3.1 INTRODUCTION

This chapter presents transportation performance, impacts, and mitigation measures for the packages listed below. For a detailed description of the packages, see Chapter 2, Alternatives Considered.

- **Package 1**: No Action
- **Package 2**: Managed Lanes/Bus Rapid Transit
- **Package 4**: General-purpose Lanes, High-occupancy Vehicle, and Bus Rapid Transit
- **Combined Alternative Package (Preferred Alternative)**: Managed Lanes, Auxiliary Lanes, and Bus Rapid Transit

Between the publication of the Draft Environmental Impact Statement (DEIS) and this Final Environmental Impact Statement (FEIS), a new regional transportation plan, the *2035 Metro Vision Regional Transportation Plan* (*2035 MVRTP*), as amended (DRCOG 2009), was adopted. This plan uses 2035 as the planning horizon (the year by which all planned projects are expected to be completed), and federal requirements necessitate the use of this year in the FEIS. The work in the DEIS was based on analysis of year 2030 travel demand data. During the DEIS process two build packages were fully evaluated, and based on this evaluation it was determined to move forward in the FEIS by combining elements from both build packages to create a package of improvements called the Combined Alternative Package (Preferred Alternative). The Combined Alternative Package (Preferred Alternative) was analyzed with year 2035 travel demand data.

The project team used the Denver Regional Council of Governments (DRCOG) regional travel demand model to estimate future travel demand in the corridor. The main components of the model include the model program and supporting files, future socioeconomic assumptions, and future roadway and transit network assumptions. DRCOG is continually updating the model to reflect the best understanding of travel behavior and to apply the latest projections for socioeconomic growth and transportation system assumptions so that the model can meet all regulatory requirements.

Between the DEIS and FEIS, some of the program changes that occurred included:

- Refined the transportation analysis zones (TAZ) structure (from 2,600 to 2,800 TAZs)
- Increased the size of the region coded in the model
- Mode choice changes based on updated ridership surveys
- Other transit-related processing changes

The socioeconomic data were updated to reflect five years of growth (2030 to 2035) and were also affected by the change in the definition of the region; the region increased in size with the 2035 model assumptions, so the overall population and employment reflected in the model includes a greater area. When comparing the population and employment for 2030 and 2035 in the original model area, the population increases from 3.97 million in 2030 to 4.34 million in 2035 (a 9 percent increase), and employment increases 2.08 million to 2.20 million (a 6 percent increase).

Within the United States Highway 36 (US 36) study area the population and employment forecasts for 2035 were only 5 percent higher than 2030, less than the change region wide. The distribution of population and employment growth within the study area, however, changed compared to 2030 socioeconomic forecasts. Development forecasts in the Boulder Valley changed between the 2030 and 2035 forecast years. In 2030, the Boulder Valley was forecast to have a population of 119,700 and 103,600 jobs. The 2035 forecasts assume a population of 119,400 (no growth) and 87,600 jobs (a decrease of 15 percent). As a result, the remainder of the study area is forecast to have an increase in employment of 10 percent.

The 2030 and 2035 models have virtually identical assumptions for the transit and roadway networks. Both years assume build-out of the Regional Transportation District (RTD) FasTracks transit system in the rest of the metropolitan area, and the roadway capacity assumptions throughout the region are similar for 2030 and 2035. No new projects of regional significance were added in the 2035 model that were not in the 2030 network.

The DEIS and FEIS models thus do have some differences, but the results are still comparable from the standpoint of overall transportation performance. Package 2 and Package 4 are presented in this document for reference and in some cases the results for these packages have been refined compared to what was presented in the DEIS; this was done to ensure comparability with the new 2035 model results.

This chapter contains the analysis and comparisons of Package 1 (No Action) (2035), Package 2, Package 4, and the Combined Alternative Package (Preferred Alternative). Each package is compared in terms of how it meets the project Purpose and Need, its relative transportation impacts, and mitigation needed. The information provided in this chapter assumes full build-out of all phases of the Combined Alternative Package (Preferred Alternative) by the year 2035. Based on the funding currently identified in the *2035 MVRTP*, as amended (DRCOG 2009), construction of all phases is unlikely to happen by 2035. As a result, some conditions, such as levels of congestion or travel time, will likely differ from what the chapter describes.

The following introduction summarizes the findings and impacts of all the build packages for the planning horizon-year.

3.1.1 Introduction and Overview of Transportation Impact Assessment

Package 2 and Package 4 are similar in many ways. Each would have a similar number of traffic lanes, amount and configuration of bus rapid transit (BRT) service and facilities, and level of high-occupancy vehicle (HOV) use. The Combined Alternative Package (Preferred Alternative) has similar BRT service, interchange improvements, and "special lane" benefits compared to the DEIS build packages (Package 2 and Package 4), but a different response to roadway capacity needs.

All of the build packages, including the Combined Alternative Package (Preferred Alternative), would have special lanes that control or restrict the number of vehicles in the lanes. The objective of special lanes is to provide reliable and predictable travel times, and to encourage a mode shift from single-occupant vehicles (SOV) to other modes of transportation.

The build packages are different with respect to how they address the need for new capacity, specifically related to additional general-purpose and managed lanes.

- Package 2 would provide two new managed lanes in each direction. These barrier-separated lanes would be used by HOVs and BRT vehicles at no charge with the remaining capacity used by SOVs for a fee if the lanes provided acceptable travel speed. Two managed lanes would be provided in each direction to increase safety and reliability. The Colorado Department of Transportation (CDOT) intends to operate the managed lanes along the US 36 corridor with the goals of optimizing the use of the lanes, maximizing travel time savings, and keeping managed lane traffic flowing at 45 miles per hour or faster. To accomplish this goal, CDOT will employ dynamic pricing, in which the toll rate is increased or decreased depending on the levels of congestion necessary to meet the operation goals. Technology is currently available to collect tolls under Package 2. The geometric configuration of the managed lanes provides for more efficient enforcement.
- Package 4 would provide one special lane in each direction as a buffer-separated BRT/HOV lane. This lane would permit usage by HOVs and BRT vehicles at no charge. If volumes become too great to provide reliable travel times, the designation of HOV could be changed from two or more occupants to three or more.

- The Combined Alternative Package (Preferred Alternative) would provide one new buffer-separated managed lane in each direction between Pecos Street and Boulder. As with Package 2, these lanes would be free to HOV and BRT vehicles, and available for use by SOVs that pay a toll. . The lane would be managed by CDOT in the same manner as identified for Package 2. Automated technology is under development to distinguish between SOV and HOV traffic under this package. Visual enforcement would be required until the appropriate technology is developed.

The new special lanes on US 36 in each package would be open in both directions at all times. Only a portion of the total highway capacity would be subject to tolls, and then only a portion of the people who choose to use the managed lanes would pay a toll. This type of roadway expansion would provide users with more choices about how to travel, taking travel time and costs into consideration.

The benefits of the managed lane arrangement in Package 2 are:

- Long-term, reliable travel time would be available to both HOV and SOV users through application of the managed lane concept with the addition of new managed lanes.
- A generally safer operation would be provided because the managed lanes and the general-purpose lanes would be separated by a concrete barrier.
- More reliable and consistent travel times and better operations for all buses would be provided because there would be two lanes in each direction instead of just one. The improved reliability combined with the other facilities proposed (median BRT stations) would achieve true "rapid transit" for buses.
- The inclusion of managed lanes would provide some revenue for operations and maintenance of the facility.
- Two new points of access to US 36 would be provided with new drop-ramps as a direct connection to the managed lanes. These new access points, at Westminster Boulevard and Midway Boulevard, would provide some potential congestion relief at the nearby Sheridan Boulevard and Wadsworth Parkway interchanges.

By comparison, Package 4 would be similar to other highways in the Denver metropolitan area that have been widened and expanded. One additional general-purpose lane would be added in each direction, so that three of the four lanes would be for general-purpose traffic. The special lane would be for HOV and BRT vehicles.

The benefits of the approach to capacity expansion of Package 4 include:

- Travel time savings and reductions in congestion would be provided for all general-purpose lane users at least through the horizon-year. Congestion in the general-purpose lanes is predicted to be less than with Package 2 and slightly less than with the Combined Alternative Package (Preferred Alternative).
- SOV drivers could take advantage of the expanded capacity in the general-purpose lanes without paying a toll.
- Priority for HOVs and buses would be provided with a single BRT/HOV lane in each direction. More reliable travel times would result for those users.
- Median BRT stations coupled with the priority of the BRT/HOV lanes would reduce travel times for all transit users and carpools in the corridor, similar to Package 2.

The Combined Alternative Package (Preferred Alternative) takes a more restrained approach to capacity expansion, relying primarily on auxiliary lanes (lanes that begin at an on-ramp and end at the next downstream off-ramp) between most interchanges to better serve the "short-trip" nature of US 36 corridor traffic. These lanes would also provide direct interchange-to-interchange lanes for RTD buses in non-express service on US 36, which would use BRT stations on the freeway ramps instead of the median BRT stations in Package 2 and Package 4. Also, by combining the more space-efficient buffer separation of BRT/HOV lanes in Package 4 with the "managed" element of Package 2, the Combined Alternative Package (Preferred Alternative) would realize benefits of both, including:

- Long-term reliable travel time provided for both HOV and SOV users.
- Revenue provided by tolls for ongoing maintenance and enforcement in the corridor.
- Improved reliability of RTD buses traveling long distances in the corridor – much less time would be spent in general-purpose lanes. Express buses would experience reduced travel times by using the managed lanes. Local buses using ramp stations would have slightly longer travel times than with median stations.
- The total distance a passenger is required to walk to access ramp stations would be equal to the distance required to access median stations. BRT stations on the ramps for RTD buses remove the need for passengers to wait in the highway median.
- Ramp stations and buffer-separation of the managed lanes translate to substantial reductions in costs and impacts, and reduce the need for extensive right-of-way (ROW) expansion.

3.1.2 Summary of Findings

Summary of Performance of Each Package

The highlights of the relative transportation performance of each of the build packages are:

- All build packages would provide a greater amount of person-trip capacity when compared to Package 1. Person-trip capacity would be noticeably greater at the eastern end of the corridor than at the central and western ends of the corridor, and is represented primarily by increased general-purpose and special lane capacity. Package 4 provides the highest person-trip capacity followed by the Combined Alternative Package (Preferred Alternative) and then Package 2.
- Package 4 and the Combined Alternative Package (Preferred Alternative) would have consistently higher general-purpose lane volumes than Package 2, because general-purpose lanes or auxiliary lanes would be added with these packages. More vehicles would use the managed lanes in Package 2 since more managed lane capacity would be provided. Each build package is forecast to serve noticeably more traffic volume on US 36 than Package 1.
- All build packages would provide improvements to many of the US 36 interchanges, with distinct reconfiguration at the Broadway, Wadsworth Parkway, and Sheridan Boulevard interchanges. Package 2 would provide two additional access points that would relieve some congestion at the existing Wadsworth Parkway and Sheridan Boulevard interchanges.
- All three build packages are forecast to operate at a daily average speed that would be noticeably faster than Package 1. Package 2 is projected to operate at a daily average speed of 48.5 miles per hour, while Package 4 would operate at 51.9 miles per hour. This compares to 41.5 miles per hour with Package 1. The Combined Alternative Package (Preferred Alternative) would exhibit a daily average speed of 48.8 miles per hour.

- All build packages would reduce the number of US 36 general-purpose lane sections operating in a highly congested manner compared to Package 1 conditions. Package 4 would have only four morning (a.m.) peak-hour sections and one evening (p.m.) peak-hour section operating in a highly congested manner. Package 2 would have eight a.m. peak-hour sections and eight p.m. peak-hour sections of the general-purpose lanes operating in a highly congested manner. The Combined Alternative Package (Preferred Alternative) would have five a.m. peak-hour sections and three p.m. peak-hour sections operating in a highly congested manner. The special lanes in all packages would operate at free-flow conditions at all times.
- The forecast a.m. peak-hour travel time from Foothills Parkway to Denver Union Station (DUS) in the general-purpose lanes under Package 1 is expected to be 52 minutes. Under Package 2, this general-purpose travel time is predicted to be 46 minutes, while Package 4 would be 43 minutes, and the Combined Alternative Package (Preferred Alternative) would be 44 minutes. Thus, Package 2 is expected to have a 6-minute general-purpose lane travel time savings over Package 1. Package 4 would have a 9-minute general-purpose lane travel time savings, and the Combined Alternative Package (Preferred Alternative) would have an 8-minute general-purpose lane travel time savings compared to Package 1.
- The forecast a.m. peak-hour travel time in special lanes from Foothills Parkway to DUS is expected to be 32 minutes under Package 1. Under typical conditions, the special lanes in all build packages are anticipated to operate at free-flow speeds. As a result, all build packages are expected to have a special-lane travel time of 24 minutes based on CDOT's proposed management strategy. Thus, all build packages would have an 8-minute special lane travel time savings compared to Package 1.
- In Package 1, the special lane travel time is estimated at 32 minutes and the general-purpose lane travel time is estimated at 52 minutes. The special lane travel time in Packages 2 and 4, and the Combined Alternative Package (Preferred Alternative) is estimated at 24 minutes. Thus, vehicles traveling in the special lanes in all the build packages would have a 28-minute time savings over vehicles traveling in the general-purpose lanes in Package 1.
- Travel time is expected to be more reliable with Package 2 than with either Package 4 or the Combined Alternative Package (Preferred Alternative) because the types and numbers of vehicles in the managed lanes could be managed by both occupancy and pricing. There is also twice the special-lane capacity with Package 2. Package 2 would provide a physical barrier between the managed lanes and the general-purpose lanes, limiting potential traffic flow conflicts and improving safety. This improved reliability would benefit both automobile travelers and bus patrons.
- All build packages would offer expanded bus service and would experience similar total ridership increases over Package 1.
- All build packages would improve overall vehicle safety because highway facilities would be upgraded to current standards. Package 2 is predicted to provide better safety performance and fewer serious crashes than either Package 4 or the Combined Alternative Package (Preferred Alternative) because it would have fewer conflict points, due to the barrier separation of managed lanes from general-purpose lanes.
- The Combined Alternative Package (Preferred Alternative) access to the University of Colorado, Boulder South Campus via Loop Drive is expected to provide better accessibility and have fewer impacts to the surrounding neighborhood compared to the Local Streets Option via Tantra Drive. All local access intersections are expected to operate at level of service (LOS) D or better under both options.

Summary of Transportation Impacts of Each Package

- All build packages would have a lower number of congested intersections at interchanges than in Package 1. Package 4 would provide slightly better LOS at most intersections than either the Combined Alternative Package (Preferred Alternative) or Package 2, although overall traffic operations at Sheridan Boulevard and Wadsworth Parkway would benefit in Package 2 from the inclusion of the two new direct-access drop-ramps.
- All build packages would include some changes to local circulation patterns that could increase peak-hour congestion in certain areas. Each build package includes the reconfiguration of westbound ramps at the Broadway interchange. The changes restrict access to Broadway from southbound I-25 and westbound US 36. The build packages also include realignment, extension, and truncation of local streets in the vicinity of some interchanges. Under the Combined Alternative Package (Preferred Alternative), access to the University of Colorado, Boulder South Campus, congestion is likely to increase at the Table Mesa Drive/Loop Drive/US 36 eastbound ramp intersection. The Local Streets Option would likely increase congestion at the Table Mesa Drive/Tantra Drive intersection.
- All of the build packages would increase a.m. peak-hour traffic by 26 to 50 percent compared to Package 1 on US 36 as the highway approaches Boulder (westbound). On a daily basis, the increase in vehicle miles traveled (VMT) to and from Boulder would be less than 5 percent. Some of these trips would be attracted from east-west arterials, and some would be from other parts of the peak period; overall the highway capacity can accommodate higher volumes such that the length of the period when volumes are highest during the day could decrease.

3.2 COMPATIBILITY WITH TRANSPORTATION PLANS

3.2.1 *2035 Metro Vision Regional Transportation Plan, as Amended*

The current regional plan adopted by governing bodies in the project area is the *2035 MVRTP*, as amended (DRCOG 2009). The *2035 MVRTP* is a single comprehensive guide for regional planning that integrates previously separate plans for growth, development, transportation, and water quality management and is also used to ensure conformity with the Clean Air Act. The transportation element of the *2035 MVRTP* is the *Fiscally-constrained Element*. During the analysis process for this FEIS, it was important to consider if the build packages were compatible with the projects set forth in the *2035 MVRTP*, as projects must be in the *2035 MVRTP*, as amended, for federal agencies to make a final decision.

The *2035 MVRTP*, as amended (DRCOG 2009) network contains several improvements planned for the US 36 corridor. US 36 is currently five to seven lanes between Interstate 25 (I-25) and Sheridan Boulevard and four general-purpose lanes in the remainder of the corridor, with the exception of an auxiliary lane between Wadsworth Parkway and East Flatiron Circle. With the improvements listed in the *2035 MVRTP*, as amended, US 36 would have an additional through-lane between East Flatiron Circle and 96th Street. In addition, the I-25, Sheridan Boulevard, Wadsworth Parkway, McCaslin Boulevard, and Foothills Parkway/Table Mesa Drive interchanges are all expected to receive improvements.

The existing HOV lanes between Pecos Street and Sheridan Boulevard would be extended to Boulder and used by BRT service as well as HOVs. The *2035 MVRTP*, as amended (DRCOG 2009) notes that the operation of the HOV lanes on US 36 may be affected by the recommendations from studies such as this US 36 corridor FEIS. The Plan includes the FasTracks regional transit system improvements approved by voters in 2004. Within the US 36 corridor, FasTracks elements including park-n-Ride improvements for express and regional buses on US 36 and commuter rail between DUS and Boulder are included in the *2035 MVRTP*, as amended.

3.2.2 Compatibility of the Packages with the Regional Transportation Plan

Only one of the four packages is consistent with the *2035 MVRTP*, as amended (DRCOG 2009). The highway and transit elements of Package 1 would be composed of only the existing plus committed projects in the corridor. Therefore, Package 1 would not complete all transportation projects within the corridor identified in the *2035 MVRTP*. Package 2 differs from the *2035 MVRTP* because it recommends four managed lanes instead of two. Package 2 is consistent with the transit elements of the *2035 MVRTP*. Package 4 differs from the *2035 MVRTP* because it recommends additional general-purpose capacity on US 36. Package 4 is consistent with the transit elements of the *2035 MVRTP*. The Combined Alternative Package (Preferred Alternative) is consistent with the *2035 MVRTP*. Key elements included in the *2035 MVRTP*, as amended, are:

- Reconstruction of the Sheridan Boulevard and US 36 interchange
- Reconstruction of the Wadsworth Parkway and US 36 interchange
- Addition of managed lanes on US 36 from Foothills Parkway to I-25
- Addition of BRT lanes on US 36 and bikeway parallel to US 36 (FasTracks Program)

Recommendations from this FEIS would be included in the yearly *2035 MVRTP,* as amended (DRCOG 2009), update process as funding is available. DRCOG, CDOT, and RTD would work together to identify portions of the Combined Alternative Package (Preferred Alternative) that could be funded and therefore would be a part of the *2035 MVRTP (Fiscally-constrained Element)*. See Chapter 5, Financial Analysis, for a discussion of funding for US 36 improvements, and Chapter 8, Phased Project Implementation, for more information.

3.2.3 Compatibility of the Packages with Local Transportation Plans

Package 1 is generally not consistent with local transportation plans because it does not provide transportation improvements beyond what is currently planned and programmed.

Comparison of the build packages with local and regional transportation plans revealed general compatibility, although none of the local plans specifically mention tolled-managed lanes included in Package 2 and the Combined Alternative Package (Preferred Alternative). Specifically, the build package would be compatible with the following plans.

- *Blueprint Denver – An Integrated Land Use and Transportation Plan (2002)* (City and County of Denver 2002). Denver's Land Use and Transportation Plan component of the Comprehensive Plan, identifies mobility as a goal and includes providing diverse mobility options, a regional transportation system, roadways, public transit, and bicycling opportunities as objectives to meet that goal. All build packages incorporate multi-modal elements that would promote mobility, including transit, roadway, and bicycle facility improvements.
- The *1996 Adams County Transportation Plan* (Felsburg et al. 1996) includes the 2020 Transportation Plan component that identifies the desire for multi-occupant vehicle facilities, expanded bus service, and roadway improvements. Specifically, the Plan lists the expansion of the bus/HOV lanes along US 36 from I-25 to Wadsworth Parkway, and improvements to the I-25 and US 36 interchange. All build packages extend bus/HOV facilities, whether in the form of managed lanes or BRT/HOV lanes, from I-25 to Boulder, and propose improvements to the US 36 and I-25 interchange.
- One of the primary goals of the *2004 Westminster Comprehensive Land Use Plan* (Clarion Associates 2004) is to promote the development of a continuous and multi-modal transportation system including supporting CDOT efforts for the US 36 corridor. Specifically, the Plan identifies street enhancements for the US 36 and Federal Boulevard interchange and the elements in the *US 36 Major Investment Study* (RTD 2001) including widening US 36, providing HOV lanes, and providing parallel bikeways. All build packages would include the widening, managed lanes, and a bikeway to enhance multi-modal opportunities along US 36.
- The vision of the *2005 Transportation Master Plan for the City and County of Broomfield* (Felsburg et al. 2005), a component of the comprehensive Plan, is an efficient and well-maintained, multi-modal transportation system that accommodates the demand from growth and facilitates convenient internal and regional accessibility; minimizes environmental impacts; and reduces dependence on the automobile. Specifically, the Plan identifies goals that address roadway capacity, major roadway connections, alternative modes of travel, and interconnected bike and pedestrian facilities. US 36 is listed as a highway that is congested and in need of additional capacity. Roadway connections including the 120th Avenue extension, the 112th Avenue reconstruction over US 36, and the extension of Midway Boulevard are listed as desired improvements in the Plan. Expanded bus services to serve the major employment and activity centers and bicycle and pedestrian facilities along US 36 are also listed in the Plan. All build packages address these components.
- The transportation goal of the *Town of Superior Comprehensive Plan* (Town of Superior et al. 2001) is to develop a multi-modal transportation system to efficiently meet the local and regional transportation needs of residents and businesses in a safe, convenient, and efficient manner, while

minimizing negative environmental and community impacts. Specifically, the Plan identifies policies that encourage alternative modes of travel through the development of bicycle facilities; encouraging use of public transit by supporting the McCaslin park-n-Ride; supporting development of BRT/HOV lanes on US 36 (with a BRT station to serve the Town of Superior); and supporting US 36 corridor pedestrian, bicycle, and local bus access to the proposed BRT station. All build packages would provide multi-modal elements including the extension of the managed lanes, BRT stations, and bicycle facilities. Additionally, the Plan lists a desire for improvements to the McCaslin Boulevard/US 36 interchange. Some elements of the improvements specifically listed are not consistent with what is being proposed in the build packages. For example, the addition of a loop-ramp in the northeast quadrant is included in the Plan but not in the US 36 design concept. However, the goal of improving the flow of traffic through the interchange is consistent with all build packages.

- The *Boulder Valley Regional Center Transportation Connection Plan* (City of Boulder et al. 2002) supports the expansion of regional transit along the US 36 corridor and continuing into Boulder via the 28th Street corridor. It identifies the creation of "super stops" and other transit friendly improvements such as queue jumps along 28th Street to facilitate transit traffic into Boulder. All build packages provide transit improvements that are compatible with this Plan.

- The goals specified in the *City of Boulder Transportation Master Plan* (LSA Associates, Inc. 2003) include providing an integrated, multi-modal transportation system emphasizing the role of the pedestrian as the primary mode of travel within the city. Reduction of single-occupant travel for regional travel is identified as a focus area for the 2003 Plan. Specific objectives to reach that goal include continued progress toward no increase in long-term vehicle traffic, reduction in SOV travel to 25 percent of all person-trips, and expanding transportation alternatives. Package 2 and the Combined Alternative Package (Preferred Alternative) would provide managed lanes to give travel time priority for HOV and BRT users. The improved travel time would provide incentive to change modes from the SOV to other modes, reinforcing the objectives in the Plan. The managed lanes would allow transit and HOV use for free, and would manage SOV use through dynamic pricing that could be managed from day-to-day or hour-to-hour to achieve specific usage levels.

  The build packages would result in less than a 5 percent increase in daily VMT within Boulder Valley compared to Package 1, indicating a relatively stable VMT. Daily trips to and from Boulder would increase less than 5 percent. The build packages would increase a.m. peak-hour traffic volumes on US 36 destined for Boulder, but all of this increase would be in the managed lane. Because capacity would be added to the highway, traffic would be shifted from east-west arterials and from other parts of the peak period, shortening the period. Traffic on local roadways such as 28th Street, Baseline Road, Foothills Parkway, and Table Mesa Drive would increase, which is not consistent with the city goals of no increase in long-term vehicle traffic and reduction in SOV travel.

  Additionally, the Plan identifies the desire for developing regional consensus for multi-modal improvements to regional corridors including, but not limited to, automobile, rail, bus, bicycle, and pedestrian access. The Plan specifically supports the locally preferred alternative improvements for US 36 identified in the *US 36 Major Investment Study* (RTD 2001), including additional travel lanes, HOV and BRT, and a corridor bikeway. In general, the build packages are compatible with this Plan. It provides multi-modal opportunities with roadway and transit elements and includes a bikeway along US 36.

  All build packages are consistent with city objectives to provide BRT service to Boulder. In the Combined Alternative Package (Preferred Alternative), BRT vehicles would be required to make one lane change from the managed lane to access the side platform ramp leading to the Table Mesa Station.

3.3 TRANSPORTATION ANALYSIS METHODOLOGY

3.3.1 Levels of Analysis

The various levels of analysis and associated methodology are presented in the following sections.

Regional

The travel demand model includes a network of the entire Denver metropolitan area, including the counties of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson, as well as parts of Clear Creek, Gilpin, and Weld counties. Therefore, regional numbers are helpful for providing reasonableness checks and for giving a larger geographic context for comparison of corridor improvements. The regional area analysis is also used for air quality conformity.

Project Area

The project area was presented previously in Figure 1.1-1, US 36 Corridor Project Area. It is a 3-mile buffer around US 36. Most effects of the proposed US 36 packages are expected to occur within this area.

US 36 Corridor

For most transportation measures, it is helpful to analyze the impacts of each package along the US 36 corridor and its interchanges between I-25 in Adams County and Foothills Parkway/Table Mesa Drive in Boulder.

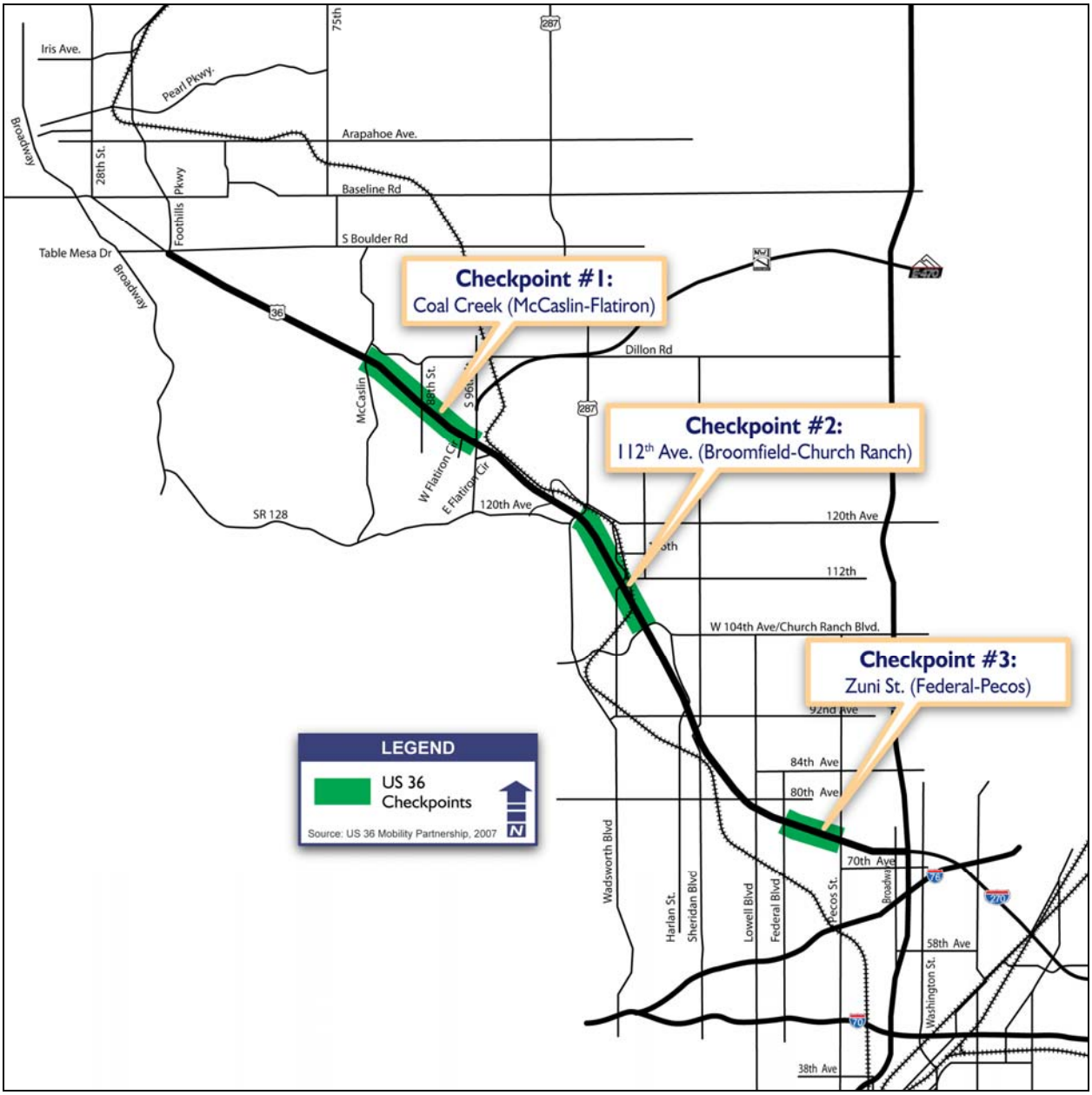
Checkpoints

Specific checkpoints along US 36 were chosen for analysis and are described in more detail below. Due to the length of the US 36 corridor, detailed reporting of results for every roadway segment would be impractical. To support reasonable comparisons between packages, three "checkpoints" were established on US 36 where transportation demand and capacity could be estimated and reported.

The three checkpoints are shown on Figure 3.3-1, US 36 Checkpoints, and are described as follows:

- **Checkpoint #1: Coal Creek (McCaslin Boulevard to East Flatiron Circle)** – Represents the western part of the corridor. This location has a predominant westbound a.m. commute toward Boulder and eastbound p.m. commute away from Boulder.
- **Checkpoint #2: 112th Avenue (Broomfield – Church Ranch Boulevard)** – Represents the middle part of the corridor. This location is expected to experience the most growth in the corridor and is expected to have fairly equal flows in both directions during both commutes.
- **Checkpoint #3**: **Zuni Street (Federal Boulevard to Pecos Street)** – Represents the eastern part of the corridor. This location has a predominant eastbound a.m. commute toward Denver and westbound p.m. commute away from Denver.

Figure 3.3-1: US 36 Checkpoints



3.4 COMPARISON OF HOW THE PACKAGES MEET THE TRANSPORTATION NEEDS OF THE CORRIDOR

Chapter 1, Purpose and Need, presented six transportation needs identified for the US 36 corridor. The following sections describe how each package meets these six needs, as well as the resulting impacts and user benefits of each package.

Each need includes the analysis of several elements. For example, Transportation Need #1: Increase Trip Capacity, includes the available capacity of each element at checkpoints and US 36 traffic volumes (Horizon-Year). For each of these elements, the build packages are compared to Package 1 and to each other.

3.4.1 Transportation Need #1: Increase Trip Capacity

Historical growth in population and employment has resulted in increased travel demand in the US 36 corridor. Additional growth is forecasted and one way to respond to this continued growth is to increase the trip capacity of the highway.

Capacity Available at Checkpoints

Capacity is an estimate of the maximum number of vehicles that can traverse a specified point over a period of time. Often capacity is measured in vehicles per hour or vehicles per day. Capacity can also be analyzed in person-trips to account for the capacity for transit users on the facility.

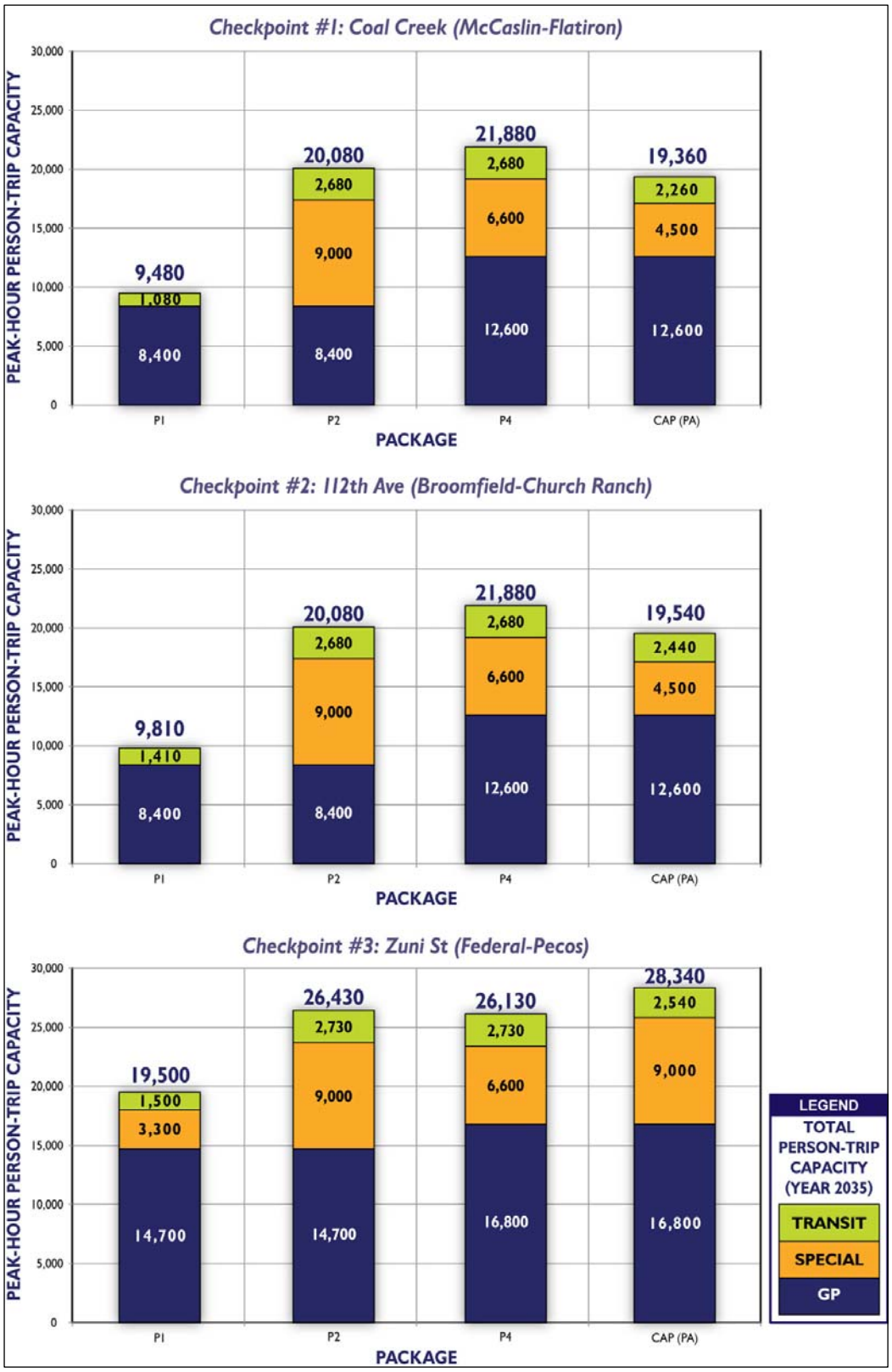
Figure 3.4-1, a.m. Peak-hour Person-Trip Capacity at US 36 Checkpoints (East and West Directions, Horizon-Year) compares the estimated capacities, at three locations along US 36, for the different analysis packages. The figure represents capacity in terms of "person-trips." To determine an approximate person-trip capacity for highway lanes, an occupancy factor was applied to the vehicle capacity of each lane type. Occupancy factors were based on regional occupancy factors in the DRCOG regional travel demand model for SOVs and carpool vehicles. The occupancy factor for general-purpose lanes was assumed to be 1.05 while the factor for managed lanes was 2.20. The application of these factors resulted in a person-trip capacity of 2,100 people per hour in a general-purpose lane and 3,300 people per hour in a managed lane. Transit capacity was calculated as the number of buses in the peak-hour multiplied by the seating capacity of each bus.

For operations analysis, the auxiliary lanes proposed in the Combined Alternative Package (Preferred Alternative) were considered equivalent to general-purpose lanes for the freeway segments containing the auxiliary lanes. The proposed auxiliary lanes would extend between adjacent interchanges but not through the entire length of the corridor. Since the auxiliary lanes would extend as a continuous lane for over 1 mile, *Highway Capacity Manual* (CDOT, Transportation Research Board 2000) methodologies consider the lanes to be the same as a general-purpose lane. Vehicles in the auxiliary lanes would be expected to operate in a similar manner as vehicles in the general-purpose lanes.

The Coal Creek Checkpoint (Checkpoint #1) is located between McCaslin Boulevard and FlatIron Crossing. Package 1 is estimated to have a person-trip capacity of approximately 9,500 people per hour at this location. The build packages provide capacities that range from 19,400 to 21,900 people per hour.

The 112th Avenue Checkpoint (Checkpoint #2) is located between Wadsworth Parkway and Church Ranch Boulevard. Package 1 is estimated to have a person-trip capacity of approximately 9,800 people per hour at this location. The build packages provide capacities that range from 19,600 to 21,900 people per hour.

Figure 3.4-1: a.m. Peak-hour Person-Trip Capacity at US 36 Checkpoints (East and West Directions, Horizon-Year)



Source: US 36 Mobility Partnership, 2009.

The Zuni Street Checkpoint (Checkpoint #3) is located between Federal Boulevard and Pecos Street. Package 1 is estimated to have a person-trip capacity of approximately 19,500 people per hour at this location. The build packages provide capacities that range from 26,100 to 28,400 people per hour.

Averaging the three checkpoints together provides a general summary of each packages capacity along the entire length of the corridor. Package 1 provides an average person-trip capacity of 12,900 people per hour. Package 2 provides an average capacity of 22,200 people per hour. The average capacity for Package 4 is estimated to be 23,300. The Combined Alternative Package (Preferred Alternative) provides an average capacity of 22,400 people per hour. The average capacities show that the three build packages are able to serve 10,000 more people per hour compared to Package 1. The difference in capacity among the three build packages is less than 5 percent, with Package 4 providing the most capacity.

US 36 Traffic Volumes

Traffic volume forecasts represent the number of vehicles expected to use the roadway system at a given point in time. Typically volumes are provided in terms of vehicles per hour or vehicles per day. Projected corridor traffic volumes (daily, a.m. peak-hour, and p.m. peak-hour) are shown in Figure 3.4-2 through Figure 3.4-4 for the four analysis packages.

Daily forecasts within the US 36 corridor range from 43,000 to 100,600 vehicles per day under the different packages. The forecast volumes increase from west to east along the corridor, with the highest volumes near the interchange with I-25. Package 1 forecasts are consistently less than the build package forecasts. In general, Package 1 was forecast to serve 15 to 40 percent less traffic than the build packages. The forecast for the three build packages were generally within 5 and 15 percent of each other. In many cases, Package 4 was forecast to serve the most traffic, while Package 2 was forecast to serve the least (of the build packages).

Morning peak-hour forecasts within US 36 corridor range from 3,100 to 9,300 vehicles per hour under the different packages. The forecast volumes increase from west to east along the corridor, with the highest volumes near the interchange with I-25. The highway is forecast to carry the same amount of traffic in each direction during the a.m. peak-hour. In general, Package 1 was forecast to serve 5 to 35 percent less traffic than the build packages. The forecast for the three build packages were generally within 5 and 15 percent of each other.

Evening peak-hour forecasts within US 36 corridor range from 3,500 to 9,200 vehicles per hour under the different packages. The forecast volumes increase from west to east along the corridor, with the highest volumes near the interchange with I-25. The highway is forecast to carry the same amount of traffic in each direction during the p.m. peak-hour. In general, Package 1 was forecast to serve 10 to 45 percent less traffic than the build packages. The forecast for the three build packages were generally within 5 and 15 percent of each other.

In general, the three build packages are forecast to serve a similar level of traffic through different proposed cross sections. Each build package is forecast to serve more traffic than Package 1, demonstrating the increased capacity provided along the corridor.

Figure 3.4-2: US 36 Daily Traffic Volumes (Horizon-Year)

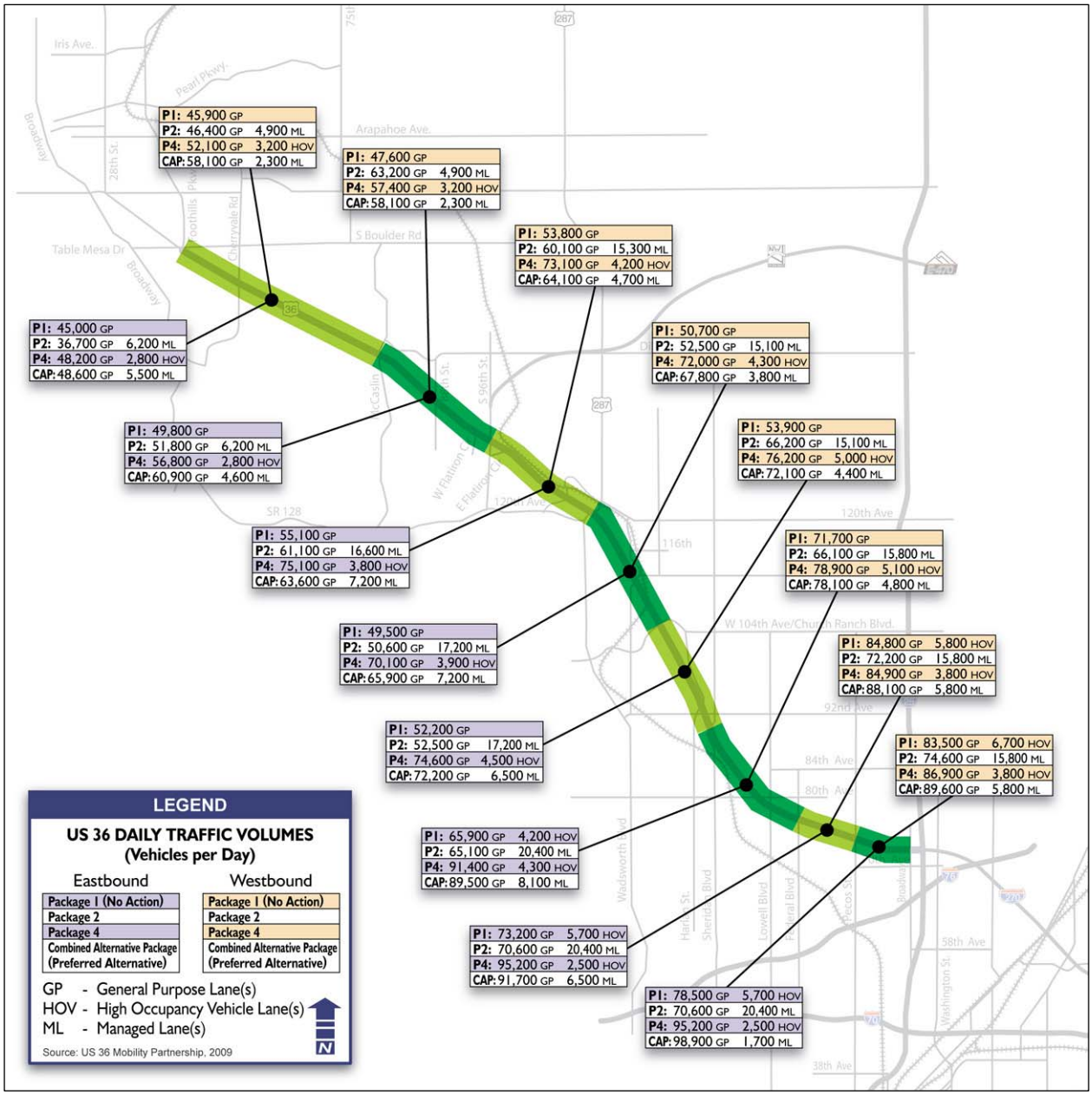


Figure 3.4-3: US 36 a.m. Peak-hour Traffic Volumes (Horizon-Year)

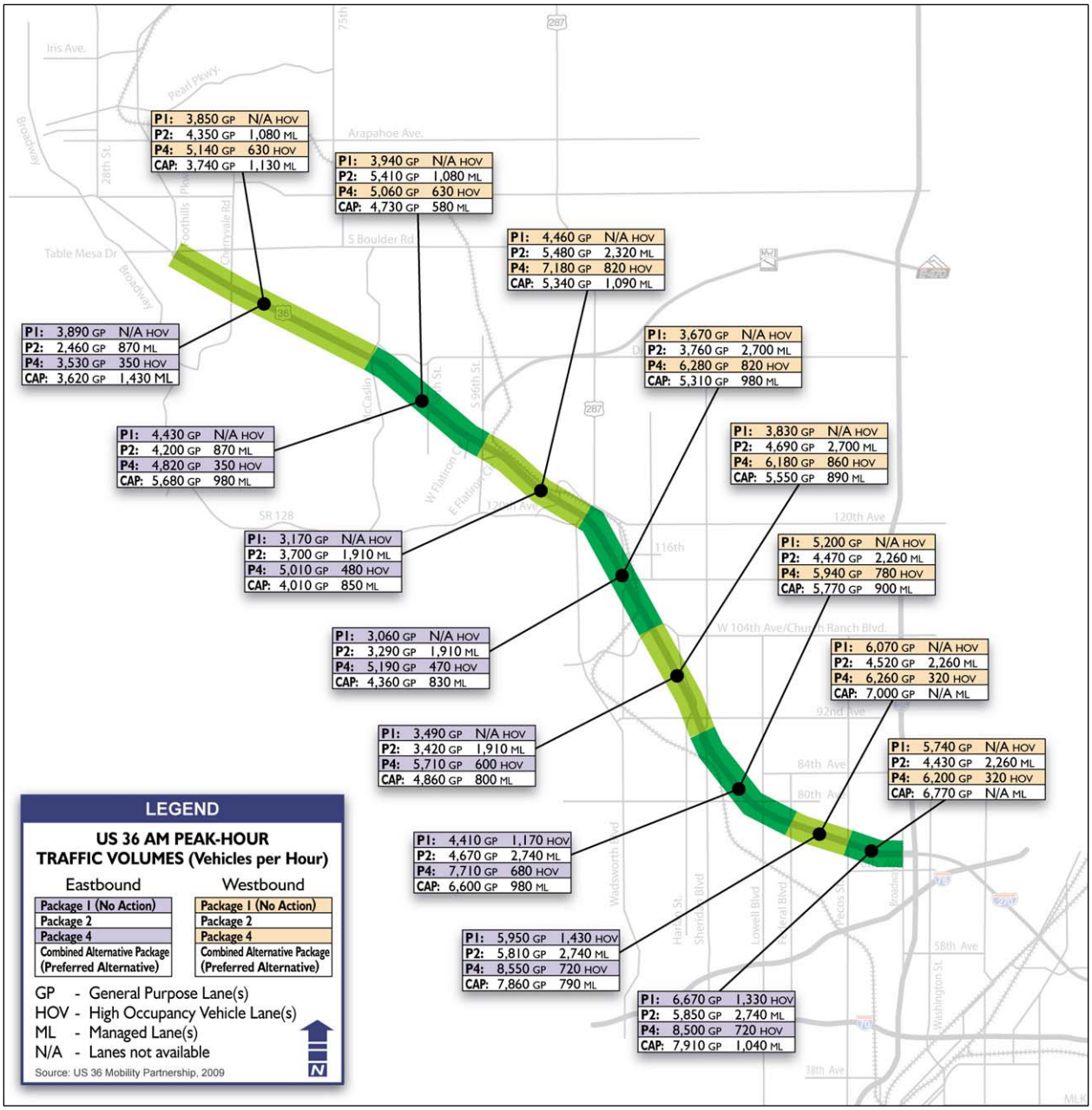
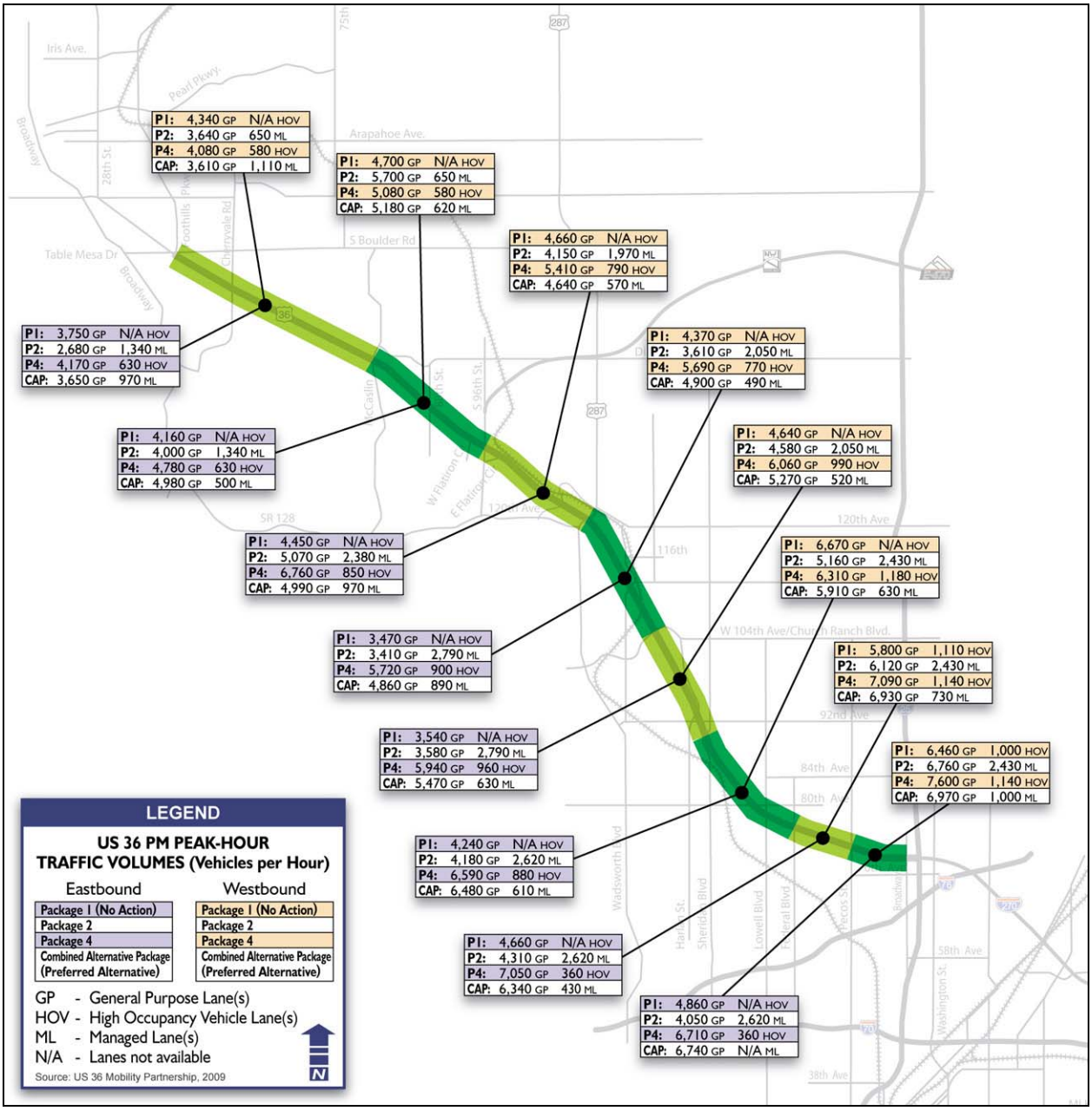


Figure 3.4-4: US 36 p.m. Peak-hour Traffic Volumes (Horizon-Year)



3.4.2 Transportation Need #2: Expand Access

Access to activity centers in the US 36 corridor such as Boulder, FlatIron Crossing/Interlocken, and Westminster Center, and to US 36 itself is limited due to capacity constraints at the interchanges along the corridor. These constraints limit the number of people who are able to access destinations along the corridor. To address this need, improved access is provided though interchange capacity improvements and additional access points.

US 36 Interchange Improvements

Interchange capacity improvements increase the number of vehicles that can use an interchange complex to access US 36 and activity centers along the corridor. Table 3.4-1, US 36 Interchange Improvements (Summary), identifies the status of each interchange complex along US 36 for each analysis package. An interchanges with no change indicates that the interchange remained in the same condition as Package 1. An updated interchange indicates geometric changes were made to a portion of the interchange complex.

Table 3.4-1: US 36 Interchange Improvements (Summary)

Interchange	Package 1 (No Action): Existing + Committed (TIP) Projects	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
I-25	Existing configuration	Updated	Updated	Updated
Broadway	Existing configuration	Updated[1]	Updated[1]	Updated[1]
Pecos Street	Existing configuration	No change	No change	No change
Federal Boulevard	Existing configuration	No change	No change	No change
Sheridan Boulevard	Existing configuration	Updated	Updated	Updated
Church Ranch Boulevard	Existing configuration	Updated	Updated	Updated
Wadsworth Parkway	Relocated park-n-Ride and added 120th Avenue crossing of US 36 (TIP)	Updated	Updated	Updated
FlatIron Crossing[2]	Existing configuration	No change	No change	No change
McCaslin Boulevard	Existing configuration	Updated	Updated	Updated
Table Mesa Drive/ Foothills Parkway	Pedestrian bridge at park-n-Ride (TIP)	Updated	Updated	Updated
Total	N/A	7	7	7

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Access to Broadway from westbound US 36 and southbound I-25 would be eliminated under these improvements.

[2]FlatIron Crossing/Interlocken includes East Flatiron Circle, 96th Street, and West Flatiron Circle ramps.

BRT = bus rapid transit
I-25 = Interstate 25
HOV = high-occupancy vehicle
N/A = not applicable
TIP = Transportation Improvement Program
US 36 = United States Highway 36

Package 1 analyzed each interchange using existing geometric conditions plus approved projects that have been included in the latest Transportation Improvement Program (TIP). TIP projects are currently planned at the Wadsworth Boulevard and Table Mesa Drive/Foothills Parkway interchanges.

All of the build packages included updates at seven of the corridor interchanges: I-25, Broadway, Sheridan Boulevard, Church Ranch Boulevard, Wadsworth Parkway, McCaslin Boulevard, and Table Mesa Drive/Foothills Parkway.

Table 3.4-2, US 36 Interchange Improvements (Details), provides a summary of the interchange updates incorporated in the build packages.

Table 3.4-2: US 36 Interchange Improvements (Details)

Interchange	Interchange Improvement
I-25	The build packages include the realignment of the southbound ramp from I-25 to westbound US 36. The ramp will be aligned to connect directly to US 36 without passing though the existing intersection at Broadway. The southbound access from I-25 to Broadway will be eliminated. The existing reversible HOT-ramp connecting I-25 to US 36 will be replaced with a new connections designed to enhance speed and safety.
Broadway	The build packages include the elimination of access from southbound I-25 and westbound US 36 to Broadway. The realignment of the southbound ramp from I-25 to westbound US 36 to provide a direct connection to US 36 would eliminate access from both southbound I-25 and westbound US 36 to Broadway.
Sheridan Boulevard	The build packages would convert the diamond interchange at Sheridan Boulevard into a split-diamond interchange with 92nd Avenue. A new eastbound on-ramp would be provided between 92nd Avenue and Sheridan Boulevard. In addition, Sheridan Boulevard would be widened from four lanes to six lanes.
Church Ranch Boulevard	The build packages would widen the bridge over US 36 on Church Ranch Boulevard by two lanes, one lane in each direction.
Wadsworth Parkway	The build packages would convert the diamond interchange at Wadsworth Parkway into a partial cloverleaf interchange that also serves 120th Avenue. Collector-distributor roads would provide access between the ramps at Wadsworth Parkway and 120th Avenue.
McCaslin Boulevard	The bridge over US 36 would be widened to provide an additional lane in each direction under all three build packages.
Table Mesa Drive/ Foothills Parkway	The build packages would include the removal of the loop-ramp that provides access from westbound Table Mesa Drive to eastbound US 36. This movement would be replaced with an at-grade left turn from Table Mesa Drive. Other ramp improvements and minor realignments would be included at the interchange.

Source: US 36 Mobility Partnership, 2009.
Notes:
HOT = high-occupancy toll
I-25 = Interstate 25
US 36 = United States Highway 36

Delay at Corridor Interchanges

One measure to assess interchange access is the average delay per vehicle experienced at the intersections within an interchange complex. Lower overall delay indicates better interchange operations and access. For the purposes of this comparison, the average delay per vehicle at all interchange intersections was averaged to provide one value for the entire interchange. The build packages were then compared to Package 1. A decrease in average delay indicated an interchange where build conditions provide improved mobility and access. Table 3.4-3, Change in Delay at US 36 Interchanges (Horizon-Year), presents the change in delay of the build packages compared to Package 1; locations with US 36 interchange improvements are shaded. More detailed LOS information for the intersections at the interchanges can be found in "Interchange and Transit Station Traffic Impacts" in Section 3.5, Transportation Impacts and Mitigation.

Table 3.4-3: Change in Delay at US 36 Interchanges (Horizon-Year)

Interchange	Number of Intersections in Area	Package 1 Total Average Intersection Delay (seconds per vehicle)		Total Average Intersection Delay Change Between Package 2 and Package 1 (seconds per vehicle)		Total Average Intersection Delay Change Between Package 4 and Package 1 (seconds per vehicle)		Total Average Intersection Delay Change Between the Combined Alternative Package (Preferred Alternative) and Package 1 (seconds per vehicle)	
		a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Broadway	4	23.3	20	-0.1	-1.1	-2.2	-1.1	-4.7	-3.6
Pecos Street	4	56	26.5	+35.5	+77.3	+29.2	+70.7	-5.6	+4.4
Federal Boulevard	4	50.5	66	+3.1	-14.3	+7.7	+5.1	+1.2	-8.5
Sheridan Boulevard	4	72.7	51.7	-20.0	-15.2	-26.3	-7.0	-40.0	-14.0
Church Ranch Boulevard	4	34.6	50.1	+16.2	-2.2	+12.2	+1.0	-2.0	-11.2
Wadsworth Parkway	4	192.5	174.1	-165.8	-128.1	-149.7	-127.3	-143.2	-137.7
FlatIron/Interlocken	7	14.5	18.3	+1.1	+2.8	+2.8	+4.7	+2.3	+0.9
McCaslin Boulevard	4	85.6	54	-24.0	+8.0	-20.6	+1.2	+43.5	+15.3
Foothills Parkway/ Table Mesa Drive	5	16.8	16.1	+10.5	+10.3	+7.9	+6.0	-0.1	+2.8

Source: US 36 Mobility Partnership, 2009.
Notes:
+ = increase
- = decrease
a.m. = morning
p.m. = evening
green shading = location with interchange improvement

As shown in Table 3.4-3, Change in Delay at US 36 Interchanges (Horizon-Year), all build packages would reduce overall delay at most intersections in the corridor when compared to Package 1.

- Delay would be reduced at interchanges that provide access to activity centers. These include:
  - Sheridan Boulevard/92nd Avenue with delay reductions of 15 to 55 percent
  - Church Ranch Boulevard with delay reductions of 5 to 20 percent under the Combined Alternative Package (Preferred Alternative)
  - Wadsworth Parkway/120th Avenue with delay reductions of 75 to 85 percent
  - McCaslin Boulevard with overall delay reductions of 25 to 30 percent under Package 2 and Package 4
- Delay would be somewhat increased at locations where capacity improvements were not provided as part of the build package. The added capacity of the special lanes and/or the general-purpose lanes would allow more traffic to access corridor destinations causing delay to increase at unimproved access points. The locations where consistent delay increases are forecast in one or more build packages include Pecos Street, Church Ranch Boulevard, and Table Mesa Drive/Foothills Parkway.
- Delay increases of less than 10 seconds would occur during both peak-hours at the Flatiron Circle/ Interlocken Loop interchange, and during the p.m. peak-hour at the McCaslin Boulevard interchange.
- Similarly, increases in delay would occur at the Federal Boulevard interchange of less than 10 seconds per vehicle. Under Package 2 and the Combined Alternative Package (Preferred Alternative) delay is forecast to decrease during the p.m. peak-hour.

- Package 2 exhibits slightly more delay reduction at interchanges where the drop-ramp access points help distribute volumes. At Sheridan Boulevard/92nd Avenue, the overall delay reduction in the p.m. peak-hour would be about 25 percent better in Package 2 than Package 4. At Wadsworth Parkway/120th Avenue, the overall delay reduction in the a.m. peak-hour would be about 30 percent better in Package 2 than Package 4.
- Both access options for the University of Colorado, Boulder South Campus are expected to affect local traffic circulation along Table Mesa Drive. However, all intersections are forecast to operate at LOS D or better. Under the Combined Alternative Package (Preferred Alternative), average delay is forecast to increase at the Table Mesa Drive/Loop Drive/US 36 eastbound ramp intersection. If the Local Streets Option is implemented instead, average delay is forecast to increase at the Table Mesa Drive/Tantra Drive intersection.

US 36 Access Locations

The number of access points to US 36 provides a measure of how readily the highway can be accessed from the surrounding roadway network. More access points typically allow drivers easier access to the facility, with less driving required on the arterial street network.

Package 1, Package 4, and the Combined Alternative Package (Preferred Alternative) include nine access points within the US 36 corridor: Broadway, Pecos Street, Federal Boulevard, Sheridan Boulevard, Church Ranch Boulevard, Wadsworth Parkway/120th Avenue, FlatIron Crossing, McCaslin Boulevard, and Table Mesa Drive/Foothills Parkway. No additional access points are proposed under these packages.

Package 2 would provide two additional access points to and from managed lanes on US 36, in addition to the nine existing access points. The two drop-ramp access points in Package 2 (at Westminster Boulevard and at Midway Boulevard) would improve conditions at adjacent interchanges slightly by redirecting traffic accessing the managed lanes; some shift of volumes to nearby arterials would occur (see "Impacts of Drop-Ramps" in Section 3.5, Transportation Impacts and Mitigation, for further discussion).

Special Lane Access to Activity Centers

Special lane access to two primary activity centers (Westminster Mall and to FlatIron Crossing) and along the US 36 corridor would be different for each build package. The drop-ramps in Package 2 would provide direct access to the Westminster Mall Activity Center via Westminster Boulevard, without having to go through the Sheridan Boulevard interchange. In particular, shorter travel times would be available for travelers to and from the west on US 36.

Similarly, special lane access to the FlatIron Crossing Activity Center would be made from the proposed Midway Boulevard overpass and drop-ramp. Direct access to the Interlocken and Broomfield employment centers would be available in Package 2. Access would be shortened via the drop-ramp as compared to using the Wadsworth Parkway interchange. For trips to FlatIron Crossing Mall, managed lane users would use Interlocken Boulevard, which would be slightly longer than access to the Interlocken Loop interchange from the general-purpose lanes.

A westbound flyover ramp in the vicinity of 88th Street between West Flatiron Circle and McCaslin Boulevard was also proposed. These three drop ramps would be the only locations between Boulder and I-25 where vehicles could access the managed lanes under Package 2. Access would not be provided between the managed lanes and the general-purpose lanes on US 36.

By contrast, Package 4 and the Combined Alternative Package (Preferred Alternative) would not provide direct access to the activity centers from the special lanes. Users would need to exit the BRT/HOV lane via slip ramps to the general-purpose lanes on US 36, weave across the general-purpose lanes, and use the appropriate off-ramp to access the activity centers.

Under Package 4, slip lanes to enter or exit the HOV lane would be provided in three locations between Boulder and I-25. One access would be between the Interlocken interchange and the Wadsworth Parkway interchange. A second access would be between the Church Ranch Boulevard interchange and the Sheridan Boulevard interchange. The third access would be between the Sheridan Boulevard and Federal Boulevard interchanges. These would be the only locations where vehicles can transfer between the HOV lane and the general-purposes lanes.

The Combined Alternative Package (Preferred Alternative) would provide slip-ramps to/from the managed lane between each pair of interchanges. This arrangement of slip-ramps minimizes the distance a vehicle using the managed lane would need to travel in the general-purpose lanes. Drivers at each interchange would have access to the managed lane at the next downstream interchange.

In addition, BRT service in Package 2 could access the managed lanes at the Westminster Parkway drop-ramp and be able to serve the Westminster Center Station. By comparison, BRT vehicles that would enter US 36 at Sheridan Boulevard in Package 4 would not be able to access the median BRT station at that location. Similarly, with the Midway Boulevard drop-ramp in Package 2, BRT service could access either the 116th Avenue Station or the Flatiron Station. In contrast, BRT service in Package 4 would not have enough distance to enter the highway at Wadsworth Parkway and weave over to the 116th Avenue Station.

Buses in the Combined Alternative Package (Preferred Alternative) would use ramp stops to serve each designated park-n-Ride rather than median BRT stations. Buses serving stops between McCaslin Boulevard and Sheridan Boulevard would use auxiliary lanes to between the stops, then transition into the managed lane between Sheridan Boulevard and Federal Boulevard. Buses would be able to transition into or out of the managed lane at any interchange in order to serve bus stops or reroute service. Express buses between Boulder and Denver would use the managed lane the entire length of the corridor.

3.4.3 Transportation Need #3: Provide Congestion Relief

Corridor capacity is inadequate to meet growing travel demands, and relief is needed for increasing levels of congestion along the US 36 corridor. This need relates to user benefits resulting from improvements to the system. These benefits could include improved trip speeds, a better LOS, and improved travel times.

Vehicle Miles Traveled, Vehicle Hours Traveled, and Average Speed

Vehicle miles of travel is a common measurement of the amount of vehicle travel within a specified area. VMT reflects overall travel activity and is an important input to air quality impact calculations. Vehicle hours traveled (VHT) measure the amount of time spent in travel. VMT divided by VHT, results in the calculation of average vehicular speed for non-transit vehicles, reflecting the overall efficiency of the transportation system.

It is helpful to analyze VMT, VHT, and average speed both for the region and project areas, as well as on specific facilities within the corridor.

Region

Daily regional VMT in the horizon-year increases with the three build packages from 119.0 million in Package 1, to 119.2 million in Package 2, 119.7 million in Package 4, and 119.4 million in the Combined Alternative Package (Preferred Alternative). The slight increase in regional VMT is due to the increased mobility allowed by the capacity increases in the US 36 corridor. Overall the regional VHT approaches 4 million across the packages, and the resulting average speeds remain similar at approximately 30 miles per hour.

US 36

Figure 3.4-5, US 36 Daily Vehicle Miles Traveled, Vehicle Hours Traveled, and Average Speed (Horizon-Year), illustrates daily VMT, VHT, and average speed on US 36. The capacity increases on US 36 serve more demand in the build packages compared to Package 1, as measured by VMT and VHT. Package 1 experiences an average speed of 41.5 miles per hour. Each of the build packages is forecast to have a higher average speed than Package 1. Package 2 has an average speed of 48.5 miles per hour while Package 4 experiences an average speed of 51.9 miles per hour. The Combined Alternative Package (Preferred Alternative) has an average speed of 48.8 miles per hour. The average speeds for the build packages correspond to the amount of additional capacity (both general-purpose and special lanes) added to the US 36 corridor. Speeds tend to increase as capacity is added.

Project Area Arterials[1]

Figure 3.4-6, Arterial Daily Vehicle Miles Traveled, Vehicle Hours Traveled, and Average Speed (Horizon-Year), shows daily VMT, VHT, and average speed for arterials in the study area. Arterial VMT decreases for all build packages compared to Package 1, indicating that some people choose to use US 36 rather than an arterial street because of the additional capacity provided on US 36 in these packages. Arterial VMT and VHT drop slightly relative to Package 1. The change is not large enough to significantly affect arterial average speed.

Highway Travel Times

Table 3.4-4, a.m. Peak-hour Travel Times Eastbound from Boulder to Denver Union Station (Horizon-Year), presents the estimated travel times[2] by vehicle mode for the a.m. peak-hour traveling eastbound between Boulder and DUS. The three packages are compared to the Package 1 travel time for travel in general-purpose lanes and in special lanes.

Table 3.4-4: a.m. Peak-hour Travel Times Eastbound from Boulder to Denver Union Station (Horizon-Year)

Route	Package 1: No Action (Existing + Committed [TIP] Projects)[1] (minutes)	Package 2: Managed Lanes/BRT (minutes)	Package 4: General-purpose Lanes, HOV, and BRT (minutes)	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT (minutes)
General-purpose lanes	52	46	43	44
Special lanes	32	24	24	24

Source: US 36 Mobility Partnership, 2009.

Notes:

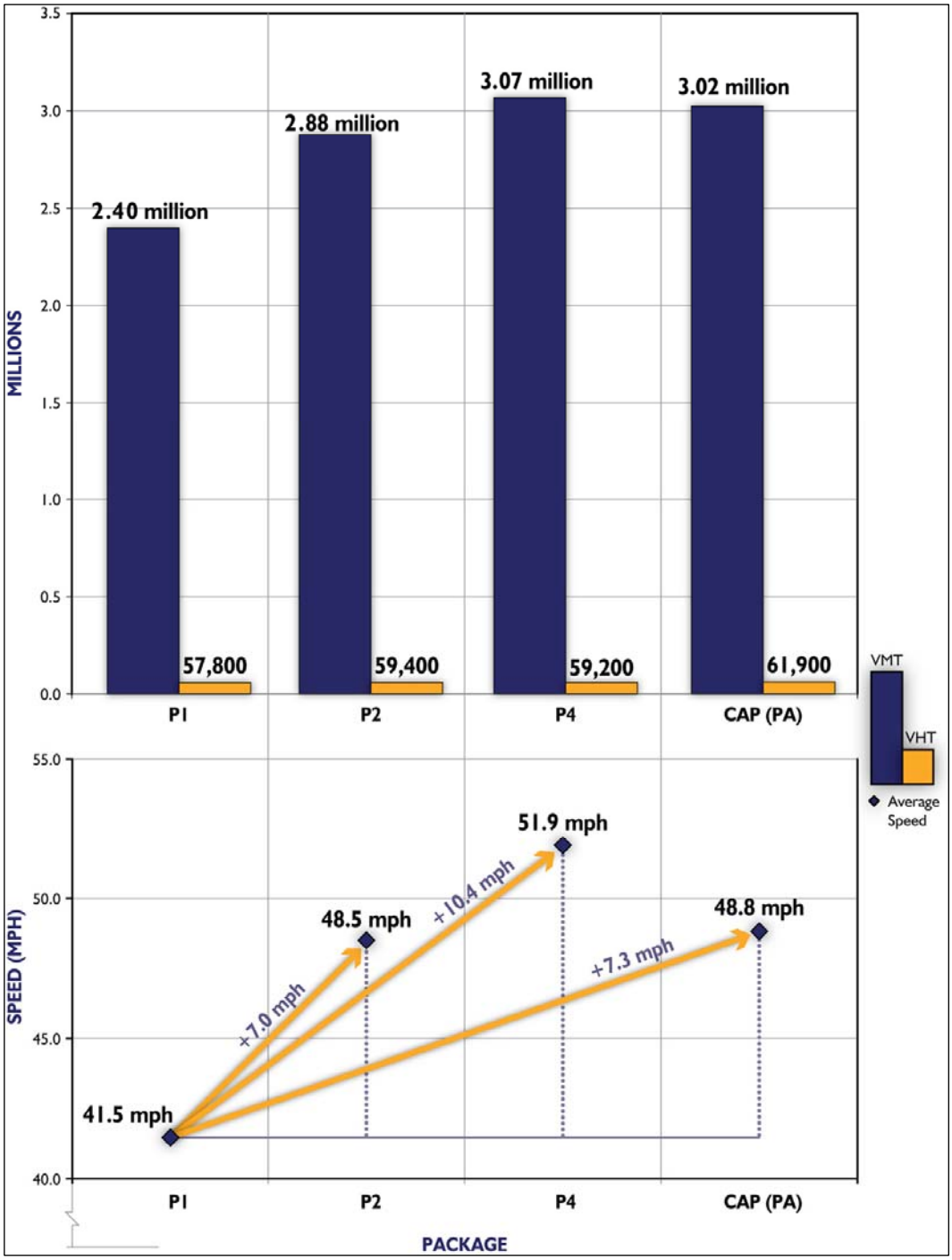
[1]Special lanes are only available in the easternmost segment of the corridor.

a.m. = morning
BRT = bus rapid transit
HOV = high-occupancy vehicle
TIP = Transportation Improvement Program

[1] Arterials include expressways, major arterials, and minor arterials.

[2] Package 2 and Package 4 travel times have been updated since the Draft Environmental Impact Statement based on a refined methodology used to ensure comparability across the packages.

Figure 3.4-5: US 36 Daily Vehicle Miles Traveled, Vehicle Hours Traveled, and Average Speed (Horizon-Year)

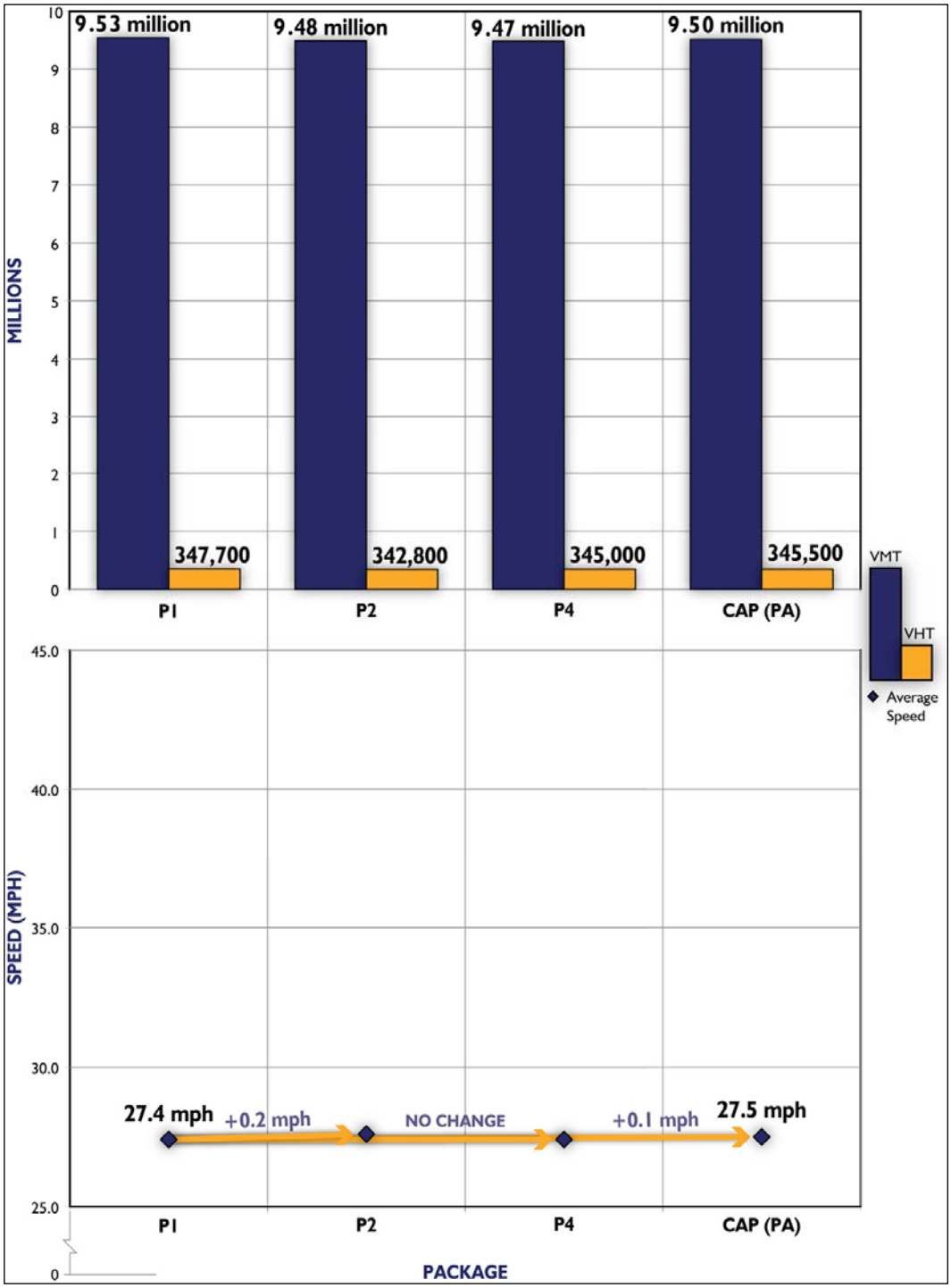


Source: US 36 Mobility Partnership, 2009.

Note:

Package 2 and Package 4 vehicle miles traveled and vehicle hours traveled measures have been adjusted to reflect 2035 conditions to provide a direct comparison with Package 1 (No Action) and the Combined Alternative Package (Preferred Alternative).

Figure 3.4-6: Arterial Daily Vehicle Miles Traveled, Vehicle Hours Traveled, and Average Speed (Horizon-Year)



Source: US 36 Mobility Partnership, 2009.

Note:

Package 2 and Package 4 vehicle miles traveled and vehicle hours traveled measures have been adjusted to reflect 2035 conditions to provide a direct comparison with Package 1 (No Action) and the Combined Alternative Package (Preferred Alternative).

All build packages show travel time savings compared to Package 1 for all route options.

General-purpose Lanes: General Traffic

For general traffic using the general-purpose lanes on US 36, Package 2 would result in a 6 minute travel-time savings between Table Mesa park-n-Ride and DUS, Package 4 would result in an 9 minute travel-time savings, and the Combined Alternative Package (Preferred Alternative) would have an 8 minute travel-time savings over the same section.

Overall, Package 2 would improve travel time in the general-purpose lanes by 12 percent while Package 4 would improve the travel time by 17 percent, and the Combined Alternative Package (Preferred Alternative) would improve travel time by 15 percent over Package 1. Package 4 is likely to have slightly faster travel times than Package 2 and the Combined Alternative Package (Preferred Alternative) because of the additional general-purpose lane capacity.

Special Lanes: Carpools/High-occupancy Vehicles

All carpools (HOV users) could benefit from special lanes in the various packages. Vehicles in Package 1 would still use the general-purpose lanes between Boulder and the entrance to the existing HOV lane just east of Sheridan Boulevard, while the build packages would include special lanes the entire length of the US 36 corridor. Under typical conditions, the special lanes in all build packages are anticipated to operate at free-flow speeds. As a result, all build packages are expected to have a special-lane travel time of 24 minutes. However, free-flow speeds may not always be achieved under CDOT's proposed management strategy. The build packages yield a 25 percent travel time savings over Package 1.

Special Lanes: Single-occupant Toll Vehicles

Toll-paying SOVs eastbound in the a.m. peak-hour would be allowed in managed lanes in Package 2 and the Combined Alternative Package (Preferred Alternative) only. As described above, managed lane users in both packages are forecast to have a travel time of 24 minutes. Package 2 has two managed lanes in each direction with a limited number of access points, and the Combined Alternative Package (Preferred Alternative) has one managed lane in each direction with more access points.

Level of Service

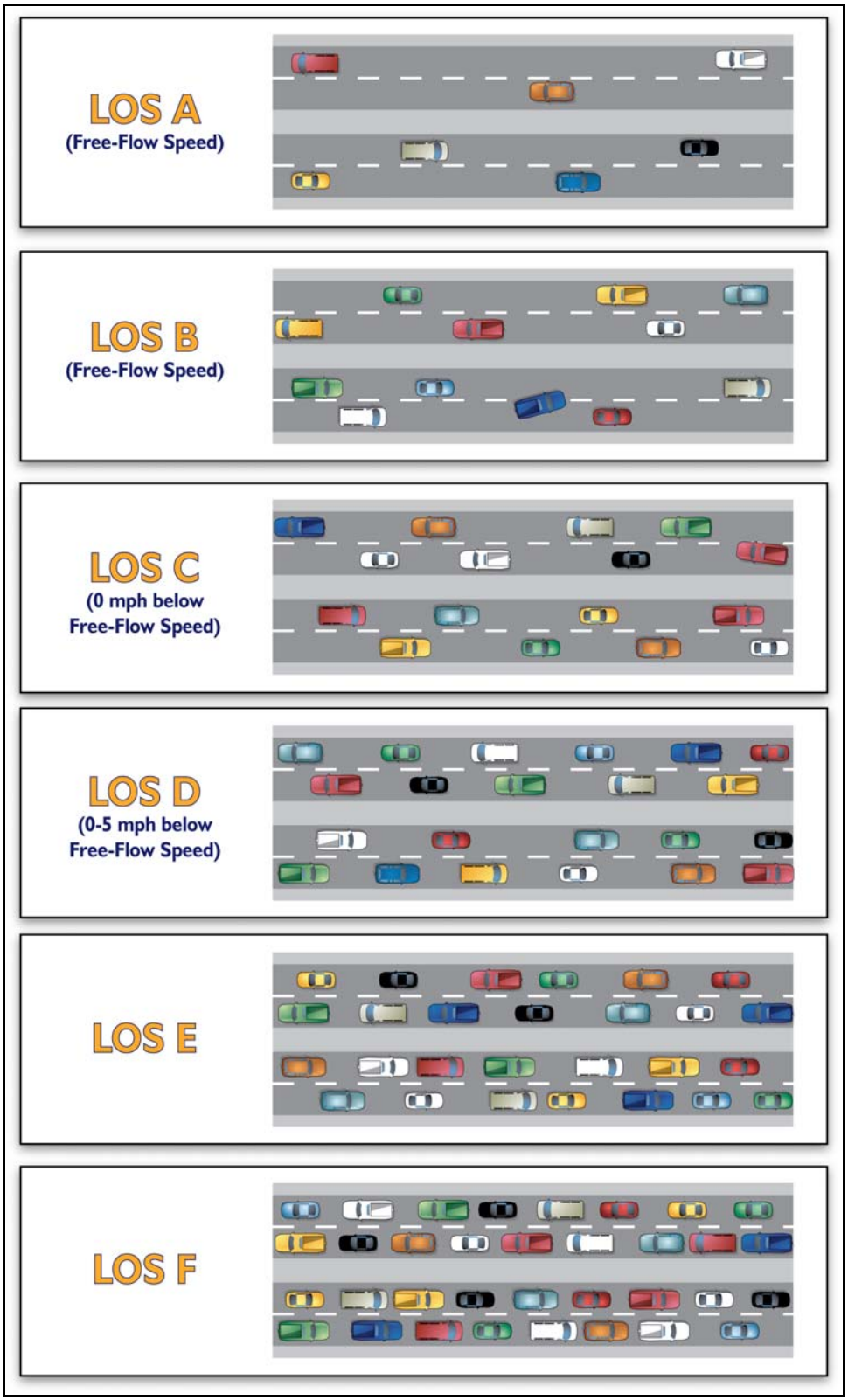
LOS is a widely used measure of congestion that employs letter grades from A through F to describe the amount of traffic congestion on a given section of road at a given time. LOS are described in Table 3.4-5, Roadway Segment Level of Service Descriptions, and are graphically depicted in Figure 3.4-7, Typical Roadway Congestion Levels for Each Level of Service Grade.

Table 3.4-5: Roadway Segment Level of Service Descriptions

LOS	Description
A/B	Free-flowing conditions; usually rare during peak-hours on urban highways.
C/D	Somewhat restricted but still satisfactory conditions. (CDOT has established a desired goal for peak-hour operations on urban highways of LOS D or better.)
E	Traffic densities are such that speeds are reduced but still mostly stable, and lane change activity could be considered difficult.
F	Stop-and-go conditions; the roadway is considered "failing" from an operational standpoint.

Source: CDOT, 2000.
Notes:
CDOT = Colorado Department of Transportation
LOS = level of service

Figure 3.4-7: Typical Roadway Congestion Levels for Each Level of Service Grade



Source: CDOT, 2000.

The quality of highway transportation service is measured by the LOS in the a.m. peak-hour and p.m. peak-hour. The CDOT desired LOS for peak-hour urban highway operations in general-purpose lanes is LOS D, meaning that any segment at LOS E or F should be considered deficient.

The LOS in special lanes is also measured based on forecast average volume per lane. The special lane operations described here meet the CDOT special-lane management strategy. This level of travel operations would provide more reliable travel times.

For a segment of freeway, the average volume per lane and LOS are typically related. As the volume per lane increases, the LOS decreases. Table 3.4-6, US 36 a.m. Peak-hour Mainline Levels of Service and Average Volume per Lane, and Table 3.4-7, US 36 p.m. Peak-hour Mainline Levels of Service and Average Volume per Lane, present the LOS and average volume per lane for each segment of US 36 during the a.m. and p.m. peak-hours, for each of the analysis packages. The two tables also summarize the number of roadway sections that would operate at LOS E or F.

Table 3.4-6: US 36 a.m. Peak-hour Mainline Levels of Service and Average Volume per Lane

Segment/Direction	General-purpose Lanes				Special Lanes			
	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)
Eastbound Direction								
Foothills Parkway to McCaslin Boulevard	1,950	1,620	1,290	1,810	N/A	870	350	1,430
McCaslin Boulevard to West Flatiron Circle	2,220	1,600	1,610	1,770	N/A	870	350	1,360
East Flatiron Circle to Wadsworth Parkway	1,060	1,230	1,250	1,270	N/A	960	480	1,060
Wadsworth Parkway to Church Ranch Boulevard	1,530	1,650	1,300	1,430	N/A	960	600	890
Church Ranch Boulevard to Sheridan Boulevard	1,750	1,710	1,430	1,540	N/A	1,370	680	1,040
Sheridan Boulevard to Federal Boulevard	2,790	2,340	1,930	2,200	N/A	1,370	720	980
Federal Boulevard to Pecos Street	2,090	1,940	1,710	1,900	1,120	1,370	720	1,040
Pecos Street to Broadway	2,220	1,950	2,130	1,580	1,330	1,620	720	1,040
Westbound Direction								
Broadway to Pecos Street	1,440	1,530	1,550	1,690	N/A	480	320	N/A
Pecos Street to Federal Boulevard	1,520	1,130	1,250	1,750	N/A	1,130	320	N/A
Federal Boulevard to Sheridan Boulevard	1,730	1,490	1,590	1,920	N/A	1,130	780	910
Sheridan Boulevard to Church Ranch Boulevard	1,920	2,350	1,560	1,840	N/A	1,350	820	920
Church Ranch Boulevard to Wadsworth Parkway	1,840	1,880	1,560	1,710	N/A	1,350	820	1,150
Wadsworth Parkway to East Flatiron Circle	1,490	1,830	1,800	1,770	N/A	1,160	820	1,120
West Flatiron Circle to McCaslin Boulevard	1,970	2,090	1,690	1,400	N/A	1,160	820	1,100

Table 3.4-6: US 36 a.m. Peak-hour Mainline Levels of Service and Average Volume per Lane

Segment/Direction	General-purpose Lanes				Special Lanes			
	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)
McCaslin Boulevard to Foothills Parkway	1,930	2,180	1,710	1,300	N/A	1,080	630	960
Number of Sections Operating at LOS E or LOS F	9	8	4	5	0	0	0	0

Source: US 36 Mobility Partnership, 2009.

Notes:

LOS are color-coded to facilitate comparison between packages.

a.m. = morning
LOS = level of service
N/A = not available

white shading = LOS B or C
green shading = LOS D
yellow shading = LOS E
red shading = LOS F

Table 3.4-7: US 36 p.m. Peak-hour Mainline Levels of Service and Average Volume per Lane

Segment/Direction	General-purpose Lanes				Special Lanes			
	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)
Eastbound Direction								
Foothills Parkway to McCaslin Boulevard	1,880	1,920	1,580	1,830	N/A	1,340	630	970
McCaslin Boulevard to West Flatiron Circle	2,080	1,330	1,590	1,520	N/A	1,190	850	910
East Flatiron Circle to Wadsworth Parkway	1,480	1,690	1,690	1,640	N/A	1,190	850	1,050
Wadsworth Parkway to Church Ranch Boulevard	1,740	1,710	1,430	1,570	N/A	1,400	960	1,040
Church Ranch Boulevard to Sheridan Boulevard	1,770	1,790	1,490	1,680	N/A	1,400	960	1,070
Sheridan Boulevard to Federal Boulevard	2,130	2,090	1,650	2,130	N/A	1,310	880	710
Federal Boulevard to Pecos Street	1,550	1,440	1,410	1,520	N/A	1,310	940	700
Pecos Street to Broadway	1,620	1,350	1,680	1,350	N/A	740	360	N/A
Westbound Direction								
Broadway to Pecos Street	1,620	1,880	1,900	1,740	1,000	1,220	1,140	1,000
Pecos Street to Federal Boulevard	1,450	1,530	1,420	1,730	1,110	1,220	1,140	730
Federal Boulevard to Sheridan Boulevard	2,120	1,720	1,590	1,900	N/A	1,220	1,180	830
Sheridan Boulevard to Church Ranch Boulevard	2,320	2,290	1,520	1,710	N/A	1,030	770	660

Table 3.4-7: US 36 p.m. Peak-hour Mainline Levels of Service and Average Volume per Lane

Segment/Direction	General-purpose Lanes				Special Lanes			
	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)	Package 1	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)
Church Ranch Boulevard to Wadsworth Parkway	2,190	1,810	1,370	1,550	N/A	1,030	770	750
Wadsworth Parkway to East Flatiron Circle	1,550	1,380	1,360	1,520	N/A	1,030	770	640
West Flatiron Circle to McCaslin Boulevard	2,350	2,190	1,690	1,640	N/A	650	580	870
McCaslin Boulevard to Foothills Parkway	2,170	1,820	1,360	1,350	N/A	650	580	660
Number of Sections Operating at LOS E or LOS F	9	8	1	3	0	0	0	0

Source: US 36 Mobility Partnership, 2009.

Notes:

LOS are color-coded to facilitate comparison between packages.

LOS	=	level of service	white shading	=	LOS B or C
N/A	=	not available	green shading	=	LOS D
p.m.	=	evening	yellow shading	=	LOS E
			red shading	=	LOS F

General-purpose Lanes

Under Package 1, average volumes per lane range from 1,060 vehicles per lane to 2,790 vehicles per lane. The forecast volumes result in nine segments of US 36 operating at LOS E or F during the a.m. peak-hour and nine segments during the p.m. peak-hour. A total of 32 freeway segments were analyzed during both peak-hours. Package 1 operates at LOS E of F in 56 percent of those segments[3].

Package 2 is forecast to serve between 1,130 and 2,350 vehicles per lane. Package 2 is forecast to have 8 segments operating at LOS E or F during the a.m. peak-hour and 8 segments during the p.m. peak-hour. This results in 50 percent of the US 36 segments operating at LOS E or F.

Average volumes per lane for Package 4 range from 1,250 to 2,130 vehicles per lane. Four highway segments are forecast to operate at LOS E or F during the a.m. peak-hour and 1 during the p.m. peak-hour. This equates to 16 percent of the segments operating at LOS E or F under Package 4.

The Combined Alternative Package (Preferred Alternative) is forecast to serve 1,270 to 2,200 vehicles per lane. These forecast volumes result in 5 segments of US 36 operating at LOS E or F during the a.m. peak-hour and 3 segments during the p.m. peak-hour. These 8 segments represent 25 percent of the US 36 segments.

The LOS analysis shows that Package 4 is forecast to have the fewest number of segments operating at LOS E or F (five). The Combined Alternative Package (Preferred Alternative) is forecast to have 8 segments operating at LOS E or F. The additional capacity constructed in the corridor with these two packages allows the forecast travel demands to be served at LOS D or better in most freeway segments.

[3] It is recognized that not all sections are of the same length and number of lanes; performing the same calculation for lane-miles yielded similar results.

The remaining two packages (Package 1 and Package 2) are forecast to have 50 percent or more of the segments operating at LOS E or F. Neither of the packages provides additional capacity in the general-purpose lanes even though travel demands are forecast to be at similar levels as Package 4 and the Combined Alternative Package (Preferred Alternative).

Special Lanes

The special lanes in each package are forecast to operate with less than 1,500 vehicles per lane in all analyzed segments with the exception of the eastbound segments between Pecos Street and Broadway during the a.m. peak-hour in Package 2. CDOT intends to operate the managed lanes along the US 36 corridor with the goals of optimizing the use of the lanes, maximizing travel time savings, and keeping managed lane traffic flowing at 45 miles per hour or faster. To accomplish this goal, CDOT will employ dynamic pricing, in which the toll rate is increased or decreased depending on the levels of congestion necessary to meet the operation goals.

3.4.4 Transportation Need #4: Expand Mode of Travel Options

As discussed in Chapter 1, Purpose and Need, expanded options for mode of travel in the corridor are needed. Providing multi-modal opportunities increases non-SOV mode share and supports a sustainable transportation system.

Travel Time Reliability

Travel time reliability is a useful measure because it refers to the consistency of travel time, regardless of the time of day or day of the week. Congestion and crashes on highways can affect travel time, and therefore, make trips unpredictable. Managed lanes provide greater consistency in travel time and reliability to the users and therefore reduce the need for managed lane users to allow extra time to accommodate unpredictable, congested conditions.

All build packages would improve travel time reliability over Package 1. Because both the number and length of special lanes are increased, the number of general-purpose sections operating at LOS E or F is reduced. Package 1 provides one special HOV lane in each direction for a limited segment of the corridor. Package 2 provides managed lanes in each direction for the length of the corridor. Package 4 and the Combined Alternative Package (Preferred Alternative) provide one BRT/HOV lane or one managed lane in each direction for the length of the corridor.

Package 2 presents the best opportunity for increasing automobile and transit reliability in the US 36 corridor for a number of reasons:

- The types and numbers of vehicles in the managed lanes in Package 2 would be managed through regulation and pricing. CDOT would manage volume levels through dynamic pricing throughout the day. Due to these management actions, travel-time reliability would be much better in Package 2 than in Package 4 or the Combined Alternative Package (Preferred Alternative).
- Two managed lanes would be provided in each direction for a majority of the corridor in Package 2, compared to one BRT/HOV lane in Package 4 and one managed lane in the Combined Alternative Package (Preferred Alternative). The availability of the second lane would allow faster moving vehicles to pass slower traffic. The second managed lane would also provide a bypass in case an incident blocks one of the lanes.
- Package 2 would use a physical barrier to separate the managed lanes from the general-purpose lanes. Standard width shoulders in the managed lane area and in the general-purpose lane area in Package 2 provide space for snow storage, disabled vehicles, and enforcement activities. In Package 4 and the Combined Alternative Package (Preferred Alternative), the inside shoulder adjacent to the BRT/HOV or managed lane would be used by vehicles from all lanes, reducing reliability.

Travel Time Reliability for Transit Vehicles

BRT operations would also be most reliable in Package 2. Based on the reasons listed above, transit vehicles would also benefit from two lanes in each direction, allowing buses to pass slower moving vehicles. The presence of standard shoulders would also benefit BRT operations. Access to and between the managed lanes and median BRT stations would be similar to the Package 4 BRT/HOV lane, but the additional through-managed lane would be available in Package 2 to help buses merge back into and out of the special lanes when leaving BRT stations.

The proposed bus-only continuous auxiliary lane from Davidson Mesa and Table Mesa Drive westbound and from Davidson Mesa to McCaslin Boulevard eastbound in the Combined Alternative Package (Preferred Alternative) could also improve travel time reliability for some transit vehicles if there is general-purpose lane congestion in that segment.

Much of the transit service on US 36 would use special lanes in the build packages. As discussed in the section above, special lanes provide greater consistency in travel time and reliability to the users.

Transit Ridership

Table 3.4-8, Daily Bus Ridership (Horizon-Year), displays the bus ridership forecasts for each of the package components. The daily ridership (the total number of daily route boardings) results are for trips in both directions on an average weekday.

Table 3.4-8: Daily Bus Ridership (Horizon-Year)

Service Type	Package 1: No Action (Existing + Committed [TIP] Projects) (minutes)	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Regional/Express/skyRide[1]	3,400	7,600	7,300	8,200
Activity Center	0	2,500	2,700	2,000
Total	3,400	10,100	10,000	10,200
Change over Package 1 (No Action)				
Regional/Express/skyRide	N/A	+4,200	+3,900	+4,800
Activity Center	N/A	+2,500	+2,700	+2,000
Total Change in Corridor Boardings	N/A	+6,700	+6,600	+6,800
		+197%	+194%	+200%

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]Regional/Express/skyRide ridership includes the routes that provide service along the US 36 corridor (AB, B-All Stops, B-Express, B-Broomfield, DD, DM, H-All Stops, H-Express, L, S, T, 31x, 80x and 86x, as applicable), except the BOLT and J routes which were excluded from the ridership. Package 2 and Package 4 ridership has been updated since the Draft Environmental Impact Statement based on a refined methodology used to ensure comparability across the packages.

% = percent
\+ = increase in ridership compared to Package 1
BRT = bus rapid transit
HOV = high-occupancy vehicle
N/A = not applicable
TIP = Transportation Improvement Program

Package 1 would attract approximately 3,400 bus riders. The Regional/Express/skyRide routes in Package 2 would attract 7,600 riders and the new Activity Center Circulator/Connector (ACCC) routes would attract another 2,500 riders for a total package ridership of 10,100. Package 4 would be similar to Package 2 with 7,300 Regional/Express/skyRide riders and 2,700 ACCC riders for a total of 10,000. The Combined Alternative Package (Preferred Alternative) would be slightly more at 8,200 Regional/Express/skyRide riders and 2,000 ACCC riders (10,200 total).

All build packages show an increase in corridor boardings compared to Package 1. The Combined Alternative Package (Preferred Alternative) assumes one less ACCC bus route than Package 2 and Package 4, explaining the slight decrease in ridership for those routes. Package 2 and Package 4 provide almost identical amounts of transit service (approximately 26,000 service miles) and thus have similar ridership levels. The Combined Alternative Package (Preferred Alternative) provides more service than Package 1 but less than Package 2 and Package 4.

The ridership total for the Combined Alternative Package (Preferred Alternative) is similar to Package 2 and Package 4 despite a slight decrease in proposed transit service. The riders using the ACCC that was eliminated in the Combined Alternative Package (Preferred Alternative) transferred to other regional routes providing similar service.

Transit Station Boardings

Station boardings indicate the relative attractiveness of a transit station (i.e., how much travelers from different areas in the corridor are expected to take advantage of the new transit options). The DRCOG model typically does a better job of predicting boardings by corridor and route type than at the transit station level. Therefore, it is useful to look at the distribution of boardings among transit stations, as well as the change in transit station boardings for the build packages compared with Package 1. Table 3.4-9, Weekday Bus Rapid Transit Daily Boardings (Horizon-Year), shows the BRT and rail daily boardings by transit station for Package 1 and the change over Package 1 for each of the build packages.

Table 3.4-9: Weekday Bus Rapid Transit[1] Daily Boardings (Horizon-Year)

Station	Package 1: No Action (Existing + Committed [TIP] Projects) (minutes)	Change from Package 1 (No Action)		
		Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Boulder Transit Village	10	+210	+220	+150
Boulder Transit Center	190	+80	+90	+140
Boulder Super Stops[2]	270	+380	+410	+380
Table Mesa	200	+320	+340	+290
McCaslin	260	+290	+250	+480
Flatiron	120	+70	+60	+290
Interlocken/ConocoPhillips Stops[2, 3]	0	+250	+240	+720
Broomfield	360	+120	+90	+400
Church Ranch/104th Avenue	110	+210	+240	+300
Westminster Center	410	+400	+400	+620
Broadway	10	+500	+500	+260
Denver Union Station	680	+360	+410	+440

Table 3.4-9: Weekday Bus Rapid Transit[1] Daily Boardings (Horizon-Year)

Station	Package 1: No Action (Existing + Committed [TIP] Projects) (minutes)	Change from Package 1 (No Action)		
		Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Downtown Denver Stops[2]	20	+420	+450	+350
Civic Center	10	+290	+310	+130
Total	2,650	+3,900	+4,010	+4,950

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]BRT routes include: AB, B-All Stops, B-Express, B-Broomfield, DD, DM, H-All Stops, H-Express, L, S, T, activity center connectors, 31x, 80x and 86x, as applicable.

[2]Group of stops.

[3]The Interlocken/ConocoPhillips stops are served by the Activity Center Circulator/Connector routes. In the Combined Alternative Package (Preferred Alternative) these routes were changed to include more stops in the area; this explains the higher number of boardings compared to Package 2 and Package 4.

\+ = increase in boardings compared to Package 1

BRT = bus rapid transit

HOV = high-occupancy vehicle

TIP = Transportation Improvement Program

Note that Table 3.4-8, Daily Bus Ridership (Horizon-Year), includes boardings for all stops for all routes that cross the project area (even if the stop is not within the project area). Meanwhile, Table 3.4-9, Weekday Bus Rapid Transit Daily Boardings (Horizon-Year), only includes certain transit stations of interest within the project area.

US 36 Bicycle/Pedestrian Facility

The US 36 corridor communities have well developed multi-use bicycle networks; bicycle usage for commuting and for recreational purposes is substantial. The US 36 bikeway was developed with the primary objective of providing a bicycle/pedestrian transportation option for users in the US 36 corridor and to provide linkages to other facilities in the corridor. Chapter 2, Alternatives Considered, provides more details on the physical layout of the bikeway.

To meet this objective, the bikeway was designed to provide a direct multi-use connection from Boulder to Denver. The bikeway would also interface with transit facilities and enhance and connect existing local bicycle infrastructure.

All three build packages would include the bikeway as a component.

3.4.5 Transportation Need #5: Efficient Transit Service

Chapter 1, Purpose and Need, identifies the need for more efficient transit service in the corridor. Transit service can benefit from a separate lane or guideway because the reliability of travel times is increased and the travel time can be competitive with automobile travel times. Indicators of more efficiency in a transit system can include an increase in riders per service mile and increase in riders per service hour.

Automobile versus Transit Travel Times

One of the ways transit can be competitive with the automobile is by providing faster travel times. Faster transit travel times are often achieved by operating in a dedicated or shared ROW, such as the HOV and high-occupancy toll (HOT) lanes proposed for US 36. Use of the special lanes for bus routes that provide service along the corridor is determined in large part by whether or not the bus is serving ramp stops or median BRT stations. Table 3.4-10, Transit Operations Comparison Eastbound from Boulder to Denver Union Station (Horizon-Year) presents the transit operational characteristics and the resulting travel times for the a.m. peak-hour in the eastbound direction between Boulder and DUS. As shown in the table, Package 1 and the Combined Alternative Package (Preferred Alternative) assume ramp stops, and Package 2 and Package 4 assume median BRT stations.

Table 3.4-10: Transit Operations Comparison Eastbound from Boulder to Denver Union Station (Horizon-Year)

Characteristic	Package 1: No Action (Existing + Committed [TIP] Projects) (minutes)	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Transit Stops (Median/Ramp Stops)	Ramp stops	Median	Median	Ramp stops
All Stops Bus				
Alignment	General-purpose until Sheridan Boulevard, then HOV	Managed lanes the entire way	HOV/BRT lanes the entire way	Auxiliary lanes until Sheridan Boulevard, then managed lanes
Travel Time (minutes)[1]	40	26	26	35
Travel Time Savings Compared to Package 1 Automobile (General Traffic) (minutes)	12	26	26	17
Express Bus				
Alignment	General-purpose until Sheridan Boulevard, then HOV	Managed lanes the entire way	HOV/BRT lanes the entire way	Bus-only auxiliary lane until McCaslin Boulevard, then managed lanes
Travel Time (minutes)[1]	34	24	24	26
Travel Time Savings Compared to Automobile (General Traffic)	18	28	28	26
Package 1 Automobile Travel Time (General Traffic) (minutes)	52	52	52	52

Source: US 36 Mobility Partnership, 2009.

Notes:

[1] Travel times are "in-vehicle" travel times expressed in minutes.

BRT = bus rapid transit
HOV = high-occupancy vehicle
TIP = Transportation Improvement Program

All Stops Bus

The All Stops buses serve most of the park-n-Rides along the US 36 corridor[4]. For the eastbound buses to access the ramp stops, it was assumed that the buses would remain in the general-purpose lanes and/or auxiliary lanes; they would not be able to use the special lanes until the reversible section of US 36 that feeds into the I-25 HOT lanes. At each ramp stop, congestion delay and dwell time were added to the total travel time of the route. It was assumed that the ramp stop locations would provide queue jumps and ramp meter bypasses to reduce overall delay for the buses. Under the median BRT station configuration, the All Stops buses would serve the stations and remain in the special lanes throughout the corridor. A dwell time at each stop was added to the total travel time at each median station stop.

These differences are reflected in the travel times: Package 1 is expected to have a travel time of 40 minutes with the Combined Alternative Package (Preferred Alternative) at 35 minutes. Package 2 and Package 4 are expected to have travel times of 26 minutes and 26 minutes, respectively. The median BRT stations allow Package 2 and Package 4 to provide the most competitive All Stops service compared to general traffic.

All Stops buses are planned to operate at longer headways during the peak periods compared to express buses and few passengers are expected to ride an All Stops bus the entire length of the corridor. The travel times are presented for comparison purposes among the different travel options within the corridor.

Express Bus

As with the All Stops buses, Package 2 and Package 4 eastbound express buses would operate in special lanes the entire length of the corridor and would benefit from the travel time savings. Package 1 express bus routes would operate mostly in the general-purpose lanes, and enter the reversible section of US 36 that feeds into the I-25 HOT lanes at Sheridan Boulevard. Combined Alternative Package (Preferred Alternative) express bus routes would use the general-purpose lanes to serve the McCaslin ramp stop and would then enter the special lanes at West Flatiron Circle for the remainder of the corridor.

Package 2 and Package 4 express buses would offer a 28-minute time savings over general traffic travel in Package 1. Express buses under the Combined Alternative Package (Preferred Alternative) would expect a 26-minute travel time savings compared to general traffic travel. Express bus travel times are forecast to be 1 to 2 minutes longer than special lane travel times since routes must stop at the McCaslin Station. The delay associated with this stop adds time to the total route travel time.

The Purpose and Need included a criterion that express buses should experience a travel time savings of 1 minute per mile compared to the general traffic travel time for Package 1. The distance from Table Mesa Drive to DUS is approximately 26 miles. Express buses, therefore, should display a 26-minute time savings compared to general traffic. The analysis in Table 3.4-10, Transit Operations Comparison Eastbound from Boulder to Denver Union Station (Horizon-Year), shows an average time savings of 26 to 28 minutes for express buses compared to general traffic travel time forecasts in Package 1. Each of the build packages meets the Purpose and Need.

University of Colorado Access Bus Operations

The two alternatives to provide access to the University of Colorado, Boulder South Campus have different impacts on bus access to the Table Mesa Station. Under the Combined Alternative Package (Preferred Alternative), buses would have to use a slip-ramp from Loop Drive to access the Table Mesa Station on the south side of US 36. This introduces a series of traffic conflicts between buses and other vehicular traffic, as all buses from Table Mesa Drive would have to turn onto Loop Drive and then immediately turn left onto the ramp to the Table Mesa Station. Due to the relatively short distance

[4] The B and H All Stops routes serve the Table Mesa, McCaslin, FlatIron Crossing, Broomfield, Church Ranch, and Westminster Center stations.

between the bus access ramp and Table Mesa Drive, buses turning left onto the access ramp may be delayed by the northbound queues on Loop Drive. A potential solution to this delay would be bus transit priority control at this location.

The Local Streets Option is expected to be more favorable to buses accessing the Table Mesa Station since all buses on Table Mesa Drive would turn directly onto the station ramp and would have fewer conflicts with other vehicular traffic. See Appendix A, Corridor Reference Maps, for drawings showing both alternatives at this location.

Bus Boardings per Mile and Bus Boardings per Hour

One way of comparing the efficiency of a bus system is to look at the number of boardings compared to the service provided in terms of miles and hours. The service miles and hours take into account both the frequency of routes, as well as the route lengths. Table 3.4-11, Daily Bus Rapid Bus Boardings per Mile, Boardings per Hour (Horizon-Year), shows the boardings per mile and boardings per hour for Regional, Express, skyRide, and ACCC routes in the US 36 corridor for the four packages. As shown in the table, all build packages provide more efficient transit service than Package 1. The Combined Alternative Package (Preferred Alternative) provides the most efficient bus service with 0.5 boarding per mile. Package 2 and Package 4 serve 0.4 boarding per mile. Furthermore, the Combined Alternative Package (Preferred Alternative) has 15.0 boardings per hour, compared to 11.6 boardings per hour under Package 2 and Package 4. The Combined Alternative Package (Preferred Alternative) is expected to do the best job at meeting the transportation need for increasing the efficiency of bus service.

Table 3.4-11: Daily Bus Rapid Bus Boardings per Mile, Boardings per Hour (Horizon-Year)

Service Type	Package 1: No Action (Existing + Committed [TIP] Projects) (minutes)	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Total Service Miles (Peak and Off-peak)	9,200	26,000	25,900	18,800
Change over Package 1	Absolute	16,800	16,700	9,600
	Percent	183%	182%	104%
Boardings per Mile	0.4	0.4	0.4	0.5
Total Service Hours (Peak and Off-peak)	340	870	860	680
Change over Package 1	Absolute	530	520	340
	Percent	156%	153%	100%
Boardings per Hour	10.0	11.6	11.6	15.0

Source: US 36 Mobility Partnership, 2009.
Notes:
BRT = bus rapid transit
HOV = high-occupancy vehicle
TIP = Transportation Improvement Program

The proposed bus service changes in the build packages are subject to change. Bus service plans for BRT would need to be merged with bus service plans for the Northwest Rail Corridor Project. Bus operations would be phased and commensurate with service standards and ridership growth. RTD makes schedule changes and adjustments several times a year to respond to demand and optimize efficiency. The proposed service changes in the build packages reflect improvements to operations compared to existing service.

Mode Share

Mode share is the percentage of trips carried by each mode of transportation. Mode share at Checkpoint #2 (both directions) was also analyzed. At this location, Package 1 is expected to be approximately 70 percent SOVs, 15 percent carpools, and 15 percent bus use. All build packages are expected to have approximately 60 percent SOVs, 30 percent carpools, and 10 percent bus use. Although the percentage of bus mode share is expected to remain the same, the number of people on buses increases in the build packages because 10 percent applies to a larger total number of users compared to Package 1.

3.4.6 Transportation Need #6: Update Outdated Highway Facilities

Existing roadway facilities need updating to meet current standards in some locations.

The aspects analyzed to assess how well each package meets the need of updating roadways include:

- Updates to outdated transportation facilities
- Safety improvements

Updates to Outdated Transportation Facilities

Structural Sufficiency – The US 36 corridor was originally constructed in the early 1950s. Many of the original roadway structures are still in use and vary in sufficiency. The sufficiency evaluation conducted for the US 36 corridor shows that at least 14 existing structures need to be replaced.

- Ten structures do not meet current standards (functionally obsolete).
- Two structures show substantial structural problems (structurally deficient).
- Two structures cannot handle stormwater flows (hydraulically deficient).

The reconstruction of the highway would replace several of these structures that have outlived their planned life.

South Boulder Creek – The City of Boulder has completed and adopted a study of the South Boulder Creek floodplain. The Federal Emergency Management Agency is currently reviewing draft flood control maps which delineate a new 100-year floodplain. A portion of US 36 would lie within the updated floodplain. None of the build packages includes removal of US 36 from the updated 100-year floodplain.

Safety Improvements

From January 1, 1999 to December 31, 2001, a total of 2,232 crashes were recorded in the US 36 corridor (CDOT 2006). Eight (0.4 percent) of these crashes resulted in fatalities. The crash history shows a rate of about 745 crashes per year. A more detailed assessment is documented in the *SH 36 Freeway Reconstruction Report* (CDOT 2005) and the *Summary of Part II: Evaluation of Proposed Designs from a Safety Standpoint* (CDOT 2006).

Design standards for high-speed facilities have changed since US 36 was originally constructed in the 1950s. The new facilities constructed under the build packages would meet current design standards which would improve highway operations and provide higher levels of safety. CDOT studies of multi-lane roadways show that additional lanes result in lower crash rates for a given volume.

The configuration of the managed lanes in relation to the general-purpose lanes along US 36 may also impact corridor safety. The two managed lanes in each direction under Package 2 would be barrier separated from the general-purpose lanes. The managed lanes in Package 4 and the Combined Alternative Package (Preferred Alternative) will be buffer separated. Considering these configurations, Package 2 could be viewed as two separate highways in each direction composed of two lanes each. Conversely, Package 4 and the Combined Alternative Package (Preferred Alternative) could be

considered a single, four-lane highway in each direction. Package 2 would be expected to have fewer crashes over time compared to Package 4 and the Combined Alternative Package (Preferred Alternative).

3.4.7 Summary of How the Packages Meet the Transportation Needs of the Corridor

The three build packages show an improvement over Package 1 for all elements discussed in the preceding sections, and in many cases they would have similar transportation operation outcomes in the corridor.

Overall, each build package demonstrates aspects of performance better than the other two build packages. Package 2 performs slightly better in terms of access points, travel-time reliability, and safety. Package 4 is expected to allow higher volumes with slightly better travel times and less congestion in the general-purpose lanes. The Combined Alternative Package (Preferred Alternative) provides more efficient transit service while matching the other build packages in additional capacity and levels of congestion.

1. **Increase Trip Capacity –** Each build package would provide a similar number of lanes through the use of auxiliary, general-purpose and managed lanes. Person-trip capacity would be similar for Package 2 and the Combined Alternative Package (Preferred Alternative) but would be less than the capacity in Package 4. The number of travel lanes in all build packages would be doubled from Package 1 through most of the corridor. Differences in the person-trip capacity that exist between the build packages result from the operating principles applied to the lanes.

   In Package 2 the managed lanes would be open to transit and carpools for free, and would also allow SOV use for a toll. The lanes would be managed to maintain free-flow conditions to ensure reliable travel time. Package 2 includes two managed lanes in each direction. Package 2 does not include an increase in general-purpose lane capacity.

   By contrast, Package 4 has one BRT/HOV lane in each direction, that would not be open to toll vehicles, and an additional general-purpose lane in each direction for most of the length of the corridor. This configuration allows for greater capacity in the general-purpose lanes and higher traffic volumes overall.

   The Combined Alternative Package (Preferred Alternative) would provide one managed lane in each direction open to transit, carpools and tolled vehicles, similar to Package 2. Auxiliary lanes would also be added between each pair of interchanges adding general-purpose lane capacity between interchanges. This combination of lanes provides additional capacity similar to Packages 2 and 4.

2. **Expand Access –** The reconstruction of US 36 that would take place in the build packages would reconstruct several interchanges within the corridor and upgrade and modify many of the remaining interchanges. Access to activity centers and other uses in the corridor would be improved with added capacity on cross-streets and additional interchange elements, resulting in increased capacity and reduced vehicle delay. Overall intersection delays at interchanges would be reduced in most locations for all build packages compared to Package 1. Package 2 would add two access points to the highway system at drop-ramp locations in Westminster and Broomfield. The distribution of trips accessing the highway via drop-ramps would reduce volumes at the adjacent interchanges on Sheridan Boulevard and at Wadsworth Parkway, respectively.

3. **Congestion Relief –** Measures of VMT and VHT are forecasted to increase with the build packages; however, VMT is projected to increase at a faster rate than VHT such that the average speed on US 36 would be noticeably higher with all of the build packages. Package 4 is forecast to provide the fastest average travel speed while Package 2 is forecast to have the slowest average speed of the build packages.

Overall VMT and VHT on the arterials would remain relatively constant under the build packages compared to Package 1. Average speed on corridor arterials would remain unchanged under all packages indicating the highway and transit improvements in the build packages would not increase congestion on the local street system compared to Package 1.

The build packages are forecast to reduce the travel time from Boulder to DUS by 5 to 8 minutes using the general-purpose lanes on US 36 and I-25, compared to Package 1. Similar time savings are expected for vehicles using the proposed managed lanes. Managed lane travel times are estimated to be 11 to 12 minutes faster than general-purpose travel under all packages. Overall, Package 4 is forecast to have the shortest travel times, while the Combined Alternative Package (Preferred Alternative) is expected to have the longest travel times of the three build packages, although the differences compared to the other build packages are slight.

Each of the build packages is forecast to serve similar vehicular volumes on a per lane basis, ranging from 1,200 to 2,300 vehicles per lane. Package 1 is forecast to serve as much as 2,700 vehicles per lane. Package 1 is forecast to have 18 of 32 mainline segments operate at LOS E or F during the a.m. and p.m. peak-hours. Package 2 is expected to have 16 segments operate at the same levels. Conditions improve under Package 4 and the Combined Alternative Package (Preferred Alternative). The Combined Alternative Package is forecast to have 8 segments operate at LOS E or F while Package 4 is forecast to have only 5 segments. Package 4 provides the best LOS operations of the build packages.

4. **Expand Mode of Travel Options –** All build packages provide expanded modal options. Proposed bus services would be similar for each of the build packages, resulting in similar levels of bus ridership. Bus route utilization of the proposed special lanes would vary between packages. In Package 2, buses would only be able to access the managed lanes at the ends of the US 36 corridor as well as at the drop-ramp locations. Routes in Package 4 would be able to access the BRT/HOV lanes from the ends of the corridor as well as through slip-ramps from the general-purpose lanes at a few locations along the corridor. Buses in the Combined Alternative Package (Preferred Alternative) would be able to access the managed lanes at each interchange using slip ramps from the general-purpose lanes.

   BRT operations would be more reliable under Package 2. Buses would benefit from two managed lanes in each direction, allowing buses to pass slower moving vehicles, as well as aid in the merging of buses into the managed lane at median BRT stations. In each build package, the special lanes would aid in providing more reliable bus service travel times between Boulder and Denver.

   In addition, each build package includes a bikeway along US 36 from Bradburn Boulevard west to Foothills Parkway/Table Mesa Drive.

5. **Efficient Bus Service –** Improvements to the highway facilities would result in improved bus operations compared to Package 1. As the highway is reconstructed, BRT stations would be built in the median under Package 2 and Package 4, providing a substantial level of priority for buses and reducing travel times on the highway. BRT stations would be built on ramps to serve park-n-Ride facilities under the Combined Alternative Package (Preferred Alternative).

   Corridor bus ridership is forecast to increase in all three build packages compared to Package 1. Each build package is expected to serve approximately 10,000 bus passengers on a daily basis. The build packages are also forecast to provide an increased number of service miles compared to Package 1 as well. Based on a comparison of service miles and bus passengers, the Combined Alternative Package (Preferred Alternative) provides the most efficient bus service with 0.5 boarding per mile. Package 2 and Package 4 serve 0.4 boarding per mile. Furthermore, the Combined Alternative Package (Preferred Alternative) has 15.0 boardings per hour, compared to 11.6 boardings per hour under Package 2 and Package 4. All build packages provide more efficient transit service than Package 1.

6. **Update Outdated Highway Facilities –** Each build package would upgrade the highway to current design standards. Many areas of the US 36 corridor still utilize structures and geometry from the original construction in the early 1950s. Reconstruction would modernize the highway and provide a safer operating environment by implementing the updated standards for high-speed facilities.

   Safety studies by CDOT have shown that crash rates on multi-lane freeways go up with the addition of more lanes. Given the proposed geometry and cross section, each build package would have different safety characteristics. Package 2 would operate as separate two-lane roadways in each direction within the highway envelope because of the barrier separation between the managed lanes and the general-purpose lanes. Package 4 and the Combined Alternative Package (Preferred Alternative) would have four lanes in each direction for most of the corridor with no separation since the managed lanes would be buffer separated. This would likely result in Package 2 having fewer crashes over time than Package 4 or the Combined Alternative Package (Preferred Alternative).

The overall observation that can be drawn from these comparisons is that three approaches are available to make improvements in the US 36 corridor. Package 2 offers a facility that would allow travel demands and operations to be managed to encourage use of a variety of modes including general-purpose lane, managed lane SOV for a fee, BRT, and HOV. Choices would be available to travelers in the corridor according to their individual needs. The result would be long-term travel-time reliability and increased safety.

Package 4 provides a similar number of new lanes but would use the traditional approach of roadway expansion to meet demand. One BRT/HOV lane would be provided in each direction for HOVs and to improve BRT operations. A general-purpose lane would also be added for much of the corridor length to serve projected travel demands. Analysis of traffic operations for Package 4 indicates the general-purpose lanes would likely operate at acceptable levels of service along most segments of the highway.

The Combined Alternative Package (Preferred Alternative) would provide a similar number of lanes as the other two build packages; however, auxiliary lanes between each set of interchanges would provide operational efficiencies allowing each segment of US 36 to serve more general traffic. Proposed bus service would operate at the most efficient level with the Combined Alternative Package (Preferred Alternative) compared to the other two build packages. In addition, all other operational characteristics are equal to or very similar to the other two build packages.

3.5 TRANSPORTATION IMPACTS AND MITIGATION

3.5.1 Interchange and Transit Station Traffic Impacts

This section summarizes the LOS results for the intersections at the US 36 interchanges based on the travel demand forecast results for each package. The interchanges are also the general location for the proposed transit stations. Therefore, the traffic analysis of intersections in the interchange influence areas includes traffic generated by the transit stations. This area of impact evaluation relates to Transportation Need #2, Expand Access.

Intersection LOS was used to measure transportation impacts at intersections. Intersection LOS is similar to roadway LOS in that letter "grades" A through F are used to convey the amount of traffic congestion on a given section of road at a given time. The difference is that roadway LOS is determined based on free-flow speed and traffic density, and intersection LOS is determined based on overall average delay (per vehicle) experienced at the intersection. The delay thresholds used in intersection LOS analysis are shown in Table 3.5-1, Intersection Level of Service Thresholds.

Table 3.5-1: Intersection Level of Service Thresholds

LOS	Delay (seconds/vehicle)	
	Signalized	Unsignalized
A	0-10.0	0-10.0
B	10.1-20.0	10.1-15.0
C	20.1-35.0	15.1-25.0
D	35.1-55.0	25.1-35.0
E	55.1-80.0	35.1-50.0
F	80.1 or more	50.1 or more

Source: CDOT, 2000.
Note:
LOS = level of service

The following methodology was used to determine if the packages would create an impact at an intersection:

1. Intersection LOS was calculated for Package 1.
2. Intersection LOS was calculated for all build packages and compared to Package 1 LOS.
3. If the LOS degraded from LOS D or better under Package 1, to LOS E or LOS F in a build package, or if the overall delay at LOS F increased as a result of the build package, then the package was determined to have an impact.
4. Mitigation of the impact was considered if the LOS degraded to LOS E or LOS F, or if the average delay per vehicle increased more than 15 percent and the intersection operated at LOS F in the build package. The change in delay of 15 percent was used to recognize the precision of the forecast and the analysis tools. Estimation of increased delay at an intersection at LOS F is subject to this level of accuracy. Therefore, a level of 15 percent change in average delay per vehicle was used at LOS F to determine if mitigation treatment was warranted.

Serving as the primary access points for US 36, the interchanges and major adjacent intersections are key elements of this project. Successful operation at these intersections is important to the corridor for the following three reasons:

1. Off-ramps that do not operate well due to poor signal operations risk developing queues that extend back onto the highway; this could result in safety concerns and compromise highway operations.
2. On-ramps that do not operate well could limit the utility of the highway by preventing traffic desiring to use US 36 from accessing it efficiently.
3. Transit stations would be located at most major interchanges from Sheridan Boulevard to the west. Improvements to interchange intersections would also improve access to transit facilities.

Table 3.5-2, Interchanges with Intersections Operating at LOS E or LOS F (Horizon-Year), shows the number of intersections at each interchange that would operate at LOS E or F for each package. For more detail on each local interchange, including impacts and mitigation, analysis and results, see the *Interchange and Station Area Intersection Impacts and Mitigation Technical Report* (URS 2007a) and *Traffic Engineering Technical Report Addendum* (URS 2009).

Table 3.5-2: Interchanges with Intersections Operating at LOS E or LOS F (Horizon-Year)

Interchange Area	Number of Intersections Operating at LOS E or LOS F (a.m./p.m. Peak-hour)			
	Package 1 (No Action)	Package 2	Package 4	Combined Alternative Package (Preferred Alternative)
Broadway	0/0	0/0	0/0	0/0
Pecos Street	2/1	3/3	3/3	2/1
Federal Boulevard	1/2	2/2	2/2	2/2
Sheridan Boulevard	3/1	1/1	1/1	1/1
Church Ranch Boulevard	1/2	1/1	1/1	1/1
Wadsworth Parkway/120th Avenue	4/4	1/1	1/1	2/1
Interlocken	0/0	0/1	0/1	0/0
McCaslin Boulevard	3/1	1/1	1/1	1/1
Foothills Parkway/Table Mesa Drive	0/0	0/0	0/0	0/0
Total	14/11	9/10	9/10	9/7

Source: US 36 Mobility Partnership, 2009.
Notes:
a.m. = morning
LOS = level of service
p.m. = evening

In comparison to Package 1, the build packages decrease the number of intersections forecast to operate at LOS E or F. Under Package 1, 14 intersections are forecast to operate at LOS E or F during the a.m. peak-hour and 11 during the p.m. peak-hour. Of note is the interchange at Wadsworth Parkway which is forecast to have 4 intersections during both the a.m. and p.m. peak-hours operate at LOS E or F.

Improvements provided in Package 2 and Package 4 reduce the number of intersections forecast to operate at LOS E or F to 9 during the a.m. peak-hour and 10 during the p.m. peak-hour. Both packages forecast similar interchange operations at all access points along the corridor. The Combined Alternative Package (Preferred Alternative) is forecast to have 9 intersections operate at LOS E or F during the a.m. peak-hour and 7 during the p.m. peak-hour.

Many of the intersections forecast to operate at LOS E or F under the build packages are located at the Pecos Street and Federal Boulevard interchanges. Neither of these interchanges was improved under any of the build packages requiring the intersections at these locations to serve higher travel demand resulting from corridor improvements without additional capacity.

Detailed impacts for each interchange location are summarized in the following section.

- **Broadway** – Access to this interchange would be reduced in Package 2, Package 4 and the Combined Alternative Package (Preferred Alternative) with the elimination of the off-ramps from southbound I-25 and from westbound US 36/I-270. Intersection operations would improve compared to Package 1 at the intersections of Broadway with Greenwood Boulevard, the westbound on-ramp, and the eastbound off-ramp. Intersection operations would degrade one level to LOS D at the intersection of Broadway and 70th Avenue in Package 2 and Package 4. Under the Combined Alternative Package operations would improve at this location. The impact assessment included traffic movements that would be accessing the Broadway park-n-Ride at this location.

- **Pecos Street** – Operations would improve in Package 2 at all four intersections in both peak-hours in the Pecos Street interchange area with two exceptions. At Pecos Street/76th Avenue, the delay would increase in the a.m. peak-hour. In the p.m. peak-hour, the delay would increase at the Pecos Street/72nd Avenue intersection. No mitigation is necessary because the delay increase in both locations would be less than 15 percent. Similarly, operations would improve in Package 4 with two exceptions. In the a.m. and p.m. peak-hours, the intersection of Pecos Street/72nd Avenue would exhibit increased delay. The delay increases are below the 15 percent threshold established for mitigation. Operations would improve or remain the same in the Combined Alternative Package (Preferred Alternative) at all four intersections in the Pecos Street complex during the a.m. peak-hour. In the p.m. peak-hour, the delay would increase at the Pecos Street/72nd Avenue intersection and the Pecos Street/76th Avenue intersection. No mitigation is necessary since the delay increase in both locations would be less than 15 percent.

- **Federal Boulevard** – The primary operational concern at this interchange is merging off-ramp traffic within the limited ramp spacing. Intersection operations in all three packages would improve at the Federal Boulevard/westbound on-ramp/Cottonwood Drive and Federal Boulevard/eastbound on-ramp. These locations would operate at LOS C or better during both peak-hours. Under each build package, an impact would occur at the Federal Boulevard/74th Avenue intersection in the a.m. and p.m. peak-hours. Turn-lane additions and lane lengthening were included in the design concept for all build packages. These improvements mitigate the delay increases below the 15 percent threshold, but LOS F would remain. This mitigation has been included in the concept plans for all build packages.

- **Sheridan Boulevard** – This interchange would be reconfigured from its existing configuration in Package 1 to a split-diamond between Sheridan Boulevard and 92nd Avenue in all three build packages. Traffic from the Westminster Center Station is considered in the impact analysis. The distribution of the traffic to and from US 36 would improve operations in all packages along Sheridan Boulevard. The two new ramp terminal intersections on 92nd Avenue would operate acceptably in all packages. Traffic volume would be handled more efficiently in both build packages, reducing delay at most intersections in both peak-hours. A slight increase in delay for Package 2 in the a.m. peak-hour at Sheridan Boulevard/92nd Avenue is forecasted. In addition, a slight increase in delay in the p.m. peak-hour at the Sheridan Boulevard/westbound ramps intersection is forecast. The delay increase would be an impact but would not exceed the 15 percent threshold required for mitigation.

- **Church Ranch Boulevard** – This interchange is a conventional diamond with arterial left-turn storage between and beyond the ramp terminals. The bridge would be widened with an additional lane in each direction for all packages. The traffic from the Church Ranch/104th Avenue Station was considered in the analysis. Operations would improve in all packages in both peak-hours with the added capacity on Church Ranch Boulevard. Intersection LOS would improve or delay and would be reduced at each of the four intersections in this complex.

- **Wadsworth Parkway/120th Avenue** – The proposed reconfiguration of this interchange would provide a partial cloverleaf at Wadsworth Parkway tied to a half-diamond on- and off-ramp to and from the east at the 120th Avenue overpass of US 36. Impacts were also evaluated at the Wadsworth

Parkway intersections with State Highway (SH) 128/120th Avenue, and with Midway Boulevard. The partial cloverleaf combined with the 120th Avenue half-diamond configuration would result in a substantially improved LOS at all but one of the intersections in the area for all three build packages in both peak-hours. The traffic analysis included volumes in the area that would be generated by the 116th Avenue Station. Impacts from increased delay would occur at the Wadsworth Parkway/Midway Boulevard intersection from project traffic volumes. Additional lanes on Wadsworth Parkway south of Midway Boulevard, and signal timing changes would mitigate the impacts to less than a 15 percent increase in delay in Package 4, but still at LOS F in both peak-hours. The mitigation treatments would improve the Midway Boulevard intersection to LOS D in both peak-hours for Package 2. Combined Alternative Package (Preferred Alternative) conditions would improve to LOS E in the a.m. peak-hour and LOS C in the p.m. peak-hour.

- **Interlocken Loop/East Flatiron Circle/West Flatiron Circle** – None of the build packages contain major additional geometric or operational improvements. With the exception of minor ramp widening to accommodate the US 36 improvements, the interchange complex would be configured much as it is today. Traffic volumes from the Flatiron Station were incorporated in the analysis. All intersections are forecast to operate at LOS D or better during both peak hours in all three build packages.
- **McCaslin Boulevard** – Improvements to McCaslin Boulevard would include an additional lane in each direction on the bridge crossing US 36. Traffic volumes from the McCaslin Station were included in the analysis. The intersection LOS would improve at most locations in the complex. At the McCaslin Boulevard/Dillon Road intersection, LOS F operations would result in impacts for Package 2 and Package 4 in both peak-hours. The proposed mitigation treatment would be the addition of a third westbound left-turn lane, shared with a through-movement. This improvement would still result in LOS F conditions, but the delay would substantially improve for both packages in both peak-hours. Under the Combined Alternative Package (Preferred Alternative) the average delay at the Dillon Road intersection decreases so no mitigation treatment is required.
- **Foothills Parkway/South Boulder Road/Table Mesa Drive** – Improvements in all three build packages to this complex would include reconstruction of the Table Mesa Drive bridge and ramps, and reconstruction of the Foothills Parkway southbound to eastbound ramp. Certain on-ramps from Table Mesa Drive would be removed or reconfigured. Traffic volumes from the Table Mesa Station were included in this analysis. In Package 2, none of the intersections would degrade to an LOS worse than LOS D. In Package 4, some of the five intersections in the complex would degrade LOS, and others would improve or remain the same compared to Package 1 with no intersections operating at worse than LOS D. In the Combined Alternative Package (Preferred Alternative), none of the intersections would exhibit a peak-hour LOS worse than LOS C. The Combined Alternative Package (Preferred Alternative) access to the University of Colorado, Boulder South Campus via Loop Drive is expected to provide better accessibility and have fewer impacts to the surrounding neighborhood compared to the Local Streets Option via Tantra Drive. All local access intersections are expected to operate at LOS D or better under both alternatives.

3.5.2 Impacts of Access Points to Special Lanes

Location of Access Points to Bus Rapid Transit/High-occupancy Vehicle Lanes in Package 4

As discussed in Chapter 2, Alternatives Considered, access to the BRT/HOV lane in Package 4 would be limited to locations where an auxiliary lane could be provided to accommodate weaving traffic entering and exiting the lane. These locations were designed to fit into the highway where interference would not be encountered from movements to and from local interchanges and the median BRT stations. A map of the proposed access points for Package 4 can be found in the package descriptions in Chapter 2.

Concept design for placement of the weaving lane buffer-breaks resulted in two segments where a break could not be located:

- Between the Church Ranch Boulevard interchange and the Wadsworth Parkway/120th Avenue interchange complex. The singular BRT/HOT access would be located half way between the two interchanges (approximately 4,000 feet from each interchange). As a result, (1) the distance for vehicles to enter the highway at Church Ranch Boulevard or at 120th Avenue is too short to allow vehicles to safely weave over three lanes of traffic to enter the BRT/HOV lane; similarly, (2) the distance available to leave the BRT/HOV lane and access the local interchanges is not sufficient to safely cross the general-purpose lanes; and, (3) BRT vehicles would present a conflict with vehicles using a BRT/HOV land access point since the 116th Avenue median station would be located just west of an access point to the general-purpose lanes. HOV vehicles using the access point may not expect maneuvering BRT buses to access the median station in such a short distance.
- Traffic forecasts show that the volume of vehicles attempting to use the BRT/HOV lane west of McCaslin Boulevard would be less than 50 vehicles in the peak-hours. The buffer-break was omitted from this segment because it would widen the roadway for the weaving lane thus impacting more of the sensitive natural resources on Davidson Mesa.

The lack of a buffer-break between Church Ranch Boulevard and Wadsworth Parkway/120th Avenue means that vehicles would need to leave the BRT/HOV lanes in advance of that segment. Westbound vehicles would exit the lanes east of Church Ranch Boulevard and use that interchange or the exit at 120th Avenue to access destinations in the segment. Similarly, eastbound vehicles would need to exit the HOV lanes west of Wadsworth Parkway and exit to that interchange or to Church Ranch Boulevard to access their destinations. Adequate signage would be installed along the BRT/HOV lanes to advise motorists of the upcoming destinations and the need to exit the lanes one interchange in advance of the destination.

The impact of the lack of a buffer-break to enter the BRT/HOV lanes west of McCaslin Boulevard is that priority travel time would not be available for travelers that enter the highway in that segment.

Location of Access Points to Managed Lanes in the Combined Alternative Package (Preferred Alternative)

Access to the managed lane in the Combined Alternative Package (Preferred Alternative) will be provided between each interchange complex. A map of proposed access points for this package can be found in the package description in Chapter 2, Alternatives Considered. Entry and exit points for the managed lane are provided at two separate locations between each interchange along US 36. Typically the entry point into the managed lane is provided approximately 1,500 feet upstream from an interchange complex while the exit point is provided approximately 1,500 feet downstream from an interchange complex. This access configuration typically provides at least 1 mile of distance for vehicles to weave across the general-purpose lanes to enter or exit the managed lanes.

The access points along the segment between Foothills Parkway and McCaslin Boulevard were adjusted to accommodate drivers traveling between Boulder and McCaslin Boulevard, allowing them to use the managed lane. In addition, the spacing of access points between Federal Boulevard and Pecos Street were adjusted to fit geometric conditions along that segment.

3.5.3 Location of Access Points for Package 2

Access to the managed lanes in Package 2 would be through a combination of drop-ramps and slip-ramps depending upon the location in the corridor. Slip-ramps would be used at the east end between I-25 and Pecos Street, and at the west end between West Flatiron Circle and McCaslin Boulevard, for access between the managed lanes and the general-purpose lanes. A map of the proposed drop-ramp locations and access points for Package 2 can be found in the package descriptions in Chapter 2, Alternatives Considered. The following subsections present the rationale for the ramp locations.

Westminster Boulevard Drop-ramp

Westminster Boulevard was identified as the location for drop-ramp access to the managed lanes for several reasons, as follows.

- A separate access point is needed because it would serve only traffic that uses the managed lanes. Adding access to the managed lanes from general-service interchanges such as Sheridan Boulevard would introduce additional traffic to an already congested interchange. The Sheridan Boulevard interchange must serve four types of traffic demands: (1) general-purpose traffic to and from the highway, (2) north/south cross traffic, (3) access to local land uses such as Westminster Center, and, (4) access to bus transit facilities. Addition of a fifth traffic purpose (managed lane traffic) would further complicate interchange operations.
- The location of Westminster Boulevard helps to intercept traffic to and from the managed lanes from the travel shed to the north and west. Trips can be collected and directed to the managed lanes without traveling through the congested area around the Sheridan Boulevard interchange.
- BRT service can enter the managed lanes upstream from the Westminster Center Station. The BRT vehicles would then be able to stop at the median platform for passenger service. Similarly, BRT vehicles would be able to access the managed lanes east of the Church Ranch/104th Avenue Station, and then access the median BRT station.
- Westminster Boulevard ties into 92nd Avenue and then directly south into Westminster Center. These two connections provide convenient access for managed lane users to the future Westminster Center redevelopment site. Because 92nd Avenue is the only continuous east/west arterial to cross US 36 in this area, connection to that roadway would provide continuity for locally-oriented trips.
- An existing bridge over US 36 would be used to provide ramps to and from both the east and the west. Using the existing bridge with some modifications would save cost.

Midway Boulevard Drop-ramp

Reasons for identifying this location include:

- The drop-ramp would provide direct travel to the largest employment center in the corridor at Interlocken Business Park. The managed lanes would be used the most during peak periods when congestion is the highest. Work trips would be the most frequent types of travel in the managed lanes.
- The location fits between the Wadsworth Parkway partial cloverleaf interchange complex and the Interlocken Boulevard/96th Street interchange complex.
- BRT service would be able to enter the managed lanes at this location and then access either the 116th Avenue Station or the Flatiron Station in the median.
- The new bridge would connect an area that is somewhat isolated in Broomfield with the major employment center in the corridor. New development along the north side of US 36 would benefit

from the connection across the highway that does not require traffic to maneuver through a congested interchange area.

Managed Lane Flyover Exit

The number of westbound managed lanes would reduce to a single lane west of the West Flatiron Circle interchange. A flyover exit would carry the other managed lane to the north side of US 36. This lane would then join the West Flatiron Circle on-ramp before merging with the westbound US 36 general-purpose lanes. The managed lane flyover exit is required because heavy traffic volumes are forecasted to access Superior and Louisville through the McCaslin Boulevard interchange, and the volume exiting the managed lanes requires a flyover to avoid congestion in the general-purpose lanes and managed lanes. For the location and illustration of this structure, see Appendix A, Corridor Reference Maps, and the *Traffic Engineering Technical Report* (URS 2007b).

One of the consequences of using drop-ramps is that travel on the managed lanes to and from some of the activity centers in the corridor would not be direct. For example, people desiring to travel to the Broomfield Events Center in the Arista development would need to leave the managed lanes at the Westminster Parkway drop-ramp or the Midway Boulevard drop-ramp and then use local streets to complete the trip. From the Westminster Boulevard drop-ramp, the most direct path would be to follow Westminster Boulevard north past 104th Avenue to 112th Avenue, then use the new crossing of US 36 west into the Arista development site. Similarly, from the Midway Boulevard drop-ramp, traffic would need to follow Interlocken Parkway south to SH 128, turn east to Wadsworth Parkway, then south to the Arista development site.

3.5.4 Impacts of Drop-ramps on Local Street System

Drop-ramps to access the managed lanes would be located at Westminster Boulevard and Midway Boulevard. The drop-ramps would allow buses, HOVs, and tolled SOVs direct access between the managed lanes and local arterials. The ramps would consist of one or more separate lanes in each direction that would transition from the managed lanes up to bridges allowing access to arterial streets. Bypass managed lanes would continue on either side of the drop-ramp lanes. The rationale for the location of the drop-ramps and impacts to local streets at each of the drop-ramp locations are summarized in the following section. In Chapter 2, Alternatives Considered, Figure 2.5-2, Managed Lane/Bus Rapid Transit Slip-Ramp and Drop-ramp Schematic, shows a conceptual drawing of how the drop-ramps operate, and Figure 2.5-3, 70th Avenue Drop-ramp to Interstate 25 Express Lanes, shows an actual drop-ramp.

Westminster Boulevard Drop-ramp Impacts: Traffic Operations on Local Streets

Managed lane traffic would use Westminster Boulevard from several directions:

- From the north via Church Ranch Boulevard/104th Avenue
- From the west via Westcliff Parkway
- From the south via 92nd Avenue/Harlan Street
- From the east via a planned 98th Avenue connection to Sheridan Boulevard

Figure 3.5-1, Origins of Eastbound Managed Lane Trips on Westminster Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year), and Figure 3.5-2, Origins of Westbound Managed Lane Trips on Westminster Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year), illustrate the percentage attraction by direction for vehicles accessing the managed lanes in the a.m. peak-hour. Observations about the distribution of trips include:

Figure 3.5-1: Origins of Eastbound Managed Lane Trips on Westminster Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year)

Figure 3.5-2: Origins of Westbound Managed Lane Trips on Westminster Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year)

- Eastbound trips are attracted from north of US 36 (61 percent), and from south and west of US 36 (39 percent). The distribution is reasonable given the orientation of the travel shed and the local street connections.
- Westbound trips are attracted from the south and east (63 percent), and from the north and east (34 percent). A small amount (3 percent) is attracted from Westminster Boulevard north of Church Ranch Boulevard, indicating some reverse travel would be used to access the lanes.
- Small amounts of trips are attracted from the general-purpose lanes on US 36. In the eastbound direction, 3 percent is diverted, while in the westbound direction, 6 percent would be diverted. Because these levels are less than 10 percent, they are not significant to traffic operations.

Detailed traffic volume forecasts were generated for the area surrounding the drop-ramp in 2030. Traffic forecasts for both the a.m. and p.m. peak-hours and for Package 1 and Package 2 were generated. Observations related to these forecasts consist of:

- Overall volumes that would access the managed lanes appear reasonable. Daily total trips to and from the west would be relatively balanced with volumes of about 2,600 to 2,800 per day entering and exiting the managed lanes. Daily totals to and from the east would be slightly higher entering the managed lanes at 5,800 per day, compared to 3,800 per day exiting to the drop-ramp. The a.m. peak-hour eastbound entering volume would be almost 1,000 vehicles, indicating that the managed lanes offer time-savings in the peak-hour inbound direction on US 36.
- Volumes on Westminster Boulevard would increase north of US 36 and remain about the same south of US 36 as compared to Package 1.
  - North of US 36, the volumes would increase between 50 and 55 percent from about 9,000 average daily traffic to about 13,800 average daily traffic.
  - South of US 36, volumes would increase about 13 percent between the drop-ramp and Westcliff Parkway, and would drop slightly (6 percent) between Westcliff Parkway and 92nd Avenue. Westcliff Parkway would see increases of 200 to 300 vehicles in the peak-hours.
- At the 92nd Avenue/Westminster Boulevard intersection, total entering volumes would be lower (down 18 percent) in the a.m. peak-hour, and about the same in the p.m. peak-hour as Package 1. This means that intersection operations are expected to be similar between Package 1 and Package 2. No impact would occur.
- Daily volumes would be less along 92nd Avenue in Package 2. Volumes would drop from 48,100 vehicles per day east of Westminster Parkway to 45,400 vehicles per day, a decrease of about 6 percent. The decrease is because some volumes would be diverted from the local service interchange at Sheridan Boulevard to the drop-ramp; disconnecting and decreasing overall volumes in the area of the Sheridan Boulevard interchange.
- A new connection to Sheridan Boulevard would be needed via 98th Avenue because about one-third of the traffic volume would access the Westminster Boulevard drop-ramp from 98th Avenue. A new development project is beginning construction south of 98th Avenue and west of Sheridan Boulevard. The development plans to build 98th Avenue as a two-lane road.

Overall traffic operations in the area would benefit from the implementation of the drop-ramp. Peak-period trips would be diverted from major arterials such as Sheridan Boulevard and 92nd Avenue to the drop-ramp, thus relieving operations at intersections and at the interchange with US 36. Volumes would be comparable to existing volumes south of US 36 such that major widening and addition of capacity are not needed. North of US 36 volumes would increase but would not exceed the capacity of Westminster Boulevard or the intersection with 104th Avenue because sufficient turn-lane capacity would be available at that location.

Midway Boulevard Drop-ramp Impacts: Traffic Operations on Local Streets

Managed lane traffic would access the Broomfield/Interlocken employment center on a new bridge over US 36 connecting the north and south sides of the highway. An extension of Midway Boulevard would intersect with Industrial Lane and then rise over the BNSF Railway to cross over US 36 and connect to Interlocken Boulevard on the south side of the highway. The new roadway would need to be located between existing commercial office buildings and associated parking areas.

Midway Boulevard would then offer connections back to Industrial Lane to the east and west, and further east to US 287. Interlocken Boulevard would connect south to SH 128, and west to Interlocken Loop.

Figure 3.5-3, Destinations of Eastbound Managed Lane Trips on Midway Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year), and Figure 3.5-4, Destinations of Westbound Managed Lane Trips on Midway Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year), illustrate the distribution of trips coming to the drop-ramp from the east and the west during the a.m. peak-hour. Observations about the distribution of trips include:

- Westbound trips from the central part of the metropolitan region would access the drop-ramp and would split 62 percent to the south into Interlocken, and 38 percent to the north into the Broomfield employment areas.
- Eastbound trips from Boulder County would access the ramp and split with 41 percent going south to Interlocken, and 59 percent north into Broomfield. The reason this split is different than the westbound distribution is because trips from Boulder County can access the Interlocken employment area at local service interchanges to the west at West Flatiron Circle and at Interlocken Loop. Volumes exiting the managed lanes to the drop-ramp from the west are about one-third the amount exiting from the east.
- The distributions are reasonable for the types of land uses in the area. The diversion of about 900 trips directly to the Interlocken/Broomfield employment core that would be westbound from the central part of the region provide some relief for the Wadsworth Parkway interchange.

Detailed traffic volume forecasts were prepared for the area surrounding the drop-ramp in 2030. Traffic forecasts for both the a.m. and p.m. peak-hours and for Package 1 and Package 2 were generated. Observations related to these forecasts consist of:

- The new overpass would link the north and south sides of US 36 in this important employment area. Total daily volumes on the crossing would be:
  - volumes north of US 36 would be 10,550 vehicles per day
  - volumes south of US 36 would be 13,500 vehicles per day
- Overall daily volumes accessing the managed lanes appear reasonable. Daily total trips to and from the west are relatively balanced with 4,100 entering and 3,950 exiting the managed lanes. Daily total volumes to and from the east show about a 12 percent imbalance with 3,700 exiting and 4,200 entering the managed lanes. The higher volume entering the lanes is indicative of the congestion in the central part of the corridor, in the p.m. period especially, making the managed lanes attractive for users.
- Volumes would increase by 51 percent on Interlocken Boulevard west of the Midway Boulevard overpass connection. East of the connection towards Wadsworth Parkway the volumes would drop by about 7 percent. In both cases, total daily volume would be approximately 13,000 vehicles per day. The average capacity of a four-lane road with a median is between 25,000 and 34,000 vehicles per day. Therefore, traffic operations with the new crossing and drop-ramp in place would not be congested or over capacity.

Figure 3.5-3: Destinations of Eastbound Managed Lane Trips on Midway Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year)

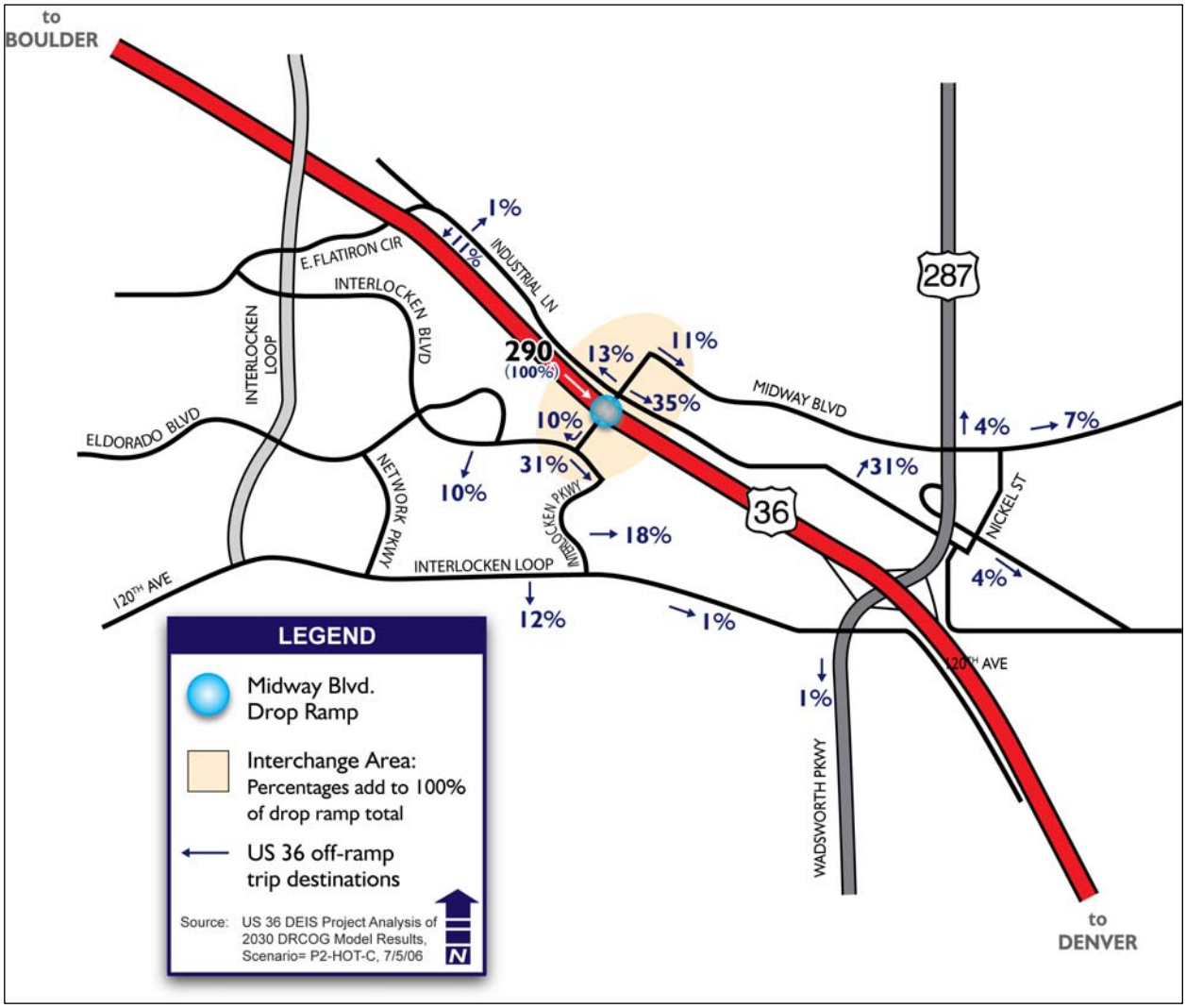
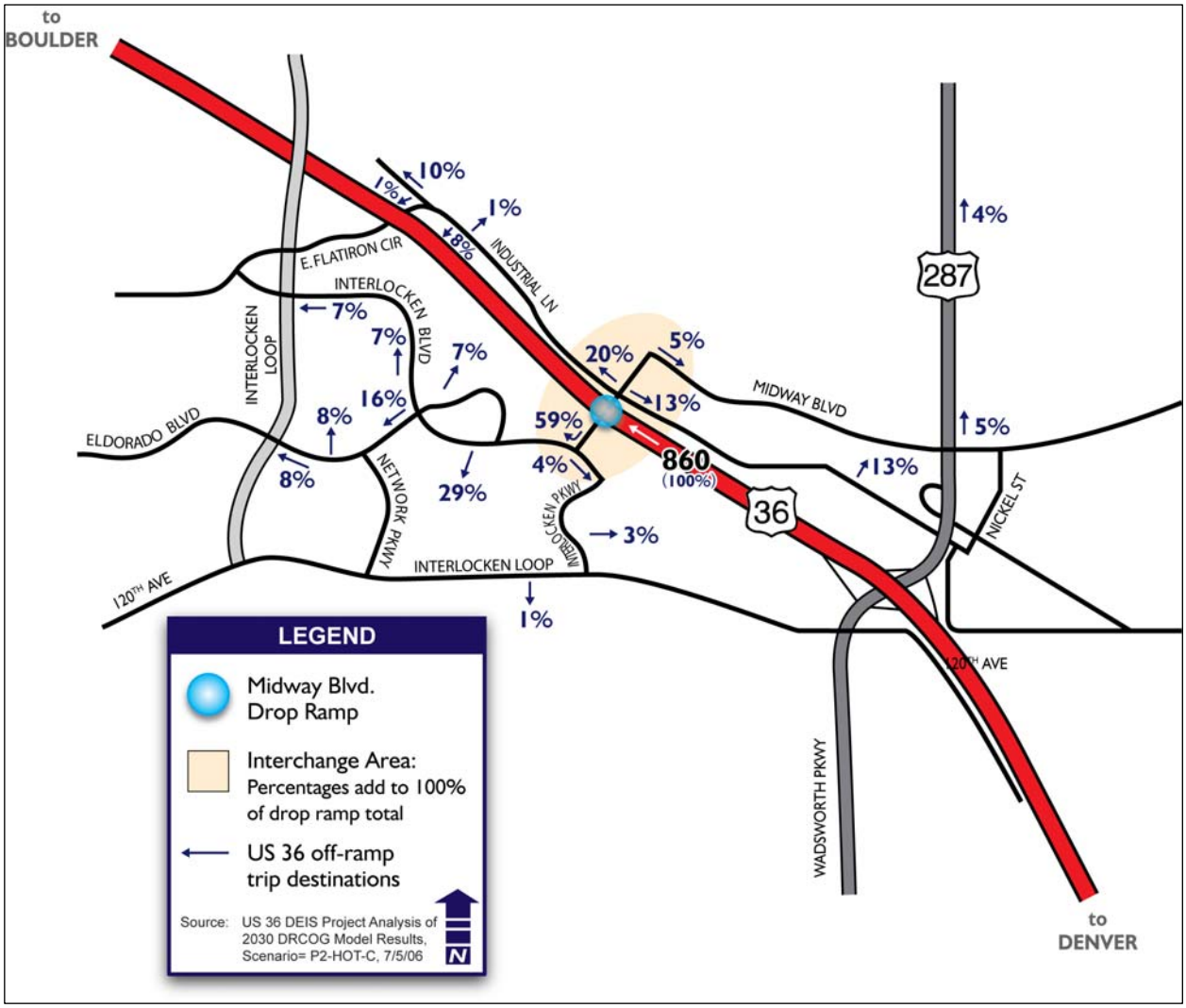


Figure 3.5-4: Destinations of Westbound Managed Lane Trips on Midway Boulevard Drop-ramp a.m. Peak Hour (Horizon-Year)



- On Midway Boulevard, daily total volumes in both directions would be 10,550 vehicles per day. The average capacity of a two-lane roadway with a continuous left-turn lane is between 13,000 and 18,000 vehicles per day. Sufficient capacity would be available for acceptable traffic operations with the drop-ramp and new overpass in place.
- On Industrial Lane, volumes would increase 59 percent daily to the east of Midway Boulevard, and 16 percent west of Midway Boulevard. In both cases, total daily volume would remain under 4,000 vehicles per day. The average capacity of a two-lane roadway is between 11,000 and 14,000 vehicles per day. Substantial additional capacity would remain for traffic on Industrial Lane such that adequate operations would result.

Overall traffic operations are not expected to degrade with the drop-ramp in place. Because the Interlocken/Broomfield area is a large employment center, peak-hour work trips would be attracted to the area regardless of the drop-ramp availability. The implementation of the drop-ramp improves access by offering both a way to access the managed lanes and a new overpass of US 36. The improved access redistributes traffic from the major local service interchanges at Wadsworth Parkway and at Interlocken Loop and would reduce traffic concentration on those roadways.

3.5.5 Impacts to Local Circulation

US 36 improvements proposed in Package 2, Package 4, and the Combined Alternative Package (Preferred Alternative) would impact local circulation in a few places in the corridor, as follows.

Denver and Adams Segments

- Improvements at US 36 and I-25 to provide the freeway-to-freeway connection between I-25 southbound and US 36 westbound would eliminate the southbound I-25 and westbound I-270 off-ramp to Broadway. This would prohibit the southbound and westbound movements to Broadway. Access to Broadway would be available via southbound I-25 at 84th Avenue, northbound I-25 via 70th Avenue, and westbound I-270/US 36 at York Street and Pecos Street. The impact of this change is that some travelers would be traveling more distance on arterials rather than freeway facilities.
- The same southbound I-25 to US 36 connection would require changing access to Broadway for Bronco Road residents. A cul-de-sac would be provided at the east end of Bronco Road at Broadway, eliminating access to Broadway at that location. Bronco Road would then be extended to the west to connect to Greenwood Boulevard and provide a connection to Broadway via Greenwood Boulevard.
- Realignment of US 36 to the south would eliminate access to the residential farm property located just west of Broadway on the south side of US 36. A new access roadway would be provided from Broadway west, to the residential farm property to maintain access.
- Realignment of US 36 to the south would require closing the Turnpike Drive access to Federal Boulevard from the west. Turnpike Drive would be realigned between Lowell Boulevard and Grove Street. Turnpike Drive access to Federal Boulevard would be maintained via the connection to Grove Street and 76th Avenue.
- Prior to any changes to local access from I-25 or US 36/I-270 to Broadway, a separate study will be undertaken. The study will evaluate local access in the area and re-evaluate the previous federal proposed action to eliminate access to Broadway.

Westminster and Broomfield Segments

- Realignment of US 36 to the south and Sheridan Boulevard to the west would require closing West 88th Place east of Sheridan Boulevard. Access to Sheridan Boulevard from 88th Place would not be maintained. Access to commercial properties that use 88th Place would need to be redirected along Sheridan Boulevard to 92nd Avenue, then east to Yates Street.
- Realignment of Wadsworth Boulevard to intersect with an extended 112th Avenue would be completed by the US 36 project. The new crossing would replace the obsolete Wadsworth Boulevard bridge. The extension of 112th Avenue to cross US 36 would be a project by others. The new connection of 112th Avenue would emphasize east-west traffic movement in the area, tying Wadsworth Parkway through the Arista development with Main Street in Broomfield.
- The reconfiguration of the Wadsworth Parkway interchange with US 36 would require closing 120th Avenue between Emerald Lane and Carr Street, and vacating Carr Street. Access to 120th Avenue would be provided via the realignment of Commerce Street and Park Street to connect to the new 120th Avenue that would be provided by others.
- Package 2 would include the extension of Midway Boulevard over US 36 and a grade-separation over the BNSF Railway tracks for the new drop-ramp. The extension of Midway Boulevard and new access over US 36 would not be provided in Package 4 or the Combined Alternative Package (Preferred Alternative).
- Package 2 would include the realignment of Industrial Lane to the north to provide access to the new Midway Boulevard drop-ramp. The realignment of Industrial Lane would not be provided in Package 4 or the Combined Alternative Package (Preferred Alternative).

Superior/Louisville and Boulder Segments

The Combined Alternative Package (Preferred Alternative) includes reconfiguration of the Foothills Parkway/Table Mesa Drive interchange to provide operational and safety improvements to local circulation. At this location, two options were evaluated that provide access from the University of Colorado, Boulder South Campus to Table Mesa Drive. Currently, this access is provided via Loop Drive, which intersects Table Mesa Drive from the south.

The two evaluated options are described below. Each option includes the elimination of the loop-ramp from westbound Table Mesa Drive to eastbound US 36.

- **Preferred Alternative (Loop Drive)**: The current access for the University of Colorado, Boulder South Campus to/from Table Mesa Drive via Loop Drive would be maintained. A new flyover ramp to eastbound US 36 would serve westbound vehicles on Table Mesa Drive. An eastbound slip-ramp would be constructed from Loop Drive to the Table Mesa Station on the south side of US 36, providing bus access to the BRT station. This option was identified as the Preferred Alternative through an agreement among CDOT, the University of Colorado, Boulder, the City of Boulder, and Boulder County based on cost sharing and the 1601 process. This part of the Combined Alternative Package (Preferred Alternative) is currently not included in the *2035 MVRTP* (DRCOG 2009).
- **Local Streets Option (Tantra Drive)**: Loop Drive would be vacated, thus eliminating the access for the University of Colorado, Boulder South Campus to/from Table Mesa Drive via Loop Drive. Instead, access would be provided by extending Tanta Drive to the University of Colorado, Boulder South Campus. Westbound traffic on Table Mesa Drive would access eastbound US 36 at the Table Mesa Drive/US 36 eastbound ramp intersection. This option may be implemented if agreement on the Preferred Alternative (Loop Drive) is not met.

3.5.6 Impacts to Boulder Roadways and Intersections

The impact of adding capacity to US 36 east of Boulder was evaluated for Package 2 and Package 4[5]. Particular attention was paid to this area because US 36 transitions to a regional arterial (28th Street) in Boulder. The addition of traffic and associated impacts were assessed and documented in the technical memorandum, *Boulder West End Traffic Operations and Supplements* (URS 2006). The following two aspects were considered:

- Changes in volumes on US 36 and the parallel east/west arterials that deliver traffic to Boulder.
- Intersection operations at signalized locations where traffic enters the Boulder street system.

Traffic Volumes Entering Boulder

Traffic forecasts for the a.m. peak-hour in the horizon-year would deliver the higher total traffic volumes to Boulder than in the p.m. peak-hour. The configuration of the westbound traffic lanes on US 36 into Boulder for each package is:

- **Package 1** – Two general-purpose lanes westbound.
- **Package 2** – Two general-purpose lanes and one managed lane westbound. In Package 2, the capacity increases would be provided by adding managed lanes, which would serve transit, HOV, and toll-paying SOV users.
- **Package 4** – Two general-purpose lanes, one HOV lane, and one auxiliary lane westbound. In Package 4, the extended BRT/HOV lanes would serve transit and carpools. In addition, the auxiliary lane between McCaslin Boulevard and Foothills Parkway/Table Mesa Drive would add capacity between these two interchanges.

During the planning process, corridor stakeholders, including the City and County of Boulder, requested the project team consider two variations of Package 4 that would modify the westbound auxiliary lane between McCaslin Boulevard and the Foothills Parkway/Table Mesa Drive interchange. The concern expressed by stakeholders was that the amount of westbound capacity that would be provided by Package 4 would be greater than the amount of traffic the local intersections in the city could reasonably accommodate.

In response to this request, a variation of Package 4 was developed with the stakeholders that would shorten the westbound auxiliary lane between McCaslin Boulevard and the Foothills Parkway/Table Mesa Drive interchange. This variation is referred to as Package 4, "Reduced Auxiliary Lane Variation."

The Package 4 "Reduced Auxiliary Lane Variation" would feature a climbing lane formed by the McCaslin Boulevard westbound on-ramp lane for traffic leading west toward Davidson Mesa, as well as enhanced off-ramp lanes at Foothills Parkway/South Boulder Road/Table Mesa Drive. The climbing lane would end near the scenic overlook, and only two general-purpose lanes would enter Boulder in this version of Package 4 (in addition to the BRT/HOV lane). Nearing the Table Mesa Drive/Foothills Parkway interchange, an additional deceleration lane would be developed approximately 0.5 mile east of the interchange to improve overall interchange operations. This variation was developed as a compromise between city/county interests in the corridor (limiting capacity into Boulder) and the interests of Federal Highway Administration and CDOT (maintaining a safe and adequately functioning highway).

In addition to the Package 4 "Reduced Auxiliary Lane Variation," Package 4 was also tested with no westbound auxiliary lanes between McCaslin Boulevard and Boulder. This scenario, termed Package 4 "Eliminated Auxiliary Lane Variation," would have the same westbound general-purpose lane

[5] The Combined Alternative Package (Preferred Alternative) showed volumes lower than Package 2 and Package 4, so additional analysis was not conducted for that package.

configuration as Package 1 between McCaslin Boulevard and Foothills Parkway/Table Mesa Drive. The HOV lane would remain as well.

Package 4 "Eliminated Auxiliary Lane Variation" was developed and analyzed to provide information regarding the level of benefit of the additional climbing and deceleration lanes in the Package 4 "Reduced Auxiliary Lane Variation." The a.m. peak-hour westbound screenline traffic results for packages and options are shown in Table 3.5-3, Comparison of Traffic Volumes at Screenlines East of Foothills Parkway (Horizon-Year).

Table 3.5-3: Comparison of Traffic Volumes at Screenlines East of Foothills Parkway (Horizon-Year)

Package	Road Segment	a.m. Peak-hour Westbound Volumes		
		Total Volume	Percent of Arterial Volume (%)	Percent of Total Volume (%)
Package 1: No Action	Arapahoe Road	1,660	31.8	17.3
	Baseline Road	1,500	28.7	15.7
	South Boulder Road	2,060	39.5	21.5
	Subtotal Arterials	*5,220*	*100.0*	*54.5*
	US 36	4,360	N/A	45.5
	Total	9,580	N/A	100.0
Package 2: Managed Lanes/ Bus Rapid Transit	Arapahoe Road	1,660	33.0	15.9
	Baseline Road	1,520	30.2	14.6
	South Boulder Road	1,850	36.8	17.8
	Subtotal Arterials	*5,030*	*100.0*	*48.3*
	US 36	5,380	N/A	51.7
	Total	10,410	N/A	100.0
Package 4: General-purpose Lanes, High-occupancy Vehicle, and Bus Rapid Transit	Arapahoe Road	1,670	33.4	15.6
	Baseline Road	1,520	30.4	14.2
	South Boulder Road	1,810	36.2	16.9
	Subtotal Arterials	*5,000*	*100.0*	*46.7*
	US 36	5,730	N/A	53.4
	Total	10,730	N/A	100.1
Package 4: "Reduced Auxiliary Lane Variation"	Arapahoe Road	1,650	31.7	15.8
	Baseline Road	1,520	29.2	14.6
	South Boulder Road	2,030	39.0	19.5
	Subtotal Arterials	*5,200*	*100.0*	*49.9*
	US 36	5,220	N/A	51.1
	Total	10,420	N/A	100.0
Package 4: "Eliminated Auxiliary Lane Variation"	Arapahoe Road	1,660	31.2	16.2
	Baseline Road	1,530	28.8	15.0
	South Boulder Road	2,130	40.0	20.8
	Subtotal Arterials	*5,320*	*100.0*	*52.0*
	US 36	4,910	N/A	48.0
	Total	10,230	N/A	100.0

Source: DRCOG 2006; URS, 2006.
Notes:
% = percent
a.m. = morning
N/A = not applicable
US 36 = United States Highway 36

The following observations can be made from the information shown in Table 3.5-3, Comparison of Traffic Volumes at Screenlines East of Foothills Parkway (Horizon-Year):

- Total traffic volume and percent of traffic destined for Boulder on all roadways would increase in the a.m. peak-hour in both the build packages, with a 23 to 31 percent increase in volume on US 36 due to its higher capacity. After leaving US 36, this traffic would follow east/west routes along South Boulder Road/Table Mesa Drive, Baseline Road, and Arapahoe Road, or north/south routes along Foothills Parkway and 28th Street to final destinations. Increases in vehicles would be expected to occur along Baseline Road, Foothills Parkway, Table Mesa Drive, and 28th Street.
- Both the build packages reduce the traffic volumes on the arterials overall, with the most reduction in traffic volume occurring on South Boulder Road.
- The shift in traffic volumes from the arterials to US 36 indicates that some traffic would benefit from the capacity improvements by using the highway rather than the arterials. The person-trips represented by the traffic volumes would not be "new" trips attracted to Boulder. The increase in capacity on US 36 would make it easier to get in and out of Boulder. This would result in people traveling further, such as choosing to live in Broomfield and work in Boulder, rather than living and working in Boulder. People would also drive further to use US 36 rather than use South Boulder Road.
- The increased peak-hour traffic volumes entering and leaving Boulder via US 36 would tend to affect other traffic-related resource areas such as noise, traffic disruption, air, and water pollution.
- Because the variations to Package 4 both result in only two through-lanes into Boulder, there would be a shift in some traffic to South Boulder Road. This shift is stronger with the elimination of westbound auxiliary lanes than with the Package 4, "Reduced Auxiliary Lane Variation," which indicates that the climbing and deceleration lanes do have an effect on overall traffic by keeping traffic on US 36 rather than diverting it to South Boulder Road.

The Package 4 variations were also compared with respect to the 2030 a.m., peak-hour westbound volume on US 36 along with the resulting projected LOS. Table 3.5-4, Comparison of a.m. Peak-hour Volumes Across Package 4 Variations (US 36 Westbound – McCaslin Boulevard to Foothills Parkway) (Horizon-Year), compares the three options.

Table 3.5-4: Comparison of a.m. Peak-hour Volumes Across Package 4 Variations (US 36 Westbound – McCaslin Boulevard to Foothills Parkway) (Horizon-Year)

Package	Lanes		Volume (per lane)		LOS	
	General-purpose/ Auxiliary	HOV	General-purpose and/or Auxiliary Lane	HOV	General-purpose/ Auxiliary	HOV
Package 4: General-purpose Lanes, High-occupancy Vehicle, and Bus Rapid Transit	3	1	5,730 (1,910)	620	E	B
Package 4: "Reduced Auxiliary Lane Variation"	2	1	5,220 (2,610)	620	F	B
Package 4: "Eliminated Auxiliary Lane Variation"	2	1	4,910 (2,455)	620	F	B

Source: DRCOG 2006; URS, 2006.

Notes:

a.m. = morning
HOV = high-occupancy vehicle
LOS = level of service
US 36 = United States Highway 36

Findings

Package 4 "Reduced Auxiliary Lane Variation" appears to represent a middle ground in terms of additional traffic into Boulder and diversion of traffic to and from east/west arterials (primarily South Boulder Road). However, it would still result in LOS F conditions in the general-purpose lanes between the scenic overlook and the start of additional deceleration lanes for Foothills Parkway/Table Mesa Drive.

Although each of the Package 4 configurations would have the same fundamental through-lane capacity, the two Package 4 variations that would change the auxiliary lane configuration exhibit different volumes and different levels of traffic diversion from South Boulder Road. This finding indicates that the climbing lane and extended deceleration lane have a small but measurable impact on traffic assignment in this segment of the US 36 corridor because about 300 to 400 vehicles would be shifted from South Boulder Road to US 36 in the a.m. peak-hour.

In both the build packages, traffic forecasts indicate that the general-purpose lanes would be loaded to capacity (LOS E or worse) in the a.m. peak-hour (see Table 3.4-4, a.m. Peak-hour Travel Times Eastbound from Boulder to Denver Union Station [Horizon-Year]). However, the managed lanes in Package 2 or BRT/HOV lanes in Package 4 have some capacity available that automobile traffic could use.

Analysis of the demand and capacity comparison for LOS produced the following findings:

- Without the auxiliary lane in Package 4, the general-purpose lanes would operate at LOS F. This is because not enough traffic would shift from the general-purpose lanes into the HOV lane to allow the general-purpose lanes to operate at LOS D or better.
- With a discontinuous or eliminated auxiliary lane, traffic operations would also be subject to disturbances from merging traffic from McCaslin Boulevard. Lane balance and continuity would provide better safety and operations with the continuous auxiliary lane in Package 4.
- The traffic volume shift from the parallel arterials to US 36 would be limited, and most of the effects would be on South Boulder Road. Without the auxiliary lane in Package 4, the traffic volumes on US 36 would exceed capacity and more traffic would use South Boulder Road.
- In Package 2, lower pricing could be used to shift volume into the managed lanes from the general-purpose lanes. The forecast shows that just over 1,000 vehicles would use the managed lanes in the a.m. peak-hour. A shift of about 500 vehicles from the general-purpose lanes would still meet CDOT management strategy in the managed lanes, and could improve the general-purpose lanes from LOS F to LOS E.

Impacts to Boulder Intersections

Because Packages 2 and 4 added capacity to US 36 in the segment immediately east of Boulder, an assessment of impacts to intersections within the city was conducted. Jurisdictions in the corridor expressed concern that the amount of traffic delivered by the increased highway capacity in the build packages would be more than the local intersections could accommodate. The following eight intersections were studied in both the a.m. and p.m. peak-hours using 2030 forecasts:

- 28th Street/Arapahoe Avenue
- 28th Street/Colorado Avenue
- Baseline Road/US 36 Ramp West
- Baseline Road/US 36 Ramp East
- Table Mesa Drive/Broadway
- Foothills Parkway/Baseline Road

- Foothills Parkway/Arapahoe Avenue
- Table Mesa Drive/Moorhead Avenue

Results of the intersection assessments are presented in Table 3.5-5, Boulder Intersection Level of Service Analysis. Observations related to the table include:

- Operations in the a.m. peak-hour would not degrade under either Package 2 or Package 4. In Package 2, the LOS would remain the same for all intersections as compared to Package 1. In Package 4, the intersection of Baseline Road/US 36 ramp east would see a degradation from LOS D to LOS E. This is primarily due to increased off-ramp volumes from US 36.
- Operations in the p.m. peak-hour in Package 1 would all operate at LOS F. Delays would be substantial with all intersections approaching or exceeding 100 seconds of delay per vehicle. Packages 2 and 4 would increase overall delay.
- Analysis of Boulder intersections was not conducted for the Combined Alternative Package (Preferred Alternative). The land use assumed in the City of Boulder for this package was less intense compared to the land use assumed for Package 2 and Package 4. As a result, traffic volumes in the City of Boulder under the Combined Alternative Package (Preferred Alternative) are consistently less than the forecasts for Package 2 and Package 4. Therefore, the analysis of Package 2 and Package 4 provides a conservative estimation of local circulation impacts. It was determined that reassessing these locations was not necessary for the Combined Alternative Package (Preferred Alternative). The impacts and mitigation measures under the Combined Alternative Package (Preferred Alternative) were identified to be the same as those identified under Package 2 and Package 4.

Table 3.5-5: Boulder Intersection Level of Service Analysis

Intersection	2005	Package 1	Package 1 Delay (seconds)	Package 2	Package 2 Delay (seconds)	Percent Difference from Package 1 to Package 2 (%)	Package 4	Package 4 Delay (seconds)	Percent Difference from Package 1 to Package 4 (%)
LOS a.m. Analysis for Key Boulder Intersections									
28th Street/Arapahoe Avenue	C	E	59.0	E	67.0	14	E	67.9	15
28th Street/Colorado Avenue	F	F	181.4	F	190.2	5	F	197.6	9
Baseline Road/US 36 West	C	D	35.6	D	38.8	9	D	43.1	21
Baseline Road/US 36 East	E	D	39.1	D	50.9	30	E	57.8	48
Broadway/Table Mesa Drive	E	F	91.6	F	95.5	4	F	97.5	6
Foothills Parkway/ Baseline Road	F	F	207.5	F	226.4	9	F	230.9	11
Foothills Parkway/ Arapahoe Avenue	F	F	124.0	F	128.0	3	F	133.9	8
Table Mesa Drive/ Moorhead Avenue	B	A	9.4	C	20.2	115	C	20.4	112

Table 3.5-5: Boulder Intersection Level of Service Analysis

Intersection	2005	Package 1	Package 1 Delay (seconds)	Package 2	Package 2 Delay (seconds)	Percent Difference from Package 1 to Package 2 (%)	Package 4	Package 4 Delay (seconds)	Percent Difference from Package 1 to Package 4 (%)
LOS p.m. Analysis for Key Boulder Intersections									
28th Street/Arapahoe Road	F	F	171.1	F	180.4	5	F	181.6	6
28th Street/Colorado Avenue	F	F	143.8	F	154.8	8	F	153.7	7
Baseline Road/US 36 West	D	F	107.7	F	118.9	10	F	119.0	10
Baseline Road/US 36 East	D	F	93.3	F	116.5	25	F	125.6	35
Broadway/Table Mesa Drive	E	F	100.2	F	105.2	5	F	108.9	9
Foothills Parkway/ Baseline Road	F	F	155.9	F	166.8	7	F	176.2	13
Foothills Parkway/ Arapahoe Avenue	F	F	200.6	F	200.8	0.1	F	206.8	3
Table Mesa Drive/ Moorhead Avenue	B	B	13.4	C	31.9	139	C	29.5	120

Source: DRCOG, 2006; URS, 2006.

Notes:

% = percent
a.m. = morning
LOS = level of service
p.m. = evening
US 36 = United States Highway 36

Impacts to intersection operations in Package 2 would occur at the following locations and time periods:

- No intersections would change an LOS grade in either the a.m. or p.m. peak-hour. Impacts from increased intersection delays would occur at seven of the eight intersections in the a.m. peak-hour, and six of the eight in the p.m. peak-hour.
- Only the Baseline Road/US 36 ramp east intersection has an LOS F operation and a delay increase of more than 15 percent. Because the 15 percent increase threshold would be reached, mitigation of the impact at this location has been included.

Impacts to intersection operations in Package 4 would occur at the following locations and time periods:

- The Baseline Road/US 36 ramp east intersection would drop one level or service from LOS D to LOS E in the a.m. peak-hour.
- Overall delays at both the Baseline Road/US 36 ramp east would increase by more than 15 percent. Because the 15 percent threshold would be reached, mitigation of the impact at this location has been included.

The two options to provide access to the University of Colorado, Boulder South Campus are not expected to have an appreciable difference in traffic congestion at local Boulder intersections, except for the following:

- Under the Combined Alternative Package (Preferred Alternative), peak-hour congestion at the intersection of Table Mesa Drive/Loop Drive/US 36 eastbound ramp is expected to increase due to traffic growth, especially from future development at the University of Colorado, Boulder South Campus. Capacity analysis of this intersection indicates that this intersection is likely to operate at LOS D or better during both peak hours in 2035.

- Under the Local Streets Option, less traffic congestion is expected at the Table Mesa Drive/US 36 eastbound ramp intersection compared to the Combined Alternative Package (Preferred Alternative), primarily because of the closure of Loop Drive. However, the intersection of Table Mesa Drive/Tantra Drive is expected to be more congested compared to the Combined Alternative Package (Preferred Alternative) conditions. Capacity analysis indicates both intersections are likely to operate at LOS D or better during both peak hours in 2035.

Mitigation of Intersection Operations

Improvements to the US 36 ramp intersections with Baseline Road were examined for improving LOS or reducing delay. Improvements are shown in Figure 3.5-5, Proposed Mitigation for Eastern Half of US 36 and Baseline Road, and consist of:

- US 36 ramp east/Baseline Road – add a right-turn lane to the northbound on-ramp for eastbound Baseline Road traffic.

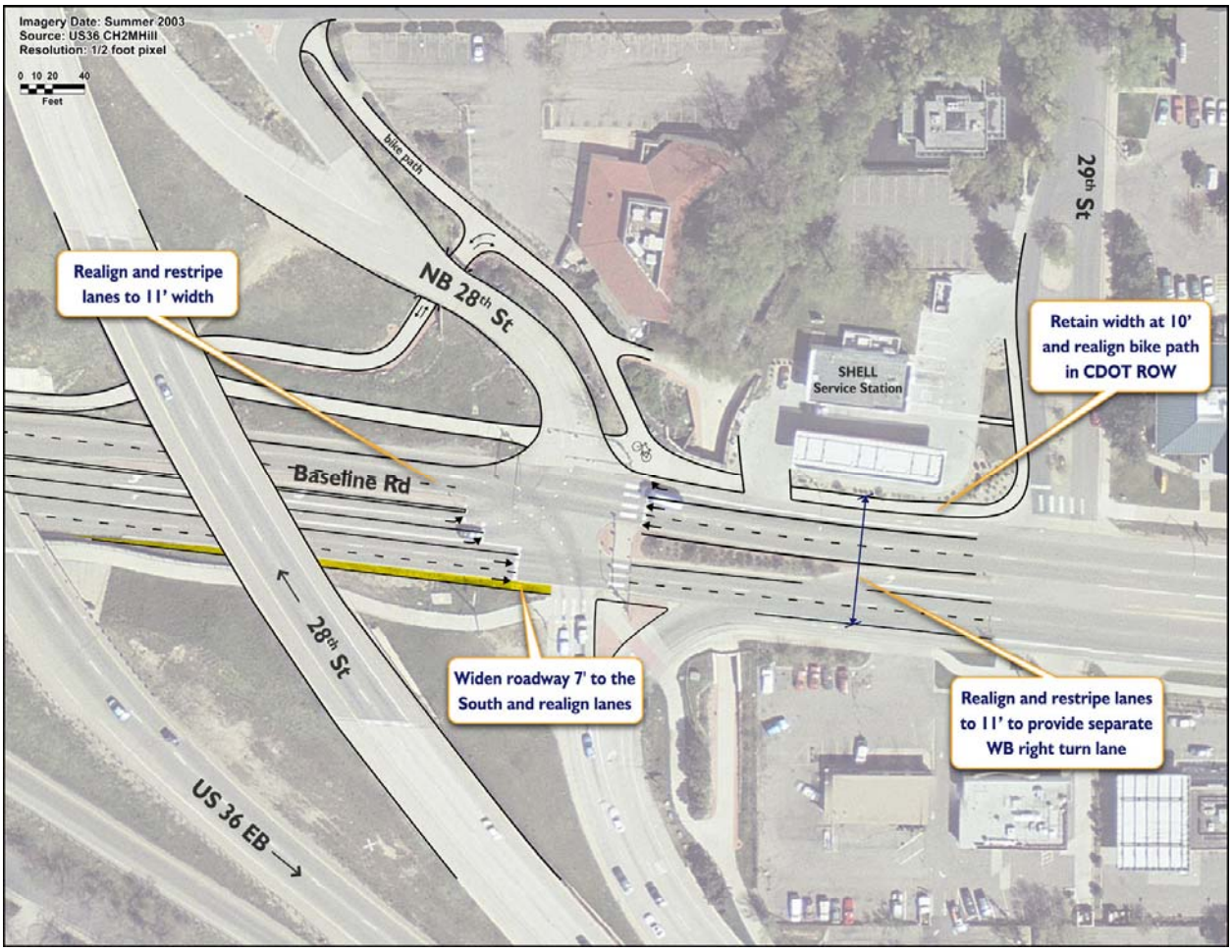
The additional right-turn lane for the east intersection would require the following configuration:

- The right-turn lane would be located on the north side of Baseline Road, leading from the on-ramp to US 36 that also serves the northbound frontage road.
- The bicycle and pedestrian path on the north side would remain adjacent to the new turn lane.
- An existing driveway leading to a gasoline service station on the north side would be adjusted.
- Some reconfiguration of the median would be necessary to provide the required width for the turn lane.

These improvements would fit within the existing ROW of the intersection and would not result in substantial reconstruction. Therefore, minimal impacts to the surrounding area would result.

The widening on the east side could limit future widening to provide bike lanes as called for in the *City of Boulder Transportation Master Plan* (LSA Associates, Inc. 2003). Future design work would clarify if the objectives of the Plan could be met.

Figure 3.5-5: Proposed Mitigation for Eastern Half of US 36 and Baseline Road



The addition of the turn lanes would result in delay reduction to keep the LOS in the acceptable range or reduce delay to be within the 15 percent increase threshold. The improvements would not change the LOS in either build package. Table 3.5-6, Impacted Intersections with Mitigation Level of Service Analysis, presents the results of the intersection operations with the mitigation improvements.

Table 3.5-6: Impacted Intersections with Mitigation Level of Service Analysis

Intersection	2005	Package 1 2030	Package 1 2030 Delay (seconds)	Package 2 2030	Package 2 2030 Delay (seconds)	Percent Difference from Package 1 to Package 2 (%)	Package 4 2030	Package 4 2030 Delay (seconds)	Percent Difference from Package 1 to Package 4 (%)
LOS for Mitigated Intersections (a.m.)									
Baseline Road/US 36 West	C	D	35.5	D	37.2	5	D	37.5	5
Baseline Road/US 36 East	E	D	39.1	D	41.5	6	D	46.3	18
LOS for Mitigated Intersections (p.m.)									
Baseline Road/US 36 West	D	F	107.7	F	94.0	10	F	101.0	6
Baseline Road/US 36 East	D	F	93.2	F	89.5	4	F	98.0	5

Source: DRCOG 2006; URS, 2006.
Notes:
% = percent
a.m. = morning
LOS = level of service
p.m. = evening
US 36 = United States Highway 36

In order to stay within the existing ROW for this intersection, adjustments have been made to the existing bikepath alignment. The effect of these adjustments is as follows:

- The bikepath has been moved so it is immediately adjacent to US 36 on-ramps. This would result in slightly decreased safety, issues with snow removal, and slightly decreased bicyclist/pedestrian experience.

3.5.7 Impacts of Bus Rapid Transit Operations in Downtown Denver and Central Boulder

Package 1 would have no additional impact on bus operations in either downtown Denver or Boulder, as it assumes programmed bus improvements in both areas.

Package 2 and Package 4 would have identical levels of service for BRT and related bus operations in downtown Denver and Boulder. The Combined Alternative Package (Preferred Alternative) would have some minor differences in the service in terms of the number of buses entering downtown Denver and Boulder. The following bullets provide a description of operation impacts on downtown Denver and Boulder for the build packages:

Downtown Denver

The overall impacts of the additional buses from the build packages in downtown Denver would be minimal. All build packages would direct the majority of BRT vehicle volume to DUS (see Table 3.5-7, Changes in a.m. Peak-hour Bus Volumes on Downtown Denver Streets [Horizon-Years]).

- Under Package 2 and Package 4 a total of 4 more buses per hour than Package 1 would arrive at DUS via the 19th Street and 20th Street reversible ramp during peak periods. Nine additional buses per hour above those shown in Package 1 would travel from the 20th Street ramp to the Civic Center transfer facility; this would add one bus on average, every 6.67 minutes during peak periods. Therefore, the impacts of those buses on traffic movements would not be noticeable.

- Under the Combined Alternative (Preferred Alternative); a total of 10 additional buses per hour above Package 1 would arrive at DUS via the 19th Street and 20th Street reversible ramp during peak periods. Seven additional buses per hour above those shown in Package 1 would travel from the 20th Street ramp to the Civic Center transfer facility; this would add one bus on average, every 8.5 minutes during peak periods. Therefore, the impacts of those buses on traffic movements would not be noticeable.

Table 3.5-7: Changes in a.m. Peak-hour Bus Volumes on Downtown Denver Streets (Horizon-Year)

Location	Package 1: No Action	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Denver Union Station				
Number of In-bound Buses[1] During the Peak Hour	22	26	26	32
Change from Package 1	-	+4	+4	+10
Civic Center Station via 19th Street				
Number of In-bound Buses[1] During the Peak Hour	3	12	12	10
Change from Package 1	-	+9	+9	+7

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]The table shows the number of in-bound buses only. It is assumed that all regional buses make round trips.

+ = increase
- = no change
a.m. = morning
BRT = bus rapid transit
HOV = high-occupancy vehicle

Central Boulder

Under all build packages, the number of in-bound buses along 28th Street and Broadway would increase substantially (see Table 3.5-8, Changes in a.m. Peak-hour Bus Volumes on City of Boulder Streets [Horizon-Year]).

- In Package 2 and Package 4 in the a.m. peak-hour, the number of in-bound buses would increase from 9 to 18 buses along Broadway, and would increase from 4 to 24 buses along 28th Street.
- In the Combined Alternative Package (Preferred Alternative) in the a.m. peak-hour, the number of in-bound buses would increase from 9 to 12 buses along Broadway, and would increase from 4 to 18 buses along 28th Street.

Table 3.5-8: Changes in a.m. Peak-hour Bus Volumes on City of Boulder Streets (Horizon-Year)

Location	Package 1: No Action	Package 2: Managed Lanes/BRT	Package 4: General-purpose Lanes, HOV, and BRT	Combined Alternative Package (Preferred Alternative): Managed Lanes, Auxiliary Lanes, and BRT
Boulder Transit Center — 14th Street/Walnut Street via Broadway				
Number of In-bound Buses[1] During the Peak Hour	9	18	18	12
Change from Package 1	-	+11	+11	+3
Boulder Transit Village — 30th Street/Pearl Street via 28th Street				
Number of In-bound Buses[1] During the Peak Hour	4	24	24	18
Change from Package 1	-	+20	+20	+14

Source: US 36 Mobility Partnership, 2009.

Notes:

[1]The table shows the number of in-bound buses only. It is assumed that all regional buses make round trips.

+ = increase
- = no change
a.m. = morning
BRT = bus rapid transit
HOV = high-occupancy vehicle

The increase in BRT vehicles along 28th Street would be from one bus approximately every 15 minutes under Package 1, to one bus every 2.5 minutes under Package 2 and Package 4 and one bus every 3 minutes under the Combined Alternative Package (Preferred Alternative). Along both 28th Street and Broadway, the impact to traffic operations from the added buses is expected to be minimal because the City of Boulder has implemented the Super Stop Program and related priority treatments. These treatments allow buses to move with the traffic stream, but assist in maintaining schedules by coordinating buses with platoons of traffic.

3.5.8 Impacts of Transit Patron Parking

This section discusses impacts of parking for transit patrons and neighborhood parking as a result of overall transit ridership. For a more detailed description of traffic impacts at transit stations, see *Transit Station Mode of Access, Parking and Traffic Impacts Technical Report* (URS 2007c).

Transit Station Parking

As presented in Table 2.5-1, Parking and Pedestrian Crossings at Transit Stations, parking impacts from the Packages 2 and 4 would occur at the following three transit station locations: Westminster Center, 116th Avenue, and McCaslin. The following is a summary of parking changes from Package 1.

Westminster Center Station – The realignment of Sheridan Boulevard south of US 36 in Package 2 and Package 4 expands the area currently available for surface parking. The existing park-n-Ride on the south side of US 36 would expand from 351 spaces to approximately 500 spaces.

116th Avenue Station – Package 1 includes an existing joint use parking structure on the west side of US 36 but does not call for BRT parking on the east side of the highway. All build packages would add 870 surface parking spaces east of US 36.

McCaslin Station – Interchange improvements called for in all build packages would encroach on existing park-n-Rides on either side of US 36 at the McCaslin Boulevard interchange. On the south side, a larger interchange loop would eliminate approximately 132 existing parking spaces under Package 2

and Package 4 and 116 existing parking spaces under the Combined Alternative Package (Preferred Alternative). On the north side, an expanded interchange ramp would eliminate approximately 92 existing parking spaces (162 spaces under the Combined Alternative Package (Preferred Alternative). RTD currently leases the north side spaces from the adjacent movie theater. Interchange modifications would therefore result in a loss of both theater parking and transit patron parking.

In total, 242 parking spaces would remain for use by BRT patrons at the McCaslin Station under Package 2 and Package 4. Under the Combined Alternative Package (Preferred Alternative), 188 parking spaces would remain.

In response to this reduction in spaces, the following mitigation measures will be considered at the McCaslin Station during final design:

1. Shift the bikeway closer to the westbound US 36 on-ramp from McCaslin Boulevard.
2. Add a retaining wall along the north side of US 36 adjacent to the current leased parking.
3. Realign the eastbound US 36 off-ramp to be parallel to US 36.
4. If necessary, renegotiate the leased parking agreement to add more parking to the west of the current leased area and behind the theater building.
5. Redesign the bus ramps and station platforms to reduce the footprint.

Preliminary analysis is that as many as 100 spaces could be added from the shift of the bikeway and the additional retaining wall. Around 50 could be added by the US 36 off-ramp realignment and an additional 105 spaces could be added to the west of the current leased area. This could increase total parking at the McCaslin Station (after this mitigation is included) to be 443 spaces.

On-street Parking Impacts and Mitigation at Transit Stations

There is currently very little on-street parking throughout the corridor because of the suburban nature of the area. Most businesses provide ample off-street parking to both employees and patrons. Parking for transit patrons using the BRT service would be provided in lots adjacent to the proposed transit stations. Much of this parking would be provided as part of Package 1. Therefore, due to the availability of off-street parking for most land uses in vicinity of transit stations, the proposed BRT service is not projected to cause any substantial on-street parking impacts.

Should overflow parking spill out onto the local streets surrounding the two stations where additional parking is being provided compared to Package 1, RTD would work with affected local jurisdictions to develop appropriate mitigation measures. These could include resident parking permit programs, identification of possible shared parking strategies, implementation of public education and marketing programs to encourage redistribution of parking among various expansions of RTD parking, and increased enforcement. These strategies should be considered short-term fixes until parking facilities could be expanded to serve additional transit patrons.

Off-street Parking Impacts and Mitigation at Transit Stations

This corridor is suburban in character, and off-street parking for commercial/retail uses can be found easily most times of day. Attractions that experience parking shortages periodically include high turnover establishments such as fast-food restaurants and convenience centers. Given the plans for parking availability at transit station locations, the proposed BRT service should have no impacts to off-street parking within the corridor, so no mitigation is needed.

3.5.9 Impacts to Truck Freight Operations

Trucking and delivery movements throughout the corridor would experience both positive and negative impacts from implementation of either of the build packages. Freight movement within US 36 corridor would be primarily for collection and distribution purposes, and these operations would generally experience positive impacts due to reduced congestion and improved travel times. Consideration of freight movement and truck routes during design of construction staging detours will be important to minimize delays. See Section 4.22, Construction-Related Impacts, for additional discussion on construction staging.

3.6 SUMMARY OF TRANSPORTATION IMPACTS AND MITIGATION

A summary of transportation impacts and mitigation for all the build packages is provided here.

- **Interchange Impacts**: All build packages improve LOS at the interchange intersections in the peak-hours compared to Package 1. Impacts are similar for all build packages.
- **Boulder Intersections**: Peak-hour operations for eight intersections were analyzed, and mitigation measures would be required at Baseline Road/US 36 at the east side ramp in Package 2 and Package 4.
- **Transit Station Traffic and Parking**: Traffic impacts were found at the intersection of Dillon Road and McCaslin Boulevard; the impacts would be mitigated by the addition of a third westbound left-turn lane combined with a through-movement and signal timing improvements. Although the number of available spaces would be reduced by project improvements, no adverse parking impacts are expected at the transit stations under the build packages.
- **Truck Freight Operations:** Freight movement within the US 36 corridor would be primarily for collection and distribution purposes, and these operations would generally experience positive impacts due to reduced congestion and improved travel times.

Mitigation for Package 2 and Package 4 is provided here.

- At the US 36 east side-ramp/Baseline Road, Package 2 and Package 4 will add a right-turn lane to the northbound on-ramp for eastbound Baseline Road traffic.
- In Package 2 and Package 4, the existing bicycle lane will be retained adjacent to the US 36 on-ramp through-lane.

During the development of the packages, all build packages were modified to avoid or minimize transportation impacts wherever possible. These modifications are included in Table 3.6-1, Mitigation Measures – Transportation Impacts.

Table 3.6-1: Mitigation Measures – Transportation Impacts

Impact	Impact Type	Mitigation Measures
Delay at the Federal Boulevard and 80th Avenue and 74th Avenue intersections	Operations	West 80th Avenue at Federal Boulevard: • A southbound lane from West 80th Avenue to the westbound US 36 on-ramp will be added. West 74th Avenue at Federal Boulevard: • The eastbound approach to left-turn, left-/through-, and right-turn lanes will be re-striped. • Signal phasing will be adjusted.
Delay at the Wadsworth Parkway and Midway Boulevard intersection	Operations	Wadsworth Parkway at Midway Boulevard: • The westbound approach to two left-turn lanes, two through-lanes, and a separate right-turn lane will be re-striped. • Signal phasing will be adjusted.
Delay at Dillon Road and McCaslin Boulevard	Operations	• Dillon Road east of McCaslin Boulevard will be widened to add one westbound lane. This lane will not extend through the McCaslin Boulevard intersection. • The east leg of the intersection will have two left-turn lanes, a left- or through-lane, and a separate right-turn lane under Package 2 and Package 4. No intersection mitigation will be necessary under the Combined Alternative Package (Preferred Alternative).

Table 3.6-1: Mitigation Measures – Transportation Impacts

Impact	Impact Type	Mitigation Measures
Closure of local access to Broadway	Access	• Prior to any changes to local access from the highway system to Broadway, a separate study will be undertaken. The study will evaluate local access in the area and re-evaluate the previous federal proposed action to eliminate access to Broadway.
Closure of local access to West 88th Place	Access	• Directional signage and traveler information will be provided to guide users to Yates Street and West 88th Place by alternate routes.
University of Colorado, Boulder South Campus access	Access	• The Loop Drive access to the University of Colorado, Boulder South Campus will be retained. The Table Mesa Drive interchange will be modified to provide bus BRT access and the westbound to eastbound loop on-ramp will be eliminated. • Based on an agreement with CDOT, the University of Colorado, the City of Boulder, and Boulder County, if access at Loop Drive is denied, Tantra Drive will be extended to provide access to the University of Colorado, Boulder South Campus.
Reduction of parking spaces at the McCaslin Station	Parking	Consider the following mitigation measures during final design: • Shift bikeway closer to the westbound US 36 on-ramp from McCaslin Boulevard. • Add a retaining wall along the north side of US 36 adjacent to the current leased parking. • Realign the eastbound US 36 off-ramp to be parallel to US 36. • If necessary, renegotiate the leased parking agreement to add more parking to the west of the current leased area and behind the theater building.

Source: US 36 Mobility Partnership, 2009.

Notes:

BRT = bus rapid transit

CDOT = Colorado Department of Transportation

US 36 = United States Highway 36