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US 34

35TH & 47TH AVENUES

INTERCHANGE SELECTION REPORT

Source:
AECOM Initial Concept Rendering, US 34 over 47th Avenue

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SECTION 1.0 INTRODUCTION

1.1 Project Background

US 34 is a critical east-west transportation corridor for northern Colorado's growing communities. US 34 extends from Granby on the western slope, through Rocky Mountain National Park, Loveland and Greeley, and into the eastern plains. It intersects major north-south routes in Colorado including US 287 in Loveland, I-25 in Loveland/Johnstown, US 257 in western Greeley, and US 85 in eastern Greeley. In January 2019, a US 34 Planning and Environmental Linkages (PEL) Study was completed with the purpose to "preserve US 34 as a vital east-west regional transportation corridor." This study encompassed US 34 from Larimer County Road 27 west of Loveland to Weld County Road 49 west of Kersey.

Since the PEL, The City of Greeley (City) residents approved funds through the "Imagine Greeley Initiative" in 2018 to help construct two critical interchanges along this corridor at 35th and 47th Avenues in the south-central part of the City. The PEL identified the following deficiencies at these intersections: congestion, significant crashes, and insufficient future capacity. The PEL recommended a six-lane section (three lanes in each direction) on US 34 with grade-separated interchanges at 35th and 47th Avenues. Conceptual interchange alternatives were developed for both intersections to address the deficiencies and were provided in the PEL recommendations.

The Colorado Department of Transportation (CDOT) and the City have partnered to advance the findings of the PEL, explore additional alternatives, and develop construction plans for new interchanges at 35th and 47th. The first step in that process is selecting a preferred alternative. This interchange selection report provides CDOT and the City comparative information on interchange types to aid in this selection. The alternatives analysis set forth in this report will evaluate the PEL recommended alternative and other concepts developed using refined traffic analysis, geometric design, hydraulic design, utility information, and environmental investigation to determine a proposed interchange alternative. As part of the analysis, the no-build scenario was used as a baseline comparison to each alternative.

The interchange selection process was coordinated with CDOT and the City as a two-level approach. Level 1 identified several potential interchange alternatives at each intersection and screened them for major flaws using categories that were considered critical to a preferred alternative. From this screening, three alternatives were advanced to a Level 2 screening at each interchange location.

The Level 2 screening process identified various categories and subcategories, including those used during the Level 1 screening, and developed criteria and qualitative and quantitative metrics to score each alternative. The goal in developing this detailed screening process was to reduce subjectivity in the interchange selection. Each category was assigned a weight based on conversations with CDOT and the City, and scoring was completed for each of 35 subcategories. The result was a weighted score that provided an overall ranking for each of the three alternatives as well as the no-build alternative for comparison.

1.2 Project Area

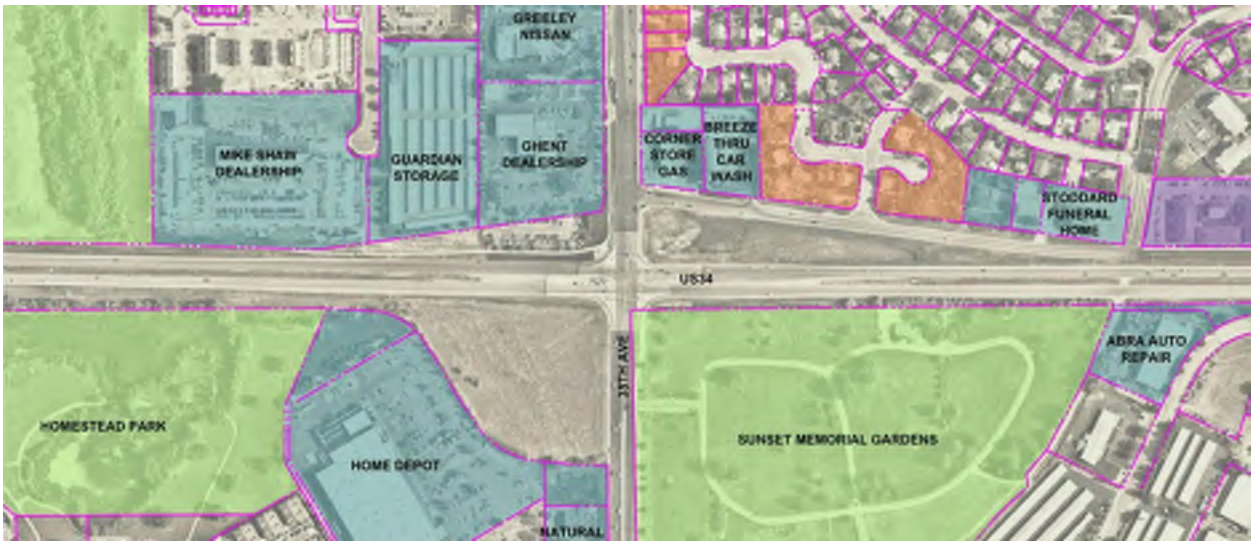
The project limits along US 34 are from approximately milepost 108.7 (approximately ½ mile west of 47th Avenue) to milepost 110.8 (about halfway between 35th Avenue and 23rd Avenue to the east). It includes 47th Avenue from 29th Street south of US 34 to 26th Street/Centerplace Drive north of US 34; and 35th

Avenue from 29th Street south of US 34 to 25th Street north of US 34. It also includes 28th Street from 35th Avenue east to Reservoir Road. Twenty-eighth Street serves as the US 34 frontage road east of 35th Avenue and ends at 35th Avenue.

1.3 Existing Land Use – 35th Avenue

Land use in the vicinity of the US 34 and 35th Avenue intersection is mixed and largely developed, as shown in Figure 1.1. There are pockets of undeveloped land in the southeast and northwest quadrants nearer to the intersection. Further south along 35th Avenue, a larger area of undeveloped agricultural land lies west of 35th Avenue and south of 37th Street. North of US 34 along 35th Avenue, the land use is generally single-family residential properties. Greeley West High School is at the northwest corner of 35th Avenue and 24th Street approximately one-half mile north of US 34.

Figure 1.1 – 35th Avenue Existing Land Use



1.3.1 Southeast Quadrant

The southeast quadrant is the Sunset Memorial Cemetery. The cemetery property extends approximately 1550 ft. east along US 34 and approximately 900 ft. south along 35th Avenue. Mixed commercial uses are east of the cemetery along US 34, and Trinity Lutheran Church/School is adjacent to 35th Avenue between US 34 and 29th Street.

1.3.2 Southwest Quadrant

The southwest quadrant is a retail center with mostly regional and national chains adjacent to the right-of-way. A multi-family apartment complex is behind the retail center along 29th Street. Homestead Park and the Gateway Lakes Natural Area is located west of the retail center and apartment complex between US 34 and 29th Street. West of the park is a single-family residential development abutting the US 34 right-of-way.

1.3.3 Northwest Quadrant

The northwest quadrant is largely automotive dealerships between US 34 and 25th Street along 35th Avenue. A multi-family apartment complex sits behind the dealerships along 25th Street. A bike park is located west of these properties between US 34 and 25th Street. West of the bike park is a large retail center that extends west to 47th Avenue.

1.3.4 Northeast Quadrant

The northeast quadrant is primarily single-family residential development north of the 28th Street frontage road. A gas station and car wash occupy the northeast corner of 35th Avenue and 28th Street. Six single-family residential units back up to 28th Street east of the car wash and neighborhood access is provided at 33rd Ave Place. An office building and funeral home are along 28th Street west of Reservoir Road. Further east along US 34/28th Street is a mix of multi-family residential and commercial uses.

1.4 Existing Land Use – 47th Avenue

Land use in the vicinity of the US 34 and 47th Avenue intersection is generally commercial and largely developed, as shown in Figure 1.2. There are parcels of undeveloped land in all four quadrants consisting of previously dedicated or preserved right-of-way for a future interchange. South of 29th Street along 47th Avenue, the adjacent land use is multi-family residential on the west side and single-family residential on the east side. North of 26th Street along 47th Avenue, the land use is commercial, with some undeveloped parcels. Approximately 0.2 miles west of 47th Avenue, single-family residential development extends northwest of US 34.

Figure 1.2 – 47th Avenue Existing Land Use

1.4.1 Southeast Quadrant

The southeast quadrant is the Gateway Estates commercial parcels, which extends approximately 950 ft. east along US 34 and south along 47th Avenue to 29th Street. Gateway Estates then transitions to single-family residential east along US 34 and south along 47th Avenue.

1.4.2 Southwest Quadrant

The southwest quadrant is the Greeley Commons retail center with mostly regional and national chains. The center extends approximately 800 ft. west along US 34 and south along 47th Avenue to 29th Street. A car dealership and a multi-family residential complex is located west of the retail center along 29th Street and adjacent to the US 34 right-of-way. Another multi-family residential complex is located south of the retail center between 29th Street and 31st Street.

1.4.3 Northwest Quadrant

The northwest quadrant consists of two automotive dealerships between US 34 and 26th Street along 47th Avenue. A single-family residential neighborhood sits behind the dealerships along 27th Street and extends northwest towards the Highland Hills Municipal Golf Course.

1.4.4 Northeast Quadrant

The northeast quadrant is largely the Centerplace Retail Center. The retail center extends approximately 3,300 ft. to the east along US 34 and north to Centerplace Drive along 47th Avenue.

1.5 Existing Traffic Operations and Forecasted Traffic Volumes

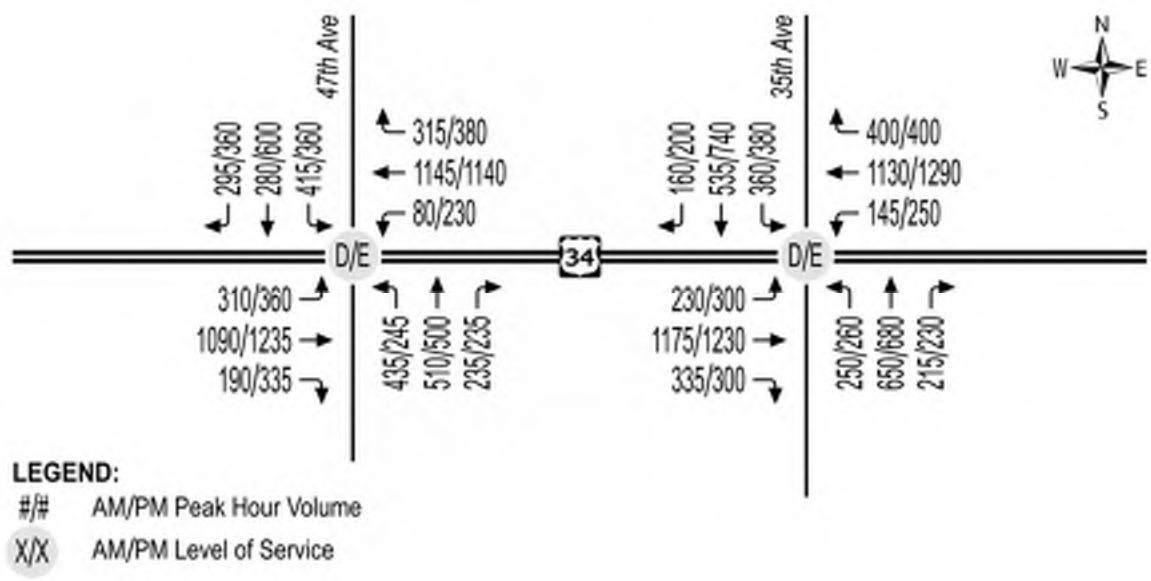
Traffic data collected in March of 2020 and a traffic analysis were used to forecast traffic in the year 2045 for US 34 and 35th and 47th Avenues in support of the alternative analysis and design of these interchanges. The collected data was used to calibrate a Vissim microsimulation model to simulate existing (2020) traffic conditions. The year 2045 forecasted traffic volumes were developed from the existing traffic counts and the North Front Range Metropolitan Planning Organization (NFRMPO) travel demand forecasts. Detailed information on the traffic analysis and forecasts can be found in the Traffic Report in Appendix B.

1.5.1 Existing Traffic Conditions

Existing traffic data were collected to conduct a detailed traffic analysis for each interchange. The data included AM and PM peak period turning movement counts, speed, travel time, and vehicle classification. Turning movement counts were conducted on Tuesday, March 3, 2020, a couple of weeks before large-scale, stay-at-home orders were in place in Colorado due to the COVID-19 pandemic. Data collection included US 34 intersections at 47th Avenue and 35th Avenue as shown in Figure 1.3 as well as all intersections from 65th Avenue to 11th Avenue. Major intersections were included along 47th Avenue from 31st Street to 26th Street and along 35th Avenue from 29th Street to 25th Street. Travel time data were collected during the AM and PM peak periods along US 34 between 11th Avenue and 65th Avenue. Bidirectional tube counts were collected for directional distribution, speed data, and classification data between major intersections along US 34 as well as on 47th Avenue and 35th Avenue near US 34. These counts are documented in AECOM's *Vissim Data Collection and Forecast Memorandum* (Appendix A).

These data were used to create calibrated microsimulation models using Vissim software for the AM and PM peak hours which were then used to estimate the level of service (LOS) in accordance with the Highway Capacity Manual (HCM 6th Edition, 2016). Vissim analysis showed that the current intersections of US 34 at 47th and 35th Avenues currently operate at poor levels of service during peak periods.

Figure 1.3 – 2020 Existing Volumes and Levels of Service



1.5.2 Forecast Traffic Conditions

The Vissim models were modified using forecasted traffic volumes to estimate future (2045) "No-build" and "Build" LOS for each interchange alternative. Forecasted traffic volumes were estimated by adjusting existing traffic volumes using data obtained in the NFRMPO Regional Travel Model. The No-build option assumed at-grade intersections at US 34 and 47th and 35th Avenues, while the Build option assumed grade-separated interchanges. Figure 1.4 (No-build) and Figure 1.5 (Build) show 2045 forecast traffic volumes accounting for increased demand. The resulting future (2045) turning movement counts were used to estimate No-build and Build LOS at all study intersections for each alternative.

Figure 1.4 – 2045 No-Build Forecast Volumes

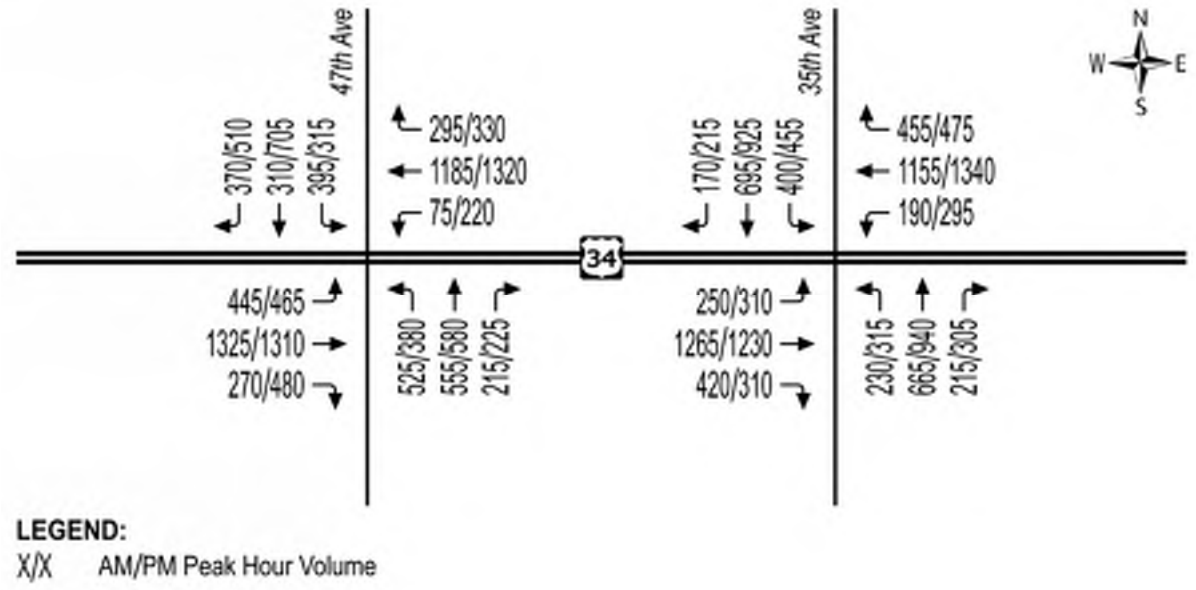
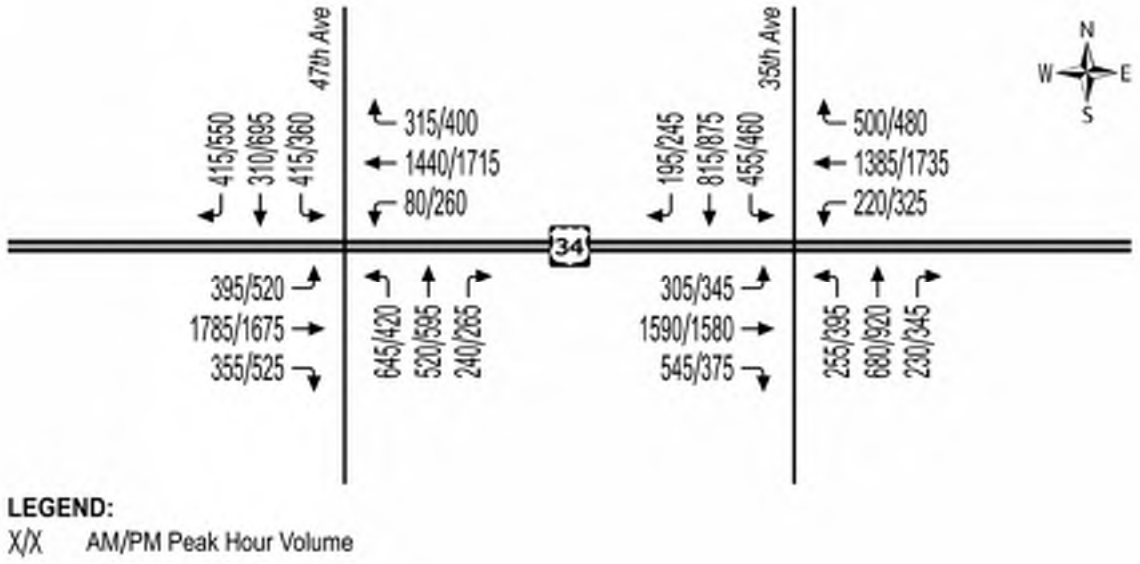


Figure 1.5 – 2045 Build Forecast Volumes



SECTION 2.0 35TH AVENUE – LEVEL 1 ALTERNATIVE ANALYSIS AND SCREENING

2.1 Level 1 Alternatives

In the development of concept alternatives for the 35th Avenue and US 34 intersection, two key constraints emerged for the geometric design. First, the cemetery in the southeast quadrant of the intersection cannot be impacted in any way, so all alternatives must remain within the existing right-of-way in this quadrant. In the southwest quadrant, adequate land has been preserved to accommodate a loop ramp that could help avoid impacting the cemetery. Second, 28th Street serves as a frontage road for US 34 and currently terminates at 35th Avenue with an unsignalized intersection approximately 200 ft. north of US 34. The proximity of this roadway and intersection to US 34 makes it a significant challenge to the overall interchange design.

These two geometric constraints require a "non-standard" configuration and an iterative approach was used to develop nine alternatives described below. Potential alternatives that would require signalization on US34 were not permitted to maintain US34 as an expressway through this intersection. The first three alternatives in (Sections 2.1.1 to 2.1.3), are "basic" configurations that form the basis of the remaining alternatives. The next three alternatives (Sections 2.1.4 to 2.1.6) customize the first three alternatives to address the geometric constraints. The preferred alternative from the PEL is shown in Figure 2.4. The last three alternatives (Sections 2.1.7 to 2.1.9) were developed to address shortcomings of the second group primarily from a traffic analysis perspective. It is important to note that the No-build alternative is also considered in the screening as a baseline comparison to the build alternatives.

2.1.1 Standard Diamond Interchange (SDI)

The standard diamond interchange (SDI) shown in Figure 4.1, has four ramps and two signalized intersections on 35th Avenue. The intersections would provide two left-turn lanes and channelized right-turn lanes. While this alternative provides capacity and a familiar interchange for drivers, it would require right-of-way in the southeast quadrant, which is not feasible with the cemetery. Refer to Appendix E for more information on advantages and disadvantages.

Figure 2.1 – Standard Diamond Interchange

2.1.2 Partial Cloverleaf (Parclo)

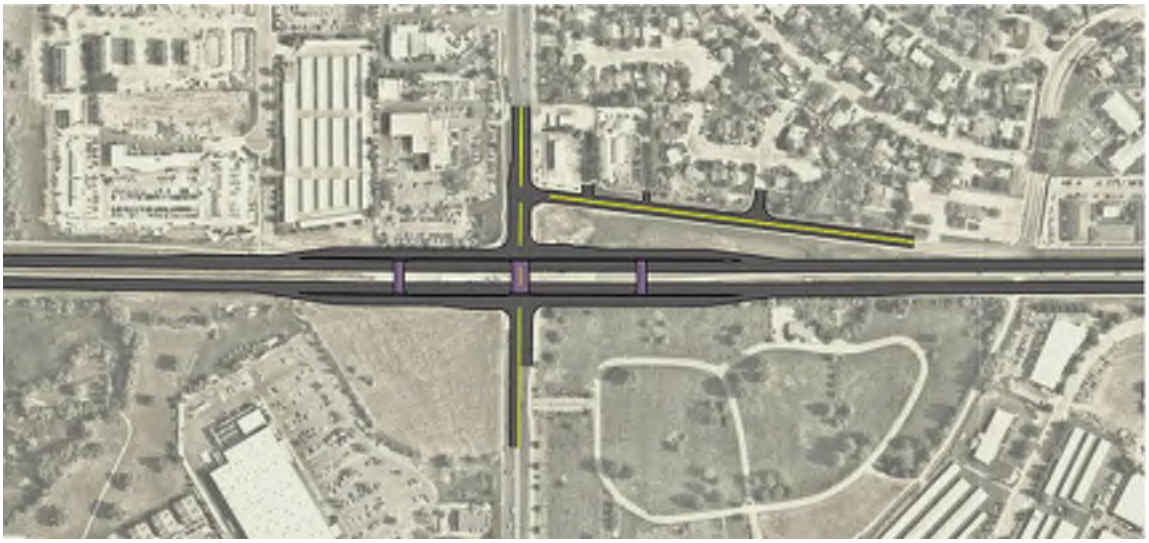
A partial cloverleaf (Parclo) shown in Figure 2.2, provides a high number of free flow turning movements and can use the land preserved in the southwest quadrant for one of the loop ramps. While this alternative provides free-flow movements at most ramps, it would require right-of-way in the northeast quadrant, impacting homes and businesses. Refer to Appendix E for more information on advantages and disadvantages.

Figure 2.2 – Partial Cloverleaf (Parclo)

2.1.3 Michigan Urban Diamond Interchange (MUDI)

The Michigan Urban Diamond Interchange (MUDI) shown in Figure 2.3, allows for removing left turns at the ramp/crossroad intersections by directing traffic to make U-turns between collector-distributor roadways connecting the on- and off-ramps. While this alternative eliminates conflicts associated with turns on 35th Avenue, it does not utilize the right-of-way set aside for a loop in the southwest quadrant, which provides a free-flow movement. Refer to Appendix E for more information on advantages and disadvantages.

Figure 2.3 – Michigan Urban Diamond Interchange (MUDI)



2.1.4 Partial Cloverleaf with Slip Ramp to 28th Street Roundabout (Parclo-R)

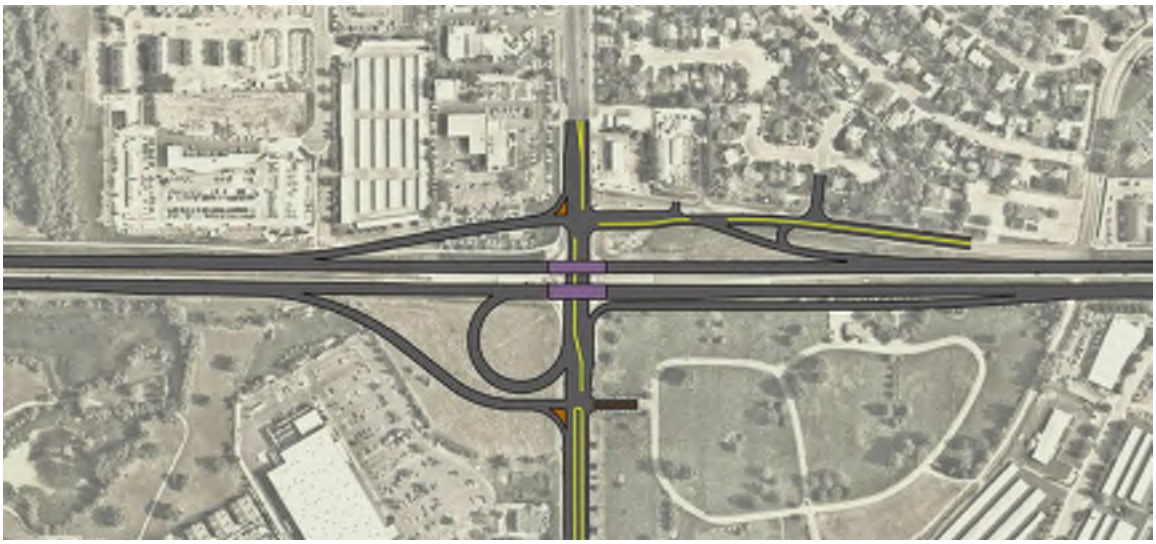
The partial cloverleaf with a slip ramp to a 28th Street roundabout alternative (Parclo-R) shown in Figure 2.4 is the preferred alternative in the PEL. It combines elements of a Parclo for ramps south of US 34 with a diamond/slip ramp system north of US 34. The westbound traffic exiting US 34 merges with 28th Street traffic at a roundabout intersection east of 35th Avenue and then proceeds to a standard signalized intersection on 35th Avenue. This alternative combines the ramp traffic and 28th Street traffic to avoid two closely spaced intersections on 35th Avenue.

Figure 2.4 – Partial Cloverleaf with Slip Ramp to 28th Street Roundabout (Parclo-R)

2.1.5 Partial Cloverleaf with Slip Ramp to Two-way 28th Street (Parclo-T)

The partial cloverleaf with a slip ramp to two-way 28th Street alternative (Parclo-T) shown in Figure 2.5, combines elements of a Parclo for ramps south of US 34 with a diamond/slip ramp system north of US 34. In this configuration, westbound traffic exiting US 34 merges with westbound 28th Street traffic while eastbound 28th Street traffic crosses the ramp traffic. Business access is combined, providing separation from the ramp crossing intersection.

Figure 2.5 – Partial Cloverleaf with Slip Ramp to Two-way 28th Street (Parclo-T)



2.1.6 D-Loop with Slip Ramp to One-way 28th Street

The D-loop with slip ramp to one-way 28th Street alternative shown in Figure 2.6, modifies the Parclo concept south of US 34 by shifting the northbound to eastbound movement to a D-loop ramp in the southwest quadrant. The D-loop eliminates squeezing a free-flow northbound to eastbound ramp adjacent to the cemetery and utilizes a new traffic signal on 35th Avenue at the eastbound exit ramp terminal/cemetery entrance. North of US 34, the diamond/slip ramp system converts 28th Street to a one-way (westbound) frontage road to merge with the westbound traffic exiting US 34.

Figure 2.6 – D-Loop with Slip Ramp to One-way 28th Street

2.1.7 Tight Diamond with D-Loop

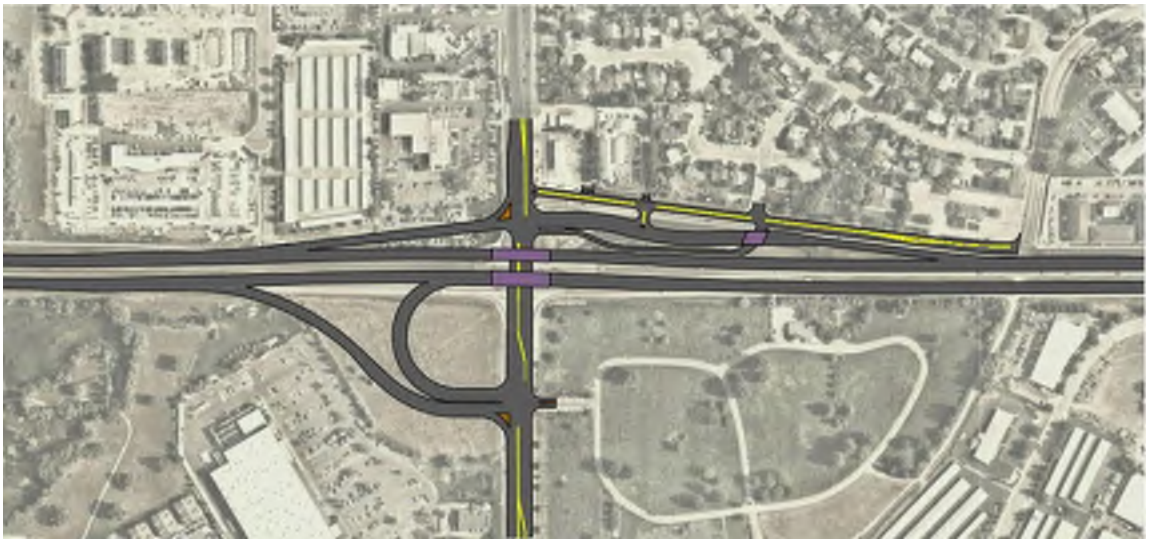
The tight diamond with a D-loop alternative shown in Figure 2.7, uses elements from various alternatives described above. It uses the D-loop configuration south of US 34. North of US 34, the exit and entrance ramps are moved close to the US 34 mainline lanes and 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue will be restricted to a ¾ movement, eliminating westbound left turns onto 35th Avenue, and partially signalized (northbound through and southbound left). This configuration provides approximately 80 ft. of separation along 35th Avenue between the ramp intersection and the 28th Street intersection.

Figure 2.7 – Tight Diamond with D-Loop

2.1.8 D-Loop and Tight Diamond with 28th Street Frontage Road Underpass

The D-loop and tight diamond with a 28th Street frontage road underpass alternative shown in Figure 2.8, uses elements from the previously described alternatives. It uses the D-loop configuration south of US 34. North of US 34, the exit and entrance ramps are moved close to the US 34 mainline lanes and 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue is converted to a right-in/right-out configuration and a new eastbound connector road is provided. The connector road is accessed at the signalized ramp intersection on 35th Avenue and passes under the westbound exit ramp to intersect with 28th Street at 33rd Ave Place. In addition, a short connector road is provided between 28th Street and the westbound exit ramp permitting ramp traffic access to 28th Street without using 35th Avenue and permitting 28th Street traffic access to a signalized left turn onto southbound 35th Avenue.

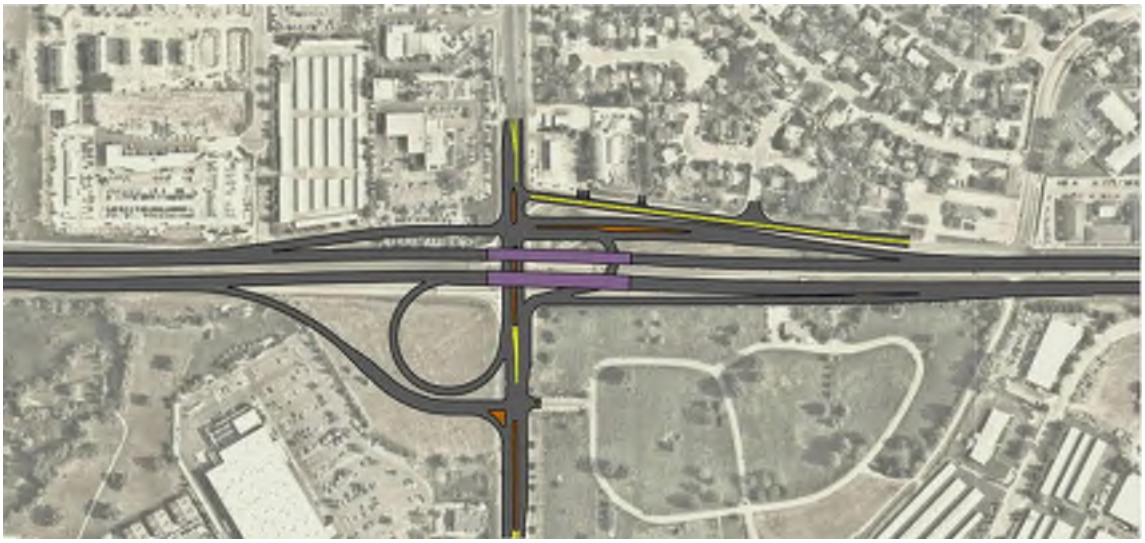
Figure 2.8 – D-Loop and Tight Diamond with 28th Street Frontage Road Underpass



2.1.9 Partial Cloverleaf and Tight Diamond with NB Indirect Left (Parclo-MUDI Hybrid)

The partial cloverleaf and tight diamond with NB indirect (Parclo-MUDI hybrid) shown in Figure 2.9, uses elements from the previously described alternatives. The goal of this alternative is to eliminate left turns from 35th Avenue to the entrance ramps for US 34. It uses the parclo configuration south of US 34 and adds a U-turn approach from the Michigan Urban Diamond concept to provide the northbound to westbound movement. This traffic movement makes a right turn from 35th Avenue and then turns left onto the westbound exit ramp to pass straight across 35th Avenue and onto the westbound entrance ramp. 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue will be restricted to a ¾ movement, eliminating westbound left turns onto 35th Avenue, and partially signalized (northbound through and southbound left).

Figure 2.9 – Partial Cloverleaf and Tight Diamond with NB Indirect Left (Parclo-MUDI Hybrid)



2.2 Level 1 Screening Criteria

Alternative screening criteria were developed in consultation with CDOT and the City of Greeley. It was decided that the same or similar criteria should be used at both the Level 1 and Level 2 screening with the Level 2 screening being more detailed. However, it was also agreed that new criteria may become apparent or previously identified criteria may be unnecessary to apply at Level 1. As a result, four criteria emerged as differentiators in the Level 1 analysis: safety, traffic operations, right-of-way impacts, and multimodal accommodations.

2.2.1 Safety

Safety focused on conflict points and estimating crash severity at these conflict points. In addition, safety included driver expectancy and potential for wrong-way movements.

2.2.2 Traffic Operations

Simplified preliminary Vissim and Synchro models based on the existing and forecasted 2045 traffic modeling were developed for each alternative to determine if the geometric layout would operate at an acceptable level of service.

2.2.3 Right-of-Way Impacts

Preliminary right-of-way was estimated using aerial imagery (not surveyed topography) and approximate right-of-way mapping. Each alternative geometric layout was evaluated to determine if the concept would remain within the existing right-of-way.

2.2.4 Multimodal Accommodations

Existing and proposed pedestrian, bicycle, and transit routes were mapped (Appendix C) to provide an overview of these facilities within the project area. Each alternative was reviewed to determine if

existing pedestrian, bicycle and transit routes could be maintained and if proposed routes could be accommodated.

2.3 Level 1 Screening

The Level 1 screening determined advantages and disadvantages for the previously described criteria for each alternative and the No-build option. Furthermore, some disadvantages were identified as a "Major Flaw" that eliminated the alternative from further consideration. A color-coded system (red, yellow, green, with green being the most favorable) was used to summarize the results of this screening as shown in Table 2.1. A detailed screening matrix with the advantages and disadvantages is provided in Appendix E.

Table 2.1 – 35th Avenue Level 1 Screening Summary

Level 1 Concept Alternative	Screening Criteria			
	Safety	Traffic Operations	Right-of-Way	Multimodal
Standard Diamond Interchange			Major Flaw	
Partial Cloverleaf (Parclo)			Major Flaw	
Michigan Urban Diamond Interchange (MUDI)			Major Flaw	
Partial Cloverleaf with Slip Ramp to 28th Street Roundabout (Parclo-R)		Major Flaw		
Partial Cloverleaf with Slip Ramp to Two-Way 28th Street (Parclo-T)	Major Flaw			
D-Loop with Slip Ramp to One-Way 28th Street		Major Flaw		
Tight Diamond with D-Loop				
D-Loop and Tight Diamond with 28th Street Frontage Road Underpass				
Partial Cloverleaf and Tight Diamond with NB Indirect Left (Parclo-MUDI Hybrid)				
No-build	Major Flaw	Major Flaw		

2.4 Level 1 Summary

The Level 1 screening process for the US 34 and 35th Avenue intersection included design iterations in addition to a comparison of alternatives. Due to the intersection constraints, the selected alternatives were determined by an evolution of ideas, testing, and refinements. Alternatives eliminated during Level 1 were early versions in the development of several basic concepts. As shown in Table 2.1, the most impactful criteria for the Level 1 screening was traffic operations. Also shown in the table, all but three alternatives have major flaws described in Appendix E which eliminate them from consideration. Therefore, the alternatives advancing to the Level 2 alternative analysis and screening are: (1) Tight Diamond with D-Loop, (2) D-Loop and Tight Diamond with 28th Street Frontage Road Underpass, and (3) Partial Cloverleaf and Tight Diamond with NB Indirect Left (Parclo-MUDI Hybrid). The No-build alternative was also carried forward to Level 2 to provide a baseline comparison for the other alternatives, in accordance with environmental guidelines.

SECTION 3.0 35TH AVENUE – LEVEL 2 ALTERNATIVE ANALYSIS AND SCREENING

3.1 Level 2 Alternatives

The three interchange alternatives (Figures 3.1 to 3.3) carried into the Level 2 alternative analysis and screening were refined based on recommendations from the traffic analysis. The number of turn lanes, storage length, and intersection operations (yield, stop or signal controlled) were adjusted as traffic models were optimized. In addition, several roadway geometric alternatives were evaluated for all three alternatives and included the following:

- The US 34 alignment was shifted to the north using long radius reverse curves. The benefits include:
    - The radii are long enough that superelevation is not required.
    - The shift allows for efficient construction phasing. The westbound lanes could be partially constructed without major temporary adjustments to the existing intersection.
    - The shift provides additional space between the US 34 eastbound lanes and the cemetery. This space could permit an eastbound entrance ramp and/or reduce the height of retaining walls in this area.
- The existing on-street bike lanes on 28th Street between 35th Avenue and Reservoir Road were replaced with a 10-ft. wide side path along the north side of the street. The benefits include:
    - Bicyclists uncomfortable riding in traffic lanes have a separate path to ride in.
    - The layout is compatible with the eastern extension of the US 34 side path planned for this area.
    - The side path on 28th Street would be an enhanced connection between the bike lanes on Reservoir Road and the side path along 35th Avenue.
    - Several of the alternatives include additional intersections at 28th Street. Providing a side path eliminates potential conflict points with on-street bike lanes and improves safety.
- Conceptual roadway vertical profiles were developed for two scenarios: US 34 over 35th Avenue and US 34 under 35th Avenue. Of the several options examined, the only option that would not meet geometric design criteria is maintaining US 34 in its current vertical location and carrying 35th Avenue over US 34. The options meeting geometric design criteria include: (1) US 34 over 35th Avenue with 35th maintaining its current vertical location, (2) US 34 over 35th Avenue with 35th being lowered, and (3) 35th Avenue over US 34 with US 34 being lowered. Even though 35th Avenue over a lowered US 34 is viable from a geometric standpoint, utility and drainage impacts as well as the potential for cut walls adjacent to the cemetery preclude this option from further consideration. Therefore, the most viable option is US 34 over 35th Avenue. A determination of whether 35th Avenue should remain at grade or lowered will be made in a future design stage because it impacts all interchange alternatives similarly and doesn't dictate the preferred alternative. It is expected that eliminating a small crest vertical curve on 35th Avenue will benefit any alternative.
- The three interchange alternatives are primarily differentiated by design features north of US 34 relating to connections with 28th Street. South of US 34, the alternatives have some level of exchangeability in that features shown below at one alternative may be able to be used at another alternative. These features include the following:
    - The D-loop (Figure 3.1 and Figure 3.3), where the southbound to eastbound movement uses a right-turn loop in the southwest quadrant, and the northbound to eastbound movement uses a left turn onto this same loop ramp.

- The Parclo loop (Figure 3.1) where the southbound to eastbound movement uses a right-turn loop in the southwest quadrant and the northbound to eastbound movement is made using a right turn onto a ramp between US 34 and the cemetery.
- While the Parclo offers slightly better traffic operations than the D-loop, it has not been determined if the northbound to eastbound ramp in the Parclo option can be constructed without impacting the cemetery. Further analysis, ground survey and right-of-way research will be required to determine the preferred configuration south of US 34.

Figure 3.1 – 35th Avenue Tight Diamond with D-Loop Interchange

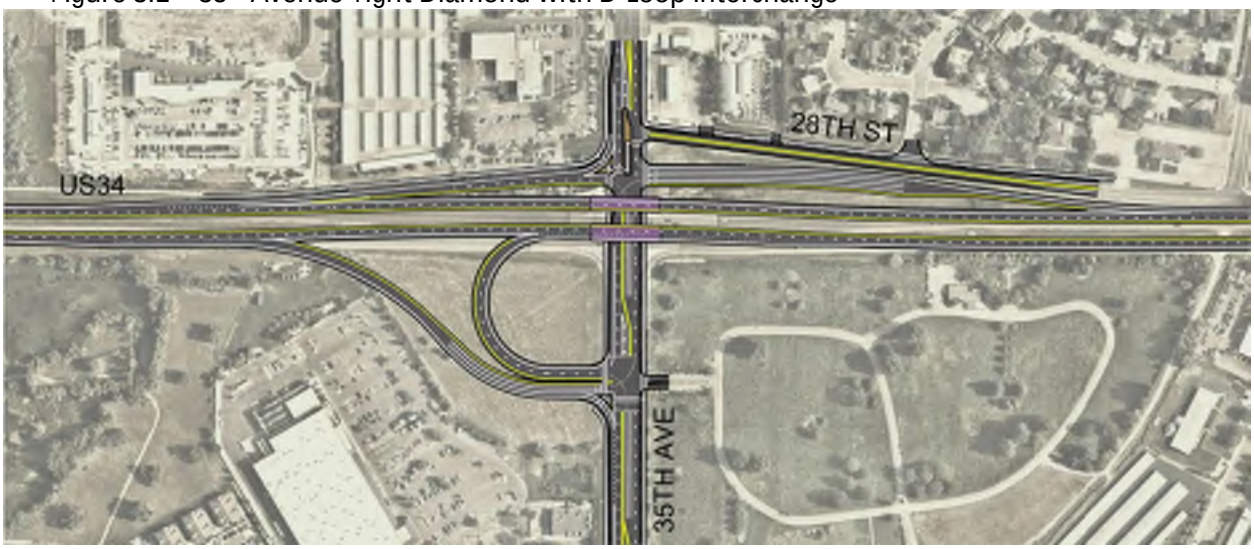


Figure 3.2 – 35th Avenue Parclo-MUDI Hybrid Interchange

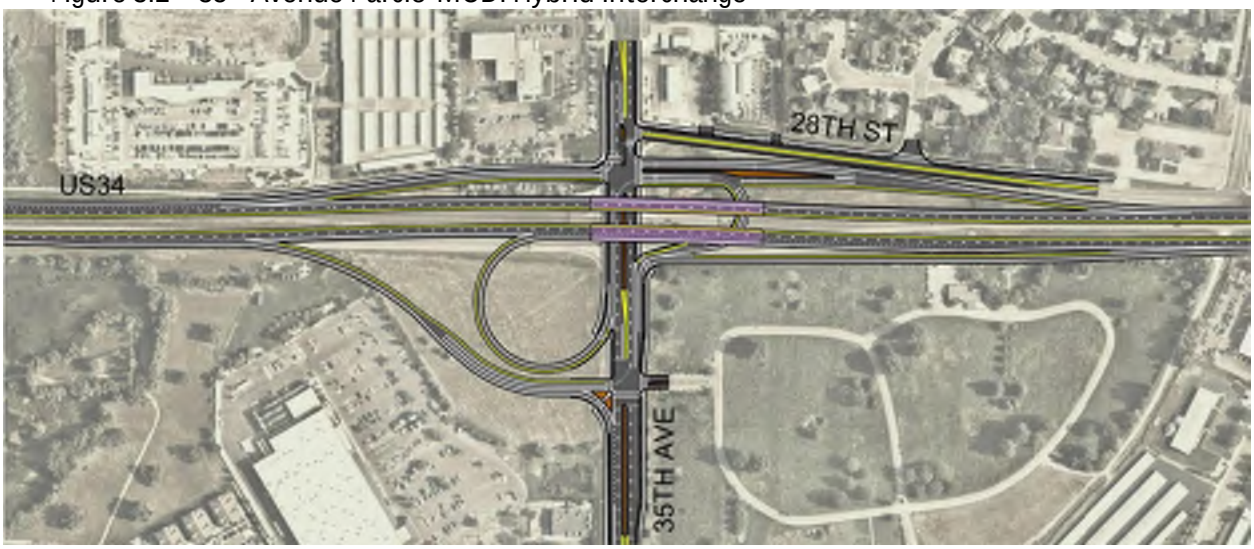
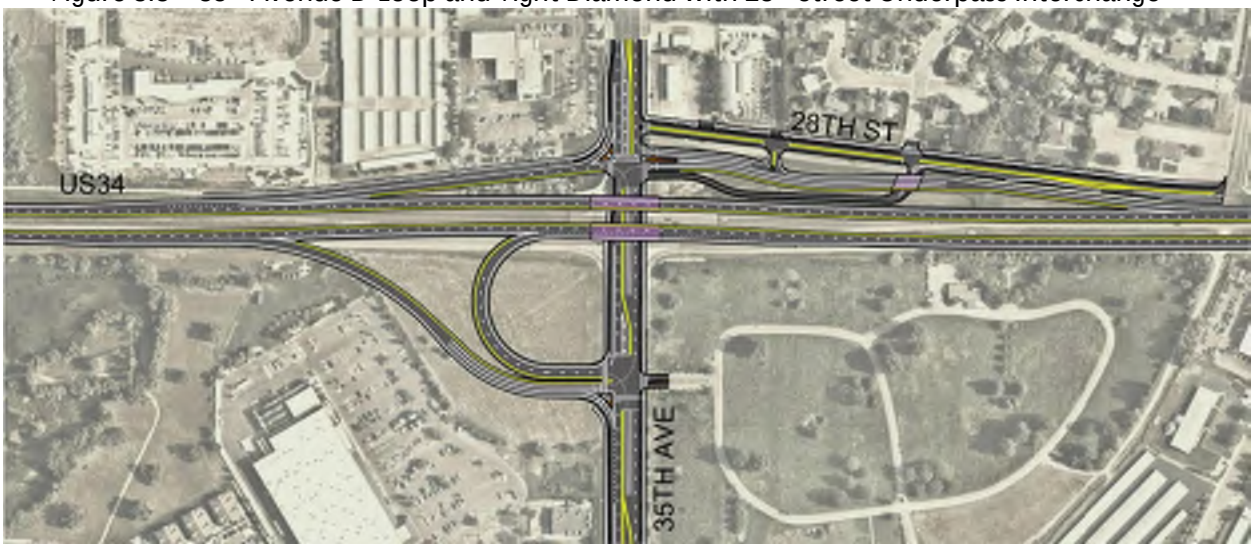


Figure 3.3 – 35th Avenue D-Loop and Tight Diamond with 28th Street Underpass Interchange



3.1.1 Design Criteria and Typical Section

In order to maintain consistency across alternatives, roadway geometric design criteria were developed and are included in Appendix D. In addition, US 34 roadway typical sections (Figure 3.4 and Figure 3.5 were determined based on the design criteria and recommendations from the PEL. The US 34 typical sections have the following features:

- Standard four-lane divided highway as determined by traffic analysis, which showed that a third lane in each direction would not be needed until after the year 2045.
- A median wide enough for a future lane in each direction as recommended in the PEL.
- The width of the median would transition between 47th Avenue and 35th Avenue such that in the future, an open median would be provided west of this transition for a more rural appearance and east of this transition, the future median would be closed with an additional third lane in each direction separated by a concrete barrier for a more urban appearance.
- Future continuous auxiliary lanes would be located between entrance and exit ramps if warranted by traffic analysis.

Figure 3.4 – US 34 Typical Section at 35th Avenue (4-Lane Interim Condition)

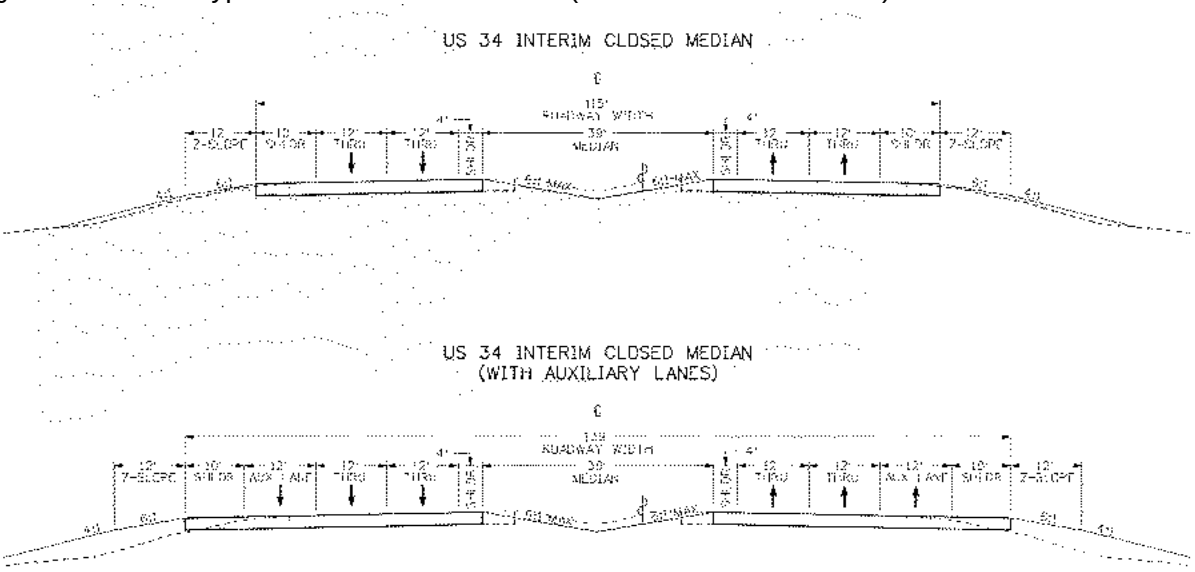
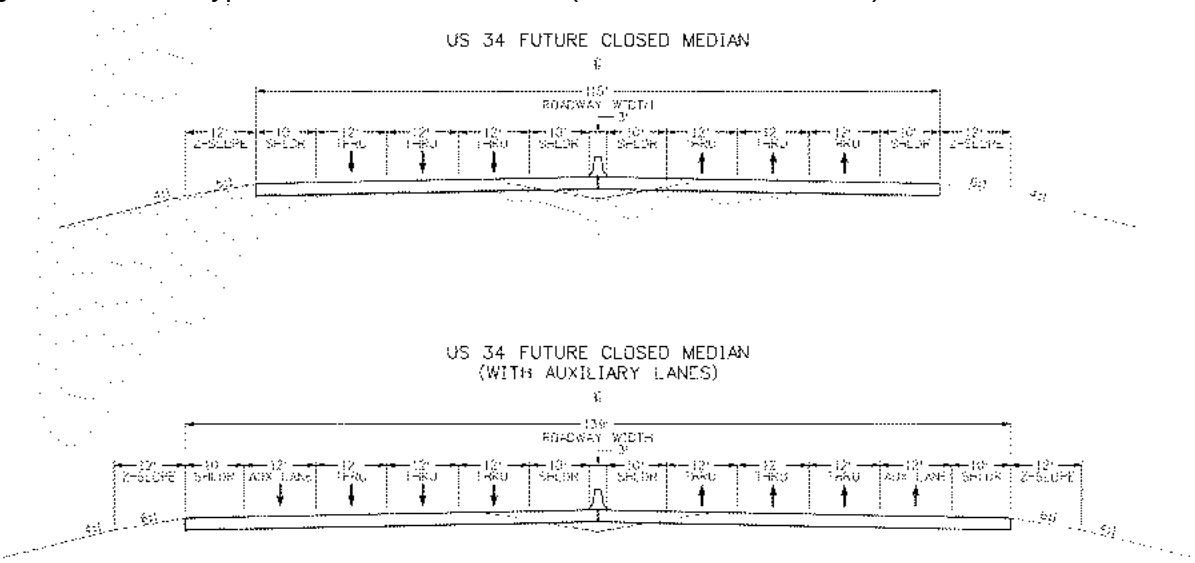


Figure 3.5 – US 34 Typical Section at 35th Avenue (6-Lane Future Condition)



The design criteria and typical section for 35th Avenue is based on the City of Greeley standard drawings for a four-lane major collector. The design criteria and typical section for 28th Street is based on CDOT standards for frontage roads since it is within CDOT right-of-way and maintained by CDOT.

3.1.2 No-build Alternative

The No-build alternative is carried forward to the Level 2 analysis and screening to comply with environmental guidelines. There were several "major flaws" identified with this alternative in the Level 1 analysis and screening but it is carried forward to provide a baseline comparison throughout the alternative analysis.

3.2 Level 2 Screening Criteria

The criteria used in Level 1 were recast as major categories in the Level 2 screening and specific criteria were developed for each category. The criteria are based on quantitative and qualitative questions with some answers being simply "yes" or "no". An explanation for criteria questions establishes the basis of the response. Quantitative metrics for the criteria questions were also established to reduce subjectivity. The following are the screening categories and the criteria questions used. Refer to Appendix F for a tabulation of the grading explanations and scoring details for each alternative, including the quantitative metrics and supporting data.

3.2.1 Safety

What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score (See Appendix F)? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.

Conflict points are a common measure of intersection safety. As stated in Chapter 9 of AASHTO's *A Policy on Geometric Design of Highways and Streets*, "Pedestrians, bicyclists and motor vehicles often cross paths at intersections where through and turning movements conflict. These crossings are referred to as 'conflict points,' and can be further categorized by movement type and corresponding severity. Table 3.1 is a summary of the conflict points associated with each alternative, categorized by crossing, merging, and diverging types.

Table 3.1 – 35th Avenue Vehicular Conflict Points

Conflict Type	Alternative			
	No-build (Existing)	Tight Diamond	Parclo-MUDI	28th Underpass
Vehicle/Vehicle Diverging	23	24	21	27
Vehicle/Vehicle Merging	23	26	25	38
Vehicle/Vehicle Crossing	24	31	22	51
Vehicle/Vehicle Crossing (High Speed)	8	0	0	0
Vehicle/Bike (Lane) Crossing	12	0	0	0
Vehicle/Ped Crossing	29	39	37	43

For each intersection, there was a weight given to each type of conflict: 0.5 to diverges, 1.0 to merges, and 2.0 for crossing movements. The total conflict interaction was the sum of the volume at the conflict points multiplied by the weighted conflict type. This was only applied to vehicle conflicts and was used to analyze various changes in conflicts of non-typical interchange features.

In addition to conflict points, existing crash data was evaluated to estimate the number and type of crashes that could be expected in the future. This exercise was used to develop a Crash Incident Score for each alternative as shown in Table 3.2. The score was developed using methodologies outlined in the *Highway Safety Manual (HSM), 1st Edition*; FHWA's *Highway Safety Benefit-Cost Analysis Guide*; and the *Transportation Systems Management and Operations Benefit-Cost Analysis Compendium*.

Table 3.2 – 35th Avenue Safety Analysis Crash Incident Score

	FHWA/Incident Plus 2016-2020 CPI	No-build	Present Value (2020) 20-Year Crash		
			Tight Diamond - D-Loop	Parlco-MUDI	28th Underpass
Fatalities	$10,464,000	0	0	0	0
Injuries	$242,600	153	70.1	69.1	84.6
Non-Injury Accidents	$3,500	143	95.5	93.6	109.0
Cost Savings (20 year)		$0	$63,936,600	$64,686,100	$52,696,100
Accident Cost (20 year)		$118,612,000	$54,675,400	$53,925,900	$65,915,900
Scoring out of 100		**45**	**99**	**100**	**82**

Severity is a measure of damage or injury a conflict incurs. Generally, crossing conflicts are more severe than merging and diverging conflicts, and all conflicts increase in severity as speed increases.

Driver expectation generalizes what drivers may consider to be a common or standard design. Driver expectation also considers local familiarity with a roadway configuration, such as similar intersections or interchanges nearby. Finally, driver confusion can be reduced with adequate signing and spacing to provide drivers adequate time to select their desired route.

3.2.2 Traffic Operations

Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.

Appendix B contains the Traffic Report with details on traffic data, traffic modeling methodology, and traffic analysis used for this project. Tables 3.3 and 3.4 provide a summary of the results of the traffic study.

Table 3.3 – 35th Avenue Average Hourly Interchange Delay and Level of Service (LOS)

2045	No-build				Tight Diamond			
	AM		PM		AM		PM	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
35th Ave	64	E	66	E	29	C	37	D

2045	Parclo-MUDI				28th Underpass			
	AM		PM		AM		PM	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
35th Ave	25	C	32	C	30	C	54	D

Table 3.4 – 35th Avenue Travel Time

2045		No-build				Tight Diamond			
		AM		PM		AM		PM	
		Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB	65th to 11th	697	11.6	746	12.4	405	6.7	579	9.6
WB	11th to 65th	833	13.9	1003	16.7	429	7.1	476	7.9
NB	35th	147	2.5	217	3.6	80	1.3	90	1.5
SB	35th	94	1.6	144	2.4	89	1.5	101	1.7

2045		Parclo-MUDI				28th Underpass			
		AM		PM		AM		PM	
		Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB	65th to 11th	397	6.6	576	9.6	391	6.5	595	9.9
WB	11th to 65th	392	6.5	480	8.0	388	6.5	470	7.8
NB	35th	67	1.1	95	1.6	72	1.2	24	0.4
SB	35th	77	1.3	42	0.7	84	1.4	83	1.4

3.2.3 Access

Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.

US 34 through the City of Greeley is a controlled-access facility and this project does not propose to change this designation. However, the project will make changes to 35th Avenue and 28th Street that impact access to adjacent properties. Each alternative introduces impacts at differing scales. This category gauges the level of permanent impact to adjacent properties. It does not consider temporary inconvenience that may be experienced during construction.

3.2.4 Constructability

What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)

This category assesses construction challenges for the project. These issues can translate into cost and risk for agencies and contractors. Constructability and construction phasing can also affect public perception and experience during construction.

3.2.5 Utilities

Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?

Utilities are commonly located within public right-of-way and must be considered during design and construction. This category evaluates utility impacts because utility infrastructure can be time consuming and costly to relocate. This evaluation is based on preliminary utility information and not a completed subsurface utility engineering (SUE) investigation.

3.2.6 Environmental

Due to the existing development and limited number of resources within the Project Area, as identified within the PEL, environmental impacts are anticipated to be limited.

Resources reviewed for the Alternatives Analysis included those present within the Study Area as identified in the US 34 Planning and Environmental Linkages Study (PEL) completed in 2019. Resources evaluated as part of the Alternatives Analysis include sensitive noise receptors, historic resources (irrigation ditches only), parks/trails, and air quality. The evaluation of these resources will allow the project team to differentiate between alternatives.

A CatEx document will be prepared to review and determine impacts to a more comprehensive list including, but not limited to air, noise, biological, Section 4(f), visual, socioeconomics, and cultural resources.

3.2.7 Flexibility for Future Needs

Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with *minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with* minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)

All build alternatives are designed anticipating future widening of US 34. This category evaluates if additional capacity could be constructed without impacting complex and costly infrastructure, such as bridges and walls. It also evaluates implementing planned future multimodal expansions.

3.2.8 Maintenance

What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?

This category evaluates long-term maintenance needs such as snow removal, landscaped areas, traffic signals, pavement, and structures. Material selection and construction quality can drastically affect long-

term maintenance but are assumed to be equal for each build alternative. In addition, this category evaluates the impact maintenance activities have on traffic and traffic control needs.

3.2.9 Multimodal Accommodations

Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease, and conflict.

This category evaluates the impact on existing multimodal (transit, bicycle, and pedestrian) facilities as opposed to the Flexibility for Future Needs category described above which addresses future plans for these facilities. This evaluation includes how bicycle and pedestrian facilities will be changed and if the changes will improve or diminish the user experience. The focus is on locations where trails and sidewalks cross roadways. Shorter distances and lower speed crossings are considered improvements to user experience.

3.2.10 Right-of-Way (ROW)

Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.

For the purposes of this report, right-of-way impacts are based on GIS information overlaid on aerials and not surveyed topography and accurate property determinations. Right-of-way impacts were an important consideration at Level 1 and all Level 2 alternatives are not expected to require significant additional right-of-way. This category also considers other right-of-way impacts, such as permanent and temporary easements, including those required by other factors such as utilities.

3.2.11 Drainage and Irrigation

Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.

Since roadways and drainage are interdependent, drainage considerations can often add significant cost to roadway projects. This category evaluates if existing drainage and irrigation facilities require adjustment based on preliminary understanding of these systems. It also factors the known drainage and irrigation issues into the alternatives analysis.

3.3 Level 2 Screening and Scoring Matrix

Similar to the Level 1 screening, a color-coded system (green, yellow, red) and numerical grading was applied to each screening category based on answers to the criteria questions and the qualitative and quantitative metrics. A color was then assigned corresponding to the grade (Green = 1.0-1.9, Yellow = 2.0-2.9 and Red = 3.0+), with green being more favorable. This grade is then weighted according to the Level 2 screening category. This weighting was based on the project goals outlined in Section 1.1 Project Background and relative importance. The weighting values were determined in consultation with CDOT

and the City of Greeley and reflect that the main purpose of the project is to improve safety and traffic operations. Finally, the weighted grades are summed and the interchange alternative with the lowest score is presumed to be preferred alternative. Appendix F provides detailed information on the grading explanations; scoring details for the qualitative and quantitative metrics; and supporting data associated with these metrics. A summary of the weighted grades and rank of each alternative is provided in Table 3.5.

It was also important to solicit public feedback during the development of the screening categories and weighting to confirm the determinations. A virtual open house was provided to the public on CDOT's US 34 project website while the Level 2 screening and alternative analysis was in progress. Six of the most important screening categories from Table 3.5 were presented in the open house which included safety; traffic operations; access; right-of-way; multimodal; and environmental. While the importance of weighting was not discussed in detail during the virtual open house, the public was asked to participate in a survey in order to rank the screening categories by importance. The survey results support the weighting for categories shown below.

Table 3.5 – 35th Avenue Level 2 Screening Summary

Category	Weight	Alternative			
		No-build	Tight Diamond	Parclo-MUDI	28th Underpass
		Grading			
Safety	30%	2.3	1.2	1.3	1.8
Traffic Operations	25%	3.0	1.0	1.0	1.0
Access	7%	1.0	2.0	2.0	1.0
Constructability	3%	1.0	2.0	2.0	2.0
Utilities	3%	1.0	2.0	2.0	2.0
Environmental	7%	2.3	1.8	1.8	1.8
Flexibility for Future Needs	7%	2.7	1.3	1.0	1.3
Maintenance	5%	2.0	1.7	1.7	1.7
Multimodal Accommodations	7%	2.0	1.4	1.6	1.4
Right-of-Way	3%	1.0	1.0	1.0	1.3
Drainage & Irrigation	3%	1.7	1.0	1.0	1.0
WEIGHTED GRADE	100%	2.25	1.33	1.35	1.45
	RANK	4	1	2	3

3.4 Conceptual Construction Cost

Conceptual cost estimates were developed primarily as a high-level comparative tool for the Level 2 alternatives. It is important to note that the cost estimate for the preferred alternative will be refined as design progresses and it is anticipated that the costs will be lower; however, these costs do not include continuous auxiliary lanes between interchanges. The estimates are based on hard features such as pavement, bridges, walls, curb and gutter, and sidewalk, developed during the Level 2 screening. A base project cost was developed using the hard feature quantities and recent construction cost data. All other elements except right-of-way typically associated with similar projects were estimated as a percentage of this base cost. Table 3.6 summarizes the construction costs for each alternative. Additional detail supporting the cost estimates can be found in Appendix G.

Table 3.6 – 35th Avenue Cost Estimate Summary

	Tight Diamond	Parclo-MUDI	28th Underpass
Base Cost	23,186,000	$29,727,000	$24,945,000
Environmental Items (2%)	$463,720	$594,540	$498,900
MOT Items (5%)	$1,159,300	$1,486,350	$1,247,250
Drainage & Water Quality Items (10%)	$2,318,600	$2,972,700	$2,494,500
Traffic Items (2%)	$463,720	$594,540	$498,900
Utility Items (10%)	$2,318,600	$2,972,700	$2,494,500
Total Construction Cost	$29,909,940	$38,347,830	$32,179,050
Force Accounts (10%)	$2,991,000	$3,835,000	$3,218,000
Right-of-Way	$160,000	$150,000	$370,000
Construction Engineering (11%)	$3,291,000	$4,219,000	$3,540,000
Construction Indirects (9.5%)	$2,842,000	$3,644,000	$3,058,000
Total Program Cost	$39,193,940	$50,195,830	$42,365,050

3.5 Level 2 Summary and Preferred Alternative

Based on the Level 2 alternative analysis and screening, all three alternatives are viable; however, the 28th Street underpass interchange scored higher (less favorable) than the tight diamond and Parclo-MUDI hybrid alternatives. While the 28th Street underpass provided the best access, it consistently scored the same or worse in other categories, including one of the highest weighted categories of

safety. The poor safety score was primarily due to the number of conflict points and a higher delay time than the other alternatives.

The tight diamond and Parclo-MUDI scored extremely close overall, with scores of 1.33 and 1.35, respectively, as shown in Table 3.6 above. While the tight diamond has the best score, the narrow margin suggests that any slight change in scoring could result in the Parclo-MUDI having the best score. This also suggests that both alternatives would be appropriate as the preferred alternative. A more detailed evaluation of the individual categories reveals the tight diamond scored better in two of the higher weighted categories, safety (30%) and multimodal (7%) which should be considered when determining the preferred alternative. While environmental guidelines remove cost as a criterion for selecting the preferred alternative, it is important to provide context in terms of cost when the alternatives score closely. In this case, the estimated cost at a conceptual design level for the Parclo-MUDI is approximately 25%-30% higher than the tight diamond.

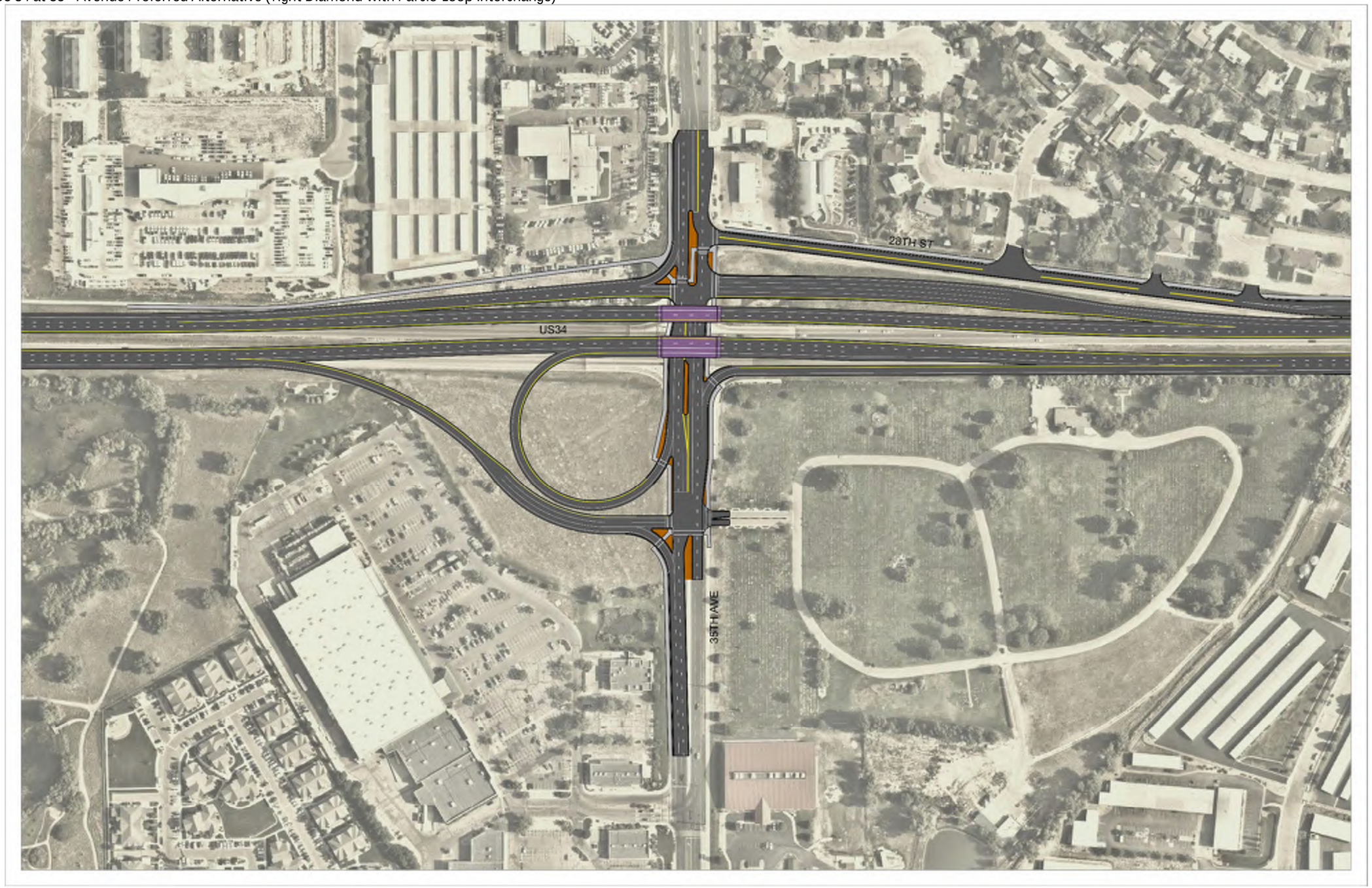
Based on a more detailed evaluation of the individual categories, the better overall score and cost impacts, the tight diamond was identified as the preferred alternative over the Parclo-MUDI; however, another level of analysis during preliminary design was necessary to determine the final configuration.

As noted in Section 3.1, the three alternatives are primarily differentiated by design features north of US 34 relating to connections with 28th Street. South of US 34 there was a level exchangeability between the Parclo-loop and the D-Loop. While both options would be satisfactory, the Parclo provides slightly better traffic operations. Additional ground survey and right-of-way research during the early stages of design proved that the northbound to eastbound ramp could be constructed without impacts to the cemetery; therefore, a revised safety analysis like that shown in Table 3.2 was developed to include a Tight Diamond with Parclo-Loop alternative. The results, shown in Table 3.7, revealed that the Tight Diamond with Parclo-Loop offered additional safety benefits compared to the Tight Diamond with D-Loop. Having identified the tight diamond configuration north of US 34 as the preferred alternative, this additional analysis slightly favors the parclo-loop configuration south of US 34; therefore, the Tight Diamond with Parclo-Loop, as shown in Figure 3.6, is the preferred alternative for the US 34 and 35th Avenue interchange.

Table 3.7 – 35th Avenue Update Safety Analysis Crash Incident Score

	FHWA/Incident Plus 2016-2020 CPI	No-build	Present Value (2020) 20-Year Crash Expectancy			
			Tight Diamond - D-Loop	Tight Diamond - Parclo	Parlco-MUDI	28th Underpass
Fatalities	$10,464,000	0	0.0	0.0	0.0	0.0
Injuries	$242,600	153	70.1	63.8	69.1	84.6
Non-Injury Accidents	$3,500	143	95.5	89.6	93.6	109.0
Cost Savings (20 year)		$0	$63,936,600	$68,820,700	$64,686,100	$52,696,100
Accident Cost (20 year)		$118,612,000	$54,675,400	$49,791,300	$53,925,900	$65,915,900
Scoring out of 100		42	91	100	92	76

Figure 3.6 – US 34 at 35th Avenue Preferred Alternative (Tight Diamond with Parclo-Loop Interchange)



SECTION 4.0 47TH AVENUE – LEVEL 1 ALTERNATIVE ANALYSIS AND SCREENING

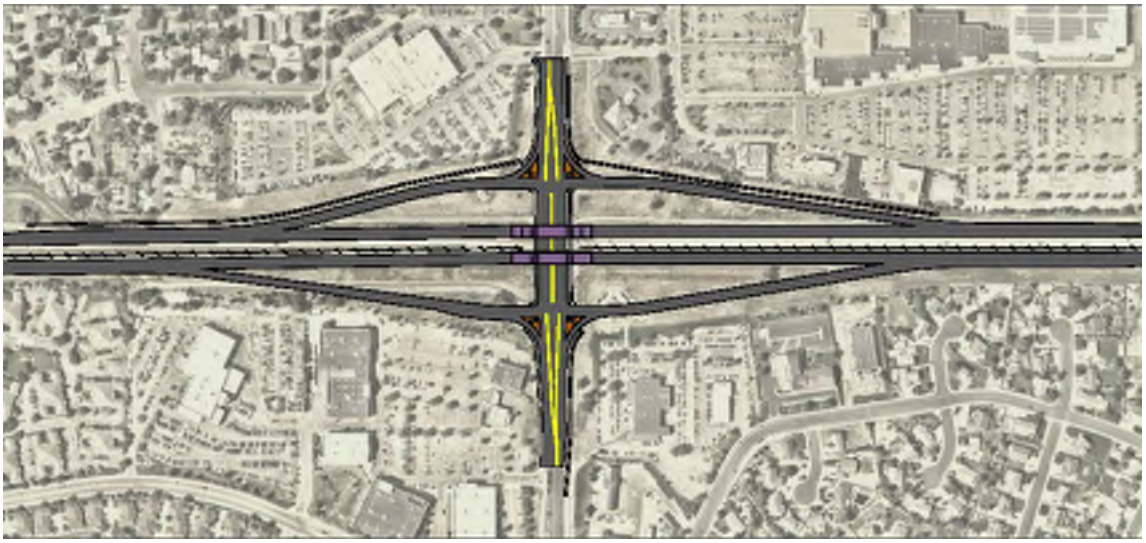
4.1 Level 1 Alternatives

At the US 34 and 47th Avenue intersection, the PEL considered diamond configurations to be the most likely alternatives due to the previously dedicated or preserved right-of-way in all four quadrants. A standard diamond, a diverging diamond, and a single point urban interchange were considered viable alternatives, with the standard diamond shown in the PEL as a "reasonably conservative footprint". As part of the interchange screening process, six interchange alternatives were developed for the US 34 and 47th Avenue intersection as described below. These alternatives included the three considered in the PEL as well as three additional alternatives that were identified to verify the assumptions in the PEL. Potential alternatives that would require signalization on US34 were not permitted in order to maintain US34 as an expressway through this intersection. The No-build scenario is considered in the screening as a baseline comparison to the build alternatives.

4.1.1 Standard Diamond Interchange with Signals (SDI)

The standard diamond interchange (SDI) shown in Figure 4.1, has four ramps and two signalized intersections on 47th Avenue. The intersections would provide two left-turn lanes and channelized right-turn lanes. Auxiliary lanes would be added to 47th Avenue between 26th Street and 29th Street in addition to two thru lanes in each direction.

Figure 4.1 – Standard Diamond Interchange with Signals (SDI)



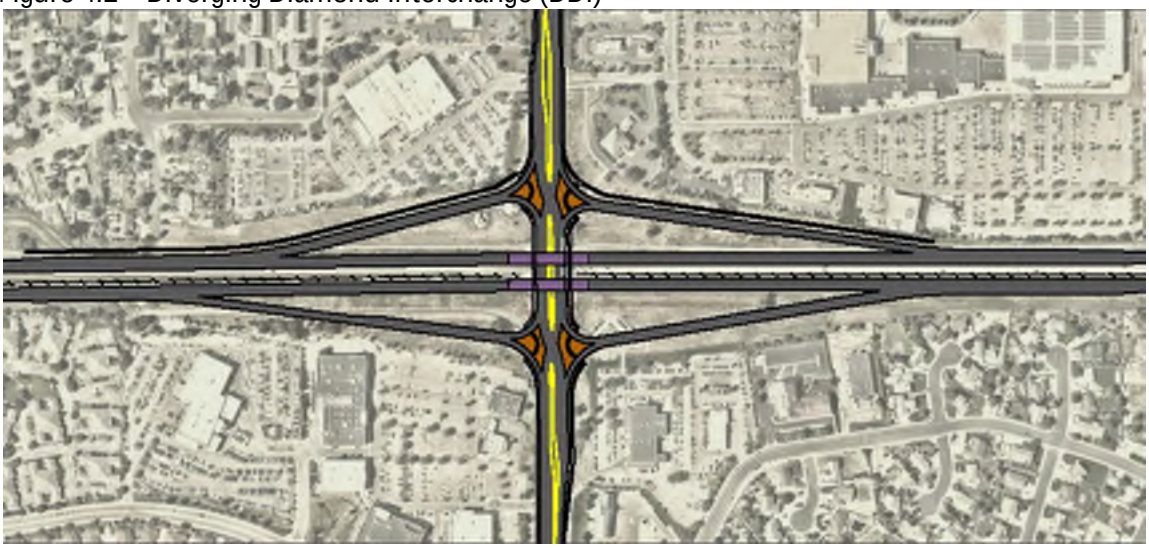
4.1.2 Standard Diamond Interchange with Roundabouts (SDI-R)

The standard diamond with roundabouts alternative (SDI-R) is like the SDI, with roundabout intersections instead of signals on 47th Avenue to potentially enhance traffic operations. The roundabouts would be two lanes with right-turn bypasses. Forty-seventh Avenue would be reconfigured between 26th Street and 29th Street to provide the required medians and deflections needed for the roundabouts.

4.1.3 Diverging Diamond Interchange (DDI)

The diverging diamond interchange (DDI) shown in Figure 4.2, has two signalized intersections on 47th Avenue. Unlike a standard diamond, 47th Avenue through and left-turn traffic would crossover at each intersection to provide free flowing left turn movements. Free flow right-turn movements are still provided at the intersections. Auxiliary lanes would be added to 47th Avenue between 26th Street and 29th Street, in addition to two thru lanes in each direction.

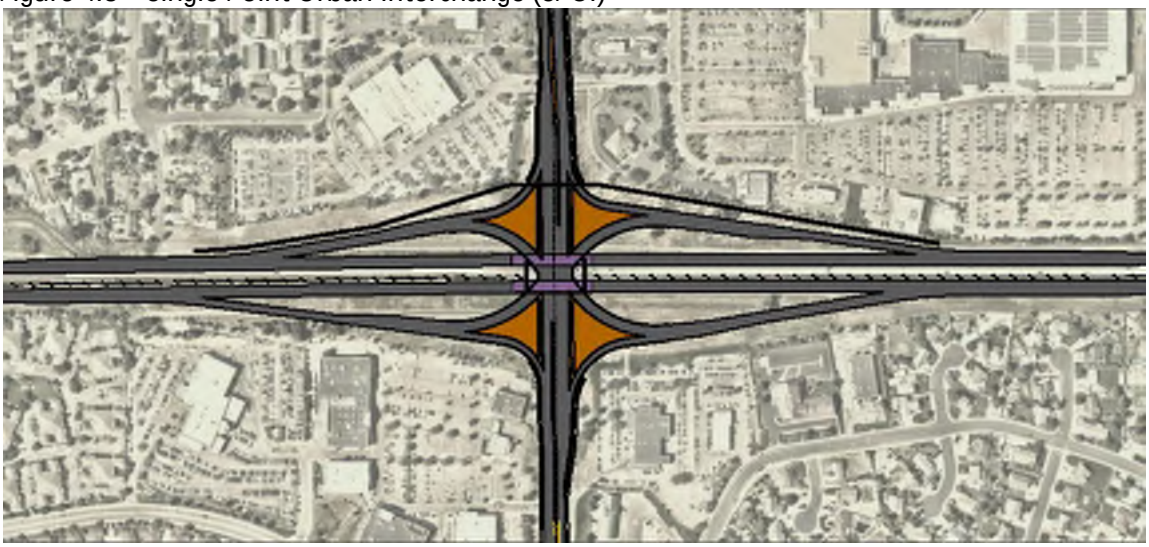
Figure 4.2 – Diverging Diamond Interchange (DDI)



4.1.4 Single Point Urban Interchange (SPUI)

The single point urban interchange (SPUI) shown in Figure 4.3, is a diamond interchange where the ramps curve into a single signalized intersection on 47th Avenue, instead of two. The single point intersection would provide dual left turns for each direction, with channelized free right turns. Auxiliary lanes would be added to 47th Avenue between 26th Street and 29th Street, in addition to two thru lanes in each direction.

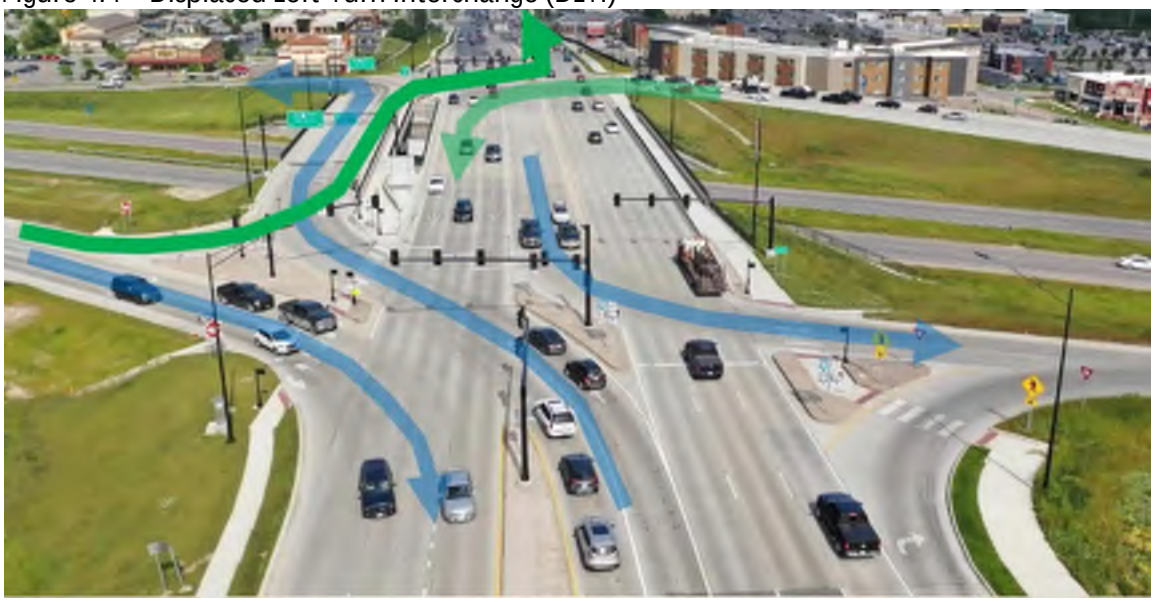
Figure 4.3 – Single Point Urban Interchange (SPUI)



4.1.5 Displaced Left-Turn Interchange (DLTI)

The displaced left-turn interchange (DLTI) is a diamond interchange with two signalized intersections on 47th Avenue. Figure 4.4 shows a rendering of a DLTI from a TranSystems presentation for the Institute of Transportation Engineers (ITE). Left turns from 47th Avenue to US 34 would crossover ahead of each intersection to prevent conflicts with opposing thru traffic. Auxiliary lanes would be added to 47th Avenue between 26th Street and 29th Street, in addition to two thru lanes in each direction.

Figure 4.4 – Displaced Left-Turn Interchange (DLTI)



4.1.6 Partial Cloverleaf Interchange (Parclo)

A partial cloverleaf interchange (Parclo) has six ramps to create two intersections on 47th Avenue. Loop ramps would be provided in the northeast and southwest quadrants to provide free flow access from

47th Avenue to US 34. Slip ramps would be provided in all four quadrants with signalized intersections on 47th Avenue for left turn movements at ramp exits. Auxiliary lanes would be added to 47th Avenue between 26th Street and 29th Street, in addition to two thru lanes in each direction.

4.2 Level 1 Screening Criteria

Alternative screening criteria were developed in consultation with CDOT and the City of Greeley. It was decided that the same or similar criteria should be used at both the Level 1 and Level 2 screening with the Level 2 screening being more detailed. However, it was also agreed that new criteria may become apparent or previously identified criteria may be unnecessary to apply at Level 1. As a result, four criteria emerged as differentiators in the Level 1 analysis: safety, traffic operations, right-of-way impacts, and multimodal accommodations.

4.2.1 Safety

Safety focused on conflict points and estimating crash severity at these conflict points. In addition, safety included driver expectancy and potential for wrong-way movements.

4.2.2 Traffic Operations

Simplified preliminary Vissim and Synchro models based on the existing and forecasted 2045 traffic modeling were developed for each alternative to determine if the geometric layout would operate at an acceptable level of service.

4.2.3 Right-of-Way Impacts

Preliminary right-of-way was estimated using aerial imagery (not surveyed topography) and approximate right-of-way mapping. Each alternative geometric layout was evaluated to determine if the concept would remain within the existing right-of-way.

4.2.4 Multimodal Accommodations

Existing and proposed pedestrian, bicycle, and transit routes were mapped (Appendix C) to provide an overview of these facilities within the project area. Each alternative was reviewed to determine if existing pedestrian, bicycle, and transit routes could be maintained and if proposed routes could be accommodated.

4.3 Level 1 Screening

The Level 1 screening determined advantages and disadvantages for the previously described criteria for each alternative and the No-build option. In addition, some disadvantages were identified as a "Major Flaw" that eliminated the alternative from further consideration. A color-coded system (red, yellow, green, with green being the most favorable) was used to summarize the results of this screening as shown in Table 4.1. A detailed screening matrix with the advantages and disadvantages is provided in Appendix H.

Table 4.1 – 47th Avenue Level 1 Screening Summary

Level 1 Concept Alternative	Screening Criteria			
	Safety	Traffic Operations	Right-of-Way	Multimodal
Standard Diamond Interchange (SDI)				
Standard Diamond Interchange with Roundabouts (SDI-R)		Major Flaw		
Diverging Diamond Interchange (DDI)				
Single Point Urban Interchange (SPUI)				
Displaced Left-turn Interchange (DLTI)		Major Flaw	Major Flaw	
Partial Cloverleaf Interchange (Parclo)			Major Flaw	
No-build	Major Flaw	Major Flaw		

4.4 Level 1 Summary

Based on the Level 1 screening of the alternatives, the SDI, SPUI, and DDI met the goals of the project and did not have any major flaws. Therefore, all three alternatives were advanced to the more detailed Level 2 alternative analysis and screening, in addition to the No-build alternative. The No-build alternative was also carried forward to Level 2 to provide a baseline comparison for the other alternatives, in accordance with environmental guidelines. The SDI-R, DLTI and Parclo were all found to have major flaws for traffic operations and/or right-of-way as described in Appendix H which prevented these alternatives from being carried forward to Level 2.

SECTION 5.0 47TH AVENUE – LEVEL 2 ALTERNATIVE ANALYSIS AND SCREENING

5.1 Level 2 Alternatives

The three interchange alternatives (Figures 5.1 to 5.3) carried into the Level 2 alternative analysis and screening were refined based on recommendations from the traffic analysis. The number of turn lanes, storage length, and intersection operations (yield, stop or signal controlled) were adjusted as traffic models were optimized. In addition, roadway geometric alternatives were evaluated and included the following:

- Conceptual roadway vertical profiles were developed for two scenarios: US 34 over 47th Avenue and US 34 under 47th Avenue. Of the several options examined, it was determined that the option that would best meet design criteria and reduce impacts on 47th Avenue is US 34 over 47th Avenue, which confirms the findings of PEL. In this scenario, 47th Avenue would remain on grade except for removing the existing US 34 crown. This profile results in an approximate 2-ft. to 3-ft. cut through the existing intersection for the SDI and DDI options. Due to the additional bridge structure depth required for the SPUI alternative, the 47th Avenue profile would be cut an additional 5 ft. Determining if 47th Avenue should remain at grade or lowered will be made in a future design stage because it impacts all interchange alternatives similarly and doesn't influence the preferred alternative.

- The SPUI configuration was revised to remove the reverse curves on 47th Avenue shown during the Level 1 screening. By modifying the ramp geometry, 47th Avenue can remain on alignment and reduce impacts to existing right-of-way and facilities.

Figure 5.1 – 47th Avenue Standard Diamond Interchange (SDI)

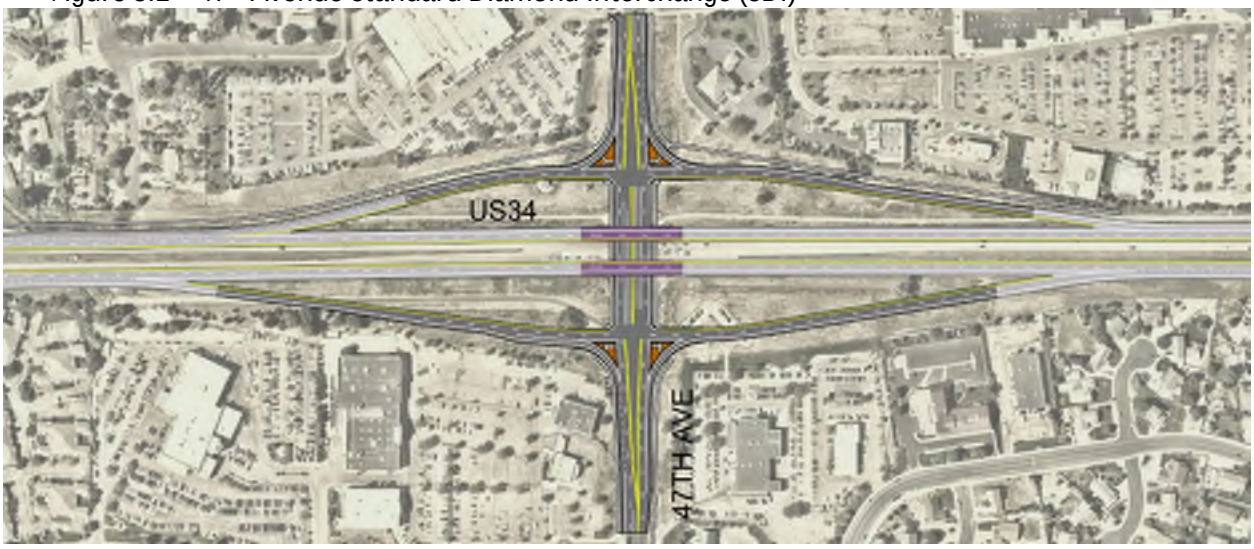


Figure 5.2 – 47th Avenue Diverging Diamond Interchange (DDI)

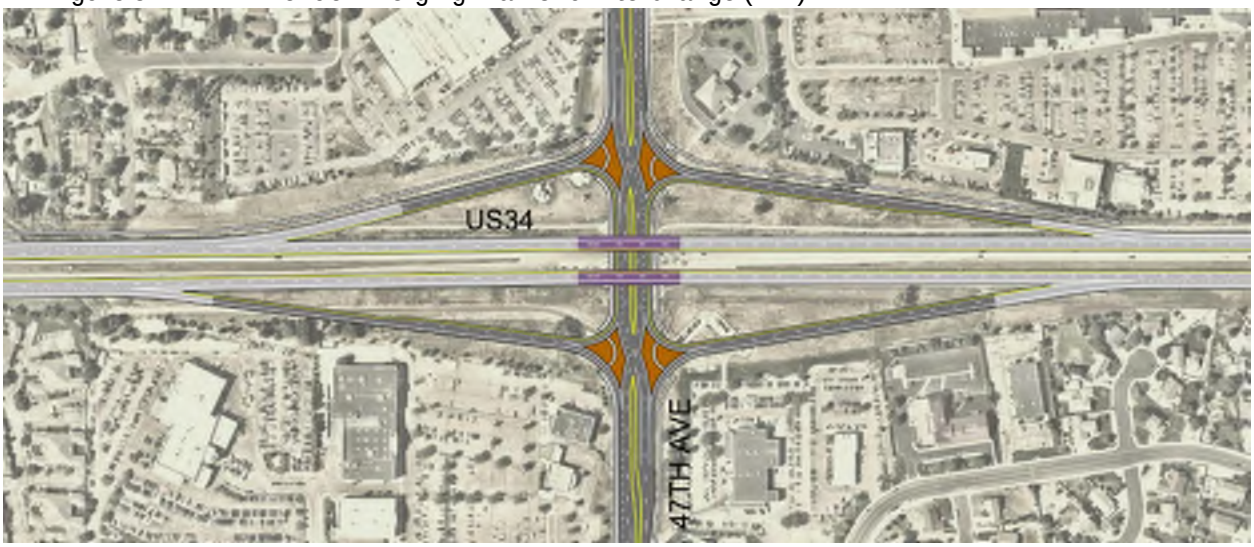
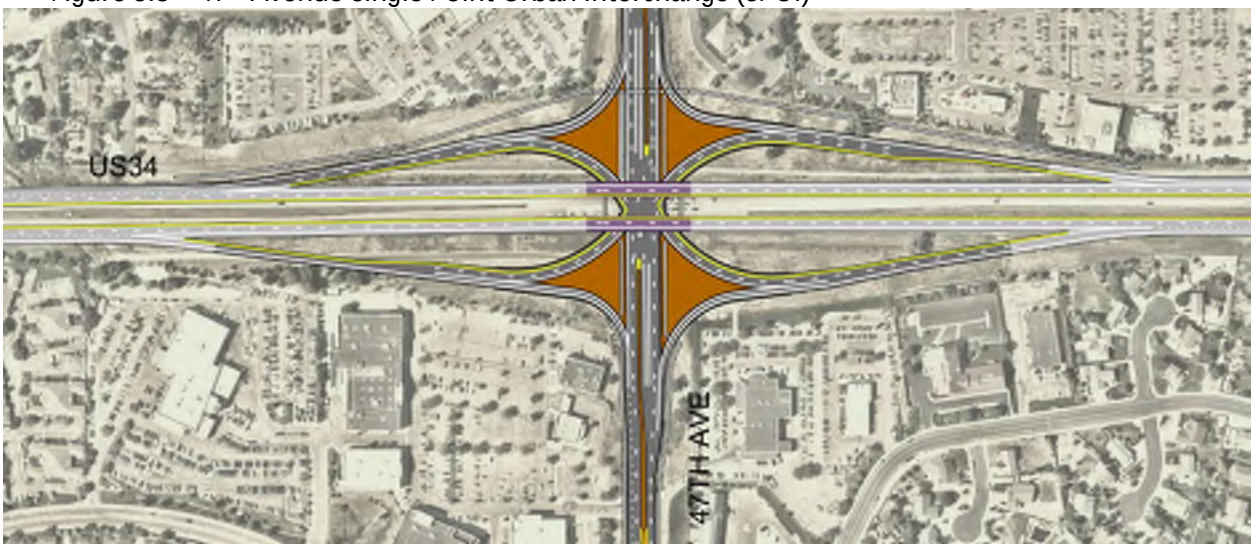


Figure 5.3 – 47th Avenue Single Point Urban Interchange (SPUI)



5.1.1 Design Criteria and Typical Section

In order to maintain consistency across alternatives, roadway geometric design criteria were developed and are included in Appendix D. In addition, US 34 roadway typical sections (Figure 5.4 and 5.5) were determined based on the design criteria and recommendations from the PEL. The US 34 typical sections have the following features:

- Standard four-lane divided highway as determined by traffic analysis, which showed that a third lane in each direction would not be needed until after the year 2045.
- A median wide enough for a future lane in each direction as recommended in the PEL.
- The width of the median would transition between 47th Avenue and 35th Avenue such that in the future, an open median would be provided west of this transition for a more rural appearance and east of this transition, the future median would be closed with an additional third lane in each direction separated by a concrete barrier for a more urban appearance.
- Future continuous auxiliary lanes would be located between entrance and exit ramps if warranted by traffic analysis.

Figure 5.4 – US 34 Typical Section at 47th Avenue (4-Lane Interim Condition)

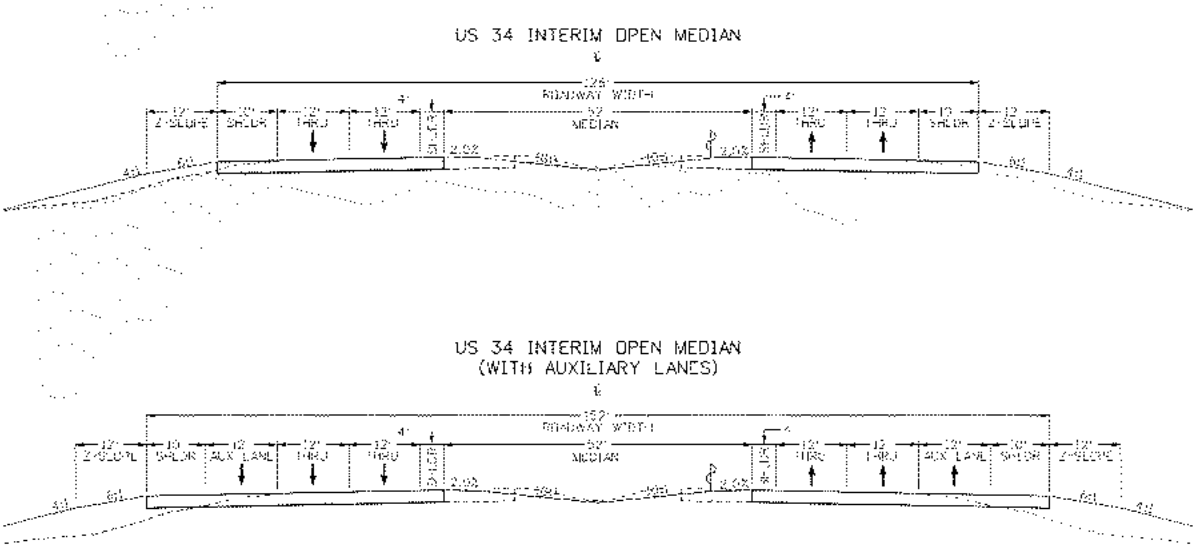
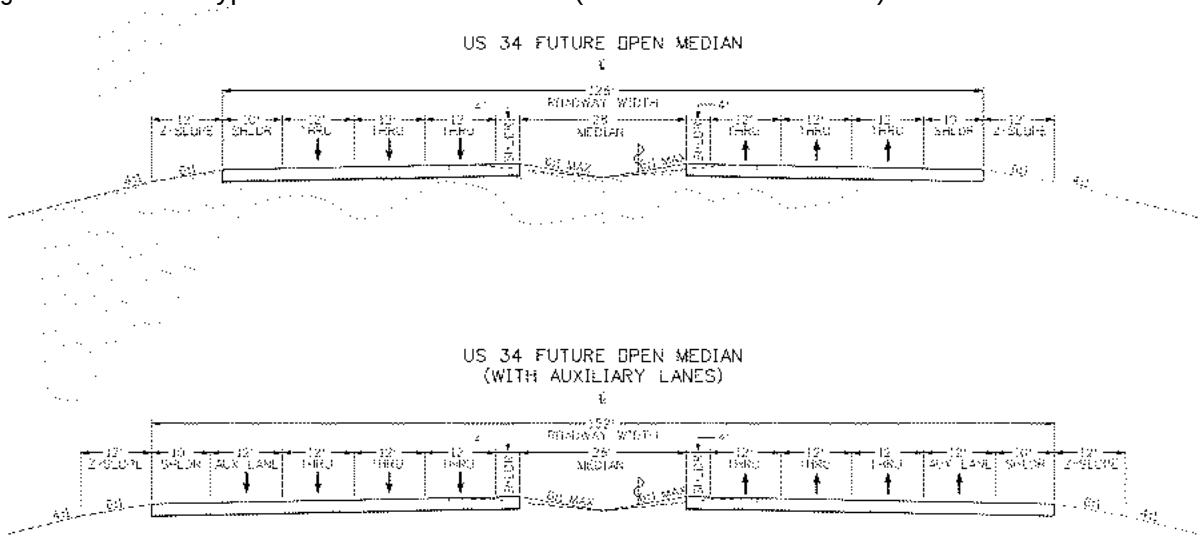


Figure 5.5 – US 34 Typical Section at 47th Avenue (6-Lane Future Condition)



The design criteria and typical section for 47th Avenue is based on the City of Greeley standards for a four-lane major collector.

5.1.2 No-build Alternative

The No-build alternative is carried forward to the Level 2 analysis and screening to comply with environmental guidelines. There were several "major flaws" identified with this alternative in the Level 1 analysis and screening but it is carried forward to provide a baseline comparison throughout the alternative analysis.

5.2 Level 2 Screening Criteria

The criteria used in Level 1 were recast as major categories in the Level 2 screening and specific criteria were developed for each category. The criteria are based on quantitative and qualitative questions with some answers being simply "yes" or "no". An explanation to criteria questions establishes the basis of the response. Quantitative metrics for the criteria questions were also established to reduce subjectivity. The following are the screening categories and the criteria questions used. Refer to Appendix I for a tabulation of the grading explanations and scoring details for each alternative, including the quantitative metrics and supporting data.

5.2.1 Safety

What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score (See Appendix I)? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.

Conflict points are a common measure of intersection safety. As stated in Chapter 9 of AASHTO's *A Policy on Geometric Design of Highways and Streets*, "Pedestrians, bicyclists and motor vehicles often cross paths at intersections where through and turning movements conflict. These crossings are referred to as 'conflict points,' and can be further categorized by movement type and corresponding severity." Table 5.1 is a summary of the conflict points associated with each alternative, categorized by crossing, diverging, and merging types.

Table 5.1 – 47th Vehicular Conflict Points

	Alternative			
Conflict Type	No-build (Existing)	SDI	DDI	SPUI
Vehicle/Vehicle Diverging	8	8	8	8
Vehicle/Vehicle Merging	8	8	8	8
Vehicle/Vehicle Crossing	16	10	2	8
Vehicle/Vehicle Crossing (High Speed)	12	0	0	0
Vehicle/Bike (Lane) Crossing	12	4	4	0
Vehicle/Ped Crossing	24	16	8	8

For each intersection, there was a weight given to each type of conflict: 0.5 to diverges, 1.0 to merges, and 2.0 for crossing movements. The total conflict interaction was the sum of the volume at the conflict

points multiplied by the weighted conflict type. This was only applied to vehicle conflicts and was used to analyze various changes in conflicts of non-typical interchange features.

In addition to conflict points, existing crash data was evaluated to estimate the number and type of crashes that could be expected in the future. This exercise was used to develop a Crash Incident Score for each alternative as shown in Table 5.2. The score was developed using methodologies outlined in the *Highway Safety Manual (HSM), 1st Edition*; FHWA's *Highway Safety Benefit-Cost Analysis Guide*; and the *Transportation Systems Management and Operations Benefit-Cost Analysis Compendium*.

Table 5.2 – 47th Avenue Safety Analysis Crash Incident Score

	FHWA/Incident Plus 2016-2020 CPI	No-build	Present Value (2020) 20-Year Crash		
			SDI	DDI	SPUI
Fatalities	$10,464,000	0	0	0	0
Injuries	$242,600	49	12	19	16.6
Non-Injury Accidents	$3,500	83	29.9	47.2	41.3
Cost Savings (20 year)		$0	$26,747,500	$38,334,900	$34,339,400
Accident Cost (20 year)		$47,311,700	$20,564,200	$8,976,800	$12,972,300
Scoring out of 100		**19**	**44**	**100**	**69**

Severity is a measure of the level of damage or injury a conflict incurs. Generally, crossing conflicts are more severe than merging and diverging conflicts, and all conflicts increase in severity as speed increases.

Driver expectation generalizes what drivers may consider to be a common or standard design. Driver expectation also considers local familiarity with a roadway configuration, such as similar intersections or interchanges nearby. Finally, driver confusion can be reduced with adequate signing and spacing to provide drivers adequate time to select their desired route.

5.2.2 Traffic Operations

Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.

Appendix B contains the Traffic Report with details on traffic data, traffic modeling methodology, and traffic analysis used for this project. Table 5.3 and Table 5.4 provide a summary of the results of the traffic study.

Table 5.3 – 47th Avenue Average Hourly Interchange Delay and Level of Service (LOS)

2045	No-build				SDI			
	AM		PM		AM		PM	
	Delay (sec)	、	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
47th Ave	45	D	70	E	22	C	32	C

2045	DDI				SPUI			
	AM		PM		AM		PM	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
47th Ave	16	B	28	C	22	C	31	C

Table 5.4 – 47th Avenue Travel Time

2045		No Build				SDI			
		AM		PM		AM		PM	
		Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB	65th to 11th	697	11.6	746	12.4	391	6.5	595	9.9
WB	11th to 65th	833	13.9	1003	16.7	388	6.5	470	7.8
NB	47th	109	1.8	172	2.9	92	1.5	98	1.6
SB	47th	126	2.1	144	2.4	110	1.8	112	1.9

2045		DDI				SPUI			
		AM		PM		AM		PM	
		Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB	65th to 11th	405	6.7	579	9.6	397	6.6	576	9.6
WB	11th to 65th	429	7.1	476	7.9	392	6.5	480	8.0
NB	47th	78	1.3	99	1.6	75	1.2	111	1.8
SB	47th	82	1.4	104	1.7	85	1.4	122	2.0

5.2.3 Access

Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.

US 34 through the City of Greeley is a controlled-access facility and this project does not propose to change this designation. However, the project may affect 47th Avenue and access to adjacent properties. This category gauges the level of permanent impacts to 47th Avenue and to accesses for adjacent properties. It does not consider temporary inconvenience that may be experienced during construction.

5.2.4 Constructability

What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)

This category assesses construction challenges for the project. These issues can translate into cost and risk for agencies and contractors. Constructability and construction phasing can also affect public perception and experience during construction.

5.2.5 Utilities

Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?

Utilities are commonly located within public right-of-way and must be considered during design and construction. This category evaluates utility impacts because utility infrastructure can be time-consuming and costly to relocate. This evaluation is based on preliminary utility information and not a completed subsurface utility engineering (SUE) investigation.

5.2.6 Environmental

Due to the existing development and limited number of resources within the Project Area, as identified within the PEL, environmental impacts are anticipated to be limited.

Resources reviewed for the Alternatives Analysis included those present within the Study Area as identified in the US 34 Planning and Environmental Linkages Study (PEL) completed in 2019. Resources evaluated as part of the Alternatives Analysis include sensitive noise receptors, historic resources (irrigation ditches only), parks/trails, and air quality. The evaluation of these resources will allow the project team to differentiate between alternatives.

A CatEx document will be prepared to review and determine impacts to a more comprehensive list including, but not limited to air, noise, biological, Section 4(f), visual, socioeconomics, and cultural resources.

5.2.7 Flexibility for Future Needs

Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)

All build alternatives are designed anticipating future widening of US 34. This category evaluates if additional capacity could be constructed without impacting complex and costly infrastructure, such as bridges and walls. It also evaluates implementing planned future multimodal expansions.

5.2.8 Maintenance

What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?

This category evaluates long-term maintenance needs such as snow removal, landscaped areas, traffic signals, pavement, and structures. Material selection and construction quality can drastically affect long-term maintenance but are assumed to be equal for each build alternatives. In addition, this category evaluates the impact maintenance activities have on traffic and traffic control needs.

5.2.9 Multimodal Accommodations

Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.

This category evaluates the impact on existing multimodal (transit, bicycle, and pedestrian) facilities as opposed to the Flexibility for Future Needs category described above which addresses future plans for these facilities. This evaluation includes how bicycle and pedestrian facilities will be changed and if the changes will improve or diminish the user experience. The focus is on locations where trails and sidewalks cross roadways. Shorter distances and lower speed crossings are considered improvements to user experience.

5.2.10 Right-of-Way (ROW)

Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.

For the purposes of this report, right-of-way impacts are based on GIS information overlaid on aerials and not on surveyed topography and accurate property determinations. Right-of-way impacts were an important consideration at Level 1 and all the Level 2 alternatives are expected to require significant additional right-of-way. This category also considers other right-of-way impacts, such as permanent and temporary easements, including those required by other factors such as utilities.

5.2.11 Drainage and Irrigation

Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.

Since roadways and drainage are interdependent, drainage considerations can often add significant cost to roadway projects. This category evaluates if existing drainage and irrigation facilities require adjustment based on preliminary understanding of these systems. It also factors the known drainage and irrigation issues into the alternative analysis.

5.3 Level 2 Screening and Scoring Matrix

Similar to Level 1 screening, a color-coded system (green, yellow, red) and numerical grading was applied to each screening category based on the answers to the criteria questions and the qualitative and quantitative metrics. A color was then assigned corresponding to the grade (Green = 1.0-1.9, Yellow = 2.0-2.9 and Red = 3.0+), with green being more favorable. This grade is then weighted according to the Level 2 screening category. This weighting was based on the project goals outlined in Section 1.1 Project Background and relative importance. The weighting values were determined in consultation with CDOT and the City of Greeley and reflect that the main purpose of the project is to improve safety and traffic operations. Finally, the weighted grades are summed and the interchange alternative with the lowest score is presumed to be preferred alternative. Appendix I provides detailed information on the grading explanations; scoring details for the qualitative and quantitative metrics; and supporting data associated with these metrics. A summary of the weighted grades and rank of each alternative is provided in Table 5.4.

It was also important to solicit public feedback during the development of the screening categories and weighting to confirm the determinations. A virtual open house was provided to the public on CDOT's US 34 project website while the Level 2 screening and alternatives analysis was in progress. Six of the most important screening categories from Table 5.5 were presented in the open house which included safety; traffic operations; access; right-of-way; multimodal; and environmental. While the importance of weighting was not discussed in detail during the virtual open house, the public was asked to participate in a survey in order to rank the screening categories by importance. The survey results support the weighting for categories shown below.

Table 5.5 – 47th Avenue Level 2 Screening Summary

Category	Weight	Alternative			
		No-build	SDI	DDI	SPUI
		Grading			
Safety	30%	2.7	1.5	1.2	1.2
Traffic Operations	25%	3.0	1.0	1.0	1.0
Access	7%	1.0	1.5	2.0	2.0
Constructability	3%	1.0	1.7	1.7	2.7
Utilities	3%	1.0	2.0	2.0	3.0
Environmental	7%	1.3	2.0	2.0	2.0
Flexibility for Future Needs	7%	2.3	1.3	1.3	2.0
Maintenance	5%	2.0	1.7	2.0	1.7
Multimodal Accommodations	7%	2.8	1.4	1.0	2.0
Right-of-Way	3%	1.0	1.7	1.7	2.3
Drainage & Irrigation	3%	2.0	1.3	1.3	1.7
WEIGHTED GRADE	100%	2.33	1.42	1.35	1.55
	RANK	4	2	1	3

5.4 Conceptual Construction Cost

Conceptual cost estimates were developed primarily as a high-level comparative tool for the Level 2 alternatives. It is important to note that the cost estimate for the preferred alternative will be refined as design progresses and it is anticipated that the costs will be lower; however, these costs do not include continuous auxiliary lanes between interchanges. The estimates are based on hard features such as pavement, bridges, walls, curb and gutter, and sidewalk, developed during the Level 2 screening. A base project cost was developed using the hard feature quantities and recent construction cost data. All other elements except ROW typically associated with similar projects were estimated as a percentage of this base cost. Table 5.6 summarizes the construction costs for each alternative. Additional detail supporting the cost estimates can be found in Appendix J.

Table 5.6 – 47th Avenue Cost Estimate Summary

	SDI	DDI	SPUI
Base Cost	$24,999,000	$26,562,000	$32,286,000
Environmental Items (2%)	$499,980	$531,240	$645,720
MOT Items (5%)	$1,249,950	$1,328,100	$1,614,300
Drainage & Water Quality Items (10%)	$2,499,900	$2,656,200	$3,228,600
Traffic Items (2%)	$499,980	$531,240	$645,720
Utility Items (10%)	$2,499,900	$2,656,200	$3,228,600
Total Construction Cost	$32,248,710	$34,264,980	$41,648,940
Force Accounts (10%)	$3,225,000	$3,427,000	$4,165,000
Right-of-Way	$4,000,000	$4,000,000	$4,000,000
Construction Engineering (11%)	$3,548,000	$3,770,000	$4,582,000
Construction Indirects (9.5%)	$3,064,000	$3,256,000	$3,957,000
Total Program Cost	$46,085,710	$48,717,980	$58,352,940

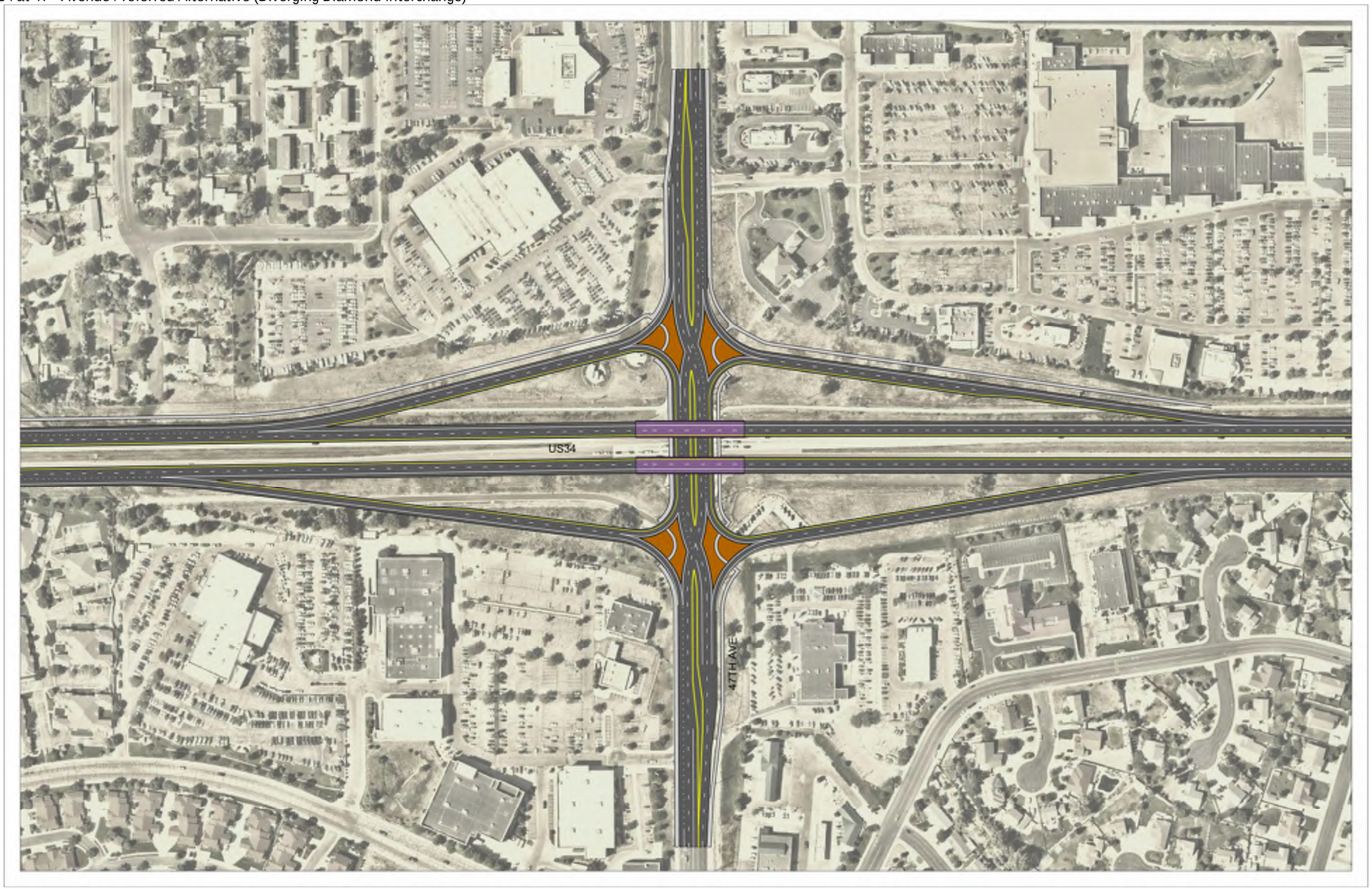
5.5 Level 2 Summary and Preferred Alternative

Based on the Level 2 alternatives analysis and screening, the SPUI is a viable alternative; however, it consistently scored worse than the SDI and DDI, as shown in Table 5.6 above. The SPUI was either tied or scored worse than at least one of the other alternatives in every category, so although the overall scoring appears close, the data supported eliminating the SPUI. The SPUI is also significantly more expensive, primarily due to a much larger bridge necessary to span the intersection when compared to the other alternatives.

The SDI and DDI scored close overall, with scores of 1.42 and 1.35, respectively. While the DDI has the best score, the scoring suggests that both alternatives would be appropriate as the preferred alternative. The construction cost estimates of the SDI and DDI are within approximately 5% of each other which is negligible considering the conceptual design level.

With a relatively tight scoring margin and construction cost estimates, it was necessary to more closely evaluate the individual categories before making a final determination on a preferred alternative. The SDI and DDI scored the same on eight of the 11 categories, including traffic operations (25% weight), with the SDI scoring better for maintenance (5%), and the DDI scoring better for safety (30%) and multimodal (7%). Based on these results, the DDI is more favorable in categories that were considered most important, namely safety. Based on a more detailed evaluation of the individual categories and the better overall score, the DDI, as shown in Figure 5.6 is the preferred alternative at the US 34 and 47th Avenue interchange.

Figure 5.6– US 34 at 47th Avenue Preferred Alternative (Diverging Diamond Interchange)



APPENDIX A

US 34 INTERCHANGES VISSIM DATA COLLECTION AND FORECAST MEMORANDUM

AECOM
7595 Technology Way
Denver, CO 80237
aecom.com

Project name:
US 34 at 47th (TO #1), US 34 at 35th (TO #2)

Project ref:
23013, 23081

To:
Mark Connelly, PE
CDOT Region 4 Traffic
10601 W. 10th St.
Greeley, CO 80634

From:
Don Holloway. PE, PTOE

Date:
April 20, 2020

CC:

FINAL Data Collection and Traffic Forecasting, US-34 at 35th and 47th Avenues – Greeley, Colorado

Objectives

This memo will describe the data collection effort (2020) and traffic forecasting methodology, which were used to prepare year 2045 traffic forecasts for the US 34 corridor in Greeley, Colorado. This effort is in support in the planning and design of grade-separated interchanges with US-34 at 35th and 47th Avenues in Greeley, Colorado. The data collection is used to develop a calibrated Vissim traffic simulation model of 2020 existing conditions. 2045 forecast were developed from the existing traffic counts and NFRMPO travel demand forecasts. The 2045 No-Build traffic forecasts will be used in running Vissim traffic analysis for 2045 No-Build traffic conditions. The No-Build model will then be modified to test the effectiveness of future build alternatives.

Data Collection

For each of the scenarios, this forecast requires the development of:

- AM peak hour link volumes
- PM peak hour link volumes
- AM peak hour turning movement volumes
- PM peak hour turning movement volumes
- AM peak hour design factors (truck percentage, directional distribution)
- PM peak hour design factors (truck percentage, directional distribution)

The project required a substantial traffic data collection effort. Turning Movement Counts (TMC) and 7-day bi-directional tube counts with vehicle classifications, and vehicular travel times were taken in early March 2020 for the following locations:

Turning Movement Counts

- US 34 and 65th Ave
- US 34 and 47th Ave
- 47th Ave and 31st St
- 47th Ave and W 29th St
- 47th Ave and Mall Entrance
- 47th Ave and 26th St/ Centerplace Dr
- US 34 and 35th Ave
- 35th Ave and W 29th St
- 35th Ave and Elk Lakes Shopping Center Dwy
- 35th Ave and Sunset Memorial Dwy
- 35th Ave and 28th St
- 28th St and 33rd Ave Pl
- 28th St and Reservoir Rd
- 35th Ave and Nissan Dwy
- 35th Ave and 25th St
- US 34 WB Ramps and 27th St
- US 34 EB Ramps and 23rd Ave
- US 34 and 17th Ave
- US 34 and 11th Ave

Bi-directional Tube Counts

- US 34 and 65th Ave along US 34
- US 34 and 47th Ave along US 34 and 47th Ave
- US 34 and 35th Ave along US 34 and 35th Ave
- US 34 and 23rd Ave along US 34
- US 34 and 17th Ave along US 34
- US 34 and 11th Ave along US 34

Travel Times

- Travel time data along US-34 collected during the times the traffic counts are taken between 11th and 65th Avenues.

From the intersection count data, peak hours were determined by calculating the largest sum of four consecutive 15-minute periods. Doing so indicated that the AM peak hour occurs from 7:15 to 8:15 AM and the PM peak hour occurs from 5:00 to 6:00 PM. The number of intersections peaking during different 15-minute intervals are depicted on **Figure 1** and **Figure 2** below:

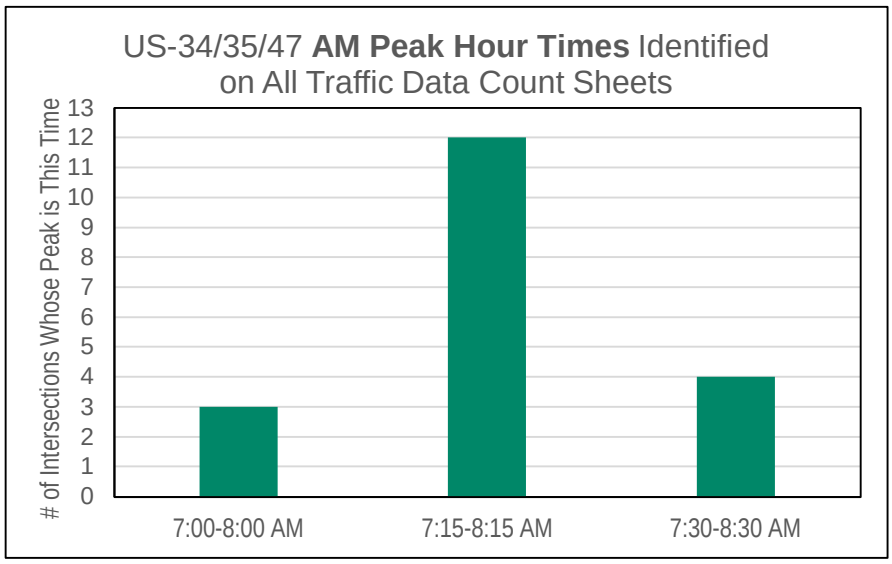


Figure 1. Study 2020 PM Existing Conditions - Intersections Peaking/Period

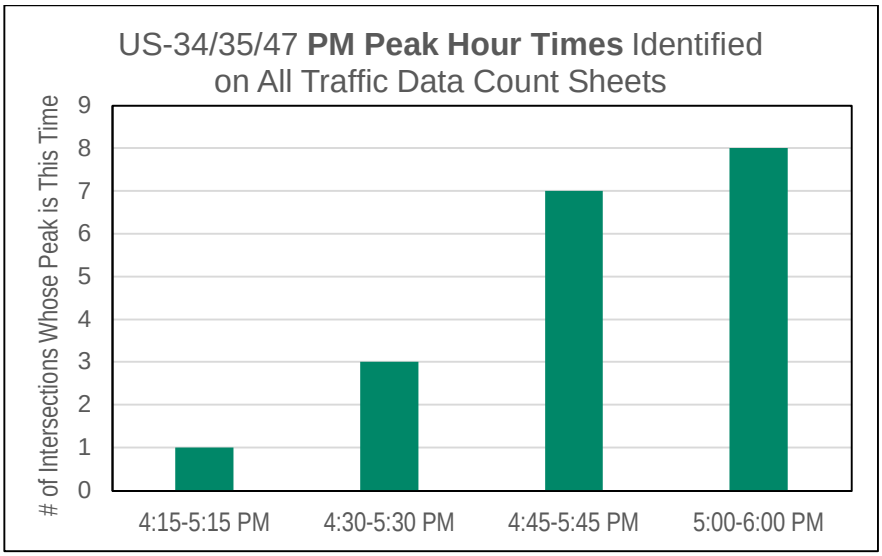


Figure 2. Study 2020 PM Existing Conditions – Intersections Peaking/Period

Raw turning movement results are depicted on Figure A1 in the Appendix to this memo. Raw peak hour turning-movement counts were overlaid on the road network and were then balanced to ensure that all vehicles leaving one intersection enter an adjacent intersection. 2020 traffic volumes used in analysis are shown on Figure A2.

2045 Travel Demand Forecasts

2045 Travel Demand forecasts were developed using the traffic data collected and Traffic Forecasts provided to AECOM by North Front Range (NFRMPO) Regional Travel Model for base year 2015 conditions and 2045 forecast travel demands. Turning movement forecast were not provided in the NFRMPO model but directional link volumes were.

NCHRP Report 765[1] outlines two factoring procedures for use in predicting future year turning movements based on the relationship between base year 2020 turning movement counts and base year model assignment. The assumption is that future turning movements will be similar in nature to existing turning movements.

Factoring Procedure - Ratio Method

The first potential factoring procedure is the Ratio Method. Based on this assumption, future year demands can be estimated by comparing the relative ratios between base year and future travel demand assignments. The procedure can be applied for both directional and non-directional demands.

This procedure comes with some caveats and the ratio method should be used with caution. Significant differences between the NFRMPO 2015 base year forecasts and future year forecasts may produce unreasonable results, especially if there is a significant change in land use within the study area or a large percentage of growth between the NFRMPO 2015 and 2045 forecasts. This latter case was found to be occurring in this study area. As many of the 2015 base model results are significantly less than 2020 traffic counts, even when factored up from 2015 to 2020, there are unrealistic results that come from this method. For these reasons we did not use the ratio method.

[1] *NCHRP Report 765, Analytical Travel Forecasting Approaches for Project-Level Planning and Design*, See Section 6.2

Factoring Procedure - Difference Method

The second factoring procedure is the Difference Method. Based on this assumption, future year movements can be estimated by comparing the relative differences between base year and future year assignments. The procedure can be applied for both directional and non-directional movements. With this method, the difference resulting in 2045 model forecasts and 2015 base year traffic forecasts grown to 2020 equivalents was then added to the 2020 balanced traffic demands. These results are depicted on Figure A2.

Iterative Procedure - Directional Method

The Iterative Procedure - Directional Method, was previously documented in NCHRP Report 255. The method has been automated through matrix balancing spreadsheets and has been applied by numerous transportation agencies and consultants. The method requires directional link volume forecasts. These link forecasts were derived using the Difference Method described in the previous section. An estimate of intersection turning movement percentages or counts is also needed. These count inputs were taken from the 2020 Balanced Turning movements depicted on Figure A2.

The method alternatively balances intersection approach (inflow) and departure (outflow) volumes in an iterative process until an acceptable level of convergence is reached. In the case of this study, the matrix convergence was less than 0.5 vehicles for each intersection matrix.

There have been other iterative directional methods or variations of this method developed in the past. However, this iterative technique, as initially documented in NCHRP Report 255, has been most widely understood and applied by practitioners since it was introduced.

The results from this process is depicted on Figure A3 which has the 2045 turning movement forecasts derived from this procedure using existing traffic count and 2015 and 2045 NFRMPO model forecasts.

Next Steps

Existing Model Calibration Analysis for 2020 and 2045

The next step is the production of the Vissim model calibration report and analysis of 2020 and 2045 No-Build. In that report we will document the model calibration efforts and results and include a list of model assumptions and modeling parameters used. This report will also have the results from the 2020 Calibrated Existing Conditions and 2045 No-Build modeling results

Appendix A

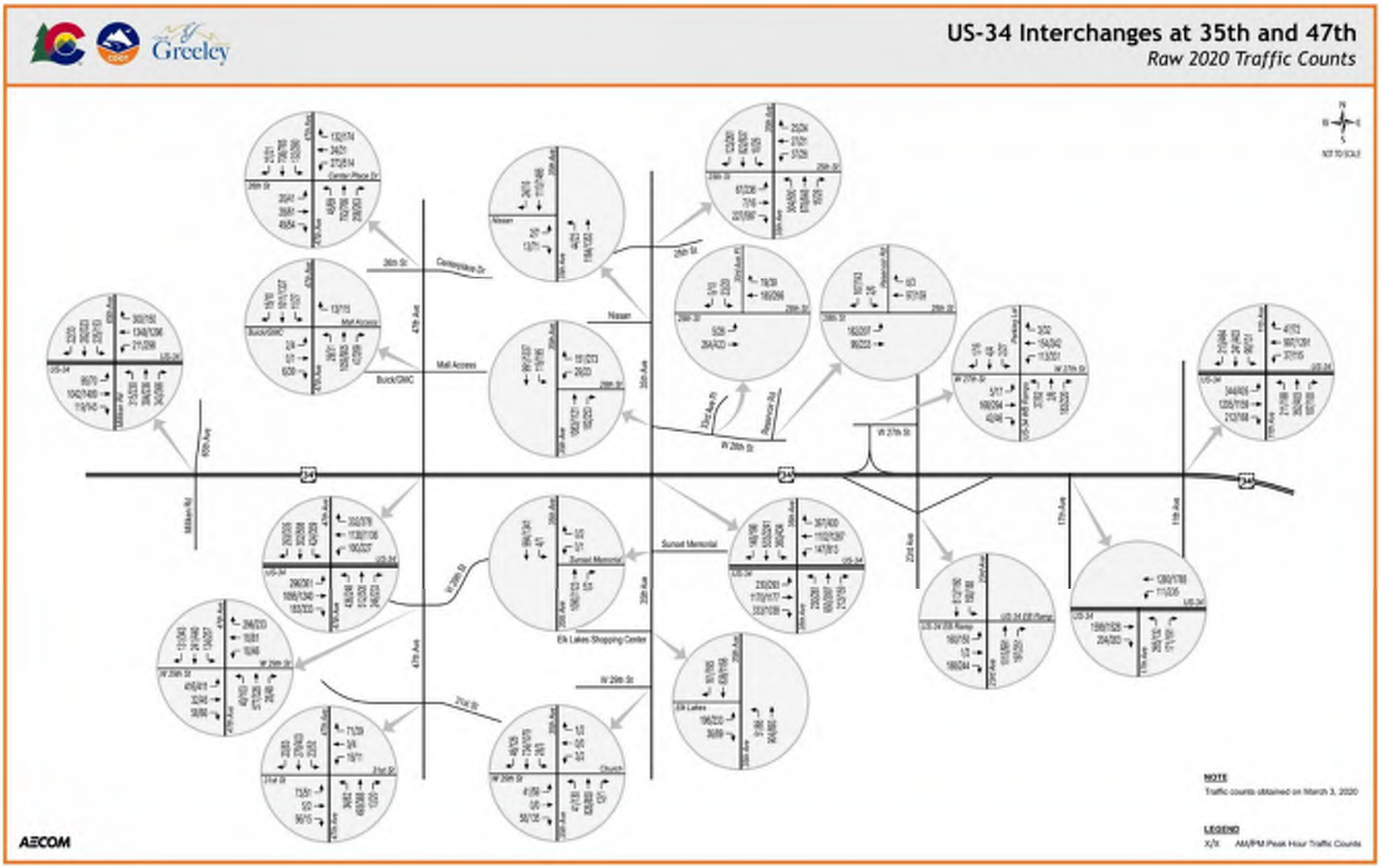


Figure A1. March 2020 Raw Turning Movement Counts

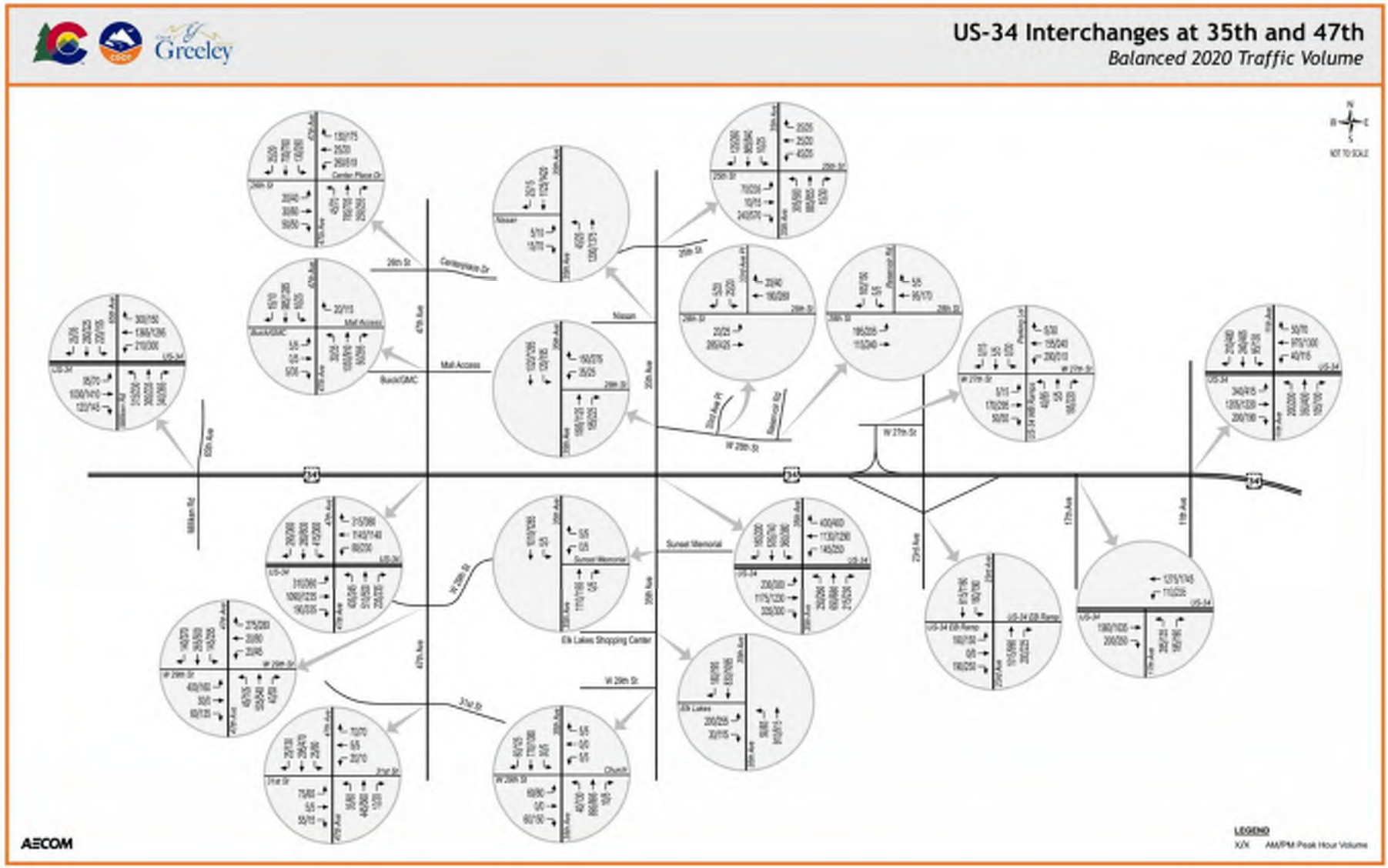


Figure A2. 2020 Balanced Vehicle Turning Movements

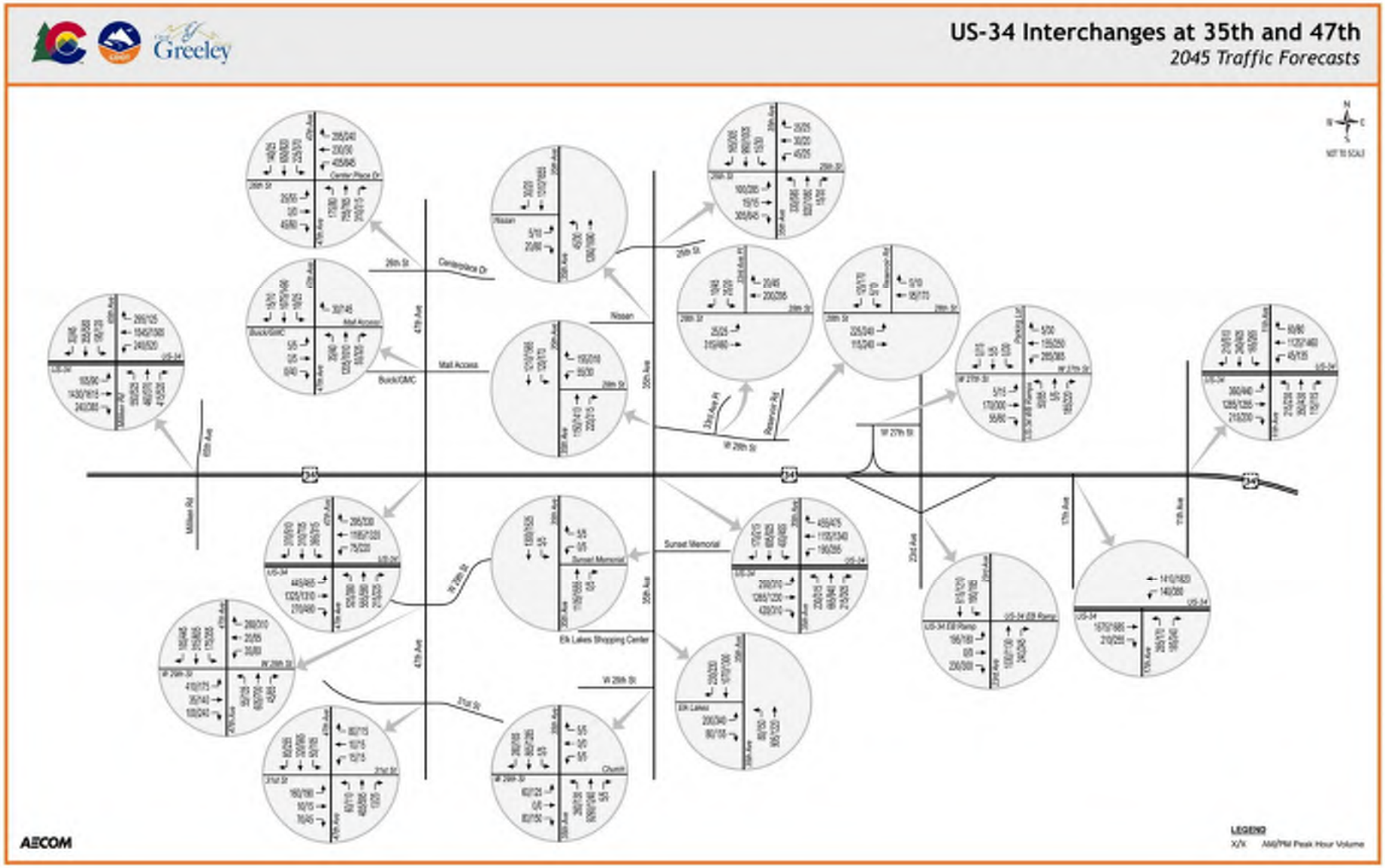


Figure A3. 2045 Traffic Forecasts

APPENDIX B

US 34 INTERCHANGES AT 35TH AND 47TH AVENUES TRAFFIC REPORT

AECOM

Microsimulation Model Calibration Methodology and Results FINAL

US-34 at 35th and 47th Avenues

Colorado Department of Transportation (CDOT), City of Greeley, CO

Project number: CDOT #23013, #23011

June 25, 2020

Quality information

Prepared by	Checked by	Verified by	Approved by
Don Holloway	Kordel Braley	Don Holloway	Craig Parent

Revision History

Revision	Revision date	Details	Authorized	Name	Position
#3 Added 2045 Build Volume	June 25, 2020	Added 2045 Build Volume	June 25, 2020	Craig Parent	Project Manager
#4, Address CDOT Comments	July 20, 2020				
#5, Final version	June 22, 2021		June 22, 2021	Craig Parent	Project Manager

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Prepared by:

AECOM
7595 Technology Way
Denver, CO 80237
aecom.com

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Tables

1. Introduction

1.1 Analysis Background

In January 2020, CDOT conducted a Planning and Environmental Linkages (PEL) Study for US Highway 34 (US-34) between Larimer County Road (LCR) 29 and Weld County Road (WCR) 53 within Larimer and Weld Counties. CDOT initiated the US-34 PEL Study to catalog existing roadway characteristics, multimodal facilities, and traffic safety conditions; identify infrastructure deficiencies; develop and evaluate a reasonable range of alternatives; determine important existing environmental resources along US-34 within the Study Area and create a vision for the US-34 corridor.

The US-34 PEL study identified the need for several grade-separated interchanges within the City of Greeley. These include interchanges on US-34 at 47th and 35th Avenues which are the focus of this project

This report describes the Vissim microsimulation model calibration effort and model results to arrive at a set of AM and PM peak hour 2020 models that are calibrated to existing conditions. This model base will be used later in the analysis of Build Alternatives. This report also includes analysis of 2045 No-Build conditions which are also based off the 2020 calibrated traffic models. In addition to the development of 2045 No-Build traffic forecasts, this report documents development of 2045 Build traffic forecasts which assume that interchanges at 47th and 35th Avenues are constructed.

1.2 Data Collection and 2045 No-Build Traffic Forecast

Data Collection and 2045 Traffic Forecast methodologies are documented in a Draft Memorandum sent to CDOT on April 22, 2020. This memo, *Data Collection and Traffic Forecasting, US-34 at 35th and 47th Avenues, Greeley, Colorado*[1] (*AECOM Data Collection Memo*) produced by AECOM is the reference that documents 2020 data collection and forecasts. Year 2045 No-Build forecasts were developed from the existing traffic counts and North Front Range (NFRMPO) Regional Travel Model demand forecasts also documented in that memorandum. Year 2020 traffic counts and 2045 No-Build Traffic Forecasts are represented on Figure 1 and Figure 2, respectively.

1.3 2045 Build Traffic Forecast

Once the 2045 No-Build traffic forecast were developed, it was apparent that the 2045 No-Build traffic forecasts (see Figure 2) were significantly less than the 2040 traffic forecasts reported in the January 2019 US 34 Planning and Environmental Linkages (PEL) Study. A new set of forecasts, the 2045 Build traffic forecasts shown on Figure 3, were developed in response.

Data Collection and Traffic Forecasting, US-34 at 35th and 47th Avenues, Greeley, Colorado, AECOM, April 22, 2020

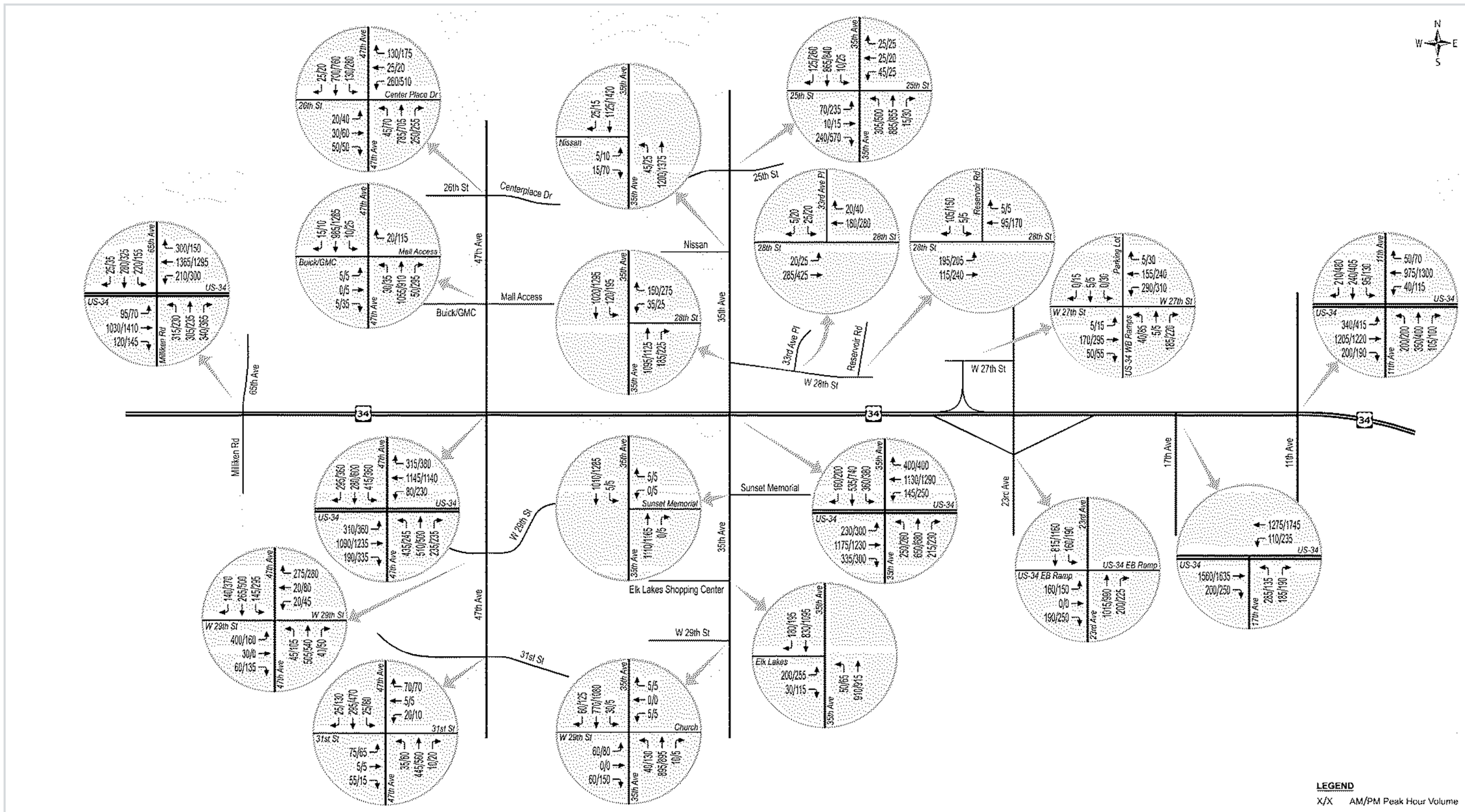


Figure 1. Balanced 2020 Traffic Volume

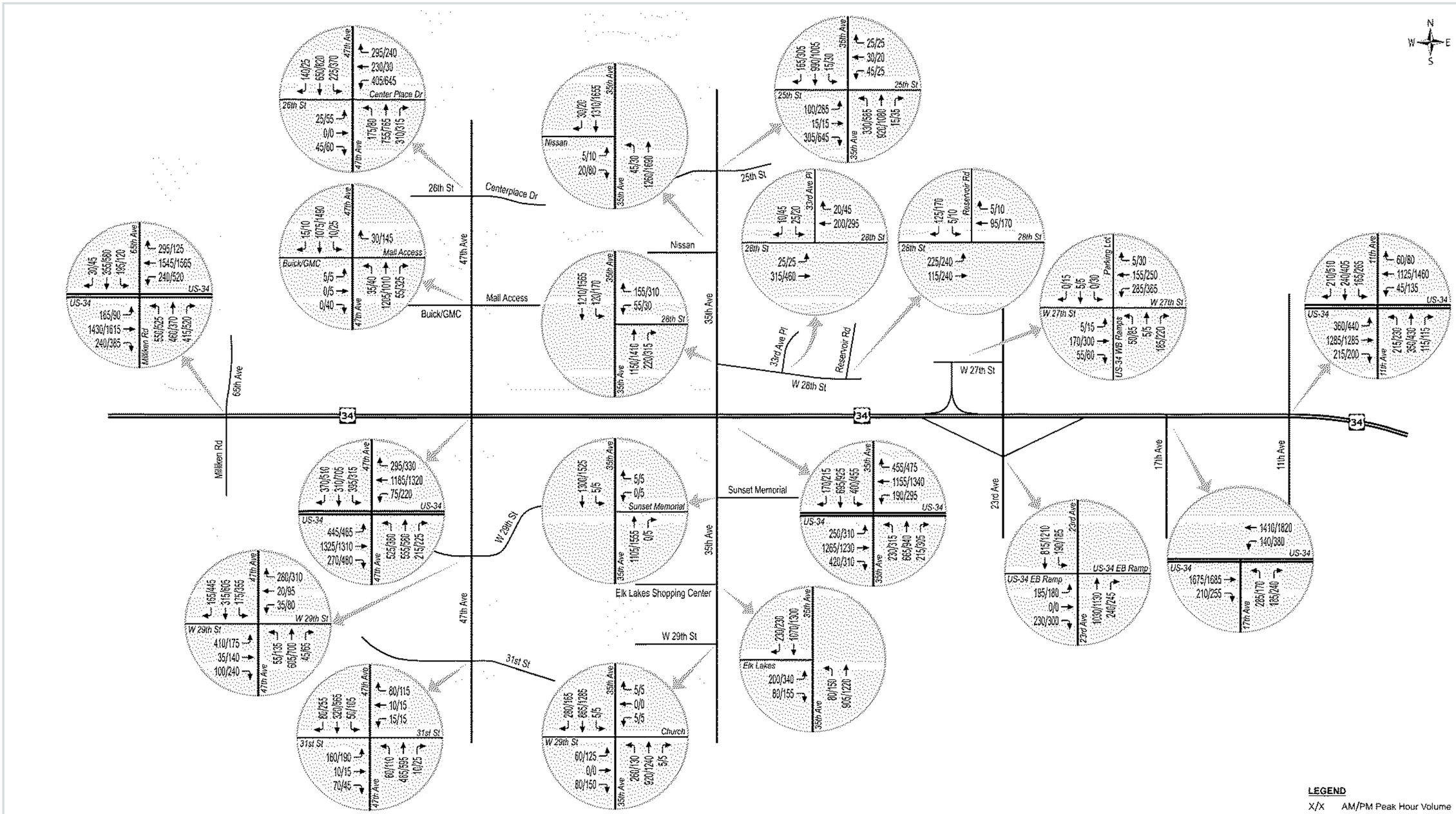


Figure 2. 2045 No-Build Traffic Forecasts

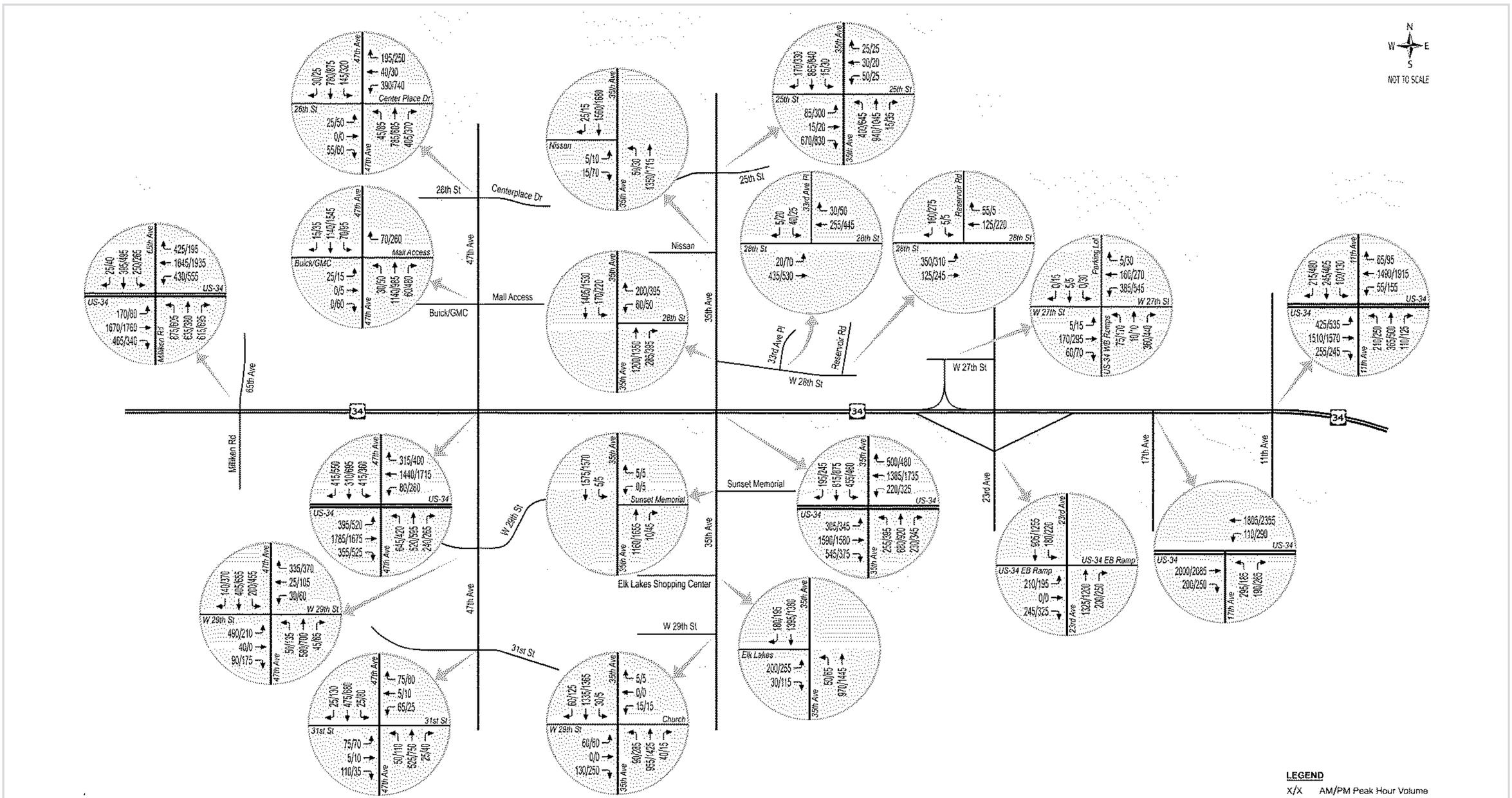


Figure 3. 2045 Build Traffic Forecasts

During conversations between AECOM and NFRMPO staff regarding the 2019 PEL, it was found that the PEL assumed interchanges at many intersections with US-34. The 2045 forecasts provided for use in the No-Build analysis did not have these new interchanges and as such, a lower traffic demand was occurring in the 2045 No-Build forecasts than in the PEL due to capacity constraints. NFRCOG agreed to re-run their travel demand model with the addition of interchanges at 47th and 35th Avenues. From this set of NFRCOG 2045 "Build" forecasts, the 2045 Build traffic forecast on Figure 3 were developed.

2045 Build traffic forecasts were developed using methodology presented in the *AECOM Data Collection Memo* with two differences; they were based on NFRMPO 2045 model forecasts that assumed interchanges at 47th and 35th Avenues, and the *NCHRP Report 765*[2] Ratio Method factoring was used instead of the Difference Method. This change was agreed to after consultations with CDOT and City of Greeley that found that the Ratio Method was more in line with 2040 PEL forecasts. A discussion of the *NCHRP 765* factoring procedures is detailed in the *AECOM Data Collection Memo*.

Traffic analysis using the 2045 Build traffic forecasts are not included in this report. The 2045 Build traffic forecasts will be used with results documented during the alternatives analysis phase of the project.

2. Traffic Operations Analysis

2.1 Analysis Methodology

The analysis of US-34 was conducted using PTV Vissim Version 11 microsimulation modeling software. For the existing conditions analysis, study corridor roadways were built in Vissim on aerial images of the study area. The existing conditions model was reused for No-Build conditions analysis. For future build conditions, the existing conditions Vissim model was modified to reflect the proposed roadway design alternatives. Future condition signal timings were developed with Synchro version 10's signal timing optimization software.

2.2 Model Calibration

The existing conditions Vissim models were calibrated by checking how well traffic volumes in the Vissim models (termed "output volumes") match 2020 traffic count volumes entered by the user (termed "input volumes"). An additional check was made by comparing vehicle travel times estimated by Vissim against actual travel times obtained in the field. These checks were made based on criteria shown in Table 1 to determine if the existing conditions model can be considered calibrated, indicating it accurately represents real-world traffic behavior on US-34.

[2] *NCHRP Report 765, Analytical Travel Forecasting Approaches for Project-Level Planning and Design*, See Section 6.2

Table 1. Microsimulation Model Calibration Targets

Category	Criteria	Additional Requirement
Simulated Traffic Volume Served 85% of network links, or additional critical links or movements as determined by CDOT, must meet the calibration target.	For < 700 vph, within ± 100 vph of observed traffic volumes For 700 to 2,700 vph, within ± 15% of observed traffic Volumes For >2,700 vph, within ± 400 vph of observed traffic volumes	≥ 85% meet criteria
Simulated Travel Time 85% of travel time routes, or additional critical links or movements as determined by CDOT, must meet the calibration target.	Within ± 1 minute of observed travel times for routes less than 7 minutes Within 15% of observed travel times for routes more than 7 minutes	n/a
Simulated Travel Speed (Segments/Links) 85% of network links, or additional critical links or movements as determined by CDOT, must meet the calibration target.	Within ± 10 miles per hour (mph) of average observed speeds	n/a
GEH of Individual Traffic Movements	GEH < 5 for each movement considered separately	≥ 85% meet criteria
GEH for Entire Road Network	GEH < 4 for each movement considered separately	n/a

Source: CDOT Traffic Analysis and Forecasting Guidelines July 2018, Table 10. GEH Criteria*, Wisconsin Department of Transportation, Traffic Engineering, Operations & Safety Manual, September 2020*

$$GEH = \sqrt{2\frac{(M-O)^2}{(M+O)}}$$

Where:
M = Modeled Data
O = Observed Data

Volume-related calibration results are summarized in Table 2 which shows the percentage of items that meet calibration criteria or the calculated calibration results. Travel time calibration results are shown in Table 3 and speed calibration results are depicted on Table 4. All volume and travel time calibration criteria were met for all Vissim models based on 10 randomized model runs conducted for each modeled scenario.

Table 2. Volume-Related Calibration Results for Existing Conditions Model

Calibration Category	Calibration Requirement	AM Model Calibration		PM Model Calibration	
		Results	Acceptable	Results	Acceptable
Volume on Individual Road Links	≥ 85% pass check	100% pass	Yes	100% pass	Yes
GEH of Individual Traffic Movements	< 5	0.0 to 1.2	Yes	0.0 to 1.5	Yes
GEH for Entire Road Network	< 4	0.44	Yes	3.92	Yes

Source: AECOM

Table 3. Travel Time Calibration Results for Existing Conditions Model

Direction	AM Travel Time (sec)				PM Travel Time (sec)			
	Actual	Model	Difference	Acceptable	Actual	Model	Difference	Acceptable
EB US-34 *65th Ave to 11th Ave*	623.9	600.9	-23.0	Yes	667.5	629.0	-38.5	Yes
WB US-34 *11th Ave to 65th Ave*	569.0	528.3	-40.7	Yes	519.7	537.6	17.9	Yes

Source: AECOM

Table 4. Calibration Results for Existing Conditions Model

Direction	**AM Travel Speed (mph)**				**PM Travel Speed (mph)**			
	Actual	Model	Difference	Acceptable	Actual	Model	Difference	Acceptable
EB US-34 *65th Ave to 11th Ave*	26.5	27.6	1.1	Yes	24.8	26.3	1.5	Yes
WB US-34 *11th Ave to 65th Ave*	29.2	31.4	2.2	Yes	31.9	30.9	-1.0	Yes

Source: AECOM

2.3 Arterial Car Following Model (Wiedemann 74)—Calibration Parameters

Table 5 shows the Vissim Wiedemann 74 model car following parameters for arterials that are options for adjustment when calibrating VISSIM microsimulation models. The calibration parameters used in the calibration process are also identified.

For US-34, higher than suggested Additive and Multiplicative parts of safety distance were used. With the Wiedemann 74 car following model, the parameters list below will give different saturation flow rates for different speeds. Given the higher speed nature of US-34, higher than suggested parameters are needed to obtain a realistic saturation flow rate. The higher model parameters used coupled with the higher speed on US-34 brings the saturation flow of US-34 to a flow rate of approximately 1,900 pcphpl. The parameters also yield the desired model calibrated travel times.

Table 5. Arterial Car Following Model (Wiedemann 74)—Calibration Parameters

Parameter	Vissim Default Value	Unit	Suggested Range	AECOM Calibration Value
Average standstill distance Desired distance between lead and following vehicle at 0 mph	6.56	feet (ft)	3.28 to 6.56	6.56 for all links
Additive part of safety distance	2.00	n/a	2.0 to 2.2	2.00 (city streets), 2.95 (US-34)
Multiplicative part of safety distance	2.00	n/a	3.0 to 3.2	3.00 (city streets), 3.95 (US-34)

Source: CDOT Traffic Analysis and Forecasting Guidelines July 2018, Table 14, AECOM

2.4 2020 Existing Conditions Results

Analysis of existing conditions involves analyzing 2020 traffic volume on the existing Greeley, Colorado road network. Traffic operations analysis results for 2020 existing conditions for intersections are shown on Figure 4 **Error! Reference source not found.**and in Table 6 and Table 7. Intersection level of service (LOS) is based on vehicle delay.

The existing conditions analysis showed a LOS C or better at all intersections in the model that were not on US-34, with most of those intersections at LOS A or B. However, most intersections on the US-34 corridor are performing at LOS D or E in the existing conditions model. The PM model shows more overall delay than the AM model. As expected, most of the movements that are failing are left turns on US-34. However, there are some through movements, especially in the PM model, that are operating at LOS E or F.

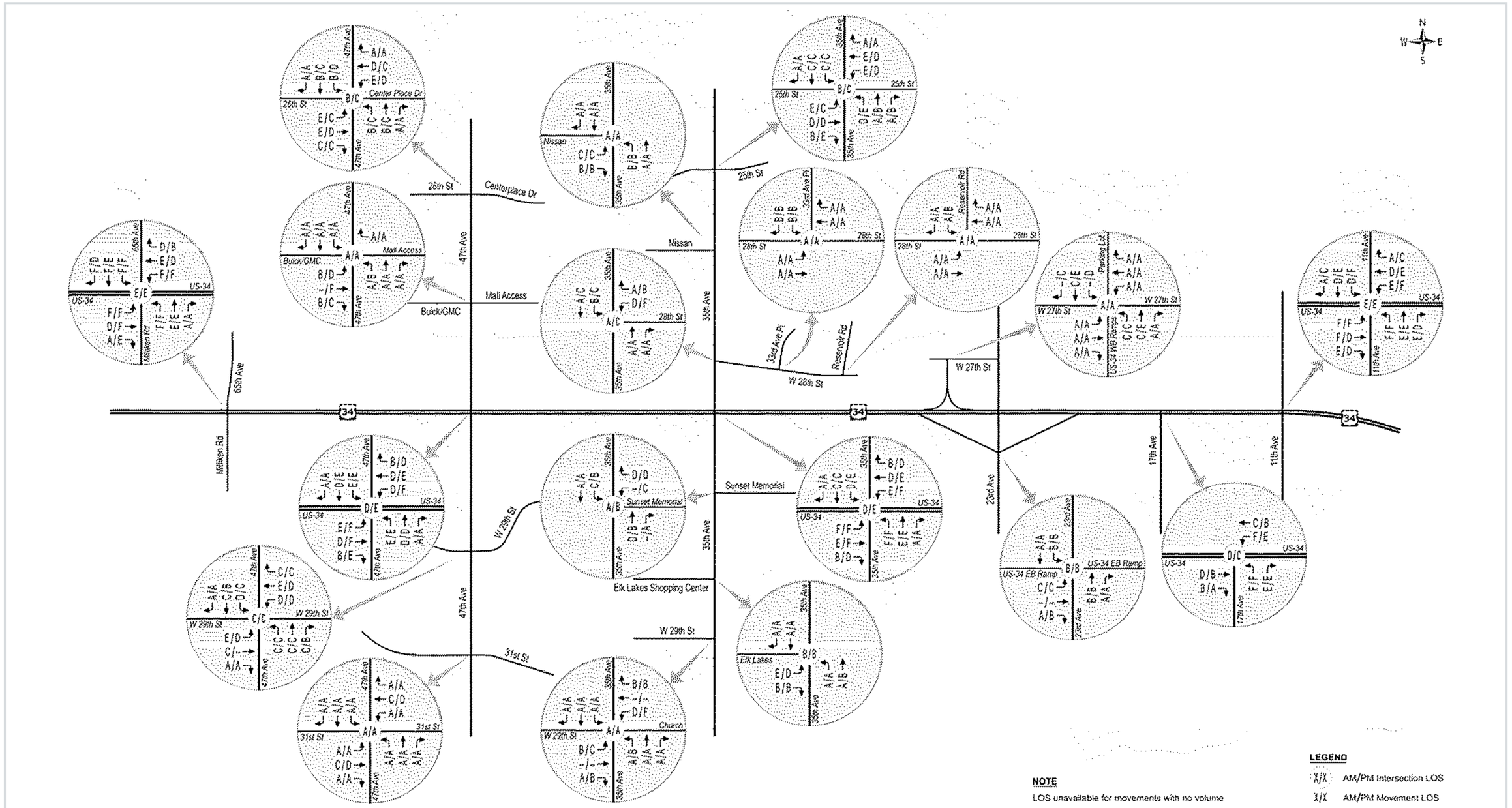


Figure 4. 2020 Existing Level of Service

Table 6. 2020 Existing AM Peak Hour Intersection Results

Intersection	Result	Northbound			Southbound			Eastbound			Westbound			Overall
		Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
65th Ave / US-34	Delay (sec)	87.3	77.0	1.9	122.0	85.4	58.1	139.5	35.3	3.9	154.8	61.6	36.3	60.9
	LOS	F	E	A	F	F	E	F	D	A	F	E	D	E
47th Ave / 31st St	Delay (sec)	3.7	1.3	3.1	4.1	0.3	1.3	8.1	28.1	9.8	8.4	28.1	6.9	2.9
	LOS	A	A	A	A	A	A	A	C	A	A	C	A	A
47th Ave / 29th St	Delay (sec)	24.4	24.6	20.0	36.9	28.1	6.6	61.1	34.2	5.8	49.1	60.8	25.4	31.7
	LOS	C	C	C	D	C	A	E	C	A	D	E	C	C
47th Ave / US-34	Delay (sec)	71.3	52.7	2.0	66.7	44.4	1.0	73.6	38.6	10.4	44.9	36.6	12.8	39.6
	LOS	E	D	A	E	D	A	E	D	B	D	D	B	D
47th Ave / Mall Entrance	Delay (sec)	8.5	0.8	1.3	6.3	1.0	1.0	10.9	-	10.7	-	-	8.2	1.1
	LOS	A	A	A	A	A	A	B	-	B	-	-	A	A
47th Ave / Centerplace Dr	Delay (sec)	14.9	10.6	4.4	18.8	10.5	6.8	56.6	64.5	22.0	60.0	45.9	8.0	16.8
	LOS	B	B	A	B	B	A	E	E	C	E	D	A	B
35th Ave / 29th St	Delay (sec)	4.4	0.5	0.9	6.4	0.6	1.7	18.7	-	9.5	52.1	-	10.1	1.8
	LOS	A	A	A	A	A	A	B	-	A	D	-	B	A
35th Ave / Elk Lakes Dwy	Delay (sec)	6.0	4.6	-	-	9.9	4.3	62.5	-	13.6	-	-	-	11.5
	LOS	A	A	-	-	A	A	E	-	B	-	-	-	B
35th Ave / Sunset Memorial	Delay (sec)	-	17.7	-	24.9	0.4	-	-	-	-	-	-	40.1	9.7
	LOS	-	B	-	C	A	-	-	-	-	-	-	D	A
35th Ave / US-34	Delay (sec)	62.7	61.6	2.6	45.5	25.2	0.9	125.5	73.1	18.7	79.9	35.6	12.8	47.4
	LOS	E	E	A	D	C	A	F	E	B	E	D	B	D
35th Ave / 28th St	Delay (sec)	-	0.7	1.4	18.2	8.5	-	-	-	-	47.4	-	9.6	5.9
	LOS	-	A	A	B	A	-	-	-	-	D	-	A	A
33rd Ave Pl / 28th St	Delay (sec)	-	-	-	11.3	-	10.8	2.0	0.4	-	-	0.2	0.6	1.1
	LOS	-	-	-	B	-	B	A	A	-	-	A	A	A
Reservoir Rd / 28th St	Delay (sec)	-	-	-	8.6	-	7.5	4.2	1.0	-	-	0.2	0.9	3.4
	LOS	-	-	-	A	-	A	A	A	-	-	A	A	A
35th Ave / Nissan Dwy	Delay (sec)	8.0	0.6	-	-	1.3	1.2	27.2	-	12.8	-	-	-	1.1
	LOS	A	A	-	-	A	A	C	-	B	-	-	-	A
35th Ave / 25th St	Delay (sec)	39.3	4.0	3.6	24.4	21.5	5.8	64.6	53.9	13.1	69.9	57.9	7.8	18.6
	LOS	D	A	A	C	C	A	E	D	B	E	E	A	B
23rd Ave / US-34 EB Ramps	Delay (sec)	-	13.1	9.2	11.6	5.7	-	29.6	-	9.3	-	-	-	11.0
	LOS	-	B	A	B	A	-	C	-	A	-	-	-	B
US-34 WB Ramps / 27th St	Delay (sec)	24.5	33.2	2.2	-	25.4	-	1.1	1.0	3.5	2.5	0.6	1.3	3.2
	LOS	C	C	A	-	C	-	A	A	A	A	A	A	A
17th Ave / US-34	Delay (sec)	86.8	-	65.5	-	-	-	-	36.4	19.4	106.0	29.6	-	40.9
	LOS	F	-	E	-	-	-	-	D	B	F	C	-	D
11th Ave / US-34	Delay (sec)	49.2	46.4	34.3	45.9	52.2	6.8	107.0	83.3	70.4	73.1	37.8	5.3	57.7
	LOS	D	D	C	D	D	A	F	F	E	E	D	A	E

Source: AECOM

Table 7. 2020 Existing PM Peak Hour Intersection Results

Intersection	Result	Northbound			Southbound			Eastbound			Westbound			Overall
		Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
65th Ave / US-34	Delay (sec)	88.0	61.8	1.6	102.7	78.9	42.3	139.0	107.4	57.2	119.0	39.0	12.8	71.2
	LOS	F	E	A	F	E	D	F	F	E	F	D	B	E
47th Ave / 31st St	Delay (sec)	4.5	1.7	2.6	5.1	0.3	1.7	8.5	49.6	8.6	8.5	45.0	6.9	2.5
	LOS	A	A	A	A	A	A	A	D	A	A	D	A	A
47th Ave / 29th St	Delay (sec)	22.0	22.0	17.5	32.7	16.1	9.4	36.4	-	5.9	37.9	42.5	31.0	22.4
	LOS	C	C	B	C	B	A	D	-	A	D	D	C	C
47th Ave / US-34	Delay (sec)	63.6	51.3	1.9	63.8	57.9	1.4	186.2	104.8	63.1	87.9	63.4	37.7	69.8
	LOS	E	D	A	E	E	A	F	F	E	F	E	D	E
47th Ave / Mall Entrance	Delay (sec)	12.1	1.0	2.2	7.7	1.4	1.2	54.2	98.3	25.6	-	-	9.1	2.4
	LOS	B	A	A	A	A	A	D	F	C	-	-	A	A
47th Ave / Centerplace Dr	Delay (sec)	33.3	20.3	6.7	45.7	20.6	7.9	25.3	47.9	28.2	37.8	22.6	8.0	25.1
	LOS	C	C	A	D	C	A	C	D	C	D	C	A	C
35th Ave / 29th St	Delay (sec)	10.0	6.9	1.1	7.9	0.4	2.2	26.5	-	14.1	89.2	-	11.3	5.2
	LOS	B	A	A	A	A	A	C	-	B	F	-	B	A
35th Ave / Elk Lakes Dwy	Delay (sec)	7.6	17.1	-	-	7.1	4.6	42.1	-	17.4	-	-	-	14.5
	LOS	A	B	-	-	A	A	D	-	B	-	-	-	B
35th Ave / Sunset Memorial	Delay (sec)	-	36.3	7.6	13.5	0.5	-	-	-	-	28.0	-	49.8	17.6
	LOS	-	D	A	B	A	-	-	-	-	C	-	D	B
35th Ave / US-34	Delay (sec)	96.8	70.3	3.9	64.1	29.8	0.9	214.1	118.0	44.7	94.1	64.9	35.8	74.3
	LOS	F	E	A	E	C	A	F	F	D	F	E	D	E
35th Ave / 28th St	Delay (sec)	-	0.8	2.2	30.6	32.1	-	-	-	-	220.1	-	11.7	18.5
	LOS	-	A	A	C	C	-	-	-	-	F	-	B	B
33rd Ave Pl / 28th St	Delay (sec)	-	-	-	12.3	-	12.7	4.3	1.0	-	-	0.3	0.7	1.5
	LOS	-	-	-	B	-	B	A	A	-	-	A	A	A
Reservoir Rd / 28th St	Delay (sec)	-	-	-	10.2	-	8.4	5.6	1.1	-	-	0.6	1.3	3.6
	LOS	-	-	-	B	-	A	A	A	-	-	A	A	A
35th Ave / Nissan Dwy	Delay (sec)	16.5	0.7	-	-	1.3	1.3	27.7	-	16.3	-	-	-	1.6
	LOS	B	A	-	-	A	A	C	-	B	-	-	-	A
35th Ave / 25th St	Delay (sec)	39.6	7.1	7.2	29.2	20.2	7.8	34.2	43.9	60.7	40.7	41.6	8.0	26.3
	LOS	D	A	A	C	C	A	C	D	E	D	D	A	C
23rd Ave / US-34 EB Ramps	Delay (sec)	-	12.4	8.9	11.3	6.8	-	25.8	-	12.7	-	-	-	10.5
	LOS	-	B	A	B	A	-	C	-	B	-	-	-	B
US-34 WB Ramps / 27th St	Delay (sec)	44.7	28.3	2.7	37.4	70.0	31.4	1.9	1.6	4.1	3.6	1.0	1.6	6.5
	LOS	D	C	A	D	E	C	A	A	A	A	A	A	A
17th Ave / US-34	Delay (sec)	98.5	-	55.4	-	-	-	-	15.4	7.0	67.3	15.7	-	22.4
	LOS	F	-	E	-	-	-	-	B	A	E	B	-	C
11th Ave / US-34	Delay (sec)	120.2	67.0	55.4	83.8	72.6	20.6	116.7	43.9	35.1	137.4	78.1	27.6	66.7
	LOS	F	E	E	F	E	C	F	D	D	F	E	C	E

Source: AECOM

2.5 2045 No-Build Conditions Results

Analysis of future No-Build conditions involves analyzing 2045 traffic volumes on the existing Greeley, Colorado road network without any roadway improvements. Traffic operations analysis results for 2045 No-Build conditions for intersections are shown in Table 8 and Table 9.

Table 8. Volume-Related Results 2045 No-Build Model

Calibration Category	Desired	AM Model Calibration		PM Model Calibration	
		Results	Meets Desired	Results	Meets Desired
Volume on Individual Road Links	≥ 85% pass check	100% pass	Yes	89% pass	Yes
GEH of Individual Traffic Movements	< 5	0.0 to 4.3	Yes	0.0 to 12.8	No*
GEH for Entire Road Network	< 4	8.81	No*	32.02	No*

Source: AECOM

GEH is a measure of coded values vs. model outputs. The lower the GEH the better the fit.

** (does not meet performance test)*

Table 9. Travel Time and Travel Speed Results for 2045 No-Build Model

Direction	AM Travel Time (sec)	PM Travel Time (sec)	AM Travel Speed (mph)	PM Travel Speed (mph)
EB US-34 *65th Ave to 11th Ave*	466.3	709.4	35.5 (+9.0 mph)	23.3 (-4.5 mph)
WB US-34 *11th Ave to 65th Ave*	896.2	996.2	18.5 (-10.7 mph)	16.7 (-15.2 mph)

Source: AECOM

GEH is a measure of coded values vs. model outputs. The lower the GEH the better the fit

** (does not meet performance test)*

Note on Table 9. (-x.x mph) is the travel speed difference between 2045 No-Build and 2020 field data collected.

For 2045 No-Build, traffic operations become significantly worse when compared to 2020 existing conditions. The biggest deterioration in traffic operation is at the intersection of 65th Avenue and US-34, where nearly every movement is operating at LOS F in both the AM and PM peak periods. The model shows this intersection is unable to serve the demand volume in the future years. This is occurring to such an extent that in the EB direction, AM 2045 No-Build is faster (see in red on Table 9) than the travel times collected.

The model shows a considerable increase in delay along US-34, especially in the PM peak period, where most intersections on the corridor are at LOS D or E. The No-Build PM peak period model also shows LOS F at every movement of the 11th Ave/US-34 intersection in the PM peak period model. US-34 does not show a great increase in delay throughout the corridor, but that may be due to the severe failure on the intersections at the west and east ends of the model. To accurately evaluate the future conditions on the corridor, a base model with some improvements at 11th Ave and 65th Ave will be created and documented in the Alternative Analysis Report. LOS results for 2045 No-Build are depicted on Figure 5**Error! Reference source not found.** and Table 10 and Table 11.

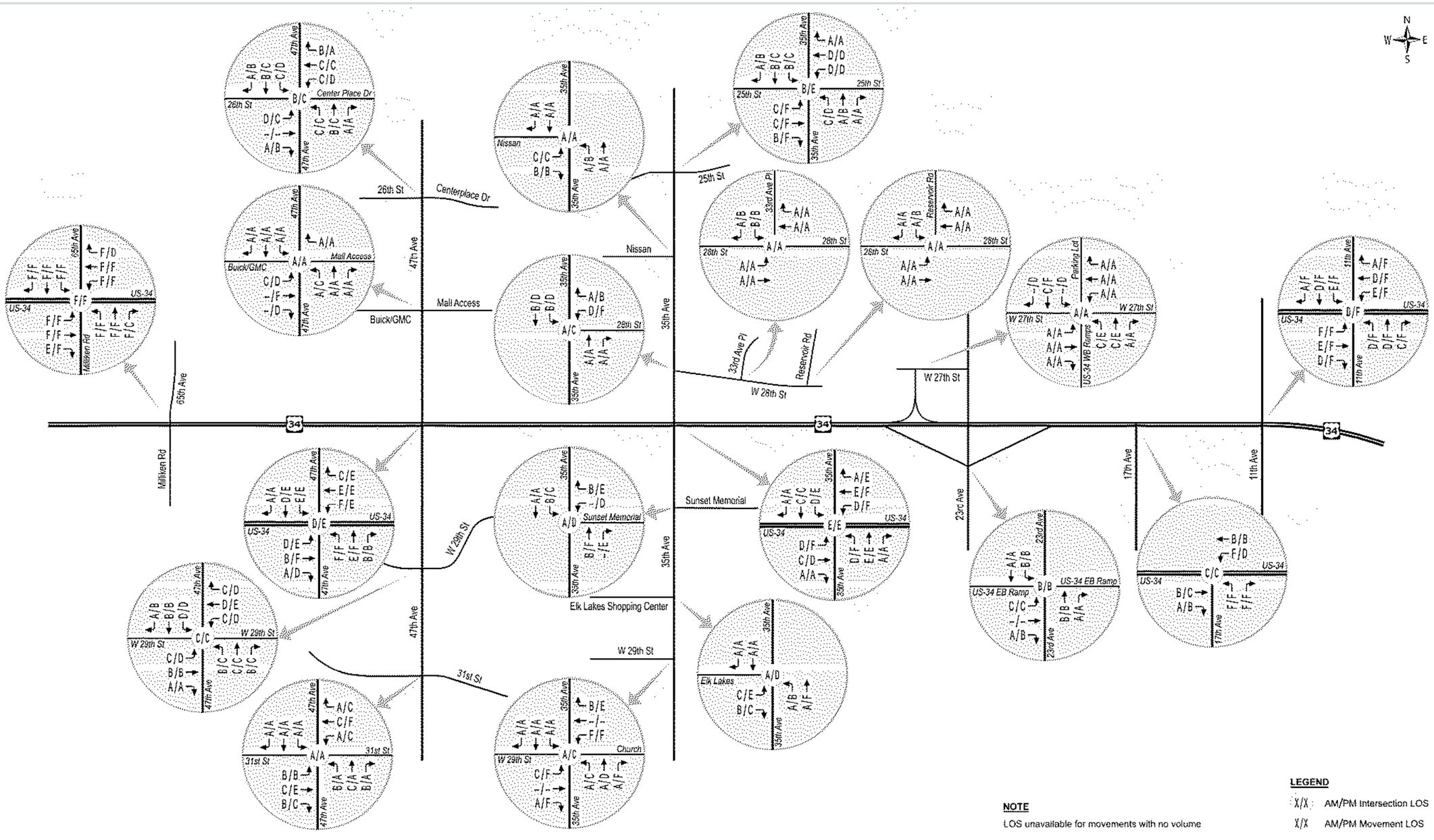


Figure 5. 2045 No-Build Level of Service

Table 10. 2045 No-Build AM Peak Results for Intersections

Intersection	Result	Northbound			Southbound			Eastbound			Westbound			Overall
		Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
65th Ave / US-34	Delay (sec)	291.8	280.4	105.8	351.2	309.2	285.9	508.7	125.6	67.8	176.2	126.7	87.7	178.6
	LOS	F	F	F	F	F	F	F	F	E	F	F	F	F
47th Ave / 31st St	Delay (sec)	3.6	1.4	2.6	3.8	0.2	1.5	10.8	32.0	10.8	9.1	22.7	7.4	4.1
	LOS	A	A	A	A	A	A	B	C	B	A	C	A	A
47th Ave / 29th St	Delay (sec)	16.1	20.6	12.6	37.8	17.8	6.2	31.7	18.1	5.5	31.0	40.3	25.6	22.4
	LOS	B	C	B	D	B	A	C	B	A	C	D	C	C
47th Ave / US-34	Delay (sec)	101.4	79.6	12.4	68.5	49.8	1.1	44.3	13.5	5.9	84.6	60.6	24.6	44.8
	LOS	F	E	B	E	D	A	D	B	A	F	E	C	D
47th Ave / Mall Entrance	Delay (sec)	6.7	0.9	1.4	8.7	1.0	1.1	22.3	-	-	-	-	8.3	1.2
	LOS	A	A	A	A	A	A	C	-	-	-	-	A	A
47th Ave / Centerplace Dr	Delay (sec)	23.5	14.0	5.8	22.7	13.3	9.4	40.0	-	8.0	27.0	25.0	11.2	16.4
	LOS	C	B	A	C	B	A	D	-	A	C	C	B	B
35th Ave / 29th St	Delay (sec)	7.2	0.8	0.8	4.3	0.5	5.2	25.1	-	7.3	113.1	-	10.7	3.0
	LOS	A	A	A	A	A	A	C	-	A	F	-	B	A
35th Ave / Elk Lakes Dwy	Delay (sec)	6.9	4.0	-	-	2.3	2.5	32.0	-	12.8	-	-	-	5.9
	LOS	A	A	-	-	A	A	C	-	B	-	-	-	A
35th Ave / Sunset Memorial	Delay (sec)	-	10.4	-	13.3	0.5	-	-	-	-	-	-	17.5	5.3
	LOS	-	B	-	B	A	-	-	-	-	-	-	B	A
35th Ave / US-34	Delay (sec)	54.9	55.4	2.2	48.2	28.4	0.9	51.0	29.5	3.9	511.2	128.8	59.0	63.7
	LOS	D	E	A	D	C	A	D	C	A	F	F	E	E
35th Ave / 28th St	Delay (sec)	-	0.7	1.3	14.4	16.2	-	-	-	-	52.4	-	8.6	9.2
	LOS	-	A	A	B	B	-	-	-	-	D	-	A	A
33rd Ave Pl / 28th St	Delay (sec)	-	-	-	11.0	-	9.4	2.7	0.5	-	-	0.2	0.7	1.1
	LOS	-	-	-	B	-	A	A	A	-	-	A	A	A
Reservoir Rd / 28th St	Delay (sec)	-	-	-	9.1	-	7.3	4.2	0.9	-	-	0.3	0.6	3.5
	LOS	-	-	-	A	-	A	A	A	-	-	A	A	A
35th Ave / Nissan Dwy	Delay (sec)	9.2	0.7	-	-	1.4	1.2	29.3	-	15.8	-	-	-	1.4
	LOS	A	A	-	-	A	A	C	-	B	-	-	-	A
35th Ave / 25th St	Delay (sec)	25.2	8.6	5.9	13.7	18.1	6.1	29.2	25.4	16.2	36.0	41.1	6.6	15.8
	LOS	C	A	A	B	B	A	C	C	B	D	D	A	B
23rd Ave / US-34 EB Ramps	Delay (sec)	-	14.5	9.8	12.7	6.3	-	24.6	-	8.1	-	-	-	11.6
	LOS	-	B	A	B	A	-	C	-	A	-	-	-	B
US-34 WB Ramps / 27th St	Delay (sec)	21.8	27.3	2.1	-	24.9	-	2.6	0.8	3.5	2.3	0.5	1.7	3.1
	LOS	C	C	A	-	C	-	A	A	A	A	A	A	A
17th Ave / US-34	Delay (sec)	180.1	-	155.6	-	-	-	-	14.5	8.1	96.1	10.2	-	34.1
	LOS	F	-	F	-	-	-	-	B	A	F	B	-	C
11th Ave / US-34	Delay (sec)	48.1	52.7	32.4	60.1	52.5	6.6	94.6	63.0	51.4	75.3	38.8	5.0	51.3
	LOS	D	D	C	E	D	A	F	E	D	E	D	A	D

Source: AECOM

Table 11. 2045 No-Build PM Peak Results for Intersections

Intersection	Result	Northbound			Southbound			Eastbound			Westbound			Overall
		Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
65th Ave / US-34	Delay (sec)	237.5	163.8	33.1	304.9	284.3	252.6	271.0	173.0	105.1	207.0	91.6	48.4	154.3
	LOS	F	F	C	F	F	F	F	F	F	F	F	D	F
47th Ave / 31st St	Delay (sec)	6.0	2.0	3.0	6.2	0.4	2.6	19.8	57.8	20.0	20.4	89.1	27.3	7.1
	LOS	A	A	A	A	A	A	B	E	C	C	F	C	A
47th Ave / 29th St	Delay (sec)	26.9	30.1	22.7	35.7	19.4	11.8	42.7	18.3	8.8	53.5	65.6	53.5	28.9
	LOS	C	C	C	D	B	B	D	B	A	D	E	D	C
47th Ave / US-34	Delay (sec)	166.3	86.5	12.0	74.3	70.0	1.9	74.9	81.3	43.6	55.4	72.6	59.9	69.9
	LOS	F	F	B	E	E	A	E	F	D	E	E	E	E
47th Ave / Mall Entrance	Delay (sec)	25.2	1.6	2.9	8.2	8.0	3.0	39.7	337.4	41.6	-	-	9.8	6.7
	LOS	A	A	A	A	A	A	D	F	D	-	-	A	A
47th Ave / Centerplace Dr	Delay (sec)	33.2	26.6	8.2	42.7	23.7	14.3	28.0	-	16.7	51.2	31.9	9.6	29.8
	LOS	C	C	A	D	C	B	C	-	B	D	C	A	C
35th Ave / 29th St	Delay (sec)	31.2	50.9	89.6	8.5	0.4	2.1	187.1	-	124.8	139.1	-	66.5	30.7
	LOS	C	D	F	A	A	A	F	-	F	F	-	E	C
35th Ave / Elk Lakes Dwy	Delay (sec)	12.3	87.7	-	-	9.0	5.0	73.6	-	29.5	-	-	-	41.4
	LOS	B	F	-	-	A	A	E	-	C	-	-	-	D
35th Ave / Sunset Memorial	Delay (sec)	-	81.1	65.8	33.2	0.4	-	-	-	-	41.4	-	72.4	38.0
	LOS	-	F	E	C	A	-	-	-	-	D	-	E	D
35th Ave / US-34	Delay (sec)	85.4	69.5	3.5	59.8	24.3	0.8	116.6	54.0	7.1	137.4	111.2	61.9	65.6
	LOS	F	E	A	E	C	A	F	D	A	F	F	E	E
35th Ave / 28th St	Delay (sec)	-	0.9	1.7	37.2	37.9	-	-	-	-	277.8	-	17.5	22.8
	LOS	-	A	A	D	D	-	-	-	-	F	-	B	C
33rd Ave Pl / 28th St	Delay (sec)	-	-	-	13.1	-	11.0	3.5	0.8	-	-	1.0	0.8	1.8
	LOS	-	-	-	B	-	B	A	A	-	-	A	A	A
Reservoir Rd / 28th St	Delay (sec)	-	-	-	11.1	-	8.7	4.9	1.0	-	-	0.6	1.0	3.6
	LOS	-	-	-	B	-	A	A	A	-	-	A	A	A
35th Ave / Nissan Dwy	Delay (sec)	16.1	0.8	-	-	2.2	1.1	30.6	-	19.8	-	-	-	2.2
	LOS	B	A	-	-	A	A	C	-	B	-	-	-	A
35th Ave / 25th St	Delay (sec)	40.3	10.0	9.7	30.2	26.2	10.4	108.6	113.5	229.6	39.9	44.5	8.9	58.5
	LOS	D	B	A	C	C	B	F	F	F	D	D	A	E
23rd Ave / US-34 EB Ramps	Delay (sec)	-	12.8	8.7	19.4	8.5	-	31.3	-	13.9	-	-	-	12.1
	LOS	-	B	A	B	A	-	C	-	B	-	-	-	B
US-34 WB Ramps / 27th St	Delay (sec)	56.1	71.8	2.8	47.6	97.1	35.8	2.1	1.6	4.9	4.0	1.2	1.9	7.4
	LOS	E	E	A	D	F	D	A	A	A	A	A	A	A
17th Ave / US-34	Delay (sec)	138.6	-	112.3	-	-	-	-	25.8	12.5	51.9	11.1	-	30.3
	LOS	F	-	F	-	-	-	-	C	B	D	B	-	C
11th Ave / US-34	Delay (sec)	242.0	169.2	147.5	389.1	316.8	229.9	197.7	143.5	130.7	182.5	156.6	98.2	189.6
	LOS	F	F	F	F	F	F	F	F	F	F	F	F	F

Source: AECOM

3. Findings and Conclusions

The calibration process was conducted according to CDOT procedures and nationally recognized standards. It was found that the 2020 Existing Conditions models were properly calibrated.

The 2045 No-Build traffic model runs based on the 2020 calibrated models shows that there is a need for improvements to the US-34 intersections with both 47th and 35th Avenues. The findings from CDOT's US-34 PEL study are verified; both 47th and 35th Avenues will need an interchange by 2045. Both intersections are expected to be operating at an unacceptable LOS by 2045. It was also found that for both the AM and PM 2045 No-Build model runs, the existing roadway network is unable to accommodate 2045 demands.

In conducting the traffic forecasting and analysis, it was found that the 65th Avenue intersection with US-34 is forecast to be well above capacity in 2045 and is metering traffic on US-34. As we move forward with the 2045 Build alternative analyses using the 2045 Build traffic forecasts, the bottlenecks at 65th Avenue, 17th Avenue, and 11th Avenue will be improved in the model to not cause reduction in travel demands downstream on US-34 intersections at 47th and 35th. These improvements at 65th will serve only to provide an adequate demand occurring east of 65th Avenue. Assumed improvements at these locations will be documented in the Alternative Analysis Report.

Appendix A Traffic Count Data

AECOM
7595 Technology Way
Denver, CO 80237
aecom.com

APPENDIX C

MULTIMODAL MAP

SCALE 1" = 400'

N

51ST AVE

50TH AVE

26TH ST

EHRLICH DEALERSHIP

WELD COUNTY GARAGE

47TH AVE

24TH ST

CENTERPLACE DR

SAFEWAY

TARGET

KOHL'S

SPORTS AUTHORITY

34

34

SPROUTS

N 29TH ST

HONDA OF GREELEY

30TH ST

30TH ST RD

31ST ST

LEGEND

- EXISTING SIDEPATH
- EXISTING BIKE LANE
- EXISTING SHARROW (SHARED BIKE LANE)
- EXISTING OFF-STREET TRAIL
- PROPOSED BUFFERED BIKE LANE
- EXISTING GET ROUTE 1 RED
- PROPOSED GET ROUTE US 34
- PROPOSED SIDEPATH
- PROPOSED BIKE LANE
- PROPOSED SHARROW (SHARED BIKE LANE)
- PROPOSED OFF-STREET TRAIL
- EXISTING BUS STOP
- EXISTING GET ROUTE 3 PURPLE
- PROPOSED GET ROUTE 47TH AVE

TYPICAL SIDEPATH
(FIGURE 2-18 - COG BICYCLE MASTER PLAN)

US 34 INTERCHANGES AT 35TH AVE & 47TH AVE
CITY OF GREELEY BIKE, TRAILS AND TRANSIT (1 OF 2)

AECOM

SCALE 1" = 400'

N

38TH AVE

35TH AVE CT

25TH ST

28TH AVE

JOHN ELWAY DEALERSHIP

GHENT DEALERSHIP

35TH AVE

28TH ST

RESERVOIR RD

PROPOSED GRADE SEPERATED CONNECTION

34

34

SUNSET MEMORIAL GARDENS

HOME DEPOT

HOMESTEAD PARK

TRINITY LUTHERAN SCHOOL

W 29TH ST

29TH ST

TYPICAL SIDEPATH
(FIGURE 2-18 - COG BICYCLE MASTER PLAN)

LEGEND

- EXISTING SIDEPATH
- EXISTING BIKE LANE
- EXISTING SHARROW (SHARED BIKE LANE)
- EXISTING OFF-STREET TRAIL
- PROPOSED BUFFERED BIKE LANE
- EXISTING GET ROUTE 1 RED
- PROPOSED GET ROUTE US 34
- PROPOSED SIDEPATH
- PROPOSED BIKE LANE
- PROPOSED SHARROW (SHARED BIKE LANE)
- PROPOSED OFF-STREET TRAIL
- EXISTING BUS STOP
- EXISTING GET ROUTE 3 PURPLE
- PROPOSED GET ROUTE 47TH AVE

US 34 INTERCHANGES AT 35TH AVE & 47TH AVE
CITY OF GREELEY BIKE, TRAILS AND TRANSIT (2 OF 2)

AECOM

APPENDIX D

US 34 AND 35TH/47TH AVENUE DESIGN CRITERIA

	Criteria		Value		Source	Comments
General	System Classification:		E-X		SHAC, s3.7, p35; OTIS	
	Design Speed:		65	mph	CRDG s8.1.1, p8-1	Drops between 47th Ave & 35th Ave (use 75 where possible)
	Posted Speed:		60	mph		
	Design Vehicle:		WB-67		PGDHS p2-55	
	AADT:		36000		OTIS	Value shown for MP 110
	% Trucks		5.3	%	OTIS	Value shown for MP 110
Horizontal / Cross Slope	Superelevation (e_{MAX}):	Table:	8	%	CRDG s3.2.3, p 3-24; M&S M-203-11	
		Design:	6	%	PGDHS t3-10, p3-45	
	Min. Curve Radius:		2710	ft	M&S M-203-11, p2; PGDHS t3-10, p3-45	Use 6% row in 8% max tables
	Min. Stopping Sight Distance:	Level:	645	ft	CRDG t3-1, p3-2; PGDHS t3-1, p3-4	60 MPH
		3% Down	682	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Up	612	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
	Clear Zone:		32	ft	RDG t3-1, p3-3	ADT > 6000
	Redirect Taper:		65:1		SHAC t4-9, p57	Use "Design Speed" instead of "Posted Speed"
	Deceleration Length:		N/A			See Ramp Design Criteria
	Acceleration Length:		N/A			See Ramp Design Criteria
	Accel/Decel Transition Taper:		N/A			See Ramp Design Criteria
	Max. Break at Crossover Line		4	%	CRDG t10-2, p10-25	Break at gore
Vertical	Grade:	Max.	4	%		
		Min.	0	%	CRDG p3-30	If the roadway is adequately crowned to drain the surface laterally
	Min. Length of Curve	3x Dsgn Spd:	195	ft	CRDG s3.3.4, p3-33	Minimum curve length also controlled by stopping sight distance
	Min. K-Value	KSAG	157		CRDG t3-1, p3-2; PGDHS t3-37, p3-176	For K-values > 167, check drainage
		KCREST	193		CRDG t3-1, p3-2; PGDHS t3-35, p3-170	
	Min. Vertical Structure Clearance:		16.5	ft	CRDG t3-3, p3-29; PGDHS s10.8.4, p10-22	Highway Underpasses (see CRDG t3-3 for additional clearances)
	Chorded Profile Grade Break	SAG	0.2	%	CRDG s3.3.4, p3-33	
		CREST	0.2	%	CRDG s3.3.4, p3-33	

Typical Section: 2 - 12ft through lanes, 1- 12ft auxiliary lane (as needed), 4ft inside shoulders, 10ft outside shoulders, and 12ft z-slopes at 6:1 (Ultimate Typical Section will have 3-12ft thru lanes with open or closed median)

Normal Cross Slope: 2%

Superelevation transition rates are based on ultimate configuration

Use of Spirals: Permitted

Entrance Ramp Type: Parallel

Exit Ramp Type: Parallel

Cut Slopes: 4:1 Typ, 3:1 Max

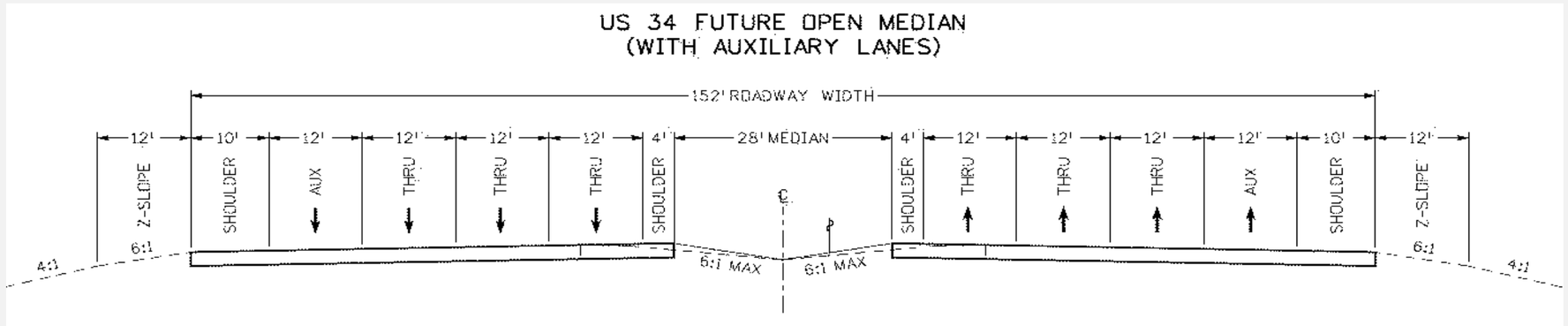
Fill Slopes: 4:1 Typ, 3:1 Max

Outside guardrail shall be Type 3

Construction: Two 11' lanes with 2' min shoulders, each direction

Abbreviations

CRDG- CDOT Roadway Design Guide (2005, Revised 2018)
M&S- CDOT M&S Standards
OTIS- Online Transportation Information System
PGDHS- AASHTO: A Policy on Geometric Design of Highways and Streets (7th Edition, 2018)
RDG- AASHTO: Roadside Design Guide (4th Edition, 2011)
SHAC- State Highway Access Code (Vol. 2, 2002)
fig- Figure
s- Section
p- Page Number
t- Table



	Criteria		Value Range		Loop	Source	Comments
General	System Classification:		E-X		E-X	SHAC, s3.7, p35	
	Design Speed:		65 mph	40 mph	25 mph	CRDG s10.6.2, p10-23, t10-1	At gore (for 75mph design speed on mainline)
	Posted Speed:		N/A	N/A	N/A		
	Design Vehicle:		WB-67	WB-67	WB-67	CRDG t9-3, p9-11; PGDHS s2.8.1, p2-58	
	AADT:		N/A	N/A	N/A		See Traffic Memo for more details
	% Trucks		N/A	N/A	N/A		See Traffic Memo for more details
Horizontal / Cross Slope	Superelevation (e_{MAX}):	Table:	6 %	6 %	6 %	CRDG s10.6.5, p 10-25; M&S M203-11	
	Min. Curve Radius:		1660 ft	485 ft	144 ft	PGDHS t3-9, p3-43	
	Min. Stopping Sight Distance:	Level:	645 ft	305 ft	155 ft	CRDG t3-1, p3-2; PGDHS t3-1, p3-4	
		3% Down	682 ft	315 ft	158 ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		6% Down	728 ft	333 ft	165 ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Up	612 ft	289 ft	147 ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		6% Up	584 ft	278 ft	143 ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
	Clear Zone:		30 ft	16 ft	16 ft	RDG t3-1, t3-2; p3-3, 3-4	If ADT > 6000; Footnote a); Horiz. Curve Adj Factors may apply
	Redirect Taper:		65:1	30:1	15:1	SHAC t4-9, p57	Based on design speed
	Deceleration Length:		390 ft	490 ft	600 ft	CRDG t10-3, p10-36; PGDHS t10-6, p10-138	See CRDG t10-5 for grade adjustment factors
	Acceleration Length:		780 ft	1160 ft	1580 ft	CRDG t10-4, p10-37; PGDHS t10-4, p10-132	See CRDG t10-5 for grade adjustment factors
	Accel/Decel Transition Taper:		300 ft	300 ft	300 ft	CRDG fig10-11B, p10-40	
	Max Break at Crossover Line		4 %	4 %	4 %	CRDG t10-2, p10-25	Break at gore
Vertical	Grade:	Max.	5 %	7 %	8 %	CRDG s10.6.4, p10-23 - 10-24	
		Min.	0.5 %	0.5 %	0.5 %	CRDG p3-30	0% permitted w/ adequate cross slope for surface drainage
	Min. Length of Curve	3x Dsgn Spd:	195 ft	120 ft	75 ft	CRDG s10.6.4, p10-24; s3.3.4, p3-33	Minimum curve length also controlled by stopping sight distance
	Min. K-Value	K_{SAG}	157	64	26	CRDG t3-1, p3-2; PGDHS t3-37, p3-176	For K-values > 167, check drainage
		K_{CREST}	193	44	12	CRDG t3-1, p3-2; PGDHS t3-35, p3-170	
	Min. Vertical Structure Clearance:		16.5 ft	16.5 ft	16.5 ft	CRDG t3-3, p3-29; PGDHS s10.8.4.2, p10-24	Highway Underpasses (see CRDG t3-3 for additional clearances)

Notes

Typical Section: 15 ft lane (single-lane ramp) with 6 ft outside shoulder, 12 ft lanes (multi-lane ramp) with 8 ft outside shoulder, 4 ft inside shoulder, 12ft Z-slopes

Normal Cross Slope: 2%

Use of Spirals: Not recommended, permitted at mainline connection

Entrance Ramp Type: Parallel

Exit Ramp Type: Parallel

Cut Slopes: 3:1 Max

Fill Slopes: 3:1 Max

Guardrail: Type 3 MGS

Abbreviations

CRDG- CDOT Roadway Design Guide (2005, Revised 2018)
M&S- CDOT M&S Standards 2019
OTIS- Online Transportation Information System (CDOT)
PGDHS- AASHTO: A Policy on Geometric Design of Highways and Streets (7th Edition, 2018)
RDG- AASHTO: Roadside Design Guide (4th Edition, 2011)
SHAC- State Highway Access Code (Vol. 2, 2002)
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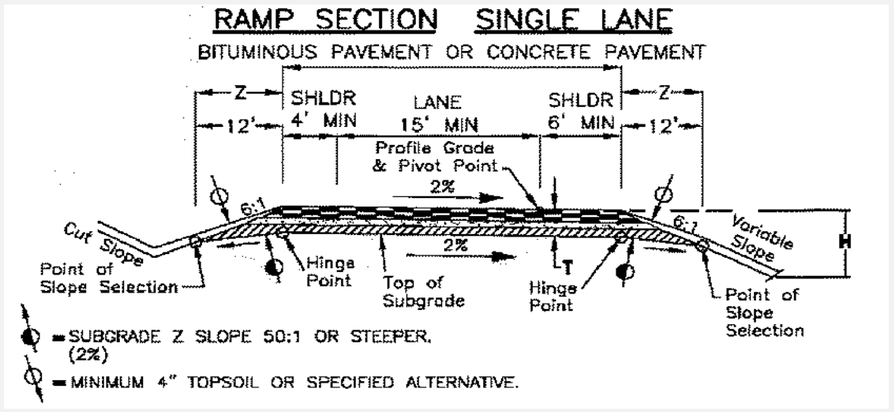
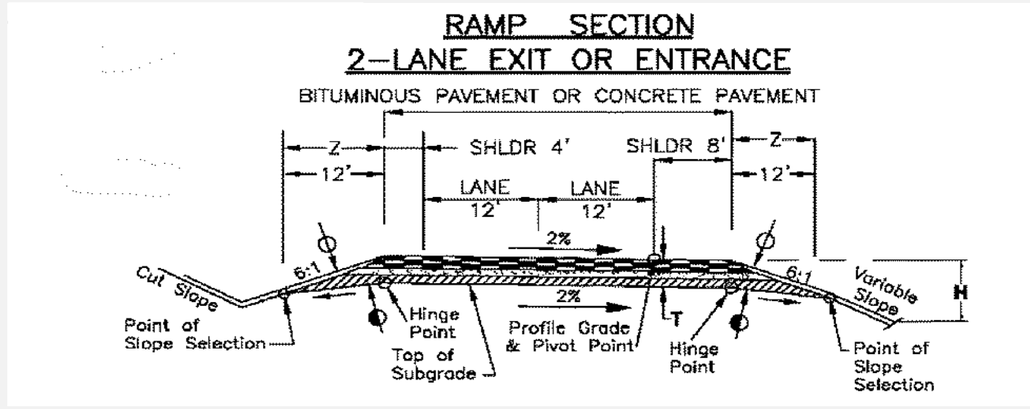




Revised February 2020

	Criteria	Value		Source	Comments
General	System Classification:	Major Collector 4-Lane		COGSM t1.03.1 p8	
	Design Speed:	45	mph	COGSM t1.03.1 p8	
	Posted Speed:	40	mph	COGSM t1.03.1 p8	
	Design Vehicle:	WB-67		PGDHS p2-55	
	AADT:	N/A			
	% Trucks	N/A			
Horizontal / Cross Slope	Superelevation (e_{MAX}):	Table: 4	%	COGSM t1.06.1 p13	
		Actual: 4	%	COGSM t1.04.2 p10	
	Min. Curve Radius:	745	ft	COGSM t1.04.2 p10	
	Min. Stopping Sight Distance:	Level: 360	ft	COGSM t1.04.2 p10	45 MPH
		3% Down 378	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Up 344	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
	Clear Zone:	20	ft	RDG t3-1, p3-3	ADT > 6000
	Redirect Taper:	45:1		SHAC t4-9, p57	
	Deceleration Length:	430	ft	COGSM s1.24, p30	See CRDG t10-5 for grade adjustment factors
	Acceleration Length:	VARIES		CRDG t10-4 p10-37; PGDHS t10-4, p10-132	See CRDG t10-5 for grade adjustment factors
	Accel/Decel Transition Taper:	VARIES		CRDG fig10-11A - 10-15	
	Max. Break at Crossover Line	5	%	CRDG t10-2, p10-25	
Vertical	Grade:	Max. 5	%	COGSM t1.06.1 p13	
		Min. 0.4	%	COGSM t1.06.1 p13	If the roadway is adequately crowned to drain the surface laterally
	Min. Length of Curve	Varies		COGSM t1.06.3 p14	Minimum curve length also controlled by stopping sight distance
	Min. K-Value	K_{SAG} 79		CRDG t3-1, p3-2; PGDHS t3-37, p3-176	For K-values > 167, check drainage
		K_{CREST} 61		CRDG t3-1, p3-2; PGDHS t3-35, p3-170	
	Min. Vertical Structure Clearance:	16.5	ft	CRDG t3-3, p3-29; PGDHS s10.8.4, p10-22	Highway Underpasses (see CRDG t3-3 for additional clearances)
	Chorded Profile Grade Break	SAG 0.2	%	CRDG s3.3.4, p3-33	
		CREST 0.2	%	CRDG s3.3.4, p3-33	

Notes

Typical Section includes: 2 - 12 ft through lanes, 8 ft shoulders, and 8 ft z-slopes at 6:1

Construction: Two 11' lanes with 2' min shoulders, each direction

Standard CDOT Z-slope

Cut Slopes: 4:1 Max

Fill Slopes: 4:1 Max

Normal Cross Slope: 2%

Abbreviations

CRDG- CDOT Roadway Design Guide (2005, Revised 2018)

COGCS- City of Greeley Corridor Standards (2016)

COGSM- City of Greeley Street Manual (Vol. 1, 2015)

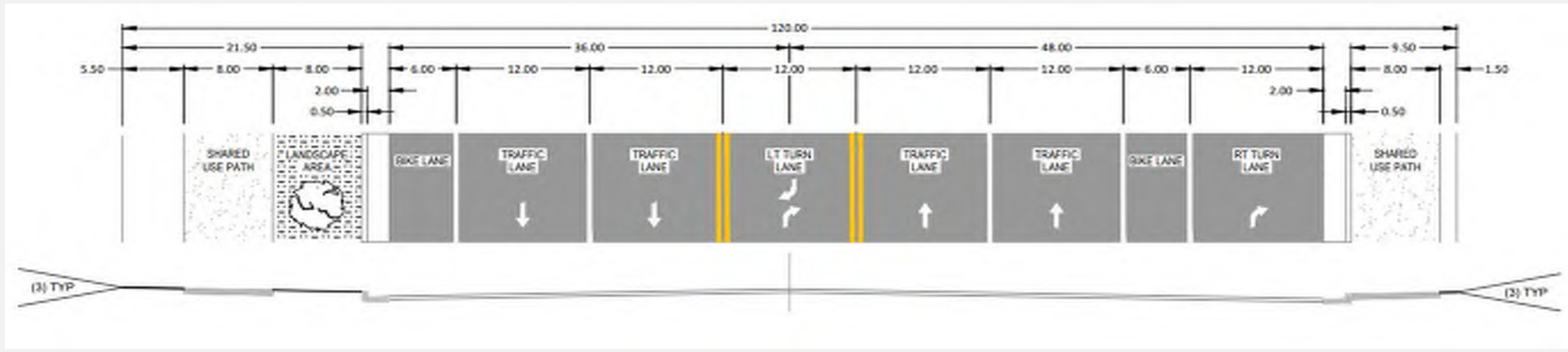
PGDHS- AASHTO: A Policy on Geometric Design of Highways and Streets (7th Edition, 2018)

RDG- AASHTO: Roadside Design Guide (4th Edition, 2011)

SHAC- State Highway Access Code (Vol. 2, 2002)

fig- Figure s- Section

p- Page Number t- Table



AECOM

Revised: January 2020

	Criteria	Value		Source	Comments
General	System Classification:	Major Collector 4-Lane		COGSM t1.03.1 p8	
	Design Speed:	45	mph	COGSM t1.03.1 p8	
	Posted Speed:	40	mph	COGSM t1.03.1 p8	
	Design Vehicle:	WB-67		PGDHS p2-55	
	AADT:	N/A			
	% Trucks	N/A			
Horizontal / Cross Slope	Superelevation (e_{MAX}):	Table: 4	%	COGSM t1.06.1 p13	
		Actual: 4	%	COGSM t1.04.2 p10	
	Min. Curve Radius:	745	ft	COGSM t1.04.2 p10	
	Min. Stopping Sight Distance:	Level: 360	ft	COGSM t1.04.2 p10	45 MPH
		3% Down 378	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Up 344	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
	Clear Zone:	20	ft	RDG t3-1, p3-3	ADT > 6000
	Redirect Taper:	45:1		SHAC t4-9, p57	
	Deceleration Length:	430	ft	COGSM s1.24, p30	See CRDG t10-5 for grade adjustment factors
	Acceleration Length:	VARIES		CRDG t10-4 p10-37; PGDHS t10-4, p10-132	See CRDG t10-5 for grade adjustment factors
	Accel/Decel Transition Taper:	VARIES		CRDG fig10-11A - 10-15	
	Max. Break at Crossover Line	5	%	CRDG t10-2, p10-25	
Vertical	Grade:	Max. 5	%	COGSM t1.06.1 p13	
		Min. 0.4	%	COGSM t1.06.1 p13	If the roadway is adequately crowned to drain the surface laterally
	Min. Length of Curve	Varies		COGSM t1.06.3 p14	Minimum curve length also controlled by stopping sight distance
	Min. K-Value	K_{SAG} 79		CRDG t3-1, p3-2; PGDHS t3-37, p3-176	For K-values > 167, check drainage
		K_{CREST} 61		CRDG t3-1, p3-2; PGDHS t3-35, p3-170	
	Min. Vertical Structure Clearance:	16.5	ft	CRDG t3-3, p3-29; PGDHS s10.8.4, p10-22	Highway Underpasses (see CRDG t3-3 for additional clearances)
	Chorded Profile Grade Break	SAG 0.2	%	CRDG s3.3.4, p3-33	
		CREST 0.2	%	CRDG s3.3.4, p3-33	

Notes

Typical Section includes: 2 - 12 ft through lanes, 8 ft shoulders, and 8 ft z-slopes at 6:1

Construction: Two 11' lanes with 2' min shoulders, each direction

Standard CDOT Z-slope

Cut Slopes: 4:1 Max

Fill Slopes: 4:1 Max

Normal Cross Slope: 2%

Abbreviations

CRDG- CDOT Roadway Design Guide (2005, Revised 2018)

COGCS- City of Greeley Corridor Standards (2016)

COGSM- City of Greeley Street Manual (Vol. 1, 2015)

PGDHS- AASHTO: A Policy on Geometric Design of Highways and Streets (7th Edition, 2018)

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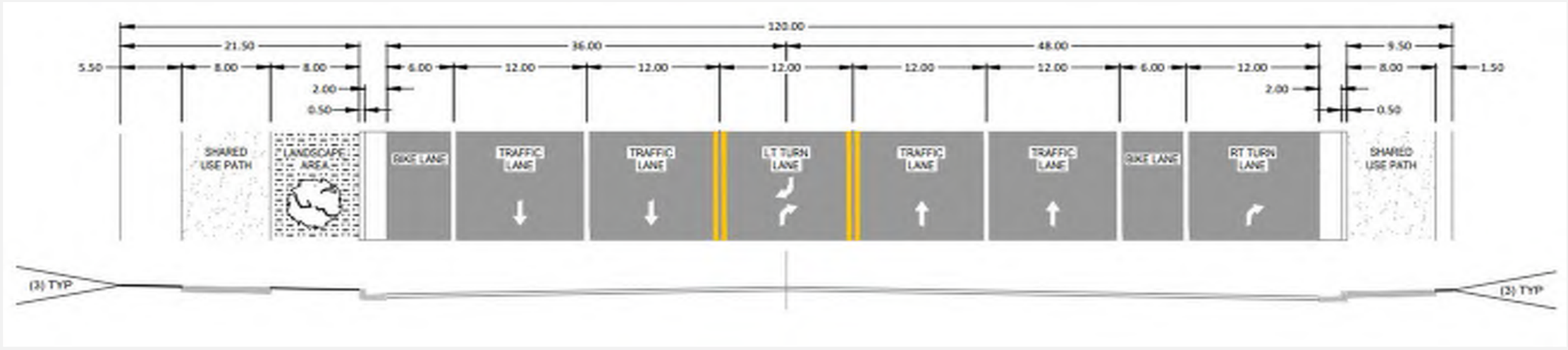

Revised: January 2020

	Criteria		Value		Source	Comments
General	System Classification:		F-R		SHAC, s3.13, p42	It was determined this is a CDOT roadway.
	Design Speed:		25	mph	CRDG s5.2.3, p5-3	
	Posted Speed:		25	mph	CRDG s5.2.3, p5-3	It was determined that design and posted speeds will be the same.
	Design Vehicle:		WB-67		PGDHS p2-55	
	AADT:		N/A			
	% Trucks		N/A			
Horizontal / Cross Slope	Superelevation (e_{MAX}):	Table:	N/A	%	CRDG s3.2.3.5	Use normal crown (2%). Superelevation not used.
		Actual:	N/A	%	CRDG s3.2.3.5	
	Min. Curve Radius:		198	ft	CRDG t3-2, p3-24; PGDHS t3-13, p3-54	For normal crown (-2%)
	Min. Stopping Sight Distance:	Level:	155	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Down	158	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
		3% Up	147	ft	CRDG t3-1, p3-2; PGDHS t3-2, p3-6	
	Clear Zone:		14	ft	RDG t3-1, p3-3	ADT > 6000
	Redirect Taper:		15:1		SHAC t4-9, p57	
	Deceleration Length:		180	ft	SHAC t4-6, p55	See SHAC t4-7 for grade adjustment factors
	Acceleration Length:		N/A	ft	SHAC t4-6, p55	See SHAC t4-7 for grade adjustment factors
	Accel/Decel Transition Taper:		7.5:1		SHAC t4-6, p55	
	Max. Break at Crossover Line		5	%	CRDG t10-2, p10-25	
Vertical	Grade:	Max.	8	%	CRDG s5.2.5, p5-3	
		Min.	0.3	%	CRDG s5.2.5, p5-3	If the roadway is adequately crowned to drain the surface laterally
	Min. Length of Curve	3x Dsgn Spd:	75	ft	CRDG s3.3.4, p3-33	Minimum curve length also controlled by stopping sight distance
	Min. K-Value	K_{SAG}	26		CRDG t3-1, p3-2; PGDHS t3-37, p3-176	For K-values > 167, check drainage
		K_{CREST}	12		CRDG t3-1, p3-2; PGDHS t3-35, p3-170	
	Min. Vertical Structure Clearance:		16.5	ft	CRDG t3-3, p3-29; PGDHS s10.8.4, p10-22	Highway Underpasses (see CRDG t3-3 for additional clearances)
	Chorded Profile Grade Break	SAG	0.2	%	CRDG s3.3.4, p3-33	
		CREST	0.2	%	CRDG s3.3.4, p3-33	

Notes

Typical Section includes: 2 - 11 ft through lanes, 6 ft shoulders, and 8 ft z-slopes at 6:1

Construction: Two 11' lanes with 2' min shoulders, each direction

Standard CDOT Z-slope

Cut Slopes: 4:1 Max

Fill Slopes: 4:1 Max

Normal Cross Slope: 2% (CRDG s5.2.7)

Abbreviations

CRDG- CDOT Roadway Design Guide (2005, Revised 2018)

COGCS- City of Greeley Corridor Standards (2016)

COGSM- City of Greeley Street Manual (Vol. 1, 2015)

PGDHS- AASHTO: A Policy on Geometric Design of Highways and Streets (7th Edition, 2018)

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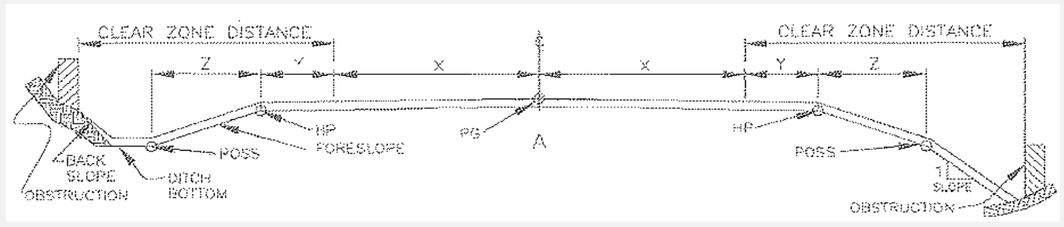

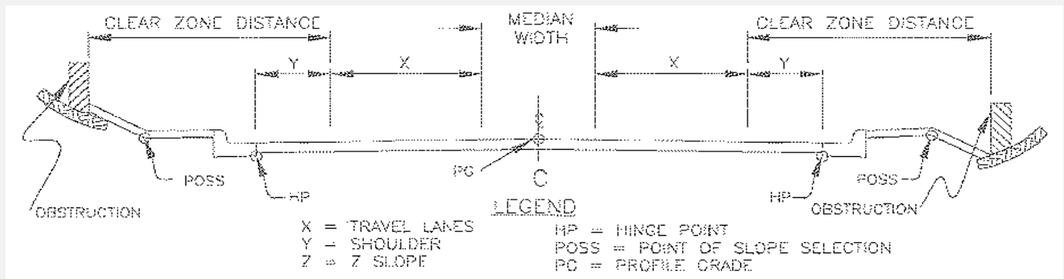

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Revised: January 2020

	Criteria	Value	FHWA Suggested Criteria	UDOT Suggested Criteria
General	Crossover Design Speed:	30 mph	25 - 35 mph; pg. 114, 116	* 35 mph to 55 mph for crossroad * 25 mph to 40 mph for crossover area. * Speed reduction in crossover area should be at least 10 mph less than speed of crossroad away from DDI. pg. 25
	Crossover Angle:	30 - 40 degrees	40 degrees; pg. 116	30 to 60 degrees; pg. 26
	Tangent in Advance of Crossover:	100 feet ideal, based on AutoTurn	100 feet; p. 129	
	Design Vehicle:	WB-67	WB-67; p. 115	WB-67; Allow for side-by-side operation in adajacent lanes; p. 32
	Distance between Crossovers:	495 feet		750-1500 feet; p. 26
Horizontal / Cross Section Elements	Lane Width:	12' typical; 13' to accommodate WB-67s at crossover movements; 16' to accomodate WB-67s at ramp turn lanes.	12' to 15'	12' minimum; Receiving lanes for crossovers or where left or right turns converge should be 14'-16'
	Turning Lane Radii:	Left turns: 20 mph, 92' Right turns: 25 mph, 167'		25 mph
	Sight Distance:	SSD on level grade: 200 ft. ISD for cars, case B1: 335 ft ISD for combo-trucks case B1: 510'	Provide Intersection Sight distance and Stopping Sight Distance at all ramp terminal and crossover intersections within the DDI. p. 140	
	Curbs and Barriers:	Use curb and gutter throughout interchange to improve channelization. Use concrete barriers in median to protect pedestrian path. Use mountable curbs where needed per turning templates to prevent scarring and where impractical to make a wider lane to accomodate turning movements. Avoid using mountable curbs adjacent to sidewalks.	Shoulders not recommended in vicinity of crossovers as they increase speeds and reduce channelization. p. 131 Protect pedestrians in center walkway with concrete barrier. Ensure that barrier placement does not hinder sight distance for right-turns at off ramps, or, if it does signalize right turns and restrict RTOR, or provide right-turn acceleration lane. p. 144	In general use barrier curbs on islands. Use mountable curbs where needed to prevent scarring from trucks and snowplows. Use concrete barrier to protect pedestrians in center walkway. p. 33
	Glare Screening:	Preferable: Use geometric design to avoid direct alignment of head-on traffic to aboid glare issue. Less Preferable: 42" max height concrete barrier recommended at eyebrows of median at the approach side of each crossover intersection. Do not overdesign height or length of glare screening - placement should be only where needed to avoid direct headlight glare.		42" max height concrete barrier recommended at eyebrows of median at the approach side of each crossover intersection. Do not overdesign height or length of glare screening - placement should be only where needed to avoid direct headlight glare.
Bike / Pedestrian Elements	Median Pedestrian Path Width	12' clear between face of barriers		11' to 14' p. 36-37
	Outside Pedestrian Path	8' wide, attached with auxiliary lane; 8' wide with 8' detachment with no auxiliary lane		
	Bike Facilities	6' Bike Lanes on 47th Avenue. 8' Multi-Use Regional Trail along the north side of US 34		
	Pedestrian Visibility	Provide stopping sight distance at all pedestrian crosswalks, and ensure a clear sight line from driver eye location to sidewalk area where pedestrians wait to cross at crosswalk.		*Consider pedestrian view of traffic from island,and driver view of pedestrian. *Check stopping sight distance at crossings on unsignalized ramp lanes. P. 36-37

Abbreviations

FHWA *FHWA Diverging Diamond Interchange Informational Guide - August 2014*

UDOT *DDI Guideline - A UDOT Guide to Diverging Diamond Interchanges - June 2014*

Notes

Diverging Diamond Interchange Criteria for 47th Avenue applies in the area within the limits of the raised median in advance of each crossover intersection, from approximately STA 22+20 to STA 40+20.

From 47th Avenue Project Typical Section

From 47th Avenue Project Typical Section, US 34 existing regional bike trail, 2015 City of Greeley Bicycle Master Plan

APPENDIX E

US 34 AND 35TH AVENUE
LEVEL 1 SCREENING

US34 & 35TH AVENUE - LEVEL 1 INTERCHANGE ALTERNATIVES ANALYSIS AND SCREENING

Alternative	Screening Criteria	Advantages	Disadvantages	Relative Rating
Echelon Intersection 	Safety	Removes some intersection conflict points	Signalizing high speed US34 has similar safety concerns as existing intersection. High speed right angle collisions are possible.	
	Traffic Operations		Requires traffic signals on US34. Left entrance ramps.	Major Flaw
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross under part of 35th and at signal for other part.	Trail crossing of free right is difficult	
Partial Cloverleaf (Parclo) 	Safety	Two left-turn movements removed		
	Traffic Operations	Most ramps are free-flow	Signals on 35th Ave for left turns from off ramps. Free-flow may cause issues at adjacent intersections.	
	Right-of-Way Impacts		Would require ROW (homes & business) in NE quadrant	Major flaw
	Multimodal Accommodations		US34 trail would require grade separations to move thru interchange. Bus route on 28th may require alteration.	
Michigan Urban Diamond Interchange (MUDI) 	Safety	Eliminates left turns on 35th.	Unfamiliarity may create increased confusion and incorrect movements	
	Traffic Operations	35th signals are two-phase	Not a familiar interchange type in Colorado--difficult signing. Out of direction left turns pass through two signals.	
	Right-of-Way Impacts	May stay within existing ROW	Does not use SW quadrant property dedicated for loop ramp. Layout is difficult within existing ROW.	Major Flaw
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal.		
Partial Cloverleaf with Slip Ramp to 28th St Roundabout (Parclo-R) 	Safety	One left-turn removed. Roundabouts slow traffic and avoid high speed crashes.	Slip ramp to roundabout requires substantial deceleration which could lead to rear-end collisions	
	Traffic Operations	NB-EB slip ramp may provide improved operations on 35th	Roundabout fails to operate well. Business traffic (car wash) & 35th signal may block roundabout operation. Significant EB 28th traffic creates operational issues.	Major Flaw
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal and avoid roundabout on north side of 28th.		
Partial Cloverleaf with Slip Ramp to Two-Way 28th St (Parclo-T) 	Safety		Wrong way movement onto WB exit ramp is serious concern. Unstopped WB exit may result in high-speed conflicts at 28th intersection.	Major Flaw
	Traffic Operations	NB-EB slip ramp may provide improved operations	EB thru movement on 28th may cause problems at 35th intersection with high free-flow exiting volumes	
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal.		
D-Loop with Slip Ramp to One-Way 28th St 	Safety		Wrong way movement on EB 28th and exit ramp is concern, but may be minimized with geometric changes.	
	Traffic Operations	D-Loop traffic operations are acceptable.	Business traffic (car wash) & 35th signal may create operational problems with ramp. Significant EB 28th traffic would need to be re-routed.	Major Flaw
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Trail could cross 35th at signal.	Bus route on 28th would need to be re-routed and would be difficult to provide service to user groups on existing route.	
Tight Diamond with D-Loop 	Safety		NB to EB movement required left-turn	
	Traffic Operations	D-Loop traffic operations are acceptable. WB ramp intersection traffic operations are acceptable.	Left turn from WB 28th St to SB 35th will likely be prohibited	
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal.		
D-Loop and Tight Diamond with 28th St Frontage Rd Underpass 	Safety	EB 28th traffic does not cross ramp traffic.	Vertical alignment of WB exit ramp requires careful design to avoid a blind crest ahead of a queue.	
	Traffic Operations	Eliminates 28th St intersection on 35th. EB 28th traffic does not interfere with exit ramp traffic	Ramp connection road may be problematic with car wash driveway.	
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal.		

US34 & 35TH AVENUE - LEVEL 1 INTERCHANGE ALTERNATIVES ANALYSIS AND SCREENING

Alternative	Screening Criteria	Advantages	Disadvantages	Relative Rating
Partial Cloverleaf and Tight Diamond with NB Indirect Left (Parclo-MUDI Hybrid) 	Safety	Removes left turn conflict points at 35th/ramp intersections	Indirect left may confuse some drivers	
	Traffic Operations	Eliminates left turn movements from 35th Ave to ramps (two phase north signal, three phase south signal--cemetery access light movement)	Extra signal two-phase on WB off ramp. Signal coordination could be complicated.	
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations	Bus route on 28th maintained. Trail could cross 35th at signal.	35th Ave sidewalks must cross free-flow right turns on both sides of the street.	
No-Build Alternative	Safety		Existing conflict points remain especially high-speed right-angle collisions. Existing safety concerns remain.	Major Flaw
	Traffic Operations		Traffic operations degrade and congestion increases. Rationale for local public funding vote based on improving congestion.	Major Flaw
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations		No change. Crossing congested and high-speed roadways is not comfortable.	

APPENDIX F

US 34 AND 35TH AVENUE
LEVEL 2 SCREENING

US34 & 35TH AVENUE - LEVEL 2 NO-BUILD ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	2.3	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. These do not change, but high speed conflicts remain. The Crash Incident Score is 71 of 100. Crash severity is expected to increase because high speed traffic is signalized and volume increases. No change in driver expectation. Driver frustration may increase. Signing may need to be adjusted to account for increased queue lengths and signal change flashing warnings may be warranted.
Traffic Operations	3.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.	No, LOS = D or better is not achieved. LOS and delay estimates are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. No, travel time degrades compared to existing on EB US 34 by 1.2/1.3 minutes (AM/PM peak hours) and WB US 34 by 4.4/8.0 minutes (AM/PM peak hours).
Access	1.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	No, driveways and side streets are not physically altered. Yes, the intersection between 35th Ave and 28th St will continue to deteriorate with increased traffic such that it may be operationally altered due to congestion.
Constructability	1.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)	No-Build has no construction or resultant traffic control to consider.
Utilities	1.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	No-Build has no impacts to existing utilities.
Environmental	2.3	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	No-Build does not impact sensitive noise receptors; however, increase in congestion may increase noise levels No-Build does not impact irrigation resources. No-Build does not impact parks or trails. No-Build does not require regional air quality conformity; however, an increase in congestion may result in an increase in idling vehicles.
Flexibility for Future Needs	2.7	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	No, adding an additional lane on US 34 would require substantial work. No, adding lanes or turn lanes on 35th would be a substantial impact to the existing intersection and signal. Yes, new transit, bike and ped facilities could be accommodated.
Maintenance	2.0	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Maintenance requirements slightly increase due to increased traffic volume and potentially more crashes. Pavement will require rehab if intersection is not reconstructed. No special maintenance needs (no changes). Traffic control for maintenance activities becomes more difficult with increased traffic and congestion (night work only may be required); no easy alternate routes for emergency issues.
Multimodal Accommodations	2.0	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated (no change). Yes, existing facilities may be ADA compliant (no changes). 9 total crossings (3 right turn lanes & 4 thru lanes at US34/35th; 1 crossing at 35th/28th; 1 crossing at 35th/cemetery). Crossing high-speed US34 traffic (80ft-110ft) and free right turns can be uncomfortable and dangerous.
Right-of-Way	1.0	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	No, ROW, permanent easements or temporary easements are not required (no work).
Drainage & Irrigation	2.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No impact to existing irrigation facilities. No impact to existing drainage facilities. No drainage issues or water quality would be addressed. Any downstream issues remain (no changes).

US34 & 35TH AVENUE - LEVEL 2 TIGHT DIAMOND INTERCHANGE ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.2	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Slight increase in conflict points over existing but no high speed conflicts. The Crash Incident Score is 98 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. The D-loop is contrary to driver expectation (left turn for a right movement). Overhead signing on 35th may be desirable for left turn to D-loop.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 4.9/2.8 minutes (AM/PM peak hours), WB US 34 by 6.8/8.8 minutes (AM/PM peak hours), NB 35th Ave by 1.2/2.1 minutes (AM/PM peak hours), and SB 35th Ave by 0.1/0.7 minutes (AM/PM peak hours).
Access	2.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: driveways on 28th will have side path crossing; 35th/28th intersection converted to signalized 3/4 movement; cemetery median adjustments for turning alignment. Yes: 35th/28th intersection converted to signalized 3/4 movement.
Constructability	2.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)	Bridge is expected to be basic highway overpass (1-span). Walls are expected to be extensive and tall (53,000 SF, 24' max height). US34 alignment chicane added to shift WB bridge north of existing pavement and provide additional space along the cemetery. Temporary walls may be required for WB to avoid temporary shift of the existing intersection. Temporary median pavement expected. Ramps are largely off-line and do not require special accommodations. Lowering 35th will require multiple traffic shifts or an alignment shift. Yes, traffic can be maintained during construction.
Utilities	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission lines (along both US34 and 35th) may need to be relocated. Underground utilities in 35th will likely need to be relocated for a distance through the existing US34 intersection area for profile lowering (~5'). Current known major underground utilities in the 35th Avenue intersection area are a 30" storm sewer and 12" & 36" water lines.
Environmental	1.8	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 22 sensitive noise receptors. Including 18 residential areas, 1 cemetery, 1 natural area, 1 school, and 1 future development area. In addition, the alternative will require work on the cemetery property during construction. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will require crossing of the Loveland and Greeley Canal on the eastern side of the project design along US 34. However, impacts would likely be minimal since the new footprint is unlikely to exceed the original US 34 footprint that crosses the canal at the same location. However, crossing would require coordination with ditch company (long-lead item). This alternative will impact the US 34 Bypass Trail, but will replace and increase the multi-use path footprint by adding an additional north-south path on the west side of 35th, as well as an additional path on the north side of 28th Avenue . The alternative will require work adjacent to Gateway Lakes Natural Area; however, it is unlikely that direct impacts to the Gateway Lakes Natural Area would be required as the alternative is depicted. Impact level may change if this alternative does require direct impacts to Gateway Lakes Natural Area. The US 34 and 35th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	1.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. Yes, Bridges, walls and intersections will provide for 35th expansion (but substantial work beyond interchange). Yes, a small expansion of US34 side path is provided (north side of 28th). 35th side paths will be maintained. Future bike/ped expansion can be accommodated. Future bus routes can be accommodated (WB stop easily, EB stop would be complicated).
Maintenance	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 35th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Maintenance traffic control involves lower volumes and speeds at intersections. Ramps provide WB alternate route.
Multimodal Accommodations	1.4	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. 28th St bike lanes will be removed and new side path on north side of 28th between 35th Ave and Reservoir Rd (this serves as an extension of US34 side path per COG bike plan). Side path and sidewalks will be maintained on 35th with crosswalks at intersections. 11 street crosswalks (35th west side path--2 free right, 2 thru/turn lanes; 35th east side path--3 thru/turn lanes; 35th crossings--3 thru/turn lanes; 33rd Ave Pl crossing - 1 thru/turn lane). Crossing distances are generally shorter and no high-speed.
Right-of-Way	1.0	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	No, additional ROW is not required assuming NW corner dedication is complete. No, unknown existing permanent easements so assume none are required. Yes, temporary easements are likely at cemetery entrance, gas station driveways (35th & 28th), car wash driveway (15,800 SF).
Drainage & Irrigation	1.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No, existing irrigation facilities are not impacted (crosses US34 near Reservoir Rd). Yes, new & updated drainage system is expected. Yes, water quality will be included in design. Downstream affects will figure into the design.

US34 & 35TH AVENUE - LEVEL 2 PARCLO-MUDI INTERCHANGE ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.3	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. There is a slight decrease from existing conditions, no high-speed conflicts. The Crash Incident Score is 100 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. Indirect left is contrary to driver expectation (right turn for a left movement). Overhead signing on 35th may be desirable for indirect left.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 5.0/2.8 minutes (AM/PM peak hours), WB US 34 by 7.4/8.7 minutes (AM/PM peak hours), NB 35th Ave by 1.4/2.0 minutes (AM/PM peak hours), and SB 35th Ave by 0.3/1.7 minutes (AM/PM peak hours).
Access	2.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: driveways on 28th will have side path crossing; 35th/28th intersection converted to signalized 3/4 movement; cemetery median adjustments for turning alignment. Yes: 35th/28th intersection converted to signalized 3/4 movement.
Constructability	2.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)	Bridge is expected to be basic highway overpass (3- or 4- span). Walls are expected to be extensive and tall (54,000 SF, 21' max height). US34 alignment chicane added to shift WB bridge north of existing pavement and provide additional space along the cemetery. Temporary walls may be required for WB to avoid temporary shift of the existing intersection. Temporary median pavement expected. Ramps are largely off-line and do not require special accommodations. Lowering 35th will require multiple traffic shifts or an alignment shift. Yes, traffic can be maintained during construction.
Utilities	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission lines (along both US34 and 35th) may need to be relocated/undergrounded. Underground utilities in 35th will likely need to be relocated for a distance through the existing US34 intersection area for profile lowering (~5'). Current known major underground utilities in the 35th Avenue intersection area are a 30" storm sewer and 12" & 36" water lines.
Environmental	1.8	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 22 sensitive noise receptors. Including 18 residential areas, 1 cemetery, 1 natural area, 1 school, and 1 future development area. In addition, the alternative will require work on the cemetery property during construction. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will require crossing of the Loveland and Greeley Canal on the eastern side of the project design along US 34. However, impacts would likely be minimal since the new footprint is unlikely to exceed the original US 34 footprint that crosses the canal at the same location. However, crossing would require coordination with ditch company (long-lead item). This alternative will impact the US 34 Bypass Trail, but will replace and increase the multi-use path footprint by adding an additional north-south path on the west side of 35th, as well as an additional path on the north side of 28th Avenue . The alternative will require work adjacent to Gateway Lakes Natural Area; however, it is unlikely that direct impacts to the Gateway Lakes Natural Area would be required as the alternative is depicted. Impact level may change if this alternative does require direct impacts to Gateway Lakes Natural Area. The US 34 and 35th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	1.0	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. Yes, Bridges, walls and intersections will provide for 35th expansion (but substantial work beyond interchange). Yes, a small expansion of US34 side path is provided (north side of 28th). 35th side paths will be maintained. Future bike/ped expansion can be accommodated. Future bus routes can be accommodated (WB stop easily, EB stop possible).
Maintenance	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 35th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Maintenance traffic control involves lower volumes and speeds at intersections. Ramps provide WB & EB alternate routes.
Multimodal Accommodations	1.6	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. 28th St bike lanes will be removed and new side path on north side of 28th between 35th Ave and Reservoir Rd (this serves as an extension of US34 side path per COG bike plan). Side path and sidewalks will be maintained on 35th with crosswalks at intersections. 12 street crosswalks (35th west side path--2 free right, 2 thru/turn lanes; 35th east side path--1 free right, 3 thru/turn lanes; 35th crossings--3 thru/turn lanes; 33rd Ave Pl crossing - 1 thru/turn lane). Crossing distances are generally shorter and no high-speed.
Right-of-Way	1.0	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	No, additional ROW is not required assuming NW corner dedication is complete. No, unknown existing permanent easements so assume none are required. Yes, temporary easements are likely at cemetery entrance, gas station driveways (35th & 28th), car wash driveway (14,800 SF).
Drainage & Irrigation	1.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No, existing irrigation facilities are not impacted (crosses US34 near Reservoir Rd). Yes, new & updated drainage system is expected. Yes, water quality will be included in design. Downstream affects will figure into the design.

US34 & 35TH AVENUE - LEVEL 2 28TH UNDERPASS INTERCHANGE ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.8	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Conflict points increase due to two additional intersections on 28th. The Crash Incident Score is 84 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. The D-loop is contrary to driver expectation (left turn for a right movement). Overhead signing on 35th may be desirable for left turn to D-loop.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 5.1/2.5 minutes (AM/PM peak hours), WB US 34 by 7.4/8.9 minutes (AM/PM peak hours), NB 35th Ave by 1.3/3.2 minutes (AM/PM peak hours), and SB 35th Ave by 0.2/1.0 minutes (AM/PM peak hours).
Access	1.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: driveways on 28th will have side path crossing; 35th/28th intersection converted to right-in-right-out with connector roads to ramp and from 35th; cemetery median adjustments for turning alignment. No: existing movements maintained in altered configuration.
Constructability	2.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)	Bridges are expected to be basic highway overpass (1-span over 35th; 1-span for ramp). Walls are expected to be extensive and tall (58,800 SF, 24' max height). US34 alignment chicane added to shift WB bridge north of existing pavement and provide additional space along the cemetery. Temporary walls may be required for WB to avoid temporary shift of the existing intersection. Temporary median pavement expected. Ramps are largely off-line and do not require special accommodations. Lowering 35th will require multiple traffic shifts or an alignment shift. Yes, traffic can be maintained during construction.
Utilities	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission lines (along both US34 and 35th) may need to be relocated/undergrounded. Underground utilities in 35th will likely need to be relocated for a distance through the existing US34 intersection area for profile lowering (~5'). Current known major underground utilities in the 35th Avenue intersection area are a 30" storm sewer and 12" & 36" water lines.
Environmental	1.8	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 22 sensitive noise receptors. Including 18 residential areas, 1 cemetery, 1 natural area, 1 school, and 1 future development area. In addition, the alternative will require work on the cemetery property during construction. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will require crossing of the Loveland and Greeley Canal on the eastern side of the project design along US 34. However, impacts would likely be minimal since the new footprint is unlikely to exceed the original US 34 footprint that crosses the canal at the same location. However, crossing would require coordination with ditch company (long-lead item). This alternative will impact the US 34 Bypass Trail, but will replace and increase the multi-use path footprint by adding an additional north-south path on the west side of 35th, as well as an additional path on the north side of 28th Avenue . The alternative will require work adjacent to Gateway Lakes Natural Area; however, it is unlikely that direct impacts to the Gateway Lakes Natural Area would be required as this alternative is depicted. Impact level may change if this alternative does require direct impacts to Gateway Lakes Natural Area. The US 34 and 35th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	1.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. Yes, Bridges, walls and intersections will provide for 35th expansion (but substantial work beyond interchange). Yes, a small expansion of US34 side path is provided (north side of 28th). 35th side paths will be maintained. Future bike/ped expansion can be accommodated. Future bus routes can be accommodated (WB stop easily, EB stop would be complicated).
Maintenance	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 35th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Maintenance traffic control involves lower volumes and speeds at intersections. Ramps provide WB alternate route.
Multimodal Accommodations	1.4	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. 28th St bike lanes will be removed and new side path on north side of 28th between 35th Ave and Reservoir Rd (this serves as an extension of US34 side path per COG bike plan). Side path and sidewalks will be maintained on 35th with crosswalks at intersections. 11 street crosswalks (35th west side path--2 free right, 2 thru/turn lanes; 35th east side path--0 free right, 4 thru/turn lanes; 35th crossings--2 thru/turn lanes; 33rd Ave Pl crossing - 1 thru/turn lane). Crossing distances are generally shorter and no high-speed.
Right-of-Way	1.3	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	No, additional ROW is not required assuming NW corner dedication is complete. No, unknown existing permanent easements so assume none are required. Yes, temporary easements are likely at cemetery entrance, gas station driveways (35th & 28th), car wash driveway, office driveway, mortuary driveway (32,800 SF).
Drainage & Irrigation	1.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No, existing irrigation facilities are not impacted (crosses US34 near Reservoir Rd). Yes, new & updated drainage system is expected. Yes, water quality will be included in design. Downstream affects will figure into the design.

US34 & 35TH AVENUE - LEVEL 2 SCORING DETAILS

Category	Criteria Elements	Basis of Grade			Alternatives							
					No Build		Tight Diamond		Parclo-MUDI		28th Underpass	
		1	2	3	Individual Grade	Composite Grade	Individual Grade	Composite Grade	Individual Grade	Composite Grade	Individual Grade	Composite Grade
Safety	What are the vehicular-vehicular conflict points? (High Speed > 45 MPH)	0	1 to 5	> 5	3	2.3	1	1.2	1	1.3	1	1.8
	Total number of vehicular-vehicular conflict points?	< 75	75 to 85	> 85	2		2		1		3	
	What are the vehicular-bike/ped conflict points?	< 40	40 to 50	> 50	2		1		1		2	
	What is the alternative Crash Incident Score?	91 to 100	81 to 90	< 80	3		1		1		2	
	What level of crash severity could be expected in the design year?	Decrease expected	About the same expected	Increase expected	3		1		1		1	
	Describe any driver expectation challenges or locations for potential for driver error.	Common configuration	Less common configuration	Rare or unique configuration	1		1		3		2	
Traffic Operations	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS (AM/PM) and average delay (AM/PM)?	Yes, LOS improves & delay decreases	Yes, LOS & delay remain about same	No, LOS decreases & delay increases	3	3.0	1	1.0	1	1.0	1	1.0
	Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.	Yes, both roadways improve	Yes, only one roadway improves	No, both roadways degrade	3		1		1		1	
Access	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration.	No changes	Yes, minimal changes	Yes, significant changes	1	1.0	2	2.0	2	2.0	1	1.0
	Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	No or Yes, minimal changes	Yes, some operations prohibited	Yes, full closure	1		2		2		1	
Constructability	What is the quantity and level of complexity of major project elements (bridges and walls)?	Basic quantity, Common elements	Extra quantity, Less common elements	Large quantity, Unique elements	1	1.0	2	2.0	2	2.0	2	2.0
	What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)?	Minimal temporary elements	Moderate temporary elements	Major temporary elements	1		2		2		2	
	Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)	Yes, with basic effort	Yes, with complications	No	1		2		2		2	
Utilities	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	None to minor adjustments under 300'	1 to 3 major relocations between 300' and 1000'	> 3 major relocations over 1000' in length	1	1.0	2	2.0	2	2.0	2	2.0
Environmental	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	No work adjacent to sensitive noise receptors	Work adjacent to sensitive noise receptors, but none categorized as FHWA land use category A	Work adjacent to sensitive noise receptors, parcel identified as FHWA land use category A	2	2.3	2	1.8	2	1.8	2	1.8
	Due to the existing built-up surroundings of the project area, it is anticipated that Irrigation will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	No impacts to irrigation ditches or canals	Impacts to irrigation ditches or canals only in previously impacted locations, impacts likely minimal or none	Impacts to irrigation ditches or canals in previously unimpacted locations, true impact determination will require survey and long lead time for coordination with ditch companies	2		2		2		2	
	Due to the existing built-up surroundings of the project area, it is anticipated that Parks & Trails will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	Impacts to multi-use trail will be replaced with new trail systems at minimum; may add new trail connections	Impacts to multi-use trail will result in one less connection (east-west or north-south)	Impacts to multi-use trail will result in more than one less connection	2		1		1		1	

	Due to the existing built-up surroundings of the project area, it is anticipated that Air Quality will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	Project is in STIP/TIP list so meets regional air conformity	Project is not in STIP/TIP list; does not meet regional air conformity	NA	3		2		2		2	
Flexibility for Future Needs	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N)	Yes		No	3	2.7	1	1.3	1	1.0	1	1.3
	Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N)	Yes		No	3		1		1		1	
	Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes	Maybe, may have complications	No	2		2		1		2	
Maintenance	What are the maintenance requirements of the alternative over the lifespan of the project?	Reduced maintenance	About the same maintenance	Increased maintenance	2	2.0	2	1.7	2	1.7	2	1.7
	Are there any special maintenance requirements for the alternative? (Y or N) Describe them.	No	Yes, Minor Adjustments	Yes, Unique Needs	1		1		1		1	
	What traffic control will be needed for expected maintenance activities?	Less traffic control	About the same traffic control	More traffic control	3		2		2		2	
Multimodal Accommodations	Can existing bus routes and stops be accommodated? (Y or N)	Yes, with improvements	Yes, about the same	No	2	2.0	2	1.4	2	1.6	2	1.4
	Can PROWAG ADA requirements be met? (Y or N)	Yes, Fully Compliant	Yes, Some Exceptions	No	2		1		1		1	
	Describe changes to the existing bike/ped facilities.	Improve over existing	About the same as existing	Degrade from existing	2		1		1		1	
	How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity?	< 20	21 to 40	> 40	2		2		2		2	
	Describe crossings in terms of bike/ped comfort, ease and conflict.	Crossings are shorter, easier, more comfortable	Crossings are about the same	Crossings are longer, circuitous, increase conflicts	2		1		2		1	
Right-of-Way	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted.	No	Yes, no impacts to built environment	Yes, with impacts to built environment	1	1.0	1	1.0	1	1.0	1	1.3
	Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted.	No	Yes, No Structures	Yes, Structures	1		1		1		1	
	Are any temporary easements require? (Y or N) If so/known, estimate area.	Yes (< 20,000-SF)	Yes, (20,000-SF to 50,000-SF)	Yes (> 50,000-SF)	1		1		1		2	
Drainage & Irrigation	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact.	No	Yes, Minor Adjustments	Yes, Major Adjustments	1	2.0	1	1.0	1	1.0	1	1.0
	Does the alternative impact existing drainage facilities? (Y or N) Describe the impact.	Improvement over existing	About the same	Degrade from existing	2		1		1		1	
	Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	Yes, Desirable	Yes, Not Desirable	No	3		1		1		1	

US34 & 35TH AVENUE - LEVEL 2 INTERCHANGE ALTERNATIVES ANALYSIS AND SCREENING SCORING MATRIX

Category	Weight	Alternative				Criteria
		No-Build	Tight Diamond	Parclo-MUDI	28th Underpass	
		Grading				
Safety	30%	2.3	1.2	1.3	1.8	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.
Traffic Operations	25%	3.0	1.0	1.0	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 35th Avenue? (Y or N) Provide estimates.
Access	7%	1.0	2.0	2.0	1.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.
Constructability	3%	1.0	2.0	2.0	2.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 35th Ave during construction? (Y or N)
Utilities	3%	1.0	2.0	2.0	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?
Environmental	7%	2.3	1.8	1.8	1.8	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.
Flexibility for Future Needs	7%	2.7	1.3	1.0	1.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 35th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)
Maintenance	5%	2.0	1.7	1.7	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?
Multimodal Accommodations	7%	2.0	1.4	1.6	1.4	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.
Right-of-Way	3%	1.0	1.0	1.0	1.3	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.
Drainage & Irrigation	3%	2.0	1.0	1.0	1.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.
WEIGHTED GRADE	100%	2.25	1.33	1.35	1.45	
	RANK	**4**	**1**	**2**	**3**	

US34 & 35TH AVENUE - LEVEL 2 TRAFFIC DATA

Intersection Conflict Type*	Alternative			
	No-Build (Existing)	Tight Diamond	Parclo-MUDI	28th Underpass
Vehicle/Vehicle Diverging	23	24	21	27
Vehicle/Vehicle Merging	23	26	25	38
Vehicle/Vehicle Crossing	24	31	22	51
Vehicle/Vehicle Crossing (High Speed)	8	0	0	0
TOTALS	**78**	**81**	**68**	**116**
Vehicle/Bike (Lane) Crossing	12	0	0	0
Vehicle/Ped Crossing	29	39	37	43
TOTALS	**41**	**39**	**37**	**43**
Bike/Ped # Lanes Crossed	33	32	33	34

***Conflict points are for the US 34 and 35th Ave intersection/interchange and 28th St only. They do not include access points.**

Crash Incident Score	HSM Cost/Incident	No-Build	Accident Savings (5 year)		
			Tight Diamond	Parlco-MUDI	28th Underpass
Fatalities	$4,008,900	0	0	0	0
Injuries	$79,000	57	16.8	17.7	10.2
Non-Injury Accidents	$7,400	143	22.9	25.3	6.4
Cost Savings (5 year)		$0	$1,495,000	$1,587,000	$853,000
Accident Cost (5 year)		$5,561,000	$4,066,000	$3,974,000	$4,708,000
Scoring out of 100		**71**	**98**	**100**	**84**

2045 LOS and Delay	No-Build				Tight Diamond			
	AM		PM		AM		PM	
	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
35th Ave	64	E	66	E	29	C	37	D

2045 LOS and Delay (cont.)	Parclo-MUDI				28th Underpass			
	AM		PM		AM		PM	
	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS	Delay (Sec)	LOS
35th Ave	25	C	32	C	30	C	54	D

2045 Travel Time	Existing				No Build				Tight Diamond			
	AM		PM		AM		PM		AM		PM	
	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB (65th to 11th)	624	10.4	667	11.1	697	11.6	746	12.4	405	6.7	579	9.6
WB (11th to 65th)	569	9.5	520	8.7	833	13.9	1003	16.7	429	7.1	476	7.9
NB (35th)	-	-	-	-	147	2.5	217	3.6	80	1.3	90	1.5
SB (35th)	-	-	-	-	94	1.6	144	2.4	89	1.5	101	1.7

2045 Travel Time (cont.)	Parclo-MUDI				28th Underpass			
	AM		PM		AM		PM	
	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB (65th to 11th)	397	6.6	576	9.6	391	6.5	595	9.9
WB (11th to 65th)	392	6.5	480	8.0	388	6.5	470	7.8
NB (35th)	67	1.1	95	1.6	72	1.2	24	0.4
SB (35th)	77	1.3	42	0.7	84	1.4	83	1.4

APPENDIX G

US 34 AND 35TH AVENUE
CONCEPTUAL CONSTRUCTION COST ESTIMATE

9/14/2020

US 34 at 35th Ave Conceptual Cost Estimate

Tight Diamond with D-Loop Interchange

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
	GENERAL ITEMS				
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
	EARTHWORK ITEMS (raw volume, no deduction for pavement and walls)				
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	25,500	$15	
203-00060	Embankment Material (Complete in Place)	CY	81,210	$18	$1,461,780
				EARTHWORK (GREATER OF 2 ITEMS):	**$1,461,780**
	ROADWAY ITEMS				
304-06000	Aggregate Base Course (Class 6)	TON	57,340	$30	$1,720,200
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	16,680	$95	$1,584,600
412-01200	Concrete Pavement (12 inch)	SY	63,500	$65	$4,127,500
608-00000	Concrete Sidewalk	SY	5,870	$80	$469,600
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	1,230	$40	$49,200
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	6,360	$40	$254,400
610-00030	Median Cover Material (Concrete)	SF	3,810	$15	$57,150
				ROADWAY ITEMS SUBTOTAL:	**$8,262,650**
	SAFETY ITEMS				
606-00710	Guardrail Type 7 (Style CA)	LF	1,164	$60	$69,840
606-20014	Tensioned Cable Rail (TL-4)	LF	5,670	$20	$113,400
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$883,240**
	TRAFFIC ITEMS				
614-86715	Traffic Signal Equipment	EACH	3	$220,000	$660,000
627-00004	Epoxy Pavement Marking	SF	27,250	$2	$54,500
				TRAFFIC ITEMS SUBTOTAL:	**$714,500**
	REMOVAL ITEMS				
202-00190	Removal of Concrete Median Cover Material	SY	1,290	$16	$20,640
202-00200	Removal of Sidewalk	SY	3,665	$30	$109,950
202-00203	Removal of Curb and Gutter	LF	7,950	$16	$127,200
202-00210	Removal of Concrete Pavement	SY	11,770	$27	$317,790
202-00220	Removal of Asphalt Mat	SY	64,780	$10	$647,800
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,353,380**
	STRUCTURE ITEMS				
504-00000	MSE Retaining Wall	SF	53,000	$90	$4,770,000
530-00000	EB Bridge	SF	6,860	$200	$1,372,000
530-00000	WB Bridge	SF	5,740	$200	$1,148,000
				STRUCTURE ITEMS SUBTOTAL:	**$7,290,000**

The Tight Diamond with D-Loop alternative interchange uses the D-loop configuration south of US 34. North of US 34, the exit and entrance ramps are moved close to the US 34 mainline lanes and 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue will be signalized in the northbound direction for the southbound left turn and is restricted to a ¾ movement intersection. This configuration provides approximately 80 feet of separation along 35th Avenue between the ramp intersection and the 28th Street intersection.

Assumptions: US 34 and ramp pavement is concrete; 35th Ave and 28th St pavement is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

MAJOR ITEMS SUBTOTAL	**$23,186,000**
MINOR - ENVIRONMENTAL (~2%)	$463,720
MINOR - TRAFFIC (~2%)	$463,720
MINOR - DRAINAGE & SWMP (~10%)	$2,318,600
MINOR - MOT (~5%)	$1,159,300
MINOR - UTILITIES (~10%)	$2,318,600
CONSTRUCTION TOTAL	**$29,909,940**
FORCE ACCOUNTS (10%)	$2,991,000
RIGHT-OF-WAY	$160,000
CONSTRUCTION ENGINEERING (11%)	$3,291,000
CONSTRUCTION INDIRECTS (9.5%)	$2,842,000
TOTAL PROJECT COST	**$39,193,940**

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COLORADO Department of Transportation

City of Greeley Colorado

9/14/2020

US 34 at 35th Ave Conceptual Cost Estimate

Parclo-MUDI Interchange

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
	GENERAL ITEMS				
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
	EARTHWORK ITEMS (raw volume, no deduction for pavement and walls)				
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	34,195	$15	
203-00060	Embankment Material (Complete in Place)	CY	82,640	$18	$1,487,520
				EARTHWORK (GREATER OF 2 ITEMS):	**$1,487,520**
	ROADWAY ITEMS				
304-06000	Aggregate Base Course (Class 6)	TON	58,680	$30	$1,760,400
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	15,805	$95	$1,501,475
412-01200	Concrete Pavement (12 inch)	SY	66,830	$65	$4,343,950
608-00000	Concrete Sidewalk	SY	5,730	$80	$458,400
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	2,885	$40	$115,400
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	6,920	$40	$276,800
610-00030	Median Cover Material (Concrete)	SF	11,400	$15	$171,000
				ROADWAY ITEMS SUBTOTAL:	**$8,627,425**
	SAFETY ITEMS				
606-00710	Guardrail Type 7 (Style CA)	LF	1,348	$60	$80,880
606-20014	Tensioned Cable Rail (TL-4)	LF	5,455	$20	$109,100
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$889,980**
	TRAFFIC ITEMS				
614-86715	Traffic Signal Equipment	EACH	4	$220,000	$880,000
627-00004	Epoxy Pavement Marking	SF	28,745	$2	$57,490
				TRAFFIC ITEMS SUBTOTAL:	**$937,490**
	REMOVAL ITEMS				
202-00190	Removal of Concrete Median Cover Material	SY	1,290	$16	$20,640
202-00200	Removal of Sidewalk	SY	3,665	$30	$109,950
202-00203	Removal of Curb and Gutter	LF	7,950	$16	$127,200
202-00210	Removal of Concrete Pavement	SY	11,770	$27	$317,790
202-00220	Removal of Asphalt Mat	SY	64,780	$10	$647,800
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,353,380**
	STRUCTURE ITEMS				
504-00000	MSE Retaining Wall	SF	54,000	$90	$4,860,000
530-00000	EB Bridge	SF	21,560	$220	$4,743,200
530-00000	WB Bridge	SF	18,040	$200	$3,608,000
				STRUCTURE ITEMS SUBTOTAL:	**$13,211,200**

The goal of Parclo-MUDI Alternative was to eliminate left turns from 35th Avenue to the entrance ramps for US 34. It uses the parclo configuration south of US 34 and it adds an element from the Michigan Urban Diamond concept by using a U-turn approach to provide for the northbound to westbound movement. The traffic making this movement will make a right turn from 35th Avenue and then turn left onto the westbound exit ramp to pass straight across 35th Avenue and onto the westbound entrance ramp. 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue will be restricted to a ¾ movement and partially signalized (northbound through and southbound left).

Assumptions: US 34 and ramp pavement is concrete; 35th Ave and 28th St pavement is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

MAJOR ITEMS SUBTOTAL	**$29,727,000**
MINOR - ENVIRONMENTAL (~2%)	$594,540
MINOR - TRAFFIC (~2%)	$594,540
MINOR - DRAINAGE & SWMP (~10%)	$2,972,700
MINOR - MOT (~5%)	$1,486,350
MINOR - UTILITIES (~10%)	$2,972,700
CONSTRUCTION TOTAL	**$38,347,830**
FORCE ACCOUNTS (10%)	$3,835,000
RIGHT-OF-WAY	$150,000
CONSTRUCTION ENGINEERING (11%)	$4,219,000
CONSTRUCTION INDIRECTS (9.5%)	$3,644,000
TOTAL PROJECT COST	**$50,195,830**

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COLORADO Department of Transportation

City of Greeley Colorado

9/14/2020

US 34 at 35th Ave Conceptual Cost Estimate

28th Underpass Interchange

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
		GENERAL ITEMS			
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
		EARTHWORK ITEMS (raw volume, no deduction for pavement and walls)			
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	24,200	$15	
203-00060	Embankment Material (Complete in Place)	CY	87,385	$18	$1,572,930
				EARTHWORK (GREATER OF 2 ITEMS):	**$1,572,930**
		ROADWAY ITEMS			
304-06000	Aggregate Base Course (Class 6)	TON	58,960	$30	$1,768,800
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	20,550	$95	$1,952,250
412-01200	Concrete Pavement (12 inch)	SY	60,320	$65	$3,920,800
608-00000	Concrete Sidewalk	SY	6,120	$80	$489,600
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	2,005	$40	$80,200
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	7,670	$40	$306,800
610-00030	Median Cover Material (Concrete)	SF	1,960	$15	$29,400
				ROADWAY ITEMS SUBTOTAL:	**$8,547,850**
		SAFETY ITEMS			
606-00710	Guardrail Type 7 (Style CA)	LF	1,155	$60	$69,300
606-20014	Tensioned Cable Rail (TL-4)	LF	5,670	$20	$113,400
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$882,700**
		TRAFFIC ITEMS			
614-86715	Traffic Signal Equipment	EACH	2	$220,000	$440,000
627-00004	Epoxy Pavement Marking	SF	28,508	$2	$57,016
				TRAFFIC ITEMS SUBTOTAL:	**$497,016**
		REMOVAL ITEMS			
202-00190	Removal of Concrete Median Cover Material	SY	1,290	$16	$20,640
202-00200	Removal of Sidewalk	SY	3,665	$30	$109,950
202-00203	Removal of Curb and Gutter	LF	7,950	$16	$127,200
202-00210	Removal of Concrete Pavement	SY	11,770	$27	$317,790
202-00220	Removal of Asphalt Mat	SY	64,780	$10	$647,800
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,353,380**
		STRUCTURE ITEMS			
504-00000	MSE Retaining Wall	SF	58,800	$90	$5,292,000
530-00000	EB Bridge	SF	6,860	$200	$1,372,000
530-00000	WB Bridge	SF	5,740	$200	$1,148,000
530-00000	28th Underpass	SF	4,410	$240	$1,058,400
				STRUCTURE ITEMS SUBTOTAL:	**$8,870,400**

The 28th Street Underpass Alternative uses the D-loop configuration south of US 34. North of US 34, the exit and entrance ramps are moved close to the US 34 mainline lanes and 28th Street is maintained in its existing location. The 28th Street intersection with 35th Avenue is converted to a right-in/right-out configuration and a new eastbound connector road is provided. The connector road is accessed at the signalized ramp intersection on 35th Avenue and passes under the westbound exit ramp to intersect with 28th Street at 33rd Ave Place. In addition, a short connector road is provided between 28th Street and the westbound exit ramp permitting ramp traffic access to 28th Street without using 35th Avenue and permitting 28th Street traffic access to a signalized left turn onto southbound 35th Avenue.

Assumptions: US 34 and ramp pavement is concrete; 35th Ave and 28th St pavement is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

MAJOR ITEMS SUBTOTAL	**$24,945,000**
MINOR - ENVIRONMENTAL (~2%)	$498,900
MINOR - TRAFFIC (~2%)	$498,900
MINOR - DRAINAGE & SWMP (~10%)	$2,494,500
MINOR - MOT (~5%)	$1,247,250
MINOR - UTILITIES (~10%)	$2,494,500
CONSTRUCTION TOTAL	**$32,179,050**
FORCE ACCOUNTS (10%)	$3,218,000
RIGHT-OF-WAY	$370,000
CONSTRUCTION ENGINEERING (11%)	$3,540,000
CONSTRUCTION INDIRECTS (9.5%)	$3,058,000
TOTAL PROJECT COST	**$42,365,050**

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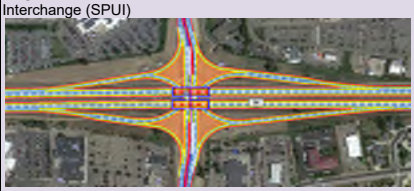
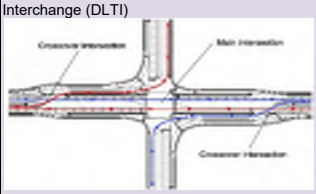
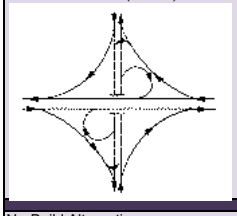
COLORADO Department of Transportation

City of Greeley Colorado

APPENDIX H

US 34 AND 47TH AVENUE
LEVEL 1 SCREENING

US34 & 47TH AVENUE - LEVEL 1 INTERCHANGE ALTERNATIVES ANALYSIS AND SCREENING

Alternative	Screening Criteria	Advantages	Disadvantages	Relative Rating
Standard Diamond Interchange with Signals (SDI) 	Safety		Does not prevent broadside/approach turn accidents; 26 conflict points	
	Traffic Operations	Provides capacity needed through 2045. Familiar for drivers.		
	Right-of-Way Impacts	Requires US 34 ROW outside of reserved ROW		
	Multimodal Accommodations	10 pedestrians crossings (4 uncontrolled); 6 multi-lane crossings		
Standard Diamond Interchange with Roundabouts (SDI-R) 	Safety	Prevents broadside/approach turn accidents; 16 conflict points		
	Traffic Operations		Does not provide capacity needed with two lane roundabout and bypass lanes.	Major Flaw
	Right-of-Way Impacts	Requires US 34 ROW outside of reserved ROW		
	Multimodal Accommodations	8 pedestrians crossings (8 uncontrolled); 4 multi-lane crossings		
Diverging Diamond Interchange (DDI) 	Safety	Reduces potential for broadside/approach turn accidents; 14 conflict points		
	Traffic Operations	Provides capacity needed through 2045.	Slightly less familiar to drivers.	
	Right-of-Way Impacts	Remains within reserved ROW		
	Multimodal Accommodations	10 pedestrians crossings (8 uncontrolled); 2 multi-lane crossings		
Single Point Urban Interchange (SPUI) 	Safety		Does not prevent broadside/approach turn accidents; 24 conflict points	
	Traffic Operations	Provides capacity needed through 2045.	Requires a shift in 47th Ave alignment	
	Right-of-Way Impacts	Remains within reserved ROW		
	Multimodal Accommodations	8 pedestrians crossings (4 uncontrolled); 4 multi-lane crossings		
Displaced Left-Turn Interchange (DLTI) 	Safety		Does not prevent broadside/approach turn accidents; 28 conflict points	
	Traffic Operations		Less familiar to drivers. Does not provide capacity needed.	Major Flaw
	Right-of-Way Impacts		Requires 47th ROW outside of reserved/existing ROW	Major Flaw
	Multimodal Accommodations	8 pedestrians crossings (4 uncontrolled); 4 multi-lane crossings		
Partial Cloverleaf (Parclo) 	Safety	Reduces potential for broadside/approach turn accidents; 18 conflict points		
	Traffic Operations	Familiar to drivers. Provides capacity needed through 2045.	Severely affects access points on 47th Avenue.	
	Right-of-Way Impacts		Requires additional ROW in all four quadrants; impacts existing parking lots/commercial properties	Major Flaw
	Multimodal Accommodations	8 pedestrians crossings (6 uncontrolled); 2 multi-lane crossings		
No-Build Alternative	Safety		Existing conflict points remain especially high-speed right-angle collisions. Existing safety concerns remain.	Major Flaw
	Traffic Operations		Traffic operations degrade and congestion increases. Rationale for local public funding vote based on improving congestion.	Major Flaw
	Right-of-Way Impacts	Stays within existing ROW		
	Multimodal Accommodations		No change. Crossing congested and high-speed roadways is not comfortable.	

APPENDIX I

US 34 AND 47TH AVENUE
LEVEL 2 SCREENING

US34 & 47TH AVENUE - LEVEL 2 NO-BUILD ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	2.7	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. These do not change, but high speed conflicts remain. The Crash Incident Score is 27 of 100. Crash severity is expected to increase because high speed traffic is signalized and volume increases. No change in driver expectation. Driver frustration may increase. Signing may need to be adjusted to account for increased queue lengths and signal change flashing warnings may be warranted.
Traffic Operations	3.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.	No, LOS = D or better is not achieved. LOS and delay estimates are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. No, travel time degrades compared to existing on EB US 34 by 1.2/1.3 minutes (AM/PM peak hours) and WB US 34 by 4.4/8.0 minutes (AM/PM peak hours).
Access	1.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	No-Build does not physically or operationally alter any driveways or side streets.
Constructability	1.0	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)	No-Build has no construction or resultant traffic control to consider.
Utilities	1.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	No-Build has no impacts to existing utilities.
Environmental	1.3	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	No-Build does not impact sensitive noise receptors; however, increase in congestion may increase noise levels No-Build does not impact irrigation resources. No-Build does not impact parks or trails. No-Build does not require regional air quality conformity; however, an increase in congestion may result in an increase in idling vehicles.
Flexibility for Future Needs	2.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	No, adding an additional lane on US 34 would require substantial work. No, adding lanes or turn lanes on 47th would be a substantial impact to the existing intersection and signal. Yes, new transit, bike and ped facilities could be accommodated.
Maintenance	2.0	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Maintenance requirements slightly increase due to increased traffic volume and potentially more crashes. Pavement will require rehab if intersection is not reconstructed. No special maintenance needs (no changes). Traffic control for maintenance activities becomes more difficult with increased traffic and congestion (night work only may be required); no easy alternate routes for emergency issues.
Multimodal Accommodations	2.8	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated (no change). Yes, existing facilities may be ADA compliant (no changes). 6 total crossings (2 right turn lanes & 4 thru lanes at US34/47th). Crossing high-speed US34 traffic (120ft-130ft) and free right turns can be uncomfortable and dangerous.
Right-of-Way	1.0	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	No, ROW, permanent easements or temporary easements are not required (no work).
Drainage and Irrigation	2.0	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No impact to existing irrigation facilities. No impact to existing drainage facilities. No drainage issues or water quality would be addressed. Any downstream issues remain (no changes).

US34 & 47TH AVENUE - LEVEL 2 SDI ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.5	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Conflict points significantly decrease, no high-speed conflicts. The Crash Incident Score is 55 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. Standard diamond configuration is familiar to drivers.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 5.1/2.5 minutes (AM/PM peak hours), WB US 34 by 7.4/8.9 minutes (AM/PM peak hours), NB 47th Ave by 0.3/1.3 minutes (AM/PM peak hours), and SB 47th Ave by 0.3/0.5 minutes (AM/PM peak hours).
Access	1.5	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: Alterations to business accesses to accommodate widening for auxiliary lanes; median adjustments to configure right-in-right-out access where it does not currently exist. Yes: Requires reconstruction of business accesses to change configurations to right-in-right-out where it does not currently exist.
Constructability	1.7	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)	Bridge is expected to be basic highway overpass (1-span). Walls are expected to be extensive and tall (34,000 SF, 16' max height). Ramps can be constructed as US 34 bypass during construction and operate as one-way pair with signals in final location and minimal rework. Ramp interfaces will require profile modifications to US 34. Yes, Traffic can be maintained on 47th during construction with minimal interruption. Opportunity for ABC construction with bridges built offline.
Utilities	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission line along US 34 and 47th Avenue will need to be relocated/undergrounded. Portions of 60" storm sewer and 20", 36" and 48" waterlines will likely need to be relocated through the existing 47th intersection for profile lowering (~2-3'). Greeley Loveland Ditch irrigation crossing of 47th Avenue will need to be modified.
Environmental	2.0	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 19 sensitive noise receptors identified as residential properties. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will impact the Loveland and Greeley Canal at one previously unimpacted location, and will expand the footprint of 47th on the south side of US 34 where it crosses the canal. The alternative will impact the Grapevine Ditch at four previously unimpacted locations. Impacting the ditches at multiple locations will require long lead times for coordination with the ditch companies. This alternative will impact the Bypass Trail where it runs east to west on the north side of US 34, but will replace the east-west connection north of the existing trail. The alternative will add two additional north-south connections on the east and west side of 47th Avenue north and south of US 34. The US 34 and 47th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	1.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. Yes, Bridges, walls and intersections will provide for 47th expansion (but substantial work beyond interchange). Ped/bike facilities are provided, with connection to Bypass Trail on the north side of US 34. Future bus stops on 47th can be accommodated with minor modifications.
Maintenance	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 47th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Ramps can easily be used for detour during maintenance activities on US 34.
Multimodal Accommodations	1.4	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. Sidewalks will be maintained on 47th with crosswalks at intersections. 10 street crosswalks (47th side paths--4 free right, 4 thru/turn lanes; 47th crossings--2 thru/turn lanes). Crossing distances are generally shorter (1-2 lanes) and no high-speed. Provides direct connection to US 34 east-west trail.
Right-of-Way	1.7	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	Yes, SDI requires additional ROW in SW and NW quadrants outside of preserved ROW (66,000 sf). Temporary easements are likely along west side of 47th. SDI does not encroach on existing built environment.
Drainage and Irrigation	1.3	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No, lowering of existing irrigation crossings of US 34 and 47th Avenue are not anticipated. Yes, An updated drainage system is expected, and permanent water quality will be included in design. Downstream effects have not been determined but will be incorporated into the preliminary design.

US34 & 47TH AVENUE - LEVEL 2 DDI ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.2	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Conflict points significantly decrease, no high-speed conflicts. The Crash Incident Score is 100 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. Diverging diamond configuration is not as familiar to drivers.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 4.9/2.8 minutes (AM/PM peak hours), WB US 34 by 6.8/8.8 minutes (AM/PM peak hours), NB 47th Ave by 0.5/1.3 minutes (AM/PM peak hours), and SB 47th Ave by 0.7/0.7 minutes (AM/PM peak hours).
Access	2.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: Alterations to business accesses to accommodate widening for auxiliary lanes; median adjustments to configure right-in-right-out access where it does not currently exist. Yes: Requires reconstruction of business accesses to change configurations to right-in-right-out where it does not currently exist.
Constructability	1.7	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)	Bridge is expected to be basic highway overpass (1-span). Walls are expected to be extensive and tall (37,000 SF, 18' max height). Ramps can be constructed as US 34 bypass during construction and operate as one-way pair with temporary signals. Ramp interfaces will require profile modifications to US 34. Yes. Traffic can be maintained on 47th during construction with multiple shifts. Opportunity for ABC construction with bridges built offline.
Utilities	2.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission line along US 34 and 47th Avenue will need to be relocated/undergrounded. Portions of 60" storm sewer and 20", 36" and 48" waterlines will likely need to be relocated through the existing 47th intersection for profile lowering (~2-3'). Greeley Loveland Ditch irrigation crossing of 47th Avenue will need to be modified.
Environmental	2.0	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 19 sensitive noise receptors identified as residential properties. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will impact the Loveland and Greeley Canal at one previously unimpacted location, and will expand the footprint of 47th on the south side of US 34 where it crosses the canal. The alternative will impact the Grapevine Ditch at three previously unimpacted locations. Impacting the ditches at multiple locations will require long lead times for coordination with the ditch companies. This alternative will impact the Bypass Trail where it runs east to west on the north side of US 34, but will replace the east-west connection north of the existing trail. The alternative will add two additional north-south connections on the east and west side of 47th Avenue north and south of US 34. The US 34 and 47th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	1.3	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. 47th expansion is not likely necessary with the configuration of the DDI. Ped/bike facilities are provided, with connection to Bypass Trail on the north side of US 34. Future bus stops on 47th can be accommodated with modifications upstream of intersections.
Maintenance	2.0	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 47th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Ramps cannot be used for detour during maintenance activities on US 34 due to configuration of DDI on 47th, and traffic control would be difficult for any maintenance activities on 47th.
Multimodal Accommodations	1.0	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. Sidewalks will be maintained on 47th with crosswalks at intersections. Option 1 - Outside Crossing: 8 street crosswalks (47th side paths--8 right/left turn (4 signalized, 4 un-signalized); 47th crossings--0, pedestrians would be required to cross upstream or downstream of the interchange). Crossing distances are generally shorter (1 lane) and no high-speed. Provides direct connection to US 34 east-west trail with either outside or median routing. Option 2 - Median Crossing: 8 street crosswalks (47th side paths--4 free right/left; 47th crossings--4 thru/turn lanes with median refuge). Crossing distances are generally shorter (1 lane) and no high-speed. Both options provide connection to US 34 east-west trail with either outside or median routing.
Right-of-Way	1.7	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	Yes, DDI requires additional ROW in SW and NW quadrants outside of preserved ROW (70,000 sf). Temporary easements are likely along west side of 47th and the east side of 47th north of Centerplace access. DDI does not encroach on existing built environment.
Drainage and Irrigation	1.3	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	No, lowering of existing irrigation crossings of US 34 and 47th Avenue are not anticipated. Yes, An updated drainage system is expected, and permanent water quality will be included in design. Downstream effects have not been determined but will be incorporated into the preliminary design.

US34 & 47TH AVENUE - LEVEL 2 SPUI ALTERNATIVE GRADING MATRIX

Category	Alternative Grading	Criteria	Grading Explanation
Safety	1.2	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.	Conflict points are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Conflict points significantly decrease, no high-speed conflicts. The Crash Incident Score is 91 of 100. Crash severity is expected to decrease because high speed traffic is not signalized. SPUI configuration is familiar to drivers.
Traffic Operations	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.	Yes, LOS = D or better is achieved. LOS and delay estimates are tabulated on the "US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA" sheet in this appendix. Yes, travel time is improved compared to the No-Build on EB US 34 by 5.0/2.8 minutes (AM/PM peak hours), WB US 34 by 7.4/8.7 minutes (AM/PM peak hours), NB 47th Ave by 0.6/1.1 minutes (AM/PM peak hours), and SB 47th Ave by 0.7/0.4 minutes (AM/PM peak hours).
Access	2.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	Yes: Alterations to business accesses to accommodate widening for auxiliary lanes; median adjustments to configure right-in-right-out access where it does not currently exist. Yes: Requires reconstruction of business accesses to change configurations to right-in-right-out where it does not currently exist.
Constructability	2.7	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)	Bridge is expected to be 1-span highway overpass, but due to SPUI footprint, the span will be significantly long. Walls are extensive and tall (49,000 SF, 22' max height). Ramps can be constructed as US 34 bypass during construction and operate as one-way pair with temporary signals. Ramp interfaces will require profile modifications to US 34. Yes. Traffic can be maintained on 47th during construction with likely temporary shoring due to profile cut and throwaway work for one-way pair. Opportunity for ABC construction with bridges built offline.
Utilities	3.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	Large overhead electric transmission line along US 34 and 47th Avenue will need to be relocated/undergrounded. Portions of 60" storm sewer and 20", 36" and 48" waterlines will likely need to be relocated through the existing 47th intersection for profile lowering (~8'). Greeley Loveland Ditch irrigation crossing of 47th Avenue will need to be lowered.
Environmental	2.0	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.	This alternative will require work adjacent to 19 sensitive noise receptors identified as residential properties. No sensitive noise receptor properties are identified as Activity Category A under FHWA noise-sensitive land use categories. In addition, it is not anticipated that noise levels will increase substantially as a result of construction of the alternative. This alternative will impact the Loveland and Greeley Canal at three previously unimpacted locations. This alternative will intersect Grapevine Ditch at five previously unimpacted locations. Impacting the ditches at multiple locations will require long lead times for coordination with the ditch companies. This alternative will impact the Bypass Trail where it runs east to west on the north side of US 34, but will replace the east-west connection north of the existing trail with a pedestrian bridge. This alternative will add two additional north-south connections on the east and west side of 47th Avenue north and south of US 34. The US 34 and 47th Avenue Interchange Improvement Project (design level) is included in the North Front Range Transportation & Air Quality Planning Council FY 2019 - FY 2022 Transportation Improvement Program. As such, this alternative meets regional air conformity. Hot spot air quality modeling may be required to demonstrate local air quality conformity prior to construction.
Flexibility for Future Needs	2.0	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes, accommodating future expansion of US34 to six thru lanes with continuous auxiliary lanes between ramps is feasible and considered as part of this layout. Ramps are largely built out, dual exits can be accommodated. No, bridges and walls mostly cannot provide for 47th expansion without major reconstruction. Ped/bike facilities are provided, but no connection to Bypass Trail on the north side of US 34 without a pedestrian bridge. Future bus stops on 47th can be accommodated with minor modifications upstream of the intersection.
Maintenance	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?	Assuming US34 & ramp pavement is PCCP = approx. 30-yr maintenance free. No major change in 47th maintenance. Adds simple bridge maintenance and two signalized intersections. Updates & expands existing drainage system. No, special maintenance is not expected. Ramps cannot be used for detour during maintenance activities on US 34 due to configuration of SPUI on 47th.
Multimodal Accommodations	2.0	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.	Yes, existing bus routes and stops can be accommodated. Yes, ADA requirements can be met. Sidewalks will be maintained on 47th with crosswalks at intersections. 8 street crosswalks (47th side paths--4 free right, 4 thru/turn lanes; 47th crossings--0, pedestrians would be required to cross upstream or downstream of the interchange). Crossing distances are generally shorter (1-2 lanes) and half-signalized, but there could be delayed time to cross due to signal phasing. Does not provide direct connection to US 34 east-west trail and would require separate pedestrian bridge to maintain connectivity.
Right-of-Way	2.3	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.	Yes, SPUI requires additional ROW in SW, NW, and NE quadrants outside of preserved ROW (61,000 sf). Temporary easements are likely along west side of 47th and the east side of 47th north of Centerplace access. SPUI encroaches on existing built environment in SE quadrant and along Centerplace.
Drainage and Irrigation	1.7	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	Yes, lowering of existing irrigation crossings of 47th Avenue are anticipated, as well as lateral adjacent to 47th Avenue. Yes, An updated drainage system is expected, and permanent water quality will be included in design. Downstream effects have not been determined but will be incorporated into the preliminary design.

US34 & 47TH AVENUE - LEVEL 2 SCORING DETAILS

Category	Criteria Elements	Basis of Grade			Alternatives							
					No Build		SDI		DDI		SPUI	
		1	2	3	Individual Grade	Composite Grade	Individual Grade	Composite Grade	Individual Grade	Composite Grade	Individual Grade	Composite Grade
Safety	What are the vehicular-vehicular conflict points? (High Speed > 45 MPH)	0	1 to 5	> 5	3	2.7	1	1.5	1	1.2	1	1.2
	Total number of vehicular-vehicular conflict points?	< 20	20 to 30	> 30	3		2		1		2	
	What are the vehicular-bike/ped conflict points?	< 20	20 to 30	> 30	3		2		1		1	
	What is the alternative Crash Incident Score?	76 to 100	50 to 75	< 50	3		2		1		1	
	What level of crash severity could be expected in the design year?	Decrease expected	About the same expected	Increase expected	3		1		1		1	
	Describe any driver expectation challenges or locations for potential for driver error.	Common configuration	Less common configuration	Rare or unique configuration	1		1		2		1	
Traffic Operations	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS (AM/PM) and average delay (AM/PM)?	Yes, LOS improves & delay decreases	Yes, LOS & delay remain about same	No, LOS decreases & delay increases	3	3.0	1	1.0	1	1.0	1	1.0
	Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.	Yes, both roadways improve	Yes, only one roadway improves	No, both roadways degrade	3		1		1		1	
Access	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration.	No changes	Yes, minimal changes	Yes, significant changes	1	1.0	2	1.5	3	2.0	3	2.0
	Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.	No or Yes, minimal changes	Yes, some operations prohibited	Yes, full closure	1		1		1		1	
Constructability	What is the quantity and level of complexity of major project elements (bridges and walls)?	Basic quantity, Common elements	Extra quantity, Less common elements	Large quantity, Unique elements	1	1.0	2	1.7	2	1.7	3	2.7
	What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)?	Minimal temporary elements	Moderate temporary elements	Major temporary elements	1		1		1		3	
	Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)	Yes, with basic effort	Yes, with complications	No	1		2		2		2	
Utilities	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?	None to minor adjustments under 300'	1 to 3 major relocations between 300' and 1000'	> 3 major relocations over 1000' in length	1	1.0	2	2.0	2	2.0	3	3.0
Environmental	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	No work adjacent to sensitive noise receptors	Work adjacent to sensitive noise receptors, but none categorized as FHWA land use category A	Work adjacent to sensitive noise receptors, parcel identified as FHWA land use category A	1	1.3	2	2.0	2	2.0	2	2.0
	Due to the existing built-up surroundings of the project area, it is anticipated that Irrigation will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	No impacts to irrigation ditches or canals	Impacts to irrigation ditches or canals only in previously impacted locations, impacts likely minimal or none	Impacts to irrigation ditches or canals in previously unimpacted locations, true impact determination will require survey and long lead time for coordination with ditch companies	1		3		3		3	
	Due to the existing built-up surroundings of the project area, it is anticipated that Parks & Trails will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	Impacts to multi-use trail will be replaced with new trail systems at minimum; may add new trail connections	Impacts to multi-use trail will result in one less connection (east-west or north-south)	Impacts to multi-use trail will result in more than one less connection	1		1		1		1	

	Due to the existing built-up surroundings of the project area, it is anticipated that Air Quality will be one of the major environmental concerns for this project. Comment on possible project impacts to this resource.	Project is in STIP/TIP list so meets regional air conformity	Project is not in STIP/TIP list; does not meet regional air conformity	NA	2		2		2		2	
Flexibility for Future Needs	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N)	Yes		No	3	2.3	1	1.3	1	1.3	1	2.0
	Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N)	Yes		No	3		1		1		3	
	Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)	Yes	Maybe, may have complications	No	1		2		2		2	
Maintenance	What are the maintenance requirements of the alternative over the lifespan of the project?	Reduced maintenance	About the same maintenance	Increased maintenance	2	2.0	2	1.7	2	2.0	2	1.7
	Are there any special maintenance requirements for the alternative? (Y or N) Describe them.	No	Yes, Minor Adjustments	Yes, Unique Needs	1		1		1		1	
	What traffic control will be needed for expected maintenance activities?	Less traffic control	About the same traffic control	More traffic control	3		2		3		2	
Multimodal Accommodations	Can existing bus routes and stops be accommodated? (Y or N)	Yes, with improvements	Yes, about the same	No	2	2.8	1	1.4	1	1.0	2	2.0
	Can PROWAG ADA requirements be met? (Y or N)	Yes, Fully Compliant	Yes, Some Exceptions	No	3		1		1		1	
	Describe changes to the existing bike/ped facilities.	Improve over existing	About the same as existing	Degrade from existing	3		1		1		2	
	How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity?	<= 20	21 to 25	> 25	3		2		1		2	
	Describe crossings in terms of bike/ped comfort, ease and conflict.	Crossings are shorter, easier, more comfortable	Crossings are about the same	Crossings are longer, circuitous, increase conflicts	3		2		1		3	
Right-of-Way	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted.	No	Yes, no impacts to built environment	Yes, with impacts to built environment	1	1.0	2	1.7	2	1.7	3	2.3
	Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted.	No	Yes, No Structures	Yes, Structures	1		1		1		1	
	Are any temporary easements required? (Y or N) If so/known, estimate area.	Yes (< 20,000-SF)	Yes, (20,000-SF to 50,000-SF)	Yes (> 50,000-SF)	1		2		2		3	
Drainage and Irrigation	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact.	No	Yes, Minor Adjustments	Yes, Major Adjustments	1	2.0	2	1.3	2	1.3	3	1.7
	Does the alternative impact existing drainage facilities? (Y or N) Describe the impact.	Improvement over existing	About the same	Degrade from existing	2		1		1		1	
	Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.	Yes, Desirable	Yes, Not Desirable	No	3		1		1		1	

US34 & 47TH AVENUE - LEVEL 2 INTERCHANGE ALTERNATIVES ANALYSIS AND SCREENING SCORING MATRIX

Category	Weight	Alternative				Criteria
		No-Build	SDI	DDI	SPUI	
		Grading				
Safety	30%	2.7	1.5	1.2	1.2	What are the vehicular-vehicular and vehicular-bike/ped conflict points? What is the alternative Crash Incident Score? What level of crash severity could be expected in the design year? Describe any driver expectation challenges or locations for potential for driver error.
Traffic Operations	25%	3.0	1.0	1.0	1.0	Does the alternative provide a level of service (LOS) of D or better? (Y or N) What is the overall alternative design year LOS and average delay? Does the alternative improve or maintain travel time on US 34 and 47th Avenue? (Y or N) Provide estimates.
Access	7%	1.0	1.5	2.0	2.0	Does the alternative physically alter any driveways or side streets? (Y or N) Describe the alteration. Does the alternative operationally alter any driveways or side streets? (Y or N) Describe the alteration.
Constructability	3%	1.0	1.7	1.7	2.7	What is the quantity and level of complexity of major project elements (bridges and walls)? What are potential challenges to phasing the construction (temporary bridges, walls, shoring, pavement, signals, etc.)? Can traffic be maintained on US34 and 47th Ave during construction? (Y or N)
Utilities	3%	1.0	2.0	2.0	3.0	Describe potential conflicts and/or relocations that may be required. Are major known utilities impacted (electric transmission lines/towers/duct banks, water lines >12", communication duct banks, etc.)?
Environmental	7%	1.3	2.0	2.0	2.0	Due to the existing built-up surroundings of the project area, it is anticipated that Sensitive Noise Receptors, Irrigation, Parks/Trails and Air Quality will likely be the major environmental concerns for this project. Comment on possible project impacts to these resources.
Flexibility for Future Needs	7%	2.3	1.3	1.3	2.0	Can additional future capacity (thru and/or auxiliary lanes) be added on US 34 and US 34 ramps with minimal reconstruction? (Y or N) Can additional future capacity be accommodated on 47th Avenue with minimal reconstruction of major elements (bridges, walls, intersections, signals, etc.)? (Y or N) Can potential future bus routes and bike/ped facilities be accommodated? (Y or N)
Maintenance	5%	2.0	1.7	2.0	1.7	What are the maintenance requirements of the alternative over the project life? Are there any special maintenance requirements for the alternative? (Y or N) Describe them. What traffic control will be needed for expected maintenance activities?
Multimodal Accommodations	7%	2.8	1.4	1.0	2.0	Can existing bus routes and stops be accommodated? (Y or N) Can PROWAG and ADA requirements be met? (Y or N) Describe changes to the existing bike/ped facilities. How many lane crossings are required for bicycles/pedestrians to maintain the existing facility connectivity? Describe crossings in terms of bike/ped comfort, ease and conflict.
Right-of-Way	3%	1.0	1.7	1.7	2.3	Does the alternative require additional ROW beyond existing ROW or dedications? (Y or N) If so, estimate area and if any structures could be impacted. Are any permanent easements required? (Y or N) If so/known, estimate area and if any structures could be impacted. Are any temporary easements required? (Y or N) If so/known, estimate area.
Drainage and Irrigation	3%	2.0	1.3	1.3	1.7	Does the alternative impact existing irrigation facilities? (Y or N) Describe the impact. Does the alternative impact existing drainage facilities? (Y or N) Describe the impact. Does the alternative provide for drainage and water quality needs? (Y or N) Comment on downstream affects.
WEIGHTED GRADE	100%	2.33	1.42	1.35	1.55	
RANK		**4**	**2**	**1**	**3**	

US34 & 47TH AVENUE - LEVEL 2 TRAFFIC DATA

Intersection Conflict Type*	Alternative			
	No-Build (Existing)	SDI	DDI	SPUI
Vehicle-Vehicle Diverging	8	8	8	8
Vehicle-Vehicle Merging	8	8	8	8
Vehicle-Vehicle Crossing	16	10	2	8
Vehicle-Vehicle Crossing (High Speed)	12	0	0	0
TOTALS	**44**	**26**	**18**	**24**
Vehicle/Bike (Lane) Crossing	12	4	4	0
Vehicle/Ped Crossing	24	16	8	8
TOTALS	**36**	**20**	**12**	**8**
Bike/Ped # Lanes Crossed	28	24	20	24

***Conflict points are for the US 34 and 47th Ave intersection/interchange only and do not include access points.**

Crash Incident Score	HSM Cost/Incident	No-Build	Accident Savings (5 year)		
			SDI	DDI	SPUI
Fatalities	$4,008,900	0	0.0	0.0	0.0
Injuries	$79,000	21	12.0	16.6	15.6
Non-Injury Accidents	$7,400	83	29.1	46.9	49.6
Cost Savings (5 year)		$0	$1,161,000	$1,662,000	$1,598,000
Accident Cost (5 year)		$2,273,000	$1,112,000	$611,000	$675,000
Scoring out of 100		**27**	**55**	**100**	**91**

2045 LOS and Delay	No-Build				SDI			
	AM		PM		AM		PM	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
47th Ave	45	D	70	E	22	C	32	C

2045 LOS and Delay (cont.)	DDI				SPUI			
	AM		PM		AM		PM	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
47th Ave	16	B	28	C	22	C	31	C

2045 Travel Time	Existing				No Build				SDI			
	AM		PM		AM		PM		AM		PM	
	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB (65th to 11th)	624	10.4	667	11.1	697	11.6	746	12.4	391	6.5	595	9.9
WB (11th to 65th)	569	9.5	520	8.7	833	13.9	1003	16.7	388	6.5	470	7.8
NB (47th)	-	-	-	-	109	1.8	172	2.9	92	1.5	98	1.6
SB (47th)	-	-	-	-	126	2.1	144	2.4	110	1.8	112	1.9

2045 Travel Time (cont.)	DDI				SPUI			
	AM		PM		AM		PM	
	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds	Minutes
EB (65th to 11th)	405	6.7	579	9.6	397	6.6	576	9.6
WB (11th to 65th)	429	7.1	476	7.9	392	6.5	480	8.0
NB (47th)	78	1.3	99	1.6	75	1.2	111	1.8
SB (47th)	82	1.4	104	1.7	85	1.4	122	2.0

APPENDIX J

US 34 AND 47TH AVENUE
CONCEPTUAL CONSTRUCTION COST ESTIMATE

9/14/2020

US 34 at 47th Ave Conceptual Cost Estimate

Standard Diamond Interchange (SDI)

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
		GENERAL ITEMS			
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
		EARTHWORK ITEMS (raw volume, no deduction for walls)			
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	49,600	$15	
203-00060	Embankment Material (Complete in Place)	CY	321,700	$18	$5,790,600
				EARTHWORK (GREATER OF 2 ITEMS):	**$5,790,600**
		ROADWAY ITEMS			
304-06000	Aggregate Base Course (Class 6)	TON	45,550	$30	$1,366,500
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	11,200	$95	$1,064,000
412-01200	Concrete Pavement (12 inch)	SY	59,150	$65	$3,844,750
608-00000	Concrete Sidewalk	SY	5,075	$80	$406,000
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	900	$40	$36,000
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	3,400	$40	$136,000
610-00030	Median Cover Material (Concrete)	SF	4,700	$15	$70,500
				ROADWAY ITEMS SUBTOTAL:	**$6,923,750**
		SAFETY ITEMS			
606-00301	Guardrail Type 3 (6-3 Post Spacing)	LF	1,140	$45	$51,300
606-20014	Tensioned Cable Rail (TL-4)	LF	4,830	$20	$96,600
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$847,900**
		TRAFFIC ITEMS			
614-86715	Traffic Signal Equipment	EACH	2	$220,000	$440,000
627-00004	Epoxy Pavement Marking	SF	27,400	$2	$54,800
				TRAFFIC ITEMS SUBTOTAL:	**$494,800**
		REMOVAL ITEMS			
202-00190	Removal of Concrete Median Cover Material	SY	380	$16	$6,080
202-00200	Removal of Sidewalk	SY	4,975	$30	$149,250
202-00203	Removal of Curb and Gutter	LF	3,870	$16	$61,920
202-00210	Removal of Concrete Pavement	SY	26,700	$27	$720,900
202-00220	Removal of Asphalt Mat	SY	30,000	$10	$300,000
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,368,150**
		STRUCTURE ITEMS			
504-00000	MSE Retaining Wall	SF	34,150	$90	$3,073,500
530-00000	EB Bridge	SF	8,200	$200	$1,640,000
530-00000	WB Bridge	SF	8,200	$200	$1,640,000
				STRUCTURE ITEMS SUBTOTAL:	**$6,353,500**

The Standard Diamond interchange has standard quadrant ramps with two signalized intersections on 47th Avenue. Connection to US 34 regional trail is at-grade.

Assumptions: US 34 and ramp pavement is concrete; 47th Ave is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems.

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

STRUCTURE ITEMS SUBTOTAL:	**$6,353,500**
MAJOR ITEMS SUBTOTAL	**$24,999,000**
MINOR - ENVIRONMENTAL (~2%)	$499,980
MINOR - TRAFFIC (~2%)	$499,980
MINOR - DRAINAGE & SWMP (~10%)	$2,499,900
MINOR - MOT (~5%)	$1,249,950
MINOR - UTILITIES (~10%)	$2,499,900
CONSTRUCTION TOTAL	**$32,248,710**
FORCE ACCOUNTS (10%)	$3,225,000
RIGHT-OF-WAY	$4,000,000
CONSTRUCTION ENGINEERING (11%)	$3,548,000
CONSTRUCTION INDIRECTS (9.5%)	$3,064,000
TOTAL PROJECT COST	**$46,085,710**

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COLORADO Department of Transportation

City of Greeley Colorado

9/14/2020

US 34 at 47th Ave Conceptual Cost Estimate

Diverging Diamond Interchange (DDI)

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
		GENERAL ITEMS			
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
		EARTHWORK ITEMS (raw volume, no deduction for walls)			
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	51,900	$15	
203-00060	Embankment Material (Complete in Place)	CY	299,600	$18	$5,392,800
				EARTHWORK (GREATER OF 2 ITEMS):	**$5,392,800**
		ROADWAY ITEMS			
304-06000	Aggregate Base Course (Class 6)	TON	51,430	$30	$1,542,900
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	17,750	$95	$1,686,250
412-01200	Concrete Pavement (12 inch)	SY	59,050	$65	$3,838,250
608-00000	Concrete Sidewalk	SY	6,055	$80	$484,400
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	5,100	$40	$204,000
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	4,380	$40	$175,200
610-00030	Median Cover Material (Concrete)	SF	41,215	$15	$618,225
				ROADWAY ITEMS SUBTOTAL:	**$8,549,225**
		SAFETY ITEMS			
606-00301	Guardrail Type 3 (6-3 Post Spacing)	LF	1,140	$45	$51,300
606-20014	Tensioned Cable Rail (TL-4)	LF	4,830	$20	$96,600
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$847,900**
		TRAFFIC ITEMS			
614-86715	Traffic Signal Equipment	EACH	2	$220,000	$440,000
627-00004	Epoxy Pavement Marking	SF	29,500	$2	$59,000
				TRAFFIC ITEMS SUBTOTAL:	**$499,000**
		REMOVAL ITEMS			
202-00190	Removal of Concrete Median Cover Material	SY	500	$16	$8,000
202-00200	Removal of Sidewalk	SY	5,735	$30	$172,050
202-00203	Removal of Curb and Gutter	LF	5,140	$16	$82,240
202-00210	Removal of Concrete Pavement	SY	26,700	$27	$720,900
202-00220	Removal of Asphalt Mat	SY	34,750	$10	$347,500
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,460,690**
		STRUCTURE ITEMS			
504-00000	MSE Retaining Wall	SF	36,800	$90	$3,312,000
530-00000	EB Bridge	SF	8,200	$200	$1,640,000
530-00000	WB Bridge	SF	8,200	$200	$1,640,000
				STRUCTURE ITEMS SUBTOTAL:	**$6,592,000**

The Diverging Diamond interchange is a standard diamond interchange with two signalized intersections on 47th Avenue. Northbound and southbound traffic on 47th Avenue would crossover at each intersection to allow for free-flow left and right turns in all directions. Connection to US 34 regional trail is at-grade.

Assumptions: US 34 and ramp pavement is concrete; 47th Ave is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems.

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

STRUCTURE ITEMS SUBTOTAL:	**$6,592,000**
MAJOR ITEMS SUBTOTAL	**$26,562,000**
MINOR - ENVIRONMENTAL (~2%)	$531,240
MINOR - TRAFFIC (~2%)	$531,240
MINOR - DRAINAGE & SWMP (~10%)	$2,656,200
MINOR - MOT (~5%)	$1,328,100
MINOR - UTILITIES (~10%)	$2,656,200
CONSTRUCTION TOTAL	**$34,264,980**
FORCE ACCOUNTS (10%)	$3,427,000
RIGHT-OF-WAY	$4,000,000
CONSTRUCTION ENGINEERING (11%)	$3,770,000
CONSTRUCTION INDIRECTS (9.5%)	$3,256,000
TOTAL PROJECT COST	**$48,717,980**

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COLORADO Department of Transportation

City of Greeley Colorado

9/14/2020

US 34 at 47th Ave Conceptual Cost Estimate

Single Point Urban Interchange (SPUI)

CONTRACT ITEM NO.	CONTRACT ITEM NAME	UNITS	QUANTITY TOTAL	UNIT COST	TOTAL COST
		GENERAL ITEMS			
201-00000	Clearing and Grubbing	LS	1	$500,000	$500,000
203-01597	Potholing	HOUR	400	$300	$120,000
620-00002	Field Office (Class 2)	EACH	1	$150,000	$150,000
620-00012	Field Laboratory (Class 2)	EACH	1	$150,000	$150,000
625-00000	Construction Surveying	LS	1	$800,000	$800,000
626-00000	Mobilization	LS	1	$1,500,000	$1,500,000
				GENERAL ITEMS SUBTOTAL:	**$3,220,000**
		EARTHWORK ITEMS (raw volume, no deduction for walls)			
203-00010	Unclassified Excavation (Complete in Place) (FIO)	CY	70,800	$15	
203-00060	Embankment Material (Complete in Place)	CY	309,700	$18	$5,574,600
				EARTHWORK (GREATER OF 2 ITEMS):	**$5,574,600**
		ROADWAY ITEMS			
304-06000	Aggregate Base Course (Class 6)	TON	51,460	$30	$1,543,800
403-33721	Hot Mix Asphalt (Grading S) (75) (PG 58-28)	TON	19,450	$95	$1,847,750
412-01200	Concrete Pavement (12 inch)	SY	56,550	$65	$3,675,750
608-00000	Concrete Sidewalk	SY	5,950	$80	$476,000
609-21010	Curb and Gutter Type 2 (Section I-B)	LF	6,450	$40	$258,000
609-21020	Curb and Gutter Type 2 (Section II-B)	LF	6,070	$40	$242,800
610-00030	Median Cover Material (Concrete)	SF	27,525	$15	$412,875
				ROADWAY ITEMS SUBTOTAL:	**$8,456,975**
		SAFETY ITEMS			
606-00301	Guardrail Type 3 (6-3 Post Spacing)	LF	1,220	$45	$54,900
606-20014	Tensioned Cable Rail (TL-4)	LF	4,830	$20	$96,600
670-00000	Electrical Systems	LS	1	$100,000	$100,000
680-00000	Lighting Systems	LS	1	$600,000	$600,000
				SAFETY ITEMS SUBTOTAL:	**$851,500**
		TRAFFIC ITEMS			
614-86715	Traffic Signal Equipment	EACH	1	$220,000	$220,000
627-00004	Epoxy Pavement Marking	SF	30,250	$2	$60,500
				TRAFFIC ITEMS SUBTOTAL:	**$280,500**
		REMOVAL ITEMS			
202-00190	Removal of Concrete Median Cover Material	SY	500	$16	$8,000
202-00200	Removal of Sidewalk	SY	6,175	$30	$185,250
202-00203	Removal of Curb and Gutter	LF	5,750	$16	$92,000
202-00210	Removal of Concrete Pavement	SY	26,700	$27	$720,900
202-00220	Removal of Asphalt Mat	SY	37,150	$10	$371,500
202-00725	Removal of Existing Lighting System	LS	1	$80,000	$80,000
202-00828	Removal of Traffic Signal Equipment	LS	1	$50,000	$50,000
				REMOVAL ITEMS SUBTOTAL:	**$1,507,650**
		STRUCTURE ITEMS			
504-00000	MSE Retaining Wall	SF	48,750	$90	$4,387,500
530-00000	EB Bridge	SF	11,480	$320	$3,673,600
530-00000	WB Bridge	SF	11,480	$320	$3,673,600
530-00000	Pedestrian Bridge	SF	3,000	$220	$660,000
				STRUCTURE ITEMS SUBTOTAL:	**$12,394,700**

The Single Point Urban interchange is a standard diamond with only one signalized intersection on 47th Avenue, instead of two. Connection to US 34 regional trail requires separate pedestrian bridge.

Assumptions: US 34 and ramp pavement is concrete; 47th Ave is HMA; Earthwork is based on top surface raw volume and does not deduct for pavement sections or retaining wall systems.

Disclaimer: The cost estimate submitted herein is based on time honored practices within the construction industry. The estimate represents our best judgement as design professionals using current information available at the time of preparation. The engineer cannot guarantee that proposals, bids, and/or construction costs will not vary from this cost estimate.

MAJOR ITEMS SUBTOTAL	**$32,286,000**
MINOR - ENVIRONMENTAL (~2%)	$645,720
MINOR - TRAFFIC (~2%)	$645,720
MINOR - DRAINAGE & SWMP (~10%)	$3,228,600
MINOR - MOT (~5%)	$1,614,300
MINOR - UTILITIES (~10%)	$3,228,600
CONSTRUCTION TOTAL	**$41,648,940**
FORCE ACCOUNTS (10%)	$4,165,000
RIGHT-OF-WAY	$4,000,000
CONSTRUCTION ENGINEERING (11%)	$4,582,000
CONSTRUCTION INDIRECTS (9.5%)	$3,957,000
TOTAL PROJECT COST	**$58,352,940**

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