constructed in Phase 1). The remaining portion of the existing northbound I-25 bridge and a portion of the existing southbound I-25 bridge is removed. The new

northbound bridge is completed in this phase. During this phase, southbound I-25 traffic will be shifted to the west and reduced lane and shoulder widths will be used.

- *Phase 3* – Northbound I-25 traffic will remain in the same location as in Phase 2, and southbound traffic will be shifted east (onto the northbound I-25 structure constructed Phase 2). In this phase, the remaining existing I-25 southbound structure is removed and the new southbound I-25 bridge is constructed.

- The typical detour section used throughout this analysis consists of 11' travel lanes, 2' shoulders, and, where possible, a 5' buffer between any barrier and the construction zone edge. All phasing plans assume concrete pavement.

- The minimum allowable length of the new structure is dependent on maintaining traffic on Arapahoe Road. Although alternative designs such as a diverging diamond may reduce the final footprint when compared a partial cloverleaf design, the minimum bridge length is defined by maintaining the existing Arapahoe Road configuration during construction. It was assumed that no lane closures along Arapahoe Road will be allowed during peak times, therefore all work would need to be completed as temporary/nighttime closures.

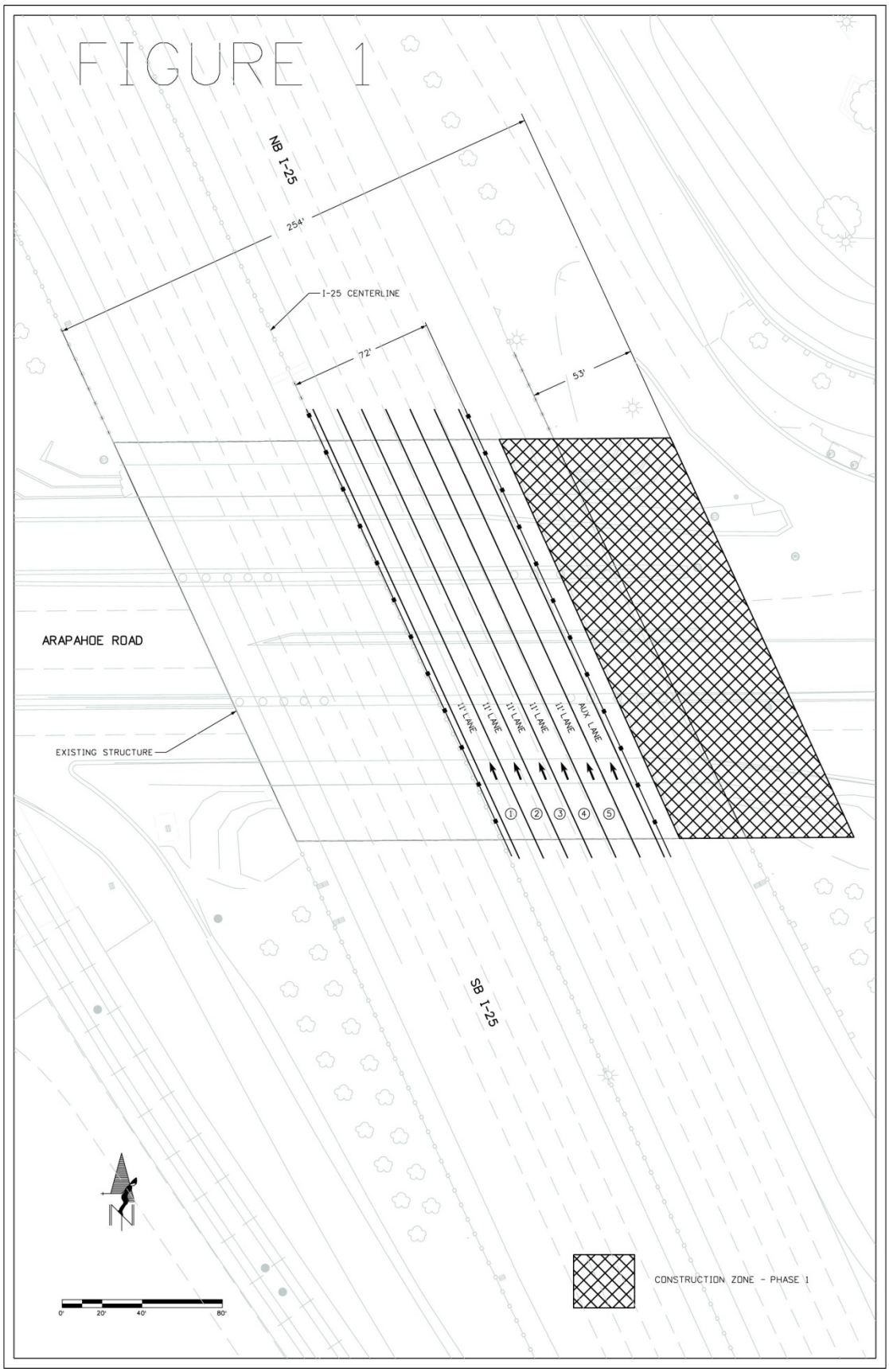
FIGURE 1
NB I-25
254'
I-25 CENTERLINE
72'
53'
ARAPAHOE ROAD
EXISTING STRUCTURE
11' LANE
11' LANE
11' LANE
11' LANE
11' LANE
AUX. LANE
1
2
3
4
5
SB I-25
N
0'
20'
40'
80'
CONSTRUCTION ZONE - PHASE 1

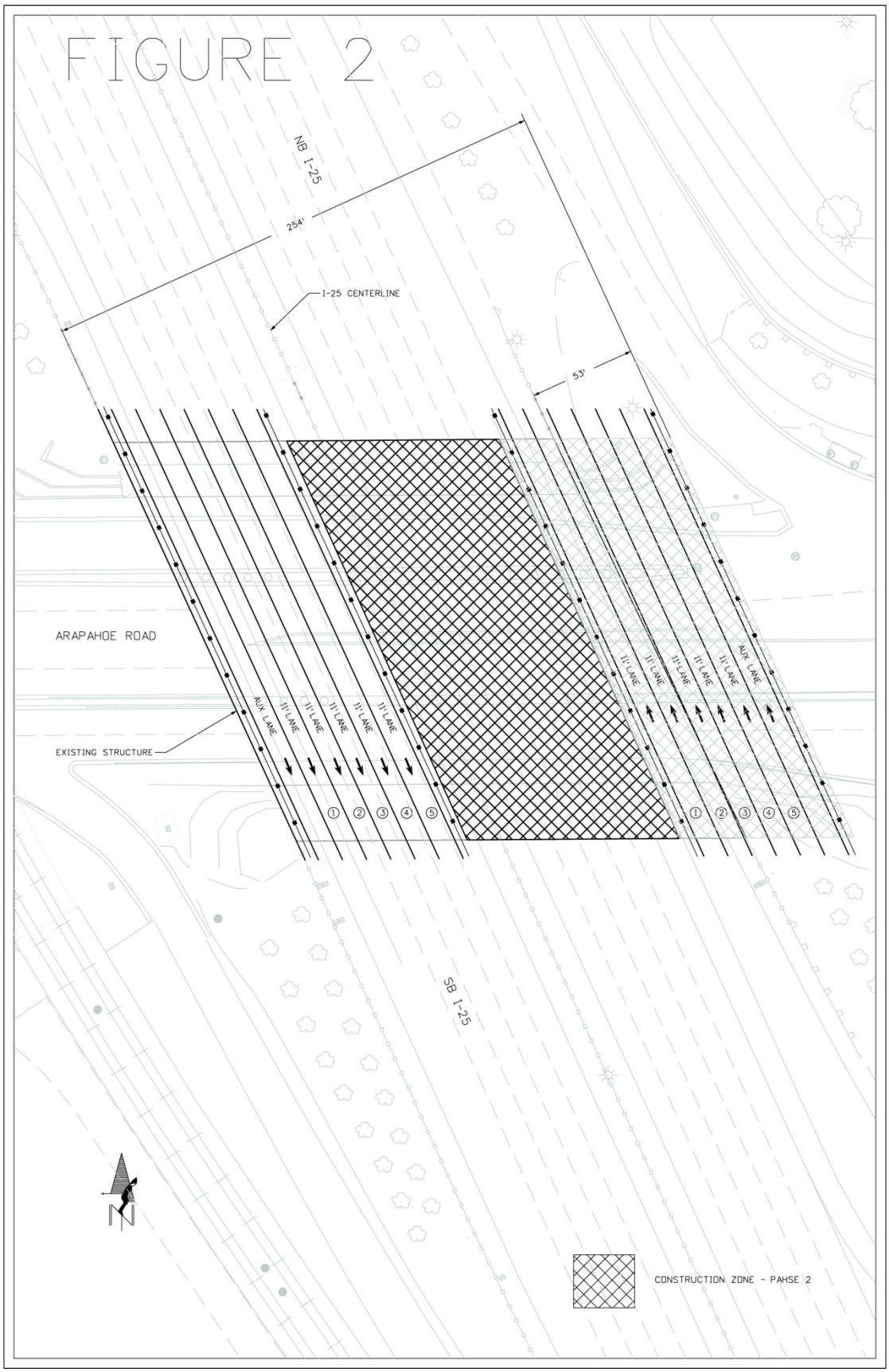
FIGURE 2
NB I-25
254'
I-25 CENTERLINE
53'
ARAPAHOE ROAD
EXISTING STRUCTURE
AUX LANE
11' LANE
SB I-25
CONSTRUCTION ZONE - PAHSE 2

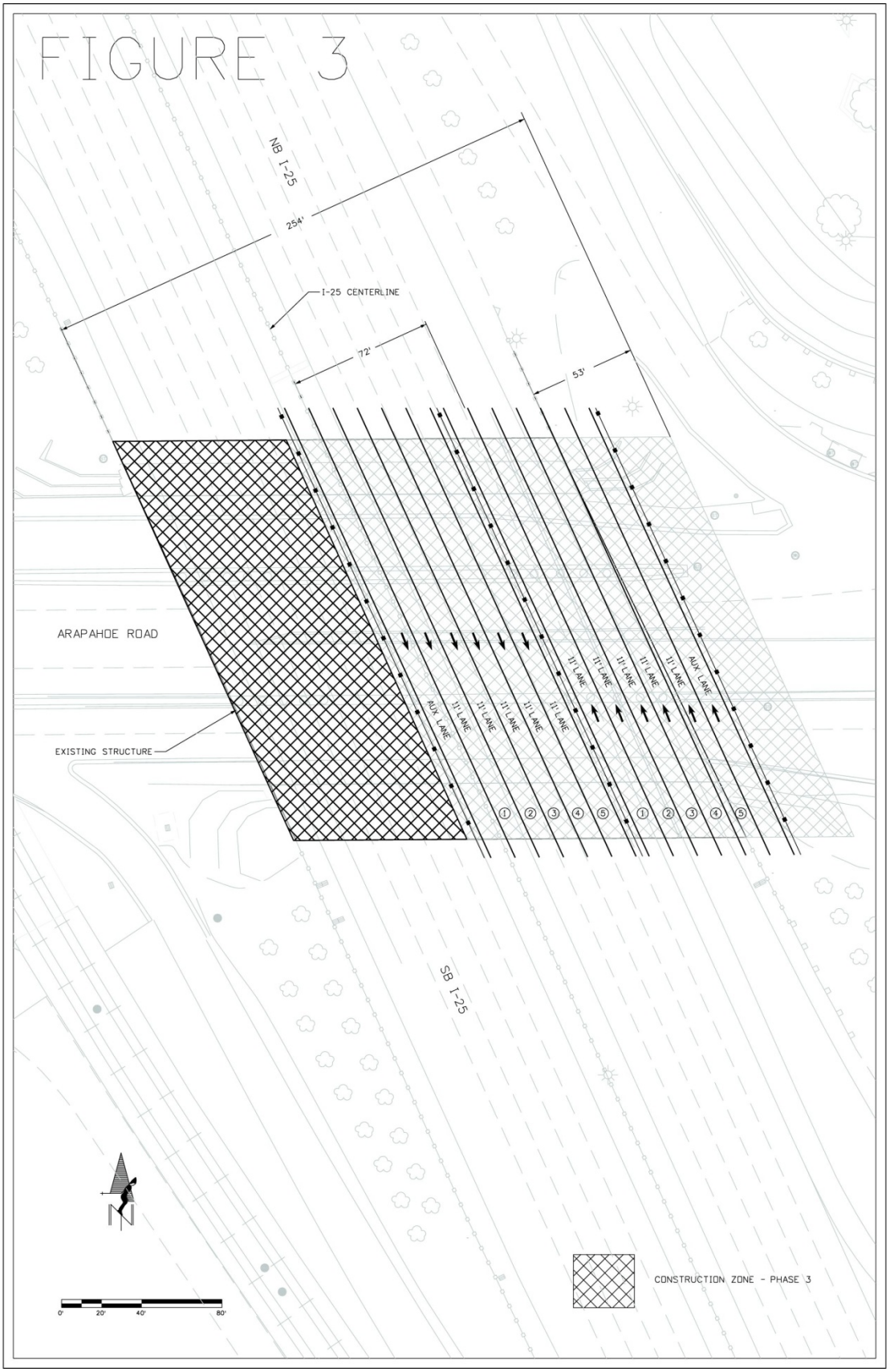
FIGURE 3
NB I-25
254'
I-25 CENTERLINE
72'
53'
ARAPAHOE ROAD
EXISTING STRUCTURE
AUX LANE
11' LANE
SB I-25
CONSTRUCTION ZONE - PHASE 3
0'
20'
40'
80'

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Appendix G

Additional Information Regarding the Previously Considered Diverging Diamond Interchange

Diverging Diamond Alternative
Traffic Operations, Design Issues and Considerations

VISSIM Analysis of Diverging Diamond Interchange (DDI) versus CORSIM Analysis of Improved Partial Cloverleaf (ParClo)

The first check of microsimulation results is a comparison of throughput volume achieved versus demand, a key measure of effectiveness. Table 1 compares the throughput for the links included in the ParClo configuration to the throughput for the same movements of the DDI. Overall service volume versus demand of the ParClo was 92% versus only 70% for the DDI. Key movements that are poorly served by the DDI are through traffic movements on Arapahoe Road and the eastbound to northbound and eastbound to southbound ramp movements. Further refinement of the DDI microsimulation model and additional lanes on Arapahoe Road could help improve operations of some movements within the DDI. However, the proximity of the Yosemite Street and Boston/Clinton Street intersections is also a factor to consider with the DDI operations due to insufficient storage length for queued vehicles.

These comparisons and findings are consistent with the review of research on the DDI configuration from other agencies, including:

- Spacing from the ramp intersections to adjacent signalized arterial intersections should be 1,320 feet or greater (the Boston/Clinton and Yosemite Street intersections are only 600 and 750 feet from the I-25 off ramp signals).
- Potential decreased performance of through traffic on the arterial due to a break in signal progression through the DDI.
- A major benefit of the DDI is the simple two-phase signals at the ramp terminal intersections. However, with the ParClo configuration, the interchange also operates with simple two-phase signals.
- When interchange ramp volumes are high, other (non-DDI) interchange types should be considered.

Diamond Ramp Merge

Modeled maximum diamond ramp merge volume with peak versus off peak mainline I-25 volumes ranges from approximately 1,500 to 2,185 vph, without ramp metering. With ramp metering, the maximum modeled ramp volume is approximately 1,300 vph.

Ramp Metering

The VISSIM analysis of the DDI assumed no ramp metering. CDOT has indicated that ramp metering is planned to be maintained for all I-25 south interchange ramps in order to preserve the system benefits on the freeway of having consistent ramp metering at all on ramps.

Potential Cost Savings/Construction Phasing

CDOT requirements for maintaining through travel lanes during construction will require additional bridge width beyond that for an ultimate DDI configuration. Also, although the ultimate bridge length may be less for the DDI number of lanes on Arapahoe Road, maintaining the existing number of lanes on Arapahoe Road during construction would require a bridge at least as long as the existing bridge length. Therefore, the typical cost savings of a DDI with reduced structure requirements cannot be realized for the I-25/Arapahoe interchange reconstruction. (See related memo from Hartwig & Associates, Inc.)

Table G-1. ParClo versus DDI Throughput Volume Comparison
2035 PM Peak Hour – Yosemite to Boston/Clinton

	Improved Partial Cloverleaf From CORSIM model prepared by DEA															
Demand	3,730	1,325	3,295	890	2,940	3,435	1,550	2,590	610	2,930	720	475	1,060	780	26,330	100%
Achieved	3,208	1,141	3,048	732	2,871	3,538	1,298	2,183	506	2,518	776	493	1,150	725	24,184	92%
% Achieved	86%	86%	92%	82%	98%	103%	84%	84%	83%	86%	108%	104%	109%	93%		
	EB Arapahoe west of Ramps	EB to SB Ramp	EB Arap between Ramps	EB to NB Ramp	EB Arapahoe east of Ramps	WB Arapahoe east of Ramps	WB to NB Ramp	WB Arapahoe between Ramps	WB to SB Ramp	WB Arapahoe west of Ramps	NB Off to WB (Signal)	NB Off to EB (Free Right)	SB Off to EB (Signal)	SB Off to WB (Free Right)	Overall Total	% of Overall Total
	Diverging Diamond (Double Crossover Diamond) Based on VISSIM model prepared by Horrocks															
Demand	3,730	1,325	3,295	890	2,940	3,435	1,550	2,590	610	2,930	660	535	890	950	26,330	100%
Achieved	2,020	696	2,060	371	2,117	2,647	1,177	2,011	464	2,358	533	425	756	813	18,448	70%
% Achieved	54%	53%	63%	42%	72%	77%	76%	78%	76%	80%	81%	79%	85%	86%		

Diverging Diamond Interchange (DDI)

Created for: I-25 / Arapahoe Interchange Environmental Assessment

When applied at appropriate locations, the DDI concept can provide greater capacity and reduced delay with minimal increases in the interchange footprint when compared with a standard diamond interchange. A diverging diamond interchange is a modified diamond interchange, with the following differences:

- Traffic on the arterial street moves to the left side of the roadway for the segment between the signalized ramp intersections (see Figures 1 and 2).
- Left-turning vehicles can enter the freeway without a left-turn signal phase at the ramp intersections.

Figure 1: Diverging Diamond Interchange in Springfield, Missouri (first built in the US)

Planning level capacity evaluation of a diverging diamond interchange:

- When current or projected through volumes are high, the DDI concept is at a disadvantage when compared to other interchange layouts, per the report titled "Missouri's Experience with a Diverging Diamond Interchange - Lessons Learned".
- Per Utah DOT guidelines, a DDI with two lanes in each direction on the arterial street fails if the sum of peak hour volumes for moments A, B, and C (see Figure 2) is greater than 2,100 vph.
  - The sum of these existing movements at the I-25 / Arapahoe Interchange is about 3,500 vph in both the AM and PM peak hours. This is about 70% above the stated threshold.

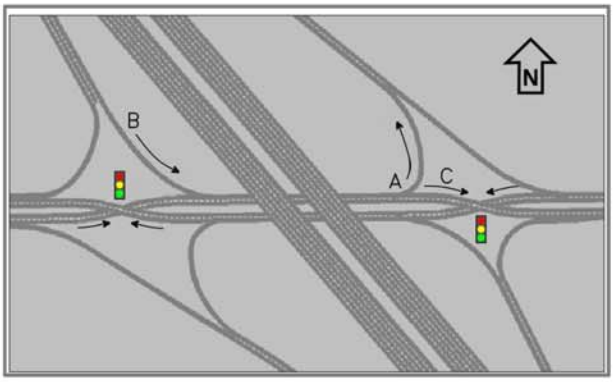

Figure 2: Critical Volumes for a Diverging Diamond Interchange

Potential application to I-25 / Arapahoe:

- For southbound left turns from I-25, at least two lanes would be required, so there would need to be a signal at the merge with the eastbound through lanes. This signal could be phased with the through movement signal, but would limit the benefits of the new configuration since the existing ramp signal is already two-phased with the partial cloverleaf configuration.
- For westbound right turns to I-25, two lanes would be required. The single lane for the eastbound to I-25 northbound movement (movement A) would either need to yield to the westbound to northbound movement or there would be three lanes that would need to merge to one before entering I-25.
- Due to the high existing and expected higher future volumes of critical movements, it appears that I-25 / Arapahoe is not a good candidate for a diverging diamond interchange configuration.