I-25/Arapahoe Interchange

Environmental Assessment

Technical Design Documentation

July 2012

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Technical Memorandum – Existing Conditions Findings

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1.0 Introduction

This memorandum details the existing conditions of the Arapahoe/I-25 interchange, Arapahoe Road from Greenwood Plaza Blvd to South Clinton Street, the Arapahoe Frontage Road, Yosemite Street, and South Xanthia Street. The following items were examined:

- Existing Cross Section
  - Number of lanes, lane width, turn lanes
  - Acceleration/deceleration lanes
  - Shoulder descriptions, general width
  - Curb and Gutter location and type
  - Median locations and type
  - Pavement type
- Guardrail location and type
- Retaining wall location and type
- Ramp metering
- Intersection Control
- Posted Speeds
- Sidewalk location and width (attached and detached)
- Utilities – from survey analysis and utility maps

This memo does not include any investigation into the existing condition of signage, minor drainage features such as street inlets, or structures.

2.0 Existing Site Conditions

The following is a general description of the existing conditions found during site visits and survey information.

Numbers of lanes, widths, turn lanes, and taper lengths:

I-25 freeway and ramp lane widths were found to be 12 feet with the exception of the westbound Arapahoe Road to southbound I-25 on-ramp and the eastbound Arapahoe Road to southbound I-25 on-ramp, which were found to have 14 foot and 10 foot lane widths. Lane widths on Yosemite Street north of Arapahoe Road were found to be as narrow as 10.5 feet. The number of lanes and turn lanes for the Arapahoe/I-25 corridor can be found in Appendix A.

Acceleration/Deceleration Lanes:

The acceleration and deceleration lanes in the Arapahoe/I-25 corridor are listed in the table below.

Location	Accel Lane Length	Decel Lane Length
Northbound Off Ramp		480 ft
Southbound Off Ramp		535 ft
Westbound Arapahoe to Northbound On Ramp	685 ft	
Eastbound Arapahoe to Southbound On Ramp	450 ft	
Northbound Off Ramp to Eastbound Arapahoe Road	95 ft	
Westbound Arapahoe to Northbound On Ramp		235 ft
Southbound Off Ramp to Westbound Arapahoe Road	105 ft	
South side of Arapahoe to Eastbound Arapahoe Road		460 ft

Shoulder descriptions, general width, and Curb and Gutter locations:

Shoulder and curb and gutter exist along the roadways within the project area. The majority of the I-25 ramps contain inside and outside shoulders. Most of the arterial and collector roads contain curb and gutter adjacent to the outside shoulder. A spreadsheet detailing shoulder and curb and gutter properties can be found in Appendix A.

Median location and curb type:

The following table details median curb type and material:

Location	Median Delineation Type	Median Material
Arapahoe Road	C&G Type 2 (Section I-B)	Patterned Concrete
Arapahoe CD Road	Guardrail Type 7	
Frontage Road	Painted	
Yosemite Street, South of Arapahoe Road	C&G Type 2 (Section I-B)	Concrete
Yosemite Street, North of Arapahoe Road	Painted	
WB Arapahoe to NB On-Ramp (HOV lane)	C&G Type 2 (Section I-B)	Patterned Concrete
EB Arapahoe to NB On-Ramp (HOV lane)	C&G Type 2 (Section I-B)	Patterned Concrete

Pavement Type:

All pavement in the Arapahoe/I-25 corridor appeared to be asphalt with the exception of the Arapahoe Road and Yosemite Street intersection which is concrete pavement.

Bridges:

Refer to Structure Selection Report for more information.

Guardrail location and type:

Guardrail Type 7 and Guardrail Type 3 were located on the I-25 freeway, ramps and the frontage road.

I-25

- Guardrail Type 7 (Style CE) between NB and SB
- Guardrail Type 7 (Style CD) along LRT walls next to SB
- Guardrail Type 3 End Treatment on NB approaching bridge

SB I-25 to Arapahoe Road Off-Ramp

- Guardrail Type 7 (Style CD) along LRT walls along outside shoulder
- Guardrail Type 7 with Type 3 End Treatment along inside shoulder

WB Arapahoe Road to SB I-25 Loop Ramp

- Guardrail Type 7 along outside shoulder
- Guardrail Type 3 End Treatment along outside shoulder at bridge approach

EB Arapahoe Road to SB I-25 On-Ramp

- Guardrail Type 7 along outside shoulder
- Guardrail Type 7 (Style CD) along LRT walls

NB I-25 to Arapahoe Off-Ramp

- Guardrail Type 7 with Type 3 End Treatment along outside shoulder
- Guardrail Type 7 (Style CD) along outside shoulder against retaining wall

EB Arapahoe Road to NB I-25 Loop Ramp

- Guardrail Type 3 End Treatment along outside shoulder at bridge approach

WB Arapahoe Road to NB I-25 On-Ramp

- No Guardrail

Arapahoe Road

- Guardrail Type 7 protecting existing piers between CD road and EB Arapahoe Road
- Guardrail Type 7 protecting existing piers between CD road and WB Arapahoe Road

Frontage Road

- Guardrail Type 3 along curve

Retaining Walls:

There are existing retaining walls on I-25 and ramps at the locations listed:

Location	**Type**	**Comments**
Westbound Arapahoe to Northbound On Ramp	MSE	Adjacent to Outside Shoulder
Northbound Off Ramp	Other	Adjacent to Outside Shoulder
Westbound Arapahoe to Northbound On Ramp	MSE	Adjacent to Outside Shoulder
Eastbound Arapahoe to Southbound On Ramp	MSE	Adjacent to Outside Shoulder
Southbound Off Ramp	CIP	Adjacent to Inside and Outside Shoulder

Westbound to Southbound On Ramp	CIP	Adjacent to Outside Shoulder
Eastbound to Southbound On Ramp	MSE	Adjacent to Outside Shoulder

Ramp Metering/HOV Lanes:

All the on-ramps of the Arapahoe/I-25 interchange incorporate ramp metering and HOV bypass lanes exist at all I-25 northbound on-ramps.

Intersection Control:

Intersection control for the Arapahoe/I-25 corridor is shown below. Traffic on Arapahoe Road is controlled by use of traffic signals. Intersecting roads are controlled by either traffic signals or stop signs.

Location	**Control Type**	**Comments**
Arapahoe Road / South Clinton Court	Stop Sign	2-Way Control (Stop on S. Clinton Ct.)
Arapahoe Road / South Clinton Street	Traffic Signal	4-way Control
Arapahoe Road / Frontage Street / Northbound I-25 Off Ramp	Traffic Signal	4-way Control
Arapahoe Road / Southbound I-25 Off Ramp	Traffic Signal	3-Way Control
Arapahoe Road / South Xanthia Street	Stop Sign	1-Way Control (Stop on S. Xanthia St.)
Arapahoe Road / South Yosemite Ct.	Stop Sign	1-Way Control (Stop on S. Yosemite Ct.)
Arapahoe Road / South Yosemite Street	Traffic Signal	4-Way Control
Arapahoe Road / Greenwood Plaza Blvd.	Traffic Signal	4-Way Control

Posted Speeds:

The posted speed limits were determined for each road and are shown below.

Location	**Posted Speed**
I-25	65
Northbound Off Ramp	35
Eastbound Arapahoe to Northbound On Ramp	30
Westbound Arapahoe to Northbound On Ramp	Not Posted
Westbound Arapahoe to Southbound On Ramp	30
Eastbound Arapahoe to Southbound On Ramp	Not Posted
Westbound Arapahoe Road	40
Eastbound Arapahoe Road	40
Frontage Road	25
Yosemite Street (north of Arapahoe)	35
Yosemite Street (south of Arapahoe)	35
South Xanthia Street	Not Posted

Light Rail Transit (LRT)

There is an existing LRT line which runs parallel to I-25, to the west. The LRT line is elevated above Arapahoe Road, with a pier located between the eastbound Arapahoe Road through lanes and the eastbound Arapahoe Road collector/distributor lanes. The LRT Structure also has a straddle bent pier over the existing SB I-25 off-ramp, and MSE abutments south of Arapahoe Road.

Sidewalks:

There are attached and detached sidewalks in the Arapahoe Road corridor. These locations are shown in the attached documents.

Utilities:

Utilities were located through surveying and utility maps. General utility locations for the Arapahoe/I-25 corridor are listed in Appendix A.

CDOT Improvements:

Recently completed improvements to the existing I-25 and Arapahoe Road interchange include modifications to the Arapahoe Road collector/distributor system and adjacent sidewalks. A through lane was added to the collector/distributor roads in both the eastbound and westbound directions. Other improvements included adding an 8 foot detached sidewalk located on westbound Arapahoe Road between the southbound I-25 off-ramp and South Yosemite Court.

Appendix A

Table 1.1 – Lane Description

Location	Number of Lanes	Auxiliary Lanes	Right Turn Lane	Left Turn Lane
Northbound I-25				
South of Northbound Off-Ramp	6			
Northbound Off Ramp Northbound On Ramp	5	1		
North of Northbound On-Ramp	6			
Southbound I-25				
North of Southbound Off Ramp	6			
Southbound Off-Ramp to Southbound On-Ramp	5	1		
South of Southbound On-Ramp	6			
I-25 Ramps				
Northbound Off-Ramp	2→3			
Northbound On-Ramp	2			
Southbound Off-Ramp	2→3			
Southbound On-Ramp	1			
Westbound Arapahoe Road				
South Clinton Court to South Clinton Street	3→4		1	2
South Clinton Street to Northbound I-25 On-Ramp	2		2	
Northbound I-25 On-Ramp to Southbound I-25 Off-Ramp	3	1		
Southbound I-25 Off-Ramp to Yosemite Street	3		1	2
Yosemite Street to Greenwood Plaza Boulevard	3		1	1
Eastbound Arapahoe Road				
Greenwood Plaza Boulevard to Yosemite Street	3		1	2
Yosemite Street to South Xanthia Street	3			
South Xanthia to Southbound I-25 On-Ramp	2	2		
Southbound I-25 On-Ramp to Northbound I-25 Off-Ramp	2	2		
Northbound I-25 Off-Ramp to Clinton Street	3		1	2
South Clinton Street to South Clinton Court	3			
Frontage Road				
Frontage Road	2			
Northbound Yosemite St.				
North of Arapahoe	2			1
South of Arapahoe	2		1	1
Southbound Yosemite St.				
North of Arapahoe	2			2
South of Arapahoe	2			

Table 1.2 – Shoulder Description

Location	Inside Shoulder	Outside Shoulder
Northbound I-25		
South of Northbound Off-Ramp	11 ft Shoulder	8 ft Shoulder
Northbound Off Ramp to Northbound On-Ramp	11 ft Shoulder	12 ft Shoulder
North of Northbound On-Ramp	11 ft Shoulder	11 ft Shoulder
Southbound I-25		
North of Southbound Off-Ramp	6 ft Shoulder	8 ft Shoulder
Southbound Off-Ramp to Southbound On-Ramp	11 ft Shoulder	11 ft Shoulder
South of Southbound On-Ramp	11 ft Shoulder	11 ft Shoulder
I-25 Ramps		
Northbound I-25 Off-Ramp	7 ft Shoulder	7 ft Shoulder
Eastbound Arapahoe Northbound I-25 On-Ramp	8 ft Shoulder	5 ft Shoulder
Eastbound Arapahoe CD	Curb & Gutter Type 2 (Section I-B)	
Westbound Arapahoe CD	Curb & Gutter Type 2 (Section I-B)	
Westbound Arapahoe to Northbound I-25 On-Ramp	5 ft Shoulder	
Southbound I-25 Off Ramp	7 ft Shoulder	8 ft Shoulder
Westbound Arapahoe to Southbound I-25 On-Ramp	9 ft Shoulder	8 ft Shoulder
Eastbound Arapahoe to Southbound I-25 On-Ramp	6 ft Shoulder	5 ft Shoulder
Westbound Arapahoe Road		
South Clinton Court to South Clinton Street	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
South Clinton Street to Northbound I-25 On-Ramp	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Northbound I-25 On-Ramp to Southbound Off-Ramp	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Southbound Off-Ramp to Yosemite Street	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Yosemite Street to Greenwood Plaza Blvd.	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Eastbound Arapahoe Rd.		
Greenwood Plaza Boulevard to Yosemite Street	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Yosemite Street to South Xanthia Street	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
South Xanthia Street to Southbound I-25 On-Ramp	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Southbound I-25 On-Ramp to Northbound I-25 Off-Ramp	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Northbound I-25 Off-Ramp to Clinton St	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
South Clinton Street to South Clinton Court	Curb & Gutter Type 2 (Section I-B)	Curb & Gutter Type 2 (Section II-B)
Frontage Road		
Northbound Frontage Rd.	N/A	4 ft Shoulder and Curb & Gutter Type 2 (Section II-B)

Southbound Frontage Rd.	N/A	4 ft Shoulder and Barrier
Northbound Yosemite St.		
North side of Arapahoe	N/A	Curb & Gutter Type 2 (Section II-B)
South side of Arapahoe	N/A	Curb & Gutter Type 2 (Section II-B)
Southbound Yosemite St.		
North side of Arapahoe	N/A	Curb & Gutter Type 2 (Section II-B)
South side of Arapahoe	N/A	Curb & Gutter Type 2 (Section II-B)
South Xanthia Street		
Northbound	N/A	Curb & Gutter Type 2 (Section II-B)
Southbound	N/A	Curb & Gutter Type 2 (Section II-B)

Table 1.5 – Sidewalk Information

Location	**Description**	**Width**
Westbound Arapahoe Road		
South Clinton Court to South Clinton Street	Attached Sidewalk	8 ft
South Clinton Street to I-25	Attached Sidewalk	5 ft
I-25 to Yosemite Street	Attached/Detached Sidewalk	5ft/8 ft
Yosemite Street to Greenwood Plaza Boulevard	Detached Sidewalk	8 ft
South Yosemite Court to South Yosemite Street	Detached Sidewalk	5ft/8 ft
Eastbound Arapahoe Road		
Greenwood Plaza Boulevard to Yosemite Street	Attached Sidewalk	5 ft
Yosemite Street to South Xanthia Street	Attached Sidewalk	5 ft
South Xanthia Street to I-25	Attached Sidewalk	5 ft/8 ft
I-25 to South Clinton Street	Attached Sidewalk	5 ft/8 ft
South Clinton Street to South Clinton Court	Attached Sidewalk	5 ft
Frontage Road		
N/A		
Northbound Yosemite St.		
North side of Arapahoe	Attached Sidewalk	5 ft
South side of Arapahoe	Attached Sidewalk	5 ft
Southbound Yosemite St.		
North side of Arapahoe	Attached Sidewalk	5 ft
South side of Arapahoe	Attached Sidewalk	5 ft
South Xanthia Street		
Northbound Xanthia Street	Attached Sidewalk	5 ft
Southbound Xanthia Street	Attached Sidewalk	5 ft

Table 1.5 – Utility Information

Adesta Utilities	
Location	**Comments**
I-25 Northbound	
South of Northbound Off Ramp Gore to North of Westbound to Northbound On Ramp Gore	Runs on the east side of I-25
I-25 Ramps	
Northbound Off Ramp	Crosses under ramp
Eastbound to Northbound On Ramp	Crosses under ramp
Westbound to Northbound On Ramp	Crosses under ramp
Eastbound CD	Crosses under road
Westbound CD	Crosses under road
Arapahoe Road	
Eastbound to Southbound I-25 to Westbound to Northbound I-25	Crosses under road
Castlewood Utilities	
Location	**Comments**
Arapahoe Road	
South Xanthia Street to South Clinton Court	Runs under road and along north side
CDOT Utilities	
Location	**Comments**
I-25	
South of Northbound Off Ramp Gore to North of Westbound to Northbound On Ramp Gore	East side of I-25
North of Southbound Off Ramp Gore to Eastbound to Southbound On Ramp Gore to joining of Eastbound to Southbound On Ramp	West side of I-25
I-25 Ramps	
Southbound Off Ramp	Crosses under ramp
Northbound Off Ramp	Crosses under ramp
Westbound to Northbound On Ramp	Crosses under ramp
Westbound to Southbound On Ramp	Crosses under ramp
Eastbound to Southbound On Ramp	Crosses under ramp
Eastbound to Northbound On Ramp	Crosses under ramp
Eastbound CD	Crosses under road
Westbound CD	Crosses under road
Frontage Road	
	Crosses under road
Arapahoe Road	
Eastbound to Southbound I-25 to South Clinton Street	Crosses under road
Denver Water Utilities	
Location	**Comments**
Arapahoe Road	
Greenwood Plaza Blvd. to South Clinton Street	Runs under road
South Yosemite St.	
North of Arapahoe Road	Runs under road
South of Arapahoe Road	Runs under road
South Xanthia Street	
	Runs under road

Greenwood Village Utilities	
Location	**Comments**
I-25 Ramps	
Southbound Off Ramp	Crosses under ramp
Westbound to Northbound On Ramp	Crosses under ramp
Westbound to Southbound On Ramp	Crosses under ramp
Westbound CD	Crosses under road
South Yosemite Street	
North of Arapahoe Road	Runs along east side of road & crosses under road
Frontage Road	
	Crosses under road entrance at Arapahoe
Arapahoe Road	
South Yosemite Street to South Clinton Court	North side of road
Westbound to Northbound I-25 to South Clinton Street	Crosses under road
South Yosemite Street to South Xanthia Street	Crosses under road
ICG Utilities	
Location	**Comments**
I-25	
South of Northbound Off Ramp Gore to North of Westbound to Northbound On Ramp Gore	East side of I-25
I-25 Ramps	
Northbound Off Ramp	Crosses under road
Eastbound to Northbound On Ramp	Crosses under road
Westbound to Northbound On Ramp	Crosses under road
South Yosemite Street	
South of Arapahoe Road	Runs along west and east sides of road & crosses under road
North of Arapahoe Road	Runs under road & along west side of road
Arapahoe Road	
Greenwood Plaza Blvd. to South Yosemite Street	Runs along north side of road & crosses under road
Westbound to Northbound I-25 to South Clinton Street	Crosses under road
Eastbound to Northbound I-25 to Westbound to Northbound I-25	Crosses under road
Southgate Utilities	
Location	**Comments**
South Yosemite Street	
North of Arapahoe	Runs under road
South of Arapahoe	Runs along west side & under road
South Xanthia Street	Runs under road
Arapahoe Road	
Greenwood Plaza Blvd. to Eastbound to Southbound I-25 Ramp	Runs under road
Telecom Utilities	
Location	**Comments**
South Yosemite Street	
South of Arapahoe	Runs along east side of road
Arapahoe Road	
Greenwood Plaza Blvd. to South Yosemite Street	Runs along north side of road
South Yosemite Street to South Xanthia Street	Crosses under road

XCEL Utilities	
Location	**Comments**
I-25	
South of Northbound Off Ramp Gore to North of Westbound to Northbound On Ramp Gore	Runs on east and west side of I-25 & under freeway
I-25 Ramps	
Westbound to Northbound On Ramp	Crosses under ramp
Eastbound to Northbound On Ramp	Crosses under ramp
Northbound Off Ramp	Crosses under ramp
Southbound On Ramp	Crosses under ramp
Westbound to Southbound On Ramp	Crosses under ramp
Eastbound CD	Crosses under road
Westbound CD	Crosses under road
South Yosemite Street	
North of Arapahoe	Runs on east and west side of road & under road
South of Arapahoe	Runs on east and west side of road & under road
Frontage Road	
	Crosses under road
Arapahoe Road	
Greenwood Plaza Blvd. to South Clinton Court	Runs on north and south side of road
Greenwood Plaza Blvd. to Eastbound to Southbound I-25	Overhead lines
South Clinton Street to Westbound to Northbound I-25	Overhead lines
South Clinton Street to South Clinton Court	Overhead lines
Xanthia Street	
	Runs on east and west side of road & under road
Century Link Utilities	
Location	**Comments**
I-25	
North of Southbound Off Ramp Gore	Runs on east and west side of road & under road
I-25 Ramps	
Westbound to Northbound On Ramp	Crosses under ramp
Northbound Off Ramp	Crosses under ramp
Eastbound to Northbound On Ramp	Crosses under ramp
Eastbound CD	Runs on South side of road
Westbound CD	Crosses under road
South Yosemite Street	
North of Arapahoe	Runs on east and west side of road & under road
South of Arapahoe	Runs on east and west side of road & under road
Arapahoe Road	
Greenwood Plaza Boulevard to South Clinton Court	Runs on north and south side of road
Xanthia Street	
	Runs on east and west side of road & under road

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I-25 Over Arapahoe Road

November 2011

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Environmental Assessment

STRUCTURE SELECTION REPORT

I-25 OVER ARAPAHOE ROAD (SH 88)

DEVELOPED FOR:

DOT

DEPARTMENT OF TRANSPORTATION

And Arapahoe County

DEVELOPED BY:

David Evans and Associates, Inc.

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November 30, 2011

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1. Project Overview

Project Description

The I-25/Arapahoe Interchange Environmental Assessment (EA) was set in motion to address congestion, functional deficiencies, traffic operations, and safety for the traveling public within the I-25 and Arapahoe Road interchange complex. This area extends along Arapahoe Road from west of the Yosemite Street intersection to east of the Boston/Clinton Street intersection. The objectives of proposed interchange improvements should:

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

Multiple interchange alternatives were considered for I-25 and Arapahoe Road. An extensive alternatives screening process was conducted to evaluate each alternative and to identify a recommended Action Alternative. The EA will document this process as well as the impacts assessment for the Action Alternative. At the same time, the EA Action Alternative has been advanced for 30-percent-level bridge type analysis and design. It should be noted that the EA Action Alternative consists of a conservative design to assess maximum feasible impacts. This Structure Selection Report documents the development and analysis of the EA Action Alternative as well as structure layouts and types that may be implemented to optimize the EA design.

Site Location and Description

Arapahoe Road and I-25 currently intersect in a partial cloverleaf interchange located approximately 15 miles southeast of downtown Denver. Approximately 100,000 vehicles per day enter the interchange complex from either Arapahoe Road or the I-25 ramps as measured by traffic counts collected in 2010. Existing average daily traffic (ADT) on Arapahoe Road (SH 88) east of the interchange complex is approximately 57,800 vehicles while west of the interchange the ADT is about 44,700 vehicles. The traffic entering the interchange is projected to increase by 2035 to over 130,000 vehicles per day.

Following improvements in the mid 1980's, travel lanes on Arapahoe Road under I-25 were split by bridge piers as traffic bound for the I-25 on-ramps was placed on the outer edges between the abutments and the piers, with through traffic lanes inside between the bridge piers. By 2007, the Transportation Expansion (T-REX) project added lanes to I-25, improved ramp acceleration and deceleration lanes, and provided lane balance along the freeway, which substantially reduced congestion on I-25. The freeway segments and merge/diverges currently operate at LOS D or better during peak hours, except the diamond northbound and southbound entrance ramp merges, which operate at LOS F due to heavy freeway volumes. As part of the T-REX project, a light rail bridge was constructed approximately 150 feet to the west of the existing I-25 bridge over Arapahoe Road.

Interim improvements completed in the summer of 2010 have resulted in two through travel lanes in each direction between the existing bridge piers and one through travel lane in each direction on the outside of the bridge piers in addition to a lane leading to the I-25 cloverleaf on-ramps. Due to the geometric design constraints of the narrow two eastbound "inside" through lanes on Arapahoe Road with no shoulders under the I-25 bridge, vehicular traffic (especially large trucks) slowly negotiate the southbound I-25 to eastbound Arapahoe Road double left turn, resulting in lengthy vehicle queuing on the southbound off-ramp that backs up onto I-25 in peak periods.

The survey data and location for the site are shown below:

Latitude: 39° 35' 70"a *Range: 67W* *Section: Northwest 27*
Longitude: 104° 53' 10" *Township: 67*

Figure 1: Project Site

Existing I-25 Bridge

The existing I-25 bridge consists of two structure types. The original bridge is a reinforced concrete slab and continuous girder 3-span structure with 48-ft, 68-ft, and 48-ft spans for a total bridge length of 166 feet. This structure was widened as part of the T-REX project with prestressed continuous concrete spread box girders with 48-ft, 68-ft, and 50-ft spans. As discussed in more detail below, the layout of the existing bridge creates functional deficiencies and safety concerns for the traveling public within the interchange.

The existing structure width varies from approximately 201 feet at the north abutment to 205 feet at the south abutment. The original bridge is founded on steel H-piles at the abutments and rectangular spread footings at the piers. The widened portion of the structure is founded on steel pipe piles at the abutments and drilled caissons at the piers.

The I-25 over Arapahoe Road Bridge is not on the FHWA select list which means it is not a candidate for replacement based solely on sufficiency rating. However, the bridge is considered for replacement because it is classified as 'Functionally Obsolete' according to the 2008 inspection report. The bridge is 'Functionally Obsolete' due to the low vertical clearance. In addition, the bridge is considered for replacement due to the insufficient lane capacity underneath the structure for Arapahoe Road.

Proposed Roadway Alignment

The Action Alternative identified in the EA is the Improved Partial Cloverleaf interchange alternative. Components of the conceptual design for the interchange are summarized below.

I-25 Mainline:

Conceptual design for I-25 includes five 12-foot through lanes in each direction, 10-foot inside and 12-foot outside shoulders, a 2-foot-wide concrete median barrier and 12-foot (minimum) acceleration/deceleration lanes, where required. The proposed alignment of I-25 over Arapahoe Road is located on a horizontal tangent that runs parallel to the existing I-25 alignment. The proposed horizontal alignment is offset approximately 24 feet east of the existing alignment to accommodate construction phasing.

The proposed I-25 vertical profile is in a crest vertical curve at the Arapahoe Road crossing. The proposed profile raises the deck elevation of the bridge at the north abutment by up to 8'-0" (depending on the structure type) in order to provide adequate vertical clearance for Arapahoe Road and provide clearance for the proposed structure. The Arapahoe Road alignment is raised as much as 5'-0" in order to improve drainage underneath the bridge.

I-25 Ramps:

The interchange ramps will be designed to accommodate 2035 traffic volume projections. The entrance ramps will provide one lane access to I-25, narrowing from two lanes at the ramp meter locations, except the Eastbound to Northbound on ramp which also has an HOV lane. The ramps will include a 4-foot left shoulder, a 15-foot-wide lane, and a minimum 6-foot right shoulder. The exit ramps will consist of two lanes, diverging I-25 as a drop lane and an option lane approaching the ramp gore. The southbound off-ramp will be modified to allow triple left turns by modification of the right turn median.

Arapahoe Road:

The existing section of Arapahoe Road is constrained by the existing pier and abutment locations of the I-25 bridge. The existing piers separate Arapahoe Road from the I-25 on-ramps and the existing abutment locations limit any future widening of Arapahoe Road. Replacing the I-25 bridge will allow for a longer structure that better accommodates existing and future multimodal demands of this interchange.

The proposed typical section at the bridge accommodates three through lanes in each direction, sidewalks on each side of the roadway, two northbound I-25 on-ramps, and one southbound I-25 on-ramp. The centerline alignment for the proposed Arapahoe Road was constrained by an existing LRT bridge pier to the west of the I-25 bridge. Therefore, the proposed Arapahoe Road was aligned with this existing pier resulting in a shift of Arapahoe Road to the south. Similarly, the pier line of the proposed I-25 structure was aligned with this LRT pier to ease the construction phasing issues encountered along Arapahoe Road.

The profile of Arapahoe Road was increased for the EA Action Alternative to improve drainage and avoid a sump condition under the I-25 structure. The modifications which could be made to the profile of Arapahoe Road were constrained by the LRT abutment on the south side of Arapahoe Road and the southbound on-ramp exit gore. To avoid undermining the abutment and reducing the design speed of the southbound on-ramp, the Arapahoe Road profile was raised.

2. Project Site Data

Geology Data

A formal geotechnical investigation for the structure was not included in the scope of the EA project; however, geotechnical information was gathered from as-built plans for the existing I-25 bridge. Based on the as-built data, bedrock elevations are approximately 5 feet below Arapahoe Road grade elevations at existing (and proposed) abutment 1, and 9 feet at existing abutment 4. At existing Pier 3 (proposed Pier 2), bedrock elevations are approximately 3 foot below Arapahoe Road grade elevations. Soil layers above bedrock consist primarily of fill material and some sandy clay mixtures.

Proposed foundation types include driven H-piles at the abutments and drilled caissons at the pier. Piles can be driven for the abutments with equipment located outside of the Arapahoe Road and I-25 travel lanes. At this conceptual design stage, it is estimated that ten caissons will be required for the center pier. While equipment is mobilized for caisson drilling and pier construction, one or two lanes of Arapahoe Road will be closed.

Utilities and Lighting

A preliminary utilities investigation was performed by Hartwig & Associates for the I-25 and Arapahoe Road EA. Findings for utilities located in the vicinity of the I-25 bridge are summarized below. For more detailed information, refer to the *Technical Memorandum – Existing Conditions Findings* report.

- Fiber optic lines: 1 line running east-west near the north abutment behind the MSE wall, 1 line running east-west under the center span approximately 15 feet south of Pier 2, 2 lines running east-west under the south span approximately 2 feet and 12 feet south of Pier 3, 1 line running east-west approximately 45 feet south of the existing Abutment 4, and 1 line running north-south approximately 2 feet east of the existing structure.
- Storm Sewer lines: 1 line runs east-west under the south span approximately 8 feet south of Pier 3, and 1 line runs north-south along SB I-25 southwest of the existing structure (I-25 roadway drainage).
- Electrical conduits: 1 underground line runs under the center span approximately 10 feet south of Pier 2, 1 line runs east-west approximately 40 feet south of the existing Abutment 4, 1 line runs north-south in the western edge of the original existing bridge feeding the lighting in the median of I-25, and 1 line runs north-south in the eastern edge of the widened existing bridge.
- Water lines: 1 line runs east-west under the center span approximately 15 feet north of Pier 3.

- Gas lines: 1 underground gas line runs east-west under the center span approximately 12 feet south of Pier 2.

According to approximate utility information, several utilities in the area may need to be relocated. Electrical conduits on the existing structure will be relocated and conduit will be installed in the proposed bridge rails to carry the lines across the structures. Additional conduit will also be provided in the bridge rails, and in between girders, for future use. The electric line south of existing Abutment 3 may be impacted, depending on the depth of the line, due to the excavation of the soil in the area to allow for the widening of Arapahoe Road. The utilities running under Arapahoe Road below the southern span may be impacted depending on their location to the east of the existing structure and the location of the proposed foundations. The wider bridge (EA Action Alternative) may impact these utilities due to the skew of the utilities with respect to the bridge. It is anticipated that there may be isolated realignment of lines required to mitigate impacts from the foundations.

A fiber optic line to the east of the existing structure will be impacted. This fiber optic line will need to be relocated to the existing structure. The fiber optic line near Abutment 1 may be impacted by the proposed foundation due to a bend in the line to the east of the existing structure. The fiber optic line south of Abutment 4 may be impacted, depending on its depth, due to the excavation of the soil in the area to allow for the widening of Arapahoe Road.

Currently, highway lights line the median of I-25. The proposed construction will require removal and replacement of these lights along with relocation of the lighting conduits. Under deck lighting currently exists. The proposed construction will require removal and replacement of these lights, along with relocation of the lighting conduits as well.

Environmental Considerations

The Environmental Assessment for the I-25 and Arapahoe Road interchange is currently underway. This study documents the development of design alternatives and associated impacts and a preferred alternative will be recommended. At this time the following impacts are anticipated for the EA Action Alternative:

- ROW
- Commercial property access
- Noise
- Potential groundwater contamination

Right-of-Way Considerations

The entire existing bridge is within CDOT right-of-way (ROW). The EA Action Alternative creates impacts to ROW due to the widening and centerline shift of I-25 to the east. Right-of-way impacts occur near the northbound on-ramp and

northbound off-ramp. These impacts are considered temporary and ROW will be returned to the owners after construction.

Aesthetic Requirements

No formal aesthetic requirements are established for this site; however, due to the high traffic volume through the area, it is recommended that the design team implement ways to improve the aesthetics without increasing costs. Such improvements may include form liner or relief lines in the pier columns and abutments. The walls at the north abutment were constructed in 2010 to accommodate recent improvements to the Arapahoe Road typical section. The walls are composed of a soil nail wall type with an aesthetic concrete finish and planters. The recommended layout of the I-25 bridge preserves as much of this recent construction as possible. Additional wall types proposed for the interchange reconstruction should match the existing walls, to the extent possible.

3. Structure Layout and Type

Structural Design Criteria

The bridge replacement design will be based on the latest edition of the CDOT Bridge Design Manual, CDOT Design Memorandums, and current AASHTO Specifications for Bridge Design. The following design criteria were used to prepare the bridge type selection report and preliminary design:

Specification:	AASHTO, LRFD Bridge Design, Fifth Edition, as amended by 2010 Interims
Live Load:	AASHTO HL-93 (Design Truck or Tandem with Design Lane Load)
Live Load Deflection:	Span/800
Bridge Railing:	Type 7
Approach Slab:	Required
Roadway Pavement:	Asphalt
Deck Protection:	Waterproofing (Membrane) with 3” Stone Matrix Asphalt (SMA) overlay
Overlay:	36 psf for Hot Bituminous Pavement
Utilities:	Assume 5 psf for future utilities
Reinforcing:	Epoxy coated reinforcing steel will be used for the new structure. Assuming a high exposure level per CDOT bridge design memos, the top and bottom mats of steel in the bridge deck will be epoxy coated. A 2” clear cover to the top reinforcing will be provided. Epoxy coated reinforcing will be used in the pier columns as well.

Construction Phasing

After evaluating multiple phasing options for the I-25 bridge replacement, two phasing alternatives have been advanced for further consideration. The first alternative encompasses the phasing developed for the EA Action Alternative; the second is an optimized variation of this alternative.

The existing northbound and southbound lanes on I-25 have a varying grade separation elevation difference of up to 9 inches. In order to cross lanes over the existing median during construction, temporary asphalt would have to be placed on the southbound lanes to make up the difference in grade. Without as-built data of the actual grade difference, it is not certain that the southbound structure can adequately support the additional dead load. The EA Action

Alternative phasing plan assumes that traffic will not cross over the existing median and therefore requires a greater width of structure for phasing. Additionally, this phasing alternative provides a structure footprint for the maximum impacts associated with the EA Action Alternative. On the other hand, the EA Optimized phasing plan is less conservative and assumes the southbound structure can accommodate the additional asphalt required for phasing across the existing median.

EA Action Alternative Phasing Plan:

The EA Action Alternative phasing plan uses conventional phasing methods that shift traffic around work zones without crossing over the existing median. Conceptual phasing plans may be found in **Appendix C** and are summarized as follows:

Phase 1: Southbound I-25 lanes will remain in their existing lane configuration and northbound I-25 lanes will shift as far west as possible using reduced lane widths and shoulders and without crossing the existing median. With northbound traffic shifted to the west, a portion of the existing northbound structure will be removed and replaced with approximately 80 feet of new northbound structure. During this phase all detour construction required for Phase 2 will occur. This includes constructing temporary retaining walls and detour ramps for northbound I-25.

Phase 2: Northbound I-25 lanes will shift onto the completed east portion of the northbound structure completed in Phase 1. Southbound I-25 traffic lanes and shoulders will reduce and shift as far west as possible on the existing structure. Once traffic on I-25 has been shifted to the outer limits of the roadway, removal of a portion of the existing bridge and construction of approximately 83 feet of the new structure will take place in the center of I-25.

Phase 3: Northbound I-25 traffic lanes will remain in the Phase 2 configuration. Southbound traffic lanes will be shifted east onto the portion of the structure completed in Phase 2. During this phase the remaining existing bridge will be removed and the remaining bridge width of approximately 70 feet will be constructed.

Once the west portion is completed, final paving and striping will be completed and the northbound and southbound lanes will be shifted into their final configurations.

The EA Action Alternative phasing plan requires a 32-foot shoulder on the east side of the structure. This extra width of bridge was required to accommodate the phasing of six open lanes in each direction at all times (not including intermittent night time closures). User costs associated with the closure of lanes on I-25 made this a cost-prohibitive option for phasing. A summary of the user cost analysis may be found in **Appendix D.**

EA Optimized Phasing Plan:

The EA Optimized phasing plan is a similar concept as the EA Action Alternative phasing plan; however, it is based upon the assumption that phasing can cross over the existing median. Conceptual phasing plans may be found in **Appendix B** and are summarized as follows:

Phase 1: Southbound and northbound lanes will shift as far west as possible using reduced lane widths and shoulders. The northbound lanes will cross over the existing I-25 centerline. With traffic shifted to the west, a portion of the existing northbound structure will be removed and replaced with approximately 81 feet of new northbound structure. During this phase all detour construction required for Phase 2 will occur. This includes constructing temporary retaining walls and detour ramps for northbound I-25. Walls and ramp detour construction will be less extensive than that required for the EA Action Alternative phasing plan.

Phase 2: Northbound I-25 lanes will shift onto the completed east portion of the northbound structure completed in Phase 1. Southbound I-25 lanes will remain in their current configuration. Once traffic on I-25 has been shifted to the outer limits of the roadway, removal of a portion of the existing bridge and construction of approximately 67 feet of the new structure will take place in the center of I-25.

Phase 3: Northbound I-25 traffic lanes will remain in the Phase 2 configuration. Southbound traffic lanes will be shifted east onto the portion of the structure completed in Phase 2. During this phase the remaining existing bridge will be removed and the remaining bridge width of approximately 63 feet will be constructed.

Once the west portion is completed, final paving and striping will be completed and the northbound and southbound lanes will be shifted into their final configurations.

Constructability:

For Phase 1 and 3, the contractor can access the site from the east and west, respectively. Girders can be erected by placing cranes next to the proposed bridge. Girders will be placed during night and/or weekend closures of Arapahoe Road. The girders can be brought into the site from Arapahoe Road.

Phase 2 has limited access for girder erection. Due to the current condition of the existing structure an evaluation of crane loading will need to be performed to determine if the contractor may set cranes on the existing structure during placement. The current phasing plan leaves approximately 15’-5” between the existing structure and the proposed structure during this phase. The contractor may be able to erect girders using a crane on Arapahoe Road, in between the structures with a second crane behind the abutment, and then lifting the girders from the haul truck that is sitting on the existing structure. The contractor may

decide to set cranes on the proposed structure during placement. The deck and girders will need to be designed for crane loading during final design.

During the geotechnical investigations for final design, the geotechnical engineering will need to determine if the soils are able to support crane pad surcharges without excessive settlement.

Recommendation:

Further consideration of the EA Optimized phasing plan is recommended after completion of a detailed rating of the existing structure with the additional asphalt required for the proposed phasing. This phasing plan could result in substantial cost savings due to the smaller width necessary for construction phasing. If it is found that the existing structure does not rate with the additional asphalt, the EA Action Alternative phasing plan would be recommended. The EA Action Alternative phasing plan was advanced for the EA to assess impacts for the maximum physical footprint of the improved bridge.

Bridge Layout Alternatives

Bridge Width:

The proposed I-25 bridge section for the EA Optimized phasing plan consists of a single bridge that accommodates five 12-ft through lanes and one 12-ft auxiliary ramp lane in the SB direction and five 12-ft through lanes and two 12-ft (minimum) auxiliary ramp lanes in the NB direction. On I-25, the outside shoulder width is 12 feet and the inside width is 10 feet. The NB and SB traffic lanes are separated by a 2-foot-wide median barrier, and the exterior barriers are 1.5 feet in width. The total superstructure width is 213 feet. The cross-section features a standard crown with 2% cross-slopes. Structure layout data for this bridge alternative may be found in **Appendix B.**

The proposed bridge width for the EA Action Alternative is 233 feet. As mentioned previously, a wider bridge and therefore a conservative footprint was assumed for assessing impacts in the EA. Structure layout data for this bridge alternative may be found in **Appendix C**.

Bridge Length and Span Configuration:

The proposed bridge span configuration for both bridge width alternatives uses a two-span (120 ft – 100 ft) layout. The span configuration positions the Abutment 1 piles behind the existing abutment which maintains an existing Soil Nail wall that was recently constructed in 2010. Pier 2 is located at the same location as the existing bridge Pier 3 and aligns with the LRT bridge pier to the west. Conceptual design for the pier layout (shown in the typical section in **Appendix B**) assumes the caissons will be located between existing bridge footings. The piles at Abutment 3 are located approximately 6 feet behind the front face of the proposed MSE retaining wall. The location of Abutment 3 was driven by the

need to provide adequate space for a sidewalk along the south side of Arapahoe Road, as well as the two lanes servicing the NB I-25 on-ramps.

The two-span bridge layout was the preferred span arrangement for accommodating the proposed typical section on Arapahoe Road. The layout provides a relatively open configuration for lanes and sidewalks on Arapahoe Road, and at the same time provides reasonable options for superstructure types and conventional construction methods. Three additional layout options were investigated but not recommended for the following reasons:

- Single-span: While a single-span option would provide the most flexibility for lane and sidewalk placement on Arapahoe Road, it was determined that the same objective could be achieved with a two-span option and for less cost. A single-span bridge would require a steel or post-tensioned concrete superstructure – both considered to be more expensive structure types. Additionally, impacts to the profile of I-25 would be significant due to the increased structure depth required to span over 220 feet.
- Three - Span: A three-span structure would require constructing a pier in the center of EB Arapahoe Rd which would cause significant traffic impacts and delays during construction. Additionally, a three-span structure would require a similar structure depth as the two-span alternative, thus would not provide any structural or roadway savings to the project. Also, a three-span layout would preclude any future lane configurations along Arapahoe Rd.
- 4 - Span: Constructing a four-span structure would require constructing a pier in the center of EB Arapahoe Rd, which would cause significant traffic impacts and delays during construction. Also, a four-span layout would preclude any future lane configurations along Arapahoe Rd.

Rehabilitation Alternatives

While the existing structure is in relatively good condition (Sufficiency Rating is 83.2), it is considered 'Functionally Obsolete' due to the sub-standard vertical clearance. In addition, the bridge length provides insufficient lane capacity underneath the structure for Arapahoe Road. Rehabilitation of the bridge will not alleviate these deficiencies and it is therefore recommended that the bridge be replaced.

Foundation Alternatives

Abutments:

Feasible abutment types include:

- *Beam seat abutments:* These abutments are free-standing and resist lateral soil loads exerted from the retained fill along the back face. They are typically used for longer bridge spans and can accommodate large superstructure thermal movements with a gap provided between the end of

the girder and abutment back wall. The girders are typically supported on expansion bearings.

- *Integral abutments:* With integral abutments, the girder ends are encased in a concrete diaphragm that is constructed integral with the abutment cap. The interface between the abutment cap and the supporting foundation is a pinned connection that is able to accommodate superstructure movements by displacing with the superstructure. Integral abutments are commonly used for shorter structures with lengths up to 700 feet.

Integral abutments are the recommended abutment type for this site. The relatively short bridge length allows the abutments to be fixed, thus precluding the need for a seat type expansion abutment. These abutments also require less long-term maintenance as they keep deck water off of the bearings.

Piers:

Three types of piers were investigated.

- *Multi-Column Bent:* This pier type consists of multiple columns that support a below-girder pier cap. Based on the as-built plan site geology and geotechnical information, 10 circular columns are required to support the structure and accommodate the construction phasing plans. Irregular column spacing is proposed in order to accommodate the phasing plan and to clear the existing spread footing foundations.
- *Wall Piers:* For this pier type, a solid wall running the length of the pier is used to support the bridge superstructure. The wall is founded on a pile cap footing.

A multi-column bent pier is the recommended pier alternative. Not only will it provide a less visually obstructed opening below I-25, it will also impose less impacts to traffic on Arapahoe Road during construction. Because the wall pier is founded on a pile cap footing, extensive excavation would be required to construct the footing and thus impact multiple lanes of traffic.

Due to the proximity of traffic to the pier, a crashwall or some other type of pier protection will be required. Per AASHTO, the design will need to protect the Pier from TL-5 impact loading. Two options are available: 1) Design the pier columns for the impact, and 2) Provide a 54” high crashworthy barrier. For preliminary design, option 2 is recommended as the smaller columns would require significant reinforcing and some type of median barrier would be required regardless to protect oncoming traffic.

Foundations:

Abutments: Based on existing bridge as-built plans, HP pile foundations are recommended at the abutments; however, drilled shafts may be used if economical. Preliminary pile lengths are estimated to be 35 feet.

Piers: Based on the as-built geotechnical information, drilled caissons are the preferred alternative for the center pier. The existing bridge foundations will dictate the location of the columns. Based on the as-built plans, there is approximately 4'-0" minimum between the edges of the concrete footings which would accommodate 3'-0" diameter drilled caissons.

The as-built Engineering Geology and Foundation Layout sheets provided geotechnical design information used in this report. According to the Geology sheet, borings were advanced to approximately 30 feet below ground surface of I-25. The existing bridge pier loads were supported with 2-6" caissons for the TREX widened section and spread footings for the original structure. The proposed structure will have much larger reactions at the pier and will therefore require deeper caissons. The following summarizes the preliminary caisson lengths estimated for the structure type alternatives.

Alternative 1- BT-54: 46 feet
Alternative 2- BX-72x33: 50 feet
Alternative 3- Steel Plate Girder: 43 feet

Structure Type Alternatives

Various superstructure types were considered for the EA Optimized phasing plan and the preferred structure span arrangement and configuration. Of these, three structure type alternatives were further evaluated and are described below.

Alternative A – Precast Prestressed Concrete Bulb-Tee (BT-54) Girders:

Preliminary analysis indicates that 26 prestressed concrete bulb-tee (BT-54) girder lines will be needed to support the bridge dead load and HL-93 live load. The girders utilize CDOT standard sections and will be spaced at 8'-4" on center. The advantages of the BT girders are that they do not require falsework to erect, and the cast-in-place deck can be poured using pre-cast deck panels or stay-in-place steel deck forms to reduce construction time and costs. The Denver area has numerous local girder fabricators and the lead times for concrete girders are generally shorter than for steel alternatives.

The BT alternative is the most economical superstructure type investigated; however, the girders are deeper than other alternatives considered which will increase roadway costs. The total estimated bridge cost for the BT-54 alternative is $86 per square foot of bridge deck. This cost is for bridge items only and does not include associated roadway and wall costs.

The disadvantage of the BT girders is that they typically weigh more than steel alternatives and require larger foundations.

Alternative B – Precast Prestressed Concrete Box (BX-72x33) Girders:

Preliminary analysis indicates that 34 prestressed concrete adjacent box (BX-72x33) girder lines will be needed to support the bridge dead load and HL-93 live load. Similar to the BT-54 girders, the box girder option utilizes CDOT standard girder sections and will not require falsework to erect. Additionally the boxes will not require deck forms which can expedite construction and reduce impacts to I-25 traffic. The girders will be spaced with a 1-inch gap to allow for horizontal sweep in the girders. The gap will be filled after the girders are set.

The box girder structure is more expensive than BT-54 girders; however, some of this cost is offset by reduced roadway costs due to a lower roadway profile. Adjacent box girders offer a key advantage in minimizing profile grade increases often required for bridge replacement projects. The total estimated bridge cost for the BX-72x33 alternative is $111 per square foot of bridge deck. This cost is for bridge items only and does not include associated roadway and wall costs.

Alternative C – Welded Steel Plate Girders:

Preliminary analysis indicates that 26 welded steel girder lines will be needed to support the bridge dead load and HL-93 live load. Similar to the BT Alternative, the girders are 54 inches deep and spaced at 8'-4" on center.

Advantages of steel plate girder superstructures are that they are much lighter than concrete girder superstructures and therefore require less expensive foundation systems and smaller cranes for girder erection. The cast-in-place deck can also use stay-in-place deck forms to reduce construction time and costs. In addition, steel girders are considered more sustainable as most steel is produced from recycled materials.

A key disadvantage of this alternative is that there are no local steel girder fabricators and the girders must be shipped from outside the state of Colorado. In addition, the steel girders require longer lead times for girder fabrication. At $138 per square foot of bridge deck, the steel plate girder superstructure is the most expensive structure type considered for this project. This cost is for bridge items only and does not include associated roadway and wall costs.

Other Superstructure Alternatives Investigated:

In addition to the alternatives described above, the following alternatives were also considered, but not further evaluated:

Cast-in-place Boxes & Girders: Cast-in-place construction was not evaluated due to the significant falsework that would be required and the resulting traffic impacts to Arapahoe Road traffic during construction.

Post-Tensioned Girders: Because the bridge can be constructed using more conventional precast-prestressed methods, a post-tensioned system was not considered to be economical for this site.

4. Alternatives Evaluation and Recommendation

Selection Criteria

The following selection criteria were used to evaluate and determine the recommended structure alternative. The alternatives were evaluated based on their ability to:

- Accommodate the construction phasing plan;
- Provide a constructible solution;
- Minimize removal of existing features that were constructed within the TREX project;
- Minimize I-25 profile impacts,
- Provide an economical solution to the owner and public;
- Maintain or enhance existing aesthetics without adding additional costs; and
- Minimize schedule impacts.

Estimate of Probable Construction Costs

Preliminary quantities and bridge construction cost estimates for each alternative are summarized below:

Alternative A – BT-54 Girders:	$5,600,000 ($86 / SF)
Alternative B – BX-72x33 Girders:	$5,700,000 ($111 / SF)
Alternative C – Steel Girders:	$8,500,000 ($138 / SF)

Refer to **Appendix A** for preliminary construction cost details. The estimated costs listed above include bridge, abutment wall, additional roadway, and additional user costs (due to longer construction periods). The costs per square foot are determined using only the bridge costs. All costs are using the bridge width required for the EA Optimized phasing plan. For detailed construction costs for the EA Action Alternative phasing plan, see **Appendix C**.

The unit costs used for the estimates are based on CDOT's 2010 Cost Data.

Structure Recommendation

Each of the three structure type alternatives evaluated can accommodate both construction phasing plans; the EA Action Alternative and the EA Optimized.

Alternative C is the most expensive and has the greatest impact on project schedule; therefore, is not recommended.

Alternatives A and B are both constructible alternatives. Although the BT-Girder structure is the least expensive, it requires the greatest increase in the I-25

profile. Additionally, the overall construction cost for each alternative is similar considering the higher box girder costs are offset by reduced construction and roadway costs. Both alternatives use similar construction techniques with similar construction schedules, although the box girder alternative offers a reduction in the construction schedule due to the elimination of deck formwork.

Alternative B, BX72x33 Box Girders would be the recommended structure type for the I-25 over Arapahoe Road structure. With a relatively shallow structure depth, this alternative minimizes roadway and wall impacts associated with the increase in the I-25 profile. The superstructure type is commonly used in projects across Colorado and can easily be handled by most local bridge contractors. Also, the box girders offer a somewhat accelerated bridge construction method as the deck can be poured without the placement of formwork, offering savings in construction schedule and cost. The BX72x33 box girders can accommodate both construction phasing plans; the EA Action Alternative and the EA Optimized.

Using a maximum girder depth of 33 inches, a 5-in (minimum) concrete deck, a 3-in SMA overlay, and a 4-in haunch, the total superstructure depth is 3’-9”. The proposed profile and superstructure depth provides 16’-6” of vertical clearance to the crown of the proposed Arapahoe road with the critical location along the east girder.

However, due to lesser cost of the BT-54 Girders, this alternative was advanced as the structure type in the EA Action Alternative as the maximum physical footprint resulting from the improved bridge.

APPENDIX A

PRELIMINARY CONSTRUCTION COST ESTIMATES

ARAPAHOE / I-25 EA

PRELIMINARY BRIDGE CONSTRUCTION COSTS

BID #	BID ITEM	UNIT	UNIT COST	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
				Two Span (120' - 100')					
				BT54		BX33		54" Steel Girder	
-	Removal of Existing Structure($10/SF)	LS	$350,000	1	$ 350,000	1	$ 350,000	1	$ 350,000
206	Structure Excavation	CY	$10.00	1,914	$ 19,140	1,459	$ 14,591	1,914	$ 19,140
206	Structure Backfill (Class 1)	CY	$20.00	1,506	$ 30,117	1,126	$ 22,523	1,506	$ 30,117
206	Structure Backfill (Class 2)	CY	$15.00	321	$ 4,811	321	$ 4,811	321	$ 4,811
206	Mechanical Reinforcement of Soil	CY	$17.50	1,506	$ 26,352	1,126	$ 19,708	1,506	$ 26,352
403	Hot Bituminous Pavement	Tons	$90.00	982	$ 88,373	982	$ 88,373	982	$ 88,373
502	Steel Piling (HP 12x74)	LF	$50.00	2,660	$ 133,000	2,660	$ 133,000	2,380	$ 119,000
503	Drilled Caisson (36 in.)	LF	$300.00	414	$ 124,200	450	$ 135,000	387	$ 116,100
509	Structural Steel	LB	$2.25					1,351,603	$ 3,041,107
515	Waterproofing (Membrane)	SY	$15.00	6,235	$ 93,518	6,235	$ 93,518	6,150	$ 92,251
518	Bridge Expansion Device (0-4")	LF	$200.00	458	$ 91,600	458	$ 91,600	458	$ 91,600
601	Concrete Class D (Bridge) - Substr.	CY	$400.00	342	$ 136,850	339	$ 135,687	339	$ 135,687
601	Concrete Class D (Bridge) - Super.	CY	$400.00	1,965	$ 786,127	1,448	$ 579,356	1,933	$ 773,025
602	Reinforcing Steel	LB	$0.90	51,319	$ 46,187	50,883	$ 45,794	50,883	$ 45,794
602	Reinforcing Steel (Epoxy Coated)	LB	$0.90	416,419	$ 374,777	300,110	$ 270,099	409,049	$ 368,144
606	Bridge Rail Type 7	LF	$85.00	789	$ 67,065	789	$ 67,065	789	$ 67,065
618	Prestressed Concrete I (BT54)	LF	$170.00	5,733	$ 974,610				
618	Pres. Concrete Box (32" - 48")	SF	$50.00			44,880	$ 2,244,000		
			TOTAL =		$ 3,346,727		$ 4,295,125		$ 5,368,566
	BRIDGE CONTINGENCY = 20%		CONTINGENCY =		$ 669,345		$ 859,025		$ 1,073,713
			TOTAL BRIDGE COST =		**$ 4,016,073**		**$ 5,154,150**		**$ 6,442,279**
			DECK AREA =		46,607		46,607		46,607
			COST/SF =		**$ 86**		**$ 111**		**$ 138**
			ABUTMENT RETAINING WALL COST =		$ 442,359		$ 442,359		$ 442,359
	WALL CONTINGENCY = 30%		CONTINGENCY =		$ 132,708		$ 132,708		$ 132,708
			TOTAL WALL COST =		**$ 575,067**		**$ 575,067**		**$ 575,067**
			TOTAL BRIDGE + WALL COST =		**$ 4,591,140**		**$ 5,729,217**		**$ 7,017,346**
			RELATIVE PROFILE INCREASE (ft.) =		2.00		0.00		1.75
			INCREASED ROADWAY COST =		**$ 690,000**		**$ -**		**$ 700,000**
			CONSTRUCTION TIME USER COST =		**$ 300,000**		**$ -**		**$ 800,000**
			TOTAL BRIDGE + WALL + ROADWAY + USER COST =		**$ 5,581,140**		**$ 5,729,217**		**$ 8,517,346**
			TOTAL SUPERSTRUCTURE DEPTH (FT.) FOR CLEARANCE =		5.75		3.75		5.50
			TOTAL SUPERSTRUCTURE DEPTH (FT.) FOR DEPTH / SPAN RATIO =		5.25		3.25		5.25
			D / L PROVIDED =		0.044		0.027		0.044
			D / L MINIMUM =		0.040		0.025		0.032

Note 1: Bridge Contigency includes Deck Drains, Conduits, Structural Concrete Coating, etc.

Note 2: Wall Contigency accounts for variable wall length, height, aesthetics features etc.

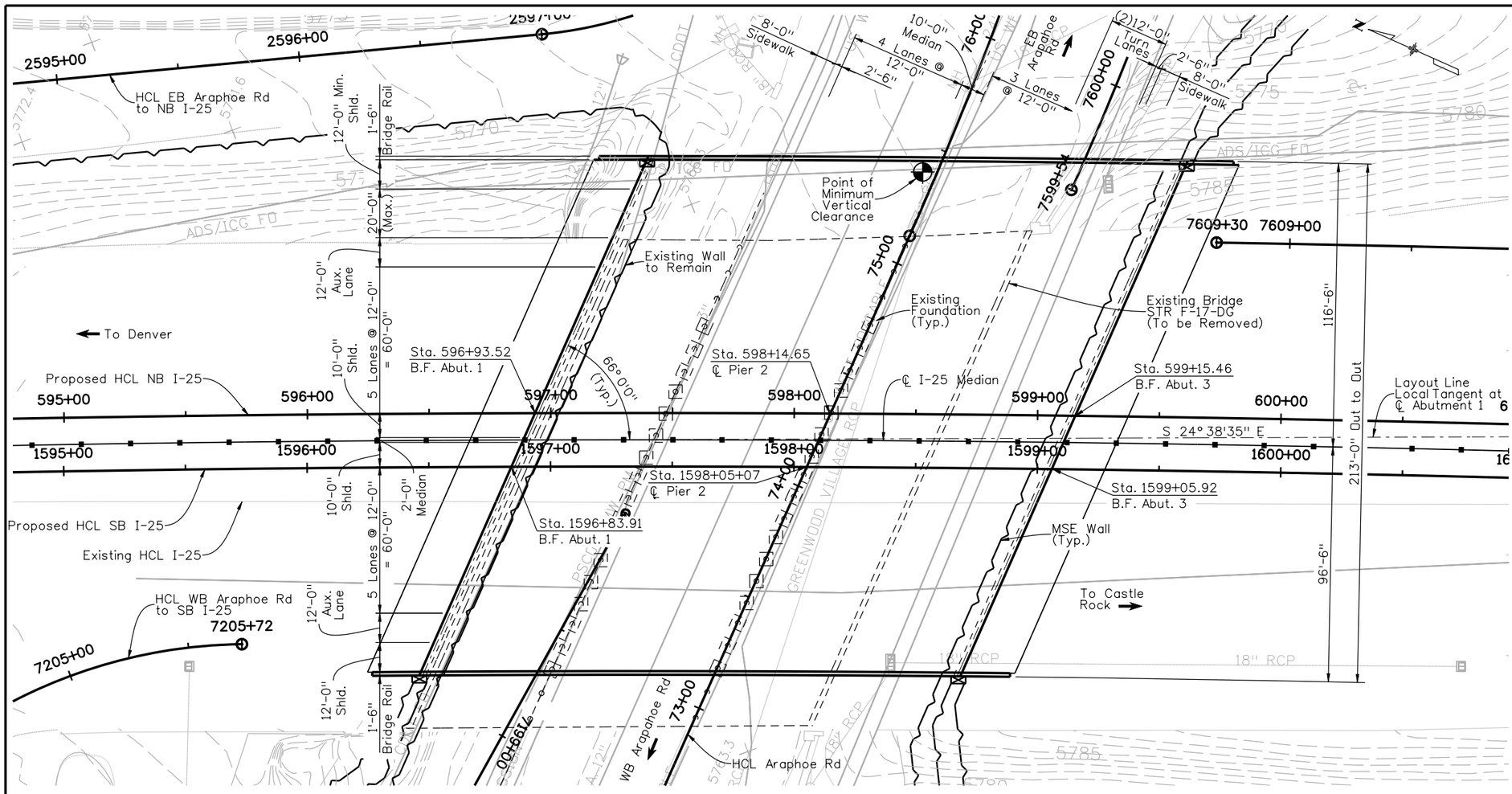
Note 3: Reinforcing Quantities are based assumed densities of 225 LB/CY Superstructure and 150 LB/CY Substructure.

Note 4: Roadway Cost includes cost for features impacted by bridge profile adjustments such as asphalt, grading, ramp retaining walls etc.

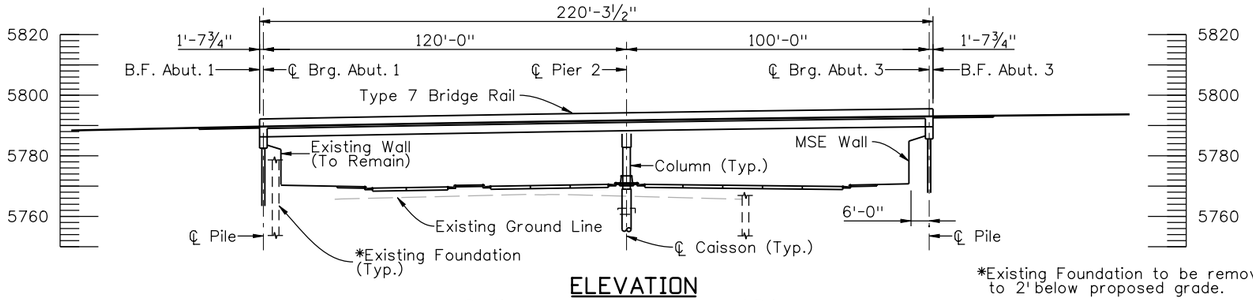
Note 5: Construction Time User Cost assumes $10,000 / day x 30 days to account for additional time required for grading retaining wall construction, deck formwork, phasing etc.

APPENDIX B

GENERAL LAYOUT, TYPICAL SECTION & CONSTRUCTION PHASING SHEETS FOR RECOMMENDED ALTERNATIVE



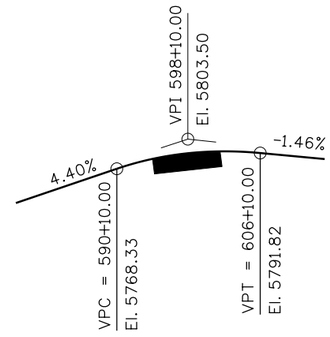
PLAN



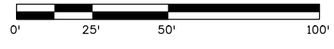
ELEVATION

Section taken along West edge of Bridge

*Existing Foundation to be removed to 2' below proposed grade.



I-25 NB PROFILE GRADE



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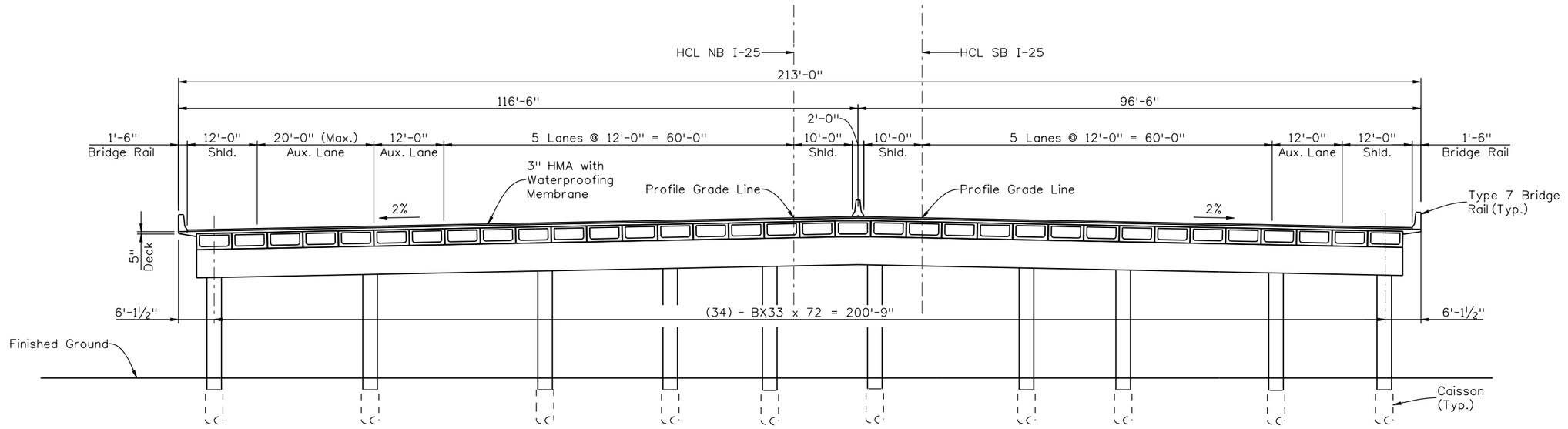
Horiz. Scale: 1:1 Vert. Scale: As Noted		Region 6 JH	Revised:
Unit Information Unit Leader Initials			Void:

I-25/Arapahoe Interchange
Environmental Assessment

GENERAL LAYOUT
EA OPTIMIZED ALTERNATIVE

Designer: J. WARREN Detailer: R. ARTMAN

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number



BOX GIRDER - TYPICAL SECTION

(Looking South)

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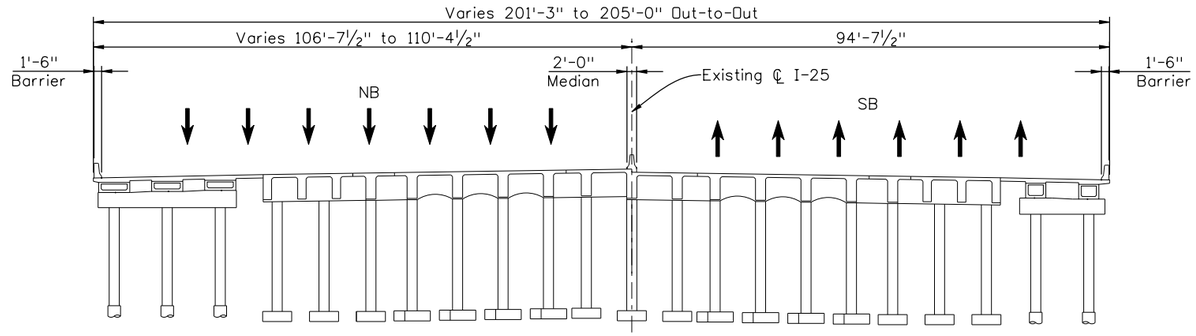
I-25/Arapahoe Interchange
Environmental Assessment

TYPICAL SECTION
EA OPTIMIZED ALTERNATIVE

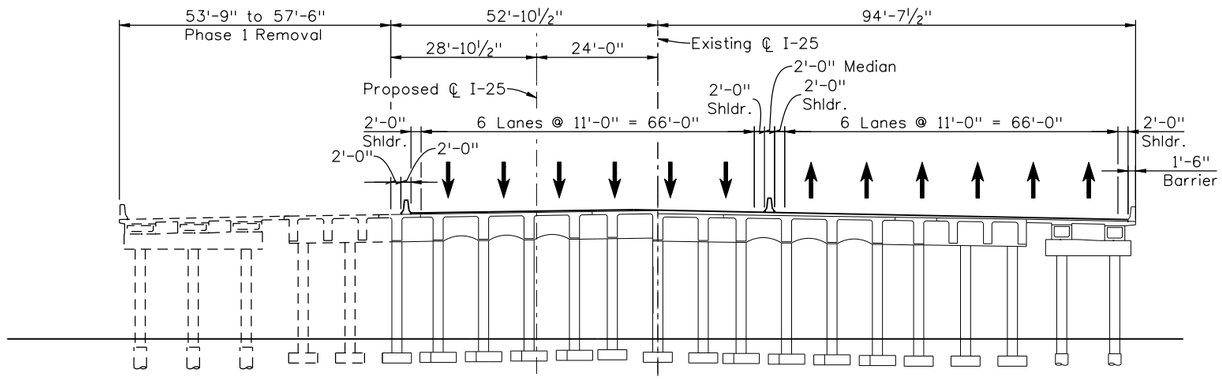
Designer: J. WARREN Detailer: R. ARTMAN

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number

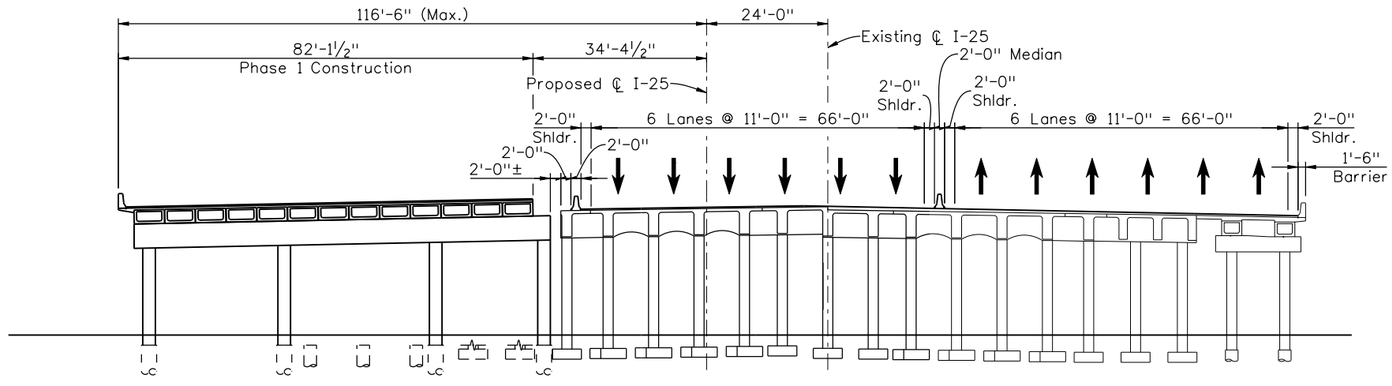


EXISTING BRIDGE

(Str. No. F-17-DG)



PHASE 1A DETOUR AND REMOVAL



PHASE 1B CONSTRUCTION

NOTE:

1. All sections looking south.

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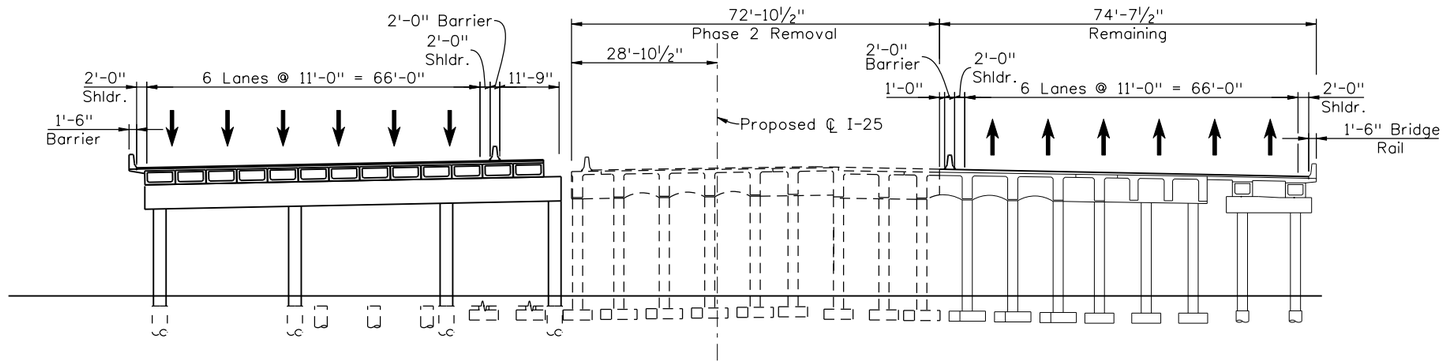
Unit Information Unit Leader Initials					

As Constructed	I-25/Arapahoe Interchange Environmental Assessment	Project No./Code
No Revisions:	CONSTRUCTION PHASING (1 OF 3) EA OPTIMIZED ALTERNATIVE	I-25/ARAPAHOE EA
Revised:		16159
Void:	Designer: J. WARREN Detailer: R. ARTMAN	Sheet Number



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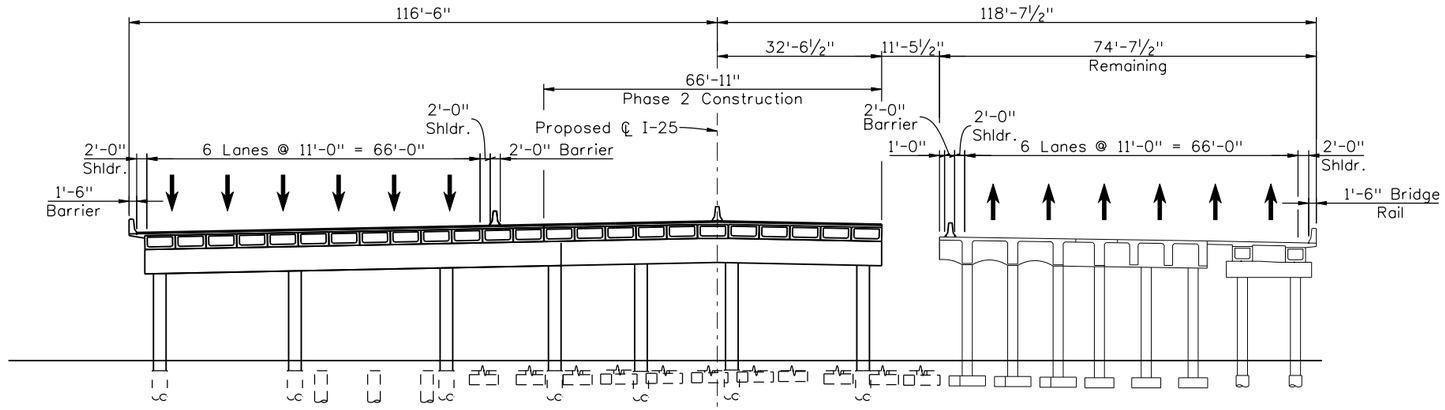
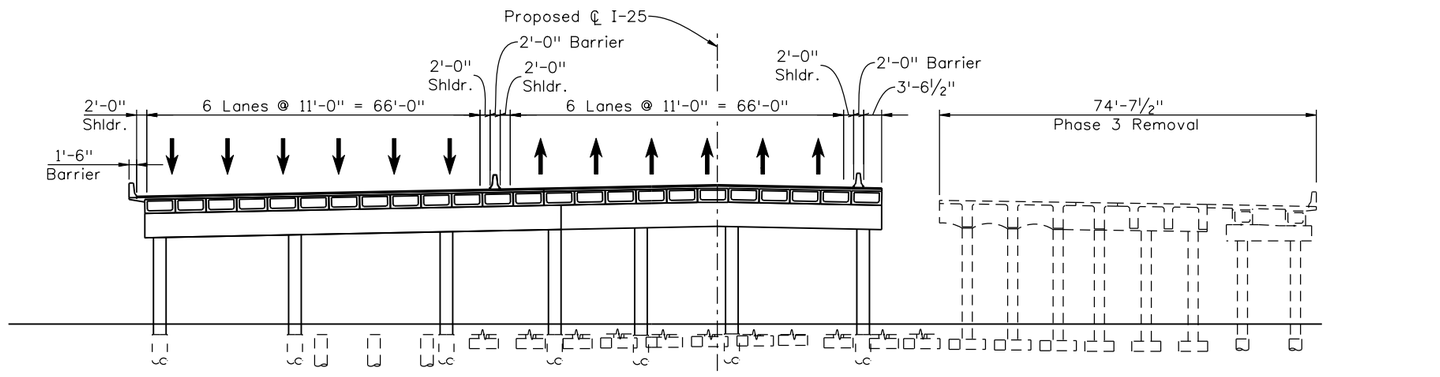


PHASE 2B CONSTRUCTION



PHASE 3A DETOUR AND REMOVAL

NOTE:

1. All sections looking south.

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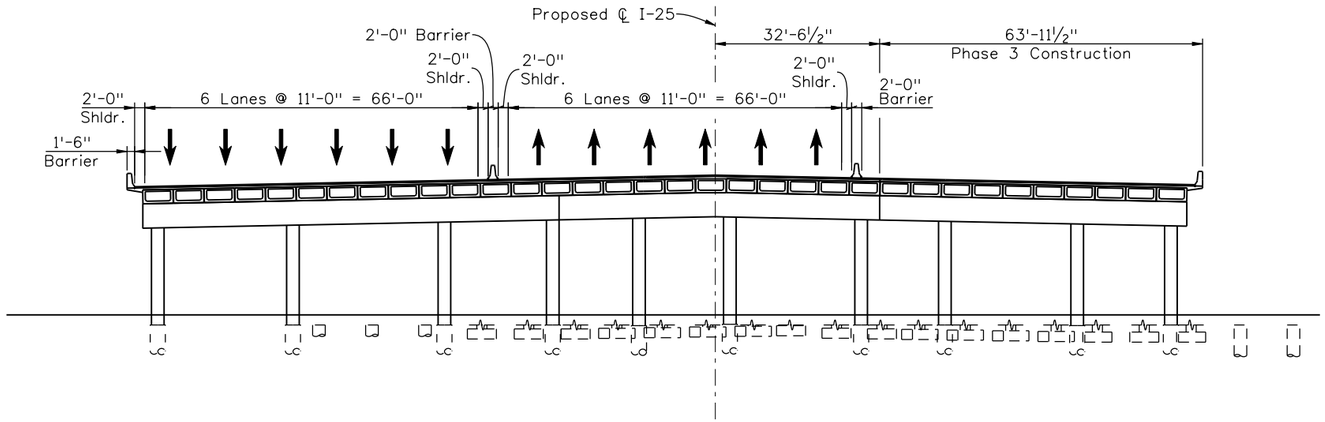
Unit Information Unit Leader Initials			Void:

I-25/Arapahoe Interchange
Environmental Assessment

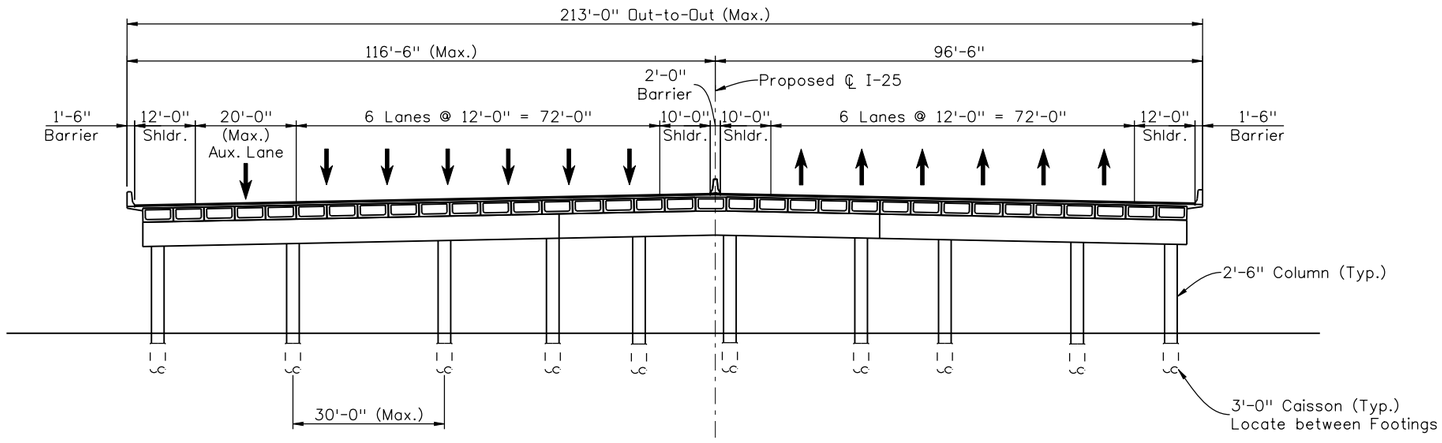
CONSTRUCTION PHASING (2 OF 3)
EA OPTIMIZED ALTERNATIVE

Designer: J. WARREN Detailer: R. ARTMAN

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number



PHASE 3B CONSTRUCTION



ULTIMATE CONFIGURATION

(Looking South)

NOTE:

1. All sections looking south.

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Horiz. Scale: 1:1 Vert. Scale: As Noted				Region 6 JH	Revised:
Unit Information Unit Leader Initials					Void:

I-25/Arapahoe Interchange
Environmental Assessment

CONSTRUCTION PHASING (3 OF 3)
EA OPTIMIZED ALTERNATIVE

Designer: J. WARREN Detailer: R. ARTMAN

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number

APPENDIX C

EA ACTION ALTERNATIVE SUMMARY, COSTS, AND DRAWINGS

Appendix C

EA Action Alternative

The EA Action Alternative is the alternative recommended for the EA evaluation. This alternative provides a conservative scenario in terms of the footprint required for reconstruction. As mentioned previously in this report, there may be opportunity to optimize this design; however, this will not be ascertained until final design is underway. The EA alternative includes the following:

- EA Action Alternative phasing plan, which sets the width of the bridge to 233'-0"
- BT-54 girder type, which sets the profile of I-25 higher than with other potentially feasible girder types

Due to these adjustments, the costs for the bridge alternatives are also conservative. See below for a summary of the updated costs:

Alternative A – BT-54 Girders:	$5,894,294 ($83 / SF)
Alternative B – BX-72x33 Girders:	$6,235,363 ($109 / SF)
Alternative C – Steel Girders:	$9,154,192 ($136 / SF)

Refer to the following pages in this appendix for preliminary construction costs details. The costs listed above include bridge, abutment wall, additional roadway, and additional user costs. The costs per square foot are determined using only the bridge costs. All costs are using the resulting width for the EA Phasing Plan.

Due to the wider bridge, there are adjustments to the preliminary design of the substructure. At the abutments, more steel H piles are used. At the pier, 10 columns and 10 caissons are used to support the structure.
The following pages are included in this appendix for the EA Alternative:

- Preliminary Construction Costs
- General Layout
- Typical Section
- Construction Phasing

ARAPAHOE / I-25 EA

PRELIMINARY BRIDGE CONSTRUCTION COSTS

BID #	BID ITEM	UNIT	UNIT COST	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
				Two Span (120' - 100')					
				BT54		BX33		54" Steel Girder	
-	Removal of Existing Structure($10/SF)	LS	$350,000	1	$ 350,000	1	$ 350,000	1	$ 350,000
206	Structure Excavation	CY	$10.00	2,129	$ 21,285	1,623	$ 16,227	2,129	$ 21,285
206	Structure Backfill (Class 1)	CY	$20.00	1,675	$ 33,492	1,252	$ 25,047	1,675	$ 33,492
206	Structure Backfill (Class 2)	CY	$15.00	350	$ 5,244	350	$ 5,244	350	$ 5,244
206	Mechanical Reinforcement of Soil	CY	$17.50	1,675	$ 29,306	1,252	$ 21,917	1,675	$ 29,306
403	Hot Bituminous Pavement	Tons	$90.00	1,076	$ 96,847	1,076	$ 96,847	1,076	$ 96,847
502	Steel Piling (HP 12x74)	LF	$50.00	2,800	$ 140,000	2,800	$ 140,000	2,520	$ 126,000
503	Drilled Caisson (36 in.)	LF	$300.00	460	$ 138,000	500	$ 150,000	430	$ 129,000
509	Structural Steel	LB	$2.25					1,506,811	$ 3,390,325
515	Waterproofing (Membrane)	SY	$15.00	6,832	$ 102,484	6,832	$ 102,484	6,832	$ 102,484
518	Bridge Expansion Device (0-4")	LF	$200.00	510	$ 102,000	510	$ 102,000	510	$ 102,000
601	Concrete Class D (Bridge) - Substr.	CY	$400.00	373	$ 149,154	373	$ 149,154	373	$ 149,154
601	Concrete Class D (Bridge) - Super.	CY	$400.00	2,155	$ 862,003	1,590	$ 636,075	2,112	$ 844,634
602	Reinforcing Steel	LB	$0.90	55,933	$ 50,339	55,933	$ 50,339	55,933	$ 50,339
602	Reinforcing Steel (Epoxy Coated)	LB	$0.90	456,543	$ 410,889	329,459	$ 296,513	446,773	$ 402,096
606	Bridge Rail Type 7	LF	$85.00	789	$ 67,065	789	$ 67,065	789	$ 67,065
618	Prestressed Concrete I (BT54)	LF	$170.00	6,174	$ 1,049,580				
618	Pres. Concrete Box (32" - 48")	SF	$50.00			50,160	$ 2,508,000		
			TOTAL =		$ 3,607,689		$ 4,716,913		$ 5,899,271
	BRIDGE CONTINGENCY = 20%		CONTINGENCY =		$ 721,538		$ 943,383		$ 1,179,854
			TOTAL BRIDGE COST =		**$ 4,329,227**		**$ 5,660,296**		**$ 7,079,125**
			DECK AREA =		51,959		51,959		51,959
			COST/SF =		**$ 83**		**$ 109**		**$ 136**
			ABUTMENT RETAINING WALL COST =		$ 442,359		$ 442,359		$ 442,359
	WALL CONTINGENCY = 30%		CONTINGENCY =		$ 132,708		$ 132,708		$ 132,708
			TOTAL WALL COST =		**$ 575,067**		**$ 575,067**		**$ 575,067**
			TOTAL BRIDGE + WALL COST =		**$ 4,904,294**		**$ 6,235,363**		**$ 7,654,192**
			RELATIVE PROFILE INCREASE (ft.) =		2.00		0.00		1.75
			INCREASED ROADWAY COST =		**$ 690,000**		**$ -**		**$ 700,000**
			CONSTRUCTION TIME USER COST =		**$ 300,000**		**$ -**		**$ 800,000**
			TOTAL BRIDGE + WALL + ROADWAY + USER COST =		**$ 5,894,294**		**$ 6,235,363**		**$ 9,154,192**
			TOTAL SUPERSTRUCTURE DEPTH (FT.) FOR CLEARANCE =		5.75		3.75		5.50
			TOTAL SUPERSTRUCTURE DEPTH (FT.) FOR DEPTH / SPAN RATIO =		5.25		3.25		5.25
			D / L PROVIDED =		0.044		0.027		0.044
			D / L MINIMUM =		0.040		0.025		0.032

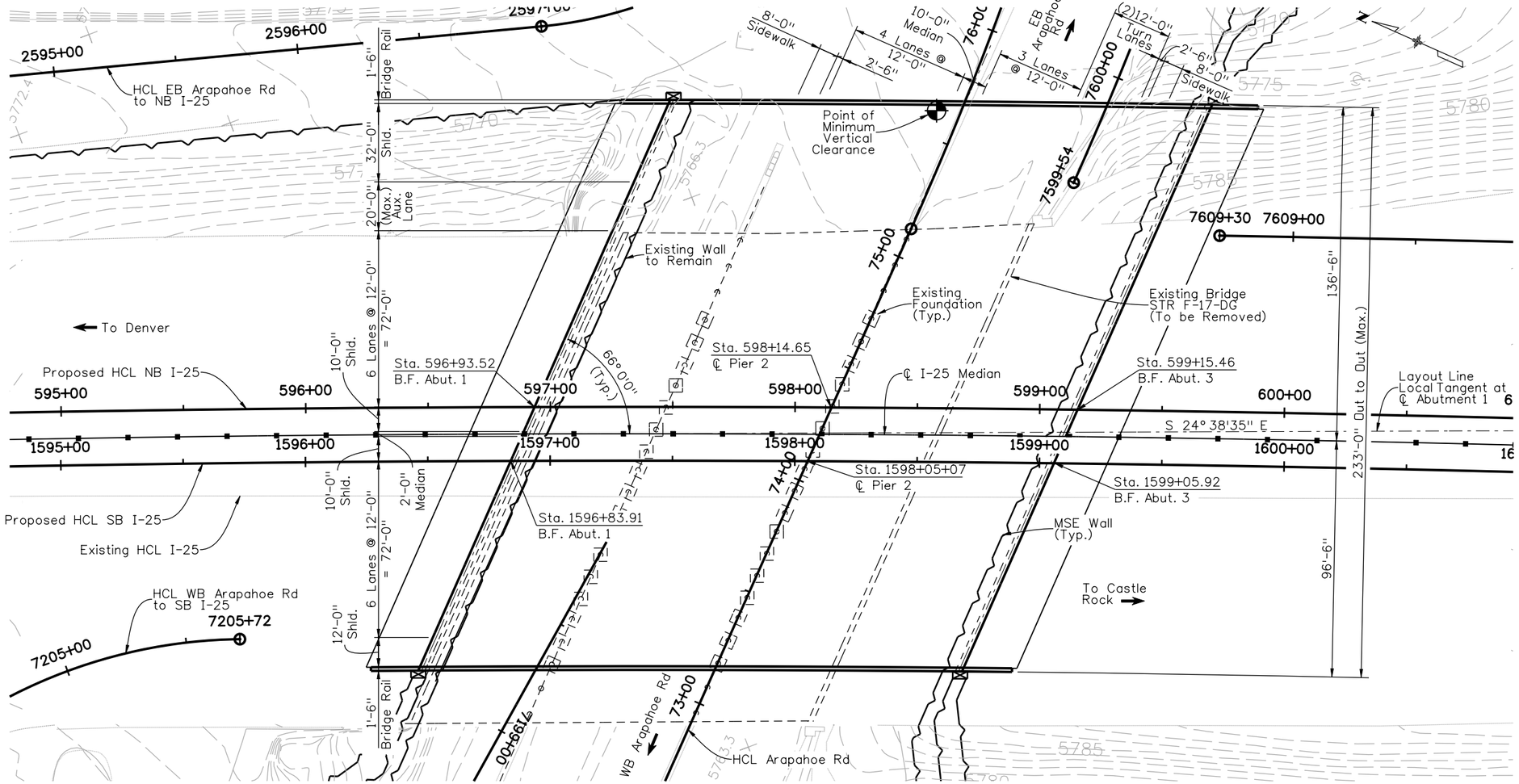
Note 1: Bridge Contigency includes Deck Drains, Conduits, Structural Concrete Coating, etc.

Note 2: Wall Contigency accounts for variable wall length, height, aesthetics features etc.

Note 3: Reinforcing Quantities are based assumed densities of 225 LB/CY Superstructure and 150 LB/CY Substructure.

Note 4: Roadway Cost includes cost for features impacted by bridge profile adjustments such as asphalt, grading, ramp retaining walls etc.

Note 5: Construction Time User Cost assumes $10,000 / day x 30 days to account for additional time required for grading retaining wall construction, deck formwork, phasing etc.



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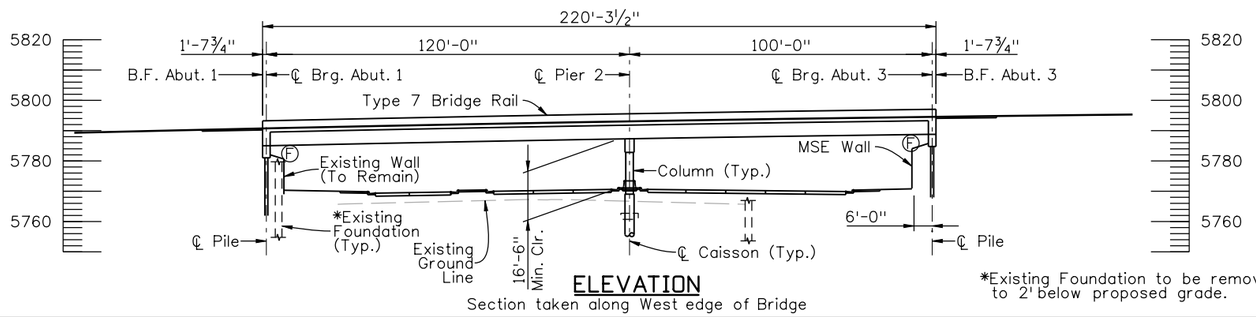
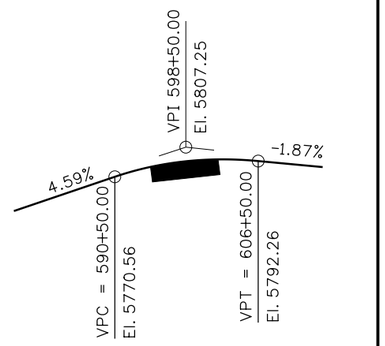


ELEVATION

Section taken along West edge of Bridge

*Existing Foundation to be removed to 2' below proposed grade.



I-25 NB PROFILE GRADE

0' 25' 50' 100'

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Unit Information Unit Leader Initials			Void:

I-25/Arapahoe Interchange
Environmental Assessment

GENERAL LAYOUT
EA ACTION ALTERNATIVE

Designer: J. Warren | Detailer: R. Artman

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number 11

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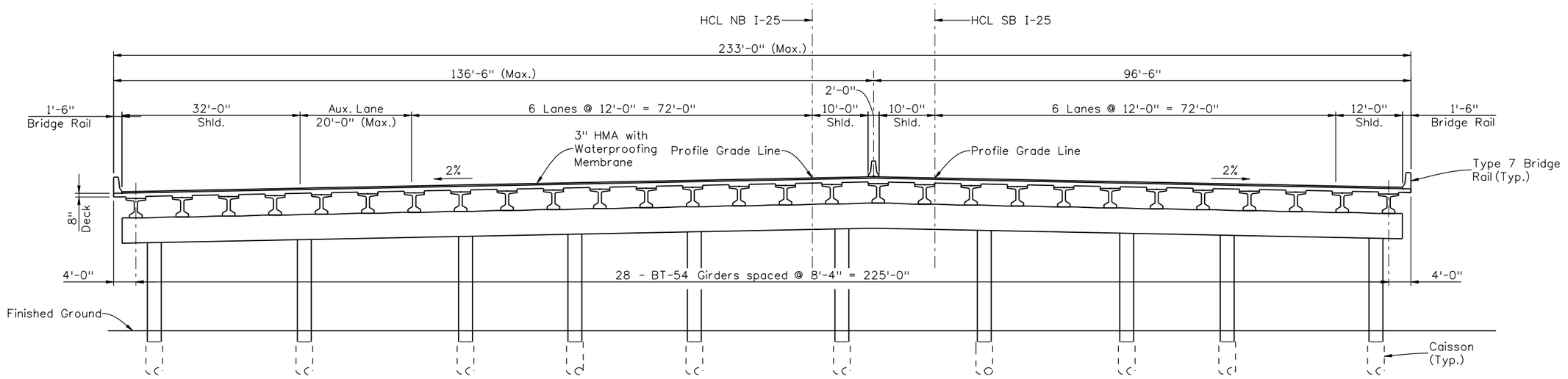

BT-54 - TYPICAL SECTION

(Looking South)

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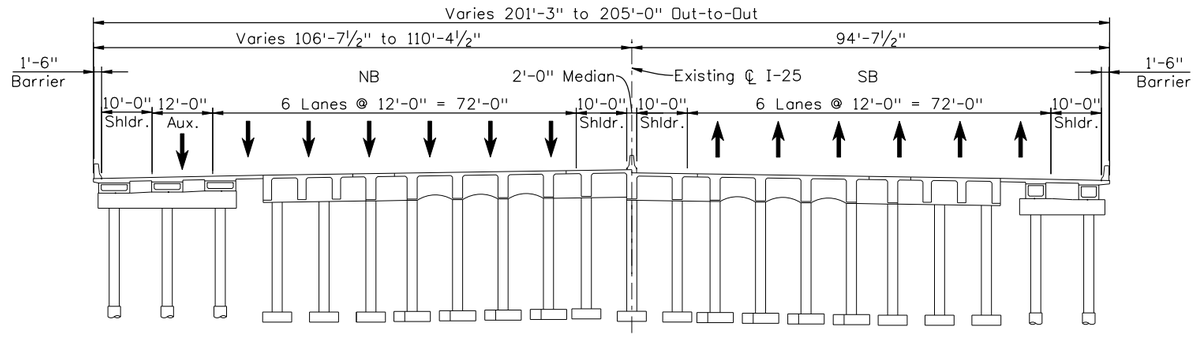
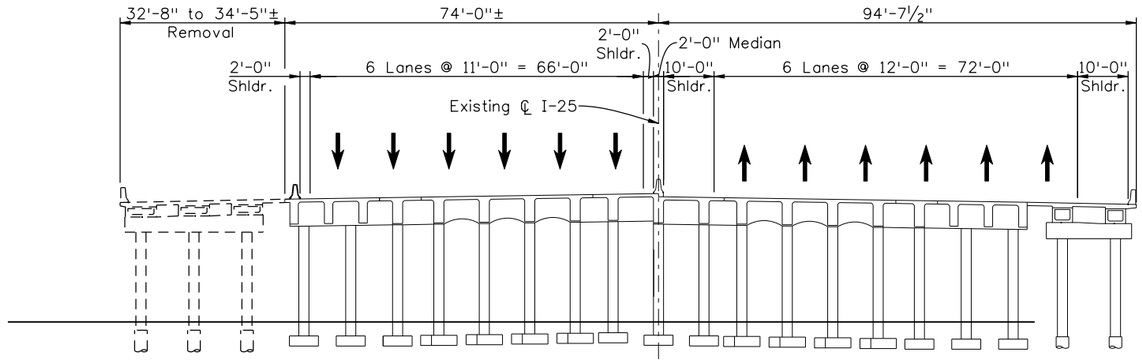
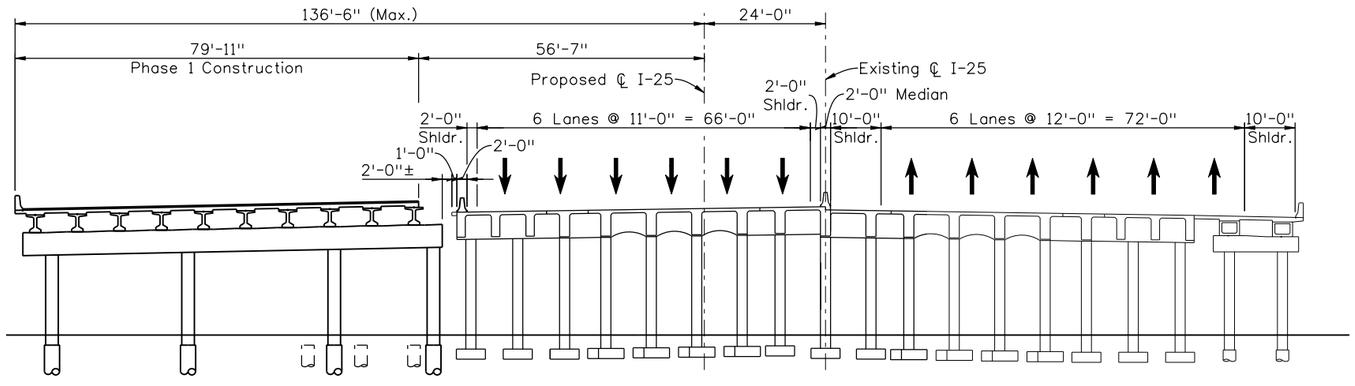


EXISTING BRIDGE

(Str. No. F-17-DG)



PHASE 1A DETOUR AND REMOVAL



PHASE 1B CONSTRUCTION

NOTE:

1. All sections looking south.

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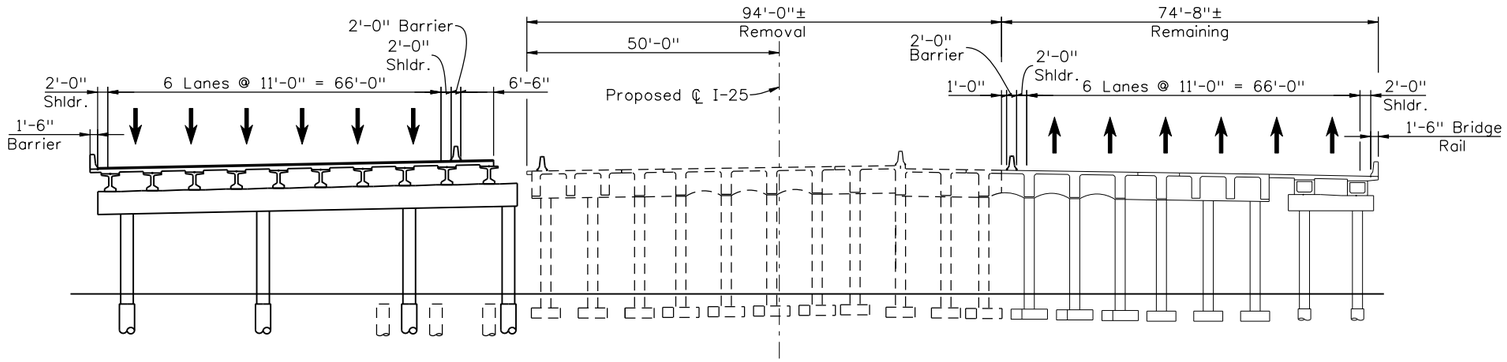

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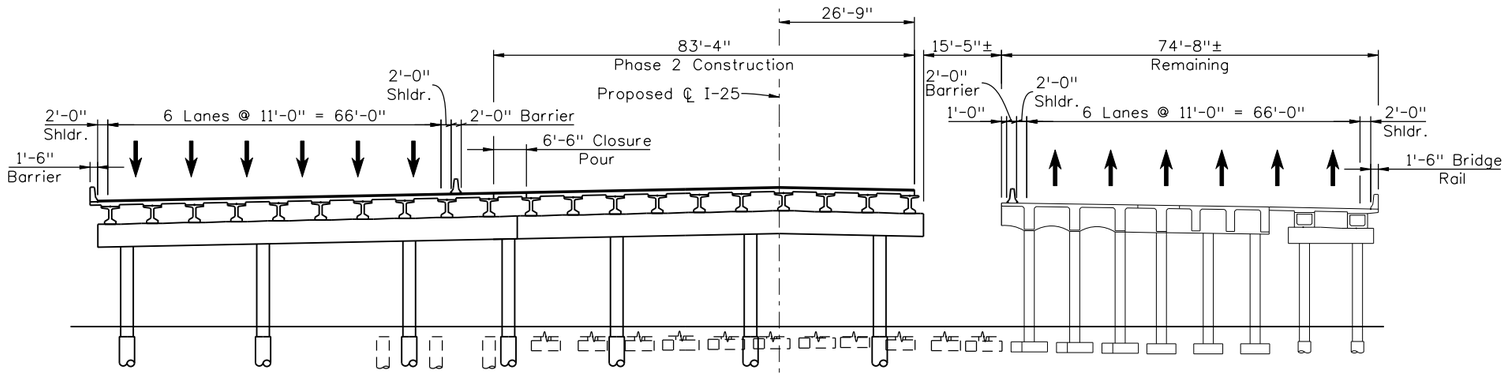

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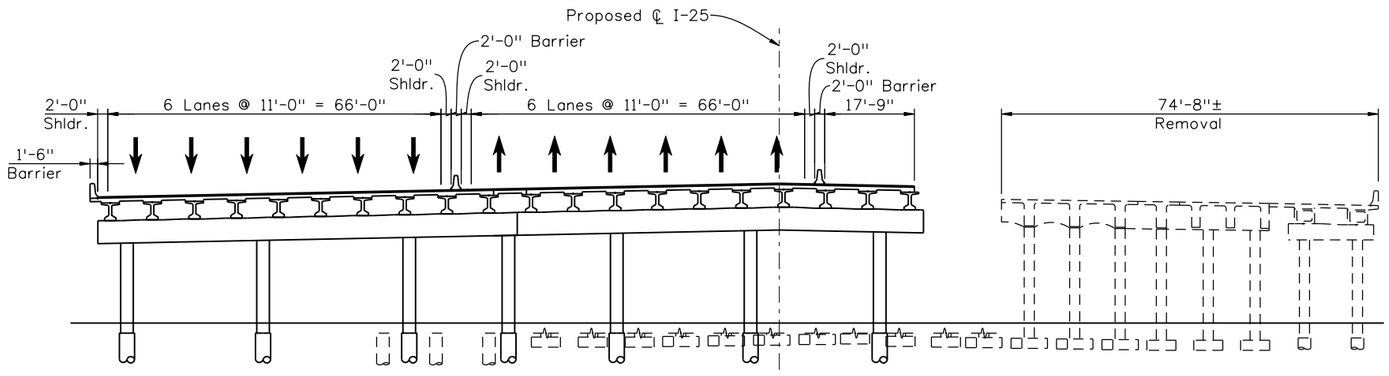

PHASE 3A DETOUR AND REMOVAL

NOTE:
1. All sections looking south.

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Unit Information Unit Leader Initials					Void:

I-25/Arapahoe Interchange
Environmental Assessment

CONSTRUCTION PHASING (2 OF 3)
EA ACTION ALTERNATIVE

Designer: J. WARREN Detailer: R. ARTMAN

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number 14

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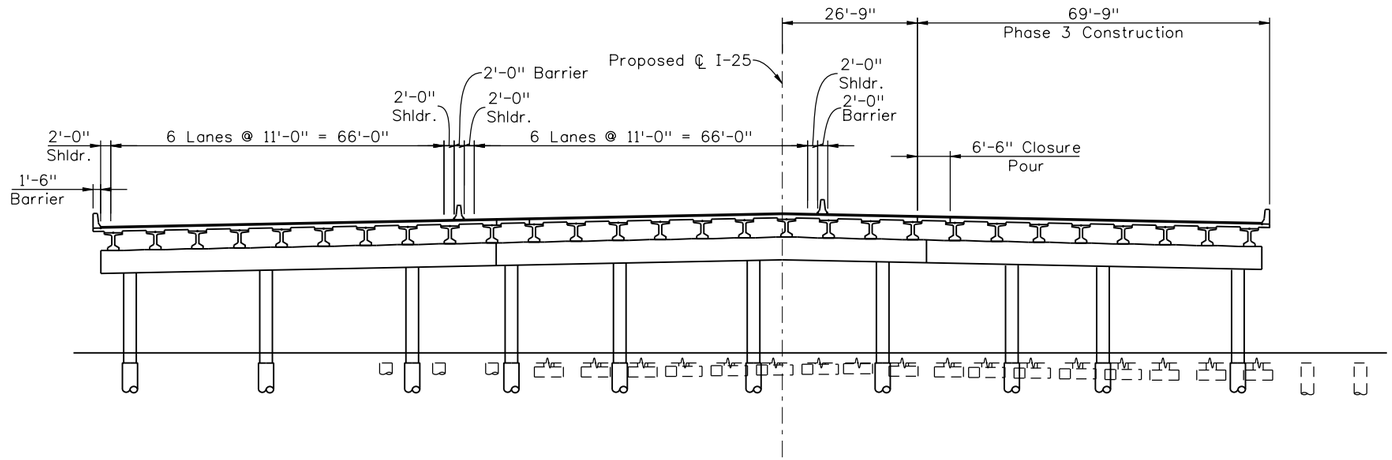

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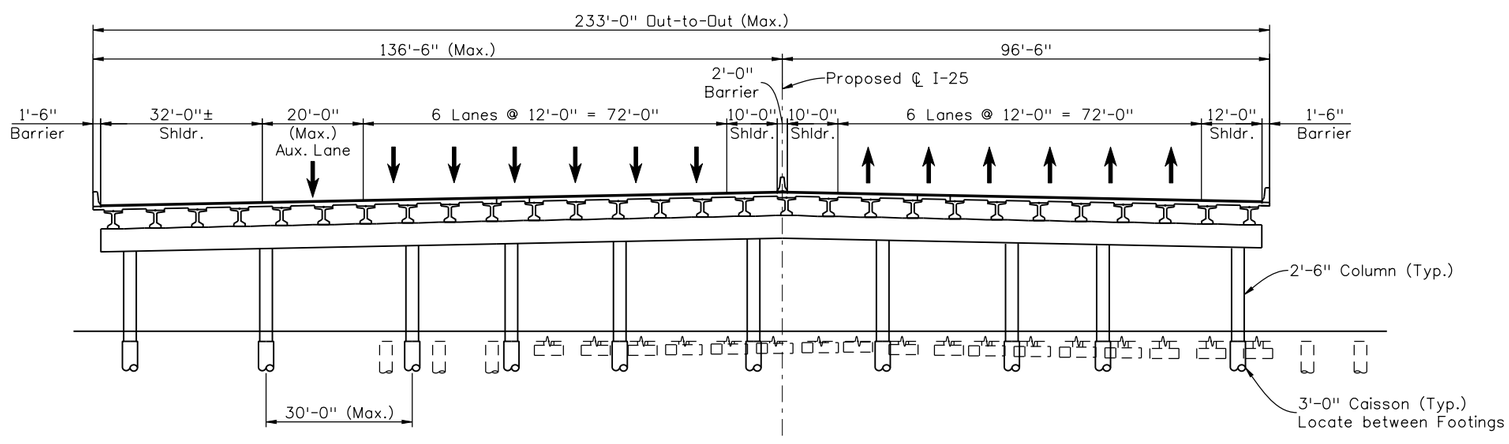

ULTIMATE CONFIGURATION

(Looking South)

NOTE:

1. All sections looking south.

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Horiz. Scale: 1:1 Vert. Scale: As Noted					Region 6 JH
Unit Information Unit Leader Initials					

As Constructed	I-25/Arapahoe Interchange	Project No./Code
No Revisions:	Environmental Assessment	I-25/ARAPAHOE EA
Revised:	CONSTRUCTION PHASING (3 OF 3) EA ACTION ALTERNATIVE	16159
Void:	Designer: J. WARREN Detailer: R. ARTMAN	Sheet Number 15

APPENDIX D

USER COST SUMMARY

I-25 OVER ARAPAHOE ROAD BRIDGE - USER COSTS DURING CONSTRUCTION (2011)

Phasing Description					Traffic Detour Information				User Costs					
Option	Description	Phase	Construction Duration (days)		NB Lanes	SB Lanes	Lane Width (ft)	Base Free Flow Speed (mph)	Hours of Delay		User Cost ($)		Option Total	
			Min	Max					Min	Max	Min	Max	Min	Max
I-25 Lane Reduction	Reduce I-25 from 6-lanes to 5-lanes for duration of construction	1	115	160	5	6	12	60	124,174	172,764	$2,175,340	$3,026,560	$3,780,000	$5,490,000
		2	85	130	5	6	12	60	91,781	140,371	$1,607,860	$2,459,080		

Added Delay Due to Reduction of NB lanes from 6 to 5:

1,080 hrs / day

Average Daily Volume for Northbound I-25 between Arapahoe Road and Orchard Road

(Estimated for Summer 2011) = 134,865 vehicles per day

Truck % = 6.0%

Added Hrs / Day determined separately in spreadsheet located at:

P:\A\ARPC00000001\0600INFO\I-25 Interchange\TT\User_Costs\NB_Volume_Data_for_User_Cost.xlsx

Delay Cost Factors:

Passenger Cars:	$16.54	$ / veh-hr of delay
Multi-Unit Trucks:	$32.88	$ / veh-hr of delay
Equivalent Vehicle:	$17.52	$ / veh-hr of delay

Source: Search for "Lane Rental" on CDOT Website. Lane rental cost spreadsheet has a 1999 cost of $12.16 for cars and $24.18 for trucks. Consumer Price Index increase = 36% from 1999 to 2011.

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Arapahoe Road Pedestrian Grade Separation Evaluation

I-25/Arapahoe Interchange

Environmental Assessment

I-25/Arapahoe Interchange

Environmental Assessment

Arapahoe Road Pedestrian/Bicycle Grade Separation Evaluation

Revised
February 2012

Arapahoe Road Pedestrian/Bicycle Grade Separation Evaluation

As part of the I-25/Arapahoe Interchange Environmental Assessment (EA) alternatives evaluation, grade separations for pedestrians and bicyclists to cross Arapahoe Road have been suggested as a means to reduce vehicular traffic flow by reducing or eliminating the pedestrian phase from the signalized intersection timing. A grade separation may also enhance pedestrian accessibility and safety. The Arapahoe Road Corridor Study (November 2007) recommendations included a grade separated pedestrian crossing of Arapahoe Road on the east side of I-25 between Boston Street/Clinton Street and Dayton Street in conjunction with area development to serve the nearby commercial area hotel and restaurants.

This memo summarizes the pedestrian activity at key intersections, the associated reduction in projected vehicular delay, and physical construction considerations for a pedestrian/bicycle grade separation across Arapahoe Road. The assessment of a pedestrian grade separation focused on two areas of the corridor:

- West side of I-25: Greenwood Plaza Boulevard/Uinta Street to Yosemite Street
- East side of I-25: Boston Street/Clinton Street to Dayton Street

1 Pedestrian and Bicycle Mobility

There are no primary or regional trail corridors, streets with bicycle lanes or designated bicycle routes that cross Arapahoe Road within the interchange complex (Yosemite Street to Boston/Clinton). On-street bike lanes exist on Dayton Street north and south of Arapahoe Road. There is complete sidewalk coverage along each side of Arapahoe Road, with some sections of detached sidewalk.

The off-street supporting pedestrian network and the nature of the surrounding land uses are generally not supportive of regional pedestrian travel. Residential land uses are primarily located immediately south of Arapahoe Road on the west side of I-25 and north of Arapahoe Road on the east side of I-25. The remaining area adjacent to the Arapahoe Road corridor is comprised of retail, office and restaurant land-uses. Primary trip types for pedestrians along and across Arapahoe Road, in order of magnitude, include:

- Work to Lunch
- Home to Work
- Home to Retail or Restaurant

Based on comments received at public meetings for the interchange project, there are also some Walnut Hills residents that walk or bike to the Arapahoe LRT Station, over a half-mile to the north.

2 Observed Pedestrian Usage

Pedestrian and bicycle in crosswalk usage was determined from three primary sources:

1. Pedestrian volume counts collected by DRCOG as part of an on-going signal timing study for Arapahoe Road from Quebec Street to Parker Road - These counts include vehicular and pedestrian volumes collected between April and June 2011. The counts consist of a single hour of volumes in the AM, Noon and PM peak periods.
2. Pedestrian volume counts collected as part of the I-25/Arapahoe Interchange Environmental Assessment - This data was collected at the area intersections in August 2009 and December 2010. Another set of pedestrian count data was collected in April 2011 at the Uinta Street/Greenwood Plaza Boulevard and Yosemite Street intersections, as part of the Walnut Hills Traffic Study.
3. Pedestrian signal activation information from Greenwood Village for the Uinta Street / Greenwood Plaza Boulevard and Yosemite Street intersections - This data consist of hourly data for an eight day period from late September to early October 2011.

Latent demand for existing pedestrian crossing activity, to estimate additional pedestrian and bicycle crossing usage that would occur if there was a more convenient, attractive means to cross Arapahoe Road, was not included in this analysis. Latent demand estimates would need to consider regional land use, regional pedestrian and bicycle corridors and routes, and extensive observations of pedestrian and bicycle behaviors within a larger area outside of the Arapahoe Road corridor.

2.1 West of I-25

The data indicates that pedestrian volumes crossing Arapahoe Road are substantially higher than pedestrian volumes traveling along (parallel to) Arapahoe Road. The pedestrian volumes crossing Arapahoe Road at the Uinta Street/Greenwood Plaza Boulevard and the Yosemite Street intersections are summarized in **Table 1**. The peak hour values represent the average pedestrian volume on a weekday and determined from a review of all available count data.

Table 1. Pedestrian Volumes at Intersections west of I-25

Period	Pedestrian Volume crossing Arapahoe Road				
	Uinta Street/Greenwood Plaza Boulevard		Yosemite Street		Total
	West Side	East Side	West Side	East Side	
AM Peak (7:30 – 8:30 AM)	1	2	3	4	10
Noon Peak (Noon – 1 PM)	4	6	3	2	15
PM Peak (4:30 to 5:30 PM)	2	2	6	5	15

2.2 East of I-25

The data indicates that pedestrian volumes crossing Arapahoe Road are higher than pedestrian volumes traveling along (parallel to) Arapahoe Road. The pedestrian volumes crossing Arapahoe Road at the Boston Street/Clinton Street and the Dayton Street intersections are summarized in **Table 2**. The primary data source available for these intersections is the DRCOG counts.

Table 2. Pedestrian Volumes at Intersections east of I-25

Period	Pedestrian Volume crossing Arapahoe Road				
	Boston Street/Clinton Street		Dayton Street		Total
	West Side	East Side	West Side	East Side	
AM Peak (7:30 – 8:30 AM)	2	4	5	4	15
Noon Peak (Noon – 1 PM)	0	2	13	7	22
PM Peak (4:30 to 5:30 PM)	3	3	6	3	15

3 Pedestrian/Bicycle Accidents

During the safety analysis period for the EA evaluation (January 2006 - December 2008), there was one pedestrian and two bicycle related accidents in the vicinity of the I-25/Arapahoe Road interchange. All three of these accidents occurred at the Arapahoe Road and Yosemite Street intersection. There were no pedestrian or bicycle related accidents reported at the two ramp terminals, Boston Street/Clinton Street, or Dayton Street intersections during the analysis period.

Additional accident data was obtained from Greenwood Village for accidents in the study area along Arapahoe Road from January 2008 through November 21, 2011 (specifically for this assessment). During those more recent years, there were three pedestrian/bicycle related accidents reported in the study area. One pedestrian and one bicycle related accident occurred at the Arapahoe Road and Boston Street/Clinton Street intersection. One pedestrian related accident occurred at the Arapahoe Road and Yosemite Street intersection.

In the almost six years of total accident data evaluated (January 2006 – November 21, 2011), there were three pedestrian and three bicycle related accidents reported in the vicinity of the I-25/Arapahoe Road interchange.

4 Traffic Signal Operations Analysis

All signalized intersections within the study area along Arapahoe Road utilize actuated-coordinated control. With this type of operation, a consistent cycle length and constant offsets are provided at the intersections to provide a minimum band of green time for progression of vehicle platoons along the major street. Within a given cycle, the amount of green time allotted to each of the movements can vary, depending on the traffic demand. Minor movements may be shortened or skipped entirely with lack of demand and any time within the cycle that is not used by these phases is added to the green time for the major street through movements. For actuated signalized intersections, pedestrian calls are likely to affect the effective greens serving the vehicle movements, which affect the capacity and delay of the intersection. When the major street is

relatively wide, the time required to accommodate pedestrians crossing the major street exceeds the amount of green time that is required to service the side street vehicular traffic.

As an example, in the absence of a pedestrian call, a maximum of 20 seconds of green time is provided for the northbound through movement at the Arapahoe Road and Yosemite Street intersection during the PM peak hour. As observed during a field visit, 30 seconds of green time are provided to Yosemite Street if there is a pedestrian call to cross Arapahoe Road. This coincides with the sum of the four-second walk phase and the 26-second flashing don't walk phase. Adding this extra green time to the minor street phase can result in a loss of coordination among signals along the corridor. It can take several cycles for the signal to recover and get back in coordination with the signals at surrounding intersections.

The Highway Capacity Manual does not provide explicit procedures that allow for the analysis of actuated-coordinated intersections that have pedestrian crossings during some, but not all, signal cycles during the analysis period. A general practice is to use one of two scenarios to calculate delays:

- Assume no pedestrians at all: Use timing that does not accommodate pedestrians when pedestrian volume is relatively low. If there are some cycles that actually have pedestrian crossings, then this assumption may underestimate actual vehicular delays.
- Assume pedestrian calls in every signal cycle: Use timing that accommodates pedestrians during every cycle when pedestrian volume is high. If there are some cycles that do not actually have pedestrian crossings, then this assumption overestimates actual vehicular delays.

The pedestrian signal actuation data indicates that less than a third of the signal cycles in the peak hour have pedestrian signal actuations, so the traffic signal operations analysis for the I-25/Arapahoe interchange Environmental Assessment assumes no pedestrian activity. This allows the intersection analysis to isolate the benefits and impacts of changes to vehicular volumes, signal timing, and roadway configurations. The existing peak hour Level of Service (LOS) analysis is summarized in **Table 3**.

Table 3. Existing (2011) LOS and Intersection Delay

Arapahoe Road Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay	LOS	Delay
Uinta St / Greenwood Plaza Blvd	B	13.8	B	18.9
Yosemite St	C	34.6	E	60.9
Boston St / Clinton St	B	18.1	C	34.1
Dayton St	B	12.6	C	21.9

Note: As shown in EA traffic analysis, the traffic signal timings do not accommodate minimum pedestrian crossing time. Therefore, this analysis does not account for pedestrian activity.

The 2035 Build peak hour level of service analysis is summarized in **Table 4**.

Table 4. Build (2035) LOS and Intersection Delay

Arapahoe Road Intersection	AM Peak Hour		PM Peak Hour	
	LOS	Delay	LOS	Delay
Uinta St / Greenwood Plaza Blvd	D	38.6	F	98.4
Yosemite St	E	66.8	F	151.2
Boston St / Clinton St	B	12.1	D	34.0
Dayton St	C	21.7	C	25.5

Note: As shown in EA traffic analysis, the traffic signal timings do not accommodate minimum pedestrian crossing time. Therefore, this analysis does not account for pedestrian activity.

4.1 Impact of Pedestrian Crossings on Intersection Delay

In order to estimate the average delay associated with a given number of pedestrian crossings, a different method for signal delay than the typical Highway Capacity Manual analysis is required. The research paper titled "Implementing Actuated Signal-Controlled Intersection Capacity Analysis with Pedestrians" (Transportation Research Record: Journal of the Transportation Research Board, 2008) presents a method to estimate the delay with pedestrian calls during a portion of the cycles, by calculating a weighted average of the "delay without pedestrians" and the "delay with pedestrians". The weighting factor is the proportion of cycles that have pedestrian calls. This methodology was determined to be appropriate and was therefore used for this Arapahoe Road crossing analysis.

5 Predicted Usage of a Pedestrian/Bicycle Grade Separation

Pedestrians have a natural desire to take the shortest path from point "A" to "B". They resist adding out-of-direction travel to their route. Bicyclists are more tolerant of added distance since their travel speeds are higher. As an example, when faced with a choice of a ramp or stairs at a grade separation with no at-grade access, pedestrians will tend to take the stairs and bicyclists will tend to take the ramp.

This analysis assumed a pedestrian grade separation would be constructed as a safe alternative to crossing Arapahoe Road at a signalized at-grade crossing, but that the at-grade crossing at the traffic signal would still be permitted. The physical construction considerations in order to prohibit all intersection pedestrian crossings are discussed in Section 11.

A literature review was conducted for research, studies, manuals or guidelines that discuss out-of-direction travel tolerance for pedestrians (and / or bikes). Only general guidance is provided, with no specific methodology identified to predict utilization of grade separated crossings, or the potential usage due to safety or other considerations. General qualitative statements, such as the following, were found:

- "... a pedestrian overpass is not likely to be used if it is too inconvenient." (Signalized Intersections: Informational Guide, from FHWA)

- "Separated paths along roadways should be evaluated using the following guidelines: … Any needed grade-separation structures do not add substantial out-of-direction travel." (Oregon DOT Design Manual)
- "... pedestrians should not be expected to make excessive or inconvenient diversions in their travel path to cross at an intersection." (Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, from ITE)
- "... pedestrians will cross where necessary to get to their destination directly and conveniently, ..." (Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, from ITE)
- "...If the grade separation adds out-of-direction travel to the path alignment or inconvenience, users will likely cross the roadway at grade, ..." (Massachusetts DOT Design Guide)
- "Pedestrians frequently chose to jaywalk across an arterial street rather than detour to a nearby signalized intersection, even if it is only a short distance away." (Maricopa Association of Governments Pedestrian Policies and Design Guidelines)

Two studies were found that use a convenience factor, R, to estimate the expected usage. (R = the ratio of time to travel on the over- or underpass divided by time to travel at grade level.)

- "If crossing the overpass takes 50 percent longer than crossing at street level (R = 1.5), almost no one will use the overpass." (1965 study by Moore and Older)
- Perceived ease of accessibility: A 1985 study indicated 95% of pedestrians would use an underpass and 70% would use an overpass if R=1 (no time difference). It also found that very few would use an overpass if R=1.5 (50% time difference). (From a 1994, ITE Proposed Recommended Practice)

Together, these statements provide two points along a line that uses relative travel time to estimate the usage of a bicycle/pedestrian grade-separation.

- Higher End: If R = 1.0, Usage = 70% (for an overpass)
- Lower End: If R = 1.5, Usage = 10% (assumed value for "almost no one")

An equation was developed based on the values in the above statements, as follows:

- Overpass Usage % = 0.70 * (1/R) ^ 5

The projected usage percentage for several R values is summarized in **Table 5**.

Table 5. Estimated Usage of a Bicycle/Pedestrian Grade-Separation

R = Ratio of travel time using grade separation / Travel time at-grade)	1.0	1.2	1.5	2.5	3.0
Percent of pedestrians that will use the grade separation	70%	28%	9%	1%	0%

In addition to the predicted usage by pedestrians at the crosswalk on the same side of the intersection as the grade separation, the usage of the grade separation by pedestrians crossing Arapahoe Road on the opposite side of the intersection was estimated based on the travel time difference and equation described above. Due to the travel time required to cross the minor street to access the overpass, the analysis showed all pedestrians on the opposite side of the intersection

would continue to cross Arapahoe Road at-grade. Therefore, this comparative analysis includes the potential usage of a grade separation only by pedestrians crossing Arapahoe Road on the same side of the intersection as the overpass.

6 Traffic Delay Benefits

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. Delay comparisons are presented for the following pedestrian usage scenarios:

- At-grade crossing only (no grade separation and a pedestrian call every traffic signal cycle)
- Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)
- Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)

The updated 2010 Manual of Uniform Traffic Control Devices (MUTCD) includes a reduction in the assumed pedestrian walking speed from 4.0 feet/second (ft/sec) utilized in the existing signal timings to 3.5 ft/sec. The following assumptions were used in the relative travel time computations:

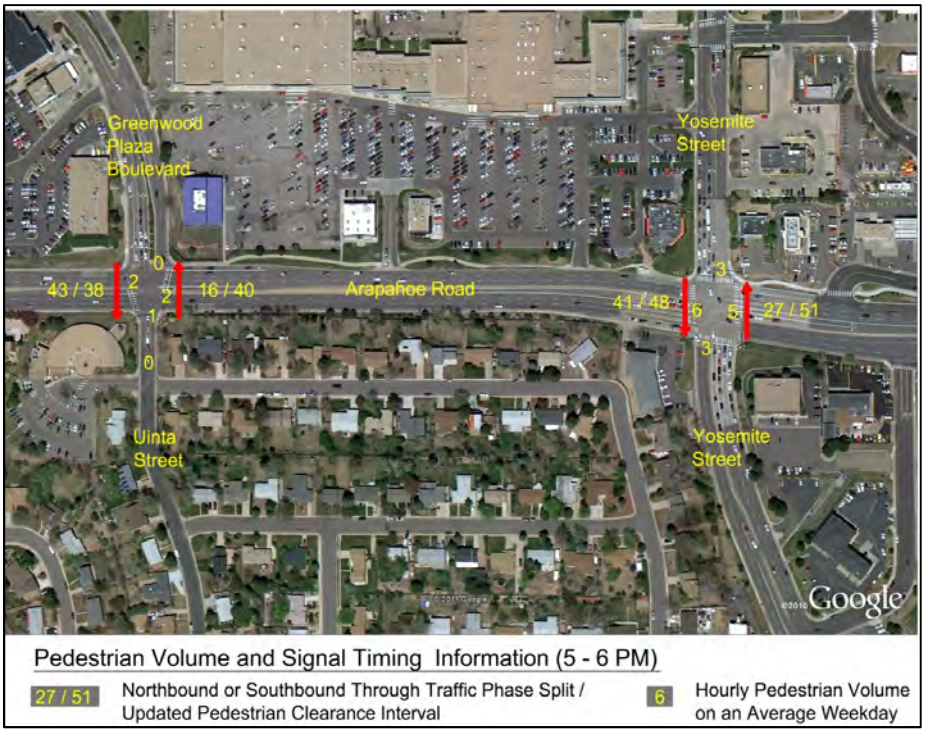
- Pedestrian crossing demand in 2035 will not substantially increase from the existing data collection.
- Travel time was calculated assuming a walking speed of 3.5 ft/sec.
- The grade separation consists of an overpass. It is believed that the cost of an underpass alternative would be substantially greater due to construction sequencing of open cut construction (or even higher cost of tunneling) significant utility impacts, and drainage considerations.
- To account for vertical out-of-distance travel, a distance of three times the vertical climb and descent of the stairs was added to the grade separation route to account for the slower time to ascend or descend stairs or wait for and ride an elevator as opposed to walking a similar flat surface distance.
- Average signal delay for pedestrians waiting at the traffic signal to cross at-grade equals half of the cycle length.

7 Potential Overpass West of I-25

At the intersections west of I-25, pedestrian and vehicular volumes are at their lowest levels during the AM peak hour and the pedestrian volumes during the Noon and PM peak hours are approximately equal. Since the Noon peak hour has less vehicular volume than the PM peak hour, traffic signal delay benefits were only analyzed for the critical PM peak hour.

Pedestrian demand is shown in **Figure 1** along with the northbound or southbound through traffic phase splits from the 2035 base (vehicle split) timing plan and updated pedestrian clearance intervals.

Figure 1: West of I-25 - Pedestrian Demand, Signal Splits and Pedestrian Clearance Intervals



7.1 Potential Overpass Locations

Each intersection was evaluated for a potential overpass based on the pedestrian crossing volumes and conflicts, and impacts of the minimum pedestrian phase.

- West side of Greenwood Plaza Boulevard/Uinta Street:
  - Pedestrians would not conflict with the high-volume southbound left turn movement.
  - Minimum pedestrian clearance would be provided on every cycle.
  - Conclusion: *No Further Analysis*
- East side of Greenwood Plaza Boulevard/Uinta Street:
  - Excessive residential property impact would occur with grade separation.
  - Conclusion: *No Further Analysis*
- West side of Yosemite Street:
  - Pedestrians would not conflict with the high volume southbound left turn movement, but the pedestrian demand is the highest of any of these crossings.
  - Minimum pedestrian clearance would cause minimal timing.
  - Conclusion: *Further Analysis*
- East side of Yosemite Street:
  - Conflicts with the high volume southbound left turn movement.
  - Minimum pedestrian clearance would cause substantial timing increase.
  - Conclusion: *Further Analysis*

7.2 Predicted Pedestrian/Bicycle Overpass Usage

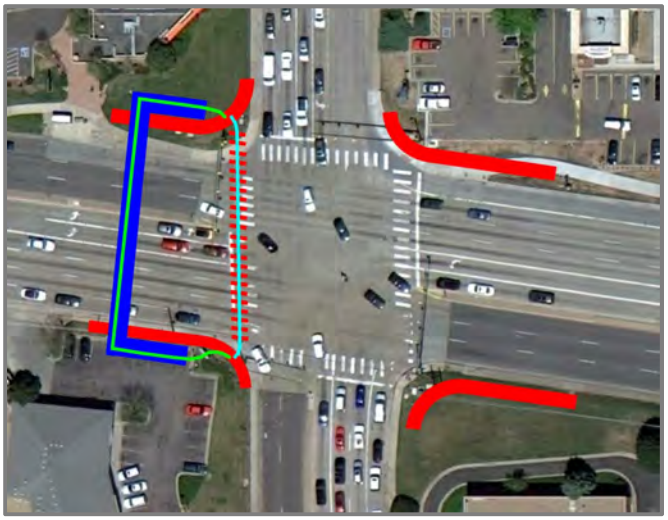
At the Yosemite Street intersection, the following changes as part of the EA Build alternative would increase the Arapahoe Road pedestrian crossing distance:

- Additional westbound lane on the west side
- Additional eastbound lane on the east side
- Larger corner radius at all four corners

7.2.1 West Side of Yosemite Street

Figure 2 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the west side of Yosemite Street (shown in dark blue) and the at-grade crossing. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade route for a pedestrian crossing Arapahoe Road on the west side of Yosemite Street is shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the west side of Yosemite Street is shown in green.

Figure 2: Route Comparison – West Side of Arapahoe and Yosemite



The components of the travel time on each route are shown in **Table 6**.

Table 6. Travel Time Comparison for Grade Separation on West Side of Yosemite

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Westside Crosswalk	Overpass	290	83	38	-	121	1.16	33%
	At-Grade	155	44	-	60	104		

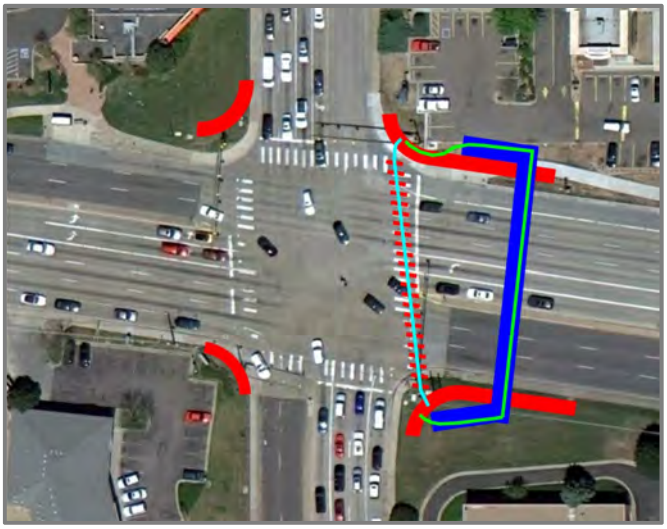
[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

With predicted usage, the base demand of six pedestrians crossing on the west side of the intersection would be separated into two pedestrians using the overpass and four pedestrians crossing the intersection at-grade. The number of pedestrian calls on the west side would be reduced from six to four.

7.2.2 East Side of Yosemite Street

Figure 3 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the east side of Yosemite Street (shown in dark blue) and the at-grade crossing. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade route for a pedestrian crossing Arapahoe Road on the east side of Yosemite Street is shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the east side of Yosemite Street is shown in green.

Figure 3: Route Comparison – East Side of Arapahoe and Yosemite



The components of the travel time on each route are shown in **Table 7**.

Table 7. Travel Time Comparison for Grade Separation on East Side of Yosemite

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Eastside Crosswalk	Overpass	305	87	38	-	125	1.15	35%
	At-Grade	170	49	-	60	109		

[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

With predicted usage, the base demand of five pedestrians crossing on the east side of the intersection would be separated into two pedestrians using the overpass and three pedestrians crossing the intersection at-grade. The number of pedestrian calls on the east side would be reduced from five to three.

7.3 Overpass Impact on Overall Signal Delay

7.3.1 West Side of Yosemite Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 8**.

Table 8. Signal Delay for Grade Separation on West Side of Yosemite – PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change with Grade Separation	
		sec/veh	%
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	155.6	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	154.1	- 1.5	- 1%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	151.2	- 4.4	- 3%

7.3.2 East Side of Yosemite Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 9**.

Table 9. Signal Delay for Grade Separation on East Side of Yosemite – PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change with Grade Separation	
		sec/veh	%
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	176.1	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	166.1	- 10.0	- 6%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	151.2	- 24.9	- 14%

8 Potential Overpass East of I-25

At the intersections east of I-25, pedestrian and vehicular volumes are at their lowest levels during the AM peak hour. At the Boston Street/Clinton Street intersection, pedestrian and vehicular volumes are both lower during the Noon peak hour as compared to the PM peak hour traffic signal delay benefits were only analyzed for the critical PM peak hour. At the Dayton Street intersection, the Noon peak hour has pedestrian volumes higher than during the PM peak hour and vehicular volumes that are almost as high as the PM peak hour. Since either period could be potentially critical, conditions were analyzed for both the Noon and PM peak hours at the Dayton Street intersection.

Pedestrian demand is shown in **Figure 4** along with the northbound or southbound through phase splits from the 2035 base (vehicle split) timing plan and updated pedestrian clearance intervals.

Figure 4: East of I-25 – Pedestrian Demand, Signal Splits and Pedestrian Clearance Intervals

8.1 Potential Overpass Locations

Each intersection was evaluated for a potential overpass based on the pedestrian crossing volumes and conflicts, and impacts of the minimum pedestrian phase.

- West side of Boston Street/Clinton Street:
  - Conflicts with the high volume northbound left turn movement.
  - Minimum pedestrian clearance would cause substantial timing increase.
  - Conclusion: *Further Analysis*
- East side of Boston Street/Clinton Street:
  - Pedestrians would not conflict with the high volume northbound left turn movement.
  - Minimum pedestrian clearance would cause less timing increase than the west side.
  - Conclusion: *Further Analysis*
- West side of Dayton Street:
  - Minimum pedestrian clearance would cause substantial timing increase.
  - Highest pedestrian demand among the four crossings.
  - Conclusion: *Further Analysis*
- East side of Dayton Street:
  - Minimum pedestrian clearance would cause timing increase.
  - Conclusion: *Further Analysis*

9 Potential Overpass at Boston Street/Clinton Street

9.1 Predicted Pedestrian/Bicycle Overpass Usage

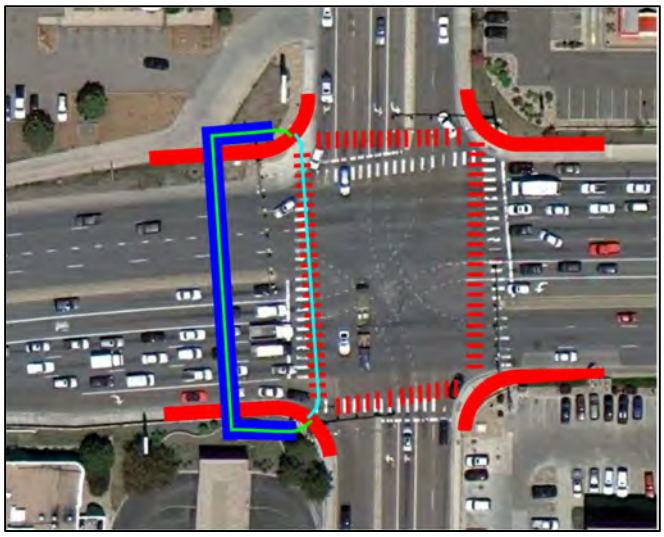
At the Boston Street/Clinton Street intersection, the following changes as part of the EA Build alternative would increase the Arapahoe Road pedestrian crossing distance:

- Additional westbound lane on the west side
- Minor increases to corner radius at all four corners

9.1.1 West Side of Boston Street/Clinton Street

Figure 5 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the west side of Boston Street/Clinton Street (shown in dark blue) and the at-grade crossing. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade route for a pedestrian crossing Arapahoe Road on the west side of Boston Street/Clinton Street is shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the west side of Boston Street/Clinton Street is shown in green.

Figure 5: Route Comparison – West Side of Arapahoe and Boston Street/Clinton Street



The components of the travel time on each route are shown in **Table 10**.

Table 10. Travel Time Comparison for Grade Separation on West Side of Boston Street/Clinton Street

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Westside Crosswalk	Overpass	285	81	38	-	119	1.08	47%
	At-Grade	175	50	-	60	110		

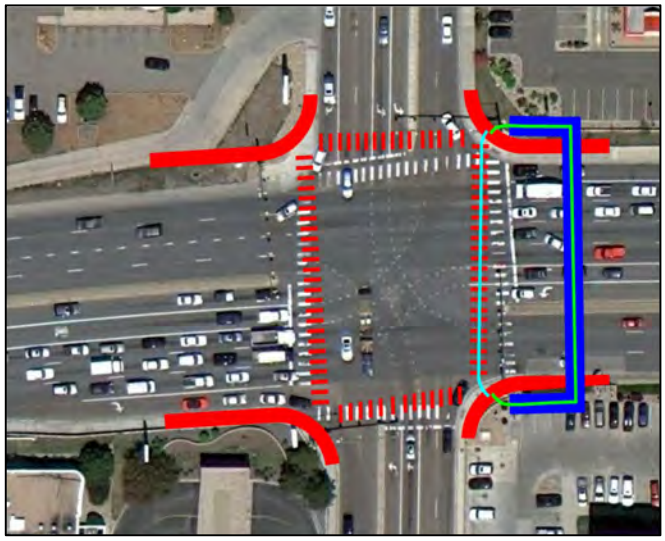
[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

With predicted usage, the base demand of three pedestrians crossing on the west side of the intersection would be separated into one pedestrian using the overpass and two pedestrians crossing the intersection at-grade. The number of pedestrian calls on the west side would be reduced from three to two.

9.1.2 East Side of Boston Street/Clinton Street

Figure 6 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the east side of Boston Street/Clinton Street (shown in dark blue) and the at-grade crossings. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade routes for a pedestrian crossing Arapahoe Road on the east of Boston Street/Clinton Street are shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the east side of Boston Street/Clinton Street is shown in green.

Figure 6: Route Comparison – East Side of Arapahoe and Boston Street/Clinton Street



The components of the travel time on each route are shown in **Table 11**.

Table 11. Travel Time Comparison for Grade Separation on East Side of Boston Street/Clinton Street

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Eastside Crosswalk	Overpass	270	77	38	-	115	1.08	47%
	At-Grade	160	46	-	60	106		

[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

With predicted usage, the base demand of three pedestrians crossing on the east side of the intersection would be separated into one pedestrian using the overpass and two pedestrians crossing the intersection at-grade. The number of pedestrian calls on the east side would be reduced from three to two.

9.2 Overpass Impact on Overall Signal Delay

9.2.1 West Side of Boston Street/Clinton Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 12**.

Table 12. Signal Delay for Grade Separation on West Side of Boston Street/Clinton Street – PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change	
		sec/veh	%
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	57.0	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	49.3	- 7.7	14%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	34.0	- 23.0	40%

9.2.2 East Side of Boston Street/Clinton Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 13**.

Table 13. Signal Delay for Grade Separation on East Side of Boston Street/Clinton Street – PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change	
		sec/veh	%
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	41.9	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	39.2	- 2.7	6%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	34.0	- 7.9	19%

10 Potential Overpass at Dayton Street

10.1 Predicted Pedestrian/Bicycle Overpass Usage

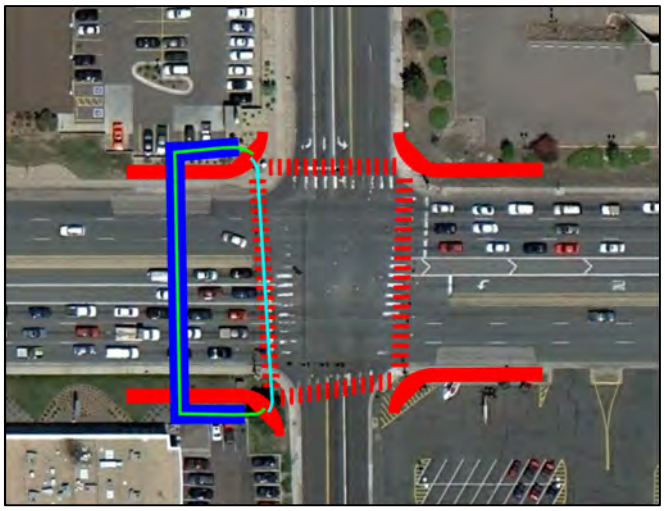
At the Dayton Street intersection, the following changes as part of the EA Build alternative would increase the Arapahoe Road pedestrian crossing distance:

- Additional westbound lane on both sides of the intersection
- Additional eastbound lane on the west side
- Minor increases to corner radius at all four corners

10.1.1 West Side of Dayton Street

Figure 7 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the west side of Dayton Street (shown in dark blue) and the at-grade crossing. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade route for a pedestrian crossing Arapahoe Road on the west side of Dayton Street is shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the west side of Dayton Street is shown in green.

Figure 7: Route Comparison – West Side of Arapahoe and Dayton Street



The components of the travel time on each route are shown in **Table 14**.

Table 14. Travel Time Comparison for Grade Separation on West Side of Dayton Street

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Westside Crosswalk	Overpass	270	77	38	-	115	1.08	47%
	At-Grade	160	46	-	60	106		

[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

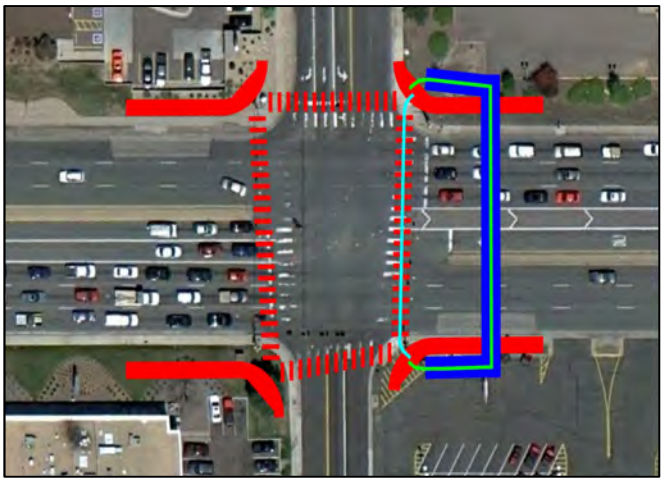
With predicted usage during the Noon peak hour, the base demand of 13 pedestrians crossing on the west side of the intersection would be separated into six pedestrians using the overpass and seven pedestrians crossing the intersection at-grade. The number of pedestrian calls during the Noon peak hour would be reduced from 13 to seven.

With predicted usage during the PM peak hour, the base demand of six pedestrians crossing on the west side of the intersection would be separated into three pedestrians using the overpass and three pedestrians crossing the intersection at-grade. The number of pedestrian calls during the PM peak hour would be reduced from six to three.

10.1.2 East Side of Dayton Street

Figure 8 shows the comparison of pedestrian routes for an overpass across Arapahoe Road located on the east side of Dayton Street (shown in dark blue) and the at-grade crossing. Sidewalk and crosswalk locations in the EA Build alternative are indicated in red. The at-grade route for a pedestrian crossing Arapahoe Road on the east of Dayton is shown in light blue. The overpass route for a pedestrian crossing Arapahoe Road on the east side of Dayton is shown in green.

Figure 8: Route Comparison – East Side of Arapahoe and Dayton Street



The components of the travel time on each route are shown in **Table 15**.

Table 15. Travel Time Comparison for Grade Separation on East Side of Dayton Street

Crossing of Arapahoe	Route	Distance (ft)	Base Travel Time	Added Stair Time	Signal Delay Time	Total Travel Time	R [1]	Overpass Usage % [2]
Eastside Crosswalk	Overpass	255	73	38	-	111	1.10	44%
	At-Grade	145	41	-	60	101		

[1] R = Travel time on the overpass / Travel time at-grade [2] Overpass Usage % = 0.70 * (1 / R) ^ 5

With predicted usage during the Noon peak hour, the base demand of seven pedestrians crossing on the east side of the intersection would be separated into three pedestrians using the overpass and four pedestrians crossing the intersection at-grade. The number of pedestrian calls during the Noon peak hour would be reduced from seven to four.

With predicted usage during the PM peak hour, the base demand of three pedestrians crossing on the east side of the intersection would be separated into one pedestrian using the overpass and two pedestrians crossing the intersection at-grade. The number of pedestrian calls during the PM peak hour would be reduced from three to two.

10.2 Overpass Impact on Overall Signal Delay

10.2.1 West Side of Dayton Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 16**.

Table 16. Signal Delay for Grade Separation on West Side of Dayton Street – Noon and PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change	
		sec/veh	%
Noon Peak Hour			
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	59.0	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	48.4	- 10.6	- 18%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	36.0	- 23.0	- 39%
PM Peak Hour			
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	48.7	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	37.1	- 11.6	- 24%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	25.5	- 23.2	- 48%

10.2.2 East Side of Dayton Street

The overall intersection delays were calculated with and without a pedestrian grade separation for the EA Build alternative under 2035 traffic conditions. The delays for each of the assumed pedestrian usage levels are shown in **Table 17**.

Table 17. Signal Delay for Grade Separation on East Side of Dayton Street – Noon and PM Peak Hour

Pedestrian Usage Scenario	Overall Intersection Delay (sec/veh)	Overall Delay Change	
		sec/veh	%
Noon Peak Hour			
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	44.3	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	40.7	- 3.6	- 8%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	36.0	- 8.3	- 19%
PM Peak Hour			
At-grade crossing only (no grade separation – pedestrian call every traffic signal cycle)	32.3	-	-
Grade separation with predicted usage (at-grade crossing available and pedestrian calls only with predicted number of at-grade crossings)	30.0	- 2.3	- 7%
Grade separation with full usage (no at-grade crossing available and no pedestrian calls at the traffic signal)	25.5	- 6.8	- 21%

11 Physical Construction Considerations

It is unlikely that a grade separation can be designed that would fit in the limited available ROW near these two developed intersections, and all at-grade pedestrian crossing physically controlled. East/west crosswalks would still exist at the intersections and any physical barrier to crossing Arapahoe Road at-grade would need to allow for the east/west crosswalk movement to access the Arapahoe Road sidewalk. Even with ROW acquisition, it is likely elevators with adjacent stairwell, rather than lengthy ramps, would be required due to physical space limitations and to meet ADA standards.

An approximate conceptual cost was calculated for this pedestrian/bicycle overpass, utilizing total project and elevator costs from the last pedestrian bridge constructed within the southeast I-25 corridor area, over Inverness Drive West. Assuming a bridge length of 300 feet and two elevators, a pedestrian/bicycle overpass across Arapahoe Road is estimated to cost between $3.5 and $5 million, not including ROW acquisition or business relocation costs.

In order to physically restrict all crossings at the intersection, a complimentary grade separation for east-west pedestrian movements would be needed, and physical barriers or fencing constructed along all intersection approaches to direct all pedestrian movements to the grade separations. The total cost to eliminate all at-grade pedestrian movements would be in the range of $7 to $10 million, not including ROW acquisitions or business relocation costs.

12 Summary and Conclusions

This memo summarizes the pedestrian activity at key intersections, the associated reduction in projected vehicular delay, and physical construction considerations for a pedestrian grade separation across Arapahoe Road. The assessment of a pedestrian/bicycle grade separation focused on two areas of the corridor:

- West side of I-25: Greenwood Plaza Boulevard/Uinta Street to Yosemite Street
- East side of I-25: Boston Street/Clinton Street to Dayton Street, including both intersection areas

The results of the expected use and reduction in projected vehicular delay at each overpass location evaluated are summarized in **Table 18**.

Table 18. Summary of Overpass Evaluation Results

Overpass Location	Peak Hour Time Period (of Maximum Benefit)	Pedestrian Crossings		Overall Intersection Delay with Overpass (sec/veh)	Overall Delay Change from without Overpass	
		Total	Expected to Use Overpass		sec/veh	%
West Side of I-25						
West Side of Yosemite	PM	6	2	154.1	-1.5	- 1%
East Side of Yosemite	PM	5	2	166.1	- 10.0	- 6%
East Side of I-25						
West Side of Boston/Clinton	PM	3	1	49.3	- 7.7	- 14%
East Side of Boston/Clinton	PM	3	1	39.2	- 2.7	- 6%
West Side of Dayton	Noon	13	6	48.4	- 10.6	- 18%
East Side of Dayton	Noon	7	3	40.7	- 3.6	- 8%

On the west side of I-25, a grade separation on the east side of Yosemite Street would be the most beneficial location with two pedestrians predicted to use the overpass and overall intersection vehicular delay reduced by six percent in the PM peak hour. An overpass on the east side of Yosemite Street would accommodate the same number of pedestrians as the west side, while having a greater reduction in intersection delay.

On the east side of I-25, a grade separation on the west side of Dayton Street would be the most beneficial location with six pedestrians predicted to use the overpass and overall intersection vehicular delay reduced by approximately 18 percent in the Noon peak hour. The west side of Dayton Street had the highest peak hour pedestrian crossing counts of any of the study area intersections. This location is also consistent with the recommendation of the Arapahoe Road Corridor Study for a grade separated pedestrian crossing in conjunction with area development to serve the nearby commercial area hotel and restaurants.

If constructed, a grade separation would provide a safety benefit for pedestrians and bicyclists that would choose to use the overpass to cross Arapahoe Road versus crossing the arterial at grade.

However, given the low expected usage from current land uses, limited reduction in vehicular delay, and substantial funding investment, a pedestrian/bicycle grade separation is not recommended as part of the I-25/Arapahoe Interchange EA alternative.

There is an unsubstantiated need given existing pedestrian activity, even if latent demand doubled or tripled the current activity, and accident data for Arapahoe Road within the study area does not show a current safety trend related to pedestrian/bicycle conflicts. Further, a grade separation would have high construction cost and require ROW acquisition and business relocations.

None of the grade separation locations are expected to more than minimally benefit the overall Arapahoe Road corridor operations due to the relatively small changes in signal timing and delay at one intersection with expected pedestrian usage. Each time a pedestrian pushes the button at a traffic signal to cross Arapahoe Road, the extra green time to the minor street phase results in a loss of signal coordination along the corridor and it can take several cycles for the signal to get back in coordination. Reducing the number of pedestrian calls at a signalized intersection would decrease the signal inefficiencies and associated delay with the loss of signal coordination. However, without extensive traffic microsimulation modeling of various signal timing scenarios, there is no effective method to qualitatively assess the vehicular delay impacts of loss of coordination due to different levels of pedestrian actuation.

Due to space limitations within the study corridor, a grade separation would require ROW acquisition even with elevators and stairs as opposed to lengthy ramps. Assuming a bridge length of 300 feet and two elevators, a pedestrian/bicycle overpass across Arapahoe Road is estimated to cost between $3.5 and $5 million, not including ROW acquisition or business relocation costs.

In order to physically restrict all crossings at the intersection, a complimentary grade separation for east-west pedestrian movements would be needed, and physical barriers or fencing constructed along all intersection approaches to direct all pedestrian movements to the grade separations. The total cost to eliminate all at-grade pedestrian movements would be in the range of $7 to $10 million, not including ROW acquisitions or business relocation costs.

A grade separation should be re-evaluated as part of future redevelopment of the Arapahoe Road corridor area, which could lower public investment with developer contribution. Redevelopment of the southwest quadrant of the interchange was addressed in the City of Centennial's Arapahoe Urban Center Sub Area Plan, indicating the potential for future substantial increase in development density. Once specific redevelopment plans are confirmed, future pedestrian and bicyclist demand could be estimated resulting from the changes in adjacent land use along with potential City plans for pedestrian/bicycle routes through the area.

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Design & Utilities Technical Memorandum

I-25/Arapahoe Interchange

Environmental Assessment

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Technical Memorandum – Roadway Design and Utilities Arapahoe Road/I-25 Interchange

1.0 Introduction

This memorandum details the assumptions, constraints, and findings related to the conceptual roadway design for the EA Action alternative of the I-25 and Arapahoe Road partial cloverleaf interchange. Outlined below is a description of the technical design elements and criteria used to develop the proposed partial cloverleaf interchange and associated roadways.

2.0 Proposed Improvements

Arapahoe Road – The EA Action alternative improvements on Arapahoe Road consist of three 12-foot through lanes from Dayton Street to Yosemite Street, and narrows to 11-foot lanes west of Yosemite Street in both the east and west directions. Several auxiliary lanes have been added to improve traffic flow at various locations within these limits. The intent of these auxiliary lanes is to create storage for the ramps leading to I-25 and improve turning movements at various locations through the development of a turn lane. For instance, the auxiliary lane for the movement from westbound Arapahoe Road to northbound Greenwood Plaza Boulevard has been extended to reduce congestion on the three Arapahoe Road through lanes. The northbound left turn lane from Yosemite Street to westbound Arapahoe Road is being widened to accommodate double left turn lanes.

The centerline alignment for the proposed Arapahoe Road was constrained by an existing LRT bridge pier which could not be relocated without considerable disruption and reconstruction of the LRT line. The EA build alternative was aligned with this existing LRT pier which resulted in the shift of Arapahoe Road to the south. Similarly, the pier line of the proposed I-25 structure was aligned with this LRT pier to ease the construction phasing issues encountered along Arapahoe Road. Additional constraints related to the horizontal design include the location of the intersections of Yosemite, Clinton, and Boston Streets as well as the need to maintain access to Yosemite Court.

The PGL of Arapahoe was altered to improve drainage and alleviate a sump condition under the I-25 structure. The modifications which could be made to the PGL of Arapahoe Road were constrained by the LRT abutment on the south side of Arapahoe Road and the southbound on-ramp exit gore. The Arapahoe Road PGL was raised to avoid undermining the LRT abutment or reducing the design speed of the southbound on-ramp by increasing the ramp grade.

I-25 – The configuration of I-25 will remain basically the same with five 12-foot through lanes in each direction as well as one 12-foot auxiliary lane in each direction. The center median will have 10-foot shoulders with a 2-foot center barrier, matching the existing configuration. Outside shoulders will generally be 12 feet in width. To minimize the amount of excess bridge needed to accommodate

construction phasing, the alignment of I-25 was shifted approximately 24 feet east at Arapahoe Road. This alignment shift used large curves that did not require superelevation.

The proposed pier line for the new I-25 bridge is at the same location as one of the existing I-25 pier lines and aligns with the LRT pier mentioned in the Arapahoe Road section of this memorandum. The proposed I-25 PGL's were set using a conservative structure depth of 69". While it may be feasible to decrease this structure depth, it is used for the EA build alternative to represent the upper bound of the profile grade increase. The proposed PGL creates grades along I-25 in excess of 4%. Though these grades are steeper than normally preferred, they were used in this case to reduce the amount of reconstruction required along I-25. Generally, the PGL of I-25 was raised between seven and eight feet to accommodate the new I-25 structure depth as well as improve clearance along Arapahoe Road.

Yosemite St – The general layout of Yosemite Street remains essentially the same. Two through lanes in each direction remain and range from 11 to 12 feet in width. The existing alignment was checked and is currently at a maximum design speed of 33 mph and posted at 35 mph. The proposed Yosemite PGL matches existing just north of Arapahoe Road and lowers Yosemite St to a tie-in point south of Arapahoe Road.

A few minor changes to Yosemite Street are proposed with the I-25/Arapahoe improvements and these include adding a median to Yosemite Street north of Arapahoe Road and the addition of an extra left turn lane south of Arapahoe Road.

South Xanthia Street – Similar to Yosemite Street only relatively minor changes have been proposed for Xanthia Street. 12-foot lanes in both the north and south direction are proposed with a center paved median approximately 14 feet in width. An island was placed at the intersection with Arapahoe Road to create a right-in/right-out condition. This differs from the existing configuration which currently has a double right turn from Xanthia Street onto Arapahoe Road.

The PGL for South Xanthia Street was lowered slightly from the existing condition due to the widening of Arapahoe Road. The proposed grade is a 5% maximum grade.

I-25/Arapahoe Road Interchange Ramps – *(SB I-25 to Arapahoe Road)* The configuration of this ramp could not change significantly due to the constraints set forth by the existing LRT walls, piers, and the ramps intersection with Arapahoe Road. As a result this ramp was left in generally the same horizontal configuration. An additional left turn lane (3 total) for the movement from southbound I-25 to eastbound Arapahoe Road was incorporated. The ramp retains one right turn lane and an optional right turn around the proposed refuge island. The PGL generally matches existing grade with minor adjustments to tie into the revised I-25 and Arapahoe Road profiles.

(NB I-25 to Arapahoe Road) The ramp configuration remains the same and the PGL will be adjusted to tie into the modified Arapahoe Road. This ramp consists of two mandatory left turns, one through/left turn, and one right turn onto eastbound Arapahoe Road.

(EB Arapahoe Road to SB I-25) The horizontal alignment of this ramp is the same as the existing condition. This ramp is constrained by the LRT line directly to the west and the revised Arapahoe Road design. The vertical maximum design speed of this ramp is 40 mph which does not meet the design criteria set forth for this project. The existing condition is a vertical maximum design speed of 45 mph. Due to the widening of Arapahoe Road and the change in elevation of the I-25 PGL the ramp vertical maximum design speed was reduced by 5 mph.

This ramp was one of the primary constraints driving the design of the I-25/Arapahoe Road improvements. The amount of proposed widening occurring on Arapahoe Road in conjunction with the location of this ramp had a significant influence on the proposed PGL of Arapahoe Road and in turn the proposed PGL of I-25. Any attempts to lower the elevation of this ramp near its intersection with Arapahoe Road had the potential to undermine the existing LRT wall and abutment.

(EB Arapahoe to NB I-25 Loop Ramp) Minimal changes were made to this ramp and the proposed configuration of a 2-lane exit with an HOV-By-Pass lane is the same as the existing condition. This ramp was adjusted horizontally and vertically to tie into the revised Arapahoe Road and I-25 surfaces, and meets a design speed of 25 mph.

(WB Arapahoe Road to NB I-25) The horizontal alignment of the revised ramp is similar to the existing configuration and consists of a 2-lane exit ramp with an HOV-By-Pass. The location of the ramp was shifted 12 feet to the east to account for alignment changes to I-25 and retaining wall construction. The PGL meets the project design criteria and varies only slightly from the existing PGL.

(WB Arapahoe Road to SB I-25 Loop Ramp) The horizontal configuration of this ramp is constrained by the existing LRT piers and its proximity to the SB I-25 off-ramp. The proposed design consists of a single exit lane from Arapahoe Road and develops an additional lane with 400 feet of storage prior to the ramp meter. The horizontal design of this loop ramp does not meet the minimum 25 mph design criteria and has a maximum design speed of 22 mph. This proposed condition matches the existing configuration. The vertical design of this loop ramp meets the project design criteria.

3.0 Design Criteria Compliance Summary

		ROADWAY DESIGN CRITERIA		
ALIGNMENT/ROADWAY	ROADWAY CLASSIFICATION	HORIZONTAL ALIGNMENT CRITERIA (SEE NOTE 1 & 2)	VERTICAL ALIGNMENT CRITERIA	STRUCTURE CLEARANCE CRITERIA
ARAPAHOE ROAD	URBAN ARTERIAL MDS=45mph POSTED 40 mph	MEETS CRITERIA (45mph MDS)	MEETS CRITERIA	16'-6" CLEARANCE (69 INCH STR. DEPTH)
YOSEMITE STREET	URBAN ARTERIAL MDS=33mph POSTED 35 mph	EXISTING ALIGNMENT POSTED AT 35mph, GREATER THAN 33mph MDS.	EXISTING YOSEMITE PROFILE ALIGNMENT CHECKED AT 35 MPH PLUS/MINUS	N/A
SOUTH XANTHIA STREET	LOCAL STREET MDS=25mph POSTED 25 mph	EXISTING ALIGNMENT MDS CHECKED AT 20mph	MEETS CRITERIA	N/A
NORTHBOUND I-25	INTERCHANGE - URBAN	MEETS CRITERIA (70mph MDS)	MEETS ALL MINIMUM 70 MPH CRITERIA EXCEPT MAX. 4% GRADE. A MAXIMUM GRADE OF 4.59% WAS USED TO REDUCE AMOUNT OF RECONSTRUCTION.	16'-6" CLEARANCE (69 INCH STR. DEPTH)
SOUTHBOUND I-25	INTERCHANGE - URBAN	MEETS CRITERIA (70mph MDS)	MEETS ALL MINIMUM 70 MPH CRITERIA EXCEPT MAX. 4% GRADE. A MAXIMUM GRADE OF 4.59% WAS USED TO REDUCE AMOUNT OF RECONSTRUCTION.	16'-6" CLEARANCE (69 INCH STR. DEPTH)
SB I-25 TO ARAPAHOE OFF-RAMP	INTERCHANGE RAMP	ONLY MEETS 35mph MINIMUM RAMP CRITERIA (Exist. TREX Design Condition)	MEETS CRITERIA	16'-6" CLEARANCE WITH LRT STR.
EB ARAPAHOE TO SB I-25 ON-RAMP	INTERCHANGE RAMP	MEETS CRITERIA	DOES NOT MEET CRITERIA: RAMP CONSTRAINTS LIMIT DESIGN TO 40 mph WITH GRADES AT THE 5% MAXIMUM	N/A
NB I-25 TO ARAPAHOE OFF-RAMP	INTERCHANGE RAMP	EXISTING RAMP (TREX DESIGN)	EXISTING RAMP (TREX DESIGN)	N/A
WB ARAPAHOE TO NB I-25 ON-RAMP	INTERCHANGE RAMP	MEETS CRITERIA	MEETS CRITERIA	N/A
EB ARAPAHOE TO NB I-25 LOOP RAMP	INTERCHANGE LOOP RAMP MDS=25mph	MEETS CRITERIA	MEETS CRITERIA	N/A
WB ARAPAHOE TO SB I-25 LOOP RAMP	INTERCHANGE LOOP RAMP MDS=25mph	DOES NOT MEET MINIMUM RADIUS FOR 25 mph DESIGN, 22mph DESIGN ACCOMODATED.	MEETS CRITERIA	16'-6" CLEARANCE WITH LRT STR.

NOTES:

1. REFER TO ARAPAHOE & I-25 ROADWAY DESIGN CRITERIA FOR ADDITIONAL INFORMATION (ATTACHMENT A)
2. SUPERELEVATION DESIGN PERFORMED AS PART OF THE EA ANALYSIS.
3. AUTOTURN ANALYSIS USING A WB-67 VEHICLE WAS NOT PERFORMED AS PART OF THE EA ANALYSIS.

4.0 Utilities

There are various utilities within the I-25/Arapahoe Road project limits which will need to be maintained, protected, or relocated as a result of this project. Impacts to the existing utilities located within the proposed right-of-way were documented using preliminary utility mapping developed from aerial surveys, base maps collected from individual utility companies, and field reconnaissance. Areas of concern include those surrounding the proposed and existing bridge substructures, retaining walls, and proposed storm sewer systems.

The utilities within the project corridor are described below:

Electric and Cable TV - Above and below grade electric lines in the corridor are owned by Xcel Energy. It is anticipated that the majority of the underground lines are deep enough to avoid excavation impacts. Many above ground lines will need to be reset since the existing poles will be impacted by Arapahoe Road improvements.

Approximately three electric lines run parallel to I-25 and will need to be relocated. Overhead and below ground cable television lines owned by TCI run parallel to Arapahoe Road and will need to be relocated.

Natural Gas - Approximately 15 natural gas pipelines, all owned and operated by Xcel Energy, cross and/or run parallel to the Arapahoe Road right-of-way. These pipelines vary from 2 to 3 inches in diameter. It is anticipated that most of these pipelines are deep enough to avoid impacts, although valves may need to be adjusted.

Sanitary Sewer - Sanitary sewer services along the Arapahoe Road right-of-way are owned by Southgate Water and Sanitation and Castlewood Water District. Approximately seven crossings have been identified, with pipelines approximately 8 inches in diameter. It is anticipated that the majority of these pipelines are deep enough to avoid excavation impacts, although manholes may need to be adjusted. There may be isolated realignment of lines required to mitigate impacts from bridge substructure or storm sewer improvements.

Water Lines - Approximately fifteen water lines cross the Arapahoe Road right-of-way and are owned by Denver Water, Castlewood Water District, or Southgate Water and Sanitation. The relocation of lines will be minor, but all fire hydrants and valves within the corridor will need to be reset or adjusted. There may be isolated realignment of lines required to mitigate impacts from bridge substructure or storm sewer improvements.

Fiber Optic Lines - Fiber optic lines run throughout the corridor and are owned by Century Link, CDOT, Adesta, MCI, Time Warner, and ICG. One line running along existing I-25 will need to be relocated to the proposed structure. Approximately 15 lines run along Arapahoe Road, but it is anticipated that most of these lines are deep enough to avoid impacts from excavation. Manholes and vaults will need to be adjusted to new grades. There may be isolated realignment of lines required to mitigate impacts from bridge substructure, storm sewer improvements, or retaining walls.

Arapahoe & I-25 EA Roadway Design Criteria **ATTACHMENT A**

11/24/2010

DESIGN ELEMENT		Standards Applied: I-25	Ramps	Arapahoe Road	Design Criteria Reference
Roadway Classification					
General					
Roadway Classification		Interstate - Urban	Interchange Ramps	Urban Arterial	
Access Control Classification		Interstate (Full)			
Design Speed					
	Minimum (MPH)	70	60/50/35	45	
	Desirable (MPH)	75	65/55/40	45	AASHTO 2004, Exhibit 10-56 / Low Speed Urban Design, Pg. 148
	Loop Ramps (MPH)		25		
Posted Speed Limit Minimum (MPH)		65	n/a	40	Maintaining Existing Conditions
Design Vehicle		WB-67	WB-67	WB-67	AASHTO 2004, Pg. 18
Horizontal Alignment Criteria					
Curve Radius For Design Speed Minimum (Ft.)		2040'	1330'/833'/340'	1040'	AASHTO 2004 Exhibit 3-26, Pg. 168 / Exhibit 3-16 Normal Crown -2% (144' Min. loop ramp radius)
Curve Radius For Design Speed Desirable (Ft.)		2500'	1660'/1060'/485'	1040'	AASHTO 2004 Exhibit 3-26, Pg. 168 / Exhibit 3-16 Normal Crown -2%
Superelevation (e_{max})		6%	6%	Normal Crown	CDOT 2005 Design Guide Sec. 8.1.6
Max. Degree of Curve - Design Speed Minimum (Calculated)		2.81	4.31	5.51	DC = 5729.6/R
Max. Degree of Curve - Design Speed Desirable (Calculated)		2.29	3.45	5.51	DC = 5729.6/R
Cross Slope - Normal		2%	2%	-2% (Normal Crown)	CDOT 2005 Design Guide Sec. 4.1.2
Maximum Algebraic Difference at Crossover Line (%)		4 to 5%	4 to 5%	4 to 5%	AASHTO 2004 Exhibit 9-49, Pg. 648
Clear Zone (On Tangent)					
	Minimum	30'	20'	14'	AASHTO 2004, table 3.1 pg. 3-6
	Desirable	34'	22'	16'	AASHTO 2004, table 3.1 pg. 3-6
Clear Zone (On Curve)					
	Minimum	39'	28'	17'	AASHTO 2004, table 3.2 pg. 3-7
	Desirable	44'	31'	19'	AASHTO 2004, table 3.2 pg. 3-7
Lane Width (Ft.)		12'	12' (2 lanes) 15' (1 lane)	12	AASHTO 2004 Exhibit 10-67, Pg. 839
Shoulder Widths					
	Left Inside (Ft.)	12'	4'	n/a	
	Right Outside (Ft.)	12'	6'-8'	n/a	AASHTO 2004 Exhibit pg. 838-840
Curb and Gutter Type		n/a	Type 2 (Section I-B, II-B)	Type 2 (Section I-B, II-B)	CDOT M & S Standards, 2006, M-609-1
Side Ditches					
	Z slope (6:1)	12'	12'	2'	CDOT 2005 Design Guide Table 4-2
	Fill Slope	4:1	4:1	4:1	CDOT 2005 Design Guide Table 4-2
	Cut Slope	4:1	4:1	4:1	CDOT 2005 Design Guide Table 4-2
Redirect Taper (Ft.)		65:1 min.	30:1 min.	30:1 min.	State of CO State Highway Access Code Pg.57
Transition Taper for Accel/Decel Lanes		25:1 min.	12:1 min.	12:1 min.	State of CO State Highway Access Code, Table 4-6
Taper Length Roadway Lane Drop		70:1 Desirable 50:1 min.			AASHTO 2004, pg. 818
Vertical Alignment Criteria					
Maximum Grade (Rolling)		4%	5%	6%	CDOT 2005 Design Guide Pg. 3-33, Table 3-4, 10-26, 10.6.4 Ramp Profiles
Minimum Grade		0.5%	0.5%	0.5%	CDOT 2005 Design Guide Pg. 3-32
Min. Vertical Grade Break without a Curve		0.20%	0.20%	0.20%	CDOT 2005 Design Guide Sec. 3.3.4
Min. Vertical Curve Length (Ft.)		300'	120'	120'	CDOT 2005 Design Guide Pg. 3-35, 3x Design Speed
K-Value Ranges					
	Crest VC (Minimum)	247	84	61	AASHTO 2004 Exhibit 3-73, Pg. 272
	Crest VC (Desirable)	312	114	61	AASHTO 2004 Exhibit 3-73, Pg. 272
	Sag VC (Minimum)	181	96	79	AASHTO 2004 Exhibit 3-75, Pg. 277
	Sag VC (Desirable)	206	115	79	AASHTO 2004 Exhibit 3-75, Pg. 277
Sight Distances					
Min. Stopping Sight Distance (Ft.) Minimum					

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

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Drainage Technical Memorandum/ Water Quality and Detention Storage Analysis

I-25/Arapahoe Interchange

Environmental Assessment

DAVID EVANS
AND ASSOCIATES INC.

MEMORANDUM

DATE: 02/23/2012

TO: Bryan Weimer, John Hall – CDOT

FROM: Erik Nyce, Joe Hart

SUBJECT: **Drainage Technical Memo/Water Quality and Detention Storage Analysis**

PROJECT: I-25/Arapahoe Interchange EA

COPIES: File, Joe Hart, Leah Langerman, Jon Chesser -CDOT

Existing Information

The I-25/Arapahoe Interchange EA project proposes improvements along Arapahoe Road from Greenwood Plaza Blvd. on the west to just past Clinton Court on the east. These improvements are located in a highly urbanized area with a majority of the area being impervious. The project site is bordered by four jurisdictions/agencies, Greenwood Village along the northwest, northeast, and southeast, the City of Centennial along the southwest, Arapahoe County further to the east, and CDOT along I-25. Each of these jurisdictions listed above has separate MS4 and water quality requirements. There are existing drainage conveyance systems existing throughout much of the project area. A majority of this project is located within the Little Dry Creek Basin and the tributary to the Holly Dam.

Improvements

The mainline on Interstate 25 will be reconstructed approximately 1,500 feet north and south of Arapahoe Road. Modifications will be made to the on and off ramps but the interchange will remain in a partial cloverleaf configuration. The existing grade of Arapahoe Road will be raised approximately five feet to improve existing drainage conditions. Improvements will be made to the access and circulation for the hotels and businesses located at the northeast quadrant of the interchange between Interstate 25 and Clinton Street. Improvements will also be made to Yosemite Street, Xanthia Street, Clinton Street, and the I-25 Frontage Road. These improvements will result in 42 acres of impacts to pervious and impervious areas, with approximately 2 acres of added impervious area. Major drainage basin flow patterns will be maintained throughout and after the construction of this project.

Criteria

As discussed in our drainage meeting in September 2011, all new impervious surface on the project will need to be treated for water quality. Any new impervious areas will need to be detained to pre-development levels. After water quality treatment and any required detention, drainage will be routed back to existing conveyance paths.

Sub-basin Delineation

In an effort to determine water quality volumes, the 42 acres of impacts have been subdivided into 18 basins delineated A1 through A18. The total area of each of these sub-basins was then calculated assuming that each of these sub-basins was 100% impervious. These areas are summarized in the attached Water Quality Sub-Basin Area Quantities Table and the attached Proposed Basin and Ponds plans.

Pond Siting

Because this site is located in a highly developed area, there are limited locations for water quality ponds without impacts to right-of-way. In analyzing available space and topography, three optimal locations for water quality ponds were identified. Two identified areas are the infield areas of the loop ramps and a third area in an undeveloped area north east of the interchange was also identified. These locations are shown on Proposed Basins and Ponds sheets in the plan set (see attached). An existing pond is also located south of Southtech Drive and immediately north of Motel 6.

An area draining to each of the three ponds was determined using proposed contours and proximity to each pond location. It was preliminarily determined that 10.8 acres drains to Pond 1, 12.1 acres drains to Pond 2 and 9.1 acres drains to Pond 3. See the attached Water Quality Catchment Summary Tables for each pond for more information. The additional 10 acres of impervious area drain away from these proposed ponds and will be explained later in this memorandum.

Water Quality Treatment Requirements

For treating water quality, the Water Quality Catchment Volume (WQCV) was determined for each pond. The Urban Storm Drainage Criteria Manual (USDCM) by the Urban Drainage and Flood Control District (UDFCD) defines the WQCV as:

$$WQCV = a(0.91\ I^3 - 1.19I^2 + 0.78I)$$

Where:

WQCV = Water Quality Capture Volume (watershed inches)

a = coefficient corresponding to WQCV drain time (assumed 1.0, most conservative)

I = Imperviousness (%/100), assumed 1.0 for 100% impervious

Applying this, the WQCV for all areas is 0.5 watershed inches. The water quality requirements for these ponds are:

Pond 1 = 0.5 watershed inches x 10.0 acres = 0.42 acre-ft

Pond 2 = 0.5 watershed inches x 12.1 acres = 0.50 acre-ft

Pond 3 = 0.5 watershed inches x 9.8 acres = 0.41 acre-ft

Detention Requirements

Newly-created impervious areas need to be detained to meet the drainage requirements. There are approximately 2 acres of new impervious surface created as part of these improvements (see attached New Impervious Area plans). 1.5 acres of new impervious surface will be treated in ponds. The remaining 0.5 acres of new impervious surface will need to be addressed by other means or offset with additional detention if required as design develops.

For the EA design of this project, it is assumed that all impervious area will be routed to pond 2. Impervious areas were analyzed using the UDFCD Full Spectrum Detention analysis. To avoid double counting water quality treatment, the WQCV for these detained areas was subtracted out of the detention requirement. The additional area required to treat for detention for each pond is:

Pond 1 = None

Pond 2 = 0.19 acre-ft additional

Pond 3 = None

Total Required Pond Sizes and Depths

Detention volumes were added to water quality treatment volume requirements. After totaling water quality treatment requirements and detention requirements, required pond sizes are:

Pond 1 = 0.45 acre-ft = 20,000 cf

Pond 2 = 0.69 acre-ft = 30,000 cf

Pond 3 = 0.38 acre-ft = 17,000 cf

Required Water Quality Pond Depths

Available surface areas for each of these ponds were evaluated and a required depth was calculated assuming uniform depth across the surface. The required depths are provided below along with detailed calculations.

Pond 1 = 1.4 ft

Pond 2 = 2.1 ft

Pond 3 = 1 ft

See the attached Pond Analysis and Depth Summary Table for more information.

Areas Not Treated in Ponds

Due to the existing topography, there are six drainage basins, A1, A4, A5, A15, A16 and A18 that do not flow to the three proposed ponds. Drainage basin A1 flows toward a separate CDOT improvement project at the Dayton Street intersection. This drainage basin will need to be treated for water quality as part of this

adjacent project. Water quality treatment for drainage basins A4 and A5 will need to be treated either by stormceptors or be routed to existing storm drains and treated in a regional detention facility.

Basins A15, A16 and A18 are located at the northeast quadrant of the Arapahoe Road interchange between Interstate 25 and Boston Street. It is assumed that these proposed improvements will not modify the existing flow patterns or impervious areas and will be collected by the existing water quality pond located south of Southtech Drive and immediately north of Motel 6.

Future improvements are anticipated to the Holly Dam and it may be possible that the untreated area for basins A1, A4 and A5 may be accommodated with these future improvements. Further coordination would be required with the City of Centennial, SEMSWA and UDFCD.

Attachments:

Pond Analysis and Depth Summary Table
Water Quality Catchment Summary Tables
Excess Urban Runoff Control (Full-Spectrum) Detention Sizing for Pond 2
Proposed Basin and Ponds Plans
New Impervious Area Plans

Arapahoe/I-25 EA
Preliminary Drainage Calcuations for WQ and Detention
12/12/2011

Pond Analysis and Depth Summary Table

Pond 1		
Water Quality Requirement		
Water Quality Catchment Volume*	0.5	Watershed Inches
Catchment area (see Pond 1 WQ Catchment Summary Table)	10.8	Acres
WQCV Required	**0.45**	**Acre-ft**
Detention Requirement	**None**	
Total Pond Volume Required	**0.45**	**Acre-ft**
	20,000	**Cubic Feet**
Pond 1 Allowable Surface Area =	14,300	SF
Pond 1 Required Depth	**1.40**	**ft (approx 1.4 feet)**

Pond 2		
Water Quality Requirement		
Water Quality Catchment Volume*	0.5	Watershed Inches
Catchment area (see Pond 2 WQ Catchment Summary Table)	12.1	Acres
WQCV Required	**0.50**	**Acre-ft**
Detention Requirement		
New Impervious Catchment Area	1.47	Acres
Full Spectrum Detention Volume with WQCV**	0.25	Acre-ft
WQCV Component	0.06	Acre-ft
Full Spectrum Detention Volume (WQCV Subtracted)	**0.19**	**Acre-ft**
Total Pond Volume Required	**0.69**	**Acre-ft**
	30,000	**Cubic Feet**
Pond 2 Allowable Surface Area =	14,300	SF
Pond 2 Required Depth	**2.10**	**ft (approx 2.1 feet)**

Pond 3		
Water Quality Requirement		
Water Quality Catchment Volume*	0.5	Watershed Inches
Catchment area (see Pond 3 WQ Catchment Summary Table)	9.1	Acres
WQCV Required	**0.38**	**Acre-ft**
Detention Requirement	**None**	
Total Pond Volume Required	**0.38**	**Acre-ft**
	17,000	**Cubic Feet**
Pond 3 Allowable Surface Area	19,700	SF
Pond 3 Required Depth	**0.86**	**ft (approx. 1 foot)**

* Water Quality Catchment Volume = a(0.91I^3-1.19I^2+.78I) = 1(0.91-1.19+.78) = 0.5 watershed inches
**See Excess Urban Runoff Control (Full-Spectrum) Dention Sizing Spreadsheet for more information

Arapahoe/I-25 EA
Water Quality Catchment Summary Tables
2/21/2012

Table 1. Water Quality Sub-Basin Area Quantities Table

Basin ID	Area (sf)	Area (Ac)	Treated in Pond
A1	160,000	3.7	N/A - See Memo
A2	492,000	11.3	1/2 P1, 1/2 P2
A3	91,000	2.1	P2
A4	186,000	4.3	N/A - See Memo
A5	68,000	1.6	N/A - See Memo
A6	46,000	1.1	P2
A7	48,000	1.1	P3
A8	192,000	4.4	1/2 P1, 1/2 P2
A9	220,000	5.1	P3
A10	69,000	1.6	P1
A11	69,000	1.6	P1
A12	50,000	1.1	P2
A13	20,000	0.5	P3
A14	31,000	0.7	P1
A15	55,000	1.3	P4 (Existing Pond)
A16	10,200	0.2	P4 (Existing Pond)
A17	10,200	0.2	P3
A18	12,200	0.3	P4 (Existing Pond)
Total	**1,829,600**	**42.0**	

Pond 1 WQ Catchment Summary Table

Basin ID	Area (sf)	Area (Ac)
Half of A2	246,000	5.6
A10	69,000	1.6
A11	69,000	1.6
A14	31,000	0.7
A15	55,000	1.3
Total	**384,000**	**10.8**

Pond 2 WQ Catchment Summary Table

Basin ID	Area (sf)	Area (Ac)
Half of A2	246,000	5.6
Half of A8	96,000	2.2
A12	50,000	1.1
A6	46,000	1.1
A3	91,000	2.1
Total	**438,000**	**12.1**

Pond 3 WQ Catchment Summary Table

Basin ID	Area (sf)	Area (Ac)
A7	48,000	1.1
A8	96,000	2.2
A9	220,000	5.1
A13	20,000	0.5
A16	12,200	0.3
Total	**396,200**	**9.1**

EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: I-25 / Arapahoe Interchange

Basin ID: New Impervious Area Routed to Pond 2

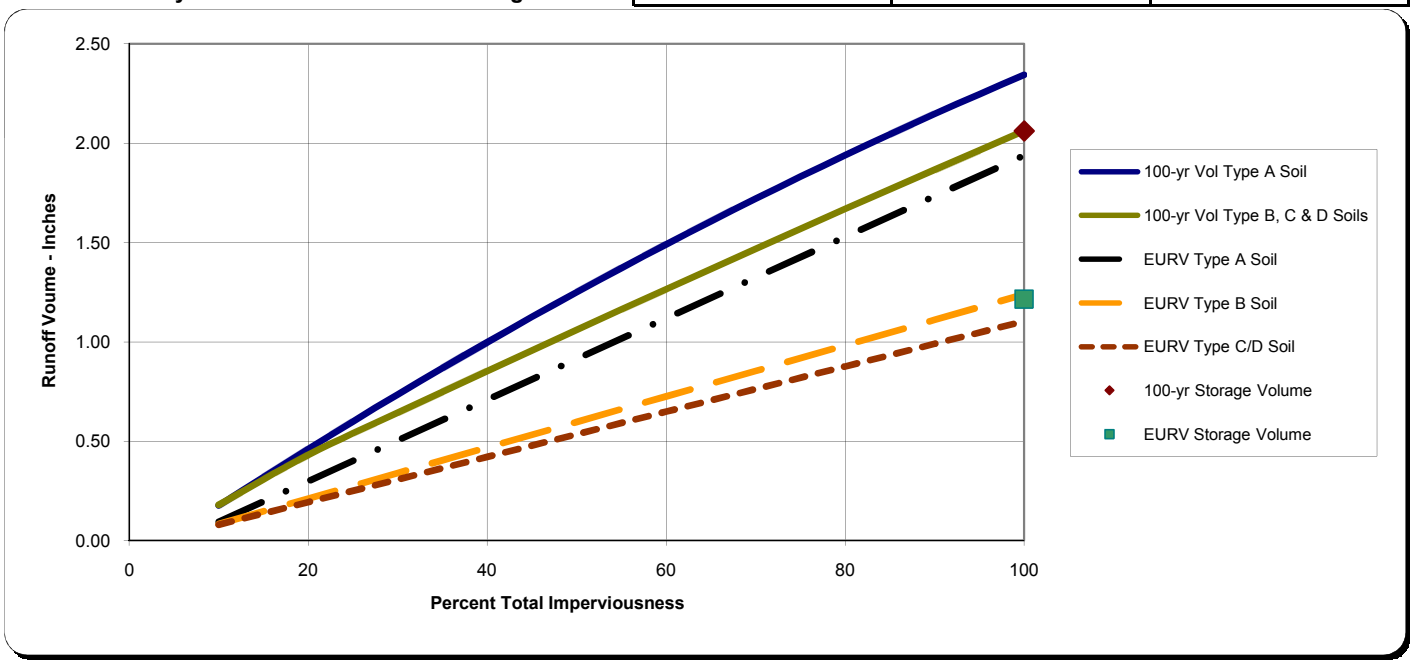
* User input data shown in blue.

Area of Watershed (acres)	1.47	
Subwatershed Imperviousness	100.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	0	0
Effective Imperviousness[1]	100.0%	

Hydrologic Soil Type	**Percentage of Area**	**Area (acres)**
Type A		0.0
Type B		0.0
Type C or D	100.0%	1.5

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		**Decay Coefficient--α**
Initial--f_i	**Final--fo**	
3	0.5	0.0018

	Detention Volumes [2,5]		**Maximum Allowable Release Rate, cfs[3]**
	(watershed inches)	**(acre-feet)**	
Excess Urban Runoff Volume[4]	1.21	0.1488	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	2.06	0.25	1.47



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).

2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.

3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.

4) EURV approximates the difference between developed and pre-developed runoff volume.

5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

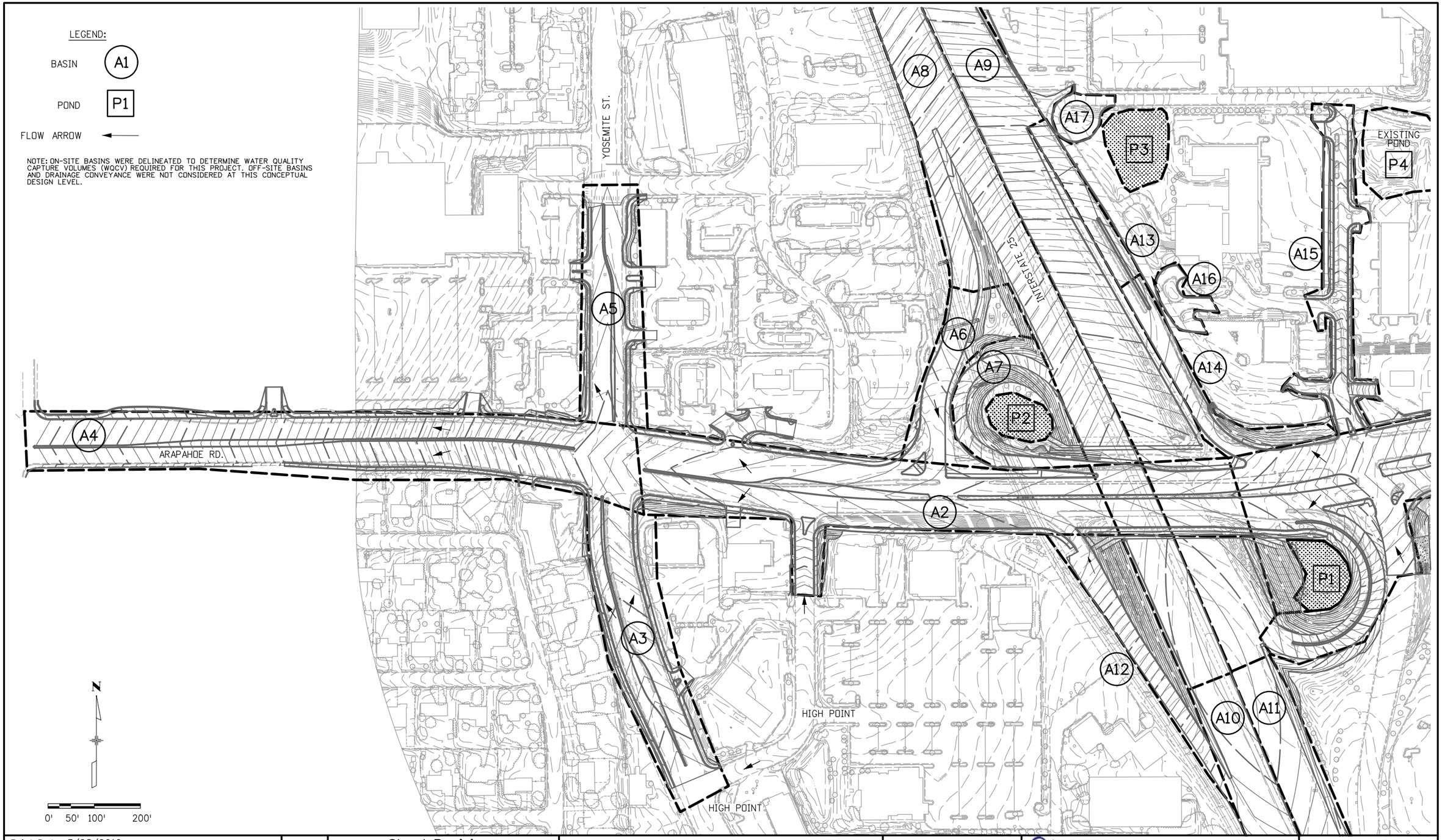
LEGEND:

BASIN A1

POND P1

FLOW ARROW

NOTE: ON-SITE BASINS WERE DELINEATED TO DETERMINE WATER QUALITY CAPTURE VOLUMES (WQCV) REQUIRED FOR THIS PROJECT. OFF-SITE BASINS AND DRAINAGE CONVEYANCE WERE NOT CONSIDERED AT THIS CONCEPTUAL DESIGN LEVEL.



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File Name: Prop-Basins_Ponds01.dgn	Date:	Comments	Init.
Horiz. Scale: 1:200 Vert. Scale: As Noted			
Unit Information Unit Leader Initials			

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
3320 South Parker Road
Aurora, CO 80014
Phone: 303-337-9519 FAX: 303-750-7452
Region 6 JH

As Constructed
No Revisions:
Revised:
Void:

I-25/Arapahoe Interchange
Environmental Assessment

PROPOSED BASINS AND PONDS 1

Designer: EJN Detailer: RGK

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number 50

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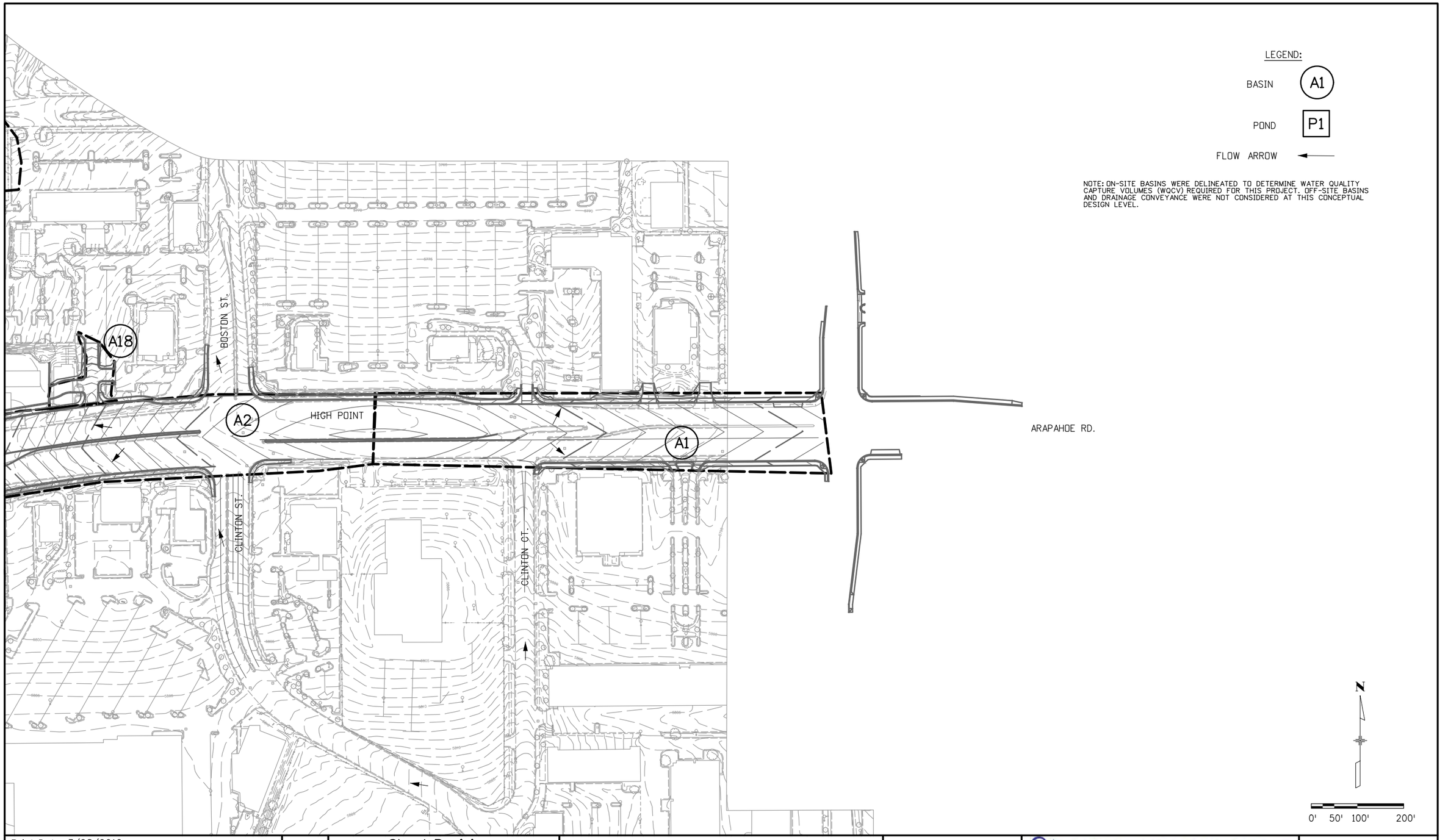

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File Name: Prop-Basins_Ponds02.dgn
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Unit Information Unit Leader Initials

Sheet Revisions		
Date:	Comments	Init.

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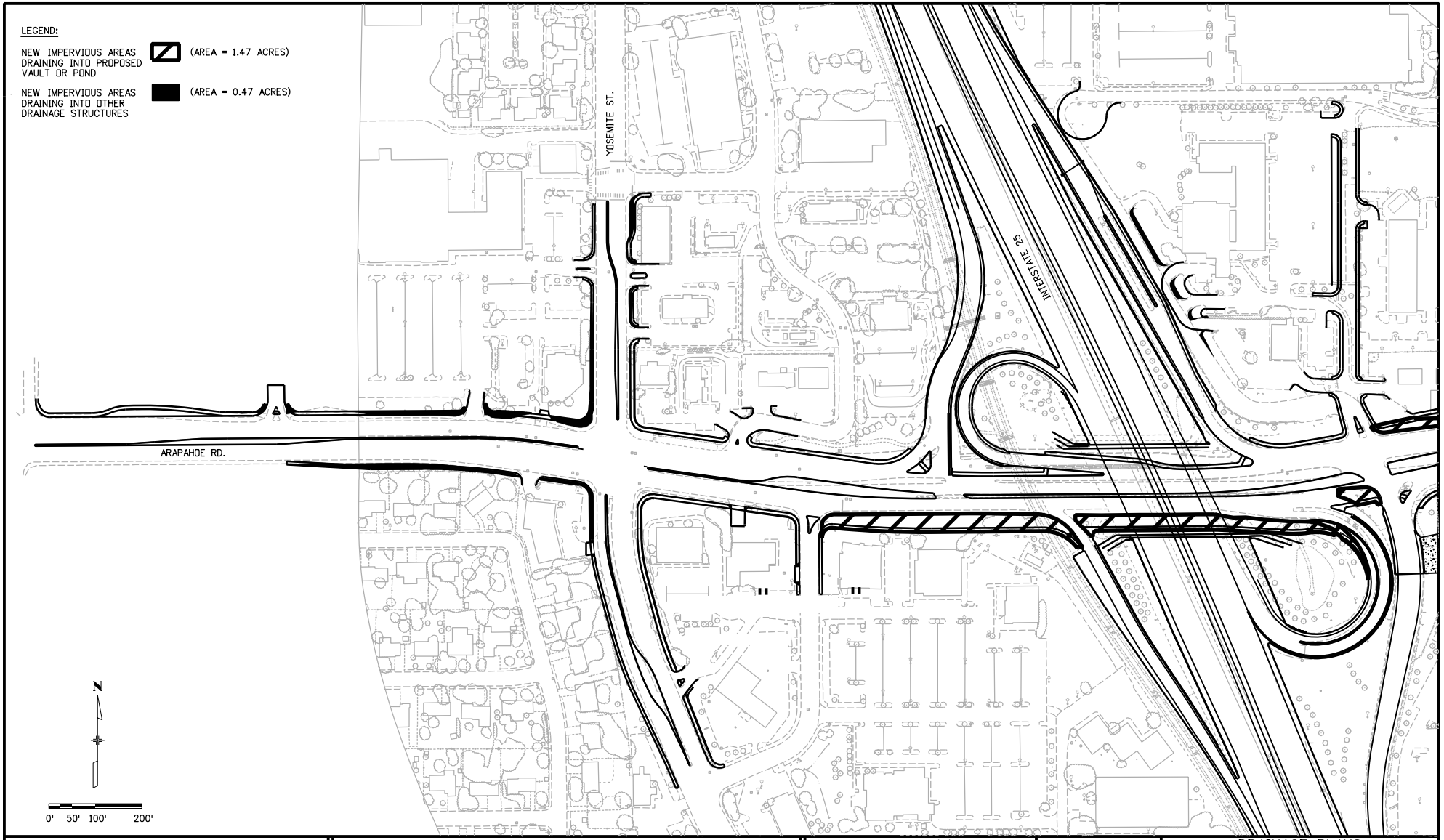
As Constructed
No Revisions:
Revised:
Void:

I-25/Arapahoe Interchange
Environmental Assessment

PROPOSED BASINS AND PONDS 2

Designer: EJN Detailer: RGK

Project No./Code
I-25/ARAPAHOE EA
16159
Sheet Number 51



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Colorado Department of Transportation

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I-25/Arapahoe Interchange

Environmental Assessment

Sheet Revisions

Date	Description	Initials

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1331 17TH STREET SUITE 900
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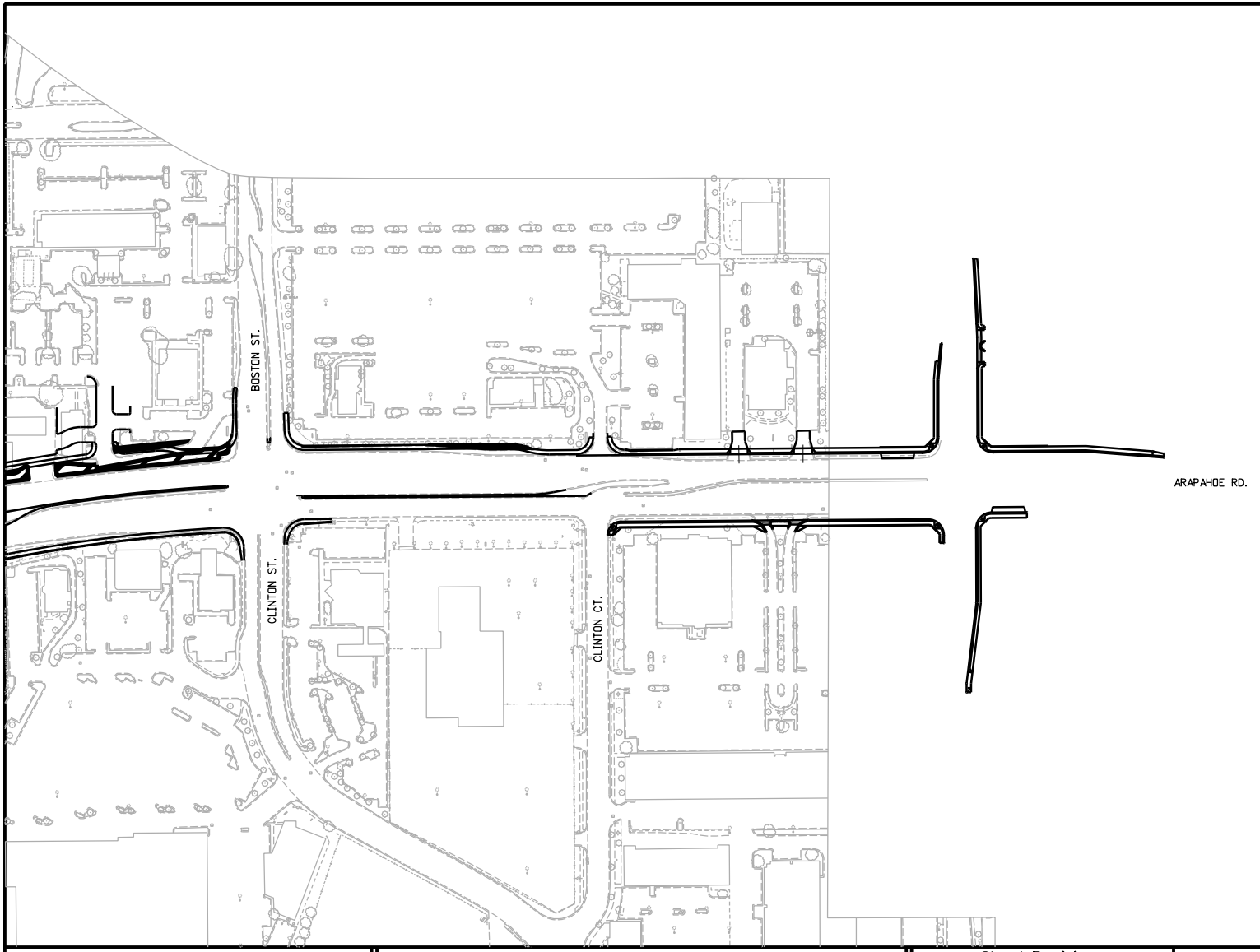
DRAINAGE PLANS

New Impervious Area

Project Number:

Project Location:

Project Code:	Last Mod. Date	Subset	Sheet No.
16159	09-13-11		



Colorado Department of Transportation

CDOT DEPARTMENT OF TRANSPORTATION

I-25/Arapahoe Interchange

Environmental Assessment

Sheet Revisions

Date	Description	Initials

DAVID EVANS AND ASSOCIATES INC.
1331 17TH STREET SUITE 900
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DRAINAGE PLANS

New Impervious Area

Project Number:

Project Location:

Project Code:	Last Mod. Date	Subset	Sheet No.
16159	09-13-11		

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Construction Phasing Technical Memorandum

I-25/Arapahoe Interchange

Environmental Assessment

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188 Inverness Drive West
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720-733-1821
720-875-1181 Fax

Technical Memorandum – I-25/Arapahoe Interchange Construction Phasing

1.0 Introduction

This memorandum details the examination and development of a conceptual phasing plan for the reconstruction of the I-25 and Arapahoe Road interchange. The project team of David Evans and Associates, Inc. and Hartwig & Associates examined multiple construction phasing options and determined the construction phasing approach detailed in this memorandum to best meet the project parameters and constraints. This conclusion was reached after examining multiple construction aspects including traffic impacts, constructability, CDOT's lane closure policies for the I-25 and Arapahoe corridors, and impacts to local business owners and residents. An attempt to match existing lane configurations when possible was made, however due to physical constraints within the project area this goal was not always attainable. Outlined in this memorandum is the preferred construction phasing approach for the EA Action alternative as well as a description of the challenges encountered during development.

2.0 Construction Phasing Approach

I-25 Reconstruction – The proposed changes to Arapahoe Road and the replacement of the existing I-25 structure present many construction challenges along the I-25 corridor. The increased profile along Arapahoe Road will require the reconstruction of I-25 nearly a thousand feet in both the northbound and southbound directions. This reconstruction poses several challenges due to multiple physical constraints which exist in the project area and limit construction phasing options.

Such constraints include the light rail line to the west of I-25 as well as several commercial properties to the east. Various retaining walls, piers, and property boundaries limit the amount of space available to shift traffic during construction. Furthermore, the existing bridge over Arapahoe Road is actually several structures which have been spliced together over time. This combining of structures has created a condition in which the northbound and southbound structures are situated at different elevations. As this project advances into final design, survey data will provide more detail regarding the existing elevations of the northbound and southbound structures. Additionally, an in-depth analysis should be performed to determine if there is adequate capacity of the existing structure to add pavement and eliminate the vertical distance between the northbound and southbound structures. With the two structures at the same elevation, traffic may be shifted across the centerline which will allow space to be better utilized during construction phasing. For the EA Action alternative it was assumed that traffic could not be shifted across the existing bridge centerline. This assumption assures a conservative footprint due to the fact a wider bridge is needed to accommodate construction phasing. Please refer to the Structure Selection Report for further discussion of bridge type and construction phasing alternatives.

Northbound and southbound grade constraints, in addition to the challenge of adhering to CDOT's current lane closure policy which states that all lanes along I-25 shall remain open during peak periods, have created a challenging construction condition. While balancing the need to maintain the current number of

lanes along I-25 and minimize the impact to local property owners, the following preferred conceptual construction phasing strategy was developed:

Phase 1 (Figure 1) – Northbound I-25 traffic will be shifted to the west (towards the median barrier) using reduced lane widths and shoulders. With northbound traffic shifted to the center removal of the existing bridge and construction of the new structure can begin on the eastern portions of northbound I-25. In this phase approximately 35 feet of extra structure will be constructed to accommodate shifting northbound traffic to the east in Phase 2. During this phase, all detour construction required for Phase 2 will occur. This includes constructing temporary retaining walls and detour ramps for northbound I-25. The speed limit through all curves is reduced to 55 MPH and ramps will be maintained using temporary detour pavement and MHT's.

Phase 2 (Figure 2) – Traffic will be shifted onto the detour and portion of the northbound structure constructed in Phase 1. Simultaneously the shoulders and lane widths of southbound I-25 will be reduced and southbound traffic shifted as far west as possible. Once traffic on I-25 has been shifted to the outer limits of the roadway, removal of the existing bridge and phase 2 construction of the new structure will take place in the center of I-25. In order to accommodate this detour there will be impacts to the properties in the northeast and southeast corners of this interchange. The speed limit through all curves is reduced to 55 MPH and ramps will be maintained using temporary detour pavement and MHT's.

Phase 3 (Figure 3) – Northbound traffic will remain in same location as in Phase 2. Southbound traffic will be shifted east onto construction previously completed in Phase 2. During this phase the remaining existing bridge will be removed and the rest of the proposed structure completed. The speed limit through all curves is reduced to 55 MPH and ramps will be maintained using temporary detour pavement and MHT's (See Figure 3).

Phase 4 (Figure 4) - Traffic along both northbound and southbound I-25 will be placed in the ultimate condition. The construction of the temporary detour required in Phase 2 will be removed and all ramps will be constructed to their ultimate condition using MHT's or sub-phases.

Arapahoe Road Construction – The proposed improvements to Arapahoe Road also pose various construction challenges. Arapahoe Road generally consists of three through lanes in each direction as well as multiple turn lanes at various locations. Abutting Arapahoe Road are various commercial properties and southwest of the Yosemite Street intersection is a residential neighborhood. In many instances along this corridor the only buffer between the roadway itself and these properties is a sidewalk which generally ranges from 5 to 8 feet in width.

Due to a lack of available space it was determined to be impractical to maintain all lanes during construction of the Arapahoe Road improvements. After considering various construction phasing scenarios it was decided that a reasonable approach would be to maintain two lanes in each direction with the addition of turn lanes at various locations. This is a compromised condition and will most likely have negative impacts to traffic, however, when taking into account constructability and safety an approach such as this may be necessary. The recommended concept for the construction phasing of Arapahoe Road is as follows:

Arapahoe/I-25 Bridge Construction (Figure 4-7) – In order to complete the improvements to Arapahoe Road the new I-25 structure must first be constructed. The conceptual phasing plan for the Arapahoe/I-25 Bridge illustrates how night time and weekend closures may be used to complete demolition and construction. In general, crews can complete the demolition and construction on nights and weekends and may stop and start as necessary to allow Arapahoe Road to maintain all lanes during peak periods. Construction of the new structure will need to match the phasing proposed above in the section titled "I-25 Reconstruction". When construction of the new structure is substantially complete the proposed improvements to Arapahoe Road may begin.

Arapahoe Road Phase 1 (Figure 8) - All traffic is shifted to the north side of Arapahoe Road. Two lanes in each direction are maintained as well as two turn lanes for each direction at all major intersections. The speed limit through all curves is reduced to 30 MPH and each intersection and ramp shall be constructed using sub-phases and MHT's.

Arapahoe Road Phase 2 (Figure 9) – All eastbound traffic is shifted to the south side of Arapahoe Road onto previously constructed Phase 1. Westbound traffic remains in the same location as in Phase 1. Two lanes in each direction are maintained as well as two turn lanes for each direction at all major intersections. The speed limit through all curves is reduced to 30 MPH and each intersection and ramp shall be constructed using sub-phases and MHT's.

Arapahoe Road Phase 3(Figure 10) – Eastbound and westbound traffic will remain in the same configuration as in Phase 2. The eastbound turn lanes at Yosemite Street and Clinton Street will be shifted to allow construction to be completed as shown. The speed limit through all curves is reduced to 30 MPH and each intersection and ramp shall be constructed using sub-phases and MHT's.

Arapahoe Road Phase 4 (Figure 11) – All eastbound traffic remains in place while westbound traffic is shifted south. All remaining construction is completed on the northern portion of Arapahoe Road. The speed limit through all curves is reduced to 30 MPH and each intersection and ramp shall be constructed using sub-phases and MHT's.

2. Construction Phasing Plan Assumptions

The typical detour section used throughout this analysis consists of 11-foot travel lanes, 2-foot shoulders, 2-foot barrier, and where possible a 5-foot buffer between any barrier and the edge of the construction zone. Due to a physical lack of space throughout this project, it was necessary to deviate from this typical section and reduce the distance between the construction zone and the concrete barrier in some areas.

To determine if any extended lane closures were permissible along this stretch of I-25 and Arapahoe Road, CDOT's Lane Closure Schedules for Region 6 were used. For the majority of the project area CDOT's policy dictates that lane closures may occur during non peak periods only, generally between the hours of 8:00 P.M. and 5:30 A.M. It was therefore assumed that it would be preferential to maintain the current lane configurations during daytime hours. This requirement was accommodated along I-25, however it was determined to be impractical along Arapahoe Road. Physical constraints combined with the large number of existing lanes along Arapahoe Road make it necessary to reduce the number of lanes to complete construction in a reasonable manner.

3. Investigated Alternatives

In addition to the preferred construction phasing approach the project team investigated several alternatives.

I-25 Reconstruction Alternatives – The number of alternatives available for the reconstruction of I-25 was limited due to the elevation difference at the centerline of the existing bridge over Arapahoe Road. This elevation difference limits the ability to shift traffic and limits the useful area of the existing structure for construction phasing.

Initially moving traffic to the west in the first phase was examined, however, this alternative was eliminated due to horizontal restrictions related to the existing light rail bridge and I-25 ramps.

After it was determined that a traffic shift to the east would be the most practical, there was a refinement to the phasing concepts and roadway alignments to limit the reconstruction area along I-25. Through lowering the profile along Arapahoe Road it was determined that the existing I-25 mainline profile could be maintained. This alternative offered several benefits. Foremost, if the current I-25 profile were maintained it would be possible to tie into the proposed structure spanning Arapahoe Road much quicker. This resulted in much less temporary detour construction and reduced the impact to adjacent property owners. These benefits to I-25 and the surrounding properties are appealing; however the negative impacts to Arapahoe Road eliminated this option from consideration. If the profile of Arapahoe Road were to be lowered to allow I-25 to maintain its current profile several challenges and constraints occur, including the potential to undermine the retaining wall and piers associated with the light rail to the west of I-25, as well as the potential to expose and have to relocate utilities located under Arapahoe Road. Lowering Arapahoe Road also has a negative impact in regards to drainage. Altering the Arapahoe Road profile may require the installation of specialized drainage structures and potentially a pump station. Due to the associated cost and complexities of resolving these issues this option was not considered in detail.

Arapahoe Road Construction Alternatives – The number of practical alternatives available for the construction of improvements along Arapahoe Road is limited. This is due in large part to the limited space available to shift traffic and the elevation difference between the proposed surface and the existing roadway.

Initially it was assumed that traffic could be shifted to the south side of Arapahoe Road first and all construction could be completed in three phases. From a horizontal standpoint this approach is satisfactory but from a vertical perspective issues arise near the southbound I-25 off-ramp. At this location the difference between the proposed surface and the existing road is approximately 3 feet. If traffic were to be shifted south in the first phase it becomes very difficult to maintain the turning movement from the southbound I-25 off-ramp onto eastbound Arapahoe Road due to the substantial vertical difference. In contrast, if traffic is shifted to the north side of Arapahoe Road first and worked south as construction is completed this ramp can remain operational a majority of the time.

APPENDIX A –

CONSTRUCTION PHASING PLAN

EXISTING I-25 CENTERLINE

LRT

EXISTING STRUCTURE

PROPOSED STRUCTURE

SPORTS AUTHORITY

R.O.W IMPACT

LRT

HOTEL

BBQ

PHASE RAMP USING MHT

SB I-25

NB I-25

WALL IMPACT

PHASE RAMP USING MHT

TARGET

ARAPAHOE ROAD

0' 100' 200' 400'

I-25 PHASE 1

CONSTRUCTION ZONE - PHASE 1

CONSTRUCTION ZONE - PHASE 2 TEMPORARY DETOUR

Print Date: 2/16/2012	R-X	Sheet Revisions			Colorado Department of Transportation
File Name: 16159DES_58_CTC_I-25 Phase 1.dgn		Date:	Comments	Init.	3320 South Parker Road Aurora, CO 80014 Phone: 303-337-9519 FAX: 303-750-7452
Horiz. Scale: 1:200 Vert. Scale: As Noted					Region 6 JH
Unit Information Unit Leader Initials					

As Constructed	I-25/Arapaho Environmental	Project No./Code
No Revisions:	ARAPAHOE ROAD/I-25	I-25/ARAPAHOE EA
Revised:	CONSTRUCTION PHASING PLAN	16159
Void:		58

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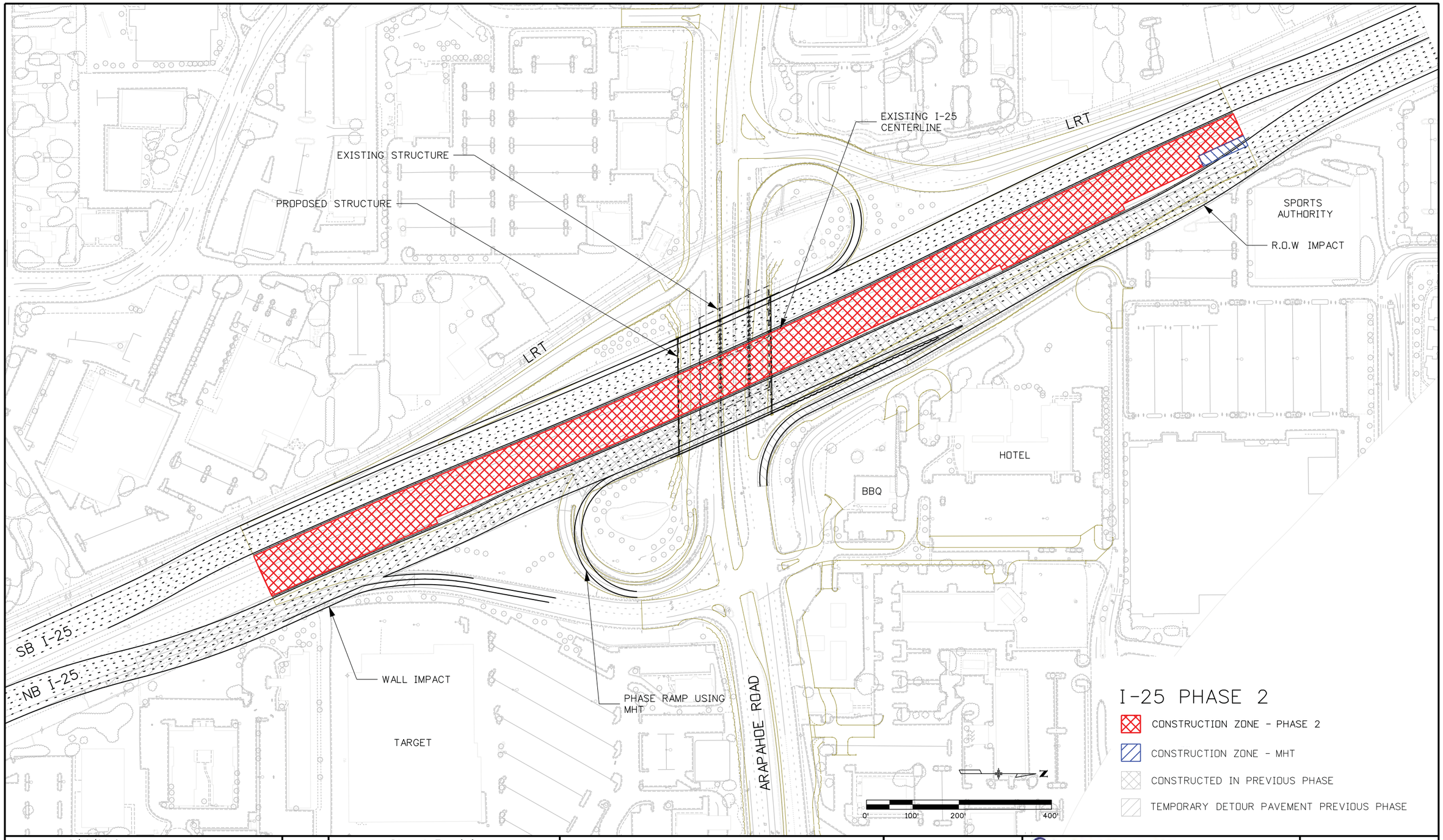

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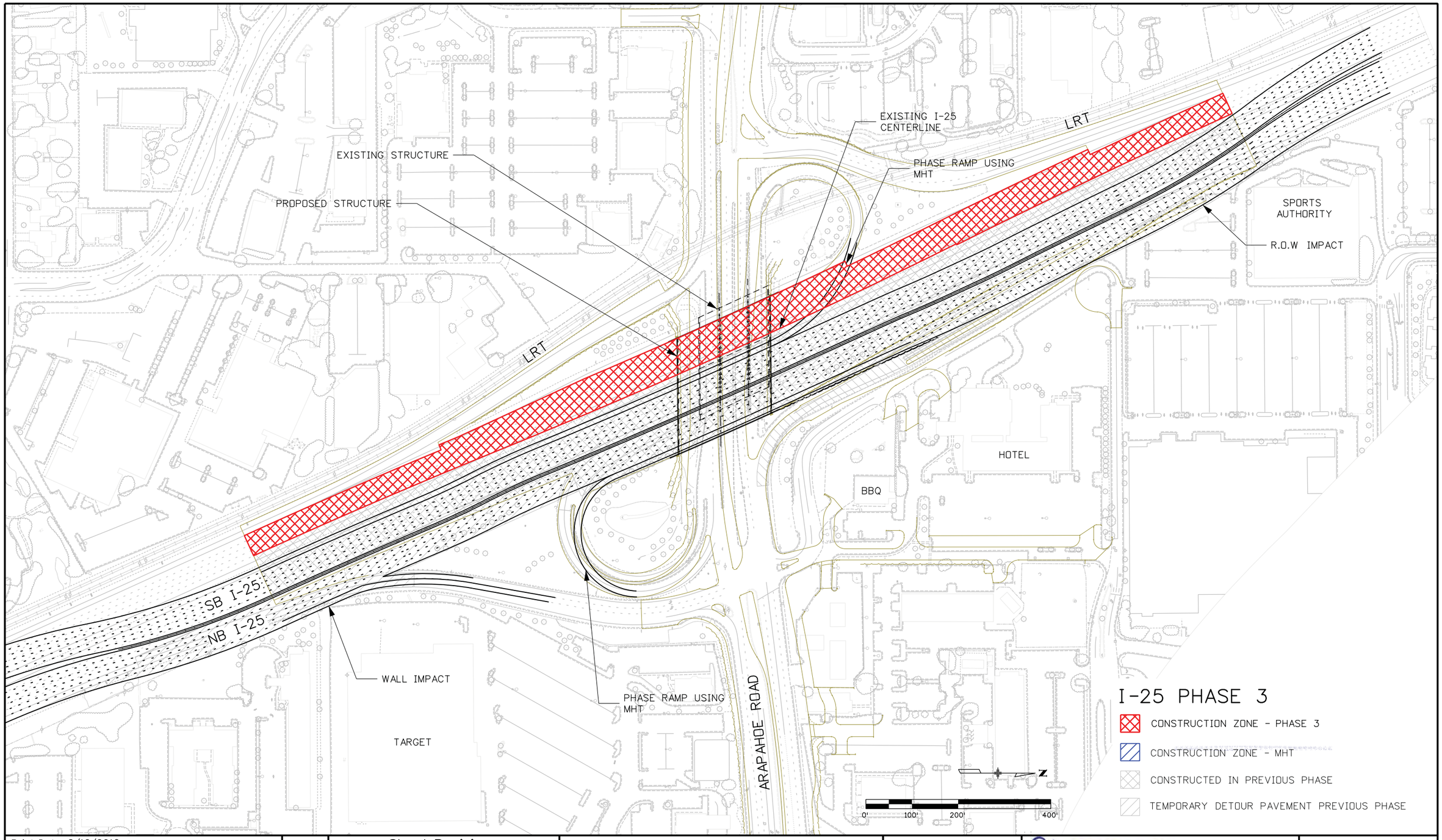
Horiz. Scale: 1:200 Vert. Scale: As Noted	Date: Comments Init.	Aurora, CO 80014	16159
Unit Information Unit Leader Initials		Phone: 303-337-9519 FAX: 303-750-7452	59
R-X		Region 6 JH	

As Constructed
No Revisions:
Revised:
Void:

I-25/Arapaho Environmental

ARAPAHOE ROAD/I-25
CONSTRUCTION PHASING PLAN



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Horiz. Scale: 1:200 Vert. Scale: As Noted					Region 6 JH	Revised:		16159
Unit Information Unit Leader Initials						Void:		60

EXISTING I-25 CENTERLINE

PHASE RAMP USING MHT/SUB-PHASES

EXISTING STRUCTURE

PROPOSED STRUCTURE

PHASE RAMP USING MHT/SUB-PHASES

LRT

LRT

SPORTS AUTHORITY

PHASE RAMP USING MHT/SUB-PHASES

HOTEL

BBQ

SB I-25

NB I-25

PHASE RAMP USING MHT/SUB-PHASES

TARGET

ARAPAHOE ROAD

N

0' 100' 200' 400'

I-25 PHASE 4

CONSTRUCTION ZONE - PHASE 4 USE SUB-PHASE OR MHT

CONSTRUCTED IN PREVIOUS PHASE

TEMPORARY DETOUR PAVEMENT PREVIOUS PHASE

Print Date: 2/16/2012
File Name: 16159DES_61_CTC_I-25 Phase 4.dgn
Horiz. Scale: 1:200 Vert. Scale: As Noted
Unit Information Unit Leader Initials

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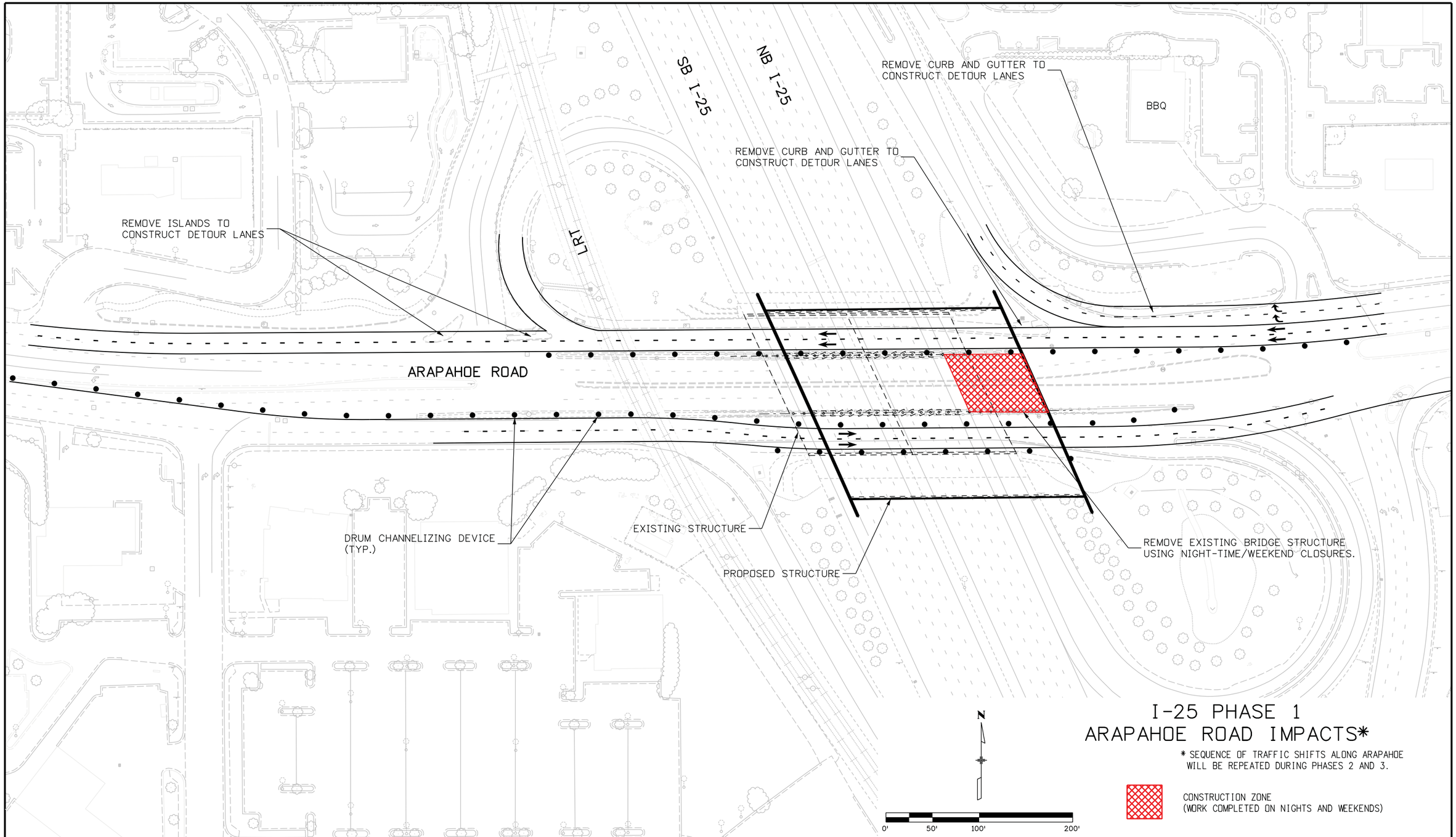
ARAPAHOE ROAD/I-25
CONSTRUCTION PHASING PLAN

Project No./Code
I-25/ARAPAHOE EA
16159
61



I-25 PHASE 1
ARAPAHOE ROAD IMPACTS*

* SEQUENCE OF TRAFFIC SHIFTS ALONG ARAPAHOE WILL BE REPEATED DURING PHASES 2 AND 3.

CONSTRUCTION ZONE
(WORK COMPLETED ON NIGHTS AND WEEKENDS)

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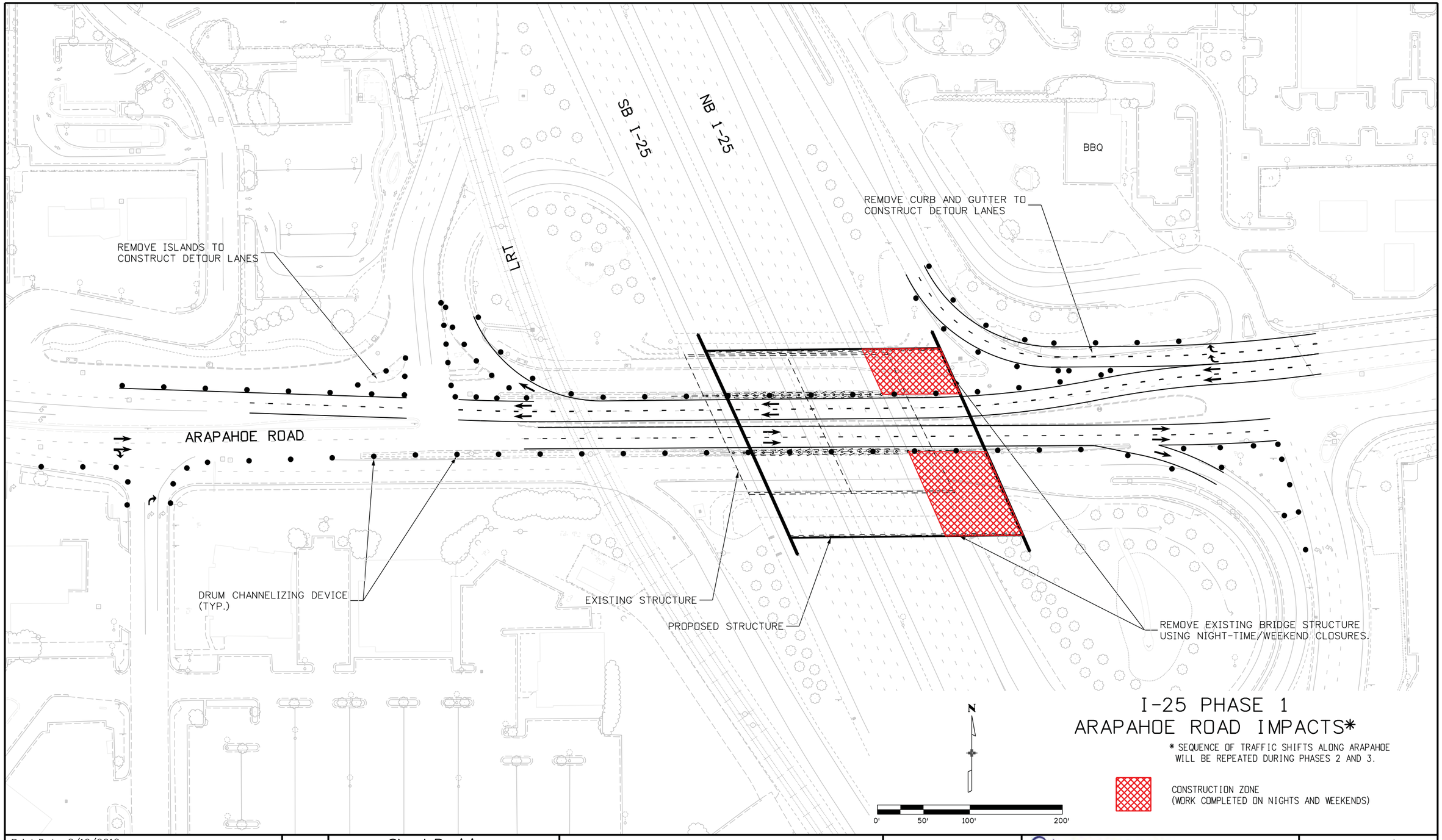
Void:	

I-25/Arapaho Environmental

ARAPAHOE ROAD/I-25
CONSTRUCTION PHASING PLAN

Project No./Code
I-25/ARAPAHOE EA
16159
62



I-25 PHASE 1
ARAPAHOE ROAD IMPACTS*

* SEQUENCE OF TRAFFIC SHIFTS ALONG ARAPAHOE WILL BE REPEATED DURING PHASES 2 AND 3.

CONSTRUCTION ZONE
(WORK COMPLETED ON NIGHTS AND WEEKENDS)

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Unit Information Unit Leader Initials			Phone: 303-337-9519 FAX: 303-750-7452
			Region 6 JH

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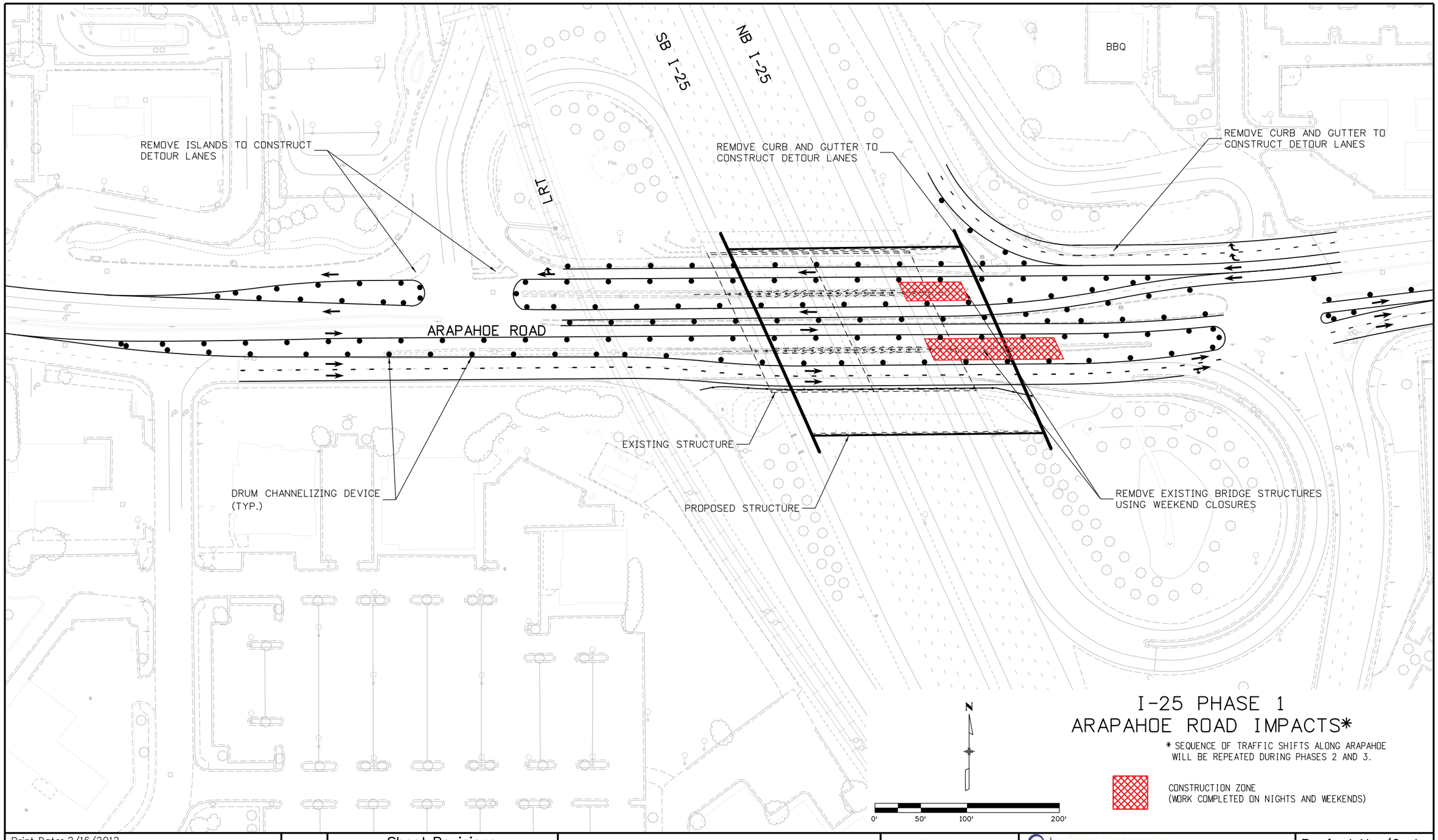

I-25 PHASE 1
ARAPAHOE ROAD IMPACTS*

* SEQUENCE OF TRAFFIC SHIFTS ALONG ARAPAHOE WILL BE REPEATED DURING PHASES 2 AND 3.

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(WORK COMPLETED ON NIGHTS AND WEEKENDS)

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Unit Information Unit Leader Initials					

As Constructed	I-25/Arapaho Environmental	Project No./Code
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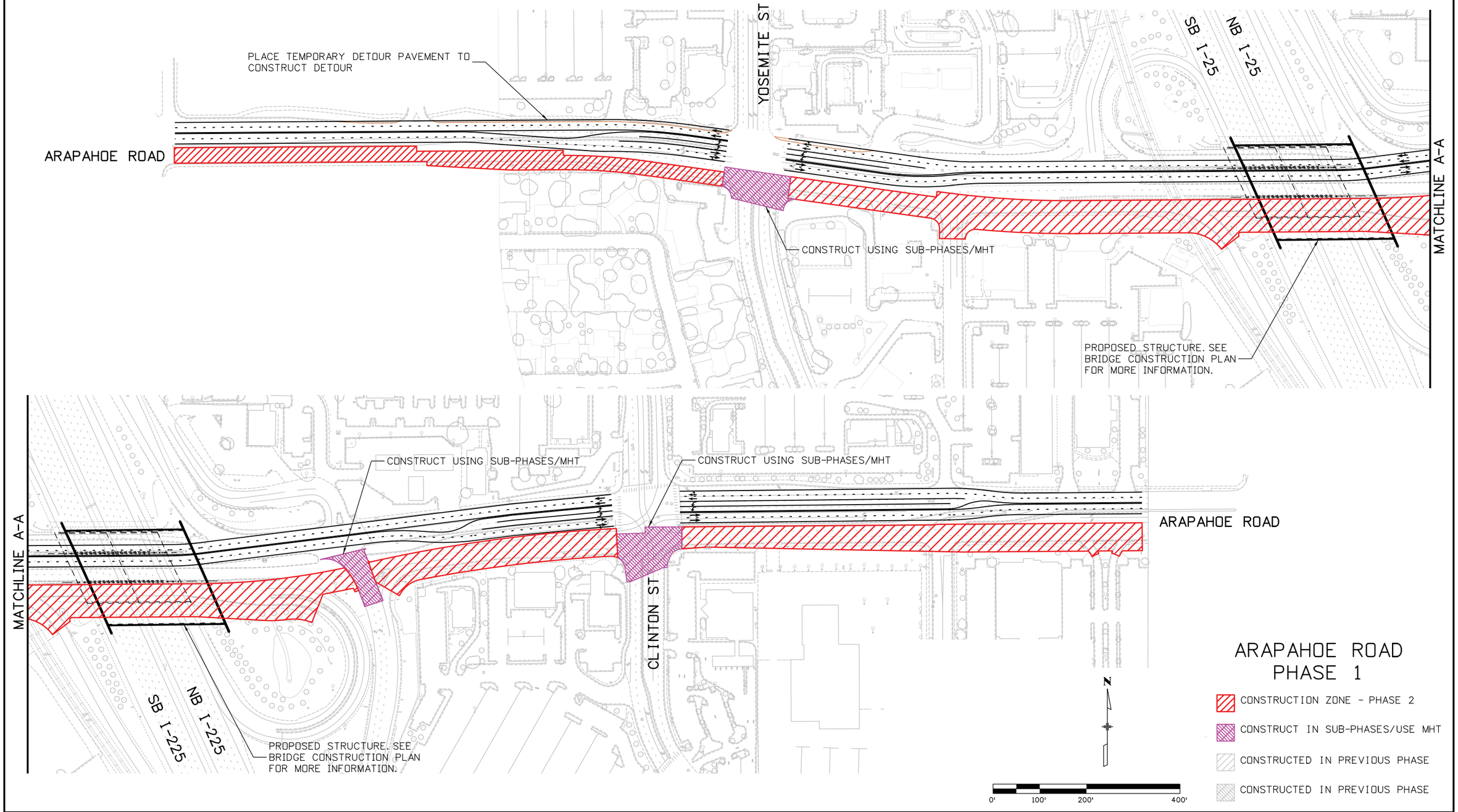

ARAPAHOE ROAD PHASE 1

- CONSTRUCTION ZONE - PHASE 2
- CONSTRUCT IN SUB-PHASES/USE MHT
- CONSTRUCTED IN PREVIOUS PHASE
- CONSTRUCTED IN PREVIOUS PHASE

Print Date: 2/16/2012	R-X	Sheet Revisions			Colorado Department of Transportation	As Constructed	I-25/Arapaho Environmental	Project No./Code
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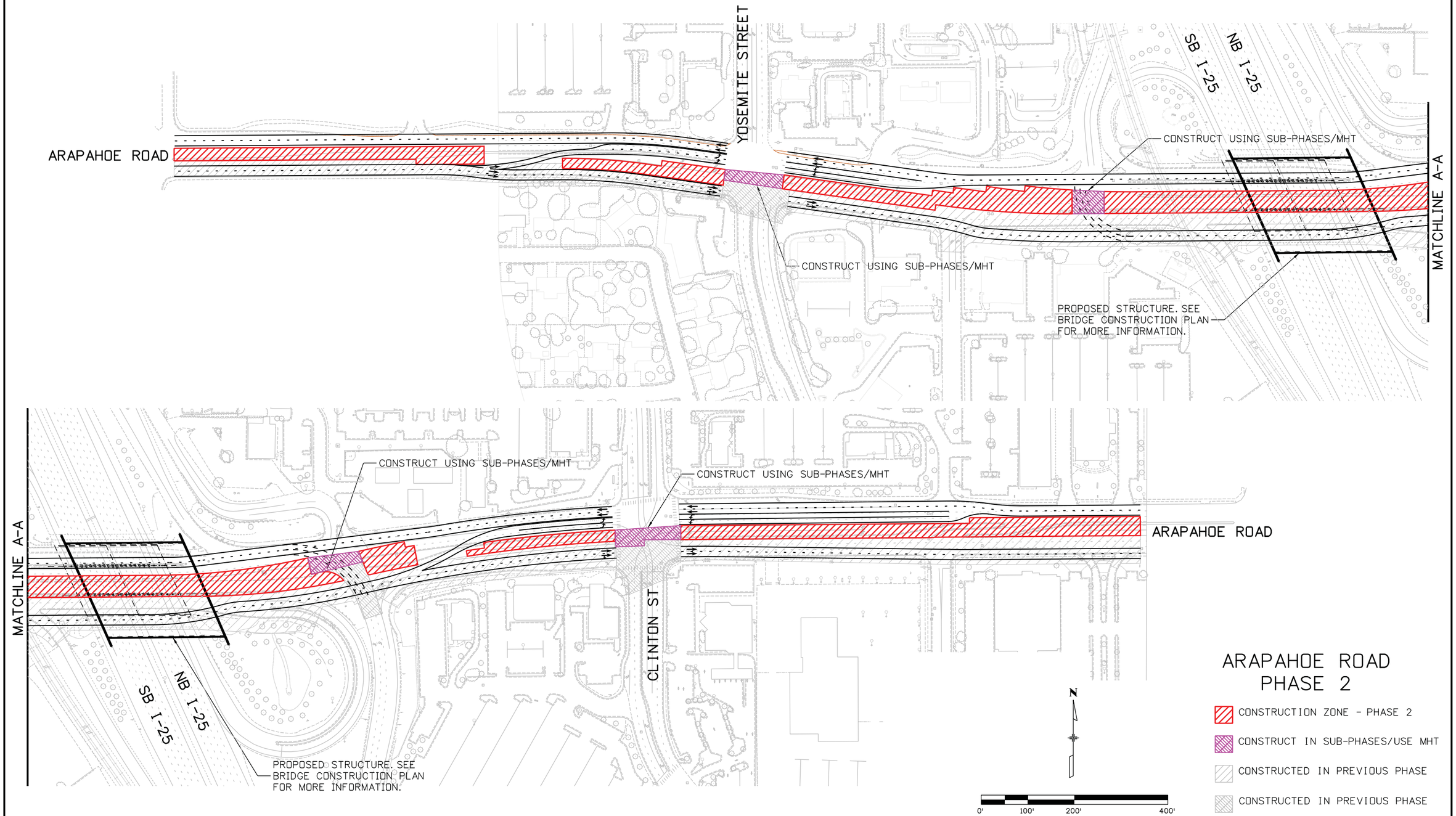

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3320 South Parker Road
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I-25/Arapaho Environmental

ARAPAHOE ROAD/I-25
CONSTRUCTION PHASING PLAN

Project No./Code
I-25/ARAPAHOE EA
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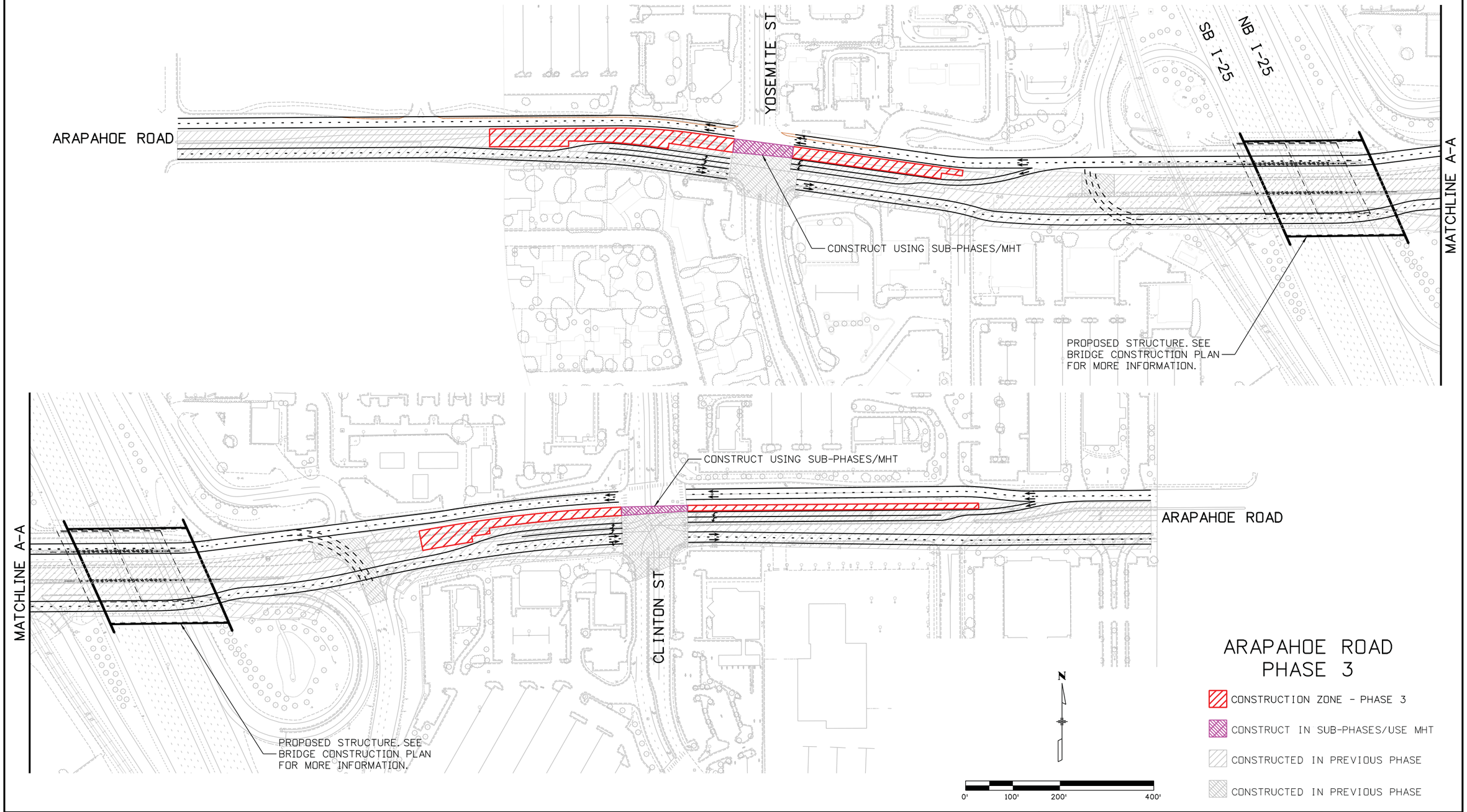

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Unit Information Unit Leader Initials					

As Constructed	I-25/Arapaho Environmental	Project No./Code
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Revised:	CONSTRUCTION PHASING PLAN	16159
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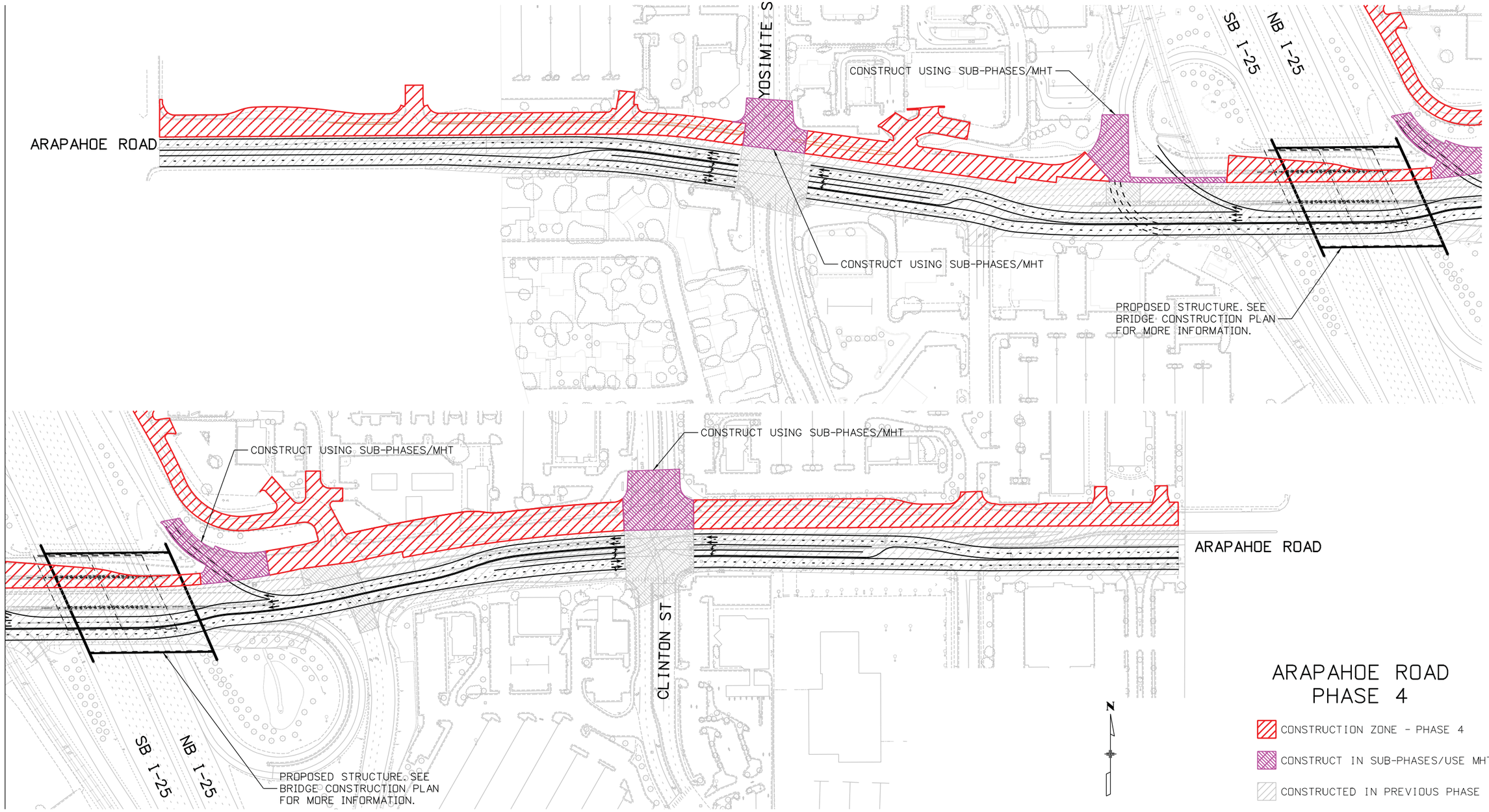

ARAPAHOE ROAD PHASE 4

- CONSTRUCTION ZONE - PHASE 4
- CONSTRUCT IN SUB-PHASES/USE MHT
- CONSTRUCTED IN PREVIOUS PHASE
- CONSTRUCTED IN PREVIOUS PHASE

Print Date: 2/16/2012	R-X	Sheet Revisions			Colorado Department of Transportation	As Constructed
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Horiz. Scale: 1:200 Vert. Scale: As Noted					Region 6 JH	Revised:
Unit Information Unit Leader Initials						Void:

I-25/Arapaho Environmental

ARAPAHOE ROAD/I-25
CONSTRUCTION PHASING PLAN

Project No./Code
I-25/ARAPAHOE EA
16159
68

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Improved Partial Cloverleaf Cost Estimate

I-25/Arapahoe Interchange

Environmental Assessment

ARAPAHOE & I-25 IMPROVEMENTS - PARCLO - ARAPAHOE RD IMPROVEMENTS

OPINION OF PROBABLE CONSTRUCTION COSTS
Conceptual Design Cost Estimate

DATE: 4/12/2012
BY: DAD

	ITEM DESCRIPTION	UNIT	UNIT COST	ARAPAHOE & I-25 IMPROVEMENTS APPROX. QUANTITY	ESTIMATED COST
A.	***BID ITEMS****				
	REMOVALS/DEMOLITION (FLATWORK)	SY	$ 12.00	150,853	$ 1,810,236.00
	REMOVAL GUARDRAIL (TYPE 7)	LF	$ 15.00	5,000	$ 75,000.00
	REMOVAL OF BRIDGE	SF	$ 12.00	33,440	$ 401,280.00
	EMBANKMENT MATERIAL (CIP)	CY	$ 12.00	119780	$ 1,437,360.00
	CONCRETE PAVEMENT (6 INCH)	SY	$ 45.00	440	$ 19,800.00
	CONCRETE PAVEMENT (11 INCH)	SY	$ 60.00	125,256	$ 7,515,360.00
	CURB AND GUTTER TYPE 2 (SECTION I-B)	LF	$ 11.00	11,702	$ 128,722.00
	CURB AND GUTTER TYPE 2 (SECTION II-B)	LF	$ 14.00	15,694	$ 219,716.00
	CONCRETE SIDEWALK	SY	$ 30.00	7,588	$ 227,640.00
	MEDIAN COVER MATERIAL	SF	$ 5.50	45,908	$ 252,494.00
	CONCRETE SLOPE AND DITCH PAVING	CY	$ 285.00	97	$ 27,645.00
	SIGNALS PER INTERSECTION	EA	$ 300,000.00	4	$ 1,200,000.00
	GUARDRAIL TYPE 3	LF	$ 15.00	84	$ 1,260.00
	GUARDRAIL TYPE 7	LF	$ 45.00	8,458	$ 380,610.00
	NOISE ABATEMENT WALL	SF	$ 45.00	14,150	$ 636,750.00
	MSE WALL	SF	$ 50.00	49,010	$ 2,450,500.00
	BRIDGE	SF	$ 110.00	51,703	$ 5,687,330.00
	SUBTOTAL A				**$ 22,471,703**
B.	ITS	(6% of A)			$1,348,302
	Drainage/Utilities	(10% of A)			$2,247,170
	Signing & Striping, Lighting	(5% of A)			$1,123,585
	Construction Signing & Traffic Control	(10% of A)			$2,247,170
	Mobilization	(7% of A)			$1,573,019
	Erosion Control/Water Quality	(12% of A)			$2,696,604
	Removals (Misc.)	(1% of A)			$224,717
	Force Account - Utilities	(12% of A)			$2,696,604
	Force Account - Misc.	(10% of A)			$2,247,170
	SUBTOTAL B				**$16,404,343**
C.	Project Construction Bid Items Contingencies	(30% of A+B)			$11,662,814
	Total Preliminary Engineering	(10% of A+B)			$3,887,605
	Total Construction Engineering	(20% of A+B)			$7,775,209
	SUBTOTAL C				**$23,325,628**
D.	Estimated R.O.W Acquisition (Land) **	Project Dependant	$ 35.00	109,390	$ 3,828,650.00
	Estimated R.O.W Acquisition (Business)***	Project Dependant	$ 250,000.00	1	$ 250,000.00
	Relocation Costs (Pat's Cheese Steak)	Project Dependant	$ 150,000.00	1	$ 150,000.00
	Estimated Easements for Detours **	Project Dependant	$ 10.00	21,039	$ 210,390.00
	SUBTOTAL D				**$ 4,439,040.00**
	GRAND TOTALS (A, B, C & D)				**$66,640,714**

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

** Does not include any costs associated with business acquisitions or impacts to operations

*** Pat's Cheese Steak Business

Note: Estimate does not include any associated costs with leased property reimbursement to Firestone.

I-25/Arapahoe Interchange Environmental Assessment

Technical Design Documentation

Eagle Hardware/Gart Highway Access Appeal Court Decision

I-25/Arapahoe Interchange

Environmental Assessment

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SUITE 900
WASHINGTON, D.C. 20004
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FAX (202) 393-7864

RECEIVED FEB 07 1997

Andrew W. Loewi

February 6, 1997

Steven S. Crowell, Jr.
City Manager
City of Greenwood Village
6060 South Quebec Street
Greenwood Village, Colorado 80111

Re: Eagle Hardware

Dear Steve:

Enclosed please find a copy of Judge Snider's decision in the Eagle/Gart Highway Access Appeal. Needless to say, we were delighted with the decision, which would not have been possible without your help.

Many thanks, and best personal regards.

Sincerely,

Andy Loewi/WRL

Andrew W. Loewi

AWL:ba
Enclosure

6141\1\207558.1

BEFORE THE DIVISION OF ADMINISTRATIVE HEARINGS
STATE OF COLORADO

CASE NO. HW 96-01

AGENCY DECISION

IN THE MATTER OF THE APPEAL OF EAGLE HARDWARE AND GARDEN, INC., DEVELOPMENT CORPORATION OF THE ROCKIES, INC., AND GART SPORTS, INC. OF THE DENIAL OF AN ACCESS PERMIT BY THE DEPARTMENT OF TRANSPORTATION; I-25 EAST FRONTAGE ROAD, NORTH OF SH-88

This case is a proceeding pursuant to Section 43-2-147 (6)(c), C.R.S. (1996) initiated by parties who have been denied a highway access permit by the Colorado Department of Transportation. A hearing in this matter was held before Administrative Law Judge Marshall A. Snider on October 7-11 and November 21, 22, 25 and 26, 1996. Appellants Eagle Hardware and Garden, Inc. ("Eagle"), Development Corporation of the Rockies, Inc. ("DCR") and Gart Sports, Inc. ("Gart") were represented at the hearing by Andrew W. Loewi, Esq. and Robert C. Troyer, Esq. The Colorado Department of Transportation ("CDOT") was represented by David A. Burlage, Esq. The Administrative Law Judge issues this Agency Decision pursuant to Section 43-2-147 (6)(c), C.R.S. (1996).

PRELIMINARY MATTERS

1. The appeal in this case was instituted by the filing of an appeal letter on December 8, 1995, supplemented by an amended letter of appeal dated February 13, 1996. The appeal raised five issues: whether CDOT is required by the State Highway Access Code to grant the access sought by the Appellants; whether CDOT is estopped to deny the access application filed in this case; whether CDOT improperly based denial of the application on the threat of litigation by nearby property owners; whether the Appellants were denied due process of law because CDOT was improperly influenced by the advice provided by an assistant attorney general; and whether CDOT improperly denied the application because it failed to consider one of the two access configurations presented in the application.

On September 24, 1996, CDOT moved for partial summary judgment on all issues other than the issue of whether the State Highway Access Code required CDOT to grant the access in question. In an order dated October 3, 1996, the Administrative Law Judge granted CDOT's motion as to the following issues: whether CDOT improperly based denial of the application on the threat of litigation by nearby property owners; whether the Appellants were denied due process of law; and whether CDOT improperly denied the application because it failed to consider one of the two access configurations presented in the application. The Administrative Law Judge denied CDOT's motion for partial summary judgment on the issue of whether

CDOT is estopped to deny the access application filed in this case. The October 3, 1996, Order is incorporated by reference into this Agency Decision. As a result of the October 3 Order, the remaining issues in this case are as follows: whether the Appellants are entitled to the access they seek on the basis of estoppel; and whether the Appellants are entitled to access pursuant to Section 3.8 of the State Highway Access Code.

2. On October 4, 1996, CDOT filed a motion to dismiss this appeal on the grounds of mootness. CDOT's position in this motion was that none of the Appellants owned any interest in the property to which access was sought. The Administrative Law Judge denied that motion at the outset of the hearing. The facts and legal conclusions upon which that ruling was based are contained below in this Agency Decision.

3. On October 7, 1996, CDOT moved to dismiss the Appellants' estoppel claim on two grounds. CDOT's first argument was that OLP Greenwood Village, Colorado, Inc., ("OLP"), the current owner of the property to which access is sought, was never involved in any discussions with CDOT and therefore could not have relied on any statements by CDOT upon which the estoppel claim is based. Ruling on that portion of the motion was taken under advisement and will be addressed in this Agency Decision.

4. The second argument raised by CDOT in its October 7 motion was that the Administrative Law Judge, as an executive branch officer, has no constitutional jurisdiction to provide the equitable relief requested by the Appellants. CDOT's argument was that the granting of equitable relief is a purely judicial function, exercisable only by courts of general jurisdiction. The Administrative Law Judge denied this portion of the motion during the hearing.

Administrative law judges ("ALJs") and agency hearing officers typically exercise the quasi-judicial functions exercised by executive branch agencies. The appellate courts in Colorado have implicitly recognized that ALJs may grant equitable relief. In numerous cases the courts have reviewed the actions of administrative agencies or ALJs granting or denying equitable relief without ever suggesting that the agency or ALJ did not have the authority to hear and decide that claim in the first instance.[1] In fact, in one such case the Colorado Supreme Court actually remanded a case to the Court of Appeals with directions to remand the case to the ALJ for development of a further factual record on the issue of equitable relief. *Garrett v. Arrowhead Improvement Association*, 826 P.2d 850 (Colo. 1992). Deciding a claim of equitable estoppel is thus an exercise of the quasi-judicial functions of executive branch agencies and officers no different than any other administrative decision on a question of law presented to an agency.

FINDINGS OF FACT

1. On September 21, 1995, the City of Greenwood Village, Colorado ("Greenwood Village") forwarded to CDOT an approved application for an access permit submitted by DCR. In this application DCR sought access from a parcel of land ("the development site") to the frontage road on the east side of Interstate 25, just north of Arapahoe Road in Greenwood Village. An aerial photograph of the area affected by this application is attached to this Agency Decision as Exhibit A.

2. CDOT denied this application on October 10, 1995. That denial led to the instant proceeding.

THE DEVELOPMENT PROJECT

3. The September 21, 1995, access application was one step in a long series of dealings and communications between DCR, CDOT and Greenwood Village. The factual scenario began on September 15, 1993, when DCR entered into a contract with Gergins Investment Corp. giving DCR an option to purchase the development site.[2] DCR planned to develop a retail project on this site. DCR believed that access to the development site from the frontage road on the east side of Interstate 25 was a crucial part of DCR's development plans for the site. DCR would not have proceeded with this project in the absence of access to the frontage road.

4. The contract with Gergins did not require as a condition of closing that DCR obtain access to the development site. However, a contractual provision did allow DCR to cancel its obligation to purchase the property for any reason, up to a specific time (Gergins extended this time limit on four occasions prior to July, 1994, in return for nonrefundable monetary considerations from DCR).

5. After DCR obtained the option from Gergins it proceeded to negotiate with certain retailers as prospective tenants of the development. By early 1994 at least one prospective tenant declined to become involved in the project because of problems DCR was experiencing in obtaining frontage road access for the development site. Eventually, DCR contracted with Gart to lease part of the development site and with Eagle to purchase the remainder of the site.

6. DCR's contracts with Gart and Eagle did not contain contingencies expressly allowing Gart and Eagle to withdraw from their respective obligations if access to the frontage road was not granted. However, that access was an important aspect of the retail development for these retailers; they would not participate in the development in the absence of access to the frontage road. The parties anticipated that Eagle and Gart would not be required to perform their contractual obligations if DCR was unable to obtain an access permit to the frontage road.

7. The agreement between Eagle and DCR expressly provided that access was not a contingency of the sale of the property. If Eagle failed to close because of DCR's inability to obtain access Eagle would forfeit a $150,000 earnest money deposit. That deposit is a small amount of money relative to this multi-million dollar venture, and Eagle intended to cancel its contract and forfeit the earnest money if access to the frontage road could not be assured.

8. Gart did not have an access contingency in its lease from DCR because Gart was aware that without access to the frontage road, DCR would not purchase the development site. In that event, DCR would have no property to lease to Gart and Gart would have no obligation under the proposed lease.

THE APPLICATION PROCESS

9. The process of applying for access to a state highway is governed by the State Highway Access Code (2 CCR 601-1, hereafter "the Code"). The usual sequence of events in seeking a highway access commences with a developer contacting CDOT in advance of making a formal application for access. The purpose of this initial contact is to determine CDOT's position on the proposal and to attempt to meet any of CDOT's concerns. Developers want to obtain informal approval from CDOT before expending large sums of money on engineering and design services (in addition, the time frame for CDOT to respond to an application is very short and does not leave much room for discussions with CDOT). It is common for the developer and CDOT to engage in discussions regarding the proposed access during this pre-application process.

10. Under the Code, when a state highway is located within the jurisdiction of a local government entity, the application is first presented to the local government. If the local jurisdiction approves the application, the application is then sent to CDOT for approval. Greenwood Village was the local governmental agency involved in this case.

11. On December 15, 1993, DCR submitted to Greenwood Village an application for the access at issue in this case. Greenwood Village was eager for access to be approved so that the development could go forward. Greenwood Village processed the application and forwarded it to CDOT.

12. Prior to December 15, 1993, CDOT had indicated that it would not grant access to the frontage road. DCR and Greenwood Village believed that access to the development site was required under Section 3.8 of the Code, which provides for access to frontage roads.[3] The December 15 application was filed to force CDOT to make a decision on this issue. When CDOT stated that it would not grant the application, DCR decided to withdraw the application to permit further negotiations with CDOT. The application was withdrawn on January 10, 1994.

13. A number of meetings were held between CDOT representatives and DCR representatives (including DCR consultants) between February and June, 1994. DCR's position was that under Section 3.8 of the Code CDOT had no discretion to deny an application for access to the frontage road. CDOT's concern during this time was that the frontage road empties into Arapahoe Road, a major arterial, at a point located within the Arapahoe Road/Interstate 25 interchange. CDOT believed, and expressed to DCR and its consultants, that connecting the frontage road to the development site would bring too much traffic down the frontage road to the Arapahoe Road intersection, thus causing the level of service ("LOS") at that intersection to deteriorate.[4] At one meeting prior to April 1, 1994, Guillermo Vidal (who at that time was the director of Region 6 of CDOT, in which this intersection is located) stated that even one more car was not acceptable at this intersection.

14. In fact, the intersection of Arapahoe Road and the frontage road had been of concern to CDOT for some time prior to the present application. Arapahoe Road is a heavily traveled arterial road. Traffic on Arapahoe Road is congested at times, and it is anticipated that congestion will increase over the next 20 years. In addition, it is unusual for an intersection to exist within the interchange of an interstate highway. These facts raise operational and safety concerns.

15. In the early 1980's CDOT studied this intersection pursuant to a federally funded project regarding access in this area. The first preference resulting from this study was to eliminate the frontage road intersection with Arapahoe Road. However, this action was not feasible. The frontage road was at this time a part of Yosemite Street, a street which was interrupted by Interstate 25 at approximately Arapahoe Road. Three businesses were located along the frontage road (Yosemite Street) just north of Arapahoe Road: an Amoco service station; a restaurant (currently Denny's); and a hotel (now Woodfield Suites). If the frontage road were eliminated these businesses would have no access to the general street system, and it was too costly for CDOT to provide access to these businesses via Boston Street, the next street to the east. Therefore, it was necessary that the frontage road intersection with Arapahoe Road remain in place. There was also discussion in the early 1980's that if the intersection could not be eliminated altogether, it would be desirable to eliminate left turns at the intersection.

16. In 1983 a Yosemite Street flyover was constructed, taking Yosemite Street over Interstate 25 at a point north of the development site. At that time Yosemite Street north of the current frontage road was abandoned. As a result, the remaining portion of the frontage road ended in a cul-de-sac just past the hotel. It was necessary that the frontage road remain intact from the cul-de-sac south to Arapahoe Road, in order to provide access to the three existing businesses.

17. When the parties to this case met in 1994 they were dealing with CDOT's historical concerns regarding locating an access in the middle of this interstate highway interchange.

18. During the discussions with DCR and Greenwood Village in early 1994 CDOT opposed access to the development site from the frontage road. Although CDOT stated that the connection from the frontage road to the site was not desirable, its representatives also stated that they were willing to discuss options to determine if CDOT's concerns could be addressed, traffic and safety problems could be mitigated, and a desirable solution could be developed.

19. One possibility discussed in the 1994 meetings was the elimination of left turns at the Arapahoe Road/frontage road intersection. At the time of these meetings, and presently, "full movement" is possible at this intersection. "Full movement" refers to the fact that vehicles are able to make the following left turn movements: from eastbound Arapahoe Road onto the frontage road; from the frontage road onto eastbound Arapahoe Road; and from the Interstate 25 northbound exit ramp onto westbound Arapahoe Road. CDOT consistently expressed its opposition to any alternative which would retain full movement at this intersection.

20. Elimination of left turns at the Arapahoe Road/frontage road intersection had been an interest of CDOT's for some time. See Findings of Fact, Paragraph 15. According to Louis Lipp, CDOT's traffic and safety engineer for Region 6, if the frontage road could not be eliminated altogether, eliminating left turns was an important step which could be taken to improve the safety and operation of the Arapahoe Road/frontage road intersection. Lipp had for many years wanted to eliminate left turns at that intersection. Lipp indicated during the 1995 meetings that access might be considered if left turns were eliminated at this intersection.

21. Another alternative discussed during the 1994 meetings was the construction of a new road to the east of the restaurant and the hotel. This road would intersect Arapahoe Road at the present location, but instead of curving to the northwest (as does the present frontage road), the new road would proceed due north and connect with Southtech Drive (Southtech Drive constitutes the southern boundary of the development site).

22. During the 1994 discussions both DCR and Greenwood Village expressed to CDOT's representatives the importance of access from the development site to the frontage road. CDOT was advised that the development project would not go forward in the absence of access, and Greenwood Village stressed the economic importance of this development to the city.

23. By the end of April, 1994, the developer and Greenwood Village felt that access would be possible under certain conditions which might be acceptable to CDOT. Specifically, they considered the elimination of left turn movements at the Arapahoe Road/frontage road intersection and the possibility of constructing a new road to the east of the hotel and restaurant. Stephen Holt, a traffic engineer hired by

Greenwood Village and DCR, prepared a drawing reflecting the possibility of such a new road.

24. During these discussions the existing businesses on the frontage road objected to the elimination of left turns at the Arapahoe Road intersection. Currently, customers traveling east on Arapahoe Road can access these businesses by turning left at the frontage road, and the businesses did not want to lose that accessibility for some of their customers. CDOT required Greenwood Village to deal with these businesses: it was not necessary to obtain their consent to any access, but CDOT wanted the city to address their concerns and deal with any criticism should left turns be eliminated.

THE JULY 18, 1994, LOUIS LIPP LETTER

25. On July 13, 1994, Greenwood Village City Manager Steven Crowell sent a letter to Louis Lipp containing a proposal for access. Lipp is the top staff person in CDOT Region 6 dealing with highway access applications. The well established history and practice in Region 6 is that Lipp speaks for CDOT on access issues in that region. On the basis of this history and practice it is understood in the community of developers, local government entities and consultants on access issues that Lipp is the Region 6 decision-maker on access applications.

26. Crowell's July 13, 1994, letter to Lipp stated that the Greenwood Village city council supported access from the frontage road to the development site. Crowell's letter contained a two phase proposal: access would be granted to the existing frontage road on a short term basis and ultimately a new road would be built east of the hotel and restaurant, running due north from Arapahoe Road. The city and DCR would pay the cost of the new roadway construction. Although not explicitly stated in the letter, this new road would connect to Southtech Drive. Crowell's letter enclosed Holt's drawing which reflected the realignment of the frontage road, running due north from the current Arapahoe Road intersection to Southtech Drive.

27. Crowell's letter noted that the new road would have to be constructed on property owned by the hotel and requested that CDOT vacate the existing frontage road. The Woodfield Suites Hotel would then be granted land on which the frontage road currently sits, to compensate the hotel for the loss of parking on its east side when the new road was constructed.

28. The Crowell letter also stated that Greenwood Village anticipated that left turns would be eliminated at the Arapahoe Road/frontage road intersection, as CDOT had previously indicated would be necessary for the granting of access. Crowell also asked for CDOT's comments as to the possibility that CDOT would transfer jurisdiction over the existing frontage road to Greenwood Village.

29. With the exception of Holt, there was no evidence that any representative of any Appellant had seen or was aware of the contents of Crowell's letter.

30. Lipp responded to Crowell's letter in a letter dated July 18, 1994. This letter stated that CDOT had reviewed "your access plan" and that before an access application is submitted, certain matters should be considered. These matters were as follows:

A. Full movement would not be beneficial to the safety and operation of the Arapahoe Road interchange. Therefore, in order to alleviate unreasonable congestion and safety problems and maintain a level of service at the Arapahoe Road/frontage road intersection, it would be necessary to eliminate all left turn movements at that intersection.

B. Ingress/egress to the frontage road must be designed so as to restrict traffic movement to a right-in/right-out and a northbound through movement. CDOT would require that the existing concrete median on Arapahoe Road be modified to eliminate an eastbound left turn.

C. CDOT agreed to relinquish the existing frontage road to Greenwood Village.

31. Lipp's July 18, 1994, letter to Crowell concluded with the following statement: "The restriction of traffic movements, modification of existing signal as indicated, and transfer of Frontage Road ownership to the City, would be considered as a favorable design by the Department and would not meet with any objections".

32. Lipp's July 18 letter to Crowell made no reference to a new road being built to the east of Woodfield Suites and did not establish such a road as a condition to the granting of access.

33. Under the usual and consistent practice in the process of obtaining an access permit, a letter such as Lipp's July 18, 1994, letter to Crowell constitutes a sufficient basis upon which to conclude that access will be granted pursuant to the conditions set forth in the letter. No higher authority in CDOT needs to review the access issue once Lipp indicates, as he did here, that access will be looked upon favorably.

34. A copy of Lipp's letter was sent to Larry Warner, the Regional Transportation Director for Region 6. There was no evidence that Warner was the decision-maker on access issues or reviewed Lipp's conclusions before Lipp's determinations became final. Warner typically became involved in access issues only

if a developer disagreed with Lipp's decision. Warner never contradicted or repudiated Lipp's July 18 letter.

35. Under the usual and consistent practice in the process of obtaining an access permit, a subsequent access application will be granted on the basis of a letter such as Lipp's letter to Crowell, unless the application varies materially from the concept to which the letter was addressed, or unless there has been a material change in condition.

36. Developers routinely move forward with a project on the basis of letters such as Lipp's July 18 letter, and do not wait for the formal access application to be filed and an access permit to be granted. CDOT understands that developers and others act in reliance upon letters such as this to acquire property, obtain financing, and begin construction of development projects.

37. DCR, Gart and Eagle moved forward with the development project in reliance upon Lipp's letter. DCR obtained financing and closed on the purchase of the development site on September 22, 1994, thus effectuating the lease with Gart. DCR then sold one parcel to Eagle, pursuant to their contract. The retail development was subsequently constructed at this site, again in reliance on Lipp's letter regarding access.

38. DCR would not have closed on the property in the absence of a letter such as Lipp's letter of July 18, 1994. Eagle would not have closed on its purchase in the absence of that letter. Gart anticipated that it would not be obligated under its lease in the absence of access to the frontage road.

39. Based upon the usual and consistent practice in the process of obtaining an access permit, as described above, DCR, Gart and Eagle reasonably and prudently relied upon Lipp's letter as a promise that access would be granted under the conditions set forth in the letter. These parties reasonably assumed at this time that access would be granted pursuant to Lipp's letter to Crowell.

40. On the basis of Lipp's letter Greenwood Village moved forward with necessary approvals from the planning and zoning commission and the city council. Philip Demosthenes, the administrator of CDOT's access program, was aware that the city was proceeding in this fashion. Planning and zoning commission and city council approvals were obtained by September 12, 1994.

41. The plan approved by the Greenwood Village planning and zoning commission did not include the building of a new road. By this time, Woodfield Suites had refused to consent to that proposal. By early August, 1994, the concept of the new road had been abandoned.

THE 1995 MEETINGS

42. In February, 1995, Greenwood Village sent CDOT construction plans for the frontage road access. These plans involved the elimination of left turns at the Arapahoe Road/frontage road intersection and modification of the median as set forth in Lipp's July 18, 1994 letter. A copy of Lipp's letter was enclosed with these plans. These plans did not refer to the construction of a new road.

43. Representatives of CDOT, DCR and Eagle met on occasion during the summer of 1995. CDOT was represented at these meetings by Demosthenes and by an assistant attorney general. During these meetings CDOT expressed serious concerns regarding granting of the access to the development site. DCR, Eagle and their representatives asserted that Lipp's July 18, 1994, letter was a binding commitment that access would be granted. CDOT disagreed with that proposition.

44. During the meetings in the summer of 1995 CDOT raised the traffic concerns it had previously mentioned. CDOT also discussed certain design concerns, CDOT's desire to retain the right-of-way to the existing frontage road, and the fact that the existing businesses on the frontage road objected to the access plan being proposed. These meetings were the first notice to DCR since July, 1994, that problems existed in the granting of the desired access.

45. Demosthenes had seen Lipp's letter of July 18, 1994, some time in July or August, 1994. Demosthenes believed that this letter did not accurately reflect CDOT's position, which was that no access was desirable at this location. It was not until June, 1995, at the earliest, that Demosthenes or any other representative of CDOT advised Greenwood Village, DCR, Gart, Eagle or their consultants that Lipp's letter was not the position of the Department.

46. The design on the table during the discussions in the summer of 1995 did not include a new road to the east of Woodfield Suites. CDOT did not mention the existence or absence of that road during these discussions.

47. Relinquishment of the frontage road was not an issue for the parties in 1995. Lipp had agreed to relinquishment because Greenwood Village had initially requested that action, and Greenwood Village had proposed relinquishment only because it thought it was required by CDOT. In fact, Lipp never intended relinquishment of jurisdiction of the frontage road to be a condition to granting access. Whether or not the frontage road was eventually relinquished to Greenwood Village had no impact on the safety and operational concerns regarding access or on the question of whether an access application would be granted prior to relinquishment.

48. DCR performed the engineering work to solve the design concerns raised in the 1995 meetings. When the parties met again, DCR representatives stated that they had solved these problems. CDOT's representatives did not comment on these solutions, but directed DCR to file an access application.

THE 1995 APPLICATION AND DENIAL

49. DCR submitted a new access permit application to Greenwood Village in September, 1995. Greenwood Village approved the application and forwarded it to CDOT on September 21, 1995.

50. Greenwood Village's letter transmitting the access application to CDOT contained two alternatives. The first alternative continued the full movement operation of the Arapahoe Road/frontage road intersection. Greenwood Village stated in this letter that the city preferred this alternative. The second alternative was to eliminate left turns at the intersection.

51. The presentation of an access application in the alternative is very unusual. The city preferred a full movement access because the other businesses on the frontage road were opposed to the elimination of left turns. Nevertheless, Greenwood Village was willing to allow CDOT to choose either option. CDOT did not notify the city that the application was invalid because it was presented in the alternative or return the application for redrafting to reflect one alternative only.

52. On October 10, 1995, CDOT sent a letter to DCR's consultant denying the application for access. The letter was written by Rudy Blea, a CDOT access coordinator. However, Warner was the decision-maker as to this application.[5] Warner consulted with various staff members, including Lipp and Demosthenes, regarding the decision to deny this application.

53. In acting upon this application CDOT addressed only the first alternative, that of full movement at the intersection. CDOT believed that responding to the proposal for full movement would address more of the issues raised by this application. The second alternative in the application was not addressed or explicitly denied in Blea's October 10 letter.

54. Blea's October 10, 1995, letter enumerated the operational and safety problems which in CDOT's opinion would result from allowing access to the frontage road while retaining full movement at the Arapahoe Road intersection. These problems related to the intersection and to the interstate highway interchange. This letter also criticized certain aspects of the traffic impact analysis conducted by Stephen Holt and submitted in support of the application.

55. CDOT has in this hearing raised several other matters as impediments to granting the present application. None of these matters was identified in the

October 10 letter as a reason for denial of the application. These matters include the following: that the access was not to a newly aligned road to the east of Woodfield Suites; that CDOT was not being asked to relinquish the frontage road right-of-way; that Greenwood Village was not the lead agency in dealing with adverse criticism of granting the access; or that the access would interfere with possible expansion of Interstate 25 for high occupancy vehicle lanes or placement of a light rail line in the Interstate 25 corridor. In fact, none of these matters constituted a reason for denial of the access application.[6]

56. Alternative two of the access application submitted on September 21, 1995, provided for the elimination of left turns at the Arapahoe Road/frontage road intersection. This alternative did not differ materially from the proposition presented by Crowell in his July 13, 1994, letter to Lipp and accepted by Lipp on July 18, 1994. For the following reasons the Administrative Law Judge finds that the fact that alternative two did not provide for a new road to the east of Woodfield Suites does not constitute a material variation from the proposal made by Greenwood Village in Crowell's letter:

A. Lipp's letter of July 18, 1994, responded to Crowell's letter and identified the specific conditions which had to be met for the access proposal to be considered a favorable design and not meet with any objections. The construction of a new road was not one of these conditions.

B. Neither Lipp nor any other CDOT representative mentioned an east road after Lipp's July 18, 1994, letter, despite the fact that the parties had several conversations during the summer of 1995 regarding CDOT's concerns with the access proposal.[7]

C. Lipp testified that he would have approved the application if the only proposal presented had been the second alternative (elimination of left turns). Therefore, the failure to include the new road to the east was not, in Lipp's mind, an impediment to granting access pursuant to his July 18 letter.

D. Operational and safety concerns would be substantially the same, whether the access granted was to the existing frontage road or the new road. The building of a new road would not substantially impact or mitigate conditions at the intersection.[8]

E. The absence of a new road was not included in Blea's letter denying the application.

57. The denial of the application for frontage road access to the development site has caused negative financial consequences to Gart and Eagle. Even though those stores have been profitable, the absence of frontage road access makes these stores inconvenient for customers to reach, which is a discouraging

factor to some customers who might otherwise shop at these stores. The number of customers reaching these stores is smaller than if frontage road access were available.[9] Fewer customers results in less revenue for these stores. In the absence of access to the frontage road these revenue shortfalls cannot reasonably be mitigated.

58. On November 3, 1995, DCR sold to OLP the parcel of land on which the Gart store sits. The lack of access to the frontage road decreased the value of this parcel in the sale. The evidence failed to establish, however, that as a result of this access dispute DCR's reputation as a developer capable of delivering access has in fact been harmed.

RELATION OF DEVELOPMENT SITE TO CDOT RIGHT-OF-WAY

59. The Code rates the frontage road as Category 5 in the access control classifications. Code Section 3.8. The purpose of a frontage road is to provide local access to abutting properties, rather than to constitute a through traffic road.

60. After construction of the Yosemite flyover the frontage road north of the cul-de-sac remained paved, though poorly, and deteriorated to a gravel road north of Southtech Drive. By early 1994 that gravel road was a privately owned road within the development property. This private road was at times used by motor vehicles prior to construction of the retail site.

61. In 1993 and 1994, prior to construction of the retail development, a defined traveled way existed from the end of the frontage road cul-de-sac north to the property line of the development site. This traveled way consisted of broken pavement with no curbs. A sign between the last Woodfield Suites driveway and the cul-de-sac advised motorists that the pavement was about to end. This sign is no longer in existence. The evidence did not establish when the sign was removed.

62. During construction of the retail development, construction vehicles consistently used the frontage road north of Woodfield Suites as a means of reaching the site. There was no evidence that other vehicles ordinarily used this portion of the frontage road at any time. Some time in 1995 CDOT placed concrete barriers at the end of the cul-de-sac to prevent construction vehicles from using the frontage road to access the site. The evidence did not establish the precise date when these barriers were placed. These barriers remain in place at the present time.

63. The north end of the cul-de-sac is approximately 50 feet from the south edge of the development site. The land between the cul-de-sac and the southern boundary of the development property is CDOT right-of way, but presently contains no roadway or highway.[10] The parcel of the development site now owned by OLP directly abuts the right-of-way.

64. On October 3, 1996, OLP executed a document concurring in the access application and in this appeal and authorized DCR, Gart and Eagle to represent OLP's interests in this matter.[11]

65. The parcel of the development site owned by Eagle does not directly abut the CDOT right-of-way. However, Eagle has an easement and cross-access agreement allowing its customers access to the Eagle site across the OLP property.

66. The development site does not directly abut a traveled roadway. Typically, property granted access to a frontage road pursuant to Section 3.8 of the Code does not directly abut pavement; generally, there is a portion of right-of-way between the property and the roadway, with a driveway connecting the property and the roadway.

THE ACCESS PROPOSAL: SAFETY AND OPERATION

67. The Appellants in this matter currently propose access pursuant to alternative two in the September 21, 1995, application. That proposal provides for the extension of the frontage road to Southtech Drive; elimination of all left turns at the Arapahoe Road/frontage road intersection (including modification of the existing concrete median on Arapahoe Road so as to prevent a left turn from eastbound Arapahoe Road onto the frontage road); a northbound through movement for traffic entering the frontage road after exiting northbound Interstate 25; the addition of a second right turn lane for southbound frontage road vehicles at Arapahoe Road (and the widening of the existing frontage road for 250 feet from Arapahoe Road to accommodate the two right turn lanes); a southbound signal on the frontage road so that vehicles can turn right onto Arapahoe Road on a green arrow while no other movements are taking place in the intersection; no right turns on a red light for vehicles turning right off of the frontage road onto Arapahoe Road; and the construction of a concrete channel to separate the two southbound frontage road right turn lanes from the northbound through traffic lane.

68. The above proposal is supported by a traffic impact analysis ("TIA") prepared by Stephen Holt. According to Holt's analysis, under this proposal the overall level of service for the Arapahoe Road/frontage road intersection will remain at its current levels of "B" at the Saturday noon hour peak and "C" at the evening weekday peak. Traffic engineers consider both of these levels of service to be acceptable to the public.

69. The above access proposal would increase the number of vehicles entering the Arapahoe Road/frontage road intersection. According to Holt's analysis the total increase of traffic at this intersection would be 31 vehicles at the evening peak hour, or one vehicle during each 100 second cycle of the traffic signals at that intersection.

70. A TIA is an analysis which quantifies the volume of traffic that will be generated at an access point. A TIA estimates the number of vehicle trips at various times of the day or week and the direction from which a trip arrives or departs. The analysis then allocates these trips to particular intersections and movements within intersections. Most TIAs are prepared before a development is built, requiring projections of traffic and direction. Holt's TIA in the present case is based upon a study of actual traffic which existed after development of the retail site and surrounding properties, and therefore is likely to have a higher degree of accuracy than pre-development projections.

71. CDOT did not prepare its own TIA in this case. Typically, CDOT does not do so, but analyzes the TIA submitted by an applicant. Holt has an excellent reputation as a traffic engineer among CDOT staff; CDOT itself uses Holt as a consultant.

72. CDOT has criticized Holt's TIA on several grounds relating to his methodology. CDOT does not maintain that Holt's report is inaccurate, but merely suggests that there are assumptions and calculations which CDOT is unable to verify or which cast doubt on the conclusions reached in the TIA. The Administrative Law Judge finds, from all of the evidence, that Holt's TIA was prepared consistently with the practices and standards in the field of traffic engineering and is accurate within a margin of error acceptable in that field.

73. Although the overall level of service at the Arapahoe Road/frontage road intersection will not be affected by the proposed access, southbound traffic on the frontage road will experience increased delay at Arapahoe Road. Southbound traffic is the only movement which will experience delay under this proposal. If the proposed access is granted, Southbound traffic will amount to only 3.5% of the traffic at this intersection.

74. CDOT's major criticism of the current access proposal relates to southbound traffic on the frontage road. A connection of the frontage road to Southtech Drive would result in an increased volume of southbound frontage road traffic from the development site, as well as traffic from additional sources. CDOT's primary concerns regarding this southbound movement are as follows:

A. The higher volume of vehicles turning right onto Arapahoe Road (the only movement permitted, because left turns will have been eliminated) will cause backups onto the frontage road (this backup is known as a "queue"). Delays will result and, in addition, southbound vehicles exiting Denny's, the Amoco station and Woodfield Suites will have difficulty breaking into the queue.

B. CDOT prefers that right turns from the frontage road be made on a stop sign or a yield sign. However, in order to avoid the queuing problem, the right turn will have to be on a signal, and the signal time ("green time") for those turns may

have to be increased.[12] An increase in green time for this movement would require a reduction of green time, and thus increased delay, for other movements at the intersection.

C. The radius of the right turn onto westbound Arapahoe Road is very sharp, and is too small for trucks and other large vehicles.

75. The access proposal does result in some difficulties because of the increase in southbound frontage road traffic at the Arapahoe Road intersection. However, if access is granted these difficulties are mitigated to some extent by the following considerations:

A. Using a double right turn, the queue would clear in less than two signal light cycles. This rate is not unacceptable given the overall operation of the intersection.

B. Allowing right turns from the frontage road on a green arrow at the current green time of six seconds (as opposed to a stop or yield sign) will allow eastbound traffic on Arapahoe Road to move at the same time, which would increase the efficiency of this movement (this eastbound through movement has the highest traffic per lane in the intersection). Westbound traffic would lose this green time, but the overall efficiency of the intersection would be improved.

C. Increasing the green time for right turns from the frontage road by an additional four seconds would add four seconds to the green time for the eastbound lanes, but would reduce westbound green time by an additional four seconds. Doing so would decrease the level of service for the westbound through movement but would improve the overall operation of the intersection.[13]

D. Allowing southbound right turns only on a green arrow will eliminate conflicts which currently exist as a result of the present configuration, which permits right turns on a red light. Restricting right turns to a green arrow will eliminate conflicts with westbound Arapahoe Road traffic, including traffic approaching the Interstate 25 on-ramps. In addition, under the Appellants' proposal traffic exiting Interstate 25 northbound will no longer be able to turn left onto westbound Arapahoe Road. The conflict of northbound left turns with southbound right turns will thus be eliminated. Right turns from the frontage road would be more safe under the Appellants' proposal than they are today.

E. The existing radius for right turns is presently too small for larger vehicles. The access proposal will thus not create a problem of larger vehicles encroaching on other lanes; that problem exists today. Large vehicles can enter and leave the development site from Boston Street, as they do today, and avoid this turn. In addition, if access is granted, large vehicles servicing Denny's and Woodfield

Suites, which today must make this right turn, could avoid the intersection by exiting via Boston Street.

76. Granting the access application would affect the operation and safety of the Arapahoe Road/Boston Street intersection. Eastbound vehicles on Arapahoe Road which currently can turn left onto the frontage road will now have to turn left at Boston.[14] Some cars may make a U-turn at Boston to return to the frontage road for access to the site.

77. The increase in left turns and U-turns at Boston Street which will result if the access proposal is accepted is a safety concern. However, left turns at Boston Street are more safe than the current left turns at the frontage road intersection, which would be eliminated under this proposal.

78. Under the proposed access the level of service for vehicles turning left onto northbound Boston Street will decrease. However, the overall level of service at that intersection will not decrease.

79. Left turns conflict with other movements at an intersection, particularly when the left turn is in front of through traffic. The elimination of left turns at the Arapahoe Road/frontage road intersection will improve overall safety at that intersection. Not only will left turn conflicts be eliminated, but northbound traffic will be able to proceed straight to the frontage road. Currently, to get to the development site northbound traffic exiting Interstate 25 must weave across the eastbound lanes of Interstate 25 to get into position to turn left at Boston Street.

80. Although some operational disadvantages will occur if the requested access is granted, compensating operational and safety advantages will be created under the access proposal. The Administrative Law Judge finds that overall the public health, welfare and safety will not be compromised if the requested access is granted.[15]

DISCUSSION AND CONCLUSIONS OF LAW

I. MOOTNESS

Shortly before the commencement of this hearing CDOT filed a motion to dismiss on the basis of mootness, asserting that there was no justiciable case or controversy. The Administrative Law Judge denied this motion at the outset of the hearing.

In this motion CDOT pointed out that DCR had sold its interest in the development site to OLP and no longer had any interest in that property, that Gart was a lessee of the property abutting the right-of-way (not an owner), and that Eagle's

parcel did not abut the right-of-way. Thus, CDOT asserted that at the time of the hearing DCR, Gart and Eagle did not own property abutting the frontage road right-of-way. CDOT argued that for this reason none of these Appellants could claim a right of access to the frontage road under Section 3.8 of the Code, which provides for access to properties abutting frontage roads.

Eagle and Gart have a clear interest in the issue of access, and the fact that neither of them owns the property immediately abutting the right-of-way does not make them ineligible to file an access permit application or appeal. An applicant for access need not be the fee owner of the property. An owner of surface rights may also be an applicant. *See* Code Sections 1.4(8), 2.4(1). As a lessee, Gart is the surface rights owner of the abutting property, and Eagle also owns surface rights by virtue of its easement and cross-access agreement. Thus, these Appellants were qualified at the time of the application to be applicants for access and continue to have an interest in that application.

At the time of the September 21, 1995, application, DCR was the fee owner of the property abutting the right-of-way. DCR has subsequently sold the abutting property to OLP. To the extent that OLP is not a surface rights owner, it is permitted to concur in writing with the application. Code Section 2.4(1). OLP has done so (Findings of Fact, Paragraph 64). OLP has an interest in the application, acquired subsequent to the filing of this appeal, and has authorized the appealing parties to represent this interest. It is true that this written concurrence was filed after the application and appeal in this case. However, to require OLP to now file a new access application and subsequent appeal would elevate form over substance and would be exceedingly uneconomical.

Therefore, the Appellants have an arguable right of access pursuant to Code Section 3.8. Even if DCR no longer has an interest in the property, the matter is not moot as to Gart, Eagle and OLP.

II. PROMISSORY ESTOPPEL

The Appellants assert that CDOT is estopped from denying the access application because of Lipp's July 18, 1994, letter. The Appellants rely on the doctrine of promissory estoppel in support of this position. The Administrative Law Judge agrees with the Appellants that CDOT is estopped from denying the application.

The doctrine of promissory estoppel provides as follows:

> A promise which the promisor should reasonably expect to induce action or forbearance on the part of the promisee or a third person and which does

induce such action or forbearance is binding if injustice can be avoided only by enforcement of the promise.

Restatement (Second) of Contracts § 90(1) (1979).

The Colorado Supreme Court has adopted Section 90(1) of the Restatement of Contracts, including cases in which promissory estoppel is asserted against the government. *Board of County Commissioners v. DeLozier*, 917 P.2d 714 (Colo. 1996); *Kiely v. St. Germain*, 670 P.2d 764 (Colo. 1983); *Vigoda v. Denver Urban Renewal Authority*, 646 P.2d 900 (Colo. 1982).

In *Berg v. State Board of Agriculture*, 919 P.2d 254 (Colo. 1996), the Colorado Supreme Court set forth the elements of a promissory estoppel claim as follows:

(1) The promisor made a promise to the promisee;

(2) The promisor should reasonably have expected that the promise would induce action or forbearance by the promisee;

(3) The promisee in fact reasonably relied on the promise to the promisee's detriment;

(4) The promise must be enforced to avoid injustice.

In addition, under Section 91 of the Restatement, if the promise is conditional the party seeking to enforce the promise must demonstrate that the conditions of the promise have been met. The Appellants have established all of the elements of promissory estoppel as set forth in the Restatement and case law.

A. Existence of a Promise.

Lipp's letter of July 18, 1994, constituted a promise that access would be granted under the conditions of the letter. This letter stated that with a restriction to right-in/right out movements, modification of the median and transfer of ownership to the frontage road, the proposed design would not meet with any objection. CDOT does not argue that relinquishment of the frontage road was a condition of access required under the terms of Lipp's letter. In fact, relinquishment was a non-issue and was included in Lipp's letter only because Lipp believed that Greenwood Village sought relinquishment.

CDOT does argue, however, that for two reasons Lipp's letter did not promise to grant access in the fashion proposed in the September 21, 1995, application. First, CDOT argues that Lipp was not the final authority on access and could not bind CDOT. Next, CDOT asserts that the plan approved by Lipp in this letter differed

materially from the access proposal made in September, 1995. The Administrative Law Judge disagrees with both of these assertions.

1. Lipp is the person who speaks for CDOT on access issues. Letters such as Lipp's letter of July 18 indicating that access will be granted are not reviewed by a higher authority at CDOT. Thus, Lipp is the final authority on the matter. CDOT argues that the Region 6 director, Larry Warner, is the final authority on access. However, there was no evidence that Warner makes access decisions or must review Lipp's conclusions before Lipp's determinations become binding or effective. In any event, Warner received a copy of Lipp's letter and never contradicted or repudiated the statements made in that letter.

Even if Warner was the actual decision-maker on access issues (which the Administrative Law Judge has found not to be the case), Lipp's July 18 letter would nonetheless bind CDOT. CDOT's well established practice was that an access permit would be issued on the basis of a letter such as Lipp's, and the history of CDOT's actions was that the community could reasonably rely on such letters as a promise that access will be granted. CDOT has allowed Lipp to speak for the Department on access issues on a consistent basis . CDOT has thus caused third parties to believe that Lipp is the authorized decision-maker on access issues, and his promises are thus binding under the doctrine of apparent authority. *See Life Investors Insurance Co. v. Smith*, 833 P.2d 864 (Colo. App. 1992); *Potomac Insurance Co. v. Industrial Commission*, 744 P.2d 765 (Colo. App. 1987).

2. Lipp's response to Crowell's letter of July 13 referred to a review of "your access plan". Crowell's letter involved a phased access, culminating in the construction of a new road to the east of the Woodfield Suites property. CDOT asserts that Lipp's letter was in response to the proposal involving this new road and was a promise that access would be granted only if the design included this new road to the east. Thus, CDOT argues that because the access permit application filed in September, 1995, did not involve a new road, the application did not meet the conditions of Lipp's letter.

The Administrative Law Judge concludes that Lipp's letter on its face contained all of the conditions for access. After referring to "your access plan" Lipp's letter never again mentions that plan. Rather, the July 18 letter informed the Appellants that an application would be viewed favorably if left turns were eliminated. Lipp's letter contained no condition that access would be granted only if the connection was to a new road. In addition, no reasonable inference exists that Lipp's letter implicitly applied only to a proposal which included a new road. The new road was not material to Lipp's decision (Findings of Fact, Paragraph 56). Further, Lipp and CDOT's subsequent conduct demonstrated that they were not in the least bit concerned with the location of the frontage road; the presence or absence of that road was never mentioned in subsequent discussions and was not a reason stated for denial of the application.

B. CDOT's Knowledge that the Appellants Would Act on Lipp's Letter.

The well-established history and practice at CDOT was that Lipp speaks for the Department on access issues and that access will be granted on the basis of a letter such as prepared by Lipp on July 18. CDOT understands that developers and others rely on promises such as Lipp's letter to go forward with development projects. CDOT thus should reasonably have expected the Appellants to proceed on the basis of this letter. In fact, CDOT staff and officials were aware that DCR was proceeding with the project and for nearly one year did nothing to advise the Appellants that Lipp's letter was not the position of the Department.

C. The Appellants Reasonably Relied on Lipp's Letter.

The Administrative Law Judge has found, as a matter of fact, that the Appellants reasonably relied on Lipp's letter (Findings of Fact, Paragraph 39). CDOT argues that the Appellants did not rely on the letter because Lipp's approval related only to the phased access plan involving a new road. Thus, CDOT asserts that the Appellants could not reasonably rely on the July 18 letter to expect that an application which did not include that road would be granted. However, as discussed above, the new road was not a material matter to Lipp or to any other party in this process. Greenwood Village, Lipp and the Appellants paid little or no attention to the concept of a new road. The evidence establishes that during this entire process the new road was nothing more than an interesting concept which all parties understood was not a material part of the proposal or Lipp's approval.

CDOT also argues that the Appellants could not rely on Lipp's letter because they did not see Crowell's letter, which was referenced by Lipp and which provided the context for Lipp's response. With the exception of Holt it does not appear that the Appellants or their representatives ever saw Crowell's letter. Nevertheless, Lipp's letter was sufficiently specific as to the conditions upon which access would be granted that his letter stands on its own. In addition, the proposed new road was immaterial in the context of the entire process. Thus, the fact that the Appellants did not see the reference to that road in the letter to which Lipp responded did not prevent them from relying on Lipp's specific statement of the conditions on which access would be granted.

CDOT further argues that because access was not a stated contingency in the contracts binding DCR, Gart and Eagle to this project, these parties were not relying on access to proceed with the project. However, the Administrative Law Judge has found that none of these parties would proceed with the project in the absence of access (Findings of Fact, Paragraphs 3, 6). DCR could cancel its option to buy the property for any reason, including the lack of access to the frontage road. Similarly, Gart needed no access contingency in its lease with DCR, because DCR would not proceed without access. Eagle would have forfeited $150,000 had it canceled its

agreement due to the lack of access, but that was a relatively small amount of money; Eagle would have forfeited this deposit rather than proceed in the absence of access. Despite the absence of any access contingency in the contractual documents, all of the Appellants relied on access to the frontage road as a condition to their going forward with this project.

It is true that for some time CDOT consistently stated its opposition to access to the frontage road. However, during the 1994 discussions CDOT also continued to hold open the possibility that a desirable solution could be developed. Thus, the Appellants could reasonably rely on Lipp's July 18 letter as reflecting the fact that this desirable solution had been achieved, despite CDOT's earlier opposition. In fact, the Appellants could reasonably have believed that CDOT's prior opposition was being set aside, and access to the frontage road was being granted, in order to accomplish the elimination of left turns, which had been a goal of the Department and Lipp for some time.

D. The Appellants Relied to their Detriment.

Gart and Eagle have suffered an economic detriment in reliance upon Lipp's letter. They proceeded with the project on the basis of this letter and have experienced a loss of revenue as a result of not receiving the promised access (Findings of Fact, Paragraph 57).

DCR has suffered some economic damage in reliance on Lipp's letter. The purchase price it received in the later sale to OLP was diminished due to the lack of access. In the absence of Lipp's letter, DCR would not have acquired the property and would thus not have been in the position of selling property lacking such access.

In other respects, DCR did not suffer an economic loss in reliance on the July 18 letter. Although DCR paid money to extend its contract with Gergins, those extensions all occurred prior to Lipp's letter. In addition, the failure of a prospective tenant to take part in the project as a result of access problems did not relate to the Lipp letter. That tenant backed out of the project in early 1994, prior to Lipp's letter.

E. CDOT's Promise Must be Enforced to Prevent Injustice.

Injustice would result if the promise contained in Lipp's letter is not enforced. Gart and Eagle went forward with the development of their retail stores in reasonable reliance upon this promise . They now are in a position in which they have invested in this project yet are economically harmed by the lack of the expected access. A grant of access will eliminate the condition which has led to the reduced revenues these businesses have suffered in the past and will place them in the position in which they expected to be as a result of the July 18 letter. In the absence of access, these revenue losses cannot be mitigated.

It is not necessary to grant the access to prevent injustice to DCR. Any monetary loss suffered by DCR has already occurred and will not be mitigated by the granting of access. DCR cannot remedy these losses by a current grant of access. DCR also argues that it has suffered harm to its reputation as a developer which can deliver access. However, the evidence did not establish that DCR's reputation has been harmed (Findings of Fact, Paragraph 58). DCR thus has failed to prove that a grant of access is necessary to restore DCR's reputation.

F. The Conditions of the Promise Have Been Met.

The Lipp letter imposed only two conditions on a grant of access. These conditions were that left turns be eliminated and that the existing median be modified accordingly. The Appellants' proposal meets both of these conditions. As noted above, as a factual matter relinquishment of the frontage road was not a condition to access. In any event, access is to be granted or denied only in compliance with the Code [Code Section 1.3(2)] and relinquishment is not a matter contained in or to be considered under the Code.

In addition, none of the other matters referred to in the evidence in this case was set forth in Lipp's letter as a condition to granting access. These other matters include the new road to the east of Woodfield Suites, that Greenwood Village would be the lead agency in dealing with public criticism of the access, and that the southbound turn signal should be eliminated.

G. Conclusion Regarding Promissory Estoppel.

Relief against a governmental entity cannot be granted based upon a claim of promissory estoppel if the promise sought to be enforced is a promise to do an act which the governmental entity is not authorized to do. *Seeley v. Board of County Commissioners*, 791 P.2d 696 (Colo. 1990); *see Montero v. Meyer*, 795 P.2d 242 (Colo. 1990). CDOT is not authorized to grant access to the frontage road if that access is detrimental to the public health, safety and welfare. Code Section 1.3(2). In the present case the granting of access to the frontage road will not harm the public health, safety and welfare (Findings of Fact, Paragraph 80). Accordingly, CDOT was authorized to grant this access and may be held to its promise to do so.

The Appellants have established all of the elements of promissory estoppel and are entitled to access as set forth in Lipp's July 18, 1994, letter. Even though the promise of access need not be enforced to avoid injustice to DCR, access is required to avoid injustice to Gart and Eagle.

In its October 7, 1996, Motion to Dismiss CDOT argued that OLP could not make a claim of estoppel because it was not involved with the property in July, 1994, and thus did not rely on Lipp's letter. Nevertheless, Gart and Eagle have established

their right to access to the frontage road on the basis of promissory estoppel. Whether OLP is also entitled to access on this basis is therefore immaterial.

III. MANDATORY ACCESS PURSUANT TO THE ACCESS CODE

The Appellants maintain that they are entitled to access to the frontage road as a matter of right pursuant to Section 3.8 of the Code. Section 3.8 provides as follows:

3.8 Category 5

Functional Characteristics

1. *Category 5 shall be assigned only to roadways that are designated as frontage or service roads where there is no intended purpose of providing for long distance or high volume traffic movements. . . . Access needs take priority over through traffic movements without compromising the public health, welfare or safety. Providing reasonable and safe access to abutting property is the primary purpose of this access category.*

Design Standards

2. *One direct access will be provided to each individual parcel or to contiguous parcels under the same ownership or control.*

The Appellants maintain that the Category 5 roadway in this case includes the right-of-way which extends beyond the frontage road cul-de-sac. This right-of-way abuts the property owned by OLP, leased by Gart, and to which Eagle has access. Therefore, the Appellants assert that they are entitled to access to the frontage road as a matter of right under Section 3.8. CDOT acknowledges that the traveled portion of the frontage road from Arapahoe Road to the cul-de-sac is a Category 5 roadway. However, CDOT maintains that the roadway ends at this point and that the OLP property does not abut the roadway.

A. The Administrative Law Judge concludes that although the OLP property abuts CDOT's right of way, it does not abut a roadway. Thus, under Section 3.8 of the Code the Appellants are not entitled to access to the frontage road as a matter of right. Categories 1 through 4 of the access control classifications all refer to access to a category of *highway*. Category 5 refers only to access to a *roadway*. Thus, the analysis must focus on whether the OLP property abuts a roadway.

A roadway is defined by Section 1.4(41) of the Code as "that portion of a highway improved, designed or ordinarily used for vehicular travel exclusive of the berm or shoulder". A "highway" is the area between the boundary lines of a right-of-

way when any part of that area is open to public use for purposes of vehicular travel. Section 1.4(27). In 1993 and 1994, prior to construction of the retail development, the frontage road extended from the cul-de-sac to the OLP property line. Although this extension consisted only of broken pavement, a traffic sign preceded the extension. This traffic sign indicated that at this time the roadway continued beyond the sign. In addition, construction vehicles used this unpaved extension of the frontage road. Given these facts, an argument can be made that the portion of the frontage road between the cul-de-sac and the OLP property line was at this time designed or ordinarily used for vehicular traffic.[16]

Some time in 1995 CDOT placed concrete barriers at the end of the cul-de-sac. These barriers prevent vehicular traffic from traveling past the cul-de-sac to the OLP property. At the present time, therefore, the area between the cul-de-sac and the OLP property does not meet the definition of a roadway: it is neither improved, designed nor ordinarily used for vehicular traffic.

In addition, the Appellants have not demonstrated that this right-of-way area qualified as a roadway at the time of the September 21, 1995, access permit application.[17] The evidence established only that in 1993 and 1994 the portion of the frontage road north of the cul-de-sac was posted with a sign indicating that it was still a roadway. There was no evidence that at the time of the Appellants' application the right-of-way north of the cul-de-sac was still posted or used as a roadway. In addition, there was no evidence that at the time of the application the concrete barriers used to cut off vehicular traffic north of the cul-de-sac were not in place.

Category 5 access is only permitted to a roadway. Whatever its prior status, the portion of the right -of- way between the cul-de-sac and the OLP property line has not been proven to have constituted a roadway at the time of the access application, and is not a roadway at the present time. Therefore, CDOT is not required to grant access to the frontage road under Section 3.8 of the Code, because the OLP property does not abut a roadway. Section 3.8 provides only for access to roadways, not access to rights-of-way.

B. As noted above, CDOT acknowledges that the traveled portion of the frontage road from Arapahoe Road to the cul-de-sac is a roadway. The Appellants argue that it is not necessary for their property to physically be in contact with the roadway in order for their property to be considered "abutting property" within the meaning of Section 3.8.

The term "abut" in this context generally refers to direct physical contact between the roadway and the property line, with no property intervening. *See Sall v. City of Colorado Springs*, 423 P.2d 11 (Colo. 1966); Webster's New Twentieth Century Dictionary, Unabridged, 2d Ed. However, Category 5 access typically occurs in situations in which the property line and the roadway to which access is sought are

not contiguous. Typically, a piece of right-of-way intervenes between the property and the traveled roadway, and access is by means of a driveway bridging that gap.

Therefore, in practice Section 3.8 does not require that "abutting property" be property which is physically contiguous to the roadway. Section 3.8 of necessity contemplates a driveway which crosses a piece of right-of-way between the property and the roadway. In this light, the most reasonable reading of Section 3.8 is that the roadway to which access is granted must be located within the right-of-way which will be crossed by the access. This concept of "abutting" recognizes the typical circumstance in which access is sought from a piece of property to a roadway *which is located within a right-of-way*. In the present case, there is no roadway within the right-of-way over which the Appellants seek access.

In addition, the Appellants' propose to build a lengthy connection between the existing frontage road and their property. By the express terms of Section 3.8, Category 5 roadways are not intended for high volume or long distance traffic. Further, the evidence established that frontage roads are not intended to constitute through traffic roads. The Appellants' proposal of a connection between Southtech Drive and Arapahoe Road differs radically from the typical circumstance contemplated by Section 3.8, in which the connection will be by a driveway, which is designed for access rather than through traffic.

Therefore, although abutting property need not be in physical contact with a roadway in order to be entitled to Category 5 access, Section 3.8 does contemplate that the connection between the roadway and the property in question be something less than a newly constructed road. Taken in a reasonable context, the purpose of Section 3.8 is only to allow properties which are reasonably contiguous to a frontage road to connect to that road by means other than a through traffic road. The Appellants' construction of Section 3.8 would lead to absurd results in which property owners could construct through roads over lengthy stretches of right-of-way in order to connect with distant frontage roads. The Administrative Law Judge therefore concludes that the OLP property does not abut a frontage road roadway such that the Appellants are entitled to access to the frontage road as a matter of right under Section 3.8.

AGENCY DECISION

The Colorado Department of Transportation shall grant the Appellants access from the OLP property to the frontage road at Interstate 25 and Arapahoe Road pursuant to alternative two of the September 21, 1995, application. The only conditions of granting this access are the two conditions set forth in Louis Lipp's letter of July 18, 1994: the elimination of all left turn movements at the Arapahoe Road/frontage road intersection and the modification of the median on Arapahoe

Road to eliminate left turns from the eastbound lanes. Relinquishment of the frontage road to Greenwood Village is not a condition of access.

DONE AND SIGNED

January 29, 1997

Marshall A. Snider

MARSHALL A. SNIDER
Administrative Law Judge

FOOTNOTES

1. *See, e.g., Garrett v. Arrowhead Improvement Association*, 826 P.2d 850 (Colo. 1992); *Johnson v. Industrial Commission*, 761 P.2d 1140 (Colo. 1988); *Orsinger Outdoor Advertising, Inc. v. Department of Highways*, 752 P.2d 55 (Colo., 1988); *Bethesda Foundation of Nebraska v. Colorado Department of Health Care Policy and Financing*, 902 P.2d 863 (Colo. App. 1995); *White House Industries, Inc. v. May*, 845 P.2d 544 (Colo. App. 1992); *Bastian v. Martinez*, 698 P.2d 1373 (Colo. App. 1984).

2. The contract with Gergins was actually in the name of Trammel Crow NW Properties, Inc., DCR's parent. Trammel Crow then created DCR as a wholly owned subsidiary to develop the project in question. Trammel Crow and DCR are virtually interchangeable for the purposes of this case, and for simplicity Trammel Crow, DCR and the two entities collectively will be referred to in this decision only as DCR.

3. Under Section 3.8 at least one frontage road access is to be provided to each "abutting property". Section 3.8 also provides that "[A]ccess needs take priority over through traffic movements without compromising the public health, welfare, or safety".

4. "Level of service" is a categorization of traffic conditions at an intersection used by traffic engineers to measure the average stopped delay for a vehicle in getting through the intersection. Level of service "A" is the most efficient level, while "F" is the least efficient.

5. Lipp had the authority to grant an access application without seeking approval from Warner. However, because CDOT was considering denying access subsequent to Lipp's letter indicating that access would be approved, it was not unusual that the matter was determined by Warner, the regional director.

6. CDOT did not raise the question of interference with the potential of a light rail line or high occupancy vehicle lanes until this appeal. Whether a light rail line or high occupancy vehicle lanes will ever be constructed in this corridor is highly speculative. In any event, the evidence was insufficient to establish that the granting of the access requested in this case would necessarily interfere with such construction.

7. As far as the evidence reflects, a new road to the east of Woodfield Suites was never mentioned by anyone after July 18, 1994. An in-house DCR memo dated August 22, 1994, did refer to an "internal road". The evidence failed to establish that this reference to an internal road was meant to describe a new road to the east of Woodfield Suites.

8. The new road would be straight, compared to the curve in the existing frontage road as it approaches Arapahoe Road. Traffic flows more easily on a straight road. However, a new, straight road might also attract more traffic. On balance, as far as the access determination was concerned, neither Lipp nor anyone else at CDOT was concerned with which configuration of frontage road was adopted.

9. Although these stores have excellent visibility from Interstate 25, that visibility is lost once customers exit the interstate. Customers must then proceed east to Boston Street, from which it is more difficult to locate the stores. If customers could access the stores directly from the frontage road, visibility and a sense of direction to the stores would be regained more quickly.

10. A right-of-way consists of property owned by the state for the purpose of providing for a highway.

11. The Code does not require the applicant for an access permit to be the property owner.

12. The access proposal assumes a signal length for right turns of 6 seconds, which is the current length of that signal. Holt used the existing signal timing in his calculations because CDOT had at some point objected to changing that timing.

13. The Appellants do not propose increasing the green time in this fashion. Whether to increase green time for right turns is a decision in CDOT's sole control. CDOT could try such an increase and, if it found the result to be unacceptable, return to the current signal phasing.

14. This increase in left turns at Boston Street will be offset to some extent because vehicles currently exiting Interstate 25 northbound must proceed east on Arapahoe Road and then turn left at Boston Street to access the development site. Under the proposal for access, those cars would proceed north on the frontage road and would not have to enter the Arapahoe Road/Boston Street intersection.

15. The requested access is consistent with the conditions set forth in Lipp's July 18, 1994, letter. In addition, Lipp testified that he would have approved the application if the only proposal presented had been the second alternative (elimination of left turns). See Findings of Fact, Paragraph 56, C. Lipp's expertise in access issues is highly regarded at CDOT. Lipp's willingness to grant access under the conditions proposed by the Appellants supports a finding that the public health, welfare and safety would not be compromised under this proposal.

16. The evidence did not establish that any vehicles other than construction vehicles "ordinarily used" this extension.

17. The Appellants have the burden of proof that their access plan meets the requirements of the Code. *See Magness v. State of Colorado*, 844 P.2d 1305 (Colo. App. 1992).

EXHIBIT A

NORTH → → → → →

CERTIFICATE OF SERVICE

I certify that a true and correct copy of the above **AGENCY DECISION** was served by placing same in the United States Mail, postage prepaid, at Denver, Colorado to: Andrew W. Loewi, Esq., and Robert C. Troyer, Esq., Brownstein, Hyatt, Farber & Strickland, P.C., 410 17th Street, 22nd Floor, Denver, CO 80202; and on David A. Burlage, Esq, Montgomery, Little & McGrew, P.C. , 5445 DTC Parkway, Suite 800, Englewood, CO 80111, on January 29th, 1997.

Sally Brown
Secretary to Administrative Law Judge

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