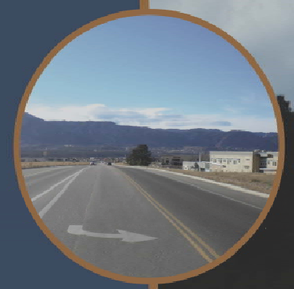

Highway 105 Corridor Study
Corridor Preservation Plan

for

El Paso County Department of Public Services

November 2012

EL PASO COUNTY
COLORADO

Highway 105 Corridor Study
Corridor Preservation Plan

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November 2011 - Revised February 2013

HDR Project No. 000000000163862

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1 Introduction and Overview

For many years the project corridor, between Woodmoor Drive and SH 83, has had a significant role in The County transportation network, including serving as the primary connection between eastern El Paso County and Palmer Lake, and providing access to adjacent, rapidly developing areas in the northeastern El Paso County. In recent years, this segment and the overall State Highway 105 corridor have become congested and, in some areas, unsafe due to increased traffic and inadequate roadway design.

Prior to 2008, the Highway 105 project corridor was part of State Highway 105 (SH 105) and was owned and maintained by the Colorado Department of Transportation (CDOT). In 2008, CDOT transferred the maintenance responsibility for the State Highway 105 between Interstate 25 and State Highway 83 to El Paso County, and initiated the process of transferring ownership of the right-of-way to the County. The Park and Ride facility located at Woodmoor Drive and Highway 105 was not part of the transfer and continues to be operated and maintained by CDOT. The 2008 Highway 105 transfer to the County was part of a larger transfer package whereby CDOT took over Powers Boulevard in exchange for selected state highway segments for which ownership and maintenance responsibilities were transferred to the County and the City of Colorado Springs.

The Highway 105 project corridor, along its entire length, is classified by the current El Paso County Major Transportation Corridor Plan (MTCP) as a principal arterial. The Corridor Preservation Plan component of the MTCP further identifies the ultimate need for a four-lane cross-section throughout the project corridor both to meet forecast travel demand and to fulfill broader County system and connectivity needs.

1.1 Project Summary

During the one-year period beginning in August of 2011, El Paso County conducted a Corridor Study for Highway 105 between Interstate 25 (I-25) and SH 83, a distance of about 5 miles, as shown in Figure 1.1. This section of roadway provides direct access to I-25 and connects the eastern portion of El Paso County to Palmer Lake. The study was conducted to identify needed capacity, mobility and safety improvements for the corridor, and to develop a phasing plan to implement those improvements based on need and available funding. While a long term plan was developed, it is anticipated that improvements will be phased in over the course of several years. Safety improvements will be completed first, with capacity improvements to be completed only as conditions warrant and funding becomes available. The Highway 105 Corridor Study provides general priorities for the design and construction of the improvements, as well as identifies any operational changes that could help maximize efficiency in the interim. Systemwide design features such as drainage will be investigated as part of subsequent design phases to determine the long term solution. Local and regional plans have previously identified the need for this section of Highway 105 to be upgraded; and the recommendations arising from this study will be coordinated with concurrent efforts. The study included opportunities for stakeholder review and comment and will ultimately documents those concerns in the Corridor Plan that will set the direction for improvements in the corridor.

1.2 Existing Conditions

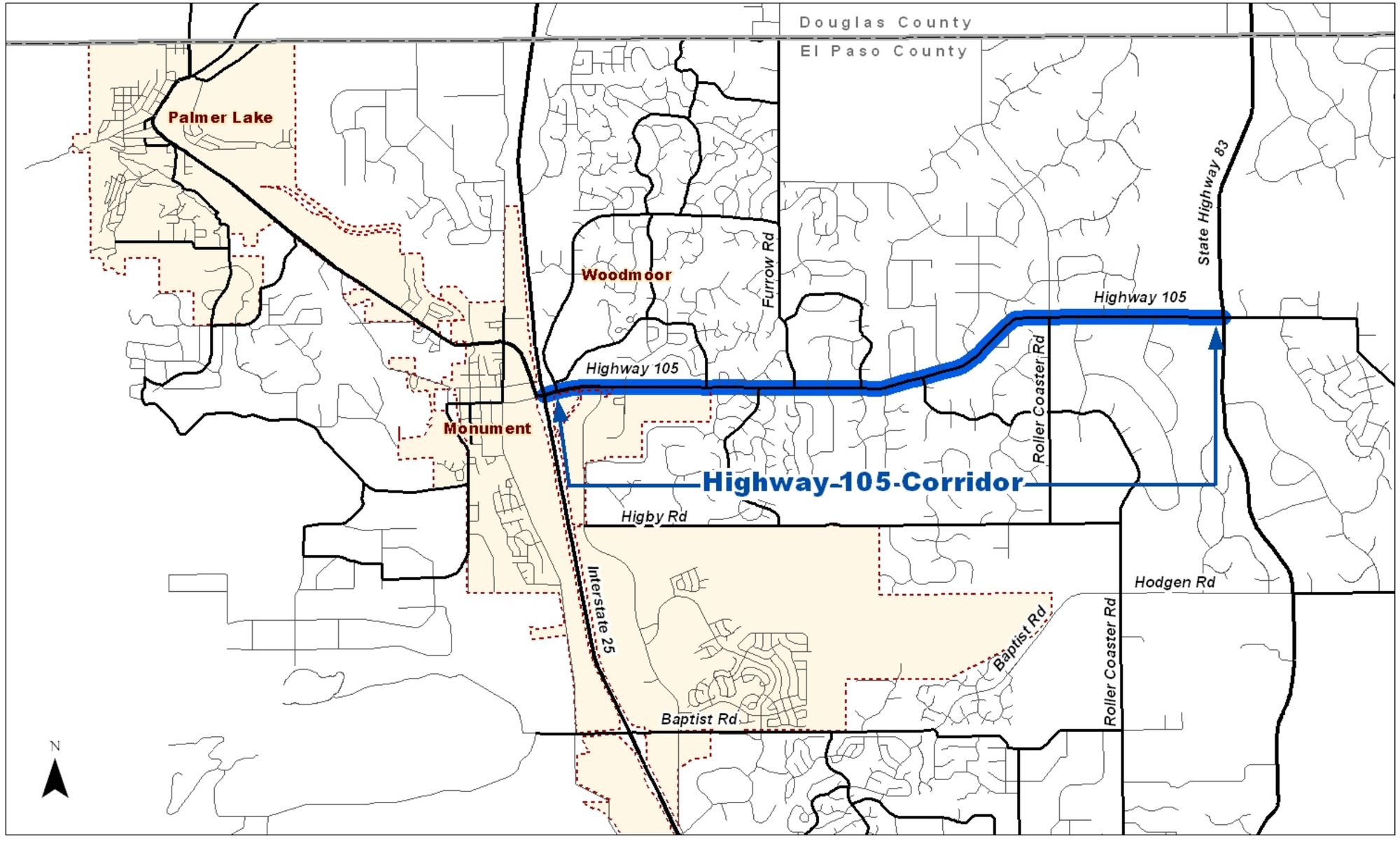
The project corridor for the El Paso County Highway 105 Corridor Study extends from Interstate 25 (I-25) to State Highway (SH 83), a distance of about 5 miles. The existing Highway 105 roadway geometry, between Woodmoor Drive and SH 83 is characterized by: inconsistent and inadequate shoulder widths or lack of shoulders, lack of turn bays or inadequate turn-bay storage lengths, lack of pedestrian and bicycle accommodations, inadequate roadway drainage provisions, and areas with limited sight distance due to substandard horizontal or vertical curves. Recent corridor crash history has included both injury and fatality crashes, crashes that congestion and roadway geometrics may have played some role in. In addition to safety and congestion, local residents also expressed concerns about inadequate drainage in some areas and traffic noise. The corridor study evaluates these concerns and makes appropriate recommendations for consideration.

1.3 Corridor Issues

Existing conditions and study scope were presented to corridor residents and identified stakeholders at the first of three open-house format public meetings for the project. Public/stakeholder input was used to identify the following corridor issues that were used to direct development of alternative solutions and as a basis to screen and refine alternatives:

- Safety
- Mobility and Traffic Congestion
- Roadway Geometry
- Access Needs and Impacts
- Drainage Requirements and Impacts
- Traffic Noise

Figure 1.1: Study Area Vicinity Map



EL PASO COUNTY COLORADO

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1.3.1 Safety

Inadequate roadway cross-section, including areas with no shoulders and a lack of turn lanes, as well as uncontrolled access, steep grades, inadequate roadway/intersection capacity, lack of pedestrian/bicycle facilities and sharp curves, contributes to a relatively high Highway 105 crash incidence. Improvements needed to correct these deficiencies were a focus of alternatives analysis for the Highway 105 Corridor Study.

1.3.2 Mobility and Traffic Congestion

Mobility and congestion relief are important considerations because Highway 105 is both a primary east-west corridor and the only means of access to a number of neighborhoods.

- Current peak hour congestion is most significant west of Lake Woodmoor Drive.
- Significant peak hour delays are experienced at the following intersections: the I-25 southbound ramps, Jackson Creek Parkway, Knollwood Drive, the Monument Academy access, and Lake Woodmoor Drive.
- Congestion and delay will increase in the future if no improvements are made.

1.3.3 Roadway Geometry

Roadway geometry upgrades that can improve corridor safety and provide needed carrying capacity include:

- Improving curves and grades
- Providing new and/or wider shoulders
- Adding turn, acceleration and deceleration lanes
- Increasing lane widths and/or number of lanes
- Adding accommodations for pedestrians and bicyclists
- Providing adequate roadside clear zones
- Intersection upgrades (e.g. adding turn bays, capacity upgrades – signalization/roundabout conversions)

1.3.4 Access Needs and Impacts

By necessity, the Highway 105 Corridor has many access points. However, access management tools that can be used to improve safety and reduce traffic congestion include:

- Timing signals and spacing signalized intersections to favor through movement
- Limiting conflict points/separating conflict areas
- Removing left-turns from through-traffic lanes
- Managing left-turn movements
- Using non-traversable medians to enforce turn restrictions

1.3.5 Drainage Requirements and Impacts

Portions of Highway 105 corridor are located adjacent to the floodplain. Thus, roadway drainage takes on greater importance. Key drainage considerations include:

- Sizing culverts to convey peak flows under roadway
- Including water quality treatment features to mitigate runoff impacts
- Providing and/or relocating curb and gutter within urban sections

1.3.6 Traffic Noise

Residences are located in close proximity to the roadway. As the study area has become increasingly urbanized, traffic volumes, including truck traffic, have increased. Existing and future noise levels are of concern to corridor residents.

1.4 Previous Regional Transportation Studies

Two regional planning documents set forth policies related to Highway 105:

- El Paso County *2040 Major Transportation Corridors Plan Update* (2040 MTCP, October 2011)
- Pikes Peak Area Council of Governments *2035 Moving Forward Update* (2035 RTP Update, January 2012)

1.4.1 El Paso County *2040 Major Transportation Corridors Plan* (MTCP) Update

In 2011 El Paso County completed the 2040 MTCP update. *The purpose of the MTCP is to understand present traffic conditions and future transportation needs for unincorporated El Paso County and to identify major transportation corridor improvements necessary to accommodate those needs.*[1] The MTCP includes both an assessment of congestion and specific recommendations regarding functional classification, transportation modes, and other uses for the Highway 105 corridor. The Highway 105 project corridor is ranked as a currently congested facility by the MTCP. This means that current traffic volumes exceed capacity, a condition that results in significant daily delays. The MTCP also identifies Highway 105 as a secondary truck route. Although the corridor is not identified by the MTCP as either a future transit route or a future bicycle route, a CDOT Park and Ride facility at Woodmoor Drive and a planned regional trail crossing at the east end of the corridor position Highway 105 as an important regional connection for both transit and bicycle travel modes. The Corridor Preservation element of the MTCP calls for Highway 105 to be upgraded to a 4-lane principal arterial along the entire length of the project corridor. Although anticipated phasing for the widening of the full corridor to 4-lanes is considered to be a long-term need, needed in the year 2030 or beyond, identified existing congestion and safety issues have made a compelling case for near-term safety and operational improvements.

[1] El Paso County 2040 Major Transportation Corridors Plan, 2011.

1.4.2 Pikes Peak Area Council of Governments *2035 Moving Forward Update* (2035 RTP Update)

The Pikes Peak Area Council of Governments (PPACG) 2035 RTP Update was adopted in January 2012. The 2035 RTP Update identifies Highway 105, between I-25 and SH 83, as 4-lane principal arterial, consistent with the County 2040 MTCP. For purposes of fiscal constraint, the Highway 105 project corridor is shown on the RTP as a locally/privately funded improvement project. Since adoption of the 2035 RTP Update, improvements in the western segment of the corridor (Project A) were selected to receive FY-2014 federal STP-Metro funding and included in the current PPACG Transportation Improvement Program (TIP) as a short-term, committed project. The balance of improvements that were identified by the Highway 105 Corridor Study is now slated to be completed using local funds as anticipated by the 2035 RTP Update. The full corridor was included as a Category A project under the Pikes Peak Regional Transportation Authority (PPRTA) capital projects extension that was approved in the November 2012 general election by an 80% margin. The PPRTA Extension will take effect in 2015, and will remain in effect through the year 2024.

1.5. Master Plan Conformance

State statutes allow for adoption of a master plan in whole, in parts, or by functional subject matter (CRS 30-28-108). El Paso County's approach is to adopt an overall Countywide Policy Plan augmented by a series of small area plans that respond to conditions and circumstances unique to different areas of the County. As articulated in Section 6.1 of the El Paso County Policy Plan, it is the expectation that private and public bodies will rely on Small Area Master Plans for site-specific land use guidance. The Master Plan is further supported by and related to a series of subject matter element plans. The Town of Monument has taken a similar approach by adopting an overarching Comprehensive Plan that is supported functional subject matter element plans. The overarching County and Monument plans are respectively referred to as the County Policy Plan and the Comprehensive Plan. Other County and Town of Monument plans and master plan elements that are relevant to this project include:

- El Paso County Parks and Leisure Services Master Plan (2005)
- Tri-Lakes Comprehensive Plan (2000)
- Black Forest Preservation Plan (1987)
- Black Forest Preservation Plan Trails Addendum (1999)
- Town of Monument Parks, Trails and Open Space Master Plan (2003)

1.5.1 El Paso County Policy Plan (Updated 1994)

The *El Paso County Policy Plan* lists goals and policies to address specific transportation issues such as mobility and land use efficiency. The plan is intended to be implemented through use as a source of guidance in the design and review of land use applications within the County.

Policies most relevant to Highway 105 address corridor preservation and access management. The County Policy Plan supports identification of rights-of-way needed to serve future travel demand, and requires preservation of corridors for transportation facilities through the land development process. The Policy Plan also encourages corridor preservation for pedestrian and bicycle facilities.

Access management policies require limits on direct access to major facilities, but also request that a balance between the support of regional mobility and provision of local access onto major facilities. Another relevant policy requests the provision of noise and visual screening through setbacks, buffers, vegetation, or other treatments. This could include noise abatement treatments if warranted.

1.5.2 Town of Monument Comprehensive Plan Update (2003)

The Town of Monument Comprehensive Plan planning area includes the incorporated portion of the Highway 105 project corridor that lies within the Town of Monument. The Comprehensive Plan provides a framework for decision-making that is advisory in nature. The Comprehensive Plan is intended to:

- *Provide a framework that supports informed and consistent decision-making by Town elected officials, appointed officials, and staff.*
- *Outline principles and policies concerning land use, housing, parks, development, transportation, and other elements.*
- *Guide public investment and provision of public services.*
- *Develop policies that balance the rights of the individual with the interest of the community.*
- *Embody policy and guiding principles for the community; zoning ordinances, subdivision regulations, and capital improvement programs then provide the detailed means of implementing those principles.*[2]

Comprehensive Plan policies that are most relevant to Highway 105 address access management, and the provision of safe, interconnected options for non-motorized facilities. The Comprehensive Plan defers to the County for Highway 105 design criteria and other policy issues.

1.5.3 El Paso County Parks and Leisure Services Master Plan (2005)

The Master Plan does not identify the project corridor as an on-road paved bicycle road, nor does the Master Plan identify existing or future trail facilities with direct connections to The Highway 105 project corridor. Guidance is included in the Master Plan relative to configuration, function and use of on-road paved bicycle facilities.[3] As shown in Table 1.1, below, paved shoulders of 8-foot width and 10-foot width, located on both sides of the roadway, will support use of the project corridor for bicycle travel in accordance with County standards and guidance. Bicycle lane signing and striping, in accordance with adopted standards, should be included in preliminary and final design, and should be implemented for interim and ultimate implementation phases.

[2] Town of Monument. Town of Monument Comprehensive Plan Update. December 2003. p. 1.
[3] El Paso County, Parks and Leisure Services Master Plan, September 2005, p. 7-29.

Table 1.1: Excerpt from El Paso County Parks and Leisure Services Master Plan				
Classification	**Size**	**Purpose/Function**	**Recreational Activities**	**Amenities**
On-Road Paved Bicycle Route	6’ to 8’ width depending on speeds of road	Separate vehicular and bicycle lanes on roadways to improve road safety and the recreational experience for the bicyclist. Provide links between communities and access to recreational areas of regional significance. Scenic route. This type of trail is not the responsibility of the Parks Department; however coordination should occur to ensure that important connections are made to the Regional Trail System and other major access trails.	• Recreational road biking • Commuter biking	• Paved lane on at least one side of the road • Identification signage (and striping)

1.5.4 Tri-Lakes Comprehensive Plan (2000)

The Tri-Lakes Planning Area includes the unincorporated portion of the Highway 105 project corridor. The remainder of the corridor (the western segment) is included in the Town of Monument Comprehensive Plan planning area. The primary purpose of the Tri-Lakes Comprehensive Plan is:

> *to function as the overall guidance document of the County Master Plan for the Tri-Lakes Planning Area. It should be relied on by the Planning Commission and the Board of County Commissioners for guidance, direction and expectations concerning broader land use planning issues including growth management, compatibility, land use equity, property rights, and service standards. A secondary purpose of this Plan is to provide a framework to take into account the individual character of the Sub-Areas within the overall context of the Plan.*[4]

Policies and observations that are most relevant to Highway 105 include the need to provide adequate capacity to serve significant growth within the planning area and need to provide pedestrian and bicycle access to roadway system facilities, particularly those that serve school access. The Plan also recognizes the need to provide better connectivity, particularly through development of additional east west connectors and/or east-west carrying capacity.

1.5.5 Black Forest Preservation Plan (1987)

The Black Forest Preservation Plan is a small area plan providing future land use guidance for the unincorporated area of El Paso County north of Colorado Springs. Its northern boundary is contiguous with County Line Road and its southern boundary extends as far south as Woodmen Road. Although the planning area extends west to I-25 and east to Eastonville Road, the Highway 105 study corridor is located outside of, and to the north of the planning boundary. The Black Forest Preservation Plan is relevant to the Highway 105 Corridor in that it includes the SH 83/Highway 105 intersection, as well as Walker Road the eastern extension of Highway 105. Thus, Highway 105 serves as part of the arterial roadway system that is *needed to allow Black Forest residents to travel quickly and safely over substantial distance between homes, work places and shopping*.[5] For roads like Highway 105 that are designated for this purpose, individual access points should be kept to a minimum. Further, the County recommends one-mile spacing between accesses to (cross streets of driveways) roadways that are classified as principal or minor arterials.

1.5.6 Black Forest Preservation Plan Trails Addendum (1999)

The Trails Addendum to the Black Forest Preservation Plan *provides planning for a network of non-motorized, multi-use trails within the Black Forest Planning Area.*[6] Although the Highway 105 project corridor lies outside of the Black Forest Preservation Plan Planning Area, a proposed trail along SH 83 would cross the Highway 105 project alignment to the west of SH 83, along a Cheery Creek tributary.

1.5.7 Town of Monument Parks, Trails, and Open Space Master Plan (2003)

The goals of the Town of Monument Parks, Trails and Open Space Master Plan include linking existing and proposed Monument trails with: *regional trails, development areas around the Town of Monument, future trail heads in the Town and around the community, and existing and proposed parks.*[7] A proposed on-street Second Street Trail extension east of Interstate 25 is identified by the Monument Parks, Trails and Open Space Master Plan to provide needed connections to the El Paso County regional trails network. The new trail/trail extension would provide connections to the existing Mitchell Road and Santa Fe north-south trails, as well as to proposed trails including the Jackson Creek Trail (Baptist Road/Baptist Road on-street trail to Highway 105) and Wahlborh Trail (Highway 105 to the Jackson Creek Trail).

1.6 Conclusions

Several themes consistently run through the planning documents that were reviewed for the Highway 105 Corridor Study: corridor preservation; accommodating multimodal transportation, especially pedestrian/bicycle mobility; providing adequate carrying capacity; and access management.

[4] El Paso County. 2000 Tri-Lakes Comprehensive Plan. October 1999. p. 4.

[5] El Paso County. Black Forest Preservation Plan Update. December 1987. p. 38.
[6] El Paso County. Trails Addendum to the Black Forest Preservation Plan. June 1999. p. A-1.
[7] Town of Monument. Town of Monument Parks, Trails and Open Space Master Plan. November 2003. p. 1.

2 Purpose and Need

The purpose of the Highway 105 Corridor Study is to identify corridor improvements needed to address the problems of congestion and safety affecting the Highway 105 between I-25 and SH 83, conditions which will continue to worsen as development and population growth continue in the area. This includes improvements needed to upgrade the roadway as needed to meet applicable design criteria as well as improvements needed to provide the additional roadway capacity needed to serve existing and future corridor travel demand. Both access management and geometric improvements must be considered as a means to optimize corridor traffic operations and improve the capacity of Highway 105, while balancing access needs to adjacent areas.

The Study resulted in a comprehensive plan that identifies the specific improvements needed to address existing and future corridor operational deficiencies, appropriate timing and phasing for the improvements, and necessary corridor preservation strategies need to minimize the impacts to the surrounding natural and human environment of future corridor expansion.

To preserve the option to utilize federal funding to finance future improvements, it was also important that the Study be undertaken using a Planning and Environmental Linkages (PEL) approach in which preliminary environmental studies were completed to set the stage for possible National Environmental Policy Act (NEPA) documentation and clearance processing should future implementation activities require full or limited NEPA documentation. Examples include: completion of a noise study, initiation of Threatened and Endangered Species (TES) coordination, and completion of Waters of the U.S. (WUS) wetlands field investigation and report.

3 Alternatives Analysis

The project team conducted existing conditions and future "no build" baseline analysis as a basis to identify corridor deficiencies and improvement needs. The results of the baseline analysis were used, together with public and stakeholder input from the first of three public meetings, to identify and confirm corridor issues to be addressed. A full range of improvement alternatives was then developed, evaluated and iteratively refined to provide:

- Improved motorist and pedestrian/bicyclist safety
- Improved Roadway Alignment and Cross Section
- Improved Intersection Layout and Control
- Improved Access Management
- Improved Roadway Drainage

County and Town of Monument staff were briefed on the improvement concepts and the various options were refined and optimized in accordance with their input. One-on-one presentations were also offered to potentially impacted individuals, businesses and neighborhoods to introduce analysis findings and final concepts to them in advance of presentation to the general public. The baseline analysis results and alternative intersection improvement strategies were then presented to corridor residents and interested stakeholders at the second of two public open house-format meetings. Technical components of alternatives evaluation included baseline and future build alternatives analysis. The existing conditions baseline and future "no build" baseline scenarios were evaluated with respect to traffic operations, safety, constructability, cost, and potential project impacts (social, economic and environmental). Cost estimates, including all but right-of-way and utility relocation costs, were also prepared by the consultant team for "short-listed" alternatives. Initial cost estimates were reviewed by County engineering staff, and were revised and updated as needed. County revisions to the draft cost estimates included addition of a line item for right-of-way for the near term Project Segment A costs. Final concept-level cost estimates for the preferred alternatives for each proposed segment/phase are detailed in *Chapter 8: Conceptual Cost Estimates and Phasing Options*.

3.1 Safety

A number of correctable factors contribute to Highway 105 crash incidence. These factors include:

- Curves and steep grades
- Lack of shoulders or turn lanes
- Frequency of access points
- Lack of pedestrian/bicycle facilities, and
- Inadequate roadway/intersection capacity

3.2 Roadway Design

The roadway design element of the Highway 105 alternatives analysis began with a thorough review of the existing horizontal and vertical alignments, as well as the typical roadway cross sections. Existing conditions were compared to County and AASHTO design criteria and the roadway cross section and functional classification specified by the Master Transportation Corridor Plan (MTCP). Based on adjacent land use and roadway usage, the Highway 105 Corridor was split into two sections for the analysis, an urban section (I-25 ramps to Lake Woodmoor Drive) and a rural section (Lake Woodmoor Drive to Highway 83).

3.2.1 El Paso County Design Criteria – 4-Lane Principal Arterial

The 2040 Major Transportation Corridor Plan lists Highway 105 as a 4-lane principal arterial. The current speed limit is 50 miles per hour. The El Paso County Engineering Criteria Manual rural and urban standards shown in *Table 3.1* and *Table 3.2* are to be used for 4-lane principal arterials.

Table 3.1: Roadway Design Criteria for 4-lane Rural Arterials

Design Speed / Posted Speed (MPH)	70 / 65
Clear Zone	34'
Minimum Centerline Curve Radius	2,510' [1]
Number of Through Lanes	4
Lane Width	12'
Right-of-Way	180'
Paved Width	38' [2]
Median Width	24'
Outside Shoulder Width (paved/gravel)	12'(10'/2')
Inside Shoulder Width (paved/gravel)	6'(4'/2')
Design ADT	40,000
Design Vehicle	WB-67
Access Permitted	No
Access Spacing	n/a
Intersection Spacing	½ mile
Parking Permitted	No
Minimum Flowline Grade	1%
Centerline Grade (Min.-Max.)	1-5%
Intersection Grades (Min.-Max.)	1-3%
Notes: 1 Assumes 4% superelevation, 6% for 70 MPH design speeds *2 Pavement width in each direction for divided roadways*	

Source: El Paso County Engineering Criteria Manual (from Table 2-4. Roadway Design Standards for Rural Expressways and Arterials)

Table 3.2: Roadway Design Criteria for 4-lane Urban Arterials	
Design Speed / Posted Speed (MPH)	50 / 45
Clear Zone	20’
Minimum Centerline Curve Radius	930’[1]
Number of Through Lanes	4
Lane Width	12’
Right-of-Way	130’
Paved Width (Excluding Gutter Pan)	36’[2]
Median Width (Including Curb & Gutter)	19’
Shoulder Width (Ext., Excluding Gutter)	8’
Shoulder Width (Int., Excluding Gutter)	4’
Required Curb/ Gutter Type (Vertical)	6”
Sidewalk Width (@ FL)	6’ detached
Design ADT	40,000
Design Vehicle	WB-67
Bike Lanes Permitted	Yes
Access Permitted	No
Access Spacing	n/a
Intersection Spacing	½ mile
Parking	No
Minimum Flowline Grade of Curb	.50%
Centerline Grade (Min.-Max.)	0.5-6%
Intersection Grades (Min.-Max.)	0.5-3%
Notes: 1 Assumes 4% superelevation, 6% for 70 MPH design speeds *2 Pavement width in each direction for divided roadways*	

Source: El Paso County Engineering Criteria Manual (from Table 2-4. Roadway Design Standards for Rural Expressways and Arterials)

3.2.2 El Paso County Design Criteria – Other Design Criteria

Additional El Paso County design criteria address roadway alignment and its relationship to sight distance adequacy. The County design criteria are specified for 10 mph increments and mirror design criteria that are provided in American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets*[8] for 5 mph increments. The AASHTO values, at 5 mph design speed increments are summarized by *Table 3.3: Design Controls for Stopping Distance and for Crest Vertical Curves* and *Table 3.4: Design Controls for Stopping Distance and for Sag Vertical Curves*.

[8] The American Association of State Highway and Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets*, 6th Edition. 2011. Washington, DC.

Table 3.3: Design Controls for Stopping Distance and for Crest Vertical Curves			
Design Speed (mph)	**Stopping Sight Distance (ft)**	**Rate of Vertical Curvature, *K****	
		Calculated	**Design**
30	200	18.5	19
35	250	29.0	29
40	305	43.1	44
45	360	60.1	61
50	425	83.7	84
55	495	113.7	114
60	570	150.6	151
65	645	192.8	193
70	730	246.9	247
75	820	311.6	312
80	910	383.7	384
*Source: A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011. Note: * Rate of vertical curvature, K, is the length of curve per percent algebraic difference in intersecting grades (A), K=LIA*			

Table 3.4: Design Controls for Stopping Distance and for Sag Vertical Curves			
Design Speed (mph)	**Stopping Sight Distance (ft)**	**Rate of Vertical Curvature, *K***	
		Calculated	**Design**
30	200	36.4	37
35	250	49.0	49
40	305	63.4	64
45	360	78.1	79
50	425	95.7	96
55	495	114.9	115
60	570	135.7	136
65	645	156.5	157
70	730	180.3	181
75	820	205.6	206
80	910	231.0	231
*Source: A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011. Note: * Rate of vertical curvature, K, is the length of curve per percent algebraic difference in intersecting grades (A), K=LIA*			

3.2.3 Existing Conditions

As discussed in the introduction, maintenance responsibility for Highway 105, formerly a segment of State Highway 105 (SH 105) was transferred to El Paso County in 2008. The roadway was transferred to the County in as is condition. As a foundation for assuming its new oversight and maintenance role for the roadway, the County sought, through the Highway 105 Corridor Study, to identify needed roadway upgrades and to develop an implementation plan for improving the roadway as needed to serve existing and future corridor travel demands.

Input from design-level survey of the corridor was used to construct CAD modeling of the full roadway alignment within the project corridor. This included development of a Digital Terrain Model (DTM) to accurately represent the existing vertical alignment of the roadway. The adherence of the existing condition to the adopted County design criteria was then evaluated. In reviewing the existing conditions models, it was found that many areas along the Highway 105 project corridor do not meet County design criteria for the posted speed and/or the designated design speed and roadway functional classification as designated by the County 2040 MTCP. Although areas throughout the corridor exhibit minor variances, there were three notable horizontal curves and five notable vertical curves that fall significantly short of meeting the County design criteria.

3.2.3.1 Existing Horizontal Alignment

The three identified areas in which horizontal curves are of concern are: at the curve west of Sierra Way, at the curve between the east Spring Park Drive access and Roller Coaster Road, and at the curve located to the west of Arches Drive. The specific variances from the County standards at these locations are listed below, with further detail is provided in *Table 3.5*.

- The curve radius is also too small to meet the minimum design criteria at the following horizontal curve locations:
  - West of Sierra Way (STA 216+58.52 to 219+87.55)
  - East Spring Park Drive to east of Roller Coaster Road (STA 275+73.23 to 281+41.16)
  - West of Arches Drive (STA 248+30.29 to 251+83.87)
- The angle break is greater than the maximum design criteria (1 degree) at the following location: Knollwood Boulevard (STA 120+00.65)

3.2.3.1 Existing Vertical Alignment

The locations of the five identified vertical curves that are of concern are centered on the following locations: east of Briarhaven Court, between Furrow Road and Martingale Drive, between Martingale Drive and Arrowwood Drive, west of West Forest Drive, and at Roller Coaster Road. The specific variances for County/AASHTO design criteria associated with these locations are listed below, with further detail provided in *Table 3.6*.

- Grade at an intersection is not between 1 % and 3% at the following vertical curve locations:
  - Centered at West Forest Drive (Curve VPI – STA 222+91.86)
  - Centered at Roller Coaster Road (Curve VPI – STA 291+15.98)
- Maximum grade of 6% in urban/5% in rural is not met at the following locations:
  - East of Briarhaven Court (Curve VPI – STA 156+03.80
  - Between Furrow Road and Martingale Road (Curve VPI – STA 192+20.31)
  - Between Martingale Road and Arrowwood Drive (Curve VPI – STA 202+98.56)
  - Centered at West Forest Drive (Curve VPI – STA 222+91.86)
  - Centered at Roller Coaster Road (Curve VPI – STA 291+15.98)

As shown in *Table 3.6*, the posted speed K values for vertical curves are not met for any of the identified substandard vertical curves. In addition, Corresponding Design Speed values shown in *Table 3.6* represent the effective design speed under existing conditions. In these cases, the effective design speed is less than the existing posted speed limit.

Table 3.5: Existing Horizontal Curve Analysis

Horizontal Curve Existing Conditions					
Location of Curve PI	**Radius (ft)**	**Length of Curve (ft)**	**Posted Speed (mph)**	**Existing *e* (%) ***	**Corresponding Design Speed (mph)**
STA 218+24.15	1160	329	50	4.6%	40
STA 250+08.46	1160	354	50	4.6%	40
STA 278+73.87	700	568	50	4.6%	30
*Note: * Design Speed is calculated on the assumption that emax = 6%*					

Table 3.6: Existing Crest Vertical and Sag Vertical Curve Analysis

Vertical Curve Existing Conditions							
Location of Curve VPI	**Type of Curve**	**SSD (ft)**	**Length of Curve (ft)**	**Posted Speed (mph)**	**Design *K* Value**	**Calculated *K* Value**	**Corresponding Design Speed (mph)**
STA 156+03.80	Crest	313	400	50	84	45.48	40
STA 192+20.31	Sag	268	250	50	84	53.52	35
STA 202+98.56	Crest	341	500	50	84	53.95	40
STA 222+91.86	Crest	236	200	50	84	25.17	30
STA 291+15.98	Crest	265	300	50	84	32.58	35

3.2.3 Alignment Analysis

As discussed in the existing conditions section, much of the existing vertical and some of the existing horizontal alignment do not meet the design criteria for the given speed and roadway classification. At the same time, much of the corridor is developed such that realignment of the full roadway corridor would create significant impacts to adjacent homes and businesses. Initially the project team developed a “best fit” alignment for the full corridor that was designed to address adherence to County design criteria with consideration given only to physical constraints, including corridor terrain and existing corridor development. The “best fit” concept is not a practical alternative in that its implementation would require full reconstruction of almost all of the alignment, a circumstance that would complicate if not preclude maintenance of traffic, would have significant impact to adjacent development in terms of right-of-way acquisition, slope easements, etc., and would cost far more than the benefit to be derived from the improvement. The “best fit” alignment layout exercise was nonetheless valuable, providing the team a clear understanding of logical limits for essential alignment improvements.

To balance the need to make alignment improvements with the desire to minimize property impacts, the project team identified select locations in which significant, beneficial alignment modifications could be made to improve the alignment in such a way that the intent of the County design criteria would be met and corridor safety would be improved. Three locations were selected as the primary focus of proposed vertical curve improvements. These locations are between Fairplay Drive and Martingale Drive, and the areas centered on West Forest Drive and Roller Coaster Road. More minor adjustments are also proposed at other locations throughout the corridor, particularly in combination with intersection improvements. All vertical alignment adjustments are shown on *Section 7: Conceptual Plan and Profile*, in *Figure 7.1* through *Figure 7.19*.

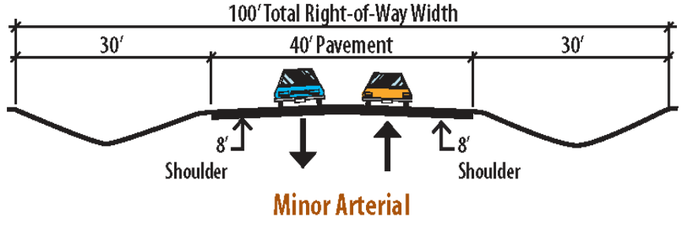
Horizontal alignment adjustments were made only within rural sections of the project corridor in which adjacent development was located at some distance from the existing roadway and edge of pavement. These adjustments generally resulted in lengthening the curves such that sight distances could be improved, and at times often were coupled with complementary vertical curve adjustments. Both retaining wall and standard cut/fill options were examined in each area as strategies to transition grade modifications to existing grade on adjacent parcels (see *Figure 3.2* and *Figure 3.4*). All horizontal curve adjustments are shown on *Section 7: Conceptual Plan and Profile*, in *Figure 7.1* through *Figure 7.19*.

Due to existing terrain, the need to maintain traffic on the existing roadway, as well as benefit/cost considerations, a total rebuild of the roadway was neither feasible nor practical. As a result, not all of the El Paso County design criteria can be met. Instead, a balance was achieved that effectively improves corridor safety and capacity such that that proposed design represents a significant improvement over the existing condition and will be adequate to meet future traffic demand.

3.2.4 Typical Sections

Typical sections from the El Paso County Engineering Criteria Manual were reviewed for the corridor, including: an urban 4-lane principal arterial section, a rural 4-lane principal arterial section and a rural 2-lane minor arterial section (see *Figure 3.1*).

Figure 3.1: Applicable El Paso County Engineering Criteria Manual Typical Cross Sections



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Although the County's 2040 MTCP Update calls for a 4-lane principal arterial cross section for the Highway 105 project corridor, traffic analysis completed as part of the project, determined a 2-lane section will adequately serve forecast 2040 traffic demands within the eastern, rural portion of the Highway 105 Corridor. Within this corridor segment, intersection turn bays improve traffic flow by eliminating spillback queuing into the through lanes. Ten-foot shoulders on both sides of the roadway provide a standard cross section and the added benefit of accommodating bicycle travel.

Figure 3.2: Rural 2-Lane Section Standard Cut/Fill Option

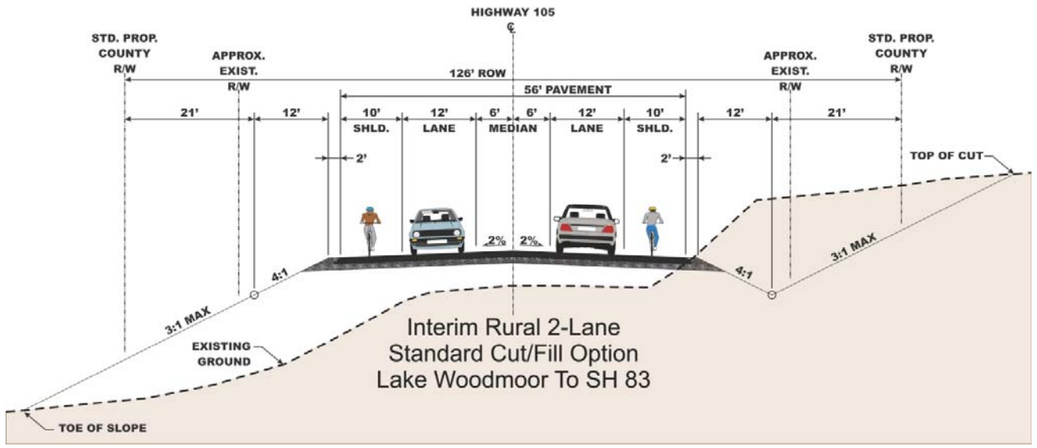
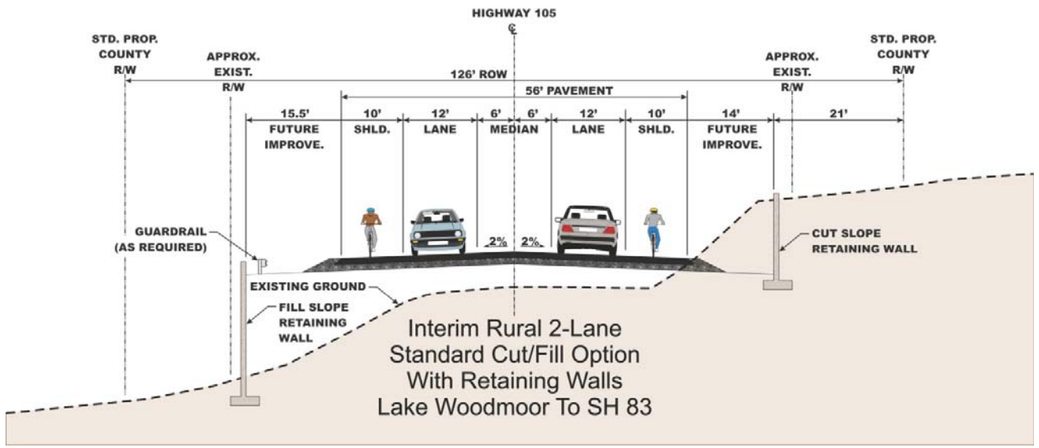
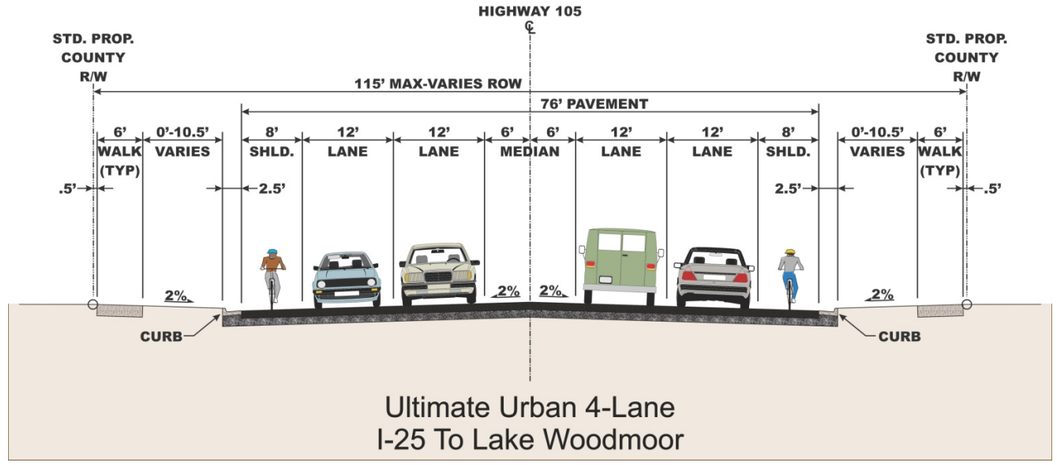


Figure 3.3: Rural 2-Lane Section – Standard Cut/Fill Option with Retaining Walls



Most of the western, urban section of the corridor is already built to the required ultimate 4-lane section. Within this portion of the corridor, planned improvements consist of: drainage improvements, intersection upgrades, and the addition of sidewalks. As shown in Figure 3.4, below, 8-foot shoulders will provide the standard shoulder width (6-foot minimum width) needed to accommodate on-street bicycle travel. In the rural portion of the corridor where right-of-way is less constrained, wider, 10-foot wide shoulders (see Figure 3.2 and Figure 3.3) will accommodate bicycle traffic within the shoulders. Although Highway 105 is not designated by the El Paso County Parks and Leisure Services Master Plan as a bicycle route, upgrade of the Highway 105 urban cross section, and the addition of shoulders, in the rural portion of the corridor where none currently exist, will support bicycle travel along the full project corridor. This will facilitate bicycle travel within the project corridor travel shed and will improve bicycle travel connectivity between Highway 105 and trails and bicycle routes that are located to the south and north, including the Jackson Creek Trail and the Fox Run Trail.

Figure 3.4: Ultimate Urban 4-Lane Section – I-25 to Lake Woodmoor Drive



3.2.5 Intersection Options

Channelized turn lanes are needed at all corridor intersections to reduce delays and improve corridor safety. Based on the traffic operations analysis, existing traffic operational deficiencies were also identified at the intersections of Gold Canyon Road, Lake Woodmoor Drive, Furrow Road and State Highway 83. For the future baseline condition, with no intersection improvements, operational deficiencies were identified at five additional intersection locations: Briarhaven Court, Winding Meadows Way, Fairplay Drive, Roller Coaster Road, and Martingale Drive. One of these intersections, the intersection with State Highway 83, will be improved by CDOT. The CDOT improvements will include an interim phase to address identified deficiencies, and may include future signalization.

Signal warrants are not met at this location at present. Three other intersections, those with Briarhaven Court, Winding Meadows Way and Martingale Drive, are currently stop-controlled, "T-intersections" that will experience increased delays in the future, with increasing difficultly entering heavier Highway 105 traffic from the side streets. In all cases, it is the left-turn onto Highway 105 that will be most affected by increased Highway 105 traffic volumes. Intersection traffic control alternatives including signals and roundabouts need to be considered in the future in order to achieve acceptable levels of service (LOS C/D). The intersections at Fairplay Road, Furrow Road, and Roller Coaster Road were evaluated for geometric and intersection control improvements beyond basic turn-bay enhancements. At least two alternatives were evaluated for each intersection as summarized in *Table 3.7: Intersection Upgrade Alternatives*, and as shown in *Figure 3.5* through *Figure 3.10*. Although the intersection configuration for each alternative is shown for an ultimate 4-lane Highway 105 rural cross section, all could be built in an interim configuration for the upgraded, 2-lane Highway 105 cross section, and widened to the 4-lane ultimate cross section with minimal or no throw-away should that be necessary at some time in the future. However, based on current forecasts, the two-lane section should provide adequate capacity for the corridor segment east of Lake Woodmoor Drive, at least through the current planning horizon. The signalized intersection alternatives and roundabout alternatives are expected to provide acceptable comparable additional intersection capacity and service to minor cross streets. Due to the close proximity of signalized intersections to the west of the Gold Canyon Road and Lake Woodmoor Drive intersections, signalized intersections were emphasized for initial concept-level alternatives analysis at those locations. Roundabout alternatives were also considered and will be assessed further in the future as improvements at these locations are advanced through preliminary and final design. *Table 3.7*, below, lists traffic control alternatives that were considered for the Fairplay Drive, Furrow Road and Roller Coaster Roads intersections. A second listing, at the bottom of *Table 3.7*, identifies the Furrow Road and Roller Coaster Road intersections as priority locations for signalized intersection or roundabout alternatives, with the Fairplay Drive, Gold Canyon Road and Lake Woodmoor Drive intersections considered as potential locations for additional signals or roundabouts.

Specific improvement alternatives for the Fairplay Drive, Furrow Road and Roller Coaster Road intersections, as well as potential locations for future signalized intersections or roundabouts, were presented to the general public at the second of three Open House-format public meetings. There was strong support among those present for a signal at Gold Canyon Road, a potential signal location that coincides with the development plan for the south side of Highway 105 that was approved by the Town of Monument. There was also skepticism and opposition expressed by citizens concerning using roundabouts as a future intersection control option. However, roundabouts are viable alternatives to signalized intersections and will be further examined as specific intersection improvements (signalization or roundabouts) are developed during future project design phases.

Table 3.7: Intersection Upgrade Alternatives

Roadway	Alternative #1	Alternative #2	Alternative #3
Fairplay Drive	Signal	Roundabout	Stop-Control led "T" intersection with left out acceleration lane
Furrow Road	Signal	Roundabout	
Roller Coaster Road	Signal	Roundabout	
New Signal or Roundabout Location			
Fairplay Drive		Potential Signal or Roundabout Location	
Furrow Road		Likely Signal or Roundabout Location	
Roller Coaster Road		Likely Signal or Roundabout Location	
Gold Canyon Road or Lake Woodmoor Drive		Potential Signal or Roundabout Location	

Traffic operations analysis for the proposed alternatives showed that either of the two alternatives proposed for Fairplay Drive, Furrow Road and Roller Coaster Road would operate at an acceptable level of service for existing and future peak period traffic. The intersection improvements that are ultimately implemented for Fairplay Drive will need to be coordinated with intersection improvements implemented for Furrow Road given the close proximity of the two intersections (1350'). Compatible improvements might include paired roundabouts or a pairing of a Fairplay Drive T-intersection with left-turn acceleration lane with a signalized Furrow Road intersection. In the second example, the Fairplay Drive intersection could later be signalized, if warranted, in a "Continuous Green T" configuration that would have minimal impact on Highway 105 through traffic flow.
The intersection improvements that were considered for the Fairplay Road intersection were a stop-controlled T-intersection with a left-turn (onto Highway 105) acceleration lane, signalization and a roundabout. For Furrow Road and Roller Coaster Road signalized alternatives and roundabout

alternatives were considered. Signal warrant analysis was not completed at either location, and it is important to note that signal warrants would need to be met for signal installation. If selected as preferred alternatives, roundabouts could be constructed at any of the five intersections even if traffic signal volume warrants were not met. Approach grade requirements (4% or less for at least 200') would be similar for either a signal alternative or a roundabout alternative, as would sight-distance related geometric considerations. Generally, signalized alternatives would require less right-of-way than would roundabout alternatives, particularly where two-lane roundabouts would be needed, west of Lake Woodmoor Drive.

Figure 3.5: Fairplay Alternative #1

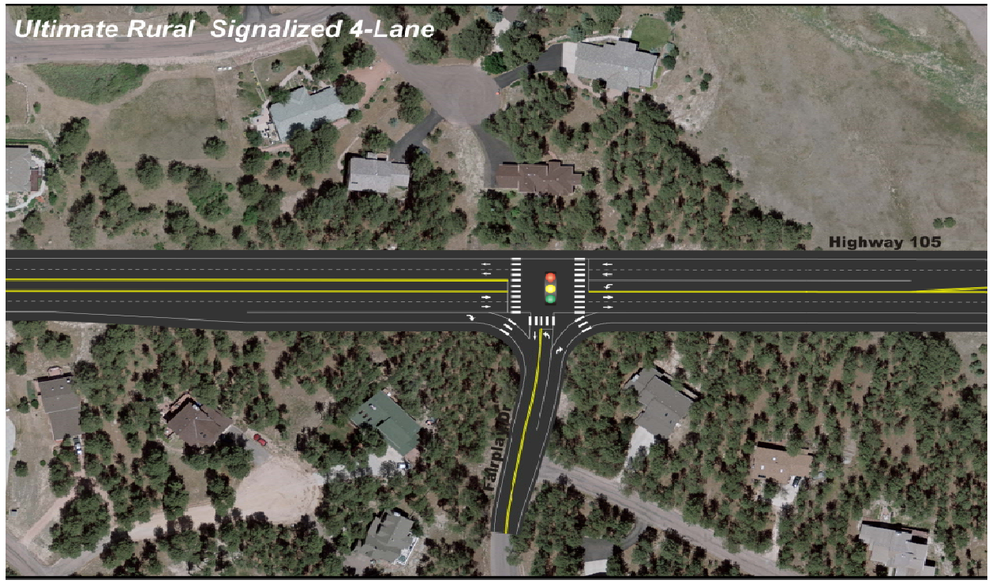


Figure 3.6: Fairplay Alternative #2

Figure 3.7: Furrow Alternative #1

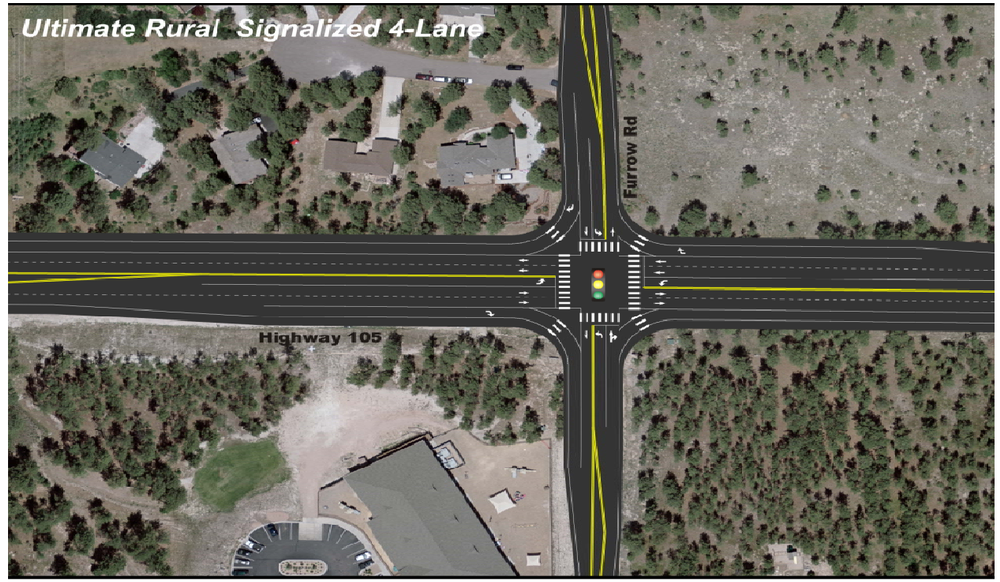


Figure 3.8: Furrow Alternative #2

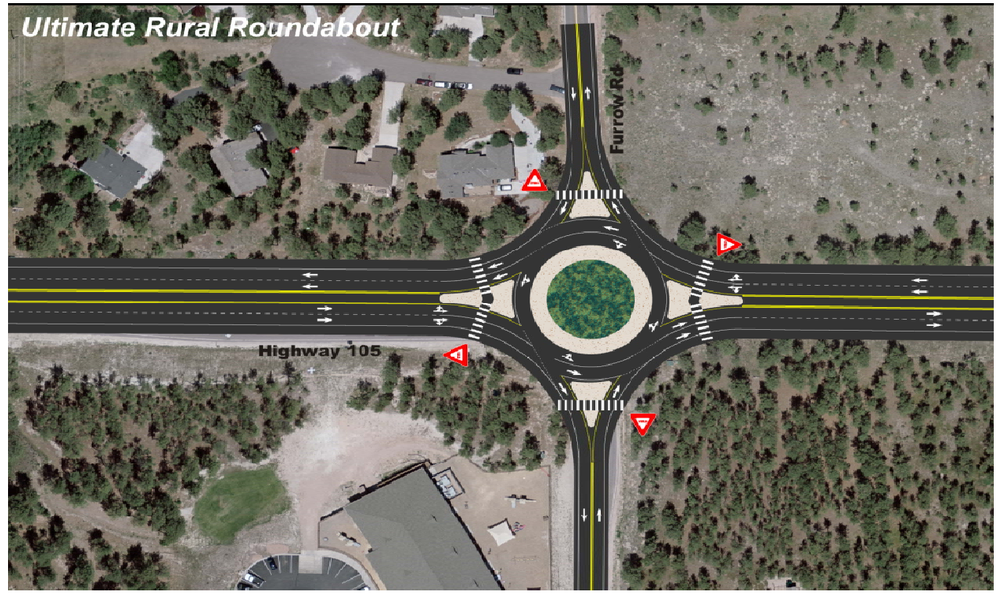


Figure 3.9: Roller Coaster Alternative #1

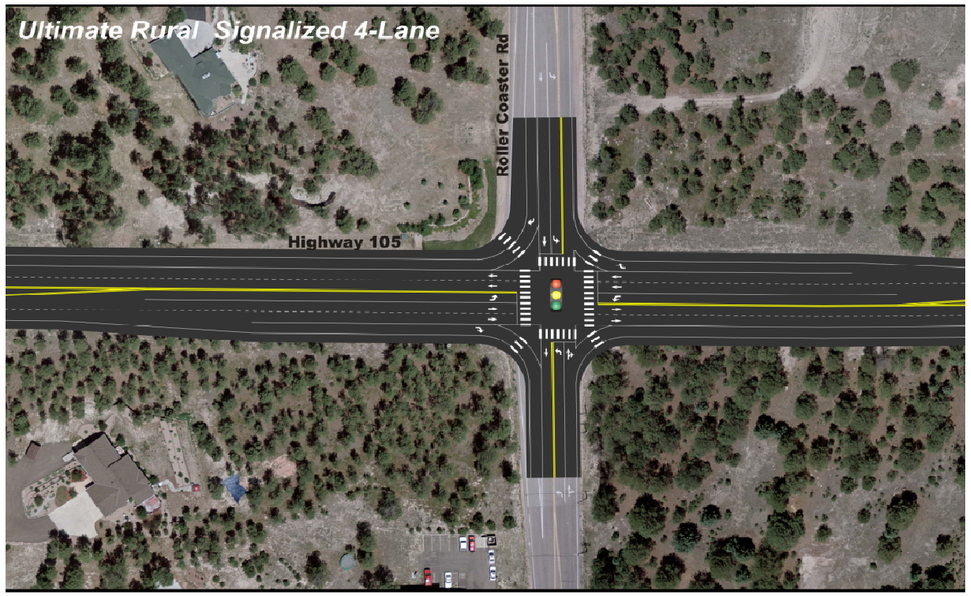
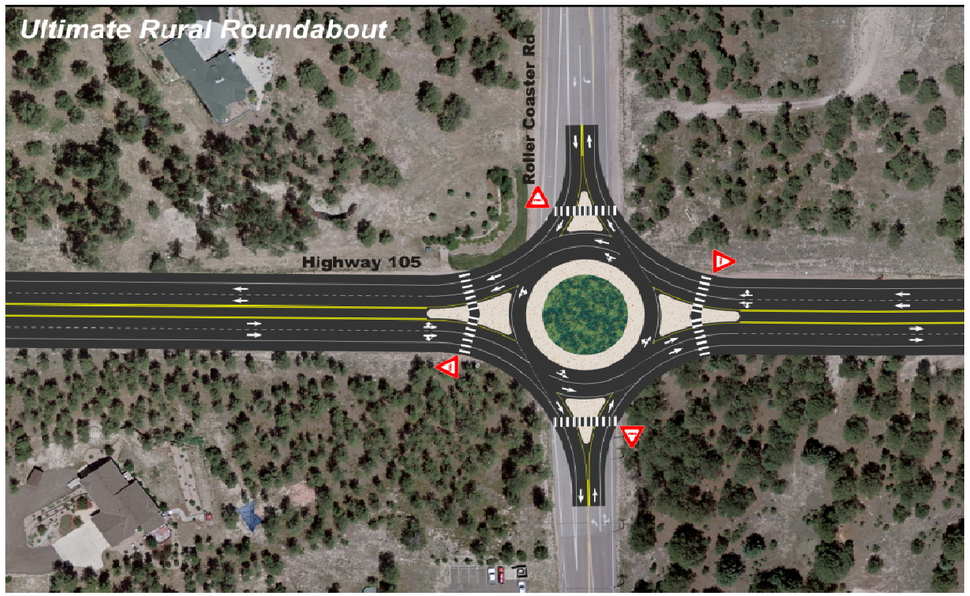


Figure 3.10: Roller Coaster Alternative #2



3.3 Access Needs and Impacts

The Transportation Research Board (TRB) Access Management Manual[9] identifies ten "Principles of Access Management," as follow:

1. **Provide a specialized roadway system** (with different types of roads to serve different functions).
2. **Limit direct access to major roadways** (those intended to convey through traffic).
3. Promote intersection hierarchy (interchanges to connect arterials, intersections connecting arterials, collectors and local street provide similar appropriate transitions).
4. **Locate signals to favor through movements** (long uniform spacing on major arterials enhances coordination).
5. **Preserve the functional area of intersections and interchanges** (adequate spacing must be preserved to accommodate necessary acceleration and deceleration lanes).
6. **Limit the number of conflict points** (conflict points include diverging, merging, weaving, crossing areas, and points at which stopping and queuing occur).
7. **Separate conflict areas** (separate intersections; the spacing needed increases as travel speed increases).
8. **Remove turning vehicles from through-traffic lanes** (turn lanes provide protected deceleration areas).
9. **Use non-traversable medians to manage left-turn movements** (medians channel turning movements on major roadways to designated locations).
10. **Provide a supporting street and circulation system** (a well-planned supporting system of collector and local streets is needed to accommodate development).

Most of the land adjacent to the Highway 105 study corridor is built out. Commercial uses predominate in the western study corridor, between Woodmoor Drive and Lake Woodmoor Drive, including a mixed use development plan that has been approved for the parcel south of Highway 105, between Knollwood Drive and Lake Woodmoor Drive. East of Lake Woodmoor Drive, and north and south of the corridor adjacent to the roadway, residential uses predominate to the west of Peaceful Pines Road. East of Peaceful Pines Road, large-lot residential and pasture land uses predominate. Woodmoor Drive, Fairplay Drive, Furrow Road, and Roller Coaster Road provide connections to most residential neighborhoods, as well as connections to east-west County Line Road (north of Highway 105) and Higby Road (south of Highway 105). However, at least three small have little or no connectivity with these north-south routes or the supporting system of collector and local streets that serve the larger residential developments located within the larger Highway 105 study area.

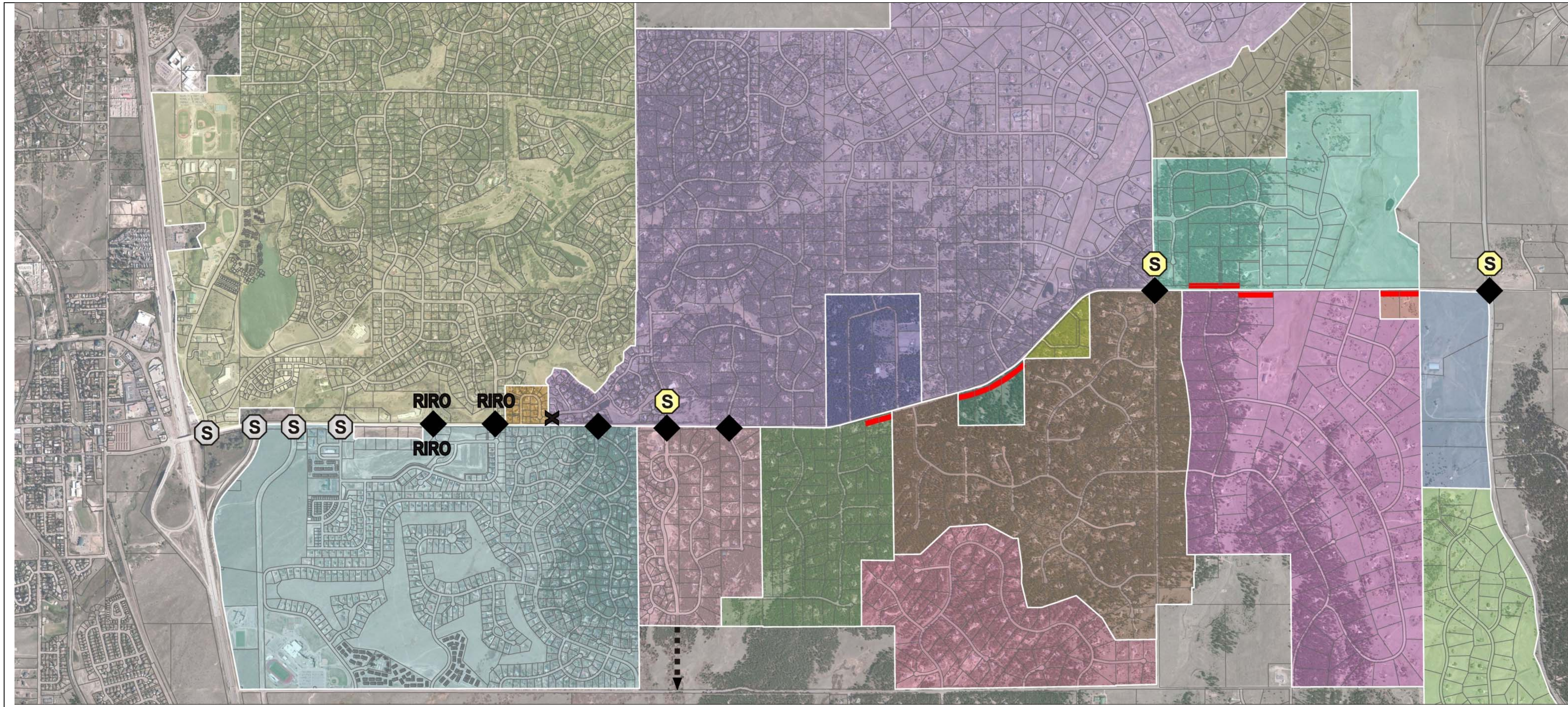
[9] Access Management Manual, Committee on Access Management, Transportation Research Board of the National Academy of Sciences, Washington, D.C., 2003.

There are also a few small subdivisions, a well as selected lots within larger subdivisions that have only direct driveway access to Highway 105. Within built-out areas, the extent and configuration of the existing supporting street and circulation systems can have a profound impact of the major arterial access requirements.

Access management alternatives, including selected access closures, were considered as means to reduce congestion and improve corridor safety. To evaluate the potential to consolidate Highway 105 study corridor access, commercial and residential parcels and subdivisions were grouped by access commonalities. Color-coded mapping of parcel by common accesses was used to identify direct access to Highway 105 that could be closed and mapped. Four alternative access management concepts were developed, as shown in *Figure 3.11 through Figure 3.14***.** These alternatives were developed giving consideration to the connectivity of existing access points to developed neighborhoods and individual ownership parcels. Access closures were proposed only where alternative, equivalent access was/could be provided. Benefits of the potential closures, if any, were then evaluated. The four access management concepts were presented to the general public at the second of three Open House-format public meetings. There was initial opposition closing access and creating new access. Additional review of the operational benefits of selected access closures, as well as the effectiveness of access management tools that could be used in lieu of access closures, was undertaken. Based on analysis findings, final recommended access management recommendation strategies to be used on the Highway 105 project corridor include intersection and mainline improvements to implement five of the ten TRB access management principles, as follow, below:

- Removing left-turns from through traffic lanes
- Limiting the number of conflict points
- Separating conflict areas
- Managing left-turn movements
- Using non-traversable medians to enforce turn restrictions

Figure 3.11: Access Concept #1



S	Existing Signalized Intersection	RIRO	Proposed RIRO
X	Proposed Access Closure	···▶	Proposed Roadway Extension
—	Segment with Highway 105 Access Only	S	Proposed Signalized Intersection
◆	Unimproved LOS E/F		

Figure 3.12: Access Concept #2

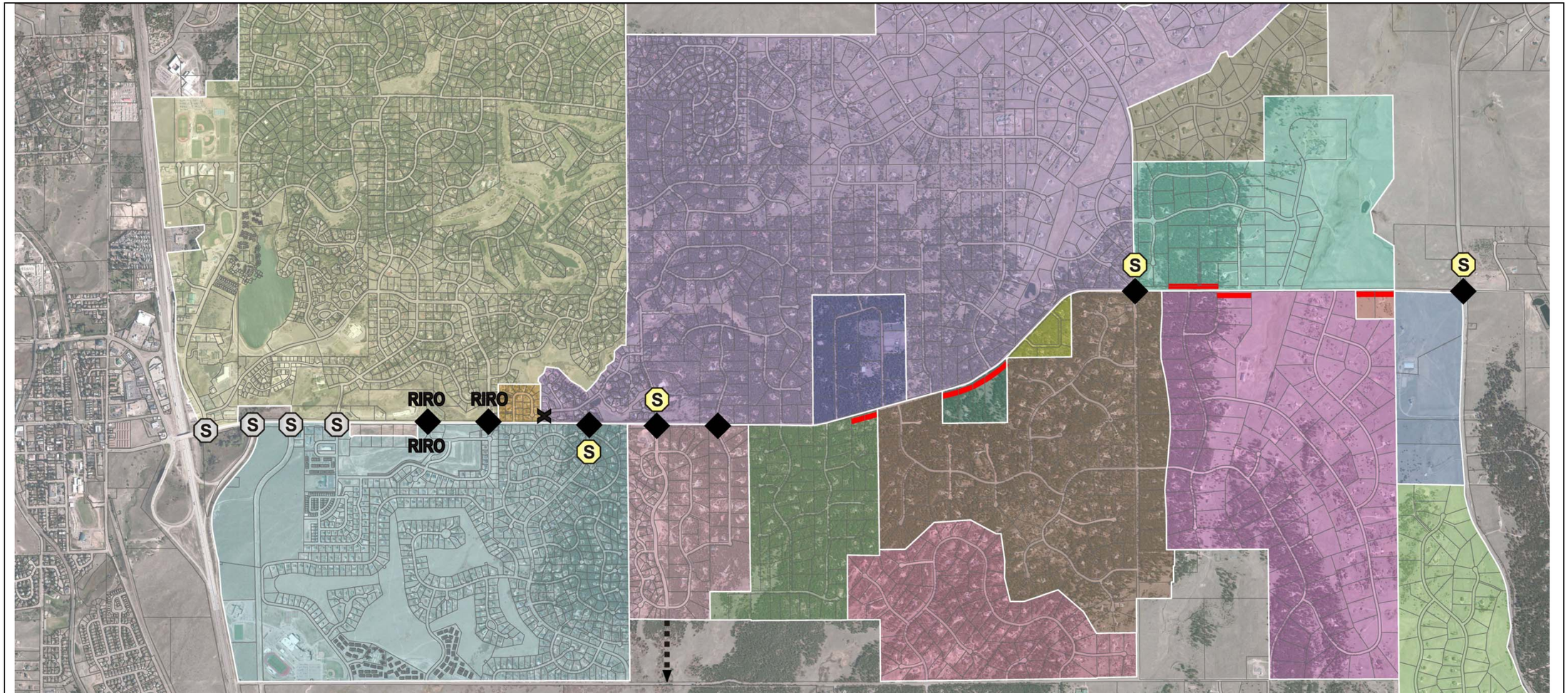


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Figure 3.13: Access Concept #3

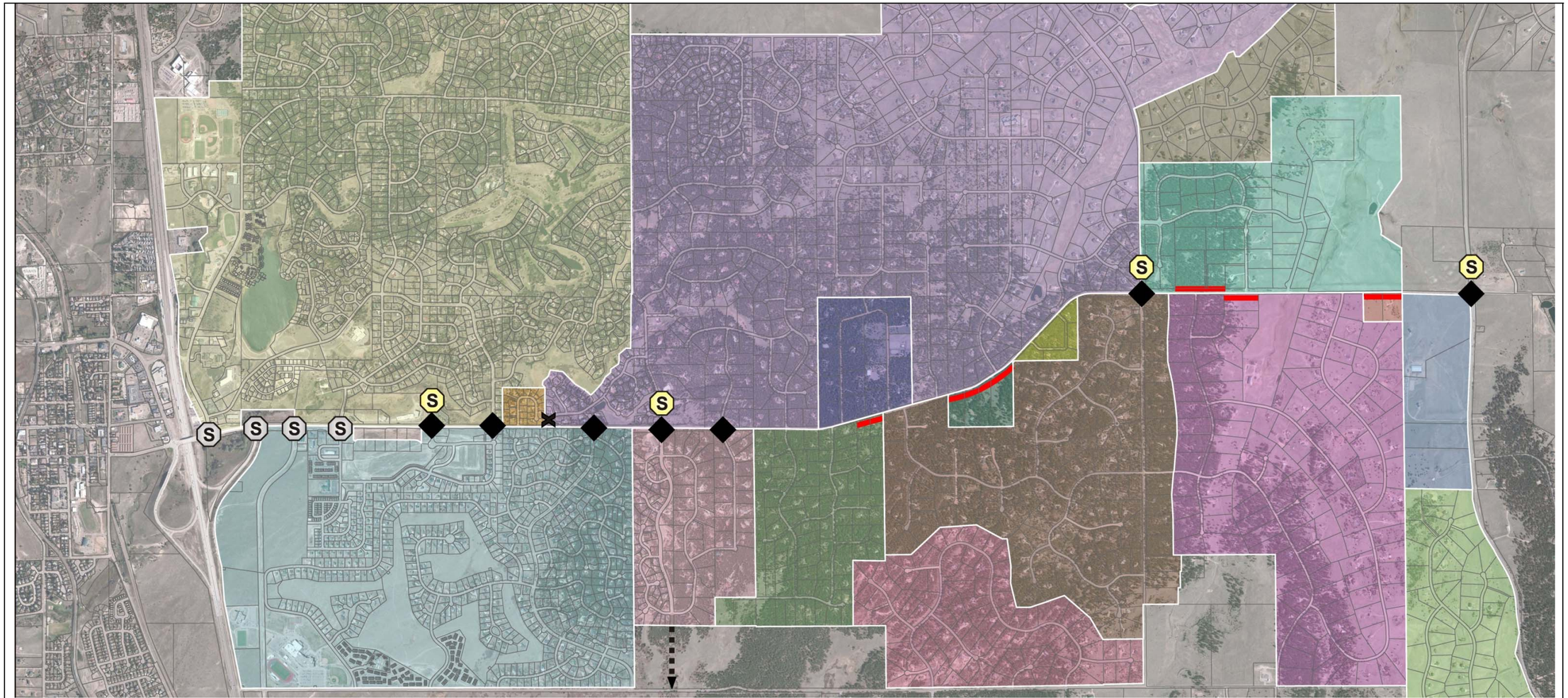

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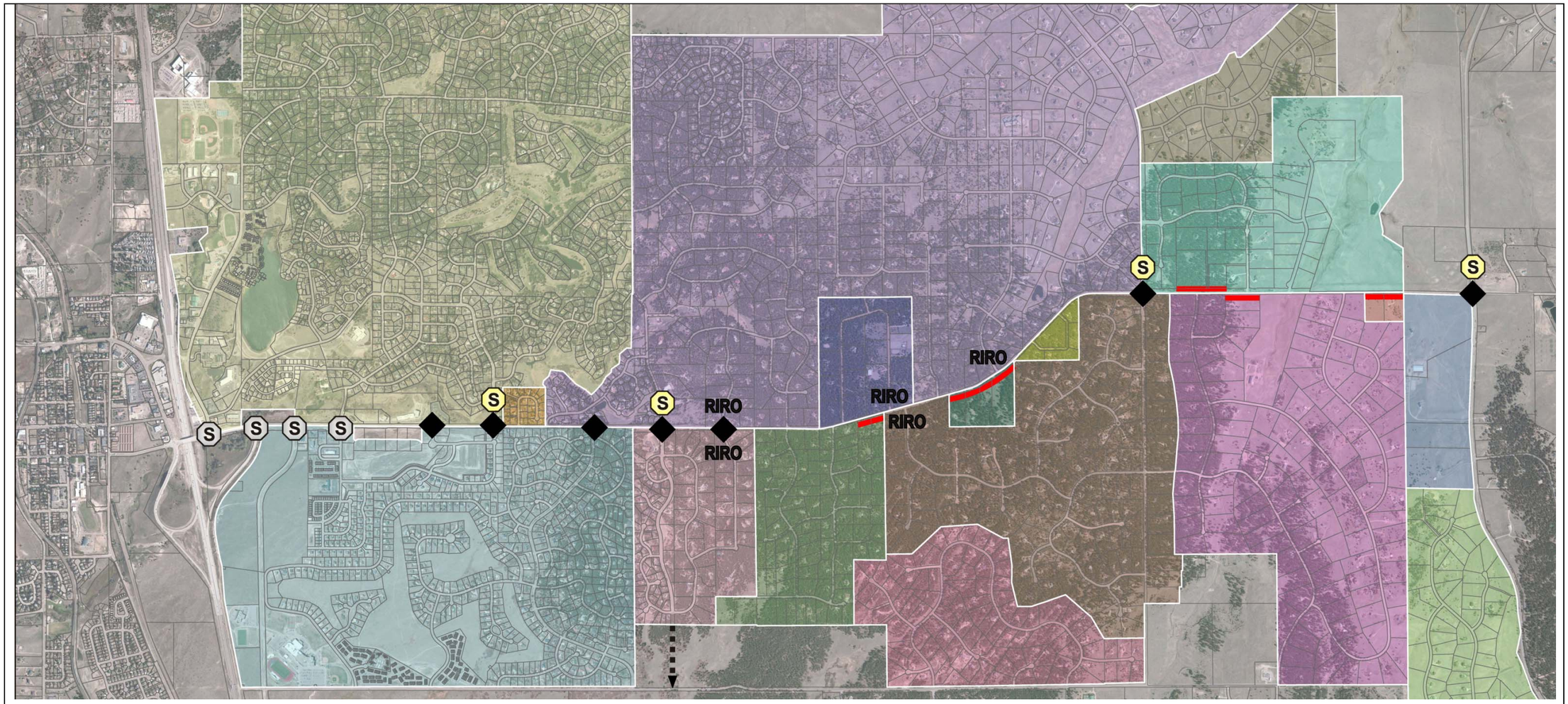
Figure 3.14: Access Concept #4



S Existing Signalized Intersection

RIRO Proposed RIRO

X Proposed Access Closure

Proposed Roadway Extension

Segment with Highway 105 Access Only

S Proposed Signalized Intersection

Unimproved LOS E/F

4 Traffic Analysis

Mobility and congestion relief are important considerations because Highway 105 is both a primary east-west corridor and the only means of access to a number of neighborhoods.

- Current peak hour congestion is most significant west of Lake Woodmoor Drive.
- Significant peak hour delays are experienced at the following intersections: the I-25 southbound ramps, Jackson Creek Parkway, Knollwood Drive, the Monument Academy access, and Lake Woodmoor Drive.
- Congestion and delay will increase in the future if no improvements are made.

4.1 Methodology

To evaluate traffic operations for the baseline condition and for future improvement options, existing peak hour traffic volume data was collected and estimates of future traffic volumes were prepared. Micro-simulation (Synchro/SimTraffic) was used to iteratively evaluate traffic operations performance for baseline conditions and future improvement alternatives. Parallel analysis of roundabout alternatives s was also conducted using Highway Capacity Software 2010. HCM2010 performance metrics, as detailed below in *Section 4.2*, were used for both analysis methodologies to identify baseline deficiencies and to evaluate the performance of alternative improvement options.

4.1.1 Existing and Forecast Traffic Volumes

Available traffic count data was assembled for use in this traffic analysis for the Highway 105 Corridor Study from sources including: the Colorado Department of Transportation (CDOT) traffic statistics data base, the Pikes Peak Area Council of Governments (PPACG), El Paso County (from traffic count data base and recent development Traffic Impact Studies), and the Town of Monument (from recent development Traffic Impact Studies). The assembled data included counts collected in 2004, 2005, 2010 and 2011. Count data included: weekday peak period turn movement counts, 48-hour, hourly counts, and adjusted Average Daily Traffic (ADT) counts.

Supplemental 2011 counts were collected in September 2011. The supplemental counts include AM and PM peak period turn movement counts for selected intersections (All Traffic Data for El Paso County), as well as for the I-25 ramp termini intersections (CDOT Region 2).

Both ADT and PM peak hour volumes for the 2005 base year of the PPACG travel model were synthesized from the assembled count data. The 2005 final, adjusted 2005 count volumes were used, together with PPACG Travel Model raw assignment volumes to develop a 2040 future “No Build” baseline for this traffic study. The assembled count data was also used to synthesize a 2011 “Existing Conditions” baseline. The methodology used to “smooth” PPACG 2035 forecast traffic volumes, using NCHRP 255 procedures, and the growth factors used to develop 2040 forecast traffic volumes for the Highway 105 corridor are detailed in *Section 4.3*.

4.1.2 Traffic Operations Analysis

The “operation” of any given intersection or stretch of roadway relates to how well or how poorly it functions given a specific volume of traffic. Analyses of existing traffic operations for the Highway 105 Corridor were completed using the Synchro/SimTraffic software package.

In general, the use of this software involves the development of a Synchro network, adjustment of the model to reflect actual measured conditions to verify the accuracy of the model network, and use of the adjusted model to analyze future-year conditions under various scenarios. For the base, the Synchro network was developed by coding existing geometrics, traffic control conditions, and traffic volumes for each study intersection into the network. Specifically, this coded data included:

Per Intersection

- Number and type of approach lanes
- Widths of lanes
- Lengths of turn lanes
- Existing traffic volumes
- Existing signal timing parameters
- Percentage of heavy vehicles

Per Link (Roadway Segment)

- Link distances (intersection to intersection)
- Speed limits
- Widths of travel lanes
- Grade of roadway segment

Network Settings: (Corridor Signal Timing/Phasing)

- Minimum cycle length, maximum cycle length, reference phase
- Control type
- Yellow time, all red time
- Minimum splits
- Lead/lag optimization (allowed/not allowed)

4.1.3 Level of Service Measures and Criteria

Once existing data is coded into the software, Synchro is used to perform a Level of Service (LOS) evaluation which measures how well an intersection or stretch of roadway functions (or operates) when a specific volume of traffic is present. This methodology is consistent with the procedures outlined in the Highway Capacity Manual (HCM) (Transportation Research Board, 2010, [HCM2010]).

The HCM2010 utilizes measures, including operating speed and delay (in seconds per vehicle), to characterize roadway and intersection operations or LOS. Level of Service evaluation results in an LOS grade that ranges from LOS A to LOS F, where LOS A is representative of little or no delay and free-flow traffic, and LOS F represents excessive delay and breakdown in traffic flow. A typical minimum acceptable LOS for peak hour conditions, and that observed by El Paso County, is LOS D, which represents moderate delay. Signalized intersections are given an LOS grade based on overall functionality of the intersection. In other words, it is a qualitative evaluation of that intersection's ability to accommodate the travel demand. Unsignalized intersections, however, are graded based on the movement that suffers the greatest delay, otherwise known as the critical movement (i.e. a left-turning movement from a minor street onto a major street). In the case of a single lane approach on a minor street (also referred to as the *minor approach*), the entire approach will be assigned a LOS grade, since all movements from that approach would suffer the same delay. Conditions associated with individual levels of service, as defined by the HCM2010, are summarized in *Table 4.1, Level of Service Criteria for Two-Way Stop-Controlled (TWSC) Intersections*, and *Table 4.2, Level of Service Criteria for Signalized Intersections*. Levels of service for roundabouts are defined by HCM2010 as shown in *Table 4.3*. HCM2010 criteria were used for Synchro/SimTraffic analysis of baseline conditions (existing and future no build) and for assessment of traffic operations for future intersection improvement options. Parallel HCS2010 analysis was completed for roundabout options.

Table 4.1: Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Description - Delay to Minor Street Traffic	Average Control Delay (sec/veh)
A	Little or no delay	0-10
B	Short traffic delays	>10-15
C	Average traffic delays	>15-25
D	Long traffic delays	>25-35
E	Very long traffic delays	>35-50
F	When demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing that may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improving the intersection.	>50

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

Table 4.2: Level of Service Criteria for Signalized Intersections

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

Source: HCM2010, Page 19-2.

Table 4.3: Level of Service Criteria for Roundabout Intersections

Control Delay (sec/veh)	Level of Service by Volume-to-Capacity Ratio[1]	
	v/c $\leq$ 1.0	v/c > 1.0
0-10	**A**	**F**
>10-15	**B**	**F**
>15-25	**C**	**F**
>25-35	**D**	**F**
>35-50	**E**	**F**
>50	**F**	**F**

Source: HCM2010, Page 21-1; For approaches and intersectionwide assessment, Los is defined solely by control delay.

4.2 Alternatives Analysis

The project team conducted baseline traffic operations analysis for existing and future "no build" conditions. Analysis results were used to identify intersection improvements, the number of through and auxiliary lanes needed to handle current and future traffic volumes. Two to three intersection improvements were then developed for each corridor intersection that was found to operate at a LOS of D or worse for the baseline conditions. Synchro/SimTraffic simulation was used to evaluate intersection delay, queuing and travel speeds for each alternative.

4.3 Baseline Traffic Volumes

For the analysis of existing conditions, available traffic counts were assembled from the County, PPACG and CDOT data bases. Additional traffic counts, including turning movement counts were obtained from traffic impact studies prepared for recent study area development proposals for the County and the Town of Monument. Factors developed from current and historic ADT counts were used to adjust assembled turning movement counts, collected from 2004 thru 2011 to represent 2011 average daily traffic (ADT) and average weekday PM peak hour conditions.

4.3.1 Peak Hour Turn Movement Traffic Volume Counts

Baseline, 2011 average AM peak hour and PM peak hour turn movement counts were collected and peak hour turning movements were developed for the following twenty-eight study area intersections:

- I-25 Southbound Ramps
- Woodmoor Drive
- I-25 Northbound Ramps
- Jackson Creek Parkway
- Knollwood Drive
- Gold Canyon Road
- Lake Woodmoor Drive
- Briarhaven Court
- Winding Meadows Way
- Fairplay Drive
- Furrow Road
- Martingale Road
- Arrowwood Drive
- Sierra Way
- Forest Drive West
- Forest Drive East
- Scottswood Drive
- Lake Drive
- Archers Drive
- Spring Park Drive West
- Spring Park Drive East
- Roller Coaster Road
- Canterbury Drive
- Rogers Pine Grove
- Peaceful Pines Road
- Cherry Springs Ranch Road
- Appaloosa Road
- SH 83

4.3.2 Existing Traffic Volumes Adjusted and Balanced

Adjusted 2011 AM and PM peak hour turn movement volumes for the twenty-eight intersections were then balanced between intersections, such that the adjusted traffic volume sent from the upstream intersection matched adjusted traffic volume arriving at the downstream intersection. Final baseline balanced 2011 AM peak hour and PM peak hour intersection turning movement volumes are shown in *Section 4.4: Baseline Traffic Operations Analysis*, together with existing AM and PM peak hour levels of service for each intersection (see *Figure 4.2* through *Figure 4.6*).

4.3.3 Future No Build Traffic Volumes

The Pikes Peak Area Council of Governments (PPACG) Travel Demand Model (TDM) was used as a basis for preparing baseline, no build 2040 traffic volumes. The 2035 Travel Model "version" was modified to provide better network detail, including small traffic analysis zones and additional network facilities. The land use data base was also updated within the study area to represent development build-out. With these changes the model was applied for alternative network scenarios.

4.3.3.1 Adjustment of PPACG Travel Model Output

Because regional travel models are intended and designed for system-wide analysis, it was necessary to adjust the raw traffic volume assignments produced by the model prior to using them for Highway 105 Corridor Study project-level traffic operations analysis. Necessary adjustments were made using standard NCHRP 255 procedures.

The following procedures were used to adjust/post-process PPACG travel model 2035 raw all day (Average Daily Traffic, ADT) traffic assignment volumes for use in Highway 105 project-level traffic operations analysis:

1. Traffic Volume Data Collected for the PPACG Model Base Year (2005)

Recent ADT counts and turning movement counts for the AM and PM peak periods were assembled/ conducted to estimate actual traffic volumes for the PPACG travel model's base year (2005).

2. PPACG 2005 Assignment Volumes Validated to Counted Traffic Volumes

The assembled ADT counts were compared to the assigned volumes generated by a 2005 base year run of the PPACG travel model (see *Figure 4.1*) in order to validate the corridor-level application of the regional model for the base year.

3. NCHRP 255-Based "Smoothing" Process Applied to Model Outputs

Using a process previously approved by PPACG (for project-level analysis for Woodmen Road, Austin Bluffs Parkway, etc.), the base year (2005) raw model assignment results were systematically "smoothed" to better replicate 2005 traffic volume ground count experience. Initially, the base year model outputs were adjusted to achieve a better fit compared to the ground counts.