ARRON/BIJOU INTERCHANGE

FIR SUBMITTAL - AUGUST 2003

PPLEMENTAL DESIGN DOCUMENTS

IMPROVEMENTS
-25
EAK REGION

DOT

WILSON &COMPANY

FELSBURG HOLT & ULLEVIG

Cimarron/Bijou design memorandum

CDOT DESIGN Project No. IM 0252-334

Date: August 29, 2003

Wilson & Company
Felsburg Holt & Ullevig

By: Binder/ Brady/Doyle/Dunkle/ Garton/ Gorse/ Hansen/ Markar/ Sheffer/ Stolfus/Turnquist/ Waterman/ Weir/Lind

Subject: **Alignment Design Memo**

Distribution: CDOT Region 2 – James Flohr, Dan Hunt, Don Garcia, FHU – Elizabeth Stolfus, Wilson – Scott Waterman

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*Design computations for alignments in this project are based on guidance from AASHTO's A Policy on Geometric Design of HIGHWAYS AND STREETS, 2001. (PGDHS)

Design criteria for this project are based on guidance from the Interstate 25 Colorado Springs Corridor Improvements Management Study and Design Guidelines, January 1, 2001 (Corridor Standards).

Design Speed

The desired design speed for I-25 is 70 mph and the posted speed is 55 mph. The horizontal alignment is controlled by several constraints. Along the east side of I-25 the alignment must avoid the Monument Creek and Fountain Creek 100-year floodway. If the alignment encroaches upon the floodway a Conditional Letter of Map Revision (CLOMR) must be obtained to modify the floodway. Along the west side of I-25 the alignment is constrained by existing businesses. To avoid major right-of-way costs the alignment must avoid Motor City and WalMart to the south of Cimarron, and the VA Clinic and El Paso County Offices just south of Bijou. In addition, impacts to the Humane Society should be minimized including avoidance of the pet memorial garden. Impacts to Walnut Avenue, the WPA rock wall along Monument Creek north of Colorado Avenue, and So-Cal Auto Restoration should also be minimized.

The maximum superelevation rate for I-25 is 6% as listed in the Corridor Standards. Based upon the 6% maximum superelevation table in Exhibit 3-22*, the following design speeds apply for I-25:

Curve	PI Station	Radius	Design Speed
1	516+35.52	1875'	65 MPH
2	551+89.27	2100'	70 MPH
3	568+85.66	2100'	70 MPH
4	593+79.16	2800'	70 MPH

In order to avoid the floodway and the businesses south of Cimarron, including the Humane Society memorial garden, the proposed design speed for Curve 1 has been reduced to 65 mph. This is an acceptable design speed for a highway posted at 55 mph.

The design speeds for I-25 listed above are based upon the maximum superelevation rate, however, the horizontal stopping sight distance for the inside lanes of Curves 1, 2, and 3 are affected by the proposed median barrier. A complete discussion regarding what effect horizontal stopping sight distance has on the design speed of each curve is found under the stopping sight distance section.

The maximum superelevation rate for ramp alignments is also 6% as listed in the Corridor Standards. Ramps are designed with parallel-type entrances and exits. The design speed for each ramp curve follows the guide values for ramp design speed as related to a 70 mph highway design speed listed in Exhibit 10-56*. Additional acceleration length is required beyond the gore to reach the mainline design speed for Ramp C-1 and Ramp C-3 due to horizontal stopping sight distance requirements.

Cimarron Street and Bijou Street are considered major arterial streets within the City of Colorado Springs. The desired design speed for this type of facility is 45 mph with a 4% maximum superelevation rate. However, existing conditions do not meet this design criteria. Cimarron Street is currently posted at 35 mph through the I-25 interchange and Bijou Street is posted at 20 mph westbound and 25 mph eastbound through the I-25 interchange. In addition, vehicles traveling along either street at this location are entering or exiting downtown Colorado Springs, which has a posted speed limit of 25 mph. Considering the existing conditions and in order to tie into the existing roadway and adjacent properties with minimum impacts, the criteria for low speed urban streets has been applied to both roadways.

The design speed for Cimarron Street is 40 mph with the provision to keep a normal crown through both curves. Two horizontal control lines were developed for Cimarron, one eastbound and one westbound, to eliminate the need for redirect tapers required to tie into the existing section if only one control line is implemented. The minimum curve radius is 675' based upon Equation 3-33*. The existing 35 mph posted speed can be maintained through the interchange based upon the 40 mph design speed.

The design speed for Bijou Street is 35 mph with the provision to keep a normal crown along the entire length of the roadway improvements. The reverse curves east of the interchange where Bijou and Kiowa split are designed for 25 mph. These curves are currently posted at 15 mph and lead into downtown Colorado Springs which is posted at 25 mph. These reverse curves are superelevated because they are very sharp. A design speed of 25 mph is consistent with the existing conditions and minimizes impacts to Monument Valley Park and the historic St. Mary's Cathedral. Further details about the three lane reverse curves on Bijou are discussed under the Bijou Reverse Curves section.

Profile Grades

The design speed for the vertical alignment of I-25 is 70 mph. The range of allowable grades is 0.50% to 4.00% as listed in the Corridor Standards. The maximum proposed profile grade along I-25 is 3.65% and the minimum proposed grade is 0.76% meeting the defined design criteria.

The proposed profile grade of I-25 under the new Bijou Street Bridge is 6.0 feet higher than the existing roadway for two phase construction and 7.9 feet higher for one phase construction (I 25 and the Bijou overpass plus Bijou Street over Monument Creek and the Railroad). This will improve the horizontal and vertical sight distance and allow for the replacement of an existing pump station (draining the area), with a gravity drainage system, and still maintain the existing coffer dam system.

The range of allowable grades for the ramps is 0.50% to 6.00% as listed in the Corridor Standards. The proposed maximum ramp grade is 6.00% on Ramp B-1 (Bijou southbound on ramp). The proposed minimum

ramp grade is 0.65% on Ramp C-1 (Cimarron southbound off ramp). The following table summarizes the maximum and minimum grades for each ramp.

Ramp *Allowable*	Maximum Grade *6.00%*	Minimum Grade *0.50%*
C-1 (Cimarron Southbound On)	2.48%	1.93%
C-2 (Cimarron Southbound Off)	5.62%	0.65%
C-3 (Cimarron Northbound On)	5.41%	1.55%
C-4 (Cimarron Northbound Off)	2.58%	1.70%
B-1 (Bijou Southbound On)	6.00%	1.95%
B-2 (Bijou Southbound Off)	2.00%	1.06%
B-3 (Bijou Northbound On)	4.33%	1.00%
B-4 (Bijou Northbound Off)	3.96%	1.96%

The design speed for the vertical alignment of Cimarron is 40 mph. The range of allowable grades is 0.50% to 4.00% as listed in the Corridor Standards. The vertical alignment of Cimarron is constrained by the existing Fountain Creek bridge to the west and the existing bridge over the Union Pacific Railroad to the east. The proposed maximum grade along Cimarron is 6.00%. This grade is greater than the allowable maximum; however, it is necessary to tie into the existing 6.00% grade and vertical curve on the railroad bridge. The proposed minimum grade along Cimarron is 0.85%.

The design speed for the vertical alignment of Bijou is 35 mph. The range of allowable grades is 0.50% to 4.00% as listed in the Corridor Standards. An interim and an ultimate profile have been proposed to allow a phased implementation of the Bijou Street bridge over Monument Creek and the Union Pacific Railroad. The interim profile ties into the existing Bijou bridge over Monument Creek and the Union Pacific Railroad, requiring only the replacement of the Bijou bridge over I-25. The proposed maximum grade of the interim profile is 6.09%. This grade is greater than the allowable maximum; however, it is required to tie into the existing bridge. The proposed minimum grade is 0.50%. With a phased approach, the ultimate profile raises the interim profile grade of Bijou Street from 0 to approximately 1.5 feet in 160 feet by thickening the pavement on the new bridge. The proposed maximum grade of the ultimate profile is 5.67%. This grade is also greater than the allowable maximum, however, in order to meet the 4.00% grade criteria and the 23 ft. required clearance over the railroad, significant impacts to businesses along Bijou west of I-25 and to Monument Valley Park on the east side of I-25 would result. The minimum grade of the proposed ultimate profile is 0.50%.

Superelevation Transition

Superelevation transition along I-25 will be accomplished through the use of spirals. There is an acknowledged discrepancy in AASHTO between appropriate runoff lengths and appropriate spiral lengths for wide pavements on high type alignments. Spiral criteria recommends spiral lengths that are significantly less than minimum runoff lengths. With this in mind, this project will apply superelevation transitions as follows:

Provide coincident runoff and spiral length equal to the minimum runoff length (L_r) up to the maximum spiral length (L_{smax}). Where L_{smax} is less than the minimum runoff length, then use L_{smax} for the spiral and runoff length provided an analysis of the outside lane edge profile confirms conformance to standard profile design criteria.

Based upon the selected method of application of superelevation transition discussed above, the table below summarizes the appropriate runoff and spiral lengths for each curve where:

e =	Superelevation rate
L_r =	Runoff length (calculations are based upon a 6 lane rotated section)
L_{smin} =	Minimum spiral length
$L_{sdesired}$ =	Desired spiral length based upon design speed
L_{smax} =	Maximum spiral length
L_s =	Actual spiral length for the project.

Curve	Radius	Design Speed	e Ex. 3-22	L_r Eqn. 3-25	L_{smin} Eqn. 3-28/29	$L_{sdesired}$ Ex. 3-34	L_{smax} Eqn. 3-30	L_s
1	1875'	65 mph	6.0%	583'	172'	191'	385'	400'
2	2100'	70 mph	6.0%	626'	182'	205'	408'	350'/345'
3	2100'	70 mph	6.0%	626'	182'	205'	408'	350'/400'
4	2800'	70 mph	5.9%	574'	210'	205'	471'	355'/300'

Superelevation transitions on the ramps are based on the method for tangent-to-curve transitions. The superelevation table in Exhibit 3-22* defines runoff lengths, and adjustment factors from Exhibit 3-28* are used as necessary for wide pavements. Exhibit 3-30* defines the location of the superelevation runoff length with respect to the end of the curve.

As mentioned previously, low speed urban street standards are applied to Cimarron Street and Bijou Street, and a normal crown will be continued along the entire length of each roadway. Therefore, superelevation transitions do not apply.

Stopping Sight Distance

The median barrier may obstruct the horizontal stopping sight distance for the inside travel lane through proposed Curves 1, 2, and 3 along I-25. Guardrail Type 7 Style CL is proposed along the centerline of I-25 where the northbound and southbound lanes are separated only by 12' shoulders, restricting the horizontal stopping sight distance for vehicles traveling on the outside of a curve in these areas. Curve 4 is not affected by these restrictions because a 24' wide depressed median is developed before entering Curve 4, eliminating the need for Guardrail Type 7.

The middle ordinate (M) for the inside travel lane is 18.625' from the center of the lane to the top edge of the barrier. The following sight distances and corresponding design speeds apply for the inside travel lane of each affected curve:

Curve (Radius)	Horizontal Stopping Sight Distance	Design Speed
1 (1875')	532'	58 mph
2 (2100')	562'	60 mph
3 (2100')	562'	60 mph

It is apparent that these design speeds, based solely on horizontal elements, are substantially lower than those listed previously in the Design Speed section, based upon the maximum superelevation rate.

A calculation of the stopping sight distance based upon all elements of design (horizontal alignment, profile grade, and superelevation) is required to determine the true horizontal stopping sight distance and maximum design speed for each horizontal curve. Attached to this memo is a station-by-station analysis of the true sight distance, accounting for profile, curvature, and superelevation. The analysis was performed for the inside and outside lanes of I-25, both northbound and southbound. The following table summarizes those stations that have less than 730 feet of sight distance (70 mph design speed).

Station	Lane Designation	Stopping Sight Distance	Design Speed*
534+00 to 536+00	Northbound - Inside	700'	> 68 mph
558+00 to 559+00	Southbound – Inside	564'	> 59 mph
442+00 to 544+00	Southbound – Inside	700'	> 68 mph
534+00 to 536+00	Northbound – Outside	700'	> 68 mph
5540+00	Northbound – Outside	655'	> 65 mph
560+00 to 562+00	Southbound - Outside	679'	> 67 mph
542+00 to 543+00	Southbound – Outside	700'	> 68 mph

*Based on equation 3-2, Page 113 ,AASHTO PGDHS

Vertical

Minimum lengths of crest curves are calculated based on the vertical stopping sight distance for an eye height of 3.5' and an object height of 2.0' (Equation 3-45 and 3-46*). Minimum lengths of sag curves are calculated based upon headlight sight distance (Equation 3-50 and 3-52*). The values of K listed in Exhibit 3-76 and 3-79* for the appropriate design speed are generally acceptable.

Weave

The northbound weave distance between Cimarron and Bijou is approximately 1350 feet and the southbound weave distance is approximately 1250 feet. Weave LOS is expected to be D or better between the two interchanges. This weave was studied in more detail since the weave distances both northbound and southbound were less than 1500 feet. Analysis using simulation software was done to determine if the weave distance would be a factor in both capacity and driver behavior. Based upon the simulations, it was determined that the length of weave was not short enough to create capacity problems or erratic lane changing. These results were also presented to the FHWA in separate meetings. Additional information is provided in the FHWA Interstate Access Request.

Bijou Southbound On Ramp Length

The proposed Bijou/I-25 southbound on ramp next to the VA building is 800 feet long and the profile grade from Bijou is 6.00% down to 1.96% at the freeway entrance. The ramp was shortened to 800 feet to provide approximately 25 foot of clearance at Station 569+/- from the edge of the ramp shoulder to the VA building. The ramp connects to a continuous lane that extends to the Cimarron southbound off ramp to provide sufficient length to meet the requirements listed in Exhibit 10-70*.

Bijou and Cimarron Triple Left Turn

A triple left turn from the I-25 southbound off ramp to eastbound Bijou Street and from the I-25 northbound off ramp to westbound Cimarron Street is being designed to provide adequate capacity for future traffic volumes. The third lane will be constructed and striped out until traffic volumes demand the increased capacity. The triple left turn at Cimarron has been designed for one WB 50 turning from one of any of the three lanes and single unit vehicles in the other two lanes. The triple left turn at Bijou has been designed for two WB 40 vehicles turning from the two exterior lanes and a single unit vehicle in the remaining lane. A larger design vehicle approach was chosen at Cimarron due to the predominance of industrial businesses accessing the Cimarron interchange. The Bijou left turn into downtown Colorado Springs is used predominately by passenger vehicles and does not warrant the more restrictive turning vehicle design.

Bijou Reverse Curves

In order to have a triple left turn from the I-25 southbound off ramp to eastbound Bijou Street, three receiving lanes must be carried along Bijou Street through the reverse curves where Bijou and Kiowa split. As discussed previously the reverse curves are designed for 25 mph. Using a WB40 as the design vehicle, AASHTO recommends 43.8'-47.0' of width for three lanes at slow speeds. A 40' envelope including pans has been provided to minimize impacts on Monument Valley Park and St. Mary's Cathedral. The following reasons support this design decision. First, three WB40 vehicles rarely pass through this segment simultaneously. Second, a simulation using Autoturn software of three WB40 vehicles in this segment pass without conflict. Autoturn does assume speeds less than the design speed for this area, but all three vehicles fit within the 40' envelope. Third, when simulated with passenger cars, a single WB40 vehicle travels through the segment with noticeable clearance from the other vehicles.

Right-of-Way

Right-of-way impacts have been minimized wherever possible. Several parcels along the west side of I-25 will need to be purchased and businesses will need to be relocated. The estimated right-of-way cost is $8 to $10 million. Specific parcels are discussed below:

Humane Society (west of Station 530 +/-) - The Humane Society will be partially impacted by the southbound on ramp from Cimarron. Approximately 8000 square feet (sf) of land will need to be purchased and approximately 180' of the existing dog run will need to be reconstructed towards the north end of the property. The entire east edge of the parcel requires a retaining wall. The memorial garden will be avoided by constructing a retaining wall.

So-Cal Auto Restoration (west of Station 547 +/-) – So-Cal Auto Restoration will be impacted by Ramp C-2 (Cimarron southbound off ramp). The project team evaluated several treatment options for the west edge of the Ramp C-2. The options included a wall for the full length, a slope for the full length, and several combinations of a slope and a wall. The evaluations showed a wall for the full length as the most economical option. This option maintains So-Cal Auto Detailing saving the costs associated with purchasing and relocating this business. A single wall will have a maximum height of 46 feet. Since constructing two shorter walls provides easier constructability than building one 46' high wall, a two-tiered wall system with a 2-foot offset was recommended. Very little difference in cost was found between these two options.

VA Clinic/El Paso County Offices (west of Station 569 +/-) – These two offices work in conjunction with one another requiring both offices to be purchased and relocated if either one is affected. The alignment of the southbound on ramp at Bijou has been designed such that neither office will be impacted. A minimum clearance of approximately 25' from the building to the edge of pavement of the ramp is provided. The project will also study noise, vibration and air quality impacts to the property.

Datum

The project mapping is on the 1988 datum. FEMA mapping and mapping from the City of Colorado Springs is on the 1929 datum. The conversion from the 1929 datum to the 1988 datum is as follows:

1929 datum + 3.47' = 1988 datum

This datum difference has been accounted for in the floodplain investigation and for existing data received from the City of Colorado Springs.

Floodplains

The conditions of the floodplains have changed since the original Flood Insurance Study was made in 1981. Changes that have occurred include filling in the flood fringe areas, construction of channel drop structures, degradation and aggradation of the channel bottom (by natural and manmade causes), channel improvements and bank protection. Many of these changes were done without approval from a local, state or federal agency. In addition, the 1981 FEMA analysis used mapping with a 1" = 500' scale and a 5-foot contour interval as opposed to the 1-foot contour interval that is currently available. The current conditions indicate that changes in the Flood Insurance Rate Map are necessary. A Preliminary Letter of Map Revision (LOMR) has been prepared that will amend the FEMA map to show the current flooding conditions. Proposed improvements will then be determined, and a Final Conditional Letter of Map Revision (CLOMR) will be prepared. This CLOMR will request a response from FEMA that the proposed project complies with the minimum criteria for FEMA. Once approved and constructed, FEMA maps can then be modified to show the new floodplain limits.

Flooding for Monument, Fountain and Bear Creeks are currently delineated as being in Zones AE (floodplain and floodway) and Zone X. Zone AE includes special flood hazard areas inundated by the 100-year flood where base flood elevations have been determined. Zone X includes other flood areas such as the 500-year flood area and 100-year flood areas with average depths of less than 1 foot. Zone X does not have a mapped base flood elevation. In general, placing fill is allowed in the floodplain but not in the floodway per FEMA regulations.

This project will include new structures for the Cimarron and Bijou interchanges as well as new Interstate 25 bridges over Fountain and Bear Creeks. Once the improvements to I-25 are determined, then a Final Conditional Letter of Map Revision (CLOMR) will be prepared and presented to FEMA. This CLOMR will be compared to the LOMR in order to assess impacts and guide the design.

This project has been coordinated with Mr. Keven Stilson, the Floodplain Administrator for the Pikes Peak Regional Building Department and Mr. John Liou, the Regional Hydrologist for FEMA. Coordination with these individuals and other parties will continue as the design continues. A brief discussion of the three drainage ways is listed below.

Fountain Creek

Fountain Creek parallels U.S. Highway 24 through western Colorado Springs prior to passing under I-25. East of I-25, Fountain Creek joins Monument Creek and bends abruptly to the south, paralleling I-25's east right-of-way.

A split flow occurs at the undersized bridge at State Highway 24 where approximately 6,200 cubic feet per second (cfs) pass into the Bear Creek drainage. Some of the water surface elevations have increased at the I-25 crossing. This is probably because the original HEC-2 model did not model the northbound on-ramp bridge from Cimarron Street to I-25. The low chord of this bridge is about 19 feet lower than the adjacent I-25 mainline bridge.

Two new ramp bridges are planned for crossing Fountain Creek. They will each be a three span bridge with a length of about 255-feet. They will have a pedestrian path and a 20-foot wide low flow channel. The structures are dependant on the elevation for existing Cimarron Street and the geometry of Fountain Creek. The 100-year storm will pass under pressure flow at the south end of the bridges. Cimarron Street will not be inundated. The upper reach of Fountain Creek produces a high amount of debris. It should be cleaned up as a part of this project. Additional information is available in the Preliminary CLOMR prepared by FHU in August 2003.

Monument Creek

Monument Creek has been channelized along the east right-of-way of I-25 in this part of Colorado Springs. The City of Colorado Springs has constructed grade control structures to limit erosion within parts of the project area. Water surface elevations have increased north of the Bijou Street Bridge. The increase is probably due to the local constricting of the floodplain in comparison to the original FEMA model.

The existing structures have adequate freeboard and can pass the 100-year flows. Proposed crossings should be at least equal to the existing structures in size.

Bear Creek

Bear Creek passes under I-25 via a double cell 14' x 10' (span x rise) reinforced concrete box culvert. The current drainage crossing in the I-25 area is fairly well defined. Water surface elevations have increased upstream of the I-25 crossing. The 100-year regulatory flow for Bear Creek is 4,140 cfs that peaks at about 1.3 hours. The split flow from Fountain Creek at State Highway 24 is about 6,200 cfs, which peaks at about 13.5 hours. Due to the wide variance in peaks, the flows will not be added together. Further refining of the model will probably modify the discharge for this split flow.

The existing box culverts can either have 5 additional 12' X10' cells placed to the south or have a bridge. Due to the cost difference between the box culverts and bridge options, the recommended structure in the Structure Type Selection Report, June 2003, is a bridge that would have a bike path with 12 feet of clearance and a low flow channel. The bridge will have about a 100-foot span. A riprap drop will be required upstream of the bridge to limit the high velocities that are now occurring.

Impacts to the WPA Wall

Immediately following this memo is an original memo, dated August 26, 2002, summarizing the proposed alignment of I-25 with respect to the WPA Wall impacts, right-of-way acquisition, and design speed. The memo identifies approximately 10,000 SF of the WPA wall to be impacted for the proposed. Following further design refinements, the total wall impact was estimated to be approximately 5,910 SF. Of this, 2,710 SF is estimated to be permanent impact due to proposed structures physically encroaching on the existing wall. The

remaining 3,200 SF is potential impact. The potential impact is an estimate based on the contractor disturbing the WPA Wall approximately 10 feet beyond the limits of proposed structures. This potential impact cannot be completely determined at this point, as it is based solely on the contractor's methods of construction. Project specifications will require the contractor to remove, and replace in kind, any of the WPA Wall that is disturbed outside the limits of the proposed physical features. (Please refer to the WPA Wall Impacts graphic that is included in this notebook)

I 25 Stoping Sight Distance

9/2/2003

NB I25 INSIDE LANE

Eye point information 19.17' right centerline

Eye point subsidiary string = TKAT
Eye point horizontal offset = 0.000
Eye point vertical offset = 3.500
Eye station interval = 100.000

Target point information 19.17' right centerline

Target point subsidiary string = TKAT
Target point horizontal offset = 0.000
Target point vertical offset = 2.000
Target station interval = 100.000

Reference string = MCAC
Visibility string = NBIN
Minimum visibility distance = 730.000
Section analysis interval = 100.000

-Point-	-Station-	-Visibility- -Distance-	-Visibility- -Deficit-
1	50000.000	730.000	0.000
2	50100.000	730.000	0.000
3	50200.000	730.000	0.000
4	50300.000	730.000	0.000
5	50400.000	730.000	0.000
6	50500.000	730.000	0.000
7	50600.000	730.000	0.000
8	50700.000	730.000	0.000
9	50800.000	730.000	0.000
10	50900.000	730.000	0.000
11	51000.000	730.000	0.000
12	51100.000	730.000	0.000
13	51200.000	730.000	0.000
14	51300.000	730.000	0.000
15	51400.000	730.000	0.000
16	51500.000	730.000	0.000
17	51600.000	730.000	0.000
18	51700.000	730.000	0.000
19	51800.000	730.000	0.000
20	51900.000	730.000	0.000
21	52000.000	730.000	0.000
22	52100.000	730.000	0.000
23	52200.000	730.000	0.000
24	52300.000	730.000	0.000
25	52400.000	730.000	0.000
26	52500.000	730.000	0.000
27	52600.000	730.000	0.000
28	52700.000	730.000	0.000
29	52800.000	730.000	0.000
30	52900.000	730.000	0.000
31	53000.000	730.000	0.000
32	53100.000	730.000	0.000
33	53200.000	730.000	0.000
34	53300.000	730.000	0.000
35	**53400.000**	**700.241**	**-29.759**
36	**53500.000**	**700.185**	**-29.815**
37	**53600.000**	**700.129**	**-29.871**
38	53700.000	730.000	0.000
39	53800.000	730.000	0.000
40	53900.000	730.000	0.000
41	54000.000	730.000	0.000
42	54100.000	730.000	0.000
43	54200.000	730.000	0.000
44	54300.000	730.000	0.000
45	54400.000	730.000	0.000
46	54500.000	730.000	0.000

SB I25 INSIDE LANE

Eye point information 19.17' left centerline

Eye point subsidiary string = TKA5
Eye point horizontal offset = 0.000
Eye point vertical offset = 3.500
Eye station interval = 100.000

Target point information 19.17' left centerline

Target point subsidiary string = TKA5
Target point horizontal offset = 0.000
Target point vertical offset = 2.000
Target station interval = 100.000

Reference string = MCAC
Visibility string = SBIN
Minimum visibility distance = 730.000
Section analysis interval = 100.000

-Point-	-Station-	-Visibility- -Distance-	-Visibility- -Deficit-
1	59900.000	730.000	0.000
2	59800.000	730.000	0.000
3	59700.000	730.000	0.000
4	59600.000	730.000	0.000
5	59500.000	730.000	0.000
6	59400.000	730.000	0.000
7	59300.000	730.000	0.000
8	59200.000	730.000	0.000
9	59100.000	730.000	0.000
10	59000.000	730.000	0.000
11	58900.000	730.000	0.000
12	58800.000	730.000	0.000
13	58700.000	730.000	0.000
14	58600.000	730.000	0.000
15	58500.000	730.000	0.000
16	58400.000	730.000	0.000
17	58300.000	730.000	0.000
18	58200.000	730.000	0.000
19	58100.000	730.000	0.000
20	58000.000	730.000	0.000
21	57900.000	730.000	0.000
22	57800.000	730.000	0.000
23	57700.000	730.000	0.000
24	57600.000	730.000	0.000
25	57500.000	730.000	0.000
26	57400.000	730.000	0.000
27	57300.000	730.000	0.000
28	57200.000	730.000	0.000
29	57100.000	730.000	0.000
30	57000.000	730.000	0.000
31	56900.000	730.000	0.000
32	56800.000	730.000	0.000
33	56700.000	730.000	0.000
34	56600.000	730.000	0.000
35	56500.000	730.000	0.000
36	56400.000	730.000	0.000
37	56300.000	730.000	0.000
38	56200.000	730.000	0.000
39	56100.000	730.000	0.000
40	56000.000	730.000	0.000
41	**55900.000**	**563.599**	**-166.401**
42	**55800.000**	**581.139**	**-148.861**
43	55700.000	730.000	0.000
44	55600.000	730.000	0.000
45	55500.000	730.000	0.000
46	55400.000	730.000	0.000

47	54600.000	730.000	0.000
48	54700.000	730.000	0.000
49	54800.000	730.000	0.000
50	54900.000	730.000	0.000
51	55000.000	730.000	0.000
52	55100.000	730.000	0.000
53	55200.000	730.000	0.000
54	55300.000	730.000	0.000
55	55400.000	730.000	0.000
56	55500.000	730.000	0.000
57	55600.000	730.000	0.000
58	55700.000	730.000	0.000
59	55800.000	730.000	0.000
60	55900.000	730.000	0.000
61	56000.000	730.000	0.000
62	56100.000	730.000	0.000
63	56200.000	730.000	0.000
64	56300.000	730.000	0.000
65	56400.000	730.000	0.000
66	56500.000	730.000	0.000
67	56600.000	730.000	0.000
68	56700.000	730.000	0.000
69	56800.000	730.000	0.000
70	56900.000	730.000	0.000
71	57000.000	730.000	0.000
72	57100.000	730.000	0.000
73	57200.000	730.000	0.000
74	57300.000	730.000	0.000
75	57400.000	730.000	0.000
76	57500.000	730.000	0.000
77	57600.000	730.000	0.000
78	57700.000	730.000	0.000
79	57800.000	730.000	0.000
80	57900.000	730.000	0.000
81	58000.000	730.000	0.000
82	58100.000	730.000	0.000
83	58200.000	730.000	0.000
84	58300.000	730.000	0.000
85	58400.000	730.000	0.000
86	58500.000	730.000	0.000
87	58600.000	730.000	0.000
88	58700.000	730.000	0.000
89	58800.000	730.000	0.000
90	58900.000	730.000	0.000
91	59000.000	730.000	0.000
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94	59300.000	603.193	0.000
95	59400.000	502.387	0.000
96	59500.000	401.460	0.000
97	59600.000	300.691	0.000
98	59700.000	200.197	0.000
99	59800.000	100.006	0.000

47	55300.000	730.000	0.000
48	55200.000	730.000	0.000
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51	54900.000	730.000	0.000
52	54800.000	730.000	0.000
53	54700.000	730.000	0.000
54	54600.000	730.000	0.000
55	54500.000	730.000	0.000
56	**54400.000**	**700.149**	**-29.851**
57	**54300.000**	**700.194**	**-29.806**
58	**54200.000**	**700.260**	**-29.740**
59	54100.000	730.000	0.000
60	54000.000	730.000	0.000
61	53900.000	730.000	0.000
62	53800.000	730.000	0.000
63	53700.000	730.000	0.000
64	53600.000	730.000	0.000
65	53500.000	730.000	0.000
66	53400.000	730.000	0.000
67	53300.000	730.000	0.000
68	53200.000	730.000	0.000
69	53100.000	730.000	0.000
70	53000.000	730.000	0.000
71	52900.000	730.000	0.000
72	52800.000	730.000	0.000
73	52700.000	730.000	0.000
74	52600.000	730.000	0.000
75	52500.000	730.000	0.000
76	52400.000	730.000	0.000
77	52300.000	730.000	0.000
78	52200.000	730.000	0.000
79	52100.000	730.000	0.000
80	52000.000	730.000	0.000
81	51900.000	730.000	0.000
82	51800.000	730.000	0.000
83	51700.000	730.000	0.000
84	51600.000	730.000	0.000
85	51500.000	730.000	0.000
86	51400.000	730.000	0.000
87	51300.000	730.000	0.000
88	51200.000	730.000	0.000
89	51100.000	730.000	0.000
90	51000.000	730.000	0.000
91	50900.000	730.000	0.000
92	50800.000	730.000	0.000
93	50700.000	700.536	0.000
94	50600.000	600.162	0.000
95	50500.000	500.032	0.000
96	50400.000	400.027	0.000
97	50300.000	300.024	0.000
98	50200.000	200.023	0.000
99	50100.000	100.026	0.000

48	54700.000	730.000	0.000
49	54800.000	730.000	0.000
50	54900.000	730.000	0.000
51	55000.000	730.000	0.000
52	55100.000	730.000	0.000
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59	55800.000	730.000	0.000
60	55900.000	730.000	0.000
61	56000.000	730.000	0.000
62	56100.000	730.000	0.000
63	56200.000	730.000	0.000
64	56300.000	730.000	0.000
65	56400.000	730.000	0.000
66	56500.000	730.000	0.000
67	56600.000	730.000	0.000
68	56700.000	730.000	0.000
69	56800.000	730.000	0.000
70	56900.000	730.000	0.000
71	57000.000	730.000	0.000
72	57100.000	730.000	0.000
73	57200.000	730.000	0.000
74	57300.000	730.000	0.000
75	57400.000	730.000	0.000
76	57500.000	730.000	0.000
77	57600.000	730.000	0.000
78	57700.000	730.000	0.000
79	57800.000	730.000	0.000
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81	58000.000	730.000	0.000
82	58100.000	730.000	0.000
83	58200.000	730.000	0.000
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85	58400.000	730.000	0.000
86	58500.000	730.000	0.000
87	58600.000	730.000	0.000
88	58700.000	730.000	0.000
89	58800.000	730.000	0.000
90	58900.000	730.000	0.000
91	59000.000	730.000	0.000
92	59100.000	730.000	0.000
	furthest target point reached.		
93	59200.000	709.155	0.000
94	59300.000	607.539	0.000
95	59400.000	505.455	0.000
96	59500.000	403.271	0.000
97	59600.000	301.534	0.000
98	59700.000	200.439	0.000
99	59800.000	100.014	0.000

48	55200.000	730.000	0.000
49	55100.000	730.000	0.000
50	55000.000	730.000	0.000
51	54900.000	730.000	0.000
52	54800.000	730.000	0.000
53	54700.000	730.000	0.000
54	54600.000	730.000	0.000
55	54500.000	730.000	0.000
56	54400.000	730.000	0.000
57	**54300.000**	**700.197**	**-29.803**
58	**54200.000**	**700.260**	**-29.740**
59	54100.000	730.000	0.000
60	54000.000	730.000	0.000
61	53900.000	730.000	0.000
62	53800.000	730.000	0.000
63	53700.000	730.000	0.000
64	53600.000	730.000	0.000
65	53500.000	730.000	0.000
66	53400.000	730.000	0.000
67	53300.000	730.000	0.000
68	53200.000	730.000	0.000
69	53100.000	730.000	0.000
70	53000.000	730.000	0.000
71	52900.000	730.000	0.000
72	52800.000	730.000	0.000
73	52700.000	730.000	0.000
74	52600.000	730.000	0.000
75	52500.000	730.000	0.000
76	52400.000	730.000	0.000
77	52300.000	730.000	0.000
78	52200.000	730.000	0.000
79	52100.000	730.000	0.000
80	52000.000	730.000	0.000
81	51900.000	730.000	0.000
82	51800.000	730.000	0.000
83	51700.000	730.000	0.000
84	51600.000	730.000	0.000
85	51500.000	730.000	0.000
86	51400.000	730.000	0.000
87	51300.000	730.000	0.000
88	51200.000	730.000	0.000
89	51100.000	730.000	0.000
90	51000.000	730.000	0.000
91	50900.000	730.000	0.000
92	50800.000	730.000	0.000
	furthest target point reached.		
93	50700.000	701.830	0.000
94	50600.000	600.495	0.000
95	50500.000	500.044	0.000
96	50400.000	400.030	0.000
97	50300.000	300.024	0.000
98	50200.000	200.023	0.000
99	50100.000	100.026	0.000

NB I25 OUTSIDE LANE

ye point information 6' left of ETW

Eye point subsidiary string = TJA0
Eye point horizontal offset = 0.000
Eye point vertical offset = 3.500
Eye station interval = 100.000

Target point information 6' left of ETW

Target point subsidiary string = TJA0
Target point horizontal offset = 0.000
Target point vertical offset = 2.000
Target station interval = 100.000

Reference string = MCAC
Visibility string = NBOT
Minimum visibility distance = 730.000
Section analysis interval = 100.000

-Point-	-Station-	-Visibility- --Distance--	-Visibility- --Deficit--
1	50000.000	730.000	0.000
2	50100.000	730.000	0.000
3	50200.000	730.000	0.000
4	50300.000	730.000	0.000
5	50400.000	730.000	0.000
6	50500.000	730.000	0.000
7	50600.000	730.000	0.000
8	50700.000	730.000	0.000
9	50800.000	730.000	0.000
10	50900.000	730.000	0.000
11	51000.000	730.000	0.000
12	51100.000	730.000	0.000
13	51200.000	730.000	0.000
14	51300.000	730.000	0.000
15	51400.000	730.000	0.000
16	51500.000	730.000	0.000
17	51600.000	730.000	0.000
18	51700.000	730.000	0.000
19	51800.000	730.000	0.000
20	51900.000	730.000	0.000
21	52000.000	730.000	0.000
22	52100.000	730.000	0.000
23	52200.000	730.000	0.000
24	52300.000	730.000	0.000
25	52400.000	730.000	0.000
26	52500.000	730.000	0.000
27	52600.000	730.000	0.000
28	52700.000	730.000	0.000
29	52800.000	730.000	0.000
30	52900.000	730.000	0.000
31	53000.000	730.000	0.000
32	53100.000	730.000	0.000
33	53200.000	730.000	0.000
34	53300.000	730.000	0.000
35	**53400.000**	**700.241**	**-29.759**
36	**53500.000**	**700.185**	**-29.815**
37	**53600.000**	**700.129**	**-29.871**
38	53700.000	730.000	0.000
39	53800.000	730.000	0.000
40	53900.000	730.000	0.000
41	54000.000	730.000	0.000
42	54100.000	730.000	0.000
43	54200.000	730.000	0.000
44	54300.000	730.000	0.000
45	54400.000	730.000	0.000
46	54500.000	730.000	0.000
47	54600.000	730.000	0.000

SB I25 OUTSIDE LANE

Eye point information 6' left of ETW

Eye point subsidiary string = E4AI
Eye point horizontal offset = 0.000
Eye point vertical offset = 3.500
Eye station interval = 100.000

Target point information 6' left of ETW

Target point subsidiary string = E4AI
Target point horizontal offset = 0.000
Target point vertical offset = 2.000
Target station interval = 100.000

Reference string = MCAC
Visibility string = SBOT
Minimum visibility distance = 730.000
Section analysis interval = 100.000

-Point-	-Station-	-Visibility- --Distance--	-Visibility- --Deficit--
1	59900.000	730.000	0.000
2	59800.000	730.000	0.000
3	59700.000	730.000	0.000
4	59600.000	730.000	0.000
5	59500.000	730.000	0.000
6	59400.000	730.000	0.000
7	59300.000	730.000	0.000
8	59200.000	730.000	0.000
9	59100.000	730.000	0.000
10	59000.000	730.000	0.000
11	58900.000	730.000	0.000
12	58800.000	730.000	0.000
13	58700.000	730.000	0.000
14	58600.000	730.000	0.000
15	58500.000	730.000	0.000
16	58400.000	730.000	0.000
17	58300.000	730.000	0.000
18	58200.000	730.000	0.000
19	58100.000	730.000	0.000
20	58000.000	730.000	0.000
21	57900.000	730.000	0.000
22	57800.000	730.000	0.000
23	57700.000	730.000	0.000
24	57600.000	730.000	0.000
25	57500.000	730.000	0.000
26	57400.000	730.000	0.000
27	57300.000	730.000	0.000
28	57200.000	730.000	0.000
29	57100.000	730.000	0.000
30	57000.000	730.000	0.000
31	56900.000	730.000	0.000
32	56800.000	730.000	0.000
33	56700.000	730.000	0.000
34	56600.000	730.000	0.000
35	56500.000	730.000	0.000
36	56400.000	730.000	0.000
37	56300.000	730.000	0.000
38	**56200.000**	**687.932**	**-42.068**
39	**56100.000**	**678.714**	**-51.286**
40	**56000.000**	**689.294**	**-40.706**
41	55900.000	730.000	0.000
42	55800.000	730.000	0.000
43	55700.000	730.000	0.000
44	55600.000	730.000	0.000
45	55500.000	730.000	0.000
46	55400.000	730.000	0.000
47	55300.000	730.000	0.000

Cimarron/Bijou design memorandum

CDOT DESIGN Project No. IM 0252-334

Date: August 26, 2002
By: Turnquist, Garton

Wilson & Company
Felsburg Holt & Ullevig

Subject: I-25 Alignment Justification
WPA Wall Impacts - cantilever retaining wall system

Distribution: Stolfus/Hansen/Markar/Weir/
Dunkle/Turnquist/Sheffer/
Brady/Gorse/Garton

The project team, at the Progress Meeting of August 22, 2002, discussed and reviewed the 2 attached memos on the WPA Wall Impacts (alternative alignments that avoided the WPA wall and a cantilevered roadway slab and retaining wall system that reduces the impacts to the WPA wall – both of these memos have been revised to include the team's comments).

Recommendations of the project team are:

1. I 25 Alignment Justification – WPA Wall Impacts – alternative alignments
   The ***proposed alignment*** is recommended for the design of the project because alternative alignment 1 does not meet the Corridor Standard design speed of 70 mph and increases the ROW required and alternative alignment 2 requires an estimated increase in ROW costs of $23.8 million for the VA-El Paso County property.

2. I 25 Alignment Justification – WPA Wall Impacts – cantilever retaining wall system The ***partial avoidance option*** for the cantilevered roadway slab and retaining wall system is recommended for the design of the project instead of the total avoidance or maximum impact options. The partial avoidance option only impacts approximately 6% (4,400 sq ft of the 75,000 sq ft) of the WPA wall located within the project limits and costs 1/3 ($320,000) of the total avoidance option. A constant 5 feet of cantilevered roadway slab overhang is recommended for the Bijou ramp area. A variable cantilevered roadway slab overhang is recommended in the area north and south of the I 25 bridge over Colorado Avenue. A portion of this cantilever is required to avoid encroaching on the flood way.

Design of the FIR plans for the project will proceed using these two recommendations.

The proposed alignment on Project IM 0252-233, Cimarron to Bijou impacts approximately 10,000 square feet (13%) of the 75,000 square feet of the WPA wall. This section of the wall is located east and west of Monument Creek within the project limits. Approximately 1,100 sq. ft. of the 10,000 sq. ft. impact to the WPA wall is to provide for a roadway drainage structure (400 sq. ft.) and the Bijou Street bridge abutment (700 sq. ft.).

The proposed alignment of I-25, with a traditional retaining wall at the edge of roadway, supporting the roadway embankment, would impact the WPA wall along Monument Creek (maximum impact option). Wilson & Company investigated that option, plus two others that used a cantilevered roadway slab to enable the retaining wall to be located such that it impacts the WPA wall to a lesser extent (partial avoidance option) or altogether (total avoidance option).

All three retaining wall layouts used an estimated construction work zone of 10 feet, measured outward from the wall face. This theoretical limit was used to quantify the impact of construction on the WPA wall (for the maximum impact and partial avoidance options), and to layout a retaining wall that could be constructed without impacting the WPA wall (for the total avoidance option).

Wilson & Company has estimated the cost of the three layouts, plus the area of the WPA wall that each would impact.

All three layouts assumed a bridge length (for I-25 over Colorado Avenue) of approximately 350 feet. Because of the differing retaining wall layouts, the bridge abutments are different for each option. Abutment costs have been estimated and included in the cost figures being presented. Other bridge costs, such as for superstructure and pier construction, are assumed to be identical for the three retaining wall layouts, and are not included in these cost figures.

All three options assumed retaining walls constructed of mechanically reinforced soil with precast panel facing ("MSE"). Although type selection is not complete, it is felt that this is a reasonable type of wall to evaluate for this purpose.

The maximum impact option layout placed retaining walls in the floodplain of Monument Creek. At such locations, Wilson & Company believes another retaining wall system is necessary for scour protection of the MSE system. This second retaining wall would be founded on a non-scourable stratum. A traditional cast-in-place concrete cantilever wall on driven steel pile was included in the analysis.

Attached are two tables showing the various impacts to the WPA wall, a table with the costs associated with each, and typical sections for the cantilever system.

FIR Structure Layout, Sta. 552 to Bijou Street

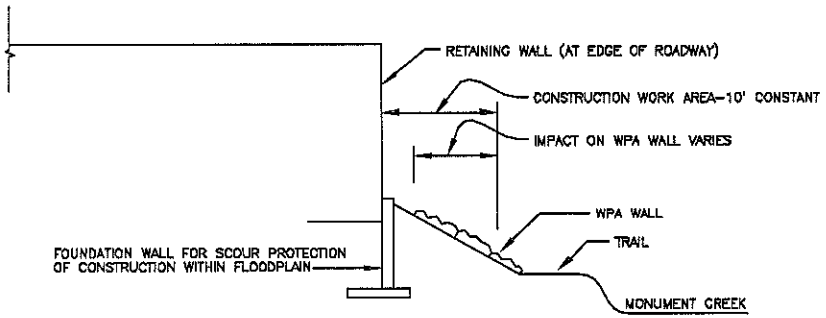
Project Name :I-25 Cimarron to Bijou FIR
Location :Colorado Springs CO

WCEA Proj. No. :X0-310-00320
Client :Colorado DOT, Region 2

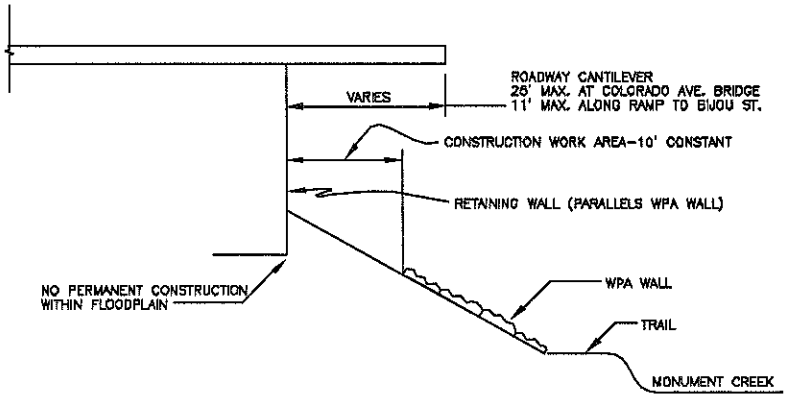
Northbound Costs

Item	Total Avoidance Layout			Maximum Impact Layout			Partial Impact Layout		
	South of Colo. Ave.	North of Colo. Ave.	Along ramp to Bijou	South of Colo. Ave.	North of Colo. Ave.	Along ramp to Bijou	South of Colo. Ave.	North of Colo. Ave.	Along ramp to Bijou
Structure Backfill (Class 1)	$ 211,029	$ 226,286	$ 87,232	$ 244,320	$ 331,662	$ 118,777	$ 214,317	$ 278,420	$ 96,048
Mech Reinforcement of Soil	$ 79,655	$ 85,518	$ 32,319	$ 91,957	$ 125,091	$ 43,436	$ 80,797	$ 105,045	$ 35,390
Precast Panel Facing	$ 178,771	$ 213,130	$ 133,484	$ 195,078	$ 251,785	$ 161,876	$ 181,605	$ 233,750	$ 142,041
Structure Excavation	$ 20,981	$ 24,445	$ 15,808	$ 22,939	$ 29,796	$ 17,658	$ 21,236	$ 27,096	$ 16,327
Concrete Class D (Br.)(Spec.)	$ 299,895	$ 830,301	$ 803,704	$ 87,049	$ 203,431	$ 112,130	$ 241,218	$ 386,426	$ 528,036
Reinforcing Steel (Epoxy)	$ 55,309	$ 163,351	$ 137,529	$ 16,272	$ 37,768	$ 21,305	$ 41,998	$ 69,129	$ 85,920
Concrete Pavement (12")	$ 141,253	$ 165,061	$ 4,437	$ 173,851	$ 228,671	$ 109,779	$ 147,279	$ 202,613	$ 34,938
Embank Mat'l (compl in pla)	$ 12,892	$ 3,414	$ -	$ 14,113	$ 2,967	$ -	$ 13,525	$ 3,033	$ -
Aggr Base Course (Class 6)	$ 10,036	$ 11,728	$ 315	$ 12,353	$ 16,248	$ 7,800	$ 10,465	$ 14,396	$ 2,482
Foundation wall				$ 48,667	$ 135,929				
Trail connection	*$ 8,000*			*$ 25,000*			*$ 25,000*		
Abutment walls	*$ 125,000*	*$ 120,000*		*$ 175,000*	*$ 145,000*		*$ 150,000*	*$ 132,500*	

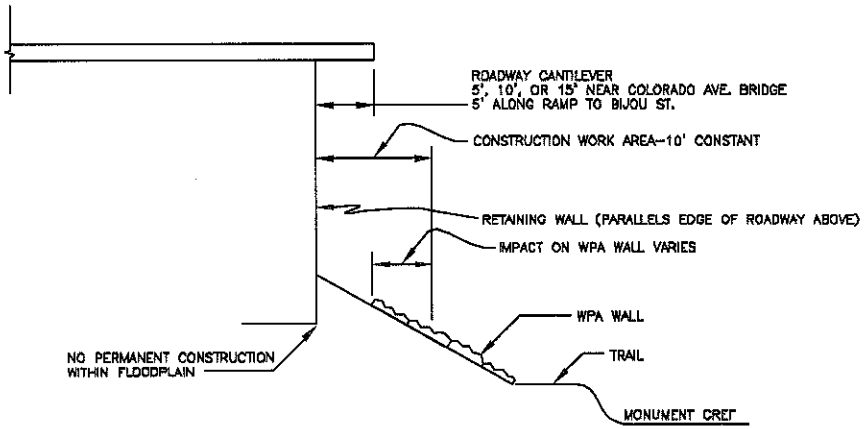
Subtotals (w/o bridge)	$ 1,142,823	$ 1,843,234	$1,214,829	$ 1,106,597	$ 1,508,346	$ 592,760	$ 1,127,440	$ 1,452,409	$ 941,182
Totals (w/o bridge)		$ 4,200,885			$ 3,207,704			$ 3,521,031	



MAXIMUM IMPACT WITHOUT CANTILEVER



TOTAL AVOIDANCE–VARIABLE CANTILEVER



PARTIAL AVOIDANCE–STEPPED CANTILEVER

WILSON & COMPANY | FELSBURG HOLT & ULLEVIG

Computer File Information			Index of Revisions			Colorado Department of Transportation	As Constructed	I-25 TYPICAL SECTION CANTILEVER	Project No./Code
Creation Date: 8/20/02	Initials: RPS					1480 Quail Lake Loop, Colorado Springs, Colorado 80906, Phone: 719-634-2323 FAX: 719-227-3268	No Revisions:		IM 0252-233
Last Modification Date:	Initials: RPS						Revised:	Designer:	PROJ. CODE
Full Path:						Region 2 James Flohr	Void:	Detailer:	
Drawing File Name:								Sheet Subset: Subset Sheets: of	Sheet Number
Acad Ver. R2002 Scale: NTS	Units: English								

Interstate 25
Cimarron and Bijou Interchanges Combined
Preliminary Cost Opinion

Wilson & Co., Felsburg Holt & Ullevig
Date: August 21,2003
By: DAK, MRH, and WD
Preliminary Cost Opinion

Item Description	Quantity	Unit	Unit Cost	Cost	Cost Extension	Remarks
Core Items						
Earthwork (embankment)	420,000	CY	$ 7.00	$ 2,940,000		
ABC (Class 6)	65,000	TON	$ 15.00	$ 975,000		6" depth under all pavements
HBP (8")	7,200	TON	$ 42.00	$ 302,400		Cimarron and Bijou tie-in pavements
Concrete Pavement (8")	38,700	SY	$ 31.00	$ 1,199,700		Ramps and Cimarron Street Intersections
Concrete Pavement (11")	162,500	SY	$ 37.00	$ 6,012,500		Mainline
Guardrail Type 3	4,000	LF	$ 13.00	$ 52,000		Along EOP
Guardrail Type 6 (Double)	1,400	LF	$ 16.00	$ 22,400		Median past STA. 588+60
Guardrail Type 7	11,100	LF	$ 55.00	$ 610,500		In median and along EOP
Bridgerail Type 10M	2,300	LF	$ 92.00	$ 211,600		At retaining walls
Impact Attenuator	1	EA	$ 25,000.00	$ 25,000		
Concrete Sidewalk	3,150	SY	$ 28.00	$ 88,200		Trail at Fountain Creek and Bear Creek
Curb and Gutter (Type 2)(Section IB)	6,450	LF	$ 11.00	$ 70,950		Cimarron and Bijou medians and islands
Curb and Gutter (Type 2)(Section IIB)	5,250	LF	$ 13.00	$ 68,250		Cimarron Street and Bijou Street
Median Cover Material (Patterned Concrete)	29,600	SF	$ 5.00	$ 148,000	$ 12,726,500	Cimarron and Bijou medians and islands
Subtotal Core Items				$ 12,726,500	$ 12,726,500	
Miscellaneous Items as Percentages of Core Items			% of Core			
Removals, Resets & Adjustments			12%	$ 1,527,180		
Water Quality and Landscape			5%	$ 636,325		
Drainage (General)			18%	$ 2,290,770		
Signing,Striping, Signals, Lighting			17%	$ 2,163,505		
Utilities (General)			5%	$ 636,325		
Traffic Control			22%	$ 2,799,830	$ 10,053,935	
			79%			
Subtotal Core and Miscellaneous Items:				$ 22,780,435	$ 22,780,435	

Interstate 25
Cimarron and Bijou Interchanges Combined
Preliminary Cost Opinion

Wilson & Co., Felsburg Holt & Ullevig
Date: August 21,2003
By: DAK, MRH, and WD
Preliminary Cost Opinion

Item Description	Quantity	Unit	Unit Cost	Cost	Cost Extension	Remarks
Major Items						
Remove existing bridges	12	TOTAL		$ 700,000		
I-25 Bridge over Bear Creek				$ 1,025,000		Precast BT-Girder (16,550 SF)
I-25 Bridge over Cimarron Street				$ 4,425,000		Precast U-Girder (78,100 SF)
Cimarron Bridge over Fountain Creek				$ 1,400,000		Precast BT-Girder (27,850 SF)
Southbound Off Ramp Bridge over Fountain Creek				$ 475,000		Precast BT-Girder (9,700 SF)
Northbound On Ramp Bridge over Fountain Creek				$ 475,000		Precast BT-Girder (9,700 SF)
Bijou Bridge over I-25				$ 1,875,000		CIP Box-Girder (21,500 SF)
I-25 over Colorado Avenue				$ 3,425,000		Precast BT-Girder (57,550 SF)
Bijou Bridge over the UPRR and Monument Creek				$ 5,675,000		Steel Plate I-Girder (62,250 SF)
Retaining Walls				$ 5,925,000		CIP (41,575 SF) and MSE (71,650 SF)
Bijou Depression Drainage Outfall				$ 5,000,000		
Utility Relocations				$ 1,250,000		Underground existing overhead electrical (West)
Environment Mitigation				$ 1,775,000		Wetland, Humane Society, Monument Valley Park
Creek Improvements				$ 650,000		Fountain Creek and Bear Creek
WPA Wall Mitigation				$ 300,000		Bijou South (5900 SF)
Traffic Signals				$ 1,000,000	$ 35,375,000	4 intersections
Total Core Items, Miscellaneous Items, and Major Items					$ 58,155,435	
Totals						
Core Items, Miscellaneous Items, and Major Items				$ 58,155,435		
Contingencies			25%	$ 14,538,859		
Construction Total				$ 72,694,294		
Design Fee			4%	$ 2,907,772		
Total Project Cost				**$ 75,602,066**		

Interstate 25
Bijou Interchange
Preliminary Cost Opinion

Wilson & Company
Date: August 21, 2003
By: DAK and WD
Preliminary Cost Opinion

Item Description	QTY	Unit	Unit Cost	Item Cost	Cost Extension	Remarks
Core Items						
Earthwork (embankment)	67,000	CY	$ 7.00	$ 469,000		
ABC (Class 6)	29,800	TON	$ 15.00	$ 447,000		6" Depth under all pavements
HBP (8" thick)	4,900	TON	$ 42.00	$ 205,800		Bijou work/ non-bridge related
Concrete Pavement (8" thick)	15,400	SY	$ 31.00	$ 477,400		Ramps
Concrete Pavement (11" thick)	73,400	SY	$ 37.00	$ 2,715,800		Mainline
Guardrail Type 3	1,200	LF	$ 13.00	$ 15,600		Along EOP
Guardrail Type 6 (Double)	1,400	LF	$ 16.00	$ 22,400		Median past STA. 588+60
Guardrail Type 7	6,000	LF	$ 55.00	$ 330,000		Along EOP
Bridgerail Type 10M	2,300	LF	$ 92.00	$ 211,600		At retaining walls
Impact Attenuator	1	EA	$ 25,000.00	$ 25,000		
Concrete Sidewalk	1,400	SY	$ 28.00	$ 39,200		Bijou Street
Curb and Gutter (Type 2) (Section I-B)	3,250	LF	$ 11.00	$ 35,750		Bijou Medians and Islands
Curb and Gutter (Type 2) (Section II-B)	2,200	LF	$ 13.00	$ 28,600		Bijou Street
Median Cover Material (Patterned Concrete)	10,500	SF	$ 5.00	$ 52,500	$ 5,075,650	Bijou Medians and Islands
Subtotal Core Items				$ 5,075,650	$ 5,075,650	
Miscellaneous Items as Percentages of Core Items			% of Core			
Removals, Resets & Adjustments			12%	$ 609,078		
Water Quality and Landscape			5%	$ 253,783		
Drainage (General)			18%	$ 913,617		
Signing,Striping, Signals, Lighting			17%	$ 862,861		
Utilities (General)			5%	$ 253,783		
Traffic Control			22%	$ 1,116,643	$ 4,009,764	
			79%			
Major Items						
Remove existing bridges	5	Total	$ 350,000	$ 350,000		
Bijou Bridge over I-25				$ 1,875,000		CIP Box-Girder (21,500 SF)
I-25 over Colorado Avenue				$ 3,425,000		Precast U-Girder (57,550 SF)
Bijou Bridge over the UPRR and Monument Creek				$ 5,675,000		Steel Plate I-Girder (62,250 SF)
Retaining Walls				$ 3,350,000		CIP (38,550 SF) and MSE 10,875 SF)
Bijou Depression Drainage Outfall				$ 5,000,000		
Utility Relocations				$ 250,000		Sanitary Sewer and Waterline (West)
Environment Mitigation				$ 1,525,000		Monument Valley Park (South) Noise & Visual Barriers
WPA Wall Mitigation				$ 300,000		Bijou South (5900 SF)
Traffic Signals				$ 500,000	$ 22,250,000	2 Intersections
Total Core Items, Miscellaneous Items, and Major Items					$ 31,335,414	
Totals						
Core Items, Miscellaneous Items, and Major Items				$ 31,335,414		
Contingencies			25%	$ 7,833,853		
Construction Total				$ 39,169,267		
Design Fee			4%	$ 1,566,771		
Total Project Cost				$ 40,736,038		

Interstate 25
Cimarron Interchange
Preliminary Cost Opinion

Felsburg Holt & Ullevig, and Wilson & Co.
Date: August 21,2003
By: MRH and WD
Preliminary Cost Opinion

Item Description	Quantity	Unit	Unit Cost	Cost	Cost Extension	Remarks
Core Items						
Earthwork (embankment)	353,000	CY	$ 7.00	$ 2,471,000		
ABC (Class 6)	35,200	TON	$ 15.00	$ 528,000		6" depth under all pavements
HBP (8")	2,300	TON	$ 42.00	$ 96,600		Cimarron tie-in pavements
Concrete Pavement (8")	9,200	SY	$ 31.00	$ 285,200		Cimarron Street intersections
Concrete Pavement (8")	14,100	SY	$ 31.00	$ 437,100		Ramps
Concrete Pavement (11")	89,100	SY	$ 37.00	$ 3,296,700		Mainline
Guardrail Type 3	2,800	LF	$ 13.00	$ 36,400		Along EOP
Guardrail Type 7	5,100	LF	$ 55.00	$ 280,500		In median
Bridgerail Type 10M	0	LF	$ 92.00	$ -		
Impact Attenuator	0	EA	$ 25,000.00	$ -		
Concrete Sidewalk	1,750	SY	$ 28.00	$ 49,000		Trail at Fountain Creek and Bear Creek
Curb and Gutter (Type 2)(Section IB)	3,200	LF	$ 11.00	$ 35,200		Cimarron medians and islands
Curb and Gutter (Type 2)(Section IIB)	3,050	LF	$ 13.00	$ 39,650		Cimarron Street
Median Cover Material (Patterned Concrete)	19,100	SF	$ 5.00	$ 95,500	$ 7,650,850	Cimarron medians and islands
Subtotal Core Items				$ 7,650,850	$ 7,650,850	
Miscellaneous Items as Percentages of Core Items			% of Core			
Removals, Resets & Adjustments			12%	$ 918,102		
Water Quality and Landscape			5%	$ 382,543		
Drainage (General)			18%	$ 1,377,153		
Signing,Striping, Signals, Lighting			17%	$ 1,300,645		
Utilities (General)			5%	$ 382,543		
Traffic Control			22%	$ 1,683,187	$ 6,044,172	
			79%			
Major Items						
Remove existing bridges	7	Total	$ 350,000	$ 350,000		
I-25 Bridge over Bear Creek				$ 1,025,000		Precast BT-Girder (16,550 SF)
I-25 Bridge over Cimarron Street				$ 4,425,000		Precast U-Girder (78,100 SF)
Cimarron Bridge over Fountain Creek				$ 1,400,000		Precast BT-Girder (27,850 SF)
Southbound Off Ramp Bridge over Fountain Creek				$ 475,000		Precast BT-Girder (9,700 SF)
Northbound On Ramp Bridge over Fountain Creek				$ 475,000		Precast BT-Girder (9,700 SF)
Retaining Walls				$ 2,575,000		CIP (3,025 SF) and MSE (60,775 SF)
Utility Relocations				$ 1,000,000		Underground existing overhead electrical (West)
Environment Mitigation				$ 250,000		Wetland Mitigation and Humane Society Improvements
Creek Improvements				$ 650,000		Fountain Creek and Bear Creek
Traffic Signals				$ 500,000	$ 13,125,000	2 intersections
Total Core Items, Miscellaneous Items, and Major Items					$ 26,820,022	
Totals						
Core Items, Miscellaneous Items, and Major Items				$ 26,820,022		
Contingencies			25%	$ 6,705,005		
Construction Total				$ 33,525,027		
Design Fee			4%	$ 1,341,001		
Total Project Cost				$ 34,866,028		

COLORADO DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-25 AT CIMARRON AND BIJOU

The 1999 Standard Specifications for Road and Bridge Construction controls construction of this project. The following special provisions supplement or modify the Standard Specifications and plans. When specifications special provisions contain both English units and SI units, the English units apply and are the specification requirement.

PROJECT SPECIAL PROVISIONS

COLORADO DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-25 AT CIMARRON AND BIJOU
PROJECT SPECIAL PROVISIONS

COLORADO DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-25 AT CIMARRON AND BIJOU
PROJECT SPECIAL PROVISIONS

COLORADO DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-25 AT NEVADA/TEJON, SOUTH NEVADA AVENUE (SH 85) BRIDGE OVER FOUNTAIN CREEK
STANDARD SPECIAL PROVISIONS

		No. of Pages
Revision of Section 101-Holidays	(May 31, 2001)	1
Revision of Sections 101 and 105 – Duties of the Engineer	(Nov. 5, 1999)	1
Revision of Sections 101 and 108 – Workplace Violence	(March 15, 2002)	1
Revision of Section 103 – Contract Bonds	(Nov. 5, 1999)	1
Revision of Section 103 – Escrow of Proposal Documentation	(July 21, 1999)	3
Revision of Section 105 – Conformity with Plans and Specifications	(Sept. 6, 2002)	5
Revision of Section 105 – Disputes and Claims for Contract Adjustments	(Nov. 5, 1999)	12
Revision of Sections 105 and 106 – Quality of Hot Bituminous Pavement	(March 6, 2003)	9
Revision of Sections 105, 106, and 412 – Quality of Portland Cement Concrete Pavement (Alternative Strength Criteria)	(June 13, 2003)	11
Revision of Sections 105, 202, 401, 405, 406, and 412 – Roadway Smoothness	(Dec. 20, 2002)	10
Revision of Sections 105 and 618 – Contractor Submittals	(June 6, 2002)	1
Revisions of Sections 106 and 620 – Qualification of Testing Personnel and Laboratories	(Oct. 4, 2001)	1
Revision of Section 108 – Liquidated Damages	(June 13, 2003)	1
Revision of Section 108 – Notice to Proceed	(Dec. 20, 2002)	1
Revision of Section 108 – Project Schedule	(March 4, 2002)	2
Revision of Section 108 – Subletting of Contract	(Sept. 6, 2002)	1
Revision of Section 109-Adjustments for Changes in Common Carrier Rates	(May 31, 2001)	1
Revision of Section 109-Fuel Cost Adjustments	(May 31, 2001)	1
Revision of Section 109 – Measurement of Quantities	(July 21, 1999)	1
Revision of Section 109 – Partial Payments	(Oct. 5, 2000)	2
Revision of Section 203-Proof Rolling	(March 4, 2002)	1
Revision of Section 206 – Shoring	(July 18, 2003)	2
Revision of Section 208 – Erosion Control	(July 21, 1999)	2
Revision of Section 208 – Erosion Control Supervisor	(March, 6, 2003)	1
Revision of Section 209-Dust Palliatives	(May 31, 2001)	1
Revision of Section 401 – Compaction Test Section	(Sept. 6, 2002)	3
Revision of Section 401 – Plant Mix Pavements	(July 21, 1999)	1
Revision of Section 401 – Plant Mix Pavements - General	(Dec. 20, 2002)	2
Revision of Section 401 – Weather Limitations and Placement Temperatures	(March 4, 2002)	2
Revision of Sections 401 and 703 – Composition of Mixtures (Non-Voids Acceptance)	(Aug. 20, 1999)	3
Revision of Sections 412 – Portland Cement Concrete Pavement	(March 6, 2003)	6
Revision of Sections 412 and 705 – Preformed Compression Seals	(July 21, 1999)	2
Revision of Section 509 – Stud Welding	(March 4, 2002)	1
Revision of Section 512 – Bearing Devices	(June 13, 2003)	1
Revision of Sections of 601 and 618 – Permanent Bridge Deck Forms	(July 18, 2003)	2
Revision of Section 601 – Structural Concrete	(June 13, 2003)	13
Revision of Sections 601 and 708 – Structural Concrete Coating	(July 21, 1999)	3
Revision of Section 602 – Installation of Tie Wire	(March 4, 2002)	1
Revision of Section 606-Guardrail Terminals and Transitions	(May 31, 2001)	1
Revision of Section 606 – Guardrail Type 7 (F-Shape Concrete Barrier)	(July 2, 2002)	2
Revision of Section 606 – Precast Type 7 Concrete Barrier	(July 2, 2002)	1
Revision of Section 613 – Screw-In Light Standard Foundations	(July 21, 1999)	2
Revision of Section 614-Traffic Signal Poles	(May 31, 2001)	1
Revision of Section 620 – Field Laboratories with Forced Air Convection Oven	(March 6, 2003)	3
Revision of Section 629 – Survey Monumentation	(Dec. 20, 2002)	1
Revision of Section 630 – Construction Zone Traffic Control	(Nov. 30, 2000)	4

COLORADO DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
I-25 AT NEVADA/TEJON, SOUTH NEVADA AVENUE (SH 85) BRIDGE OVER FOUNTAIN CREEK
STANDARD SPECIAL PROVISIONS

		No. of Pages
Revision of Section 630 – Method of Handling Traffic	(Dec. 20, 2002)	1
Revision of Section 630 – NCHRP 350 Requirements	(Sept. 26, 2000)	1
Revision of Section 630 – Signing for Double Fines	(June 13, 2003)	1
Revision of Section 701 – Hydraulic Cement	(March 6, 2003)	2
Revision of Section 702 – SuperPave PG Binders	(Sept. 6, 2002)	1
Revision of Section 703 – Concrete Aggregates	(March 6, 2003)	1
Revision of Section 706 –Concrete Pipes	(Dec. 20, 2001)	1
Revision of Section 713 – Epoxy Pavement Marking Material	(June 8, 2000)	1
Affirmative Action Requirements – Equal Employment Opportunity	(July 21, 1999)	10
Disadvantaged Business Enterprise – Definitions and Requirements	(Dec. 20, 2002)	10
Emerging Small Business Program	(March 15, 2002)	8
Materials and Labor Used, Form FHWA-47	(July 21, 1999)	1
Minimum Wages Colorado, U.S. Department of Labor General Decision Numbers CO030014 and CO030015, Highway Construction, Statewide	(June 13, 2003)	8
On the Job Training	(Dec. 20, 2002)	4
Partnering Program	(July 21, 1999)	1
Railroad Insurance	(July 21, 1999)	1
Required Contract Provisions – Federal-Aid Construction Contracts	(July 21, 1999)	11
Special Notice to Contractors	(Jan. 17, 2003)	4

FELSBURG HOLT & ULLEVIG

Memo

To: Elizabeth Stolfus

From: Stephanie Sangaline

CC: Rob Refvem

Date: October 4, 2002

Re: Cimarron-Bijou - Opinion of Vibration Impact to Historic Buildings

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As requested, we have investigated the criteria and potential for vibration impact to several historic buildings, in relation to this project. The following information outlines the data reviewed, and our opinion of the potential impact.

Criteria Reviewed: Transit Noise and Vibration Impact Assessment – Final Report
April 1995
Prepared for the Federal Transit Administration (FTA), Washington, D.C.

It should be noted that this criteria manual is predominantly directed toward transit and train operation noise and vibration, as the source. Receivers are primarily residential properties, and buildings with vibration-sensitive equipment, such as electron microscopes.

However, there is some discussion regarding rubber-tire transportation corridors, and references to "fragile historic buildings", from which we developed this information and opinion.

There are two vibration scenarios to be considered:
1. On-going Vibration – permanent due to the highway corridor
2. Vibration during Construction – temporary due to construction activities

This memorandum includes the Summary of Findings and Recommendations, followed by the detailed analysis and exhibits.

Summary of Findings and Recommendations

On-going Vibration –

There are roadways in the vicinity of the five buildings that are the subject of this analysis. Those roadways are traveled regularly by a variety of vehicles.

Due to lack of verifiable information regarding the building materials and foundations of the five structures, it was assumed, conservatively, that the building materials, construction and foundation are wood frame and propagate vibration easily. However, the area geology and lack of complaint history does not support the conclusion that on-going vibration impact, even as a result of current traffic, is a problem. Due to the close proximity of existing driving lanes that are not restricted as to size, weight and type of vehicle usage, it is not anticipated that the buildings in question will experience any more intense on-going vibration than exists currently.

To further refine this evaluation, verification of building materials and foundations would be needed. In the absence of additional data, and to support this opinion of no *additional* on-going vibration impact, a "current condition" photo log of these facilities should be taken to document the baseline condition of the buildings prior to and following construction associated with this project. It is suggested that similar views be taken once prior to construction, and two times following construction (immediately following and 3-6 months following) to inspect for changes as a result of on-going close proximity roadway usage.

To firmly document the effects of vibration on these facilities as a result of this project, a full structural evaluation could be completed for each building prior to construction. Following construction, a follow up evaluation and documentation would verify the effects, if any, as a result of this project.

Vibration During Construction –

St. Mary's School Administration Building –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 380 feet is anticipated.

2. Pavement removal and earthwork activities using jackhammers and small bulldozers at a distance of 15 feet results in no vibration impact as a result of these activities.

Restricted Activities:

1. Pavement removal and earthwork activities using a large bulldozer are restricted to not closer than 20' – 6" to the building to avoid impact as a result of vibration.

2. Construction traffic of all types, most notably loaded trucks, are restricted to not closer than 18' – 6" to the building to avoid impact as a result of vibration.

Recommendations:

1. Produce a photo log of the building prior to and following construction
2. Provide demarcation (fencing/cones) to limit proximity of construction equipment to the allowable distance
3. Provide the Contractor with written and oral instruction regarding construction limitations

St. Mary's School Church –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 315 feet is anticipated.

2. Pavement removal and earthwork activities using jackhammers and small bulldozers at a distance of 15 feet results in no vibration impact as a result of these activities.

3. Construction traffic, including loaded trucks, at a distance of 20 feet results in no vibration impact as a result of this activity.

Restricted Activities:

1. Pavement removal and earthwork activities using a large bulldozer are restricted to not closer than 20' – 6" to the building to avoid impact as a result of vibration.

Recommendations:

1. Produce a photo log of the building prior to and following construction
2. Provide demarcation (fencing/cones) to limit proximity of construction equipment to the allowable distance
3. Provide the Contractor with written and oral instruction regarding construction limitations

Knights of Columbus –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 485 feet is anticipated.

2. Pavement removal and earthwork activities using jackhammers, small bulldozers or large bulldozers at a distance of 50 feet results in no vibration impact as a result of these activities.

3. Construction traffic, including loaded trucks, at a distance of 50 feet results in no vibration impact as a result of this activity.

Restricted Activities: None within the types of activities and equipment evaluated in this analysis.

Recommendations:

1. Produce a photo log of the building prior to and following construction
2. Provide the Contractor with written and oral instruction regarding allowable construction activities, equipment and distances.

Library –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 572 feet is anticipated.

2. Pavement removal and earthwork activities using jackhammers, small bulldozers or large bulldozers at a distance of 150 feet results in no vibration impact as a result of these activities.

3. Construction traffic, including loaded trucks, at a distance of 150 feet results in no vibration impact as a result of this activity.

Restricted Activities: None within the types of activities and equipment evaluated in this analysis.

Recommendations:

1. Produce a photo log of the building prior to and following construction
2. Provide the Contractor with written and oral instruction regarding allowable construction activities, equipment and distances.

Railroad Depot –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 788 feet is anticipated.

2. Retaining wall construction that may involve any of the following methods at a distance of 434 feet results in no vibration impact to the building as a result of this activity:
   - Pile driver (impact)
   - Pile driver (sonic)
   - Clam shovel drop (slurry wall)
   - Hydromill (slurry wall)

Restricted Activities: None within the types of activities and equipment evaluated in this analysis.

Recommendations:

1. Produce a photo log of the building prior to and following construction
2. Provide the Contractor with written and oral instruction regarding allowable construction activities, equipment and distances.

NOTE: Calculations and results are for the distances shown on the attached exhibits and the equipment listed only. No assumptions should be made with regard to other distances or other types of equipment without revisiting the FTA guidelines for the specific scenario in question.

Detailed Analysis and Exhibits

On-going Vibration:

Levels of Vibration -
The background vibration velocity level in residential areas is usually 50 VdB (vibration decibels) or lower, well below the threshold of perception for humans which is around 65 VdB. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.

The attached Figure 7-3 from the FTA manual illustrates common vibration sources and human and structural response to ground-borne vibration. The range of interest is from approximately 50 VdB to 100 VdB. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. Electron microscopes and high-resolution lithography equipment are typical of equipment that is highly sensitive to vibration.

Although the perceptibility threshold is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. This is a typical level 50 feet from a rapid transit or light rail system. Buses and trucks rarely create vibration that exceeds 70 VdB unless there are bumps in the road.

The guidelines indicate that it is extremely rare for vibration from *train* operations to cause any sort of building damage, even minor cosmetic damage. However, there is sometimes concern about damage to fragile historic buildings. Even in these cases, damage is unlikely except when the *track* will be very close to the structure. In terms of roadways with rubber tire vehicles, most complaints about vibration caused by buses and trucks are related to rattling of windows or items hung on the walls. These vibrations are usually the result of airborne noise and not ground-borne vibration. In the case where ground-borne vibration is the source of the problem, the vibration can usually be related to potholes, some sort of bump in the road, or other irregularities.

Receiving Structures -
The vibration levels inside a building are dependent on the vibration energy that reach the building foundation, the coupling of the building foundation to the soil, and the propagation of the vibration through the building. The general guideline is that the heavier the building is, the lower the response will be to the incident vibration energy. Wood frame buildings, such as the typical residential structure, are more easily excited by ground vibration than heavier buildings. In contrast, large masonry buildings with spread footings have a low response to ground vibration.

No verifiable information is available regarding the building materials, construction or foundation type for any of the buildings in question. With this in mind, the conservative assumption is made that the building materials and foundations support high vibration propagation.

Geology –
The FTA guidelines indicate that there are situations where ground-borne vibration propagates much more efficiently than normal. The result is unacceptable vibration levels at distances two to three times the normal distance. Unfortunately, the geologic conditions that promote efficient propagation have not been well documented and are not fully understood. Shallow bedrock or stiff clay soil often are involved. One possibility is that shallow bedrock acts to keep the vibration energy near the surface. Much of the energy that would normally radiate down is directed back towards the surface by the rock layer with the result that the ground surface vibration is higher than normal. Generally, it is more difficult to get vibration energy into rock. Therefore, propagation through rock usually results in lower vibration than propagation through soil. Some geologic conditions are repeatedly associated with efficient propagation. Shallow bedrock, less than 30 feet below the surface, is likely to have efficient propagation. Other factors that can be important are soil type and stiffness. In particular, stiff clayey soils have sometimes been associated with efficient vibration propagation.

In order to effectively determine if vibration propagation occurs to a facility, it is best to review available geological data and any complaint history from the facilities where the propagation is possible.

Review of the closest soil borings to the buildings in question indicate that under 1-2 feet of base course/paving or fill material, the soil is clayey sand and sandy clay or sand to a depth of between 38 and 53 feet, underlain by claystone bedrock. The bedrock does not appear to be shallow enough to enhance vibration propagation. The soil type is not described as stiff, and therefore also is not likely to have efficient propagation of vibration.

No documented complaint data associated with vibration to these buildings was found.

Other Considerations -
Calculations were completed as part of the Vibration During Construction portion of the analysis (next section) regarding distance between "loaded trucks" and "extremely fragile historic buildings." Those calculations determined that loaded trucks could have a vibration impact on extremely fragile historic buildings at a distance of 18'-6" or closer. This is mentioned in the On-going Vibration discussion because the existing pavement and driving lanes in the vicinity of the St. Mary's School Administration building, the Knights of Columbus building and the Library are less than the allowable 18'-6". This distance is not a result of this project, but rather an existing condition. Therefore on-going vibration from loaded trucks, of any kind, within 18'-6" of these facilities may be having a vibration impact on these buildings as the trucks travel in the close proximity lanes currently.

Conclusions -
Despite the assumption that the building materials, construction and foundation may be wood frame and propagate vibration easily, the area geology and lack of complaint history does not support the conclusion that on-going vibration impact as a result of this project will occur. Due to the close proximity of existing driving lanes that are not restricted as to size, weight and type of vehicle usage, it is not anticipated that the buildings in question will experience any more intense on-going vibration than exists currently.

Vibration during Construction:
The FTA manual provides a procedure for estimating the potential vibration at sensitive structures based on the distance from the equipment to the structure, and the type of equipment to be used. To use this procedure, we identified the closest construction activities to each of the facilities, and the anticipated types of equipment at each of those locations. The attached exhibit shows those activities and distances.

The equation used is as follows:

$PPV_{equip} = PPV_{ref} \times [25/D]^{1.5}$, where

PPV_{equip} = peak particle velocity in in/sec of the equipment adjusted for distance
PPV_{ref} = reference vibration level in in/sec at 25 feet (from attached Table 12-2)
D = distance from the equipment to the receiver

The "vibration damage" threshold criterion for "extremely fragile historic buildings" is 0.12 in/sec (or 95 VdB). The following tables summarize the findings of this analysis for each structure.

St Mary's School Administration Building

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	380	Caisson drilling	0.089	0.0015	0.12	Well below threshold	N/A
Pavement removal / earthwork	15	Large bulldozer	0.089	0.1915	0.12	**Above allowable threshold**	Closest distance for this equipment is 20'-6"
Pavement removal	15	Jackhammer	0.035	0.0753	0.12	Well below threshold	N/A
Construction Traffic – Loaded Trucks *	15	Loaded trucks	0.076	0.1635	0.12	**Above allowable threshold**	Closest distance for this equipment is 18'-6"
Pavement removal / earthwork	15	Small bulldozer	0.003	0.0065	0.12	Well below threshold	N/A

* It should be noted that the existing pavement and driving lanes in the vicinity of this building are 15 feet away. This distance is not a result of this project. This analysis indicates that vibration from loaded trucks may be having an impact on this structure as they travel in the close proximity lanes currently. A current condition photo log of this facility should be taken to document the baseline condition of this building, prior to construction associated with this project. Otherwise, vibration impacts to this structure that may be a result of past and current traffic in close proximity to the building, may be misconstrued as being a result of activities associated with this project.

St Mary's Church

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	315	Caisson drilling	0.089	0.002	0.12	Well below threshold	N/A
Pavement removal / earthwork	20	Large bulldozer	0.089	0.1244	0.12	**Just above allowable threshold**	Closest distance for this equipment is 20'-6"
Pavement removal	20	Jackhammer	0.035	0.0489	0.12	Well below threshold	N/A
Construction Traffic – Loaded Trucks *	20	Loaded trucks	0.076	0.1062	0.12	Below allowable threshold	N/A
Pavement removal / earthwork	20	Small bulldozer	0.003	0.0042	0.12	Well below threshold	N/A

* It should be noted that the existing pavement and driving lanes in the vicinity of this building are about 16 feet away. This distance is not a result of this project. This analysis indicates that vibration from loaded trucks within 18'-6" (from the St. Mary's School Administration Building analysis) may be having an impact on this structure as they travel in the close proximity lanes currently. A current condition photo log of this facility may be necessary to set the baseline condition of this building, prior to construction associated with this project. Otherwise, vibration impacts to this structure that may be a result of past and current traffic in

close proximity to the building, may be misconstrued as being a result of activities associated with this project.

Knights of Columbus

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	485	Caisson drilling	0.089	0.0010	0.12	Well below criteria	N/A
Pavement removal / earthwork	50	Large bulldozer	0.089	0.0315	0.12	Well below criteria	N/A
Pavement removal	50	Jackhammer	0.035	0.0124	0.12	Well below criteria	N/A
Construction Traffic – Loaded Trucks *	50	Loaded trucks	0.076	0.0269	0.12	Well below criteria	N/A
Pavement removal / earthwork	50	Small bulldozer	0.003	0.0011	0.12	Well below criteria	N/A

Library

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	572	Caisson drilling	0.089	0.0008	0.12	Well below criteria	N/A
Pavement removal / earthwork	150	Large bulldozer	0.089	0.0061	0.12	Well below criteria	N/A
Pavement removal	150	Jackhammer	0.035	0.0024	0.12	Well below criteria	N/A
Construction Traffic – Loaded Trucks *	150	Loaded trucks	0.076	0.0052	0.12	Well below criteria	N/A
Pavement removal / earthwork	150	Small bulldozer	0.003	0.0002	0.12	Well below criteria	N/A

Railroad Depot

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	788	Caisson drilling	0.089	0.0005	0.12	Well below criteria	N/A
Retaining Wall	434	Pile Driver (Impact)	1.518	0.0210	0.12	Well below criteria	N/A
Retaining Wall	434	Pile Driver (Sonic)	0.734	0.0101	0.12	Well below criteria	N/A
Retaining Wall	434	Clam Shovel Drop (Slurry Wall)	0.202	0.0028	0.12	Well below criteria	N/A
Retaining Wall	434	Hydromill (Slurry Wall)	0.017	0.0002	0.12	Well below criteria	N/A

Consideration of annoyance or interference with vibration-sensitive activities is evaluated by calculating the vibration level, L_v, at any distance, D, from the construction activity. The equation used is as follows:

$L_v(D) = L_v(25\text{ ft}) - 20\log[D/25]$, where

L_v = velocity in decibels (VdB)
D = distance from the equipment to the receiver

The threshold criterion for "extremely fragile historic buildings" is 95 VdB. The following tables summarize the findings of this analysis for each structure.

St. Mary's School Administration Building

Activity	Distance (D) (ft)	Equipment	L_v at 25 ft.	L_v at Distance, D	Threshold Criteria (VdB)	Comments
Caisson for new viaduct	380	Caisson drilling	87	63	95	Below allowable threshold
Pavement removal/earthwork	15	Large bulldozer	87	91	95	Below allowable threshold
Pavement removal	15	Jackhammer	79	83	95	Below allowable threshold
Construction traffic – Loaded Trucks	15	Loaded Trucks	86	90	95	Below allowable threshold
Pavement removal/earthwork	15	Small bulldozer	58	62	95	Below allowable threshold

St. Mary's School Church

Activity	Distance (D) (ft)	Equipment	L_v at 25 ft.	L_v at Distance, D	Threshold Criteria (VdB)	Comments
Caisson for new viaduct	315	Caisson drilling	87	65	95	Below allowable threshold
Pavement removal/earthwork	20	Large bulldozer	87	89	95	Below allowable threshold
Pavement removal	20	Jackhammer	79	81	95	Below allowable threshold
Construction traffic – Loaded Trucks	20	Loaded Trucks	86	88	95	Below allowable threshold
Pavement removal/earthwork	20	Small bulldozer	58	60	95	Below allowable threshold

Knights of Columbus

Activity	Distance (D) (ft)	Equipment	L_v at 25 ft.	L_v at Distance, D	Threshold Criteria (VdB)	Comments
Caisson for new viaduct	485	Caisson drilling	87	61	95	Below allowable threshold
Pavement removal/earthwork	50	Large bulldozer	87	81	95	Below allowable threshold
Pavement removal	50	Jackhammer	79	73	95	Below allowable threshold
Construction traffic – Loaded Trucks	50	Loaded Trucks	86	80	95	Below allowable threshold
Pavement removal/earthwork	50	Small bulldozer	58	52	95	Below allowable threshold

Library

Activity	Distance (D) (ft)	Equipment	L_v at 25 ft.	L_v at Distance, D	Threshold Criteria (VdB)	Comments
Caisson for new viaduct	572	Caisson drilling	87	60	95	Below allowable threshold
Pavement removal/earthwork	150	Large bulldozer	87	71	95	Below allowable threshold
Pavement removal	150	Jackhammer	79	63	95	Below allowable threshold
Construction traffic – Loaded Trucks	150	Loaded Trucks	86	70	95	Below allowable threshold
Pavement removal/earthwork	150	Small bulldozer	58	42	95	Below allowable threshold

Railroad Depot

Activity	Distance (D) (ft)	Equipment	L_v at 25 ft.	L_v at Distance, D	Threshold Criteria (VdB)	Comments
Caisson for new viaduct	788	Caisson drilling	87	57	95	Below allowable threshold
Retaining Wall	434	Pile Driver (Impact)	112	87	95	Below allowable threshold
Retaining Wall	434	Pile Driver (Sonic)	105	80	95	Below allowable threshold
Retaining Wall	434	Clam Shovel Drop (Slurry Wall)	94	69	95	Below allowable threshold
Retaining Wall	434	Hydromill (Slurry Wall)	75	50	95	Below allowable threshold

Based on the results of this evaluation, it is not anticipated that the proposed project will have vibration impacts on the five building facilities during construction.

Although none of the construction activities are anticipated to have vibration impacts on the facilities, the FTA manual provides guidance regarding avoidance of potential vibration which can be included in the construction specifications or in an agreement with or instructions to the Contractor. These guidelines offer suggestions regarding design considerations, sequencing of operations, and construction methods which will help control the level of vibration.

Attachments
FTA Figure 7-3 Typical Levels of Ground-Borne Vibration
FTA Table 12-2 Vibration Source Levels for Construction Equipment
Vibration Impact Exhibits – Bijou Street Area (3 – 11 x 17 exhibits)
Closest Caisson Construction
Closest Pavement Removal

FELSBURG HOLT & ULLEVIG

Memo

To: Elizabeth Stolfus

From: Stephanie Sangaline

CC: Rob Refvem

Date: October 31, 2002

Re: Cimarron-Bijou - Opinion of Vibration Impact to the **Historic Monument Valley Park Entrance Arch**

As requested, we have investigated the criteria and potential for vibration impact to an historic arch, located in close proximity to Bijou Street. The following information outlines the data reviewed, and our opinion of the potential impact.

Criteria Reviewed: Transit Noise and Vibration Impact Assessment – Final Report
April 1995
Prepared for the Federal Transit Administration (FTA), Washington, D.C.

It should be noted that this criteria manual is predominantly directed toward transit and train operation noise and vibration, as the source. Receivers are primarily residential properties, and buildings with vibration-sensitive equipment, such as electron microscopes.

However, there is some discussion regarding rubber-tire transportation corridors, and references to "fragile historic buildings", from which we developed this information and opinion.

There are two vibration scenarios to be considered:
1. On-going Vibration – permanent due to the highway corridor
2. Vibration during Construction – temporary due to construction activities

This memorandum includes the Summary of Findings and Recommendations, followed by the detailed analysis and exhibits.

Memorandum
October 31, 2002

Summary of Findings and Recommendations

On-going Vibration –

The historic arch is about 8 feet from the curb face of Bijou Street. This roadway is traveled regularly by a variety of vehicles.

From observation only, it appears the arch is a heavy masonry or stone structure. This type of material would not propagate vibration easily. Area geology does not support the conclusion that on-going vibration impact, even as a result of current traffic, is a problem. Due to the close proximity of existing driving lanes that are not restricted as to size, weight and type of vehicle usage, it is not anticipated that the arch will experience any more intense on-going vibration than exists currently.

To further refine this evaluation, verification of materials and foundation type would be needed. In the absence of additional data, and to support this opinion of no *additional* on-going vibration impact, a "current condition" photo log of the arch should be taken to document its baseline condition prior to and following construction associated with this project. It is suggested that similar views be taken once prior to construction, and two times following construction (immediately following and 3-6 months following) to inspect for changes as a result of on-going close proximity roadway usage.

To firmly document the effects of vibration on this historic arch as a result of this project, a full structural evaluation could be completed. Following construction, a follow up evaluation and documentation would verify the effects, if any, as a result of this project.

Vibration During Construction –

Historic Arch –

Allowable Activities:

1. Calculations for caisson drilling activities result in vibration levels well below allowable thresholds for "extremely fragile historic buildings." Therefore no vibration impact as a result of caisson drilling at 123 feet is anticipated.

2. Pavement removal and earthwork activities using small bulldozers at a distance of 8 feet results in no vibration impact as a result of these activities.

Restricted Activities:

1. Pavement removal and earthwork activities using jackhammers and large bulldozers are restricted. Jackhammers should not be used closer than 11'-0" to the arch. Large bulldozers should not be used closer than 20' – 6" to the arch to avoid impact as a result of vibration.

2. Construction traffic of all types, most notably loaded trucks, are restricted to not closer than 18' – 6" to the arch to avoid impact as a result of vibration.

Recommendations:

1. Produce a photo log of the arch prior to and following construction
2. Provide demarcation (fencing/cones) to limit proximity of construction equipment to the allowable distance
3. Provide the Contractor with written and oral instruction regarding construction limitations

NOTE: Calculations and results are for the distances shown on the attached exhibits and the equipment listed only. No assumptions should be made with regard to other distances or other types of equipment without revisiting the FTA guidelines for the specific scenario in question.

Detailed Analysis and Exhibits

On-going Vibration:

Levels of Vibration -
The background vibration velocity level in residential areas is usually 50 VdB (vibration decibels) or lower, well below the threshold of perception for humans which is around 65 VdB. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.

The attached Figure 7-3 from the FTA manual illustrates common vibration sources and human and structural response to ground-borne vibration. The range of interest is from approximately 50 VdB to 100 VdB. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. Electron microscopes and high-resolution lithography equipment are typical of equipment that is highly sensitive to vibration.

Although the perceptibility threshold is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. This is a typical level 50 feet from a rapid transit or light rail system. Buses and trucks rarely create vibration that exceeds 70 VdB unless there are bumps in the road.

The guidelines indicate that it is extremely rare for vibration from *train* operations to cause any sort of building damage, even minor cosmetic damage. However, there is sometimes concern about damage to fragile historic buildings. Even in these cases, damage is unlikely except when the *track* will be very close to the structure. In terms of roadways with rubber tire vehicles, most complaints about vibration caused by buses and trucks are related to rattling of windows or items hung on the walls. These vibrations are usually the result of airborne noise and not ground-borne vibration. In the case where ground-borne vibration is the source of the problem, the vibration can usually be related to potholes, some sort of bump in the road, or other irregularities.

Receiving Structures -
The vibration levels inside a building are dependent on the vibration energy that reach the building foundation, the coupling of the building foundation to the soil, and the propagation of the vibration through the building. The general guideline is that the heavier the building is, the lower the response will be to the incident vibration energy. Wood frame buildings, such as the typical residential structure, are more easily excited by ground vibration than heavier buildings. In contrast, large masonry buildings with spread footings have a low response to ground vibration.

There is no specific information regarding structures, other than buildings. Therefore this arch is evaluated as though it is an historic building. Based on observation only, it appears the materials of the arch are masonry or heavy stone, which would not typically support high propagation of vibration.

Geology –
The FTA guidelines indicate that there are situations where ground-borne vibration propagates much more efficiently than normal. The result is unacceptable vibration levels at distances two to three times the normal distance. Unfortunately, the geologic conditions that promote efficient propagation have not been well documented and are not fully understood. Shallow bedrock or stiff clay soil often are involved. One possibility is that shallow bedrock acts to keep the vibration energy near the surface. Much of the energy that would normally radiate down is directed back towards the surface by the rock layer with the result that the ground surface vibration is higher than normal. Generally, it is more difficult to get vibration energy into rock. Therefore, propagation through rock usually results in lower vibration than propagation through soil. Some geologic

conditions are repeatedly associated with efficient propagation. Shallow bedrock, less than 30 feet below the surface, is likely to have efficient propagation. Other factors that can be important are soil type and stiffness. In particular, stiff clayey soils have sometimes been associated with efficient vibration propagation.

In order to effectively determine if vibration propagation occurs to a facility, it is best to review available geological data and any complaint history from the facilities where the propagation is possible.

Review of the closest soil borings to the arch indicate that under 1-2 feet of base course/paving or fill material, the soil is clayey sand and sandy clay or sand to a depth of between 38 and 53 feet, underlain by claystone bedrock. The bedrock does not appear to be shallow enough to enhance vibration propagation. The soil type is not described as stiff, and therefore also is not likely to have efficient propagation of vibration.

Other Considerations -
Calculations were completed as part of the Vibration During Construction portion of the analysis (next section) regarding distance between "loaded trucks" and "extremely fragile historic buildings." Those calculations determined that loaded trucks could have a vibration impact on extremely fragile historic buildings at a distance of 18'-6" or closer. This is mentioned in the On-going Vibration discussion because the existing pavement and driving lanes in the vicinity of the arch are less than the allowable 18'-6". This distance is not a result of this project, but rather an existing condition. Therefore on-going vibration from loaded trucks, of any kind, within 18'-6" of the arch may be having a vibration impact as the trucks travel in the close proximity lanes currently.

Conclusions -
Due to the observed arch materials along with the area geology, it is not anticipated that on-going vibration impact as a result of this project will occur. Due to the close proximity of existing driving lanes that are not restricted as to size, weight and type of vehicle usage, it is not anticipated that the arch will experience any more intense on-going vibration than exists currently.

Vibration during Construction:
The FTA manual provides a procedure for estimating the potential vibration at sensitive structures based on the distance from the equipment to the structure, and the type of equipment to be used. To use this procedure, we identified the closest construction activities to the arch, and the anticipated types of equipment at each of those locations. The attached exhibit shows those activities and distances.

The equation used is as follows:

$$PPV_{equip} = PPV_{ref} \times [25/D]^{1.5}, \text{ where}$$

PPV_{equip} = peak particle velocity in in/sec of the equipment adjusted for distance
PPV_{ref} = reference vibration level in in/sec at 25 feet (from attached Table 12-2)
D = distance from the equipment to the receiver

The "vibration damage" threshold criterion for "extremely fragile historic buildings" is 0.12 in/sec (or 95 VdB). The following tables summarize the findings of this analysis for each structure.

Historic Arch

Activity	Distance (D) (ft)	Equipment	PPV $_{ref}$ (in/sec)	PPV $_{equip}$ (in/sec)	Threshold Criteria (in/sec)	Comments	Distance from structure at which activity is allowable
Caisson drilling for new bridge	123	Caisson drilling	0.089	0.0082	0.12	Well below threshold	N/A
Pavement removal / earthwork	8	Large bulldozer	0.089	0.4917	0.12	**Above allowable threshold**	Closest distance for this equipment is 20'-6"
Pavement removal	8	Jackhammer	0.035	0.1933	0.12	**Above allowable threshold**	Closest distance for this equipment is 11'-0"
Construction Traffic – Loaded Trucks *	8	Loaded trucks	0.076	0.4198	0.12	**Above allowable threshold**	Closest distance for this equipment is 18'-6"
Pavement removal / earthwork	8	Small bulldozer	0.003	0.0166	0.12	Well below threshold	N/A

* It should be noted that the existing pavement and driving lanes in the vicinity of the arch are 8 feet away. This distance is not a result of this project. This analysis indicates that vibration from loaded trucks may be having an impact on this structure as they travel in the close proximity lanes currently. A current condition photo log of this feature should be taken to document the baseline condition of the arch, prior to construction associated with this project. Otherwise, vibration impacts to the arch that may be a result of past and current traffic in close proximity, may be misconstrued as being a result of activities associated with this project.

Consideration of annoyance or interference with vibration-sensitive activities is evaluated separately by calculating the vibration level, L_v, at any distance, D, from the construction activity. Because the historic arch does not house any habitable space or contain any potentially vibration sensitive equipment, this calculation does not apply to this feature, and was not completed as part of this evaluation.

Based on the results of this evaluation, it is not anticipated that the proposed project will have vibration impacts on the arch during construction.

Although none of the construction activities are anticipated to have vibration impacts on the historic arch, the FTA manual provides guidance regarding avoidance of potential vibration which can be included in the construction specifications or in an agreement with or instructions to the Contractor. These guidelines offer suggestions regarding design considerations, sequencing of operations, and construction methods which will help control the level of vibration.

Attachments
FTA Figure 7-3 Typical Levels of Ground-Borne Vibration
FTA Table 12-2 Vibration Source Levels for Construction Equipment
Vibration Impact Exhibit – Bijou Street Area (1 – 11 x 17 exhibit)
Closest Caisson Construction
Closest Pavement Removal

HANKARD ENVIRONMENTAL
ACOUSTICS AND VIBRATION CONSULTING

June 26, 2002

Mr. James Flohr
Colorado Department of Transportation – Region 2
1480 Quail Lake Loop, Suite A
Colorado Springs, CO 80906

Re: Traffic Noise and Vibration at the Raintree Office Plaza B

Dear Mr. Flohr,

Per your request, we recently completed a noise and vibration investigation at the Raintree Office Plaza B, 25 North Spruce Street, Colorado Springs, Colorado. This 3-story office building is adjacent to the southbound Interstate 25 on-ramp off of Bijou Street. The purpose of this investigation was to determine what effects the proposed alignment changes to I-25 and the southbound ramp will have on noise and vibration inside the building.

As explained in the subsequent paragraphs of this letter, noise and vibration levels were first measured at the site. Then, future levels were projected using the measured data, the proposed alignment of I-25 and the on-ramp, and projected future traffic volumes. Noise levels are not projected to exceed Federal Highway Administration guidelines for the type of activities currently taking place inside the building. Vibration levels are predicted to barely exceed perceptible levels.

Test Set-Up and Measurement Conditions

Noise measurements were conducted in Room 310 next to a closed window on the third floor facing the highway. Measurements were also conducted in the 1st floor conference room, also next to a closed window facing the highway. Finally, noise levels were measured outside the building at the fence line adjacent to the highway. Vibration measurements were conducted in Room 310, and in the stairwell on the 1st floor. Both vibration measurements were conducted on the floor, in the vertical direction.

During the measurements, Room 310 was unoccupied, but normal office activities were occurring elsewhere in the building. The first floor conference room was also unoccupied, however voices in the next room were slightly audible during the measurements. HVAC and other building mechanical systems were also operating. Vibration measurements were conducted according to recommendations listed in American National Standards Institute (ANSI) Standard s3.29-1983- *Guide to the Evaluation of Human Exposure to Vibration in Buildings.*

103 East Simpson Street • Lafayette, Colorado 80026
phone: (303) 666-0617 • fax (303) 666-1053 • www.hankardinc.com

Measurements of Existing Levels

Figure 1 shows the measured noise levels in octave band format. The X-axis is frequency of the noise and the Y-axis is amplitude. The overall level (Leq) for each measurement is shown in the legend on the right. The inside levels are quieter than at the fence line, which is primarily due to the window but also distance to the highway. The third floor measurement is louder than the first floor measurement likely because the 3rd floor does not have the benefit of the noise-absorbing effects of the ground.

Figures 2 and 3 show the measured levels of vibration. Each plot represents 40 consecutive 0.75 second-long measurements for a total time of 30 seconds. The amplitude is the overall level of vibration velocity from 3 Hz to 100 Hz, expressed as VdB, relative to 1E-6 inches per second (in/s), as recommended in ANSI Standard s3.29-1983.

Figure 2 shows the vibration levels measured in Room 310 with no human traffic nearby. Two heavy trucks passed by on the northbound and southbound lanes of I-25 at the times indicated by the arrows. The peak at 62 VdB is the highest measured that day. It is clear that the trucks had a measurable effect on the floor vibration. However, while the effect was measurable, it was not noticeable by the test engineers. This agrees with the accepted standard that 65 VdB is the threshold of human perception to vibration. It should be noted that many other trucks were observed passing by without any measurable effect in the building.

Figure 3 shows several more vibration measurements. The two lower curves were made on the first floor, in the stairwell. Their levels are lower since the floor here is concrete on grade, as opposed to the beam construction on the third floor. Note the measurement made on the third floor while a person climbed the stairs nearby. From this plot, it is clear that the vibration from the person climbing the stairs was higher than that from the trucks. This agrees with many other studies that indicate vibration from humans and mechanical equipment inside a building usually exceeds that from highway traffic.

Predictions of Future Levels

Noise levels were predicted for two future time frames. The first is "Opening Day," in 2006. The Opening Day prediction shows increases due mainly to moving the ramp and highway closer to the building, though some of the increase is due to the slight increase in traffic (assumed 2.5% per year). The second future time frame is Year 2020. The Year 2020 prediction shows noise increases that are due both to moving the highway closer to the building and to the projected increase in traffic volume.

The proposed alignment changes will move the ramp centerline from approximately 80 feet from the façade of the building to approximately 50 feet away. The centerline of I-25 would move from approximately 160 feet to approximately 130 feet away. The changes in distance will affect both the noise and the vibration levels in the building. Also, noise levels will increase due to the projected increase in traffic volume on I-25 and the on-ramp since noise is the cumulative effect of each vehicle.

Vibration levels are not significantly affected by changes in traffic volume, because it is the vibration peaks caused by individual vehicles that are of concern.

For noise, the effects of distance change were calculated using the generally accepted propagation rate of 4.5 dB per doubling of distance from a line source. The effects of traffic volume increase were calculated using the relationship of 3 dB per doubling of traffic volume. Projected Year 2006 (opening Day) and Year 2020 peak hour traffic volumes were used in the calculations. Speeds were assumed unchanged. The predictions are summarized in Table 1, below.

TABLE 1
EXISTING AND PREDICTED FUTURE NOISE LEVELS

	Ramp to Building Distance (feet)	I-25 to Building Distance (feet)	Ramp Traffic Volume (Vehicles/ hr)	I-25 Traffic Volume (Vehicles / hr)	Noise Level at Fenceline (dB(A))	Noise Level on 1st Floor (dB(A))	Noise Level on 3rd Floor (dB(A))
Existing	80	160	283	5,743	73	44	49
Opening Day	50	130	320	6,498	79	49	53
Year 2020	50	130	630	9,476	83	53	57

CDOT policy states that for certain activities or land uses, impact occurs if interior noise levels approach or exceed 52 dB(A). Those activities and land uses include residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums. Both Year 2006 Year 2020 interior noise levels are predicted to equal or exceed 52 dB(A) on the side of the building facing I-25. Those rooms are currently conference rooms and administrative offices, and are therefore not considered impacted. Noise levels in other parts of the building will be at least 5 dB(A) less than those shown in Table 1. The only potentially impacted use inside the building is the VA clinic. While hospital-like, there are no overnight stays, which we believe is the focus of CDOT and FHWA policy. Therefore, we do not believe there is any impact to the clinic.

Future vibration levels were predicted in nearly the same way as noise levels except that only the effects of moving the ramp and highway alignments were considered. Increases in traffic volume were not considered. This is because while noise is the cumulative effect of vehicles, vibration impacts result from individual events, such as heavy trucks rolling over irregularities in the road. To calculate the effects of distance change, vibration was assumed to decrease 6 dB per doubling of distance, which is typical of the silty, sandy soil type in the area. Table 2, below, summarizes the results of the predictions.

TABLE 2
EXISTING AND PREDICTED FUTURE VIBRATION LEVELS

	Vibration Levels On the 1st Floor (VdB)	Vibration Levels On the 3rd Floor (VdB)
Existing Conditions	54	62
After Moving Alignments	58	66
Projected Increase	4	4

As shown in Table 2, vibration levels are expected to increase by 4 VdB from moving the ramp and highway closer to the building. The highest level measured was 62 VdB, on the third floor. Therefore, one could expect levels to occasionally reach 66 VdB on the third floor. Although the perceptibility threshold is approximately 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB (*Transit Noise and Vibration Impact Assessment – Federal Transit Administration*). Therefore, people may occasionally feel a slight bit of vibration from highway and ramp traffic. It should be noted, however, that people will feel more vibration from human traffic within the building.

We are not aware of any impact criteria for traffic induced vibration, as it is rarely a problem. However, the Federal Transit Administration states that impact from transit rail occurs at 75 VdB for commercial buildings. Thus, no vibration impact is expected. Also, the predicted levels are well below the 100 VdB threshold for structural damage.

Please feel free to call me at (303) 666-0617 if you have any questions, or if I can be of any further assistance.

Sincerely,

Jim Stanley
Senior Engineer
Hankard Environmental Inc.

Cc: Jim Brady – Wilson & Company
Attachments: Figures 1 – 3

Figure 1
Existing Noise Levels
Raintree Office Plaza B

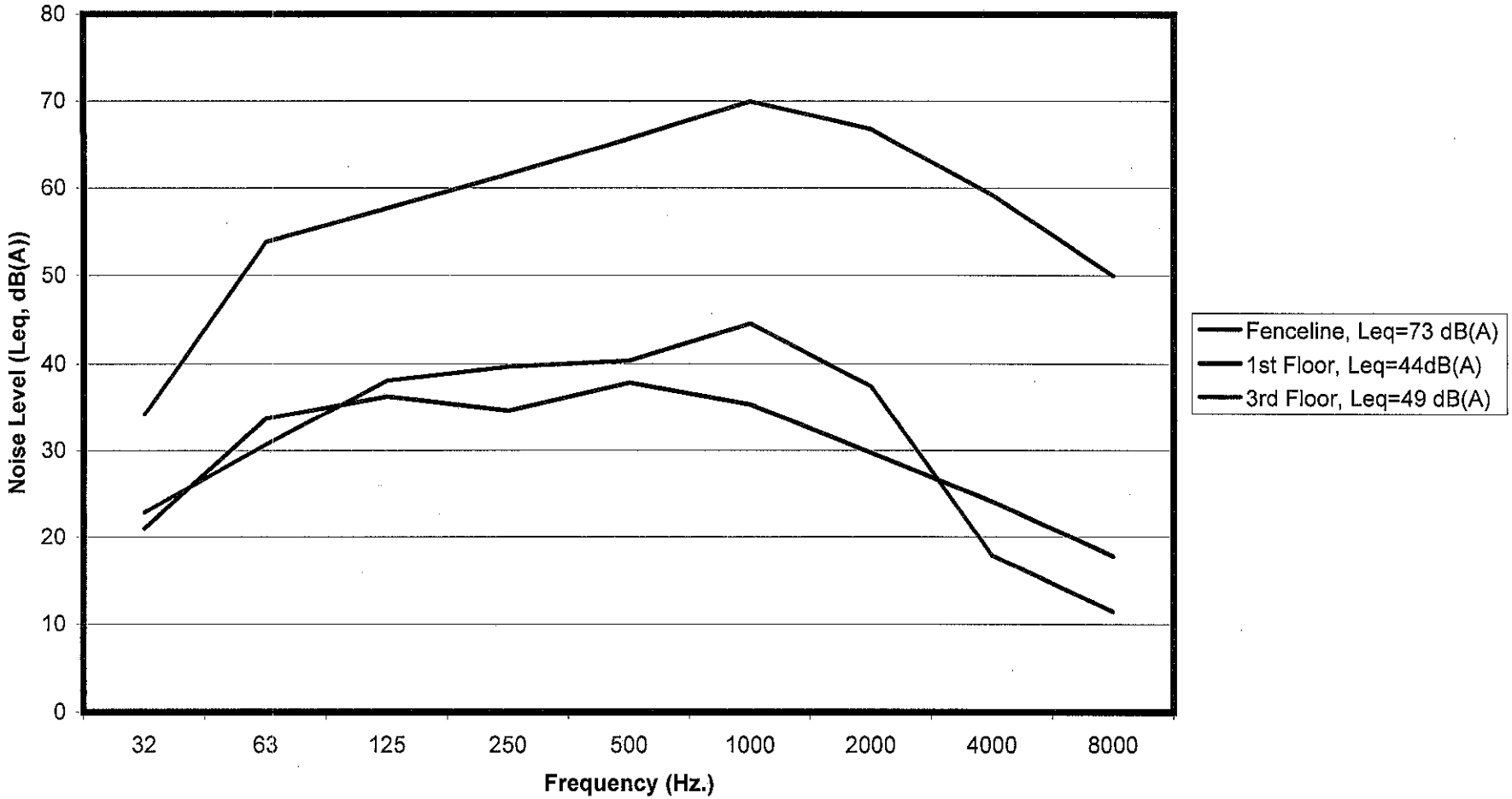


Figure 2
Existing Vibration Levels
Raintree Office Plaza B, Room 310

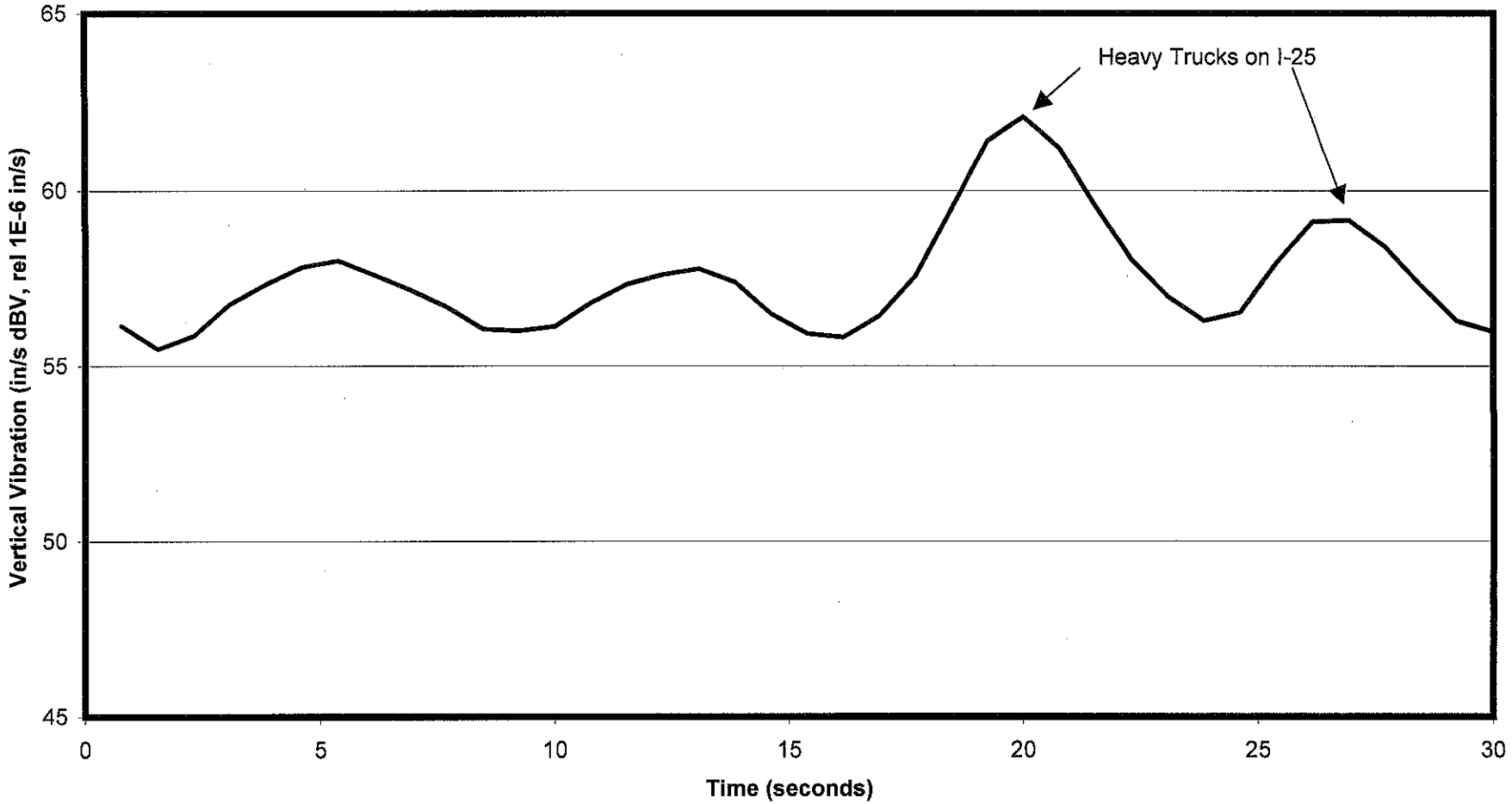
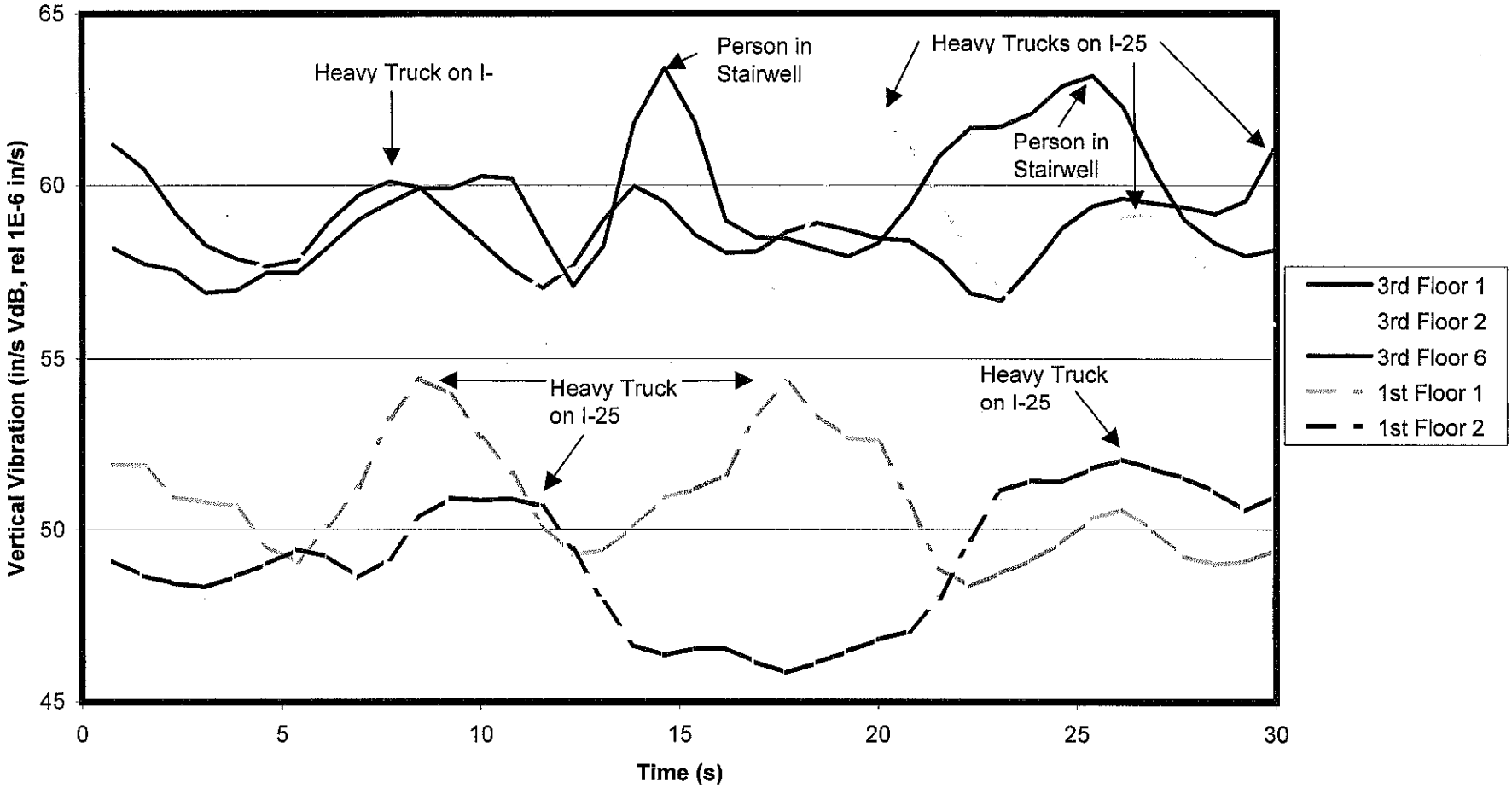
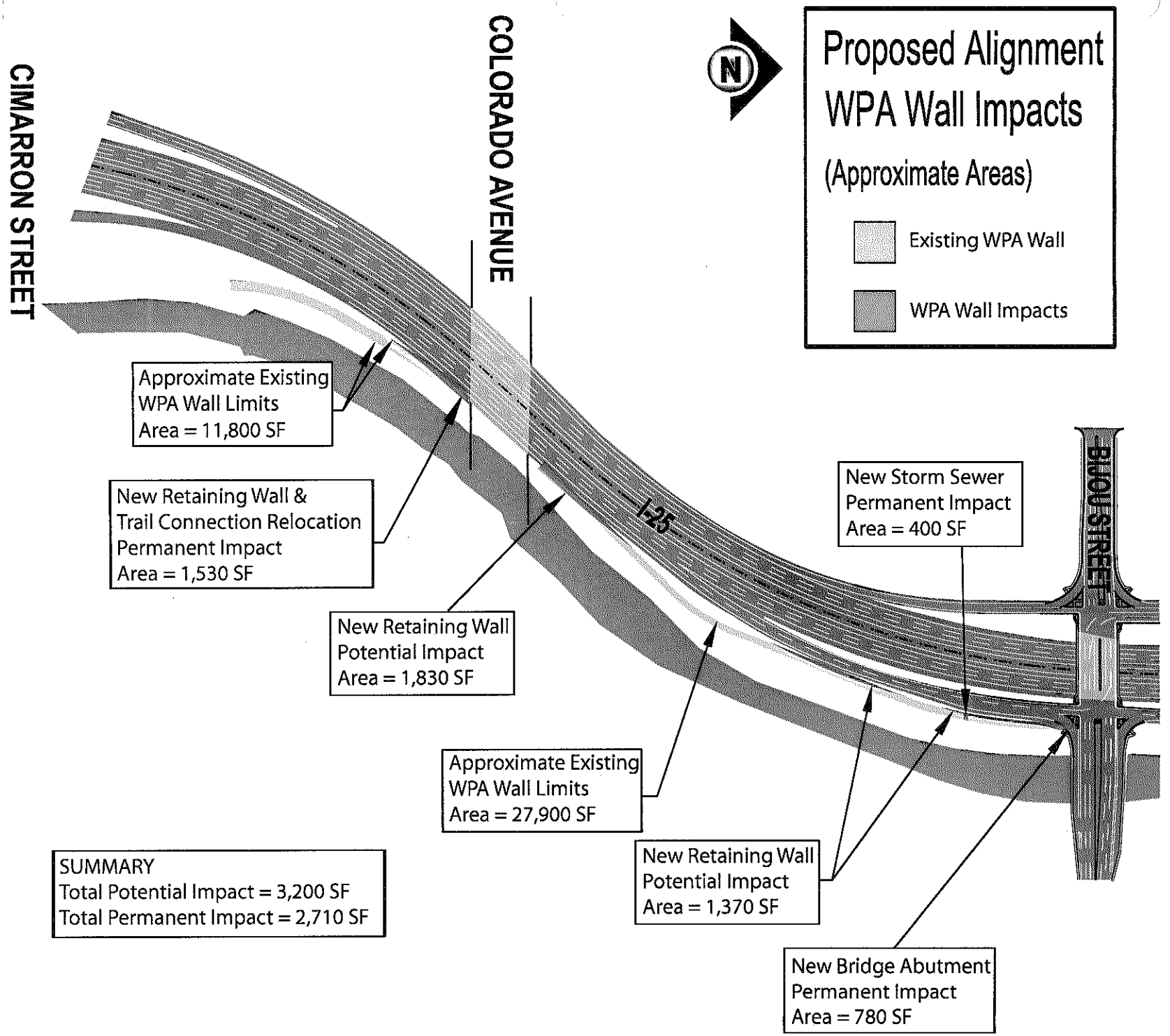


Figure 3
Existing Vibration Levels
Raintree Office Plaza B




CIMARRON STREET
COLORADO AVENUE
N
Proposed Alignment
WPA Wall Impacts
(Approximate Areas)
Existing WPA Wall
WPA Wall Impacts
Approximate Existing
WPA Wall Limits
Area = 11,800 SF
New Retaining Wall &
Trail Connection Relocation
Permanent Impact
Area = 1,530 SF
New Retaining Wall
Potential Impact
Area = 1,830 SF
I-25
New Storm Sewer
Permanent Impact
Area = 400 SF
BIJOU STREET
Approximate Existing
WPA Wall Limits
Area = 27,900 SF
New Retaining Wall
Potential Impact
Area = 1,370 SF
New Bridge Abutment
Permanent Impact
Area = 780 SF
SUMMARY
Total Potential Impact = 3,200 SF
Total Permanent Impact = 2,710 SF

OLSON ENGINEERING, INC.

Condition Evaluation of the Civil Infrastructure
Specializing in Nondestructive Technologies

NONDESTRUCTIVE TESTING INVESTIGATION
STEEL ANCHOR BOLT LENGTH EVALUATION
BRIDGE ABUTMENT AND PIERS
COLORADO SPRINGS, COLORADO

Prepared for:

Wilson and Co.
1099 18th St., Suite 940
Denver, CO 80202

Attn: Mr. David Wier
Ofc: 303/297-2976
Fax: 303/297-2693

Olson Engineering Job No. 1299

January 16, 2003

Phone: 303/423-1212 Fax: 303/423-6071
5191 Ward, Suite #1, Wheat Ridge, Colorado 80033-1936
www.olsonengineering.com

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1.0 SCOPE/OBJECTIVE

Olson Engineering was contracted by Wilson and Co. to provide a nondestructive evaluation (NDE) investigation to evaluate the length of anchor bolts set into the side of an abutment of the Bijou Street bridge over a creek near I-25 in Colorado Springs, Colorado. The testing was done with the nondestructive Ultrasonic Testing (UT) and Impact Echo (IE) methods. We understand that an estimate of the anchor bolt lengths was needed to determine if the anchor bolts would interfere with future excavation planned nearby behind the abutment.

The NDT field investigation on the bolts was performed on December 31, 2002 by Mr. Dennis Sack, Vice President with our firm. UT and IE tests were performed on 5 bolts on the abutment at various heights in the lower portion of the abutment wall, and on 4 additional bolts found in a pier supporting the mid-span of the bridge. The pier bolts were tested to provide a baseline of comparison, as these bolts were known the be less than about 7 feet in length. In addition to field tests, a small-scale mockup of two typical anchor bolt types was created and tested with both methods in our office.

2.0 TEST PLAN AND RESULTS

Testing with UT and IE was conducted in the field on 9 bolts extending out from the west abutment and in the center-west pier of the bridge. All bolt ends were ground off smooth prior to UT testing with a portable grinder. The 5 abutment bolts were tested at different heights in the lower portions of the abutment. The 4 pier bolts were tested to establish a baseline expected response for shorter bolts, as these were known the be less than 7 feet in length. The abutment bolts were of unknown length, with lengths of greater than 30 feet possible. In addition to field tests, a set of tests was done on smaller bolts in our office. One of the bolts was left straight and the other bent to simulate a J-bolt of a similar length to the unbent bolt. A photograph of the mock-ups is presented in Fig. 1. A photograph of the west abutment with the tested bolt locations noted is presented as Fig. 2.

The results of the UT tests (Ultrasonic Pulse Echo method) showed no echoes at all for all tested bolts, even the bolts tested on the piers (known to be less than 7 feet long). The maximum range of the UT device used is over 30 feet, so it was expected that a normal bolt of less than 7 feet would echo well. The IE testing of the bolts showed clear, strong echoes from all tested bolts, with overall lengths of about 2 to 5 feet. The actual results are tabulated in Table I. Sample data from IE and UT tests is included in Sections 4.0 and 6.0.

The mockup testing performed in our office showed that the UT device (running at 2-5 MegaHertz (MHZ)) saw clear, strong echoes from a straight bolt, but no echoes at all from a similar bolt bent at 90 degrees (similar to a J-bolt) at the same length. Impact Echo tests conducted on the mock-ups showed clear, strong echoes from the bolt end for the straight bolt, and from the bend location for the J-bolt.

These results indicate that the bolts in the abutment and pier at the tested bridge are apparently J-bolts of 2-5 feet in length to the bend depth as shown in Table I.

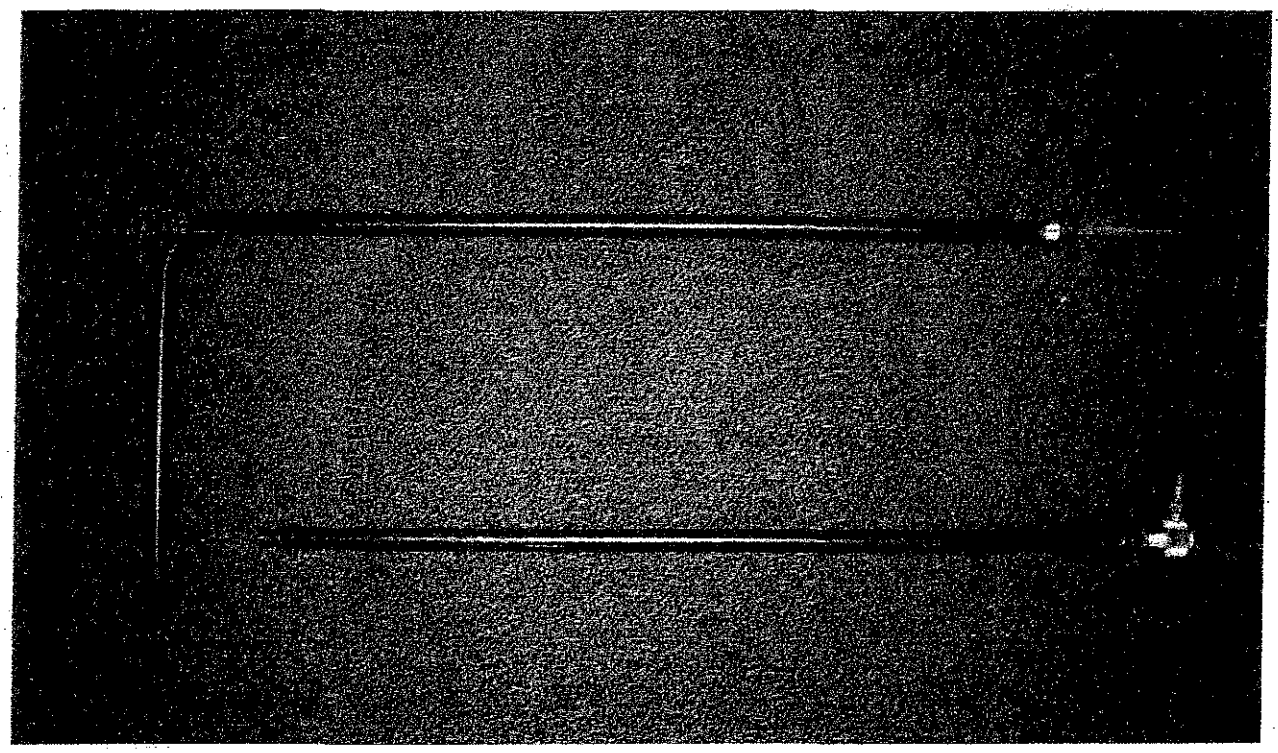


Figure 1 Mockup of Straight Bolt and J-Bolt with UT Transducer Shown

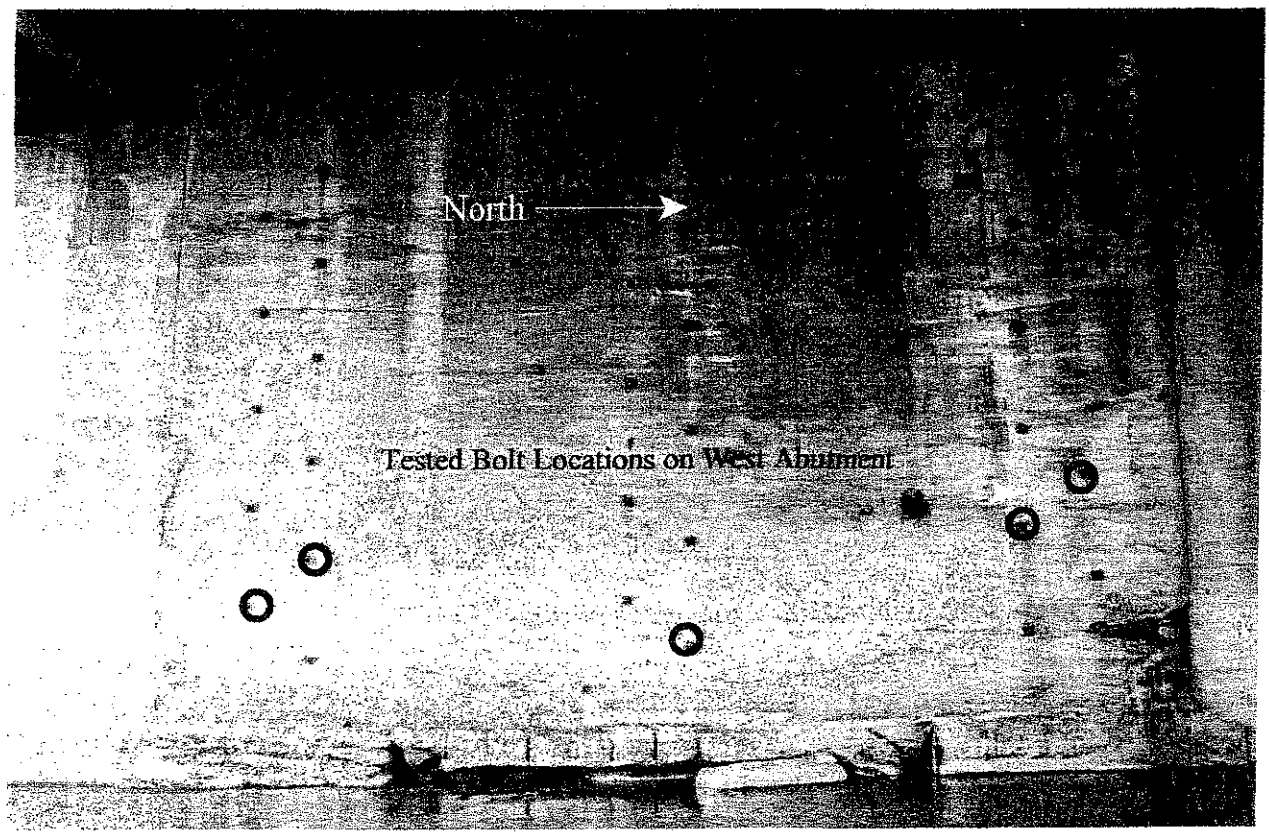


Figure 2 West Abutment with Tested Bolts Noted

TABLE I
ANCHOR BOLT LENGTHS BASED ON IE TESTING

Bolt Location	Length to Bend (feet)
West Abutment, Center, Bottom	3.65
West Abutment, North, Lower	3.24
West Abutment, North, Upper	3.13
West Abutment, South, Lower	1.67
West Abutment, South, Upper	2.16
West Pier, West Side, Upper	4.94
West Pier, West Side, Lower	2.83
West Pier, East Side, Lower	3.07
West Pier, East Side, Upper	3.20

Note: Refer to Fig. 2 for West Abutment test locations.

3.0 IMPACT ECHO (IE) TEST METHOD

The Impact Echo (IE) tests were performed using our Olson Instruments Concrete Thickness Gauge (CTG), version CTG-1TF. The CTG is a nondestructive, battery powered, handheld instrument normally used for measuring the thickness of concrete slabs, pavements, tunnel linings, walls and other plate-like structures. It reliably measures the thickness of any type of concrete based on the Impact Echo principle. Since it is capable of measuring thicknesses of concrete out to over 12 feet, it is also applicable to measuring lengths of bolts, timbers, etc. in this length range.

The IE tests performed in this investigation involved hitting the nut present near or at the end of each bolt and identifying the reflected wave energy with a displacement transducer in a handheld unit pressed against the bolt end. The resonant echoes of the displacement responses are usually not apparent in the time domain, but are more easily identified in the frequency domain. Consequently, the linear frequency spectra of the displacement responses are obtained with a Fast Fourier transform (FFT), which can be used to determine the resonant peaks.

The relationship among the resonant frequency peaks (f), the Impact Echo compressional wave velocity (V) for a given shape and the test member thickness (D) is expressed in the following equation:

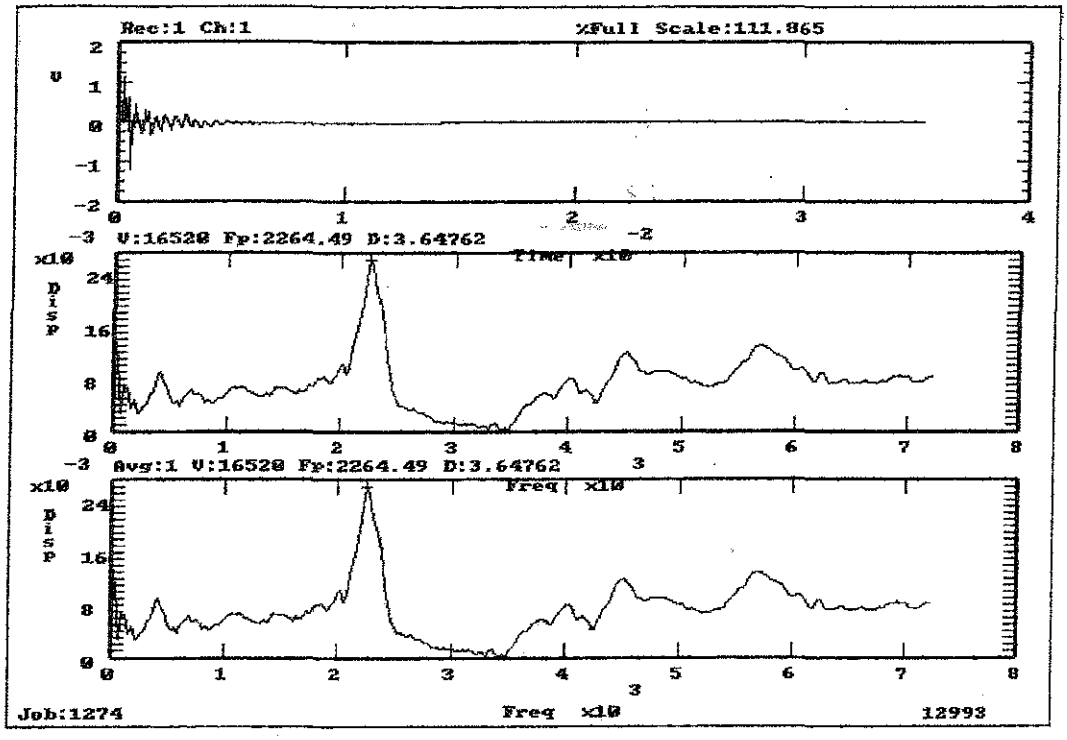
$$D = V/(2 \times f) \qquad (1)$$

The velocity in this case is the velocity of long-wavelength sound waves in steel. This was measured on our mock-up bolts at the office subsequent to the field tests.

4.0 SAMPLE IMPACT ECHO (IE) TEST RECORDS

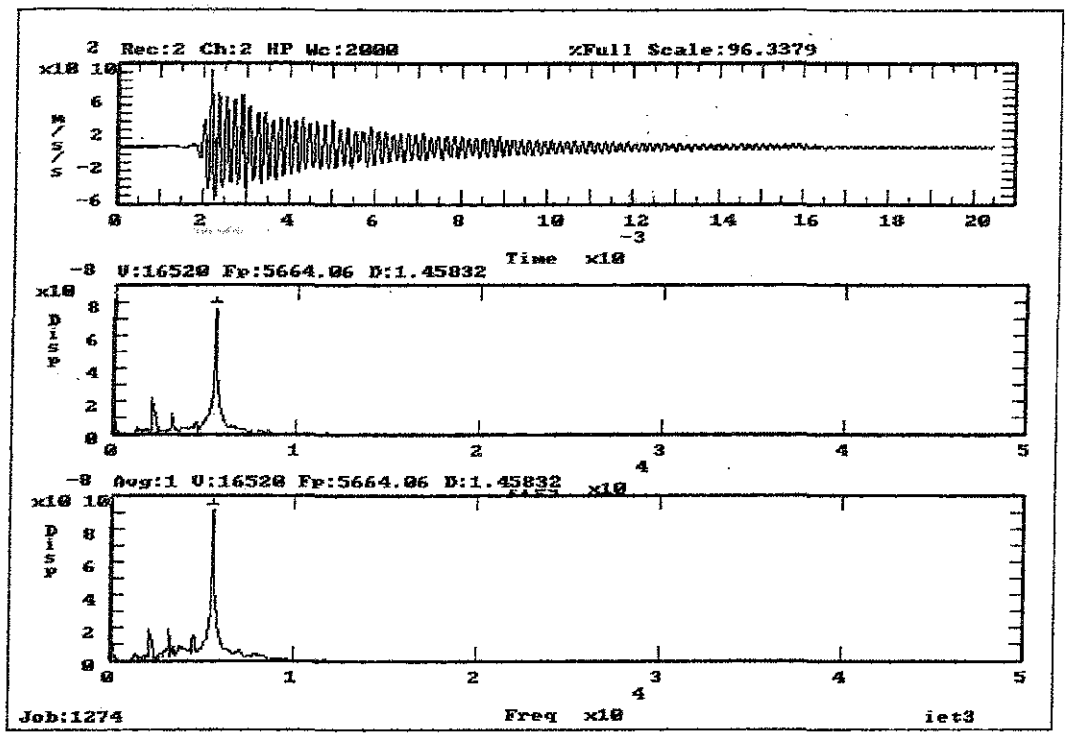
A sample IE test record from a test on a bolt on the abutment wall near the bottom center is presented Fig. 3. The upper trace in the figure represents the displacement response of the displacement transducer to the hammer impact in the time domain, while the middle and lower traces are the linear frequency spectra of the displacement response computed from the upper trace for a single impact. A compression wave velocity for steel of 16,520 feet per second (fps) was used to calculate the length. This velocity was determined based on the mockup tests on steel bolts of known length. Note that this record has a single clear, sharp frequency peak, indicative of the reflection of wave energy from the end of the bolt (or the bend location for a J-bolt). The peak in the frequency spectra is at 2,264 Hz, indicating a bolt length of 3.65 feet.

A pair of example records from IE tests performed on our mock-up test samples are presented in Figs. 4 and 5. The test data shown in Fig. 4 is from the straight bolt, while that in Fig. 5 is from the bent bolt (J-bolt). Again, the upper traces in the figures represent the displacement responses of the transducer to the hammer impact in the time domain, while the middle and lower traces are the linear frequency spectra of the displacement response computed from the upper trace for a single impact. The only peaks seen in these records are at frequencies of 5,664 Hz (straight bolt) and 5,322 Hz (bent bolt). These correspond to lengths of 17.5 and 18.5 inches, which correspond to the actual length of the straight bolt and the bend location length of the bent bolt. This shows that the IE response in a J-bolt is from the bend location depth. These results also show the applicability of the IE method to testing both straight and J-bolt geometries.



CMD: Accept Reject Loop Prt Sub Meas Chan Var Filter Zoom Toggle Outfile Nxtset

Figure 3 Sample IE Test Record, Abutment Bolt at Lower Center of Wall



CMD: Accept Reject Loop Prt Sub Meas Chan Var Filter Zoom Toggle Outfile Nxtset

Figure 4 Sample IE Test Record - Straight Bolt Mockup

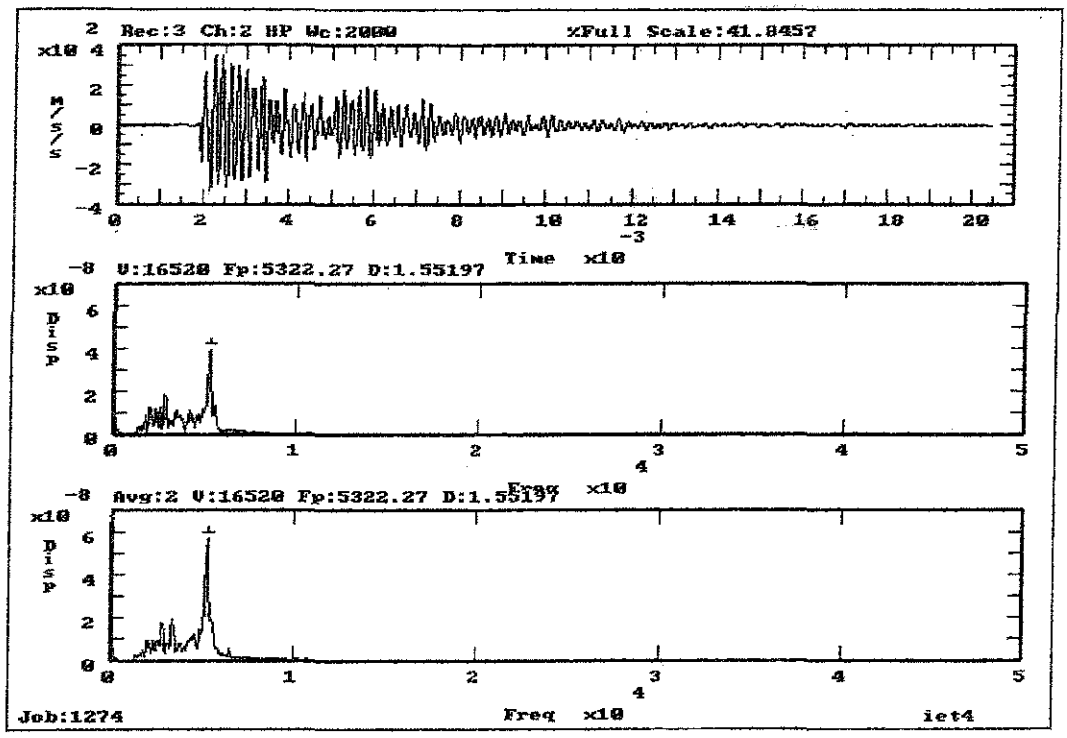


Figure 5 Sample IE Test Record - J-Bolt Mockup

5.0 ULTRASONIC TESTING (UT) TEST METHOD

The Ultrasonic Testing (UT) tests were performed using our Krautkramer USM-25 instrument. The USM-25 is a nondestructive, battery powered, handheld instrument normally used for locating flaws and measuring the thickness of metal members of various types based on the Ultrasonic Pulse Echo method. The unit can be used on very thin (less than 0.1 inches) to very thick/long (greater than 30 feet) members.

For the UT tests performed in this investigation, the ends of the bolts were first ground smooth, then a couplant applied to the end to facilitate acoustic coupling from the transducer to the bolt. The transducer was pressed against the bolt end and a reading taken. The UT method is performed by using a single piezoelectric transducers to both generate a high frequency pulse (about 5 MHZ) and receive any resulting echoes of the pulse. The echoes result from the generated pulse encountering a change in acoustic properties (such as the end of a bolt or a break) and reflecting back. The time required to reflect back is used to compute the depth of the reflector. This calculation is done automatically in the USM-25 in accordance with:

$$L = (V * t) / 2.$$

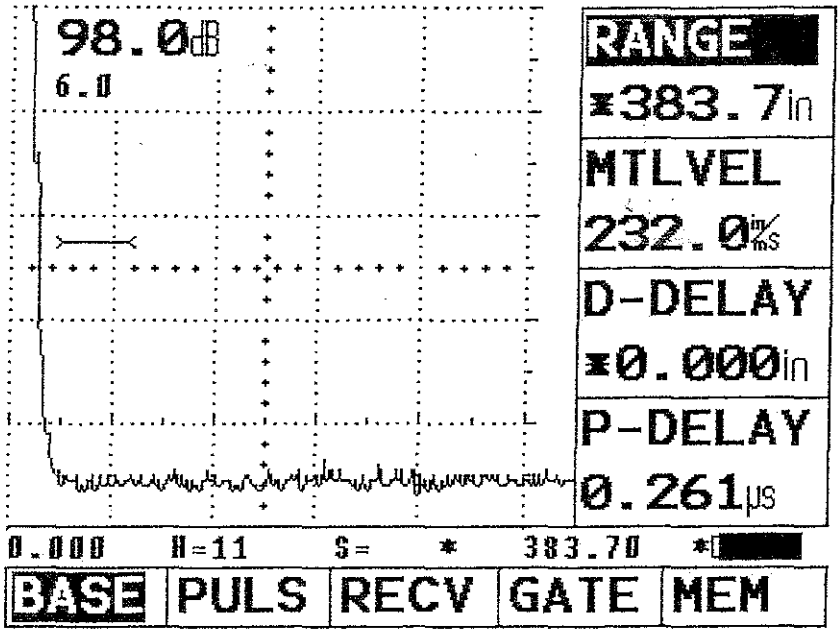
Where L = length, t = time, and V = velocity. The units of length will depend on the units used for velocity.

6.0 SAMPLE ULTRASONIC TESTING (UT) TEST RECORDS

A sample test record from an abutment wall bolt is presented in Fig. 6. This bolt was the same bolt as the one used to present the sample IE test data in Fig. 3. The test record, seen in the upper half of the page, is a plot of time (or distance) on the horizontal axis versus amplitude on the vertical axis. Note that no echoes or reflections of any kind are visible in the record. The noise at the bottom of the record shows the noise floor of the data, which is the minimum visible signal amplitude.

A pair of sample test records from UT tests on the straight bolt and J-bolt mock-ups are presented in Figs. 7 and 8. The test on the straight bolt, Fig. 7, shows a clear, strong reflection of the pulse at 18.19 inches (using the default velocity in the unit of 231.9 in/millisecond). This corresponds to a reflection from the end of the bolt. The test on the J-bolt, Fig. 8, shows no reflections at all. This is similar to the result seen on the actual abutment wall tested, and supports the conclusion that the anchor bolts in the abutment wall are J-bolts.

USM 25 DAC-Inspection Report



Instrument adjustment:

GAIN 98.0dB		dB-STEP 6.0
RANGE *383.7in	DAMPING ..... low	aLOGIC ..... pos
MTLVEL ... 232.0in/ms	POWER ..... high	aSTART 39.58in
D-DELAY *0.000in	DUAL ..... off	aWIDTH 50.20in
P-DELAY 0.261us	PRF-MOD 4	aTHRSH 55%
bSTART 10%	ANGLE 0.0	FINE G 0
bTHRSH 30%	X-VALUE 0.00in	REJECT 0%
ALARM ..... off	THICKNE 1.00in	FREQU ..... 0,5 - 4
DACMODE ..... off	aTOF ..... peak	R-start 0.000in
DACECHO 0	RECTIFY ..... full-w	H= 11%
dB CORR 0.0dB	SVEL1 .... 250.0in/ms	S= ..... *in
OFFSET 0.0dB	SVEL2 .... 123.0in/ms	R-end 383.70in
	S-DISP ..... off	
FLAWIND	OBJECT	SET-# ..... * 2
FLAWLEN 0.00in	OPERAT	DATNAME
X-POS 0.00in	SURFACE	RECALL ..... off
Y-POS 0.00in	COMMENT	DATE 07-06-2002

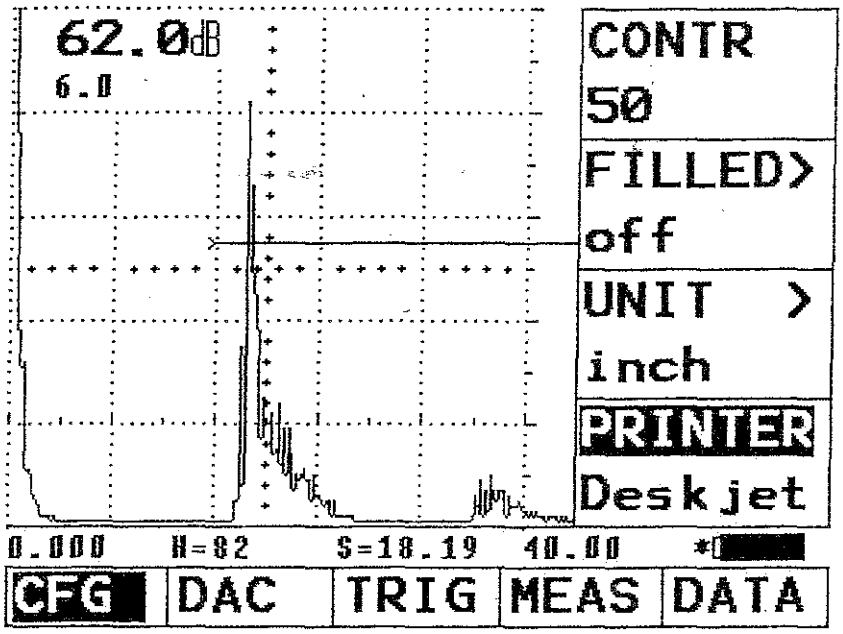
Inspection data:

Job number:	Test object:	Material:
Specification:	Test class:	Probe:
Recording threshold:	Instruction:	
Company:	Operator:	Test location:
Date:	Signature:	

Olson Job No. 1299

Fig. 6

USM 25 DAC-Inspection Report



Instrument adjustment:

GAIN 62.0dB		dB-STEP 6.0
RANGE *40.00in	DAMPING ..... low	aLOGIC ..... pos
MTLVEL ... 231.9in/ms	POWER ..... high	aSTART 15.86in
D-DELAY *0.000in	DUAL ..... off	aWIDTH 50.20in
P-DELAY 0.261us	PRF-MOD 4	aTHRSH 55%
bSTART 10%	ANGLE 0.0	FINE G 0
bTHRSH 30%	X-VALUE 0.00in	REJECT 0%
ALARM ..... on	THICKNE 1.00in	FREQU ..... 0,5 - 4
DACMODE ..... off	aTOF ..... peak	R-start 0.000in
DACECHO 0	RECTIFY ..... full-w	H= 82%
dB CORR 0.0dB	SVEL1 .... 250.0in/ms	S= 18.19in
OFFSET 0.0dB	SVEL2 .... 123.0in/ms	R-end 40.00in
	S-DISP ..... off	
FLAWIND	OBJECT	SET-# ..... * 8
FLAWLEN 0.00in	OPERAT	DATNAME
X-POS 0.00in	SURFACE	RECALL ..... off
Y-POS 0.00in	COMMENT	DATE 23-06-2002

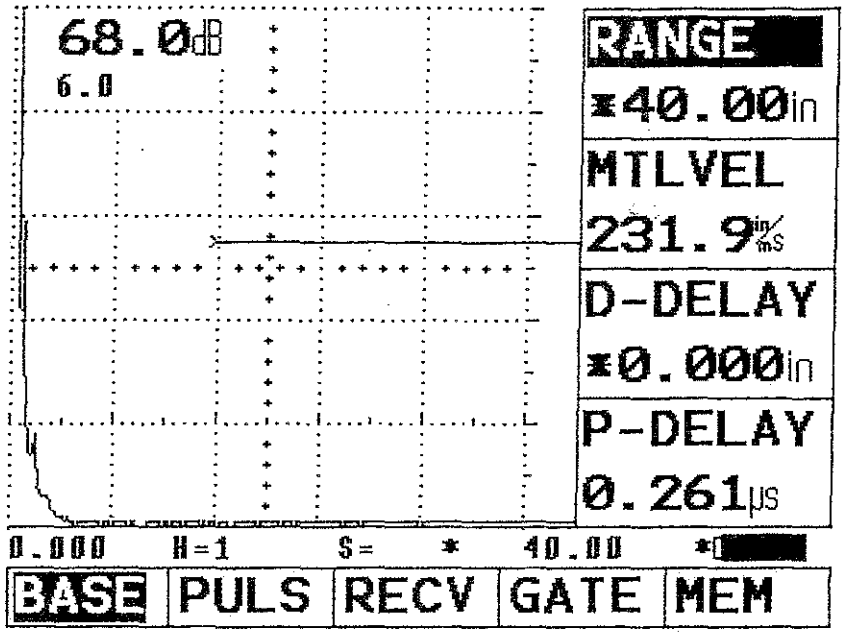
Inspection data:

Job number:	Test object:	Material:
Specification:	Test class:	Probe:
Recording threshold:	Instruction:	
Company:	Operator:	Test location:
Date:	Signature:	

Olson Job No. 1299

Fig. 7

USM 25 DAC-Inspection Report



Instrument adjustment:

GAIN 68.0dB		dB-STEP 6.0
RANGE *40.00in	DAMPING ..... low	aLOGIC ..... pos
MTLVEL ... 231.9in/ms	POWER ..... high	aSTART 15.86in
D-DELAY *0.000in	DUAL ..... off	aWIDTH 50.20in
P-DELAY 0.261us	PRF-MOD 4	aTHRSH 55%
bSTART 10%	ANGLE 0.0	FINE G 0
bTHRSH 30%	X-VALUE 0.00in	REJECT 0%
ALARM ..... off	THICKNE 1.00in	FREQU ..... 0,5 - 4
DACMODE ..... off	aTOF ..... peak	R-start 0.000in
DACECHO 0	RECTIFY ..... full-w	H= 1%
dB CORR 0.0dB	SVEL1 .... 250.0in/ms	S= ..... *in
OFFSET 0.0dB	SVEL2 .... 123.0in/ms	R-end 40.00in
	S-DISP ..... off	
FLAWIND	OBJECT	SET-# ..... * 9
FLAWLEN 0.00in	OPERAT	DATNAME
X-POS 0.00in	SURFACE	RECALL ..... off
Y-POS 0.00in	COMMENT	DATE 23-06-2002

Inspection data:

Job number:	Test object:	Material:
Specification:	Test class:	Probe:
Recording threshold:	Instruction:	
Company:	Operator:	Test location:
Date:	Signature:	

Olson Job No. 1299

Fig. 8

7.0 CLOSURE

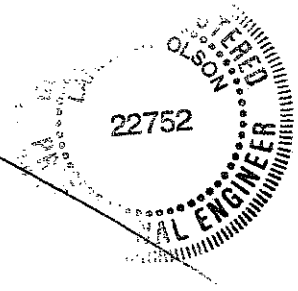
The field portion of this NDT investigation was performed in accordance with generally accepted testing procedures. If additional information is developed which is pertinent to our investigation, please contact our office. If we can provide any additional information, please call.

Respectfully submitted,

OLSON ENGINEERING, INC.

Dennis A. Sack
Associate Engineer

Larry D. Olson, P.E.
Principal Engineer



(1 copy faxed, 2 copies mailed)

FINAL REPORT
VALUE ENGINEERING STUDY

CDOT – Region 2
I-25/Cimarron and Bijou Interchanges

December 2001

Prepared for
Felsburg Holt & Ullevig
and
Wilson & Company

By

SOLUTIONS ENGINEERING & FACILITATING, INC.
9032 Gray Fox Drive
Evergreen, CO 80439
303-670-5620

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SECTION 1 - SUMMARY

SUMMARY

This Value Engineering (VE) Study generated fifteen proposals.

Caveats:

- Cost estimates made by the VE Team are intended to reflect relative values between alternatives. The estimated savings identified within each proposal are based upon comparison of the proposal to the design basis. Therefore, as is true with all cost estimates, the savings indicated are only approximate.

- Only potential savings are shown. As the proposals are implemented, additional costs or savings may result from redesign or modification.

- The proposed savings represent life cycle cost savings, not just initial (capital) savings. Future operations, maintenance, and periodic replacement costs are all calculated into the potential life cycle cost savings listed.

- Future estimated potential life cycle savings are presented on a present worth basis calculated as a 8 percent interest rate over a 20-year expected equipment life span for asphalt paving, 30 years for concrete paving and 50 years for bridges (I = 8% and N = 20, 30, or 50 years). The actual life cycle costs will vary as a function of equipment life span and the interest rate charged for capital financing.

- Some VE Proposals are mutually exclusive. Therefore, the potential savings are not the sum of all the VE Proposals presented.

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD DISPOSITION (See Section 8 for Comments)	PAGE NO.
P01-009	Shift I-25 to the east approximately 8' and construct a cantilevered moment slab on top of the proposed mechanically stabilized earth (MSE) walls to prevent further encroachment into the floodplain. *Initial Est. Savings: $9,000* *Future Est. Savings: $0,000* *Total Est. Savings: $9,000*	Accept.	3-1
P01-015	Reduce lane widths on local streets constructed by project from 12 feet to 11 feet. *Initial Est. Savings: $1,200,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,200,000*	Partially Accept.	3-4
P01-030	Reduce the spacing between the ramp terminals at the Cimarron interchange. *Initial Est. Savings: $2,000,000* *Future Est. Savings: $0,000* *Total Est. Savings: $2,000,000*	Reject.	3-7
P04-017	Use 12' HOV lanes versus 14' lanes *Initial Est. Savings: $1,252,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,252,000*	Accept.	3-9
P01-005	Raise profile grade of I-25 at Bijou. *Initial Est. Savings: $2,287,000* *Future Est. Savings: $0,000* *Total Est. Savings: $2,287,000*	Accept.	3-11
P01-010	Lower the profile grade of I-25 between Colorado and Cimarron. *Initial Est. Savings: $1,037,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,037,000*	Accept.	3-14
P04-008	Use double left-turn lanes for the southbound exit ramp at Bijou Street instead of triple left-turn lanes. *Initial Est. Savings: $1,400,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,400,000*	Reject.	3-17
P01-046	Use existing westbound Bijou bridge over the RR and Monument Creek and only replace the eastbound bridge. *Initial Est. Savings: $4,300,000* *Future Est. Savings: $0,000* *Total Est. Savings: $4,300,000*	Reject.	3-20
P02-002	Retain and rehabilitate the existing Bijou Street bridges over RR and Monument Creek *Initial Est. Savings: $8,500,000* *Future Est. Savings: $0,000* *Total Est. Savings: $8,500,000*	Reject.	3-22

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD DISPOSITION (See Section 8 for Comments)	PAGE NO.
P02-005	Widen and rehabilitate the existing bridges on Bijou Street over Monument Creek and the Railroad. *Initial Est. Savings: $7,800,000* *Future Est. Savings: $0,000* *Total Est. Savings: $7,800,000*	Reject.	3-24
P01-048	Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron Street ramps and the main line *Initial Est. Savings: $3,600,000* *Future Est. Savings: $0,000* *Total Est. Savings: $3,600,000*	Reject.	3-27
P03-009	Put Cimarron St. on top of Fountain Creek by using a triple box culvert. *Initial Est. Savings: $1,500,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,500,000*	Reject.	3-31
P03-015	Keep existing Cimarron Street bridge for westbound and build new eastbound bridge *Initial Est. Savings: $2,400,000* *Future Est. Savings: $0,000* *Total Est. Savings: $2,400,000*	Reject.	3-35
P01-028	Reduce the median width on Cimarron Street across Fountain Creek. *Initial Est. Savings: $240,000* *Future Est. Savings: $0,000* *Total Est. Savings: $240,000*	Accept.	3-37
P01-002	Put I-25 over Bijou by using a structure in lieu of fill *Initial Est. Savings: $750,000* *Future Est. Savings: $0,000* *Total Est. Savings: $750,000*	Reject	3-39

Estimated Construction Cost at time of VE Study: $101,000,000
Designer's Estimate of VE Savings[(1)]: $4,348,000

[(1)] After subtracting redesign costs

SECTION 2 - INTRODUCTION

INTRODUCTION

Value Engineering (VE) analysis identifies the high cost areas of a project during the early design stages. The VE Study then determines less expensive alternative designs that can still be incorporated into the final design drawings and specifications without incurring large costs for redesign or major project delay. These VE proposals are substantiated with technical and economic analyses.

PROJECT DESCRIPTION

Over the past decade, traffic in the Pikes Peak region has substantially increased. Today, volumes on Interstate 25 through Colorado Springs are about three times higher than expected when the highway was originally built. Based upon projections, traffic will continue to increase in the years to come, resulting in severe congestion and traffic delays.

These problems will be particularly evident in the old, elevated section of the interstate from the Bijou Street interchange through the Cimarron (Midland Expressway) interchange. The sharp, short ramps and narrow bridges, together with high traffic volumes, make this one of the most complex and challenging areas to improve.

A variety of alternatives to improve capacity and safety for the Cimarron-Bijou segment of the interstate will be evaluated by the Colorado Department of Transportation (CDOT). Planning and development of these alternatives will be lead by Wilson & Company, CDOT's manager for the I-25 Corridor, and the engineering and design firm of Felsburg, Holt & Ullevig. These alternatives must be compatible with other planned improvements, like those now being developed for the Nevada/Tejon interchange complex. They must also be consistent with long-term strategies to improve mobility in the I-25 Corridor through El Paso County.

The selection of an alternative for the Cimarron-Bijou is a critical first step in the development of an overall plan for the entire I-25 Corridor. That plan, which is currently being developed by CDOT, will recommend strategies for long-term capacity and safety improvements in the I-25 Corridor. The first set of these improvements, including the recommended changes for the Cimarron-Bijou area, will be evaluated in an Environmental Assessment that is scheduled for completion next year.

Work will include:

- Construction additional acceleration/deceleration lanes
- Improving impacted portions of local streets to lessen traffic congestion at interstate on- and of-ramps
- Softening the sharply curved sections of the interstate
- Reconstructing the bridges at Cimarron Street, Bijou Street, and the interchange bridges at Fountain and Monument Creeks

Several factors contribute to the planning and progress of this project. Capacity improvements to the interstate, which may include widening I-25, are being determined by CDOT's Environmental Assessment (EA) which is currently underway for the entire I-25 Corridor throughout El Paso County. The timing of the EA is such that results will be known and integrated into the project's final design.

The Cimarron-Bijou project is being coordinated with other nearby construction plans, including the City's Springs Community Improvements Program's (SCIP) Fountain Creek improvement, Confluence Park and Downtown redevelopment projects.

ORGANIZATION

VE STUDY TEAM

The following individuals are members of the VE Team:

VE TEAM MEMBER	FIRM	TELEPHONE/E-MAIL
Judy De Haven	CDOT – Region 2 905 Erie Avenue P.O. Box 536 Pueblo, CO 81002	(t) 719-546-5409 (f) 719-546-5414 (e) judy.dehaven@dot.state.co.us
Lew Garton	612 Verde Avenue Fort Collins, CO 80524	(t) 970-484-3523 (e) lgarton@prodigy.net
Marvinetta Hartwig	Carter-Burgess 216 – 16th Street Mall Suite 1700 Denver, CO 80202	(t) 303-820-5240, Ext. 5225 (f) 303-820-2402 (e) hartwigml@c-b.com
Alan Prudic	CDOT – Region 2 905 Erie Avenue P.O. Box 536 Pueblo, CO 81002	(t) 719-546-5725 (f) 719-546-5414 (e) alan.prudic@dot.state.co.us
David Shriner	Parson Transportation Group 600 Broadway Suite 1700 Denver, CO 80290	(t) 303-863-7900 (f) 303-863-7900 (e) david.a.shriner@parsons.com
Joseph Siccardi	Figg Bridge Engineers, Inc. 1873 S. Bellaire Street Suite 1025 Denver, CO 80222	(t) 303-757-7400 (f) 303-757-0698 (e) jsiccardi@figgbridge.com
John Vetterling	URS Greiner Woodward Clyde 8181 E. Tufts Avenue Denver, CO 80237	(t) 303-796-4639 (f) 303-694-3946 (e) john_vetterling@urscorp.com

FACILITATOR	FIRM	TELEPHONE/E-MAIL
C. Bernerd Dull, PE, CVS	Solutions Engineering & Facilitating, Inc.	(t) 303-670-5620 (f) 303-282-3817 (e) bdull@solutions-engineering.com
Fred Kolano, CVS	Solutions Engineering & Facilitating, Inc.	(t) 303-670-5620 (f) 303-232-3817 (e) bdull@solutions-engineering.com

THE REVIEW BOARD

The Review Board is comprised of the following representatives.

REVIEW BOARD MEMBER	FIRM	TELEPHONE/E-MAIL
Richard Annand	CDOT – Region 2 Region Environmental & Planning Manager	(t) 719-546-5410 (f) 719-546-5414 (e) richard.annand@dot.state.co.us
Jim Brady	Wilson & Company Project Manager	(t) 303-297-2976 (f) 303-297-2693 (e) jbrady@co.wilson.com
James Flohr	CDOT – Region 2 Resident Engineer	(t) 719-634-22323 (f) 719-632-2172 (e) james.flohr@dot.state.co.us
Dave Poling	CDOT – Region 2 North Program Engineer	(t) 719-634-2323 (f) 719-632-2172 (e) dave.poling@dot.state.co.us
Rob RefveM	Felsburg Holt & Ullevig Project Manager	(t) 303-721-1440 (f) 303-721-0832 (e) rob.refvem@fhueng.com
	City of Colorado Springs	(t) (f) (e)

The Review Board may decide upon the status of the VE proposals one of four ways:

1. Accept the proposed alternative as it stands. This will require the design team to implement the accepted proposed alternative. Those individuals comprising the Review Board are expected to have this authority for their respective organization.

2. Accept the proposed alternative with modifications. This disposition is similar to item 1 but with some changes imposed by the Review Board.

3. Decline the proposed alternative altogether. This disposition is obvious but proper reasoning must be given for the final report.

4. Table the proposed alternative for further study or information gathering. This is the least desirable of the options since it delays progress; however, practicality sometimes deems it necessary. If a proposed alternative is tabled, it is wise to assign responsibilities to resolve the issue(s), assign a schedule for resolution, and set a decision tree.

METHOD OF THE VE STUDY

VE ANALYTICAL PROCESS

STEP	PROCEDURE INVOLVED
Information	The VE Team reviewed the existing design to identify basic functions where effectiveness could be improved or potential cost savings could be significant. These basic functions were organized into a Function Analysis Systems Technique (FAST) diagram. FAST diagrams serve as tools to help the VE Team visualize the functions that different portions of a project must perform. The FAST diagrams set priorities for analysis and for assessing the compatibility of alternatives with the total project design package.
Creative	The VE Team selected the basic functions for further analysis on the basis of cost and potential for improvement. Formal brainstorming sessions generated as many alternative methods as possible for achieving the selected basic functions.
Analysis	Analysis was performed by first passing or failing the brainstormed ideas, then combining or grouping similar ideas. The VE Team as a whole then discussed and recorded the relative advantages and disadvantages of each idea. The ideas surviving these discussions were selected as candidates for further development by individual team members.
Development	A detailed technical examination followed, including specific quantities, costs, and calculations for ideas shown to have potential for significant savings. An economic analysis of technically feasible alternatives was made. Ideas that passed the technical and economical analyses and, in the opinion of the VE Team should be incorporated into the design, were prepared as formal proposals.
Presentation & Report	All ideas, calculations, and cost analyses were recorded during the VE process and were compiled to provide support to this document.

SECTION 3 – VE PROPOSALS

VALUE ENGINEERING PROPOSAL NO. 01-009

SUMMARY PROPOSAL DESCRIPTION:

Shift I-25 to the east approximately 8 feet and construct a cantilevered moment slab on top of the proposed mechanically stabilized earth (MSE) walls to prevent further encroachment into the floodplain.

Estimated potential savings:

Initial:	$ 9,000
Future:	$ 0,000
Total:	$ 9,000

Discussion:

Shifting I-25 by 8 feet will narrow the right-of-way requirements along the west side by the same 8 feet. The retaining walls on the east side can remain in their present location and the shoulder of I-25 and the ramps will be cantilevered over the floodplain.

Related Ideas:

N/A

EVALUATION
Idea Number: 01-009 Idea Description: Shift I-25 to the east approximately 8 feet and construct a cantilevered moment slab on top of MSE walls.
Advantages: 1. Reduces right-of-way takes on west side of I-25 2. Possible geometry improvements using curve flattening 3. No additional impact to floodplains.
Disadvantages: 1. More complex construction and durations 2. Increased infrastructure. 3. Potentially higher maintenance costs. 4. Sign bridges must be located off of cantilever sections
Risks: 1. Structure analysis may require MSE walls to be converted to cast-in-place.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

A concrete moment slab will be required over the top of the MSE retaining wall to allow for an 8-foot cantilever. This cantilever will be required where retaining walls have been identified in the concept design along the east side of I-25 except adjacent to Confluence Park where the floodplain will be allowed to be increased. The moment slab cost is an added cost; however, there will be reduced unreinforced concrete pavement where the moment slab is constructed and a net height reduction in MSE wall of approximately one foot. This concept allows the right-of-way (ROW) to be reduced by approximately 8 feet along the entire west side of I-25.

Moment Slab Cost = 1.55cy/lf @ $300/cy =	$465/lf
Unreinforced Pavement (20'width) = 2.22 SY/lf @ $35/sy =	$77/lf
Reduced MSE Wall (1' high) = 1sf/lf @ $45/sf =	$45/lf
Net cost addition per linear foot = $465 - $77 - $45 =	$343/lf

Total cost of cantilever section = $343 x 2,500 lf Wall = $857,500

ROW area saved = 9,000 lf x 8' wide = 72,000 sf

Total ROW cost savings = 72,000 @ $12/sf = $864,000

Net cost of savings of cantilever section = $6,500

PE, CE, and Contingency @ 35% = $2,275

Total Savings = $9,000

VALUE ENGINEERING PROPOSAL NO. 01-015

SUMMARY PROPOSAL DESCRIPTION:

Reduce lane widths on local streets constructed by project from 12 feet to 11 feet.

Estimated potential savings:

Initial:	$ 1,200,000
Future:	$ 0,000
Total:	$ 1,200,000

Discussion:

11-foot lanes would result in significant savings in pavement and bridge costs with only a 3.3% reduction in local street capacity.

Related Ideas:

EVALUATION
Idea Number: 01-015 Idea Description: Reduce lane widths on local streets constructed by project from 12 feet to 11 feet.
Advantages: 1. Reduced pavement quantities 2. Reduced bridge quantities
Disadvantages: 1. Slight reduction in capacity 2. Variation from City standards
Risks: 1. None noted.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

The Highway Capacity Manual estimates that 11-foot lanes have 96.7% of the capacity of 12-foot lanes (Table 9-5).

TABLE 9-5 ADJUSTMENT FACTOR FOR AVERAGE LANE WIDTH (f_w)

AVERAGE LANE WIDTH, W (FT)	LANE WIDTH FACTOR, f_w
8	0.867
9	0.900
10	0.933
11	0.967
12	1.000
13	1.033
14	1.067
15	1.100
16	1.133

NOTE: $f_w = 1 + \frac{W - 12}{30}$ $W \geq 8$ (if $W > 16$, a two-lane analysis may be considered).

BRIDGES	Length	Reduced Width	Area (SF)	Unit Cost	Cost Savings
Cimarron over Creek	310	5	1550	115	178,250
Bijou over I-25	235	7	1645	85	139,825
Bijou over crk/RR	500	6	3000	120	360,000
I-25 over Cimarron[1]	8	150	1200	100	120,000
Total					798,075

[1]For I-25 Bridge over Cimarron, length is reduced while width stays the same

PAVEMENT	Length	Reduced Width	Area (SY)	Unit Cost	Cost Savings
Cimarron Ave	1900	6	1266.667	35	44,333
Bijou Street	1250	6	833.3333	35	29,167
Total					73,500

EARTHWORK		Depth	Vol(CY)	Unit Cost	Cost Savings
Cimarron	1900	2	844.4444	10	8,444
Bijou Street	1250	5	1388.889	10	13,889
					22,333

TOTAL SAVINGS		893,908
Markup for PE, CE & Contingency	0.35	312,868
Total Project Savings		1,206,776

VALUE ENGINEERING PROPOSAL NO. 01-030

SUMMARY PROPOSAL DESCRIPTION:

Reduce the spacing between the ramp terminals at the Cimarron interchange.

Estimated potential savings:

Initial:	$ 2,000,000
Future:	$ 0,000
Total:	$ 2,000,000

Discussion:

Narrowing ramp spacing allows moving ramps closer to freeway and reducing right-of-way takes on west side. Reduced spacing has slight reduction in capacity, but intersections would still operate at LOS C or better in 2020.

Related Ideas:

EVALUATION
Idea Number: 01-030 Idea Description: Reduce the spacing between the ramp terminals at the Cimarron interchange.
Advantages: 1. Reduced right-of-way requirements. 2. Redused cleanup of contaminated property.
Disadvantages: 1. Potential increased street width under structure 2. Potential increased structure length 3. Potential increased width of Cimarron bridge over Fountain Creek 4. Potential for walls between I-25 and ramps.
Risks: 1. None noted.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Narrowing ramp spacing allows moving ramps closer to freeway and reducing right-of-way takes on west side. Reduced spacing has slight reduction in capacity, but intersections operate at LOS C or better.

Right-of-way Cost Savings

	Est. Reduction in Land Takes	Cost	Est. Reduction in Bldg. Takes	Cost (from R.O.W. est.)	Total
Parcel 23	14000	168,000	11239	1,011,510	1,179,510
Parcel 24	1512	18,144	8910	801,900	820,044
Parcel 30	900	10,800			10,800
TOTAL					2,010,354

Reduction in Land Takes was estimated based on the decrease in partial takes from the project ROW estimate.

Reduction in Building Takes was estimated from the estimate for the relevant buildings in the project ROW estimate.

VALUE ENGINEERING PROPOSAL NO. 04-017

SUMMARY PROPOSAL DESCRIPTION:

Use 12-foot HOV lanes versus 14-foot lanes.

Estimated potential savings:

Initial:	$ 1,100,000
Future:	$ 0,000
Total:	$ 1,100,000

Discussion:

This proposal would eliminate the buffer between the general traffic lanes and the HOV lanes. This could potentially reduce the efficiency of HOV operations when the general traffic lanes are stopped.

Related Ideas:

SR 04-016	Use 16-foot HOV lanes versus 14-foot lanes
SR 04-018	Restripe HOV/Shoulder for 8-foot buffer

EVALUATION
Idea Number: 04-017 Idea Description: Use 12-foot HOV lanes versus 14-foot lanes.
Advantages: 1. Reduced infrastructure cost 2. Reduced ROW impacts
Disadvantages: 1. Potentially less efficient HOV operation
Risks: 1. Reduced HOV operations
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Pavement	sq yd	$ 35.00	4,356	$ 152,444.44
Reduced ROW	sq ft	$ 12.00	39200	$ 470,400.00
Bridges				
Bridge at Bijou	sq ft	$ 85.00	520	$ 44,200.00
Bridge at Cimarron	sq ft	$ 100.00	1600	$ 160,000.00
Bridge at Colorado Ave.	sq ft	$ 100.00	1000	$ 100,000.00
Subtotal				$ 927,044.44
PE,CE,Contingency@35%				$ 324,465.56
Total savings				**$ 1,251,510.00**

VALUE ENGINEERING PROPOSAL NO. 01-005

SUMMARY PROPOSAL DESCRIPTION:

Raise profile grade of I-25 at Bijou.

Estimated potential savings:

Initial:	$ 2,300,000
Future:	$ 0,000
Total:	$ 2,300,000

Discussion:

Raising the grade can be accomplished by using a 5-foot depth structure instead of the proposed 8-foot depth structure (see SR01-020 for depth of bridge). This will also eliminate the need to stabilize the subgrade in the existing roadway. The I-25 grade may be raised more if the profile of Bijou Street west of I-25 to North Spruce Street can be raised. There are business approaches in this area and not enough information to evaluate this. Evaluating this is recommended.

SR02-025 has a method to raise the I-25 profile also.

Related Ideas:

SR01-020 Minimize the depth of I-25 Bijou Bridge by using different type of structure.

SR02-025 Build concrete retaining walls and abutment so you do not have to modify the length of the Bijou/I-25 bridge.

EVALUATION
Idea Number: 01-005 Idea Description: Raise profile grade of I-25 at Bijou.
Advantages: 1. I-25 grade above flow line of Monument Creek. 2. Improves gravity flow to drain interchange. 3. Less earthwork quantities. 4. Eliminate the need to stabilize 1/3 of subgrade.
Disadvantages: 1. Design speed 60 mph
Risks: 1. None noted.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Raise PVI 3 feet at Bijou Station 121+40; leave the PVI north of Bijou Station 132+00 and Colorado at Station 109+00. Reduce excavation and retaining wall height 3 feet Station 113+00 to 125+00. Wilson & Co. estimate – Station 117+50 to 129+00 stabilization cost $800,000, construction dewatering $800,000, cofferdam $1,300,000, and underdrain system $500,000 for a total of $3,400,000.

Earthwork:	1,200' x 3' x 180' (average width)/27 = 24,000 cy x $10 =	$240,000
Retaining wall 1,200' x 3' = 3,600 sf x 2 (both sides) = 7,200 sf x $45 =		$324,000
Estimate 1/3 of above Wilson cost:	$3,400,000/3 =	$1,130,000
	Total:	$1,694,000
	Plus PE, CE, and contingencies at 35%:	$2,287,000

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	8.00%	
	ORIG. COSTS OR ONLY SAVINGS	ALTERNATIVE "A" COSTS	ALTERNATIVE "B" COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Embankment	$720,000.00	$480,000.00		
Retaining wall	$4,770,000.00	$4,446,000.00		
Wilson cost (stabilize subgrade, dewater etc)	$3,400,000.00	$2,270,000.00		
SUBTOTAL INITIAL COSTS:	$8,890,000.00	$7,196,000.00		
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$8,890,000.00	$7,196,000.00		
TOTAL SAVINGS (original - alternative)		$1,694,000.00		
CAPITAL SAVINGS		$1,694,000.00		
FUTURE SAVINGS		$0.00		

NOTE: Items in italics are calculated

VALUE ENGINEERING PROPOSAL NO. 01-010

SUMMARY PROPOSAL DESCRIPTION:

Lower the profile grade of I-25 between Colorado and Cimarron.

Estimated potential savings:

Initial:	$ 1,000,000
Future:	$ 0,000
Total:	$ 1,000,000

Discussion:

Lowering the profile grade will decrease embankment, shorten the height of retaining walls, and may reduce ramp grades. See SR01-020 for bridge depth of 5 feet instead of the proposed 8 feet for the Bijou bridge. The Cimarron bridge has spans similar to the Bijou bridge.

Related Ideas:

SR01-020	Minimize the depth of I-25 Bijou bridge by using different type of structure
P03-009	Move Cimarron on top of Fountain Creek
P01-048	Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron Street ramps and the mainline

EVALUATION
Idea Number: 01-010 Idea Description: Lower I-25 profile grade south of Cimarron to Colorado.
Advantages: 1. Reduce height of retaining wall. 2. Less earth work. 3. May flatten ramp grades.
Disadvantages: 1. Design speed (60mph) same as Colorado to Bijou
Risks: 1. None noted.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Lower PVI 3 feet at Cimarron Station 89+00; leave PVI south of Cimarron at Station 80+00 and PVI at Colorado Station 109+00. Retaining wall Station 92+00 to 105+00 can be decreased by 3 feet. Embankment will be decreased 3 feet Station 80+00 to Station 105+00.

Embankment:	2,500' x 3' x 150'/27 = 41,667 cy x $10 =	$417,000
Retaining walls:	1,300' x 3' = 3,900 sf x 2 = 7,800 sf x $45 =	$351,000
	Total	$768,000
	Plus PE, CE, and contingencies of 35%	$1,037,000

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	8.00%	
	ORIG. COSTS OR ONLY SAVINGS	**ALTERNATIVE "A" COSTS**	**ALTERNATIVE "B" COSTS**	**ALTERNATIVE "C" COSTS**
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Embankment	$3,100,000.00	$2,683,000.00		
Retaining wall	$6,700,000.00	$6,349,000.00		
SUBTOTAL INITIAL COSTS:	$9,800,000.00	$9,032,000.00		
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$9,800,000.00	$9,032,000.00		
TOTAL SAVINGS (original - alternative)		$768,000.00		
CAPITAL SAVINGS		$768,000.00		
FUTURE SAVINGS		$0.00		

NOTE: Items in italics are calculated

VALUE ENGINEERING PROPOSAL NO. 04-008

SUMMARY PROPOSAL DESCRIPTION:

Use double left-turn lanes for the southbound exit ramp at Bijou Street instead of triple left-turn lanes.

Estimated potential savings:

Initial:	$ 1,400,000
Future:	$ 0,000
Total:	$ 1,400,000

Discussion:

Related Ideas:

P02-002 Retain and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.

EVALUATION
Idea Number: 02-008 Idea Description: Use double left-turn lanes for the southbound exit ramp at Bijou Street instead of triple left-turn lanes.
Advantages: 1. Reduced structure width over I-25 2. Reduced pavement width on ramp 3. Reduced structure requirements for Bijou Street. 4. Better driver understanding/consistent with driver expectations.
Disadvantages: 1. Lower capacity for interchange intersection.
Risks: 1. Future volumes significantly greater than the 2020 forecasts could lead to interchange failure.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

The original analysis of the tight diamond with double left turns indicated a LOS E on the east side and LOS D on the west side during the AM peak. A signal optimization and analysis indicates that the double left-turn lane can be operated at levels-of-service in the C/D range with optimized signal timing.

BRIDGE COSTS

	Length	Width	Area(SF)	Unit Cost	Savings
Bijou over RR/creek	500	12	6000	120	$720,000.00
Bijou over I-25	235	12	2820	85	$239,700.00

PAVEMENT	Length	Width	Area (SY)	Unit Cost	Savings
Bijou 2lane easbnd	1250	12	1666.667	35	$58,333.33
Southbound off-ramp	400	12	533.3333	35	$18,666.67

EARTHWORK	Length	Area (SF)	Vol (CY)	Unit Cost	Savings
WB approach	300	72	800	10	$8,000.00
EB departing	500	72	1333.333	10	$13,333.33
West of I-25	450	24	400	10	$4,000.00
Southbound off-ramp	400	30	444.4444	10	$4,444.44
Total					$1,066,477.78
Markup for PE, CE & Contingency				0.35	$373,267.22
Project Savings					$1,439,745.00

VALUE ENGINEERING PROPOSAL NO. 01-046

SUMMARY PROPOSAL DESCRIPTION:

Use existing westbound Bijou bridge over the railroad and Monument Creek and only replace the eastbound bridge.

Estimated potential savings:

Initial:	$ 4,300,000
Future:	$ 0,000
Total:	$ 4,300,000

Discussion:

Westbound structure was built in 1958. It has 23 feet of vertical clearance, which is adequate for an existing bridge and it is structurally sufficient. If the westbound structure does not need to be replaced, there will be a construction savings of $3,390,000. Allocating $200,000 to rehabilitiate the existing westbound bridge leaves a net savings of $3,190,000. Including a markup for CE, PE, and contingencies yields a project savings of $4,300,000.

Related Ideas:

SR01-019	Better definition of railroad requirements.
P02-002	Retain and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.
P02-005	Widen and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.
SR01-036	Bridges disconnected

EVALUATION
Idea Number: 01-046 Idea Description: Use existing westbound Bijou bridge over the railroad and Monument Creek and only replace the eastbound bridge.
Advantages: 1. Significant reduction in structure replacement. 2. Reduced project cost.
Disadvantages: 1. Reduced cross section westbound.
Risks: 1. Existing bridge will have a shorter life expectancy than a new bridge.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Westbound structure was built in 1958. It has 23 feet of vertical clearance, which is adequate for an existing bridge and it is structurally sufficient. Not replacing the westbound structure will save $3,390,000 (based on the project cost estimates). Allocating $200,000 to rehabilitate the existing westbound bridge leads to a net construction savings of $3,190,000. Including a markup for CE, PE, and Contingencies yields a project savings of $4,300,000.

VALUE ENGINEERING PROPOSAL NO. 02-002

SUMMARY PROPOSAL DESCRIPTION:

Retain and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.

Estimated potential savings:

Initial:	$ 8,500,000
Future:	$ 0,000
Total:	$ 8,500,000

Discussion:

Rehabilitating the existing structures and retaining them will cost approximately $500,000 versus $6,800,000 (in construction costs) to replace them. With the markup for PE, CE, and contingencies the project savings is $8,500,000. This proposal is contingent on the existing laneage being sufficient.

Related Ideas:

SR01-019	Better definition of railroad requirements
P01-046	Use existing westbound Bijou bridge over the railroad and Monument Creek and only replace eastbound bridge.
P02-005	Widen and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.
P04-008	Use double left-turn for southbound exit ramp at Bijou Street instead of triple left turn.

EVALUATION
Idea Number: 02-002 Idea Description: Retain and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek.
Advantages: 1. Simplified construction 2. Reduced project cost. 3. Reduced construction in Monument Park
Disadvantages: 1. Reduced cross section width (2-lanes). 2. Substandard clearance over railroad.
Risks: 1. Existing bridges will have a shorter service life than new bridges. 2. Requires 2-lane left at SB off ramp.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Westbound structure was built in 1958. It has 23 feet of vertical clearance, which is adequate for an existing bridge and it is structurally sufficient. The eastbound structure was built in 1937. It is also structurally sufficient, but functionally obsolete. This structure only has about 21 feet of clearance. Not replacing these structures will save $6,780,000. Allocating $500,000 to rehabilitiate the existing bridges leads to a net savings of $6,280,000 in construction costs. With the markup for PE, CE, and contingencies the project savings is $8,500,000.

This proposal is dependent on reducing the eastbound lanes to two (P04-008). A related proposal calls for widening the existing bridges (P02-005).

VALUE ENGINEERING PROPOSAL NO. 02-005

SUMMARY PROPOSAL DESCRIPTION:

Widen and rehabilitate the existing bridges on Bijou Street over Monument Creek and the railroad.

Estimated potential savings:

Initial:	$ 7,800,000
Future:	$ 0,000
Total:	$ 7,800,000

Discussion:

Widening the existing structures to meet the laneage requirements, and rehabilitating them, will provide substantial cost savings. A related proposal (P02-002) rehabilitates the bridges, but does not widen them.

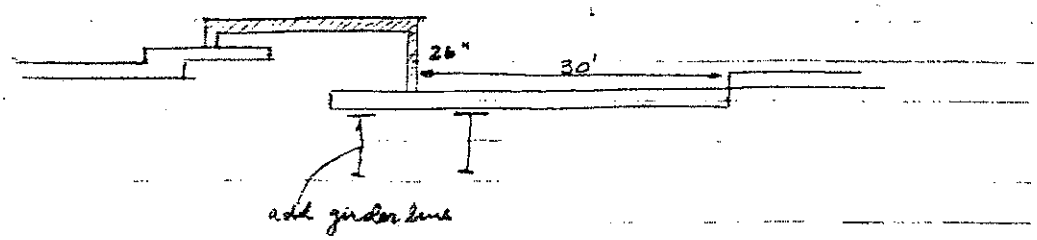
Related Ideas:

SR01-019	Better definition of railroad requirements
P01-046	Use existing westbound Bijou bridge over the railroad and Monument Creek and only replace eastbound bridge
P02-002	Retain and rehabilitate the existing Bijou Street bridges over railroad and Monument Creek

EVALUATION
Idea Number: 02-005 Idea Description: Widen and rehabilitate the existing bridges on Bijou Street over Monument Creek and the railroad.
Advantages: 1. Reduced construction cost. 2. Simplied construction 3. Reduced construction in Monument Park 4. Reduced construction impacts to traffic.
Disadvantages: 1. Reduced cross section width 2. Substandard clearance over railroad.
Risks: 1. Existing bridges will have a shorter service life than new bridges.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

Widen Bijou Structure (Eastbound)



Remove slab		$ 50,000
Remove sidewalk		50,000
Add 2 girder lines	360#/' x 483 x 2 x 1.00 #/ft	350,000
Conc deck	8"/12 x 483 x 8' = 2576 ft³ / 27 = 95 yd³ x 300 =	28,500
Rebar	250#/yd³ x 2576 ft³ x .5 =	12,000
Rehab (upgrade Rail, street in general		500,000
		$ 990,500 say $ 990,000

Remove slab		$50,000
Remove sidewalk		$50,000
Add two girder lines	360#/ft*483*2*1.00$/#	$350,000
Concrete deck	8"/12*483*8'/27*300	$28,500
Rebar	250#/yd*2576/9	$12,000
Rehab (upgrade rail, street, general)		$500,000
TOTAL		$990,500

ORIGINAL BRIDGE COST	$6,780,000
NET CONSTRCTION SAVINGS	$5,789,500
Markup for PE, CE, & Cont.	$2,026,325
Total Project Savings	$7,815,825

VALUE ENGINEERING PROPOSAL NO. 01-048

SUMMARY PROPOSAL DESCRIPTION:

Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron Street ramps and the main line.

Estimated potential savings:

Initial:	$ 3,600,000
Future:	$ 0,000
Total:	$ 3,600,000

Discussion:

Evaluating the crossing of US 24 over Fountain Creek, the opening seems to be only about 500 square feet which means, that at the time of high water during the 100-year storm event, Fountain Creek is out of its banks. It thus seems reasonable to consider using a closed system. A closed system will not solve the problem, but will not exacerbate it and may actually mitigate it. The calculations are, of course, rather preliminary but indicate that the solution is viable. It would appear that one might be able to accomodate the 100-year flood in a closed system.

Related Ideas:

EVALUATION
Idea Number: 01-048 Idea Description: Use improved inlet culvert for Fountain Creek in lieu of bridges at the Cimarron St. ramps and the mainline.
Advantages: 1. Eliminates need for ramp structures 2. Provides opportunity to reclaim land in backwater area of Fountain Creek overflow to be left in open space condition. This assumes CDOT will purchase properties in this backwater area. If not, the area can be reclaimed by its owners. 3. Allows shortening of the mainline I-25 bridges 4. Provides opportunity to redirect Fountain Creek in a more hydraulically efficient manner at its confluence with Monument Creek
Disadvantages: 1. Does not eliminate existing problem of Fountain Creek flooding, but does improve the existing condition. 2. May require a 404 permit although any activity in the creek may require such a permit; e.g., ramp and mainline bridges 3. May require revision of FEMA mapping
Risks: 1. Potential danger for people to be drawn into the culvert 2. May require some movement of the confluence of the two creeks although the confluence as it exists is not as precise as depictede on the plans for the project.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

Calculations and/or Discussion:

The cost savings includes a 35% factor for PE, CE, and Contingencies and the factor was not applied to Right-of-Way. (ROW not applicable to this proposal.)

Poi-0448 1/2

Improved Culvert @ Fountain Creek

Discharge in Fountain Creek Upstream of Fountain Creek

50 YEAR = 14,000 cfs

100 YEAR = 20,500 cfs.

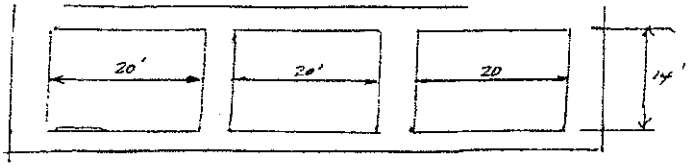
Between Sections EG & EF Grade drops approx 3' in 300', ≈ S=0.01 or 1%

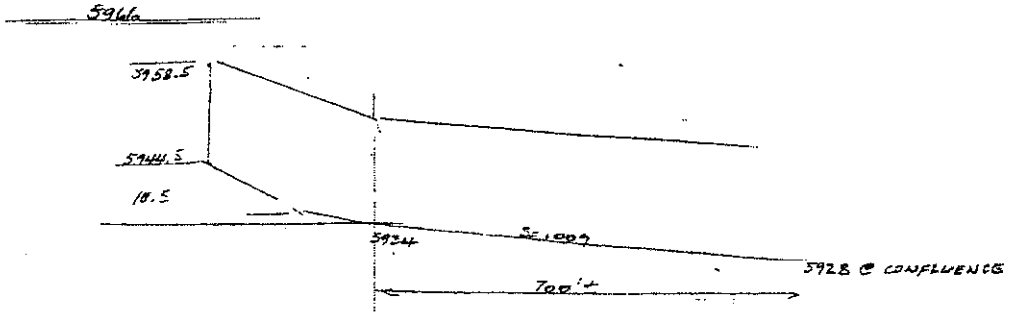
Generally, the channels seems to flatten to 8'/1000' = .008 %

using S=0.009 for calculations

Assume a box depth of 14'; to provide roughly a 500# opening 500/14 = 36'±

Try a 3-cell box

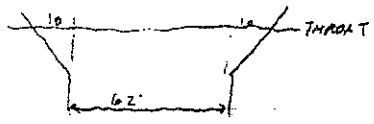




$\frac{H_f}{D} = \frac{20}{14} = 1.4$ $\frac{Q}{B_f D^{3/2}} = 4.4$ $Q = 4.4 \times 83 \times 14^{3/2} =$

$= 4.4 \times 83 \times 14^{\frac{3}{2}} =$

$= 4.4 \times 83 \times 53 = 19,350$ cfs



This appears reasonable

Cost of box. $1024 - 840 = \frac{184}{27} \times 700' \times \$250 =$

$= 6.8 \times 700 \times 250 = 1,190,000$

Rebar $= 250 \times 6.8 \times 700 \times .50 = 595,000$

Inlet $= 250,000$

Outlet $= 250,000$

$2,285,000$

42

ELIMINATE BRIDGE AT SB RAMP	700,000
ELIMINATE BRIDGE AT NB RAMP	300,000
SHORTEN I-25 BRIDGE .50 x 200 x 100	3,000,000
ELIMINATE RETAINING WALL	200,000.
TOTAL	5,000,000
LESS REMOVED CULVERT	2,300,000
SAVINGS	2,700,000

ADD 35% FOR PE, CE and Contingencies which would not apply to R/W. (R/W not applicable here)

VALUE ENGINEERING PROPOSAL NO. 03-009

SUMMARY PROPOSAL DESCRIPTION:

Put Cimarron St. on top of Fountain Creek by using a triple box culvert.

Estimated potential savings:

Initial:	$ 1,500,000
Future:	$ 0,000
Total:	$ 1,500,000

Discussion:

This proposal looked at reducing the overall length of the I-25 bridges at Cimarron and Fountain Creek by realigning Cimarron (to the north) on top of Fountain Creek. This proposal is economical if a box culvert can be used for Fountain Creek as described in proposal 01-048.

Related Ideas:

SR03-006	Retain flood upstream of I-25
P01-048	Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron St. ramps and mainline

EVALUATION
Idea Number: 03-009 Idea Description: Put Cimarron St. on top of Fountain Creek.
Advantages: 1. Reduces the I-25 bridge spans 2. Eliminates the ramp bridges (combined with Fountain Creek).
Disadvantages: 1. Requires additional bridge for Fountain Creek or Box Culvert 2. I-25 bridges would need to be long enough to accommodate existing Cimarron during construction (this would result in approximately 50 feet extra of structure) and the number of lanes on Cimarron would have to be reduced during construction of the SB I-25 bridge. 3. The intersection approaches would be on a curved alignment 4. Reduces the weave distance between Cimarron and Bijou by approximately 150 feet. 5. Requires a curved bridge for the Cimarron/Fountain Creek 6. Potential encroachment into Confluence Park 7. Possible wetland impacts. 8. Requires individual 404 permit. 9. Possible increased noise impacts at Confluence Park. 10. Monument Creek trail relocation.
Risks: 1. May not be consistent with the overall trail plan for Fountain Creek 2. Safety issues related to people falling in and getting swept into the culvert.
Conclusion: ☒ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

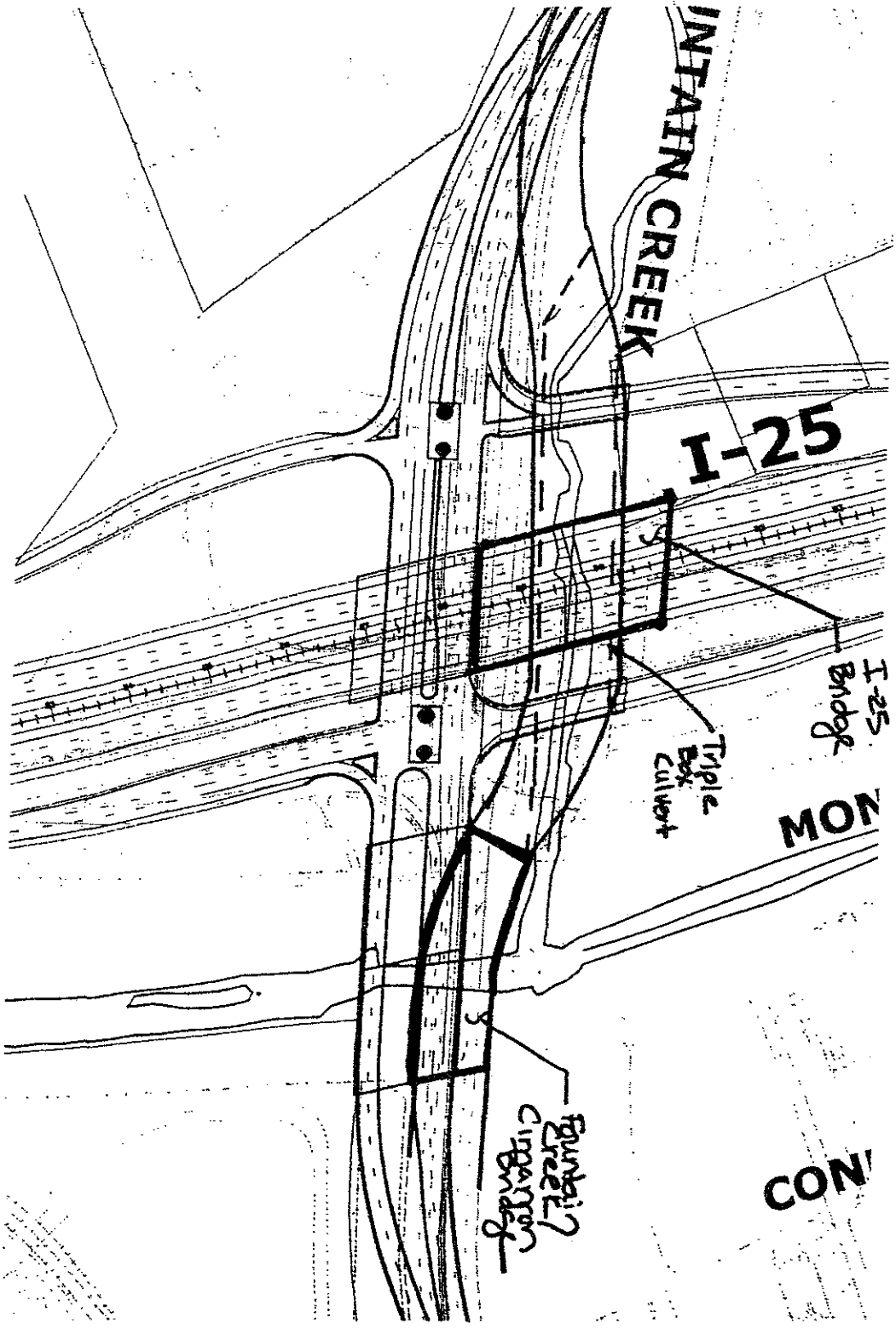
Calculations and/or Discussion:

The construction phasing of the alternative will require shifting a reduced number of lanes on Cimarron to the westbound side prior to constructing the SB I-25 bridges. Construction of Fountain Creek bridge (under I-25) may have to be phased depending on what the existing structure configuration is.

This proposal is economical if a box culvert can be used for Fountain Creek.

Estimated cost for triple box culvert: $3,000,000
I-25 Bridge: (260 ft x 150 ft) = 39,000 sf x $100/sf = $3,900,000

The following calculations are for the base case, a bridge option, and a triple box culvert option. The net savings is $1,100,000. This is adjusted by 35% for project markup (PE, CE, and contingency) for a total savings of ***$1,500,000***


INTAIN CREEK
I-25
I-25 Bridge
Triple Box Culvert
MON
Fountain Creek
CON

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	8.00%	
	ORIG. COSTS OR ONLY SAVINGS	BRIDGE ALTERNATIVE COSTS	BOX CULVERT ALTERNATIVE COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:	$0.00			
OTHER INITIAL COSTS:				
Fountain/Cimarron	$4,135,400.00	$10,800,000.00	$4,135,400.00	
I-25 Over Fountain & Cimarron	$6,000,000.00	$4,200,000.00	$3,900,000.00	
NE Ramp	$900,000.00	$0.00	$0.00	
NW Ramp	$800,000.00	$0.00	$0.00	
Retaining Wall	$328,000.00	$0.00	$0.00	
Cimarron Pavement	$340,000.00	$90,000.00	$340,000.00	
Triple Box Culvert			$3,000,000.00	
SUBTOTAL INITIAL COSTS:	$12,503,400.00	$15,090,000.00	$11,375,400.00	
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
SUBTOTAL ANNUAL COSTS:				
PRESENT WORTH OF ANNUAL COSTS:				
NET PRESENT VALUE	$12,503,400.00	$15,090,000.00	$11,375,400.00	
TOTAL SAVINGS (original - alternative)		($2,586,600.00)	$1,128,000.00	
CAPITAL SAVINGS		($2,586,600.00)	$1,128,000.00	
FUTURE SAVINGS		$0.00	$0.00	

NOTE: terms in italics are calculated

P 02-005	*Widen and rehabilitate the existing bridges on Bijou Street over Monument Creek and the Railroad.*	WCEA	Reject		
P 03-009	*Put Cimarron St. on top of Fountain Creek by using a triple box culvert.*	FHU	Reject		
P 03-015	*Keep existing Cimmaron Street Bridge for westbound and build new eastbound bridge.*	FHU	Reject		
P 04-008	*Use double left-turn lanes for the southbound exit ramp at Bijou Street instead of triple left-turn lanes.*	FHU	Reject		
P 04-017	*Use 12' HOV lanes versus 14' lanes.*	WCEA	Accept	*$1,252,000*	*$1,252,000*
			Total Cost Savings of Proposals Accepted =	**$4,348,000**	**$4,348,000**

Notes:

1. The Total Cost Savings is the designer's estimated cost savings minus the estimated cost for the design change.
2. The "Total Cost Savings of Proposals" is the sum of all savings associated with "accepted" or "partially accepted" proposals.
3. ND - Not Determined, NA - Not Applicable

Response to Value Engineering Proposal **Project:**
Proposal No.: P 01-002
Proposal Description: Put I-25 over Bijou by using a structure in lieu of fill.
Recommended Action: Reject.
Discussion: A more detailed analysis was completed in October 2000 and resulted in an additional cost of $5.5M
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 750,000* **Designer Savings Estimate <$5,500,000>** **Reason for Difference in Estimates** **VE Team did not consider several additional costs including ramps and phasing**
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal Project:	
Proposal No.: P 01-005	
Proposal Description: Raise profile grade of I-25 at Bijou.	
Recommended Action: Accept.	
Discussion: Preliminary design will investigate additional means to raise further.	
Construction Cost Savings Comparison VE Team Savings Estimate Designer Savings Estimate Reason for Difference in Estimates	 *$ 2,287,000* *$ 560,000* *Savings in underdrain, cofferdam, dewatering, and stabilization are not included at this time. Further design may result in realization of the additional $1.13M or more.*
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 560,000*

Response to Value Engineering Proposal **Project:**	
Proposal No.: P 01-009	
Proposal Description: Shift I-25 to the east approximately 8' and construct a cantilevered moment slab on top of the proposed mechanically stabilized earth (MSE) walls to prevent further encroachment into the floodplain.	
Recommended Action: Accept.	
Discussion: Study further in preliminary design. Anticipate increasing lateral clearance to VA building. Plan to implement some cantilevered element where benefits arise.	
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 9,000* **Designer Savings Estimate** *$ 9,000 (will require further analysis to modify)* **Reason for Difference in Estimates**	
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 9,000*

Response to Value Engineering Proposal Project:	
Proposal No.: P 01-010	
Proposal Description: Lower the profile grade of I-25 between Colorado and Cimarron.	
Recommended Action: Accept.	
Discussion: Attempt to minimize Colorado superstructure depth, which is currently controlling profile.	
Construction Cost Savings Comparison VE Team Savings Estimate Designer Savings Estimate Reason for Difference in Estimates	 *$ 1,037,000* *$ 1,037,000*
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 1,037,000*

Response to Value Engineering Proposal Project:	
Proposal No.: P 01-015	
Proposal Description: Reduce lane widths on local street constructed by project from 12 feet to 11 feet.	
Recommended Action: Partially accept.	
Discussion: Reduction in design standards. *-Cimarron is US Highway.* *-Bijou requires wider lanes east of railroad.*	
Construction Cost Savings Comparison VE Team Savings Estimate *$ 1,200,000* Designer Savings Estimate *$ 90,000* Reason for Difference in Estimates *Savings result from narrowing lanes on Bijou Bridge over Monument Valley Park only.*	
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 90,000*

Response to Value Engineering Proposal Project:	
Proposal No.: P 01-028	
Proposal Description: Reduce the median width on Cimarron Street across Fountain Creek.	
Recommended Action: Accept.	
Discussion: Two independent structures will be used for Cimarron over Fountain Creek.	
Construction Cost Savings Comparison VE Team Savings Estimate *$ 240,000* Designer Savings Estimate *$ 1,400,000* Reason for Difference in Estimates *Construction of two bridges reduces bridge deck by 30' +/- for approximately 300' in length*	
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 1,400,000*

Response to Value Engineering Proposal **Project:**
Proposal No.: P 01-030
Proposal Description: Reduce the spacing between the ramp terminals at the Cimarron interchange.
Recommended Action: Reject.
Discussion: Left-turn storage requirements preclude reduction of intersection spacing.
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 2,000,000* **Designer Savings Estimate** **Reason for Difference in Estimates**
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 01-046
Proposal Description: Use existing westbound Bijou bridge over the RR and Monument Creek and only replace the eastbound bridge.
Recommended Action: Reject.
Discussion: For 1-046, 2-002, 2-005 *Existing Bridge does not work with proposed horizontal and vertical geometry. CDOT may defer the construction of Bijou east of the east ramps until a later time (approx. $10M in savings).*
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 4,300,000* **Designer Savings Estimate** **Reason for Difference in Estimates**
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 01-048
Proposal Description: Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron Street ramps and the main line.
Recommended Action: Reject.
Discussion: Not compatible with future pedestrian/recreational uses planned for the creek area.
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 3,600,000* **Designer Savings Estimate** **Reason for Difference in Estimates**
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 02-002
Proposal Description: Retain and rehabilitate the existing Bijou Street bridges over RR and Monument Creek.
Recommended Action: Reject.
Discussion: Existing Bridge does not work with proposed horizontal and vertical geometry. CDOT may defer the construction of Bijou east of the east ramps until a later time (approx. $10M in savings).
Construction Cost Savings Comparison **VE Team Savings Estimate** *$ 8,500,000* **Designer Savings Estimate** **Reason for Difference in Estimates**
Estimated Design Cost.
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 02-005
Proposal Description: Widen and rehabilitate the existing bridges on Bijou Street over Monument Creek and the Railroad.
Recommended Action: Reject.
Discussion: Existing Bridge does not work with proposed horizontal and vertical geometry. CDOT may defer the construction of Bijou east of the east ramps until a later time (approx. $10M in savings).
Construction Cost Savings Comparison VE Team Savings Estimate *$ 7,800,000* Designer Savings Estimate Reason for Difference in Estimates
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal Project:
Proposal No.: P 03-009
Proposal Description: Put Cimarron St. on top of Fountain Creek by using a triple box culvert.
Recommended Action: Reject.
Discussion: Cimarron will not be moved on top of Fountain Creek (north) to avoid conflict with Confluence Park and to avoid minimization of weave on I-25.
Construction Cost Savings Comparison VE Team Savings Estimate *$ 1,500,000* Designer Savings Estimate Reason for Difference in Estimates
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 03-015
Proposal Description: Keep existing Cimarron Street Bridge for westbound and build new eastbound bridge.
Recommended Action: Reject.
Discussion: The profile of Cimarron Street will be raised from existing to reduce constriction of floodplains at the confluence of Fountain Creek and Monument Creek.
Construction Cost Savings Comparison VE Team Savings Estimate *$ 2.4 M* Designer Savings Estimate Reason for Difference in Estimates
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**
Proposal No.: P 04-008
Proposal Description: Use double left-turn lanes for the southbound exit ramp at Bijou Street instead of triple left-turn lanes.
Recommended Action: Reject.
Discussion: Project will build ramp to accommodate triple-left; however, a double-left will be used from opening day until the 3rd left turn lane is needed. This will allow CDOT to defer the cost of construction east of the east ramps (approximately $10M) until the 3rd left lane is needed.
Construction Cost Savings Comparison VE Team Savings Estimate *$ 1,400,000* Designer Savings Estimate Reason for Difference in Estimates
Estimated Design Cost
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)

Response to Value Engineering Proposal **Project:**	
Proposal No.: P 04-017	
Proposal Description: Use 12' HOV lanes versus 14' lanes.	
Recommended Action: Accept. (pending CDOT and FHWA corridor decision)	
Discussion: Corridor decision to be documented in the EA.	
Construction Cost Savings Comparison VE Team Savings Estimate *$ 1,252,000* Designer Savings Estimate *$ 1,252,000* Reason for Difference in Estimates	
Estimated Design Cost	*N/A Alignment to be refined in Preliminary Design*
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	*$ 1,252,000*

Calculations:

04-015

	unit	unit cost	quantity	cost
Reductions				
Guardrail	lin feet	$ 45.00	-9000	$ (405,000.00)
Total Reduction				***($405,000.00)***
Addition				
Bridge at Bijou	sq ft	$ 85.00	2835	$ 240,975.00
Bridge at Cimarron	sq ft	$ 100.00	8400	$ 840,000.00
Bridge at Colorado Ave.	sq ft	$ 100.00	3570	$ 357,000.00
				$ 1,437,975.00
Additional ROW:				
9000 ft				
11 ft (assumed ROW just needed on one side)				
	sq ft	$ 12.00	99000	$ 1,188,000.00
Assumed no additional buildings were impacted				
Total Additional Cost				***$ 2,625,975.00***

SUPPLEMENTAL RECOMMENDATION NO. 05-001

SUMMARY RECOMMENDATION DESCRIPTION:

Steepen side slopes by using concrete slope and ditch paving.

Description:

Concrete slope and ditch paving can be used to steepen the side slopes at interchange areas and where tight right-of-way constraints exist.

Related Ideas:

EVALUATION
Idea Number: 05-001 Idea Description: Steepen side slopes by using concrete slope and ditch paving
Advantages: 1. Reduces lateral distances. 2. Reduces right of way requirements.
Disadvantages: 1. Cost more than slope construction. 2. Eliminates landscape opportunities.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☒ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

DISCUSSION AND/OR CALCULATIONS:

Other ideas proposed are: consider more vertical elements such as vertical abutments and soil nail walls and alternate soil treatments.

The idea is to consider slope and ditch paving between the ramps and mainline at the Cimarron interchange to bring the ramps closer to the mainline to avoid the floodplain and minimize right of way acquisitions.

SUPPLEMENTAL RECOMMENDATION NO. 01-034

SUMMARY RECOMMENDATION DESCRIPTION:

Investigate installing a wearing course on concrete pavement to reduce noise.

Description:

Use a wearing course on concrete pavement to reduce noise due to tire whine.

Related Ideas:

EVALUATION
Idea Number: 01-034 Idea Description: Use a wearing course on concrete pavement to reduce noise.
Advantages: 1. If effective, reduces traffic noise (tire whine). 2. Appeases public.
Disadvantages: 1. May lose noise reduction effectiveness over time, reducing credibility with public. 2. Not as effective with increased distance from roadway (may not be perceptible by neighborhood). 3. If effectiveness is reduced over time wouldn't want to not provide noise mitigation based on use of a wearing course. 4. Increased maintenance to account for repeated applications. 5. Increased initial costs.
Risks: 1. Technology may not be proven. 2. Sets precedence.
Conclusion: ☐ Propose this idea ☒ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

DISCUSSION AND/OR CALCULATIONS:

A 5/8" asphalt-wearing course is being installed over a concrete roadway (Table Mesa Road) in the City of Boulder to address neighborhood noise concerns. It is recommended that concept be investigated further to determine if it would be appropriate for use on I-25.

SUPPLEMENTAL RECOMMENDATION NO. 01-031

SUMMARY RECOMMENDATION DESCRIPTION:

Use ramp metering of on ramps between Cimarron and Bijou Street interchanges to alleviate weaving problems.

Description:

Analysis of the weaving sections northbound and southbound indicates a Level-of-Service D under a Highway Capacity Software analysis and simulation indicates a LOS C. Ramp metering could space entering traffic out more uniformly creating more gaps for exiting traffic and reducing conflicts.

Related Ideas:

EVALUATION
Idea Number: 01-031 Idea Description: Use ramp metering of on ramps between Cimarron and Bijou Street interchanges to alleviate weaving problems.
Advantages: 1. Improved traffic operations on mainline 2. Improved weaving operations
Disadvantages: 1. Public acceptance 2. Increased delay to entering traffic 3. Increased maintenance cost
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☒ Propose this idea as a Supplemental Recommendation ☐ Do not propose this idea because

DISCUSSION AND/OR CALCULATIONS:

Even if metering is not done initially, it can be added in the future. Ramp metering is not currently used in Colorado Springs.

SECTION 5 – IDEAS ANALYZED BUT NOT PROPOSED

EVALUATION
Idea Number: 01-003 Idea Description: Use a refined collector/distributor road concept that does not include access to Colorado Ave.
Advantages: 1. Provides adequate weave between Bijou Street and Cimarron 2. Conflicts (weave) are handled outside of the mainline traffic.
Disadvantages: 1. Additional right-of-way would be required because of the wider section 2. Additional bridge width required for widen section for Colorado Ave. bridge 3. Additional guardrail would be required for the C-D road 4. Retaining walls are required between C-D road, ramps and mainline.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there is no apparent benefit for the cost of this alternative.

Calculations and/or Discussion:

Additional cost at the Colorado Ave. bridge:

24 ft x 170 ft = 4,080 sf x 2 (both sides) = 8,160 sf x $100/sf = $816,000

Additional cost for retaining walls (between ramps, C-D Road and Mainline):

800 ft x 10 ft = 8,000 sf
1,000 ft x 15 ft = 15,000 sf
Subtotal = 23,000 sf x 2 (both directions) = 46,000 sf

46,000 sf x $45/sf = $2,070,000

Additional structure costs (bridge and walls):
816,000+2,070,000 = $2.9 Million

Additional cost with project markup of 35% for PE, CE & Contingency: **$3.9 Million**

There are other costs for this proposal that have not been calculated, including additional right-of-way costs, potential building takes and relocations, additional pavement, and earthwork.

EVALUATION
Idea Number: 01-017 Idea Description: Use a split alignment of Bijou across I-25 and tie EB Bijou in at Pikes Peak
Advantages: 1. No impacts to the existing Bijou Bridge over the railroad tracks 2. Reduces traffic through the St. Mary's Church complex 3. Construction phasing would be simplified because it is new bridge construction 4. Would eliminate the cost of removing an existing bridge.
Disadvantages: 1. Increased cost because of additional right-of-way required over tracks and between I-25 and Monument Creek 2. Longer structure to span Sierra Madre 3. Right-of-way/access issues on Pikes Peak 4. Decreases the distance between the gores/weave of Bijou and Cimmaron Interchanges. 5. This proposal would provide a system (eastbound) that would dead end at Cascade Ave., therefore not providing a continous system into downtown.
Risks: 1. This is not the historic use/location of traffic coming into downtown. Probably would have opposition by business owners along Pikes Peak and Bijou St.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there is no operational benefit for this alternative and it would be more expensive, have additional right-of-way impacts, and would most likely have public opposition. In addition, it would not provide a continous eastbound movement into downtown because Pikes Peak dead ends at Cascade.

Calculations and/or Discussion:

EVALUATION
Idea Number: 01-018 Idea Description: Use retaining walls along the west side of I-25 to reduce the need for additional right of way.
Advantages: 1. Reduces right-of-way acquisition and relocation costs. 2. Minimizes damages to the remaining property.
Disadvantages: 1. Maintenance costs increase. 2. Visually unacceptable. 3. Removal of unwanted marks (graffiti)
Risks: 1. Failure of the wall would result in the collapse of the slope that it is retaining.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because it is considered in the base case and has been determined to be cost effective.

Calculations and/or Discussion:

The current proposal contains MSE retaining walls from Colorado Avenue south to Cimarron. The wall ranges in height from 5 feet to 46 feet. Estimated cost for this segment of the wall is $2,237,000. Between Colorado Avenue and Bijou Street, the current proposal shows MSE retaining walls north from Colorado Avenue to West Pikes Peak Avenue and along the County Social Service Buildings. The cost estimate for this segment is $177,000. The greatest right-of-way impact would be that segment between Stations 91 to 99 where there is an auto recycling facility, auto body and paint shop and storage buildings. A comparison was made between the cost of the wall and the costs associated with the additional right-of-way.

Between Stations 91 and 99, the MSE wall is estimated at $924,000 in the base case. If the wall was eliminated, an additional 46,000 square feet of right-of-way would be required for the fill slope at an estimated cost of $550,000. The wider fill slope and right-of-way would require the displacement of the buildings on the site. The costs of the buildings reported in the Preliminary Summary of Right-of-Way Costs for a 70 mph Design is just over $1,000,000. In addition, damages to the remainders would be substantial resulting in total acquisition of the properties. The additional acquisition costs for the remainders would be about $2,100,000. Once the buildings are impacted by the slope, relocation of the businesses would be necessary. These additional relocation costs are estimated at $500,000 due to the complexities with the auto recycle shop and auto body and paint shop. Together, these costs exceed $4,000,000, which does not include the costs of the additional embankment material required for the widened slope.

Conclusion:

The cost of the MSE walls in this area is about $924,000. The wall save over $4,000,000 in additional right-of-way costs. The construction of the MSE wall is appropriate. This type of analysis should be performed at each wall location.

EVALUATION
Idea Number: 01-039 Idea Description: Move Fountain Creek to south side of SH 24/Cimarron
Advantages: 1. May reduce structure requirements at interchange by improving channel upstream and lowering flows at downstream structures. 2. May reduce cost of interstate structures if structures can be reduced. 3. Could eliminate Fountain Creek structure on SH 24. 4. Could reduce flood damage downstream, i.e. Fountain Creek trail system. 5. May have opportunity to partner with City or Corps of Engineers, i.e. cost share. 6. Would improve channel capacity and stability of stream. 7. Could improve water quality and provide opportunity for wetland mitigation.
Disadvantages: 1. Requires additional right-of-way, i.e. additional impacts and costs. 2. May not reduce structure requirements - will shift from north side of SH24/Cimarron to south side of Cimarron. 3. Would require redefinition of FEMA floodplain, i.e. time, cost and modeling for FEMA map revision 4. Would require individual 404 permit, i.e. time requirements & perception of significant impacts. 5. Not consistent with Confluence Park. 6. New floodplain impacts.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there is no economic advantage.

Calculations and/or Discussion:

This proposal failed because there is no cost savings at the SH 24/Cimarron interchange structures. These structures are just shifted from the north side to the south side with no apparent cost savings. Requires 72,000 sf right-of-way from Holiday Inn at $12/sf.

This would also place the confluence of the two creeks south of Cimarron Street (i.e. may not be consistent with City plans for Confluence Park).

One overall benefit that is not reflected in these costs is the elimination of a bridge on SH 24 and Fountain Creek (outside of the scope of this project), but this is a trade-off with building new structures south of the interchange.

Long-term advantage could be improvement of Fountain Creek channel without significant cost sharing by others. The expenditure does not appear to justify the benefits at this time.

Calculations:

It was estimated that 1,400 lf of channel would be filled in. The average channel width (at the top) was 50 feet and the average depth was 15 feet. The channel was assumed to be triangular, so average area was calculated to be 375 sf. The area to be filled was calculated to be 375 sf x 1,400 lf = 525,000/27 = 19,444 cy. A $10/cy cost for embankment was utilized. Total cost was estimated to be $194,000.

The seeding quantity was estimated to be 160-foot width minus 128-foot top channel width leaving a 32-foot width for seeding. The length of the new channel is 1,600 feet. The total area to be seeded was estimated at 32 x 1,600 = 51,200/9 = 5,689 sy. The erosion/seeding cost was $2/sy. Total cost: 5,689 x 2 = $11,378.

The right-of-way required from Holiday Inn was estimated to be 450 feet by 160 feet for a total of 72,000 sf. The cost for right-of-way used was $12/sf.
Total cost 72,000 x 12 = $864,000.

The channel relocation costs were calculated as follows: 1,600 channel length, design flows for 50-year event at 14,000 cfs using 10 cfs velocity requires 1,400 sf channel opening or 1,400/27 = 52cy/lf. Using a 14-foot deep channel with 2:1 side slopes requires channel bottom width of 72 feet with top channel width of 128 feet. Using $10/cy for excavation, the cost per linear foot is 52*10 = $520.
Total cost 520* 1,600 = $832,000.

Total cost for the riprap was estimated to be: 256 sf (slopes)/27 = 9.5 cy/lf. At a cost of $20/cy the cost was estimated to be 20*9.5 = $190 lf.
The total cost was: 190 x 1,600= $304,000.

Filling in channel	$194,000
Erosion/seeding	$11,378
Right of way	$864,000
Excavation	$832,000
Riprap	$304,000
Total cost	$2,205,378

EVALUATION
Idea Number: 01-050 Idea Description: Use 10 or 12-foot outside shoulder instead of a 6-foot shoulder where there are auxiliary lanes, as shown in the typical section.
Advantages: 1. Meets AASHTO's requirement/preference for freeways with truck traffic that exceeds 250 DDHV 2. Provides additional area for snow storage especially in areas where the section will be limited by guardrail and walls. 3. Provides additional area for drainage flows/spreads. 4. A vehicle stopped on a shoulder should clear the travel lane by at least 1 foot (preferably 2 feet). A vehicle is typically around 7 feet wide. 5. When vertical elements(barrier/walls) are adjacent to a shoulder, there should be a minimum of 2 feet to the useable shoulder
Disadvantages: 1. Additional pavement would be required (increased cost) 2. Additional earthwork would be required (increased cost). 3. Additional right-of-way could be required (increased cost). 4. Increased bridge spans/lengths would be required (increased cost).
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because this is the As Design condition (10-foot shoulders)

DISCUSSION AND/OR CALCULATIONS:

EVALUATION
Idea Number: 01-053 Idea Description: Build a fly-over structure from SB I-25 to EB Kiowa south of Monument Park
Advantages: 1. Eliminates the need for improvements to Bijou Street east of I-25 2. Improves travel time of SB movements into downtown 3. Eliminates 4f impacts at St. Marys Cathedral
Disadvantages: 1. Does not replace aging Bijou structure over RR tracks and Monument Creek 2. Requires acquisition of Building to south of St Marys school and the Carnegie Library annex
Risks: 1. Public oposition to property impacts
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because the property impacts are too high

Calculations and/or Discussion:

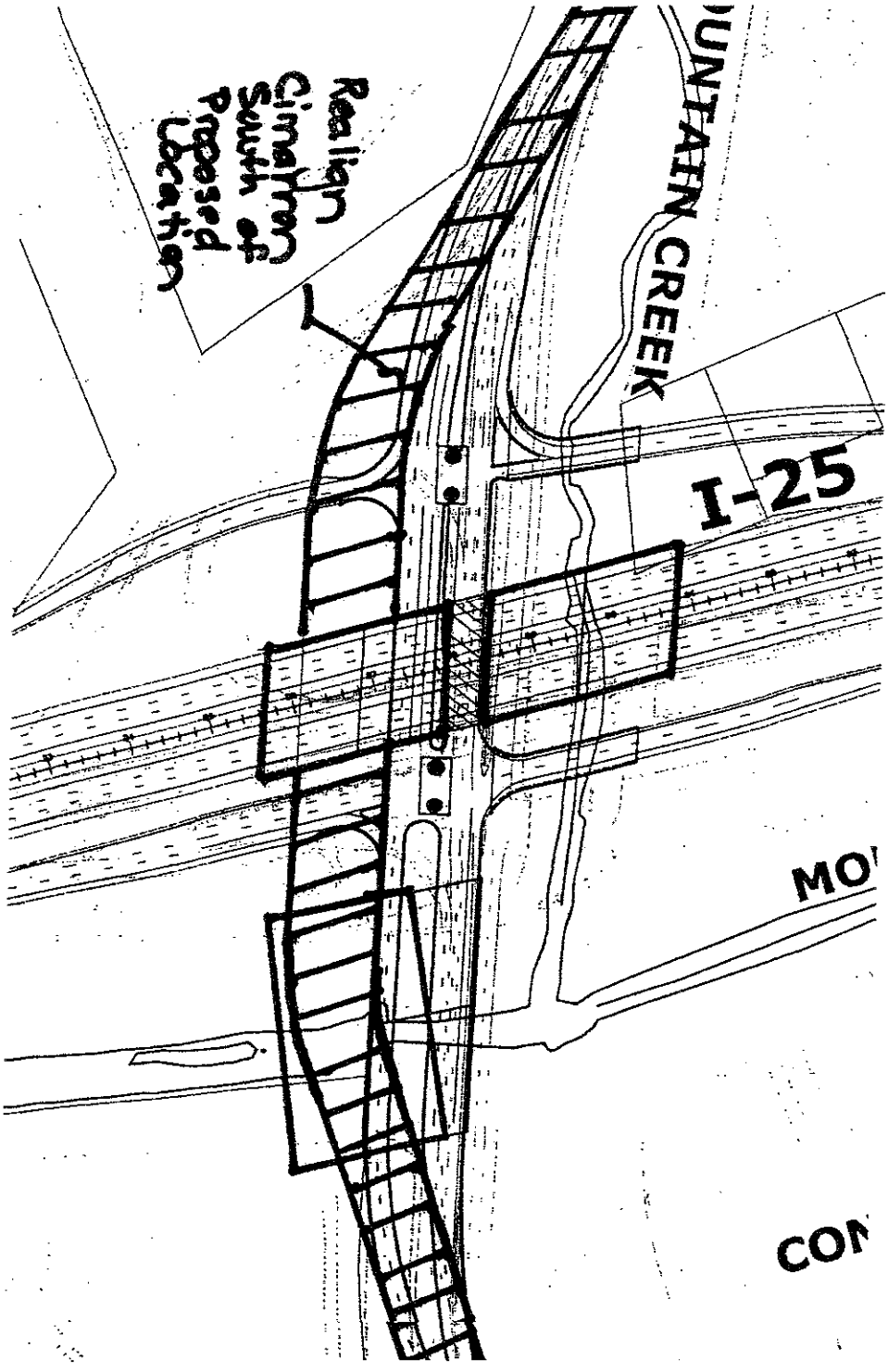
Required infrastructure:

1,400 lf fly-over structure over I-25 and railroad 1,400' x 28' (out to out) = 39,200 sf @ $100/sf =	$3,920,000
700 lf retaining wall along each side of SB off-ramp 700' x 2 = 1,400 lf @ 15' ht = 21,000 sf @ $45/sf =	$945,000
350 lf retaining wall along each side of east touchdown area 350 x 2 = 700 lf @ 15' ht = 10,500 sf @ $45/sf =	$472,000
2,000 sf of pavement at east touchdown 2,000 sf x $35 =	$70,000
75,000 sf ROW @ $50 =	$3,750,000
Total Infrastructure Cost =	$9,157,000
Elimination of Bijou Street local road improvements:	($8,198,000)
Net cost of fly-over alternative =	$959,000
PE, CE, and Contingency 35% =	$336,000
Total Cost Savings =	$1,295,000

This alternative would become much more feasible if the Palmer Deed restrictions for Monument Park could be resolved allowing the fly-over to span the park. This would eliminate the need for acquisition of the buildings adjacent to St. Mary's Church. Discussions with city officials should remain open at this time.

EVALUATION
Idea Number: 01-057 Idea Description: Move the I-25/Cimarron Interchange further south than the base case.
Advantages: 1. Increase weave/gores between the Bijou and Cimmaron Interchanges approximately 100 feet.
Disadvantages: 1. The length of the I-25 bridges would be equal to or greater than the proposed design due to construction phasing. 2. Would require additional right-of-way in the southeast corner of the interchange. 3. A curved bridge would be required for the Fountain Creek bridge.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there is no operation benefit, it will cost more, it would be more difficult to construct, and this proposal would most likely have more impacts on the traveling public during construction.

Calculations and/or Discussion:


Realign Cimarron Southbound Proposed
UNTAIN CREEK
I-25
MO
CO

EVALUATION
Idea Number: 01-065 Idea Description: Partial Urban Interchange at Bijou
Advantages: 1. Potentially less bridge deck than tight diamond 2. Potentially better traffic operations
Disadvantages: 1. More complicated structure 2. Not as well accepted by public as traditional diamond
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there are no apparent cost savings and no operational benefit.

Calculations and/or Discussion:

EVALUATION
Idea Number: 01-066 Idea Description: Convert Bijou Street east of Sierra Madre to two-way operations.
Advantages: 1. Maintains the existing Kiowa St and Sierra Madre alignments and widths. 2. Eliminates the need for right of way from Saint Mary's Church.
Disadvantages: 1. Minor changes to traffic patterns in the area. 2. Requires signal modifications at Bijou Street and Cascade.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there are no apparent cost savings.

Calculations and/or Discussion:

Extend Bijou to the east as a two-way facility to Cascade Avenue. Kiowa Street continues to operate as a one-way facility with an intersection at Bijou Street and Sierra Madre. Provide a free flow right from Bijou eastbound to Kiowa and a left turn slot for westbound Bijou to Kiowa. The proposed Bijou Street and Kiowa intersection could line up with the city street to the north, which could have full movements.

The intersection at Bijou and Cascade would need to be modified to include the new movements on Bijou Street and changes to the traffic signal.

The proposed change would result in the elimination of 3,733 square yards of pavement and about 2,700 square feet of right of way. Based on the provided cost estimate, $62.40 per square yard of pavement and $12 per square foot of right-of-way was used. The estimated cost savings is $260,000.

Widening Bijou Street to four lanes would require about 3,900 square yards of pavement and signal modifications at Bijou and Cascade. It was estimated that the signal modifications would cost $20,000. The estimated cost for changing Bijou St to four lanes is $260,000. There is no apparent cost saving with this proposal but could have some operational benefits.

EVALUATION
Idea Number: F02-015 Idea Description: Drop Monument Creek grade by 5 feet to shorten gravity drain at Bijou.
Advantages: 1. Reduces length of gravity drain system, i.e. reduces costs 2. Reduces long term maintenance
Disadvantages: 1. Impacts to Monument Creek, wetlands, retaining wall, and Fountain Creek trail 2. Probably not supported by public 3. Requires reconstruction of minimum of 1600 foot of channel 4. Impacts to WPA rock wall, 4(f) impacts 5. Would require individual 404 permit, extensive time requirements.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because not cost effective.

Calculations and/or Discussion:

Regrading Monument Creek:

4 Drop Structures @ $5,000 =	$20,000
Earthwork 26,000 cy @ $10/cy =	$260,000
Riprap 18,000 cy @ $20/cy =	$360,000
Retaining Wall 4,000 sf @ $45/sf =	$180,000
Total Channel Cost =	$820,000

Storm Sewer Cost:

1,400 lf 36" RCP @ $120/lf =	($168,000)
Net Cost =	$652,000
PE, CE, and Contingency @ 35% =	$228,000
Total Cost Addition of this proposal =	$880,000

EVALUATION
Idea Number: 03-004 Idea Description: Split Cimarron Street alignment and center Fountain Creek in the middle of Cimarron.
Advantages: 1. Shortens I-25 Bridges (20 ft)
Disadvantages: 1. Requires right-of-way from Confluence Park 2. Would require some realignment of Fountain Creek west of I-25 3. Would reduce the distance between the Bijou Interchange therefore reducing the weave distance 4. Requires a bridge over the confluence of Fountain Creek and Monument Creek for westbound Cimarron 5. Requires an additional bridge for westbound Cimarron as it crosses Fountain Creek west of I-25 6. Intersection approaches would be on a curved alignment 7. Requires additional right-of-way in the northwest corner of Cimarron and I-25
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there are no economical or operational benefits for this proposal.

Calculations and/or Discussion:

EVALUATION
Idea Number: 04-006 Idea Description: Various permutations of northbound right-turns at Bijou/I-25
Advantages: 1. None noted.
Disadvantages: 1. None noted.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because there are no cost benefits.

Calculations and/or Discussion:

EVALUATION
Idea Number: 06-003 Idea Description: Offset I-25 from the existing alignment and build towards one side only to minimize traffic disruptions
Advantages: 1. Minimizes traffic disruptions during construction. 2. Construction takes place away from the travel lanes of I-25. 3. Reduces construction time.
Disadvantages: 1. Shifts the location of the bridges at the interchanges. 2. Substantial right of way acquisition and relocation when shifting the improvements to the west. 3. Substantial floodplain impacts and construction costs when shifting the improvements to the east.
Risks: 1. None noted.
Conclusion: ☐ Propose this idea ☐ Propose this idea as a Supplemental Recommendation ☒ Do not propose this idea because

DISCUSSION AND/OR CALCULATIONS:

This idea would substantial increase the cost of the project due to the limitation of the floodplain on the east side of I-25 and the highly developed property along the west side. The idea was not developed because of the uncertainty of the costs.

The following ideas were dismissed during the initial idea cull. They were not analyzed to the point of listing individual advantages and disadvantages.

INITIALLY FAILED IDEAS TABLE

Idea No.	Idea Description	Reason for Failing Idea
01-001	Put confluence of Junction and Monument Creeks in a structure to save land for highway use	The flows are too great to put them in an economical structure. It violates the intent of Confluence Park.
01-004	Move I-25 east of Monument Creek and perform a land swap	Not consistent with the City's plans for Confluence Park. There are hazardous waste issues. There are problems with the highway geometrics. No discernable advantage.
01-007	Use a partial cloverleaf interchange at Bijou	The impacts to the right-of-way are too great. Would exacerbate the weave distance problem on I-25 S.B. The impacts to Spruce would be too great.
01-008	Realign a portion of I-25 to the east with a split alignment (Monument Creek is in the middle.)	Not consistent with the City's plans for Confluence Park. There are hazardous waste issues. There are problems with the highway geometrics. No discernable advantage.
01-011	Make an expressway/freeway connection at Cimarron and I-25 (free movements between the two highways)	No operational or economic advantage
01-021	Build over and fill under old Midland railroad bridge structure (do not remove)	There are concerns regarding structural integrity and it appears there is no real economic advantage.
01-025	Lower the railroad profile under the Bijou Bridge	Bridge over Monument Creek limits grade plus it would affect all of the yard tracks also.
01-029	Shift I-25 to the west to incorporate loop in the northeast Cimmaron/I-25 quadrant	Impacts to Confluence Park and major right-of-way impacts
01-038	Combine the two (I-25 and local) Bijou Bridges	No apparent economic advantage, more bridge structure and the ramps will probably be on structures also. Hydraulic problems also.
01-054	Move Monument Creek closer to the railroad near Bijou in order to shorten the bridge	There appears to be no economic advantage
01-056	Flatten curve between Bear Creek and Colorado Ave.	No economic advantage
01-060	Move the Cimarron St. directional off ramp under I-25 instead of over I-25	No apparent economic advantage
01-061	Drop I-25 and take Cimarron St. over I-25	No apparent advantage
01-062	Take I-25 under Colorado Ave.	No apparent economic advantage and flood issues
01-063	Keep the Spruce Street connection and eliminate Sierra Madre	No apparent economic advantage
01-064	Shift I-25 to west at Bijou to create more separation between interchange and existing bridge	Requires too much right-of-way takes

Idea No.	Idea Description	Reason for Failing Idea
02-012	Put Monument Creek in a box and shorten some bridge length	Flood flow precludes the use of a structure
02-013	Move the railroad out of the project area	Impossible
02-016	Install concrete channel for Monument Creek near Bijou St.	No apparent advantage. Major environmental issues
02-018	Relocate Bijou St.	No apparent advantage
02-021	Shift the railroad closer to Monument Creek	No apparent economic advantage
02-022	Bijou St. over I-25 and under the railroad	No apparent economic advantage
02-023	Bijou St. over I-25 and under the railroad and under Monument Park	No apparent economic advantage
02-027	Double deck Bijou St. through Monument Park	Not practical, major cost and impacts to the community
03-001	Conduit Fountain Creek over to Bear Creek	Against the principles of Monument Park, hydraulic problems, and not economical
03-003	Flip-flop I-25 and Fountain Creek and move the confluence west	Against the principles of Monument Park, hydraulic problems, and not economical
03-005	Conduit Fountain Creek through the interchange	Would require too large of a conduit structure to accommodate the flood flows
03-010	Take Fountain Creek over I-25	Impractical
03-011	Move Fountain Creek north to intercept Monument Creek further upstream	No apparent advantage
03-012	Move Cimarron St. to the north of Fountain Creek	Impinges on Confluence Park and no apparent advantages
03-014	Make an offset interchange at I-25 and Cimarron St.	No economic advantage
04-003	Increase median width on SH 24 (make it an expressway cross-section)	No apparent economic advantage
04-004	Close Colorado Ave.	Incompatible with the City's plans
04-009	Increase weave distance N.B. I-25 between Cimarron and Bijou	This is a goal not an alternative
04-012	Eliminate vertical broken back curves	No apparent advantage
04-020	Spread the I-25 ramps at Cimarron	No apparent advantage and deleterious right-of-way impacts
04-021	Southbound I-25 to eastbound Colorado Ave. flyover	The costs outweigh the benefits and their numerous operational difficulties
05-005	Raise or lower surrounding terrain	Too many right-of-way issues
05-006	Make I-25 a viaduct from Bijou to Bear Creek,	Not economical
05-007	Depress I-25 from Bijou to Bear Creek	Not economical

SECTION 7 – BRAINSTORMING IDEAS

The following table lists all of the ideas generated by the VE Team. They are arranged by the function from which they were generated. Shotgun list ideas are alternatives the VE Team members initially brought to the workshop as a result of their pre-study assignment.

Each idea can be traced to its ultimate disposition by crosschecking the disposition column of this table with Sections 3, 4, and 5 of this report.

PLEASE NOTE: One of the rules for creativity exercises in a formal VE Study requires the team members to "stretch" their imaginations by generating sometimes facetious and seeming nonsensical ideas in order to ideate a possible conceptual blockbuster. These ideas, too, are recorded in this table.

Brainstorming List

Idea No.	Idea Description	Disposition	With
	Shotgun List		
01-001	Put confluence of Junction and Monument Creeks in a structure to save land for highway use	Fail	-
01-002	Put I-25 over Bijou by using a structure instead of fill	Pass	-
01-003	Use refined collector/distributor road concept	Pass	-
01-004	Move I-25 east of Monument Creek and perform a land swap	Fail	-
01-005	Raise profile grade of I-25 at Bijou	Pass	-
01-006	Incentive/disincentive for Bijou Bridge to allow a complete interchange shutdown and allow pedestrian traffic	Supplemental Recommendation	-
01-007	Use a partial cloverleaf interchange at Bijou	Fail	-
01-008	Realign a portion of I-25 to the east with a split alignment (Monument Creek is in the middle.)	Fail	-
01-009	Realign I-25 east of its present location (minimal change)	Pass	-
01-010	Lower the profile of I-25 at Colorado and/or Cimarron	Pass	-
01-011	Make an expressway/freeway connection at Cimarron and I-25 (free movements between the two highways)	Fail	-
01-012	Reduce the I-25 south bound off ramp to Bijou to two lanes	Combine	02-002
01-013	Raise Bijou west of I-25 to reduce grade of Bijou	Combine	01-005
01-014	Detour I-25 traffic during construction	Combine	01-044
01-015	Reduce lane widths on local streets to 11 feet	Pass	-
01-016	Use cantilever section on portion of east side of I-25	Combine	01-009
01-017	Use a split alignment of Bijou going across I-25	Pass	-
01-018	Use walls on portions of west side of I-25 to reduce right-of-way	Pass	-
01-019	Better definition of railroad requirements	Supplemental Recommendation	-

Idea No.	Idea Description	Disposition	With
01-020	Minimize the depth of I-25 Bijou Bridge by using different type of structures, e.g., arches	Supplemental Recommendation	-
01-021	Build over and fill under old Midland railroad bridge structure (do not remove)	Fail	-
01-022	Split some Cimarron or Bijou structures into separate contracts	Supplemental Recommendation	-
01-023	Use precast for Bear Creek structure	Combine	01-024
01-024	Maximize the use of precast structures	Supplemental Recommendation	-
01-025	Lower the railroad profile under the Bijou Bridge	Fail	-
01-026	Vigorously "discuss" reducing the number of tracks with the railroad	Combine	01-019
01-027	Squeeze the railroad tracks closer together	Combine	01-019
01-028	Reduce the median width on Cimarron across Fountain Creek	Pass	01-
01-029	Shift I-25 to the west to incorporate loop in the northeast Cimmaron/I-25 quadrant	Fail	-
01-030	Reduce the ramp spacing at Cimarron	Pass	-
01-031	Use ramp meters to alleviate weaving problems	Supplemental Recommendation	-
01-032	Let I-25 and Cimarron encroach on floodplain and use alternative mitigation measures	Combine	01-009
01-033	Spread the railroad lines apart to accommodate a pier(s) at Bijou	Combine	01-019
01-034	Put wearing course on concrete to mitigate noise	Supplemental Recommendation	-
01-035	Redo the accesses to businesses on Bijou between I-25 and Spruce Street	Combine	01-005
01-036	Uncouple the designs for the I-25/Bijou Bridge and the Bijou Street improvements	Supplemental Recommendation	-
01-037	Acquire the right-of-way earlier	Supplemental Recommendation	-
01-038	Combine the two (I-25 and local) Bijou Bridges	Fail	-
01-039	Move Fountain Creek to the south side of Cimarron	Pass	-
01-040	Separate the northbound and southbound I-25 profiles	Pass	-
01-041	Use variances to facilitate final design	Pass	-
01-042	Reduce design speed to more closely match posted speed	Combine	01-041
01-043	Cantilever east side of I-25 near Bear Creek	Combine	01-009
01-044	Do a constructability review now	Supplemental Recommendation	-
01-045	Use a two span structure for Bijou	As Designed	-
01-046	Just rebuild the eastbound structure of the Bijou Bridge	Pass	-
01-047	Keep existing laneage on Bijou St. and don't rebuild the Bijou Street Bridge at all	Combine	02-002

Idea No.	Idea Description	Disposition	With
01-048	Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron St. ramps and the main line	Pass	-
01-049	Reroute the eastbound traffic on Bijou St. to prevent off traffic of I-25 and permit phased construction of Bijou bridge	Combine	01-044
01-050	Use 12 foot outside shoulder in lieu of 6-foot	Supplemental Recommendation	-
01-051	Change the typical section underneath Bijou I-25 and close up the area raise the profile of I-25	Combine	01-005
01-052	Eliminate the sidewalks on Bijou bridge and use the area for lanes	Combine	02-002
01-053	Make a flyover structure from southbound I-25 to eastbound Kiowa (flyover is south of Monument Park)	Pass	-
01-054	Move Monument Creek closer to the railroad near Bijou in order to shorten the bridge	Fail	-
01-055	Depress the railroad in the Bijou area, install stub walls for flood protection and noise abatement	Duplicate	01-025
01-056	Flatten curve between Bear Creek and Colorado Ave.	Fail	-
01-057	Move the I-25 / Cimarron interchange further to the south	Pass	-
01-058	Drop the mainline grades between Cimarron St. and Colorado Ave.	Duplicate	01-010
01-059	Use sheet piling or drilled caisson walls behind the WPA walls	Combine	01-009
01-060	Move the Cimarron St. directional off ramp under I-25 instead of over I-25	Fail	-
01-061	Drop I-25 and take Cimarron St. over I-25	Fail	-
01-062	Take I-25 under Colorado Ave.	Fail	-
01-063	Keep the Spruce Street connection and eliminate Sierra Madre	Fail	-
01-064	Shift I-25 to west at Bijou to create more separation between interchange and existing bridge	Fail	-
01-065	Install a partial urban interchange at Bijou	Pass	-
01-066	Convert Bijou to a two-way street	Pass	-
	Cross Railroad/Creek (at Bijou St.)		
02-001	Only carry two lanes in both directions	Combine	02-002
02-002	Keep the existing bridges	Pass	01-012
02-003	Consolidate the railroad tracks	Combine	01-019
02-004	Lower the railroad tracks	Duplicate	01-025
02-005	Widen the existing bridges	Pass	
02-006	Move the creek to the east	Duplicate	01-054
02-007	Rehabilitate the existing structure	Combine	02-002
02-008	Get a variance on the track height clearance at Bijou St.	Combine	01-019
02-009	Get a lateral clearance for the railroad at Bijou St., e.g., mainline and siding clearances	Combine	01-019

Idea No.	Idea Description	Disposition	With
02-010	Shift the Bijou St. interchange to the west	Duplicate	01-064
02-011	Use different structure type, i.e., low depth structures, e.g., arch bridge	Combine	01-020
02-012	Put Monument Creek in a box and shorten some bridge length	Fail	-
02-013	Move the railroad out of the project area	Fail	-
02-014	Shorten the railroad yard, e.g., wider but shorter	Supplemental Recommendation	-
02-015	Drop Monument Creek, e.g., 5-feet and lower I-25	Pass	-
02-016	Install concrete channel for Monument Creek near Bijou St.	Fail	02-015
02-017	Move I-25 interchange to the east and combine the Bijou Interchange and Bijou St. Bridges	Duplicate	01-038
02-018	Relocate Bijou St.	Fail	-
02-019	Put the railroad in an arch culvert	Combine	02-014
02-020	Relocate the railroad yard	Combine	02-014
02-021	Shift the railroad closer to Monument Creek	Fail	-
02-022	Bijou St. over I-25 and under the railroad	Fail	-
02-023	Bijou St. over I-25 and under the railroad and under Monument Park	Fail	-
02-024	Close Bijou St. to the east but putting a half diamond at Bijou St. and a half diamond at Colorado Ave.	Combine	01-003
02-025	Build concrete retaining walls and abutment so you do not have modify the length of the Bijou/I-25 Bridge	Supplemental Recommendation	-
02-026	Build south bound flyover at Bijou to eastbound Kiowa	Duplicate	01-053
02-027	Double deck Bijou St. through Monument Park	Fail	-
	Cross Fountain Creek Channel		
03-001	Conduit Fountain Creek over to Bear Creek	Fail	-
03-002	Move Monument and Fountain Creeks to the east and tie-in downstream (along side the power plant)	Combine	01-054
03-003	Flip-flop I-25 and Fountain Creek and move the confluence west	Fail	-
03-004	Split Cimarron St. and put Fountain Creek in the middle	Pass	-
03-005	Conduit Fountain Creek through the interchange	Fail	-
03-006	Retain flood upstream of I-25	Supplemental Recommendation	-
03-007	Put Confluence Park and detention on west side of I-25	Duplicate	01-004
03-008	Put Monument Creek in a lined channel	Duplicate	02-016
03-009	Put Cimarron St. on top of Fountain Creek	Pass	-
03-010	Take Fountain Creek over I-25	Fail	-
03-011	Move Fountain Creek north to intercept Monument Creek further upstream	Fail	-

Idea No.	Idea Description	Disposition	With
03-012	Move Cimarron St. to the north of Fountain Creek	Fail	-
03-013	Shorten Cimarron St. Bridges over Fountain Creek	Supplemental Recommendation	-
03-014	Make an offset interchange at I-25 and Cimarron St.	Fail	-
03-015	Keep existing Cimarron Br. for westbound and build new eastbound bridge (or visa versa)	Pass	-
	Improve Geometrics		
04-001	Drop profile between Cimarron and Colorado	Duplicate	01-010
04-002	Raise profile between Colorado Ave. and Bijou	Duplicate	01-005
04-003	Increase median width on SH 24 (make it an expressway cross-section)	Fail	-
04-004	Close Colorado Ave.	Fail	-
04-005	Provide two through east bound lanes on Bijou St. east of I-25	Combine	02-002
04-006	Extend the right turn acceleration lane onto Bijou St. (N.B off ramp)	Pass	-
04-007	Establish a yield condition instead free right for N.B. I-25 to E.B. Bijou	Combine	04-006
04-008	Double left turn from W.B. Bijou St. to S.B. I-25	Pass	01-047
04-009	Increase weave distance N.B. I-25 between Cimarron and Bijou	Fail	-
04-010	Flatten ramp grades from 6% to 4%	Combine	01-010
04-011	Flatten Bijou St. to 5% and adjust I-25 profile	Combine	01-005
04-012	Eliminate vertical broken back curves	Fail	-
04-013	Flatten curves in lieu of superelevations (check super elevation overlaps at Colorado Ave.) (Independent profiles)	Combine	01-056
04-014	Eliminate S.B. on ramp at Bijou St.	Combine	01-003
04-015	Put a wider median on I-25	Pass	-
04-016	Put in a 16 ft. HOV lanes	Supplemental Recommendation	-
04-017	Put in a 12 ft. HOV lane	Pass	-
04-018	Reduce the inside shoulder to 4ft. and put in wider buffer	Supplemental Recommendation	-
04-019	Eliminate the buffer for the HOV lane	Combine	04-017
04-020	Spread the I-25 ramps at Cimarron	Fail	-
04-021	Southbound I-25 to eastbound Colorado Ave. flyover	Fail	-
	Reduce slopes		
05-001	Steepen slopes by using slope and ditch pavers	Supplemental Recommendation	-
05-002	Use more vertical elements, e.g., vertical abutments, soil nail walls	Combine	05-001
05-003	Alternative soil treatments	Combine	05-001
05-004	Build I-25 over Bijou on a structure	Duplicate	01-002
05-005	Raise or lower surrounding terrain	Fail	-

Idea No.	Idea Description	Disposition	With
05-006	Make I-25 a viaduct from Bijou to Bear Creek,	Fail	-
05-007	Depress I-25 from Bijou to Bear Creek	Fail	-
05-008	Depress all of I-25 from Bijou to Bear Creek	Duplicate	05-008
	Minimize Impacts		
06-001	Review constructability now	Combine	01-044
06-002	Make this a design/build project after the environmental analysis is complete	Supplemental Recommendation	-
06-003	Offset I-25 from the existing alignment and build towards one side only to minimize traffic disruptions	Supplemental Recommendation	-

SECTION 8 – REVIEW BOARD COMMENTS

Summary of Responses to Value Engineering Proposals

Project

Definitions of Response Terminology

Accept: The VE proposal will be accepted and the original design concept will be modified accordingly.

Partially Accept: Portions of the VE recommendation will be accepted and/or the VE proposal will be modified somewhat.

Reject: The VE proposal will not be accepted and the original design concept will be implemented

VE Proposal No./Supplementary Recommendation No.	Proposal Description	Lead Responder	Response	Total Initial Savings ($)	Total Cost Savings ($) [1]
P 01-002	*Put I-25 over Bijou by using a structure in lieu of fill.*	WCEA	Reject		
P 01-005	*Raise profile grade of I-25 at Bijou.*	WCEA	Accept	*$560,000*	*$560,000*
P 01-009	*Shift I-25 to the east approximately 8' and construct a cantilevered moment slab on top of the proposed mechanically stabilized earth (MSE) walls to prevent further encroachment into the floodplain.*	WCEA	Accept	*$9,000*	*$9,000*
P 01-010	*Lower the profile grade of I-25 between Colorado and Cimarron.*	WCEA	Accept	*$1,037,000*	*$1,037,000*

P 01-015	*Reduce lane widths on local street constructed by project from 12 feet to 11 feet.*	WCEA	Partially Accept	*$90,000*	*$90,000*
P 01-028	*Reduce the median width on Cimarron Street across Fountain Creek.*	FHU	Accept	*$1,400,000*	*$1,400,000*
P 01-030	*Reduce the spacing between the ramp terminals at the Cimarron interchange.*	FHU	Reject		
P 01-046	*Use existing westbound Bijou bridge over the RR and Monument Creek and only replace the eastbound bridge.*	WCEA	Reject		
P 01-048	*Use an improved culvert design for Fountain Creek in lieu of bridges at the Cimarron Street ramps and the main line.*	FHU	Reject		
P 02-002	*Retain and rehabilitate the existing Bijou Street bridges over RR and Monument Creek.*	WCEA	Reject		