DRAFT

Pavement Report and Life Cycle Cost Analysis

I-25 and Cimarron Street Design-Build

Colorado Springs, Colorado

CDOT Region 2

Yeh Project No.: 213-207

April 14, 2014

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Consulting Engineers & Scientists

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1.0 PURPOSE AND SCOPE OF WORK

This report presents the results of Yeh and Associates Inc.'s pavement design recommendations and life cycle cost analysis for the I-25 and Cimarron Street Design-Build Project. The approximate limits of the project are shown on Figure 1. The purpose of this report is to provide subsurface information for use by Wilson and Company. Inc. and Colorado Department of Transportation (CDOT) to develop a Design-Build bid package for the improvement of the Interstate 25 (I-25) and Cimarron Street Interchange in Colorado Springs, Colorado.

The scope of this evaluation included the following tasks:

Conduct a subsurface investigation to obtain information on the subsurface materials.
Perform laboratory testing on soil samples obtained during the subsurface investigation to determine the engineering characteristics of the on-site soils and bedrock.
Prepare a pavement designs and a life cycle cost analysis to provide information for pavement thickness design and pavement type selection

2.0 REGIONAL GEOLOGY

The surface deposits at the proposed project location are mapped as Artificial fill (af) of latest Holocene age, Colluvium (Qc) of Holocene and late Pleistocene age, Terrace alluvium one (Qt1) of Holocene age and Sheetwash Deposits (Qsw) of Holocene and late Pleistocene age as shown on Figure 2. These deposits are the result of man-made and geomorphic activity that has shaped the present landforms and vary considerably in thickness. The mapped soils appear to be consistent with the subsurface conditions encountered in the borings drilled at the project location.

3.0 SUBSURFACE INVESTIGATION

Eleven borings (YA-B01 through YA-B11) were drilled for the proposed project. The Boring Location Plan is presented in Appendix A. The borings were completed by Dakota Drilling, Inc. and CDOT utilizing CME 75 and CME 55 drill rigs, equipped with 8-inch outside diameter, hollow-stem augers. The subsurface conditions encountered in the borings were logged by a representative of Yeh and Associates, Inc. The legend and boring logs are included in Appendix B.

The boring locations were surveyed by Farnsworth Group, Inc.

The thickness of the existing pavement was recorded during drilling and bulk soil samples were taken at each boring to provide information on the existing subgrade conditions immediately below the pavement. In addition, some information from previous sampling was provided by CDOT for mainline I-25.

The recorded penetration resistance measurements were obtained by driving either a modified California sampler or a standard split spoon sampler, typically at 5-foot intervals, into the subsurface materials with a 140-pound hammer falling 30 inches and recording the number of blows required to advance the sampler into the ground. A system that employs an automatic trip hammer was used. The types of drill rigs, augers, samplers and hammer systems used are noted on the boring logs. The driving procedure is similar to ASTM D1586, “Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils”. The penetration resistance values (blow counts corresponding to 12 inches of penetration or N-values) are a useful index to the consistency, the relative density or hardness of the materials encountered.

Groundwater observations were made during the field investigation and results are shown on the boring logs presented in Appendix B. Year-round groundwater conditions were not established as part of the field investigation. Groundwater conditions in the study area may vary considerably throughout the year. Variations can occur during different seasons, following precipitation events, irrigation, after construction and site grading, and due to changes in surface and subsurface drainage characteristics of the surrounding area.

4.0 LABORATORY TESTING

Yeh and Associates performed laboratory testing on samples to determine the classification and engineering characteristics of the on-site soil and bedrock. Laboratory tests performed included natural density, natural moisture content, gradation analyses, Atterberg limits, R-value, pH, water soluble sulfate, water soluble chloride, resistivity and swell/consolidation. The laboratory test results are presented in Appendix C, Laboratory Test Results.

5.0 SUBSURFACE CONDITIONS

The existing ground surface elevations at the boring locations range from approximately 5944 to 5990 feet. The existing pavement section at the boring locations generally consisted of 7.5 inches to 8.5 inches of asphalt (borings YA-B02, YA-B03, YA-B04 and YA-B11). Fill materials were encountered in most of the borings except for borings YA-B01 and YA-B05. The fill materials extended from 7 feet to 33 feet below the existing grade and generally consisted of medium stiff to hard sandy clay with gravels, loose to dense silty sand and loose to medium dense clayey sand. The native soils encountered in the borings generally consisted of loose to very dense silty sand with varying amounts of gravel, cobbles and clay lenses in various mixtures.

The native soils were underlain by bedrock at depths ranging from 11 to 47 feet below existing grade, approximately elevation 5930 to 5949 feet. The bedrock consisted of residuum to very hard claystone. Groundwater was observed at depths of approximately 7 to 46 feet below the existing grade in all the borings at the time they were drilled.

Both these borings and the CDOT data show sandy fill material to a depth of 4 or more feet with clay soils below and claystone bedrock. The CDOT data is also presented in Appendix C following the current soil test data.

Most soils n the upper 4 feet, below the pavement, were classified as A-1 or A-2 soils. The A-2 soil classification was used as the input for the DARWin ME pavement design model used for the pavement thickness designs.

Table 1 summarizes the conditions at the boring locations, the existing grade elevation; the approximate depth to the top-of-unweathered bedrock; the approximate depth and elevation of groundwater and the thickness of the existing pavement.

Table 1 Summary of Subsurface and Pavement Conditions

Boring No.	Approximate Location	Top Hole Elev.	Unweathered Bedrock Depth	Groundwater Depth	Existing Pavement Thickness
		(ft)	(ft)	(ft)	(in)
YA-B01	Pikes Peak Greenway Trail, North of Cimarron	5959.8	11	9	-
YA-B02	NB I-25 Near On Ramp, Right Lane	5989.8	47	46	8.0
YA-B03	EB US-24, East of I-25, Right Lane	5968.9	30	28	8.5
YA-B04	NB I-25 Near Off Ramp, Right Lane	5972.7	40	30	8.0
YA-B05	SE of I-25 and US-24, on Bike Path	5944.3	14	10	-
YA-B06	331 South Chestnut, South of Access Gate	5956.9	20	8	-
YA-B07	221 S. Chestnut, South Side of Lot	5956.7	16	7	-
YA-B08	NW of intersection of I-25 and US-24, Nursery	5972.1	37	24	-
YA-B09	Abandoned Nursery, East of Greenhouse	5958.7	28	17	-
YA-B10	331 South Chestnut, West of Existing Building	5957.0	19	8	-
YA-B11	NB I-25 On Ramp, Right Lane	5969.9	28	25	7.5

6.0 CORROSION AND SULFATE RESISTANCE

6.1 Corrosion

Ten representative samples collected from ground surface to 12.5 feet below existing grade in the borings were tested to determine the concentrations of water soluble sulfates, water soluble chlorides, pH and resistivity. The test results are summarized below.

Water soluble sulfates – 0.004 to 0.138 percent
Water soluble chlorides – 0.0013 to 0.0366 percent
pH – 7.6 to 8.2
Resistivity – 481 to 3175 ohm-cm

The pH of the soils at the site indicates that the soils are slightly basic and should represent a mild to no corrosion potential (non-aggressive) based on Table 3.9 from Federal Highway Administration Publication No. FHWA0-IF-03-017, Geotechnical Engineering Circular No. 7 (GEC 7).

The test results on the samples indicated a water–soluble chloride concentration combined with the water soluble sulfate concentration and soil pH that correspond to a Corrosion Resistance Level 2 (CR2), as presented in CDOT Pipe Material Selection Policy, dated May 7, 2012.

Based on Table 3.9 from GEC 7, soils that have resistivity values less than 2,000 ohm-cm are considered to have a strong corrosion potential (aggressive). Resistivity values greater than 5,000 ohm-cm are considered to have mild to no corrosion potential (non-aggressive). The designer should refer to CDOT Standard Specifications, Sections 603 and 624, Culvert, Sewer and Drainage Pipe for design requirements.

6.2 Sulfate Resistance

The concentrations of water-soluble sulfate in the samples generally represent a Class 1 degree of sulfate attack on concrete exposed to these soils in the project area as presented in Table 601-2 of Sections 601, Structural Concrete of the CDOT Standard Specifications, 2011 edition.

7.0 Traffic Loading

Traffic volumes and loading in the form of equivalent single axle loads (ESAL) for this project were provided by Wilson. The DARWin ME program used truck volumes and growth factors as traffic inputs and this data was included in the Wilson data.

In addition to the truck volumes and growth factors, volumes starting from present to 40 years were calculated based on this data. The future volumes were used for input to the User Cost program to calculate user costs. These volumes were used to determine user costs for initial construction and rehabilitation treatments. Hot Mix asphalt (HMA) pavement is designed using 20-year truck volumes and Portland Cement Concrete (PCC) pavement is designed using 30-year truck volumes. The cumulative 20-year and 30-year truck volumes are presented in Table 2.

The CDOT version of DARWin ME contains typical truck distributions depending on what the portion of Class 5 (single units) and Class 9 (combination units). For I-25, the distribution of the two truck class is similar, so Cluster 3 was used in the design program. For US 24,the trucks are primarily Class 5 trucks, so Cluster 1 was used to model truck traffic. Table 2 presents the 20-year and 30-year truck volumes for the pavement designs.

Table 2 - Truck Loading

Segment	Cumulative 20-Year Truck Volume	Cumulative 30-Year Truck Volume
US 24 / Cimarron E/O I-25	4,542,670	7,208,220
US 24 / Cimarron Under I-25	7,367,980	11,691,400
US 24 / Cimarron W/O I-25	9,613,470	15,254,500
I-25 NB Mainline	29,808,400	47,527,100
I-25 SB Mainline	29,808,400	47,527,100
NB Exit Ramp	6,119,320	9,756,780
NB Entrance Ramp	5,824,760	9,287,140
SB Exit Ramp	5,883,060	9,300,360
SB Entrance Ramp	5,667,110	9,035,770

The traffic loading information and future volume calculations for each roadway segment are presented in Appendix D.

8.0 Pavement Recommendations

8.1 Darwin ME Program Inputs

For this project, the DARWin ME pavement design program is being used to determine the recommended pavement thickness. The DARWin ME program is the current design program supported by AASHTO. Additionally, this program has been calibrated to conditions and materials properties used by CDOT.

8.1.1 Subgrade and Base Course Inputs

The subgrade for all of the pavements on this project were modeled using 4 feet of A-2-4 soil on a clay subgrade with a soil classification of A-7-6. This configuration closely models the conditions under the existing pavements.

All pavement options contain 6 inches of aggregate base course (ABC) between the subgrade and pavement regardless of pavement type. A Class 1 separator geotextile conforming to AASHTO M288 and Section 712.08 of the CDOT 2011 Standard Specifications should also be included between the ABC and subgrade in the pavement construction.

As part of the design model inputs, the resilient moduli (M_R) from Table 4.5 of CDOT 2014 Pavement Design Manual with DARWin ME. The MR values are presented in Table 3.

8.1.2 Climate Information

Historic climate data for many weather stations in Colorado is already available in the CDOT model data. For the climate information used in the pavement designs, the built in data from the Colorado Springs Airport was used.

8.1.3 Pavement Thickness Recommendations

For the pavement designs on this project numerous requirements needed to be met. For example, all designs had to meet bottom up cracking at 20 years for HMA and slab cracking at 30-years for PCC pavements. Some of the requirements for designs were:

* 90% Reliability - all designs

* Pass ride and bottom up cracking at 20 years for HMA
* Pass rutting at a minimum of 12 years for HMA
* Pass cracking at 30-years for PCC
* Pass ride and faulting at 30 years for PCC

Table 3 presents the minimum recommended thickness for the various segments of this interchange project.

Table 3 - Minimum Pavement Thickness

Segment	HMA Thickness (in.)	PCC Thickness (in.)
US 24 / Cimarron E/O I-25	7.0	8.5
US 24 / Cimarron Under I-25	7.5	8.5
US 24 / Cimarron W/O I-25	8.5	9.0
I-25 NB Mainline	14	9.5
I-25 SB Mainline	14	9.5
NB Exit Ramp	7.5	8.5
NB Entrance Ramp	7.5	8.5
SB Exit Ramp	7.5	8.5
SB Entrance Ramp	7.5	8.5
I-25 NB & SB south end mill and overlay	4.5	-
I-25 NB & SB south end White-top	-	8.0

All PCC pavements shall have load transfer devices in accordance with the CDOT M & S Standard 412, using No. 5 tie bars and 1.25 inch dowel bars.

8.1.4 Hot Mix Asphalt Type

For this project, the HMA mixes chosen were a 2 inch top mat of Stone Mastic Asphalt (SMA) which contains the polymer modified binder PG 76-28. The lower lifts will use S(100) mix in accordance with the CDOT standard specifications containing PG 64-22 binder. Both of these mixes have shown good performance in this project area.

The Long Term Pavement Performance binder selection model (LTPPBind) shows that the binder PG 76-28 exceeds the requirements for binder rut resistance at high temperatures and resistance to low temperature cracking for a top mat. The PG 64-22 binder has a 98 percent reliability resistance to low temperature cracking and high temperature rutting for layers deeper than 2 inches in this area.

9.0 LIFE CYCLE COST AND PAVEMENT TYPE SELECTION

In accordance with the 2014 CDOT Pavement Design Manual, a life cycle cost covering a 40-year period shall be performed to help select the pavement type. For this life cycle cost analysis, both HMA and PCC pavement options shall be compared and there must be at least one rehabilitation for each paving material.

9.1 HMA Rehabilitation Cycles and Treatments

For HMA, since the pavement designs met the rutting requirements at 12 years, a period of 12 years between rehabilitation cycles was chosen because of the requirement for meeting the rut criteria at a minimum of 12 years. Mainline I-25 just met the 12 year criteria and all of the US 24 sections exceeded the 12 year requirement. This timing falls within the range shown in Table 10.1 for performance years.

The treatment for HMA is to mill 2 inches from the surface followed by placement of a new 2 inch lift of SMA at 12 year intervals

9.2 PCC Rehabilitation Cycles and Treatments

Following the guidelines in the CDOT Pavement Design Manual, the rehabilitation cycles for PCC are at 26 years.

The treatment for PCC is to replace 0.5 percent of the pavement slabs, grind the driving lanes and clean and reseal all of the longitudinal and transverse joints.

User costs for rehabilitation treatments are included in the LCCA. It is anticipated that all work will be constructed using restricted hours and night closures.

9.3 LCCA Materials Costs

Costs for the rehabilitation treatments were obtained from local projects in the Colorado Springs area and also from cost data published on the CDOT web page. Table 4 presents the materials costs used in the LCCA analysis.

Table 4 - Materials Costs for LCCA

HMA Construction Material	Cost
ABC, Class 6	$25/yd^3
S(100) PG 64-22	$78/ton
SMA	$95/ton
HMA Rehabilitation Materials	Cost
SMA	$95/ton
Milling	$1.65/yd^2
PCCP Construction Material	Cost
PCCP	$4.00/yd^2-in.
PCCP Rehabilitation Materials	Cost
Replace Concrete Slab	$62/yd^2
Grind Concrete	$5/yd^2
Saw and Reseal Joints	$4/lin. ft

Following the guidelines in the 2014 CDOT Pavement Design Manual (Manual), all of these materials initial costs were expanded by adding 10 percent for Design Engineering (DE), 18.1 percent for Construction Engineering (CE) and 15 percent for Traffic Control, for a total of a 43.1 percent increase in the construction costs.

To provide a probabilistic analysis, each variable contained a range of plus or minus 10 percent.

Additionally, the present worth for all rehabilitation treatments and engineering costs are calculated using a discount rate of 2.6 percent with a standard deviation of 0.25 percent.

Annual Maintenance costs are also included in the analysis. Maintenance costs were taken from Table 10.4 of the Manual and adjusted to address the size in lane miles of each highway segment. In order to conduct the life cycle cost analysis, three separate segments are to be considered. Segment 1 is mainline I-25, Segment 2 is the entrance and exit ramps to I-25,and Segment 3 will be US 24.

Segment 1 - Mainline I-25: Mainline I-25 is anticipated to be constructed in two phases with most of the southbound lanes being constructed on new alignment, the traffic then moved over to the new roadway for construction the northbound lanes. New mainline structures are considered to be the time critical path for this construction, so user costs for initial construction between HMA and PCC are considered to be the same. User costs are addressed for rehabilitations.

For this LCCA, Mainline I-25 contains 77,605 square yards of pavement with 12 inches of S(100) PG 64-22 and 2 inches of SMA compared to 9.5 inches of PCC.

CDOT uses the 40-year LCCA at the 75th percentile to compare the costs of the two pavement materials. Table 5 presents the initial construction costs for pavement and ABC for Mainline I-25 and the current value of the 40-year LCCA at the 75th percentile.

Table 5 - Mainline I-25 Costs

Paving Material	Initial Pavement Construction Cost*	40-Year Life Cycle Pavement Cost*
Hot Mix Asphalt	$5,129.43	$7,576.08
Portland Cement Concrete	$3,815.58	$4,665.18
Difference = (Higher - Lower) / Lower	34.4% Lower with PCC	62.4% Lower with PCC

*Cost in thousands

Segment 2 - Ramps: Ramps to and from I-25 are also planned to have most construction on virgin alignment, so structures are considered the time critical factor, so no user costs are considered during initial construction.

The LCCA for the ramps addresses 17,500 square yards of pavement. The PCC used is 8.5 inches thick, and the HMA will consist of 5.5 inches of S(100) PG 64-22 and 2.0 inches of SMA. Both pavements will be placed on 6 inches of Class 6 ABC which is included in the initial construction cost. Table 6 contains the initial construction costs as well as the comparison of the 40-year life cycle costs.

Table 6 - Ramp Costs

Paving Material	Initial Pavement Construction Cost*	40-Year Life Cycle Pavement Cost*
Hot Mix Asphalt	$668.70	$1,271.65
Portland Cement Concrete	$772.92	$1,011.49
Difference = (Higher - Lower) / Lower	15.6 % Lower with HMA	25.7% Lower with PCC

*Cost in thousands

Segment 3 - US 24: US 24 will contain 18,660 square yards of pavement and is planned to be constructed on the existing alignment. The HMA pavement thickness varies 6.5 to 7.0 inches of S(100) PG 64-22 and 2.0 inches of SMA over 6 inches of Class 6 ABC. The PCC thickness varies from 8.5 to 9.0 inches also over 6 inches of Class 6 ABC.

The initial construction will have a major impact on traffic flow within the project. It is estimated that construction with PCCP will require approximately 5 days longer than construction using HMA with restricted lane usage (4 to 3 lanes) and that the tie-ins will restrict traffic flow with lane reductions. These user costs are presented in Table 7 with the initial construction and also are included in the 40-year LCCA costs.

Table 7 - US 24 Costs

Paving Material	Initial Pavement Construction Cost*	40-Year Life Cycle Pavement Cost*
Hot Mix Asphalt	$723.16	$1,748.76
HMA User Costs	$412.57	(included)
Portland Cement Concrete	$832.98	$2,054.53
PCC User Costs	$585.31	(included)
Difference = (Higher - Lower) / Lower	24.7 % Lower with HMA	17.4 % Lower with HMA

*Cost in thousands

As shown in Table 7, the inclusion of the user costs for the high volumes on US 24 have a dramatic effect on the total costs of a project. Without considering the user costs the two pavement type options would be within 10 percent.

9.4 Pavement Type Recommendations

Based on the results of the LCCA, we recommend that mainline I-25 and the ramps be constructed using PCC.

Since we do not know what type of traffic control or construction phasing a contractor will use for US 24, we recommend that CDOT allow the contractor to choose the pavement type.

10.0 REFERENCES

American Association of State Highway and Transportation Officials, 2012, AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 6th Edition: Washington DC

Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction (2011) and related Specifications

Colorado Department of Transportation, 2014 Pavement Design Manual with DARWin ME, Revised Draft 2/10/14.

Colorado Department of Transportation, CDOT Pipe Material Selection Policy, dated May 7, 2012

Federal Highway Administration Publication No. FHWA0-IF-03-017, Geotechnical Engineering Circular No. 7 (GEC 7) Soil Nail Walls, March 2003

Carroll, C.J., and Crawford, T.A., Geologic Map of the Colorado Springs Quadrangle, El Paso County, Colorado 2000, Colorado Geological Survey Open-File Report OF-00-3, scale 1:24000

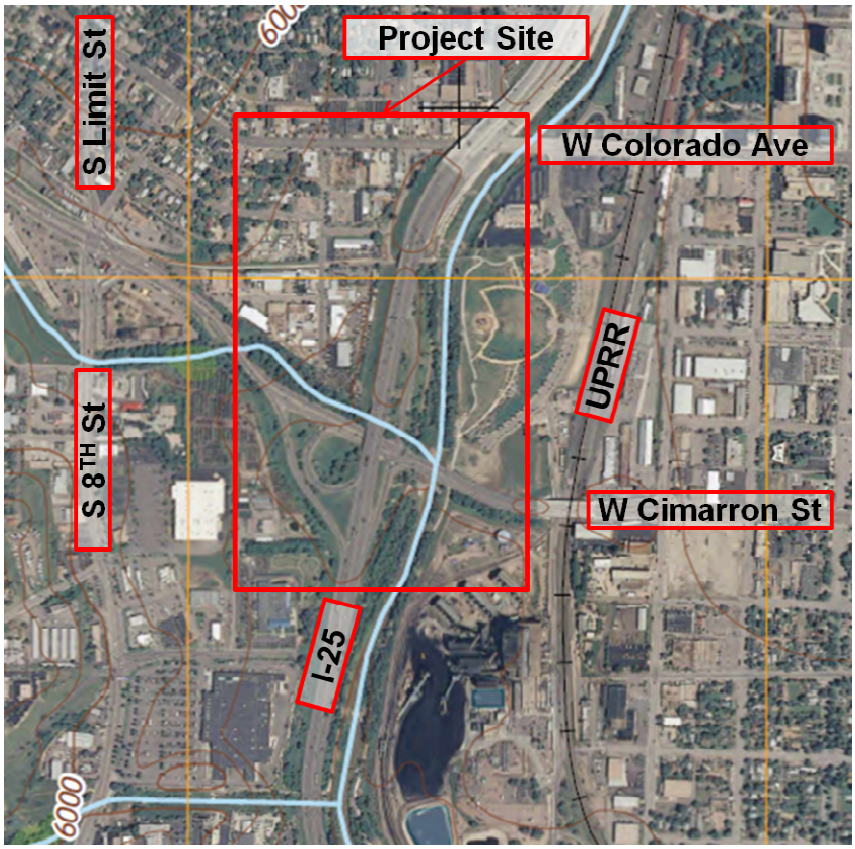
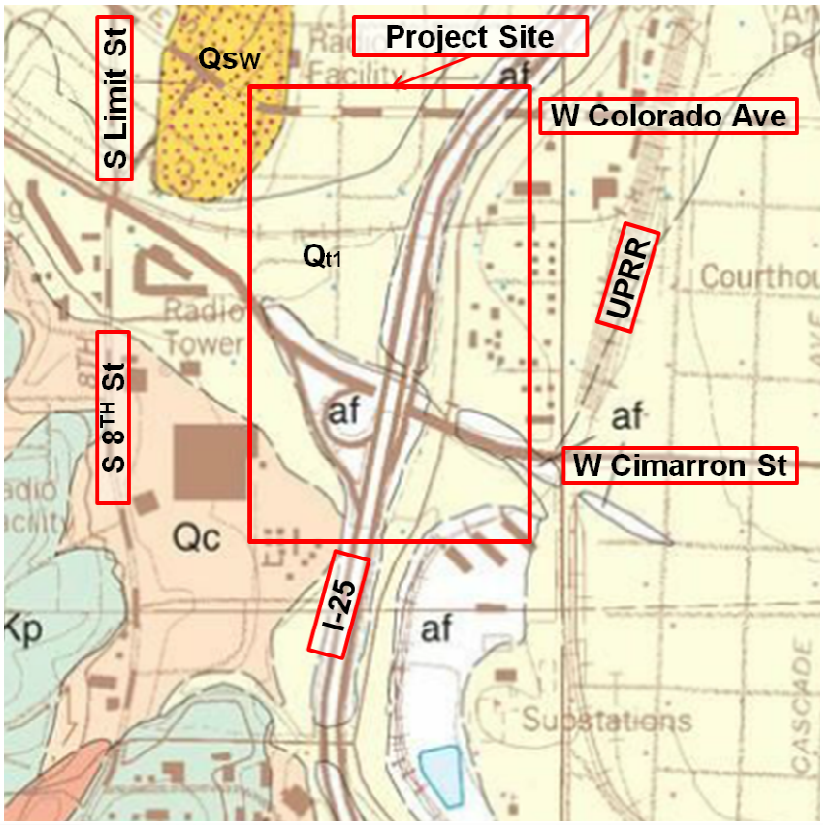


Figure 1 Site Vicinity Map (USGS Colorado Springs, CO, 7.5 Minute Quadrangle, 2013)

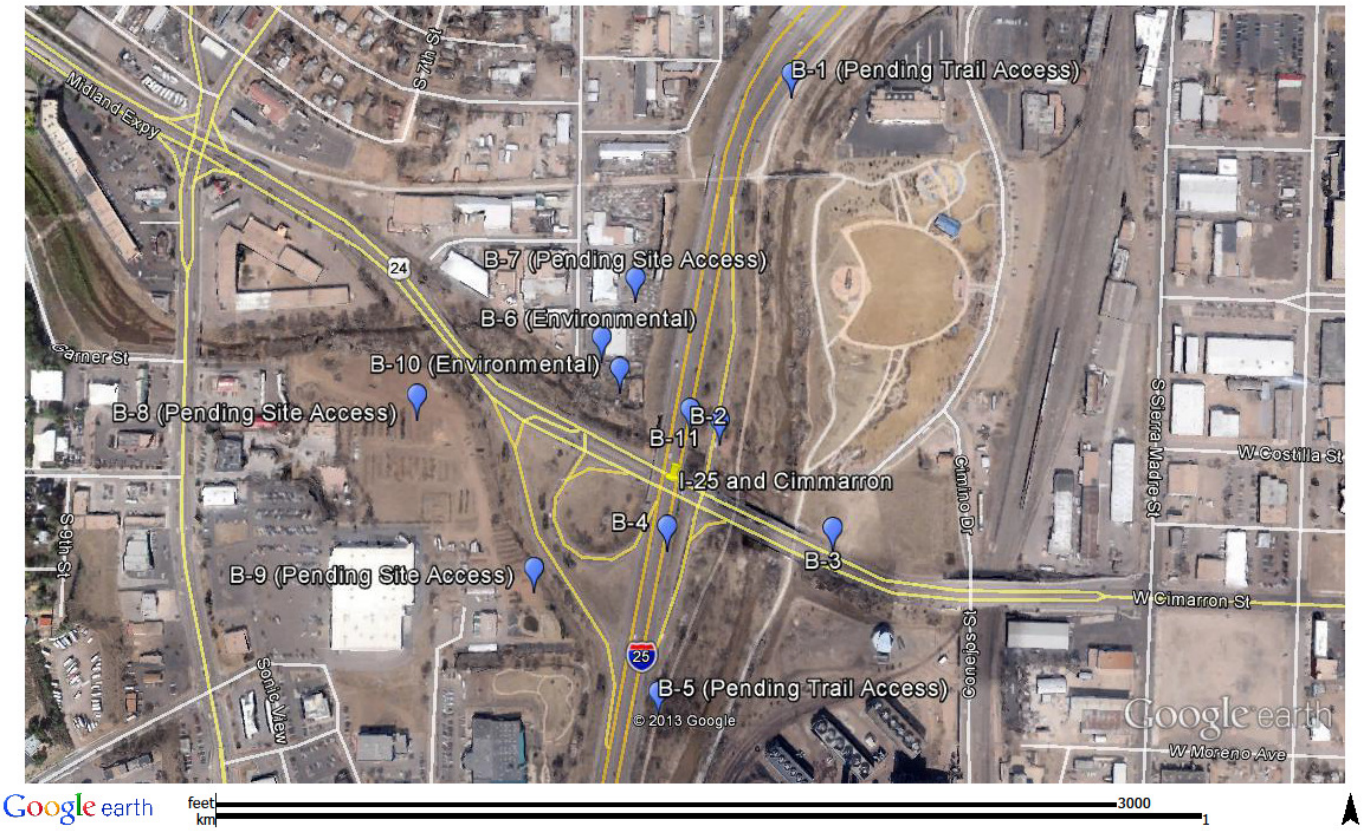


af	**Artificial fill (latest Holocene)**—Fill and waste rock placed during construction of roads, railroads, buildings, dams, landfills, and reclamation projects
Qc	**Colluvium (Holocene and late Pleistocene)**—Unit is mostly matrix-supported, gravelly sand, silty clay, and clayey silt. Deposits are usually coarser grained in upper reaches and finer grained in lower reaches where Pierre Shale parent material is present. Consists of very coarse-grained debris along steep slopes of Cheyenne Mountain and medium- to fine-grained sand over clayey material in slopes below terraces underlain by pediment deposit two (Qg_2). Unit may also include landslide deposits (Qls), or sheetwash deposits (Qsw)
Qt_1	**Terrace alluvium one (Holocene)**—Poorly to moderately sorted, unconsolidated, matrix-supported cobble gravel in a sandy, silty, or clayey matrix. Includes stream-channel deposits, flood-plain deposits, and low-terrace deposits up to 10 ft above Fountain and Monument Creeks
Qsw	**Sheetwash deposits (Holocene and late Pleistocene)**—Silty sand, clayey silt, and clay deposited in valleys of intermittent and ephemeral streams, on gentle hillslopes below terraces, landslides and alluvial fans, or in basinal areas locally derived from Pierre Shale

Figure 2 Geologic Map of Project Area (USGS, Carroll, C.J., and Crawford, T.A., 2000)

Appendix A

BORING LOCATION PLAN



Appendix B

LEGEND AND BORING LOGS

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron

Project Number: 213-207 Date:

Legend for Symbols Used on Borehole Logs

Sample Types

Auger Cuttings

Grab Sample

Modified California Sampler

Split Spoon

Soil Lithology

Asphalt

Clayey Sand

Cobbles and gravel

Silty Sand

Fill with Clay as major soil

Fill with Sand as major soil

Bedrock Lithology

CLAYSTONE

WEATHERED BEDROCK

Lab Test Abbreviations

MC-Moisture Content
DD-Dry Density
#200-Percent Passing #200 Sieve
LL-Liquid Limit
PL-Plastic Limit
PI-Plasticity Index
S-Sulfate Content
CL-Chloride Content
S/C-Swell/Consolidation
UCCS-Unconfined Compressive Strength
Re-Resistivity
PtL-Point Load Test
AASHTO-AASHTO Classification
USCS-USCS Classification

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B01**
Sheet 1 of 1

Boring Began: 1/14/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: CDOT
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/14/2014
Drill Bit:
Casing:
Weather: Cool, Calm, Overcast

Total Depth: 25.3 ft
Ground Elevation: 5959.8 ft
Location: Pikes Peak Greenway Trail, N of Cimarron
Coordinates: N: 65,017.7 E: 191,139.5

Ground Water Notes: Observed at approximately 9' at time of drilling

Depth	∇ 9.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 11.0 ft. silty SAND with gravel, brown to reddish brown, damp to wet, loose.	@ 0 - 5 ft. MC= 5.4 % #200= 22 % LL= 22 PL= 15 PI= 7 pH= 7.7 S= 0.005 % Re= 2053 ohms-cm AASHTO: A-2-4 (0) USCS: SM-SC CL= 0.0120%
5955	5				5/5	10			
5950	10				2/5	7			
								11.0 - 25.3 ft. CLAYSTONE, blue-gray, very hard.	
5945	15				50:4"	50:4"			@ 15 ft. MC= 10.6 % DD= 114.8 pcf #200= 68 % LL= 42 PL= 22 PI= 20 UCCS= 7952 psf AASHTO: A-7-6 (12) USCS: CL
5940	20				50:3"	50:3"			@ 20 ft. MC= 11.6 % DD= 101.1 pcf #200= 90 % LL= 53 PL= 23 PI= 30 S/C= 1.2 % AASHTO: A-7-6 (30) USCS: CH
5935	25				50:3"	50:3"		Bottom of Hole at 25.3 ft.	
5930	30								
5925									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B02**
Sheet 1 of 2

Boring Began: 1/9/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 75, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/10/2014
Drill Bit:
Casing:
Weather: Cool, Calm

Total Depth: 60.5 ft
Ground Elevation: 5989.8 ft
Location: NB I-25 Near On Ramp, Right Lane
Coordinates: N: 63,765.8 E: 190,620.3

Ground Water Notes: Observed at approximately 46' at time of drilling

Depth	∇ 46.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.7 ft. Asphalt Pavement 8 inches.	@ 0 - 5 ft. MC= 4.8 % #200= 19 % LL= NV PL= NP PI= NP pH= 7.7 S= 0.004 % Re= 1855 ohms-cm AASHTO: A-1-b (0) USCS: SM CL= 0.0130 %
								0.7 - 5.0 ft. silty SAND FILL with trace gravels, brown, moist, loose.	
5985	5				5/4	9		**5.0 - 33.0 ft. sandy CLAY FILL** with sand lenses and trace gravels, brown to light brown, moist, stiff to very stiff.	@ 5 ft. MC= 25.8 % DD= 95.9 pcf #200= 92 % LL= 60 PL= 20 PI= 40 AASHTO: A-7-6 (40) USCS: CH
5980	10				7/5	12			
5975	15				7/9	16			@ 15 ft. MC= 16.5 % DD= 108.9 pcf #200= 57 % LL= 49 PL= 16 PI= 33 AASHTO: A-7-6 (15) USCS: CL
5970	20				8/7	15			
5965	25				7/7	14			
5960	30				10/12	22			@ 30 ft. MC= 12.1 % DD= 109.6 pcf #200= 41 % LL= 49 PL= 17 PI= 32 AASHTO: A-7-6 (7)
								33.0 - 38.0 ft. silty SAND with trace gravel, brown to dark brown, damp, medium dense, fine grained.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B02**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
					9/9	18			USCS: SC @ 35 ft. MC= 12.9 % DD= 94.5 pcf #200= 49 %
								38.0 - 47.0 ft. silty SAND with trace gravel, red to brown, moist, medium dense.	LL= NV PL= NP PI= NP AASHTO: A-4 (0) USCS: SM
5950	40				6/9	15			
5945	45				8/10	18			@ 45 ft. MC= 7.1 % DD= 128.1 pcf #200= 4 %
								47.0 - 60.5 ft. CLAYSTONE, blue-gray, very hard.	LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: SW
5940	50				50:5"	50:5"			
5935	55				70:6"	70:6"			
5930	60				70:5"	70:5"			MC= 17 % DD= 111.8 pcf #200= 83 % LL= 53 PL= 27 PI= 26 AASHTO: A-7-6 (24) USCS: CH
								Bottom of Hole at 60.5 ft.	
5925	65								
5920	70								
5915	75								

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B03**
Sheet 1 of 2

Boring Began: 1/15/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: CDOT
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/15/2014
Drill Bit:
Casing:
Weather: Cool, Calm, Clear

Total Depth: 40.3 ft
Ground Elevation: 5968.9 ft
Location: EB US-24, E of I-25, Right Lane
Coordinates: N: 63,229.5 E: 191,047.0

Ground Water Notes: Observed at approximately 28' at time of drilling

Depth	∇ 28.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.7 ft. Asphalt Pavement 8.5 inches.	@ 0 - 5 ft. MC= 5.5 % #200= 15 % LL= 22 PL= 13 PI= 9 pH= 8 S= 0.01 % Re= 1490 ohms-cm AASHTO: A-2-4 (0) USCS: SC CL= 0.0163 %
								0.7 - 2.0 ft. gravelly SAND FILL, very silty, brown to red, damp.	
								2.0 - 17.0 ft. clayey SAND FILL with gravels and sandy clay lenses, brown to red, moist, loose to medium dense.	@ 5 ft. MC= 7.1 % DD= 117.6 pcf #200= 17 % LL= 53 PL= 18 PI= 35 AASHTO: A-2-7 (0) USCS: SC @ 10 ft. MC= 3.3 % DD= 117.1 pcf #200= 4 % LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: SW @ 13 ft. MC= 19.7 % #200= 58 % LL= 47 PL= 22 PI= 25 AASHTO: A-7-6 (12) USCS: CL @ 20 ft. MC= 19.3 % DD= 99.1 pcf #200= 68 % LL= 33 PL= 22 PI= 11 AASHTO: A-6 (6) USCS: CL
5965									
	5				9/4	13			
					5/6/6	12			
5960									
	10				9/7	16			
					2/4/5	9			
5955									
	15				3/4/5	9			
								17.0 - 30.0 ft. silty SAND with sandy clay lenses, brown to gray, damp to wet, loose.	
5950									
	20				2/4	6			
5945									
	25				4/6	10			
5940									
	30				12/12	24		**30.0 - 40.3 ft. CLAYSTONE**, blue-gray, hard to very hard.	
5935									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B03**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
					83:9"	83:9"			@ 35 ft. MC= 16.9 % DD= 111.3 pcf #200= 86 % LL= 53 PL= 24 PI= 29 UCCS= 22060 psf AASHTO: A-7-6 (18) USCS: CH
5930									
	40				50:3"	50:3"		Bottom of Hole at 40.3 ft.	
5925									
	45								
5920									
	50								
5915									
	55								
5910									
	60								
5905									
	65								
5900									
	70								
5895									
	75								

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B04**
Sheet 1 of 2

Boring Began: 1/8/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 75, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/9/2014
Drill Bit:
Casing:
Weather: Cool, Calm

Total Depth: 50.3 ft
Ground Elevation: 5972.7 ft
Location: NB I-25 Near Off Ramp, Right Lane
Coordinates: N: 63,184.2 E: 190,512.2

Ground Water Notes: Observed at approximately 30' at time of drilling

Depth	∇ 30.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.7 ft. Asphalt Pavement 8 inches.	@ 0 - 5 ft. MC= 5.6 % #200= 14 % LL= NV PL= NP PI= NP pH= 7.8 S= 0.005 % Re= 1099 ohms-cm AASHTO: A-1-b (0) USCS: SM CL= 0.0366 %
								0.7 - 5.0 ft. silty SAND FILL with trace gravel, reddish brown, damp.	
5970									
	5				8/10	18		**5.0 - 19.0 ft. sandy CLAY FILL** with trace gravel and sand lenses, brown to reddish brown, damp, stiff to hard.	
5965									
	10				4/11	15			@ 10 ft. MC= 21.8 % DD= 101.9 pcf #200= 85 % LL= 55 PL= 19 PI= 36 AASHTO: A-7-6 (32) USCS: CH
5960									
	15				20/18	38			
					16/16/16	32			
5955									
								19.0 - 30.0 ft. silty SAND with trace gravel and occasional clay lenses, brown to dark brown, damp, loose to medium dense, fine grained.	
	20				8/8	16			
					5/6/6	12			
5950									@ 22 ft. MC= 15.5 % #200= 51 % LL= 50 PL= 20 PI= 30 AASHTO: A-7-6 (11) USCS: CH
					6/7/17	24			
	25				9/20	29			
5945									
	∇ 30				5/7	12		**30.0 - 40.0 ft. silty SAND** with gravel, red to brown, wet, loose to medium dense.	@ 30 ft. MC= 18.6 % DD= 101.0 pcf #200= 8 % LL= NV PL= NP PI= NP AASHTO: A-3 (0)
5940									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B04**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
					18/8/12	20			USCS: SP-SM @ 35 ft. MC= 11.3 % #200= 5 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SP-SM
5935									
	40				50:7" 50:2"	50:7" 50:2"		**40.0 - 50.3 ft. CLAYSTONE**, blue-gray, very hard.	
5930									
	45				50:4"	50:4"			@ 45 ft. MC= 16.4 % DD= 112.0 pcf #200= 89 % LL= 48 PL= 23 PI= 25 S/C= 0.7 % AASHTO: A-7-6 (24) USCS: CL
5925									
	50				50:3"	50:3"		Bottom of Hole at 50.3 ft.	
5920									
	55								
5915									
	60								
5910									
	65								
5905									
	70								
5900									
	75								

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B05**
Sheet 1 of 1

Boring Began: 1/15/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: CDOT
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/15/2014
Drill Bit:
Casing:
Weather: Warm, Calm, Clear

Total Depth: 25.5 ft
Ground Elevation: 5944.3 ft
Location: SE of I-25 and US-24, on Bike Path
Coordinates: N: 62,614.2 E: 190,475.4

Ground Water Notes: Observed at approximately 10' at time of drilling

Depth	∇ 10.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 3.0 ft. clayey SAND with gravels and cobbles, brown to gray, damp.	@ 0 - 5 ft. MC= 4.2 % #200= 21 % LL= 29 PL= 15 PI= 14 pH= 8 S= 0.138 % Re= 1129 ohms-cm AASHTO: A-2-6 (0) USCS: SC CL= 0.0154 %
5940	5				50:0"	50:0"		**3.0 - 9.0 ft. COBBLES**, very dense.	
					50:0"	50:0"			
5935	10				7/20	27		**9.0 - 12.0 ft. silty SAND** with gravel, brown to red, wet, medium dense.	
					4/8	12		**12.0 - 14.0 ft. CLAYSTONE**, blue-gray, moderately weathered, residuum.	@ 12.5 ft. MC= 28.9 % DD= 87.0 pcf pH= 8.2 S= 0.03 % Re= 481 ohms-cm CL= 0.0023 %
5930	15				24/50	74		**14.0 - 25.5 ft. CLAYSTONE**, brown-gray, very hard, iron staining.	@ 15 ft. MC= 18.6 % DD= 109.6 pcf #200= 85 % LL= 51 PL= 27 PI= 24 UCCS= 27464 psf AASHTO: A-7-6 (23) USCS: CH
5925	20				50:5"	50:5"			@ 20 ft. MC= 16.6 % DD= 106.3 pcf #200= 86 % LL= 51 PL= 28 PI= 23 S/C= 1.3 % AASHTO: A-7-6 (22) USCS: CH
5920	25				50:5"	50:5"		Bottom of Hole at 25.5 ft.	
5915	30								
5910									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B06**
Sheet 1 of 1

Boring Began: 1/23/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/23/2014
Drill Bit:
Casing:
Weather: Cold, Cloudy, Snow

Total Depth: 30.5 ft
Ground Elevation: 5956.9 ft
Location: 331 S. Chestnut, S of Access Gate
Coordinates: N: 63,812.6 E: 190,200.6

Ground Water Notes: Observed at approximately 8' at time of drilling

Depth	∇ 8.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
5955								**0.0 - 8.0 ft. silty SAND FILL** with gravel and clay lenses, brown to dark gray, moist, dense.	@ 0 - 5 ft. MC= 8.1 % #200= 28 % LL= NV PL= NP PI= NP pH= 7.7 S= 0.073 % Re= 901 ohms-cm AASHTO: A-2-4 (0) USCS: SM CL= 0.0098 %
	5				22/9	31			@ 5 ft. MC= 18.5 % DD= 107.7 pcf #200= 35 % LL= 36 PL= 20 PI= 16 AASHTO: A-6 (1) USCS: SC Slight petroleum odor observed from 7 ft to 8 ft.
5950								**8.0 - 20.0 ft. silty SAND** with gravel, reddish brown to light brown, wet, medium dense.	
	10				30/20	50			
5945									
	15				7/7/7	14			@ 15 ft. MC= 11 % #200= 6 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SP-SM
5940									
	20				50:6"	50:6"		**20.0 - 30.5 ft. CLAYSTONE**, brown-gray, very hard.	
5935									
	25				50:5"	50:5"			
5930									
	30				50:6"	50:6"			@ 30 ft. MC= 13.6 % DD= 119.4 pcf #200= 86 % LL= 50 PL= 22 PI= 28 UCCS= 31832 psf AASHTO: A-7-6 (26) USCS: CH
5925								Bottom of Hole at 30.5 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B07**
Sheet 1 of 1

Boring Began: 1/24/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/24/2014
Drill Bit:
Casing:
Weather: Cool, Clear

Total Depth: 25.3 ft
Ground Elevation: 5956.7 ft
Location: 221 S. Chestnut, S Side of Lot
Coordinates: N: 63,921.8 E: 190,416.0

Ground Water Notes: Observed at approximately 7' at time of drilling

Depth	∇ 7.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	N	Lithology	Material Description	Field Notes and Lab Tests
5955								**0.0 - 7.0 ft. clayey SAND FILL** with clay lenses, dark gray to gray, moist, loose.	@ 0 - 5 ft. MC= 20.5 % #200= 50 % LL= 31 PL= 21 PI= 10 AASHTO: A-4 (2) USCS: SC
	5				2/3	5			@ 5 ft. MC= 45.4 % DD= 77.8 pcf #200= 94 % LL= 61 PL= 27 PI= 34 S/C= 0.7 % AASHTO: A-7-6 (37) USCS: CH
5950 ∇								**7.0 - 16.0 ft. silty SAND** with gravel and occasional cobbles, tan to reddish brown, wet, loose to medium dense.	
	10				4/6	10			
5945									
	15				7/7/11	14			
5940					50:7"	50:7"		**16.0 - 25.3 ft. CLAYSTONE**, blue-gray, very hard.	
	20				50:6"	50:6"			
5935									
	25				50:4"	50:4"		Bottom of Hole at 25.3 ft.	@ 25 ft. MC= 15.3 % DD= 108.3 pcf #200= 84 % LL= 52 PL= 25 PI= 27 S/C= 0.8 % AASHTO: A-7-6 (24) USCS: CH
5930									
	30								
5925									

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: I-25 and Cimarron Street Project Number: 213-207 Date:	Boring: **YA-B08** Sheet 1 of 2

Boring Began: 1/16/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: CDOT
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/16/2014
Drill Bit:
Casing:
Weather: Cool, Calm, Clear

Total Depth: 45.3 ft
Ground Elevation: 5972.1 ft
Location: NW of intsection of I-25 and US-24, Nursery
Coordinates: N: 63,648.8 E: 189,799.0

Ground Water Notes: Observed at approximately 24' at time of drillign

Depth	24.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	N	Lithology	Material Description	Field Notes and Lab Tests
5970								**0.0 - 6.0 ft. clayey SAND FILL**, red to brown, damp, loose.	@ 0 - 5 ft. MC= 12.3 % #200= 35 % LL= 33 PL= 18 PI= 15 pH= 7.6 S= 0.08 % Re= 971 ohms-cm AASHTO: A-6 (1) USCS: SC CL= 0.0018 %
	5				2/4	6			
5965								**6.0 - 18.0 ft. silty SAND FILL** with gravel, clay and cobbles, gray to brown, moist, loose to medium dense.	
	10				9/12	21			@ 10 ft. MC= 9.5 % DD= 127.1 pcf #200= 26 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM
5960									
	15				3/6	9			
5955								**18.0 - 37.0 ft. silty SAND** with gravel and cobbles, red to brown, moist to wet, loose to very dense.	
	20				12/9	21			@ 20 ft. MC= 3.3 % DD= 125.3 pcf #200= 6 % LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: SP-SM
5950									
	25				3/2	5			
5945					50:0"	50:0"			
	30				3/5/6	11			@ 30 ft. MC= 11.8 % #200= 3 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SW
5940									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B08**

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
5935								**37.0 - 45.3 ft. CLAYSTONE**, blue-gray, medium hard to very hard.	
	40				11/20	31			@ 40 ft. MC= 20.7 % DD= 106.2 pcf #200= 69 % LL= 51 PL= 27 PI= 24 UCCS= 12030 psf AASHTO: A-7-6 (16) USCS: CH
5930									
	45				50:3"	50:3"		Bottom of Hole at 45.3 ft.	
5925									
	50								
5920									
	55								
5915									
	60								
5910									
	65								
5905									
	70								
5900									
	75								
5895									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B09**
Sheet 1 of 2

Boring Began: 1/16/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: CDOT
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/16/2014
Drill Bit:
Casing:
Weather: Cool, Calm, Clear

Total Depth: 40.3 ft
Ground Elevation: 5958.7 ft
Location: Abandoned Nursery, E of Greenhouse
Coordinates: N: 63,089.4 E: 189,986.1

Ground Water Notes: Observed at approximately 17' at time of drilling

Depth	∇ 17.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	N	Lithology	Material Description	Field Notes and Lab Tests
5955								**0.0 - 5.0 ft. silty SAND FILL**, red to brown, damp.	@ 0 - 5 ft. MC= 8.5 % #200= 19 % LL= NV PL= NP PI= NP pH= 7.7 S= 0.01 % Re= 3175 ohms-cm AASHTO: A-1-b (0) USCS: SM CL= 0.0013 %
	5				4/3	7		**5.0 - 13.0 ft. sandy CLAY FILL** with trace gravel, gray to brown, moist, medium stiff.	@ 5 ft. MC= 24.1 % DD= 97.1 pcf #200= 89 % LL= 60 PL= 22 PI= 38 AASHTO: A-7-6 (37) USCS: CH
5950									
	10				3/5	8			
5945								**13.0 - 28.0 ft. silty SAND** with gravel and cobbles, red to brown, moist to wet, very loose to medium dense.	
	15				11/11	22			
	∇								
5940					3/3/3	6			@ 17.5 ft. MC= 13.7 % #200= 7 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SW-SM
	20				3/1	4			
5935									
	25				3/11/12	23			
5930								**28.0 - 40.3 ft. CLAYSTONE**, blue-gray, very hard.	
	30				50:4"	50:4"			@ 30 ft. MC= 16.9 % DD= 109.0 pcf #200= 88 % LL= 47 PL= 23 PI= 24 UCCS= 27604 psf
5925									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B09**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
					50:3"	50:3"			AASHTO: A-7-6 (23) USCS: CL
5920									
	40				50.3"	50.3"			
								Bottom of Hole at 40.3 ft.	
5915									
	45								
5910									
	50								
5905									
	55								
5900									
	60								
5895									
	65								
5890									
	70								
5885									
	75								

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B10**
Sheet 1 of 1

Boring Began: 1/23/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 55, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/23/2014
Drill Bit:
Casing:
Weather: Cold, Cloudy, Snow

Total Depth: 30.2 ft
Ground Elevation: 5957.0 ft
Location: 331 S. Chestnut, W of Existing Building
Coordinates: N: 63,754.6 E: 190,343.2

Ground Water Notes: Observed at approximately 8' at time of drilling

Depth	∇ 8.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
5955								**0.0 - 8.0 ft. clayey SAND FILL** with gravel, gray to brown, moist, medium dense.	@ 0 - 5 ft. MC= 6.6 % #200= 23 % LL= 23 PL= 14 PI= 9 AASHTO: A-2-4 (0) USCS: SC
	5				14/8	22			
5950								**8.0 - 19.0 ft. silty SAND** with gravel, reddish brown, wet, medium dense.	
	10				13/13	26			@ 10 ft. MC= 9 % DD= 129.4 pcf #200= 6 % LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: GP-GM
5945									
	15				7/7/7	14			@ 15 ft. MC= 9.7 % #200= 5 % LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: SW-SM
5940									
	20				50:3"	50:3"		**19.0 - 30.2 ft. CLAYSTONE**, blue-gray, very hard.	@ 20 ft. MC= 18.3 % DD= 108.8 pcf #200= 75 % LL= 52 PL= 26 PI= 26 S/C= 0.5 % AASHTO: A-7-6 (20) USCS: CH
5935									
	25				50:3"	50:3"			@ 25 ft. MC= 20.4 % DD= 106.7 pcf #200= 65 % LL= 47 PL= 22 PI= 25 UCCS= 8941 psf AASHTO: A-7-6 (15) USCS: CL
5930									
	30				50:2"	50:2"		Bottom of Hole at 30.2 ft.	
5925									

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: I-25 and Cimarron Street Project Number: 213-207 Date:	Boring: **YA-B11** Sheet 1 of 2

Boring Began: 1/7/2014
Drilling Method: Hollow-Stem Auger
Drill: CME 75, Automatic Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 1/8/2014
Drill Bit:
Casing:
Weather: Cool, Calm

Total Depth: 40.5 ft
Ground Elevation: 5969.9 ft
Location: NB I-25 On Ramp, Right Lane
Coordinates: N: 63,727.3 E: 190,710.2

Ground Water Notes: Observed at approximately 25' at time of drilling

Depth	∇ 25.0 ft	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.6 ft. Asphalt Pavement 7.5 inches.	@ 0 - 5 ft. MC= 5.5 % #200= 15 % LL= NV PL= NP PI= NP pH= 7.9 S= 0.006 % Re= 1825 ohms-cm AASHTO: A-1-b (0) USCS: SM CL= 0.0182 %
								0.6 - 5.0 ft. silty SAND FILL with trace gravel, reddish brown, damp.	
5965	5				9/9	18		**5.0 - 13.0 ft. clayey SAND FILL** with trace gravel and occasional clay lifts, brown to dark brown, moist, medium dense.	@ 5 ft. MC= 8.5 % DD= 120.4 pcf #200= 21 % LL= 32 PL= 14 PI= 18 AASHTO: A-2-6 (0) USCS: SC
5960	10				9/11	20			@ 10 ft. MC= 18.3 % DD= 93.5 pcf #200= 53 % LL= 50 PL= 17 PI= 33 AASHTO: A-7-6 (13) USCS: CH
								13.0 - 17.0 ft. silty SAND with gravel and cobbles, gray to brown, moist, very dense.	
5955	15				50:4" / 50:8"	50:4" / 50:8"			
								17.0 - 28.0 ft. silty SAND with trace gravel, brown to gray, moist to wet, medium dense.	
5950	20				9/9	18			@ 20 ft. MC= 2.6 % #200= 4 % LL= NV PL= NP PI= NP AASHTO: A-1-a (0) USCS: SW
5945 ∇	25				7/8	15			
								28.0 - 40.5 ft. CLAYSTONE, blue-gray, very hard.	
5940	30				50:5"	50:5"			

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B11**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
					70:6"	70:6"			@ 35 ft. MC= 14.7 % DD= 113.7 pcf #200= 89 % LL= 55 PL= 27 PI= 28 S/C= 0.5 % AASHTO: A-7-6 (28) USCS: CH
5930	40				50:5"	50:5"			
								Bottom of Hole at 40.5 ft.	
5925	45								
5920	50								
5915	55								
5910	60								
5905	65								
5900	70								
5895	75								

Appendix C

LABORATORY TEST RESULTS

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 213-207 Project Name: I-25 and Cimarron Street Date: 1/24/2014

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
YA-B01	0-5	Bulk	5.4	–	32	46	22	22	15	7	7.7	0.005	2053	0.0120	–	–	–	A-2-4 (0)	SM-SC
YA-B01	15	CA	10.6	114.8	–	–	68	42	22	20	–	–	–	–	–	7952	–	A-7-6 (12)	CL
YA-B01	20	CA	11.6	101.1	–	–	90	53	23	30	–	–	–	–	1.2	–	–	A-7-6 (30)	CH
YA-B02	0-5	Bulk	4.8	–	13	68	19	NV	NP	NP	7.7	0.004	1855	0.0130	–	–	–	A-1-b (0)	SM
YA-B02	5	CA	25.8	95.9	0	8	92	60	20	40	–	–	–	–	–	–	–	A-7-6 (40)	CH
YA-B02	15	CA	16.5	108.9	14	29	57	49	16	33	–	–	–	–	–	–	–	A-7-6 (15)	CL
YA-B02	30	CA	12.1	109.6	24	35	41	49	17	32	–	–	–	–	–	–	–	A-7-6 (7)	SC
YA-B02	35	CA	12.9	94.5	0	51	49	NV	NP	NP	–	–	–	–	–	–	–	A-4 (0)	SM
YA-B02	45	CA	7.1	128.1	26	70	4	NV	NP	NP	–	–	–	–	–	–	–	A-1-a (0)	SW
YA-B02	60	CA	17.0	111.8	–	–	83	53	27	26	–	–	–	–	–	–	–	A-7-6 (24)	CH
YA-B03	0-5	Bulk	5.5	–	18	67	15	22	13	9	8.0	0.01	1490	0.0163	–	–	–	A-2-4 (0)	SC
YA-B03	5	CA	7.1	117.6	11	72	17	53	18	35	–	–	–	–	–	–	–	A-2-7 (0)	SC
YA-B03	10	CA	3.3	117.1	28	68	4	NV	NP	NP	–	–	–	–	–	–	–	A-1-a (0)	SW
YA-B03	13	CA	19.7	–	7	35	58	47	22	25	–	–	–	–	–	–	–	A-7-6 (12)	CL
YA-B03	20	CA	19.3	99.1	0	32	68	33	22	11	–	–	–	–	–	–	–	A-6 (6)	CL
YA-B03	35	CA	16.9	111.3	–	–	86	53	24	29	–	–	–	–	–	22060	–	A-7-6 (18)	CH

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 213-207 Project Name: I-25 and Cimarron Street Date: 1/24/2014

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
YA-B04	0-5	Bulk	5.6	–	22	64	14	NV	NP	NP	7.8	0.005	1099	0.0366	–	–	–	A-1-b (0)	SM
YA-B04	10	CA	21.8	101.9	1	14	85	55	19	36	–	–	–	–	–	–	–	A-7-6 (32)	CH
YA-B04	22	CA	15.5	–	7	42	51	50	20	30	–	–	–	–	–	–	–	A-7-6 (11)	CH
YA-B04	30	CA	18.6	101.0	10	82	8	NV	NP	NP	–	–	–	–	–	–	–	A-3 (0)	SP-SM
YA-B04	35	CA	11.3	–	20	75	5	NV	NP	NP	–	–	–	–	–	–	–	A-1-b (0)	SP-SM
YA-B04	45	CA	16.4	112.0	–	–	89	48	23	25	–	–	–	–	0.7	–	–	A-7-6 (24)	CL
YA-B05	0-5	Bulk	4.2	–	26	53	21	29	15	14	8.0	0.138	1129	0.0154	–	–	–	A-2-6 (0)	SC
YA-B05	12.5	CA	28.9	87.0	–	–	–	–	–	–	8.2	0.030	481	0.0023	–	–	–	–	–
YA-B05	15	CA	18.6	109.6	–	–	85	51	27	24	–	–	–	–	–	27464	–	A-7-6 (23)	CH
YA-B05	20	CA	16.6	106.3	–	–	86	51	28	23	–	–	–	–	1.3	–	–	A-7-6 (22)	CH
YA-B06	0-5	Bulk	8.1	–	15	57	28	NV	NP	NP	7.7	0.073	901	0.0098	–	–	–	A-2-4 (0)	SM
YA-B06	5	CA	18.5	107.7	10	55	35	36	20	16	–	–	–	–	–	–	–	A-6 (1)	SC
YA-B06	15	CA	11.0	–	24	70	6	NV	NP	NP	–	–	–	–	–	–	–	A-1-b (0)	SP-SM
YA-B06	30	CA	13.6	119.4	–	–	86	50	22	28	–	–	–	–	–	31832	–	A-7-6 (26)	CH
YA-B07	0-5	Bulk	20.5	–	4	46	50	31	21	10	–	–	–	–	–	–	–	A-4 (2)	SC
YA-B07	5	CA	45.4	77.8	–	–	94	61	27	34	–	–	–	–	0.7	–	–	A-7-6 (37)	CH

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 213-207 Project Name: I-25 and Cimarron Street Date: 1/24/2014

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
YA-B07	25	CA	15.3	108.3	–	–	84	52	25	27	–	–	–	–	0.8	–	–	A-7-6 (24)	CH
YA-B08	0-5	Bulk	12.3	–	10	55	35	33	18	15	7.6	0.080	971	0.0018	–	–	–	A-6 (1)	SC
YA-B08	10	CA	9.5	127.1	10	64	26	NV	NP	NP	–	–	–	–	–	–	–	A-2-4 (0)	SM
YA-B08	20	CA	3.3	125.3	37	57	6	NV	NP	NP	–	–	–	–	–	–	–	A-1-a (0)	SP-SM
YA-B08	30	CA	11.8	–	19	78	3	NV	NP	NP	–	–	–	–	–	–	–	A-1-b (0)	SW
YA-B08	40	CA	20.7	106.2	–	–	69	51	27	24	–	–	–	–	–	12030	–	A-7-6 (16)	CH
YA-B09	0-5	Bulk	8.5	–	14	67	19	NV	NP	NP	7.7	0.010	3175	0.0013	–	–	–	A-1-b (0)	SM
YA-B09	5	CA	24.1	97.1	–	–	89	60	22	38	–	–	–	–	–	–	–	A-7-6 (37)	CH
YA-B09	17.5	CA	13.7	–	20	73	7	NV	NP	NP	–	–	–	–	–	–	–	A-1-b (0)	SW-SM
YA-B09	30	CA	16.9	109.0	–	–	88	47	23	24	–	–	–	–	–	27604	–	A-7-6 (23)	CL
YA-B10	0-5	Bulk	6.6	–	15	62	23	23	14	9	–	–	–	–	–	–	–	A-2-4 (0)	SC
YA-B10	10	CA	9.0	129.4	53	41	6	NV	NP	NP	.	–	–	–	–	–	–	A-1-a (0)	GP-GM
YA-B10	15	Bulk	9.7	–	33	62	5	NV	NP	NP	–	–	–	–	–	–	–	A-1-a (0)	SW-SM
YA-B10	20	CA	18.3	108.8	–	–	75	52	26	26	–	–	–	–	0.5	–	–	A-7-6 (20)	CH
YA-B10	25	CA	20.4	106.7	–	–	65	47	22	25	–	–	–	–	–	8941	–	A-7-6 (15)	CL
YA-B11	0-5	Bulk	5.5	–	16	69	15	NV	NP	NP	7.9	0.006	1825	0.0182	–	–	–	A-1-b (0)	SM

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 213-207 Project Name: I-25 and Cimarron Street Date: 1/24/2014

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
YA-B11	5	CA	8.5	120.4	25	54	21	32	14	18	–	–	–	–	–	–	–	A-2-6 (0)	SC
YA-B11	10	CA	18.3	93.5	7	40	53	50	17	33	–	–	–	–	–	–	–	A-7-6 (13)	CH
YA-B11	20	CA	2.6	–	20	76	4	NV	NP	NP	–	–	–	–	–	–	–	A-1-a (0)	SW
YA-B11	35	CA	14.7	113.7	–	–	89	55	27	28	–	–	–	–	0.5	–	–	A-7-6 (28)	CH
Mix YA-B02,YA-B04 Bulk			5.3	–	22	64	14	NV	NP	NP	–	–	–	–	–	–	–	A-1-b (0)	SM

Appendix D

TRAFFIC LOADING

PROJECT: I-25/Cimarron Design Build
ANALYST: D. Krauth
DATE: 12/12/2013

Facility	AADT						Lanes Both Dir.	Vehicle Distribution				Design Year Volumes			ESALs					
								Trucks[3]				Trucks			Flexible Pavement			Rigid Pavement		
	Existing (T_1)[1]	Year[2]	20yr Factor	Future (T)	Year	Midpoint Volume T_m		Single Unit	Comb	Total	Pass. Cars	SU	Comb	Pass. Cars	Daily	Total Design Period	Design Lane	Daily	Total Design Period	Design Lane
US24/Cimarron e/o I-25	24525	2007		38800	2035	31662	4	3.70%	0.19%	3.88%	96.12%	1170	60	30432	448	3,268,604	1,470,872	526	5,760,886	2,592,399
US24/Cimarron under I-25	37541	2007		65185	2035	51363	4	3.70%	0.19%	3.88%	96.12%	1898	97	49368	726	5,302,368	2,386,065	853	9,345,375	4,205,419
US24/Cimarron w/o I-25	50300	2007	1.3	83700	2035	67000	4	3.70%	0.19%	3.88%	96.12%	2476	127	64397	947	6,916,597	3,112,469	1,113	12,190,440	5,485,698
I-25 NB Mainline	113000	2007	1.43	159274	2035	136137	6	4.07%	4.72%	8.80%	91.20%	5546	6429	124162	8,742	63,813,009	19,143,903	12,831	140,494,348	42,148,304
I-25 SB Mainline	113000	2007	1.43	159274	2035	136137	6	4.07%	4.72%	8.80%	91.20%	5546	6429	124162	8,742	63,813,009	19,143,903	12,831	140,494,348	42,148,304
NB Exit Ramp	10700	2007		22852	2035	16776	2	4.07%	4.72%	8.80%	91.20%	683	792	15300	1,077	7,863,539	4,718,124	1,581	17,312,816	10,387,689
NB Entrance Ramp	9964	2007		21954	2035	15959	1	4.07%	4.72%	8.80%	91.20%	650	754	14556	1,025	7,480,838	7,480,838	1,504	16,470,239	16,470,239
SB Exit Ramp	6214	2007		25752	2035	15983	2	4.07%	4.72%	8.80%	91.20%	651	755	14577	1,026	7,491,787	4,495,072	1,506	16,494,344	9,896,606
SB Entrance Ramp	12207	2007		18848	2035	15527	1	4.07%	4.72%	8.80%	91.20%	633	733	14162	997	7,278,377	7,278,377	1,463	16,024,488	16,024,488

Notes:

1 Volumes taken from *Traffic Impact Analysis Technical Memorandum - US 24* , Colorado Department of Transportation, December 2008
2 Based on *Traffic Impact Analysis Technical Memorandum* - US 24, Colorado Department of Transportation, December 2008
3 Source: CDOT OTIS 12/10/2013

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

Mainline I-25 Traffic Volumes NB and SB

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	113000		
CDOT 20-Yr Factor	1.43		
Annual Growth Factor	1.012335		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	91.21%	103067
Single Units	4.07%	4599
Comb & Busses	4.72%	5334
	1.00	
	Total Volume =	113000

Year	Volume AADT					
2007	113000		2032	153527		Given
2008	114394		2033	155421	**20-Year**	2035
2009	115805		2034	157338	**AADT =**	Volume
2010	117233		2035	**159279**	**159,279**	**159,274**
2011	118679		2036	161243		
2012	120143		2037	163232		
2013	121625	**Opening**	2038	165246		
2014	123126	**Volume**	2039	167284		
2015	**124644**	**124644**	2040	169347		
2016	126182		2041	171436		
2017	127738		2042	173551		
2018	129314		2043	175692	**30-Year**	
2019	130909		2044	177859	**AADT =**	
2020	132524		2045	**180053**	**180,053**	
2021	134158		2046	182274		
2022	135813		2047	184522		
2023	137489		2048	186798		
2024	139184		2049	189102		
2025	140901		2050	191435		
2026	142639		2051	193796		
2027	144399		2052	196187		
2028	146180		2053	198607		
2029	147983		2054	201057		
2030	149808		2055	203537		
2031	151656					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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Cimarron (US 24) East of I-25

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	24525		
CDOT 20-Yr Factor	1.3		
Annual Growth Factor	1.01652		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	96.11%	23571
Single Units	3.70%	907
Comb & Busses	0.19%	47
	1.00	
	Total Volume =	24525

Year	Volume AADT					
2007	24525		2032	36941		Given
2008	24930		2033	37551	**20-Year**	2035
2009	25342		2034	38171	**AADT =**	Volume
2010	25761		2035	38802	**38,802**	**38,800**
2011	26186		2036	39443		
2012	26619		2037	40095		
2013	27059	**Opening**	2038	40757		
2014	27506	**Volume**	2039	41430		
2015	**27960**	**27960**	2040	42115		
2016	28422		2041	42811		
2017	28891		2042	43518		
2018	29369		2043	44237	**30-Year**	
2019	29854		2044	44967	**AADT =**	
2020	30347		2045	45710	**45,710**	
2021	30848		2046	46465		
2022	31358		2047	47233		
2023	31876		2048	48013		
2024	32403		2049	48807		
2025	32938		2050	49613		
2026	33482		2051	50432		
2027	34035		2052	51266		
2028	34597		2053	52112		
2029	35169		2054	52973		
2030	35750		2055	53848		
2031	36341					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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Cimarron (US 24) Under I-25

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	37541		
CDOT 20-Yr Factor	1.3		
Annual Growth Factor	1.0199		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	96.11%	36081
Single Units	3.70%	1389
Comb & Busses	0.19%	71
	1.00	
	Total Volume =	37541

Year	Volume AADT					
2007	37541		2032	61439		Given
2008	38288		2033	62662	**20-Year**	2035
2009	39050		2034	63909	**AADT =**	Volume
2010	39827		2035	65181	**65,181**	**65,185**
2011	40620		2036	66478		
2012	41428		2037	67801		
2013	42252	**Opening**	2038	69150		
2014	43093	**Volume**	2039	70526		
2015	**43951**	**43951**	2040	71929		
2016	44825		2041	73361		
2017	45717		2042	74821		
2018	46627		2043	76310	**30-Year**	
2019	47555		2044	77828	**AADT =**	
2020	48501		2045	79377	**79,377**	
2021	49467		2046	80957		
2022	50451		2047	82568		
2023	51455		2048	84211		
2024	52479		2049	85886		
2025	53523		2050	87596		
2026	54588		2051	89339		
2027	55675		2052	91117		
2028	56783		2053	92930		
2029	57913		2054	94779		
2030	59065		2055	96665		
2031	60240					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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Cimarron (US 24) West of of I-25

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	50300		
CDOT 20-Yr Factor	1.3		
Annual Growth Factor	1.018355		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	96.11%	48343
Single Units	3.70%	1861
Comb & Busses	0.19%	96
	1.00	
	Total Volume =	50300

Year	Volume AADT					
2007	50300		2032	79259		Given
2008	51223		2033	80714	**20-Year**	2035
2009	52163		2034	82195	**AADT =**	Volume
2010	53121		2035	83704	**83,704**	**83,700**
2011	54096		2036	85240		
2012	55089		2037	86805		
2013	56100	**Opening**	2038	88398		
2014	57130	**Volume**	2039	90021		
2015	**58178**	**58178**	2040	91673		
2016	59246		2041	93356		
2017	60334		2042	95069		
2018	61441		2043	96814	**30-Year**	
2019	62569		2044	98591	**AADT =**	
2020	63717		2045	100401	**100,401**	
2021	64887		2046	102244		
2022	66078		2047	104120		
2023	67291		2048	106032		
2024	68526		2049	107978		
2025	69784		2050	109960		
2026	71065		2051	111978		
2027	72369		2052	114033		
2028	73697		2053	116126		
2029	75050		2054	118258		
2030	76427		2055	120429		
2031	77830					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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I-25 Northbound Exist Ramp

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	10700		
CDOT 20-Yr Factor	1.43		
Annual Growth Factor	1.02747		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	91.21%	9759
Single Units	4.07%	435
Comb & Busses	4.72%	505
	1.00	
	Total Volume =	10700

Year	Volume AADT					
2007	10700		2032	21067		Given
2008	10994		2033	21646	**20-Year**	2035
2009	11296		2034	22241	**AADT =**	Volume
2010	11606		2035	22852	**22,852**	**22,852**
2011	11925		2036	23480		
2012	12253		2037	24124		
2013	12589	**Opening**	2038	24787		
2014	12935	**Volume**	2039	25468		
2015	**13290**	**13290**	2040	26168		
2016	13655		2041	26887		
2017	14031		2042	27625		
2018	14416		2043	28384	**30-Year**	
2019	14812		2044	29164	**AADT =**	
2020	15219		2045	29965	**29,965**	
2021	15637		2046	30788		
2022	16066		2047	31634		
2023	16508		2048	32503		
2024	16961		2049	33396		
2025	17427		2050	34313		
2026	17906		2051	35255		
2027	18398		2052	36224		
2028	18903		2053	37219		
2029	19422		2054	38241		
2030	19956		2055	39292		
2031	20504					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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I-25 Northbound Entrance Ramp

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	9964		
CDOT 20-Yr Factor	1.43		
Annual Growth Factor	1.02862		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	91.21%	9088
Single Units	4.07%	406
Comb & Busses	4.72%	470
	1.00	
	Total Volume =	9964

Year	Volume AADT					
2007	9964		2032	20175		Given
2008	10249		2033	20752	**20-Year**	2035
2009	10543		2034	21346	**AADT =**	Volume
2010	10844		2035	21957	**21,957**	**21,954**
2011	11155		2036	22585		
2012	11474		2037	23232		
2013	11802	**Opening**	2038	23897		
2014	12140	**Volume**	2039	24581		
2015	**12487**	**12487**	2040	25284		
2016	12845		2041	26008		
2017	13212		2042	26752		
2018	13591		2043	27518	**30-Year**	
2019	13980		2044	28305	**AADT =**	
2020	14380		2045	29115	**29,115**	
2021	14791		2046	29949		
2022	15215		2047	30806		
2023	15650		2048	31687		
2024	16098		2049	32594		
2025	16559		2050	33527		
2026	17032		2051	34487		
2027	17520		2052	35474		
2028	18021		2053	36489		
2029	18537		2054	37533		
2030	19068		2055	38608		
2031	19613					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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I-25 Southbound Exit Ramp

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	6214		
CDOT 20-Yr Factor	1.43		
Annual Growth Factor	1.05209		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	91.21%	5668
Single Units	4.07%	253
Comb & Busses	4.72%	293
	1.00	
	Total Volume =	6214

Year	Volume AADT		Year	Volume AADT		
2007	6214		2032	22115		Given
2008	6538		2033	23267	**20-Year**	2035
2009	6878		2034	24479	**AADT =**	Volume
2010	7237		2035	25754	**25,754**	**25,752**
2011	7613		2036	27096		
2012	8010		2037	28507		
2013	8427	**Opening**	2038	29992		
2014	8866	**Volume**	2039	31555		
2015	**9328**	**9328**	2040	33198		
2016	9814		2041	34928		
2017	10325		2042	36747		
2018	10863		2043	38661	**30-Year**	
2019	11429		2044	40675	**AADT =**	
2020	12024		2045	42794	**42,794**	
2021	12651		2046	45023		
2022	13310		2047	47368		
2023	14003		2048	49836		
2024	14732		2049	52432		
2025	15500		2050	55163		
2026	16307		2051	58036		
2027	17157		2052	61059		
2028	18050		2053	64240		
2029	18990		2054	67586		
2030	19980		2055	71107		
2031	21020					

Appendix D

Traffic Data for I-25 at Cimarron (US 24) Interchange Project: 213-207

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I-25 Southbound Entrance Ramp

Future Traffic Volume Calculations

Given:		Based on:	Future volumes supplied by Wilson and Company, and present traffic (2015) and growth factors were obtained from the CDOT web page.
Volumes:			
2007 AADT	12207		
CDOT 20-Yr Factor	1.43		
Annual Growth Factor	1.015635		
Distribution:	Uniform		

	% of Total	Volume
Passenger Cars	91.21%	11134
Single Units	4.07%	497
Comb & Busses	4.72%	576
	1.00	
	Total Volume =	12207

Year	Volume AADT	**Opening Volume**				
2007	12207		2032	17991		Given
2008	12398		2033	18272	**20-Year**	2035
2009	12592		2034	18558	**AADT =**	Volume
2010	12789		2035	18848	**18,848**	**18,848**
2011	12989		2036	19143		
2012	13192		2037	19442		
2013	13398	**Opening**	2038	19746		
2014	13607	**Volume**	2039	20055		
2015	**13820**	**13820**	2040	20368		
2016	14036		2041	20687		
2017	14256		2042	21010		
2018	14478		2043	21339	**30-Year**	
2019	14705		2044	21672	**AADT =**	
2020	14935		2045	22011	**22,011**	
2021	15168		2046	22355		
2022	15405		2047	22705		
2023	15646		2048	23060		
2024	15891		2049	23420		
2025	16139		2050	23786		
2026	16392		2051	24158		
2027	16648		2052	24536		
2028	16908		2053	24920		
2029	17173		2054	25309		
2030	17441		2055	25705		
2031	17714					

Appendix E

PAVEMENT DESIGN OUTPUTS

I-25 at Cim clay I-25 NB an SB (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim clay I-25 NB an SB (01312014).dgpx

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	12.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

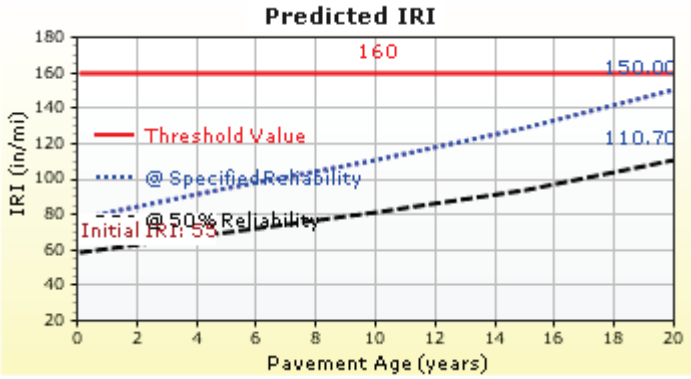
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	11,975
2025 (10 years)	13,966,000
2035 (20 years)	29,808,400

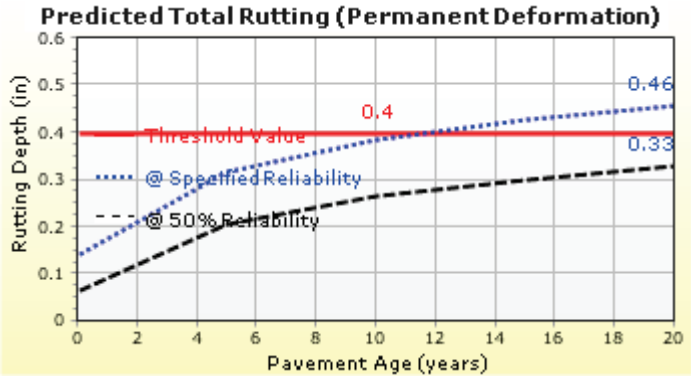
Design Outputs

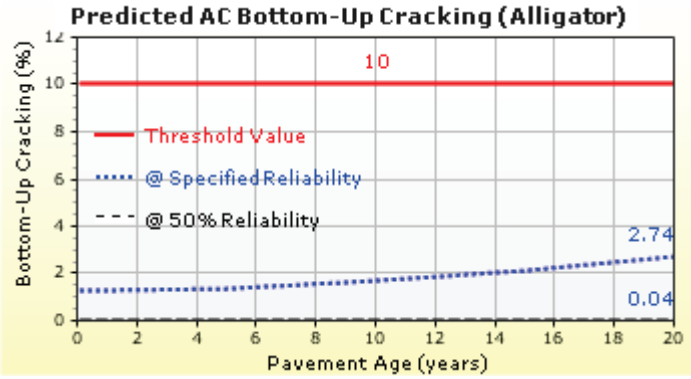
Distress Prediction Summary

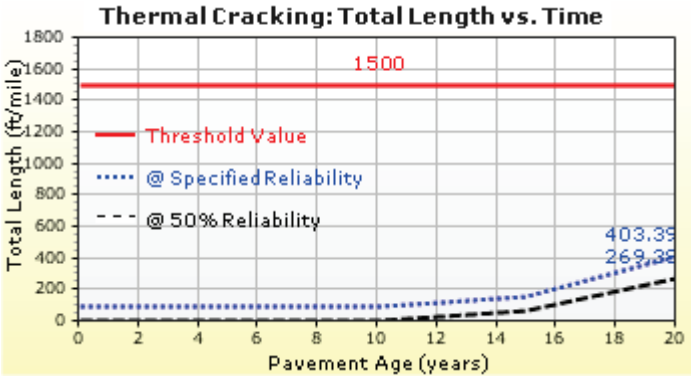
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	160.00	150.05	90.00	94.59	Pass
Permanent deformation - total pavement (in.)	0.40	0.46	90.00	75.66	Fail
AC bottom-up fatigue cracking (percent)	10.00	2.74	90.00	100.00	Pass
AC thermal cracking (ft/mile)	1500.00	403.39	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	257.13	90.00	100.00	Pass
Permanent deformation - AC only (in.)	0.25	0.36	90.00	56.32	Fail

Distress Charts









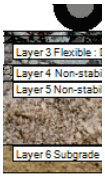
I-25 at Cimarron Overlay 2 2.5

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Asphalt_XML_Files\I-25 at Cimarron Overlay 2 2.5.dgpx

Design Inputs

Design Life:	10 years	Existing construction:	May, 2006	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	AC over AC	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX (100) PG 64 -22 (Existing)	2.5
Flexible	Default asphalt concrete	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	24.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

Age (year)	Heavy Trucks (cumulative)
2015 (initial)	11,975
2020 (5 years)	10,122,700
2025 (10 years)	20,949,000

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	160.00	98.01	80.00	99.98	Pass
Permanent deformation - total pavement (in.)	0.40	0.36	80.00	87.81	Pass
Total Cracking (Reflective + Alligator) (percent)	5	0.06	-	-	Pass
AC thermal cracking (ft/mile)	1500.00	72.55	80.00	100.00	Pass
AC bottom-up fatigue cracking (percent)	10.00	0.85	80.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	174.68	80.00	100.00	Pass
Permanent deformation - AC only (in.)	0.25	0.33	80.00	54.55	Fail

I-25 at Cim US 24 WO I-25 clay 2 6.5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim US 24 WO I-25 clay 2 6.5 (01312014).mdgpx

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	6.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

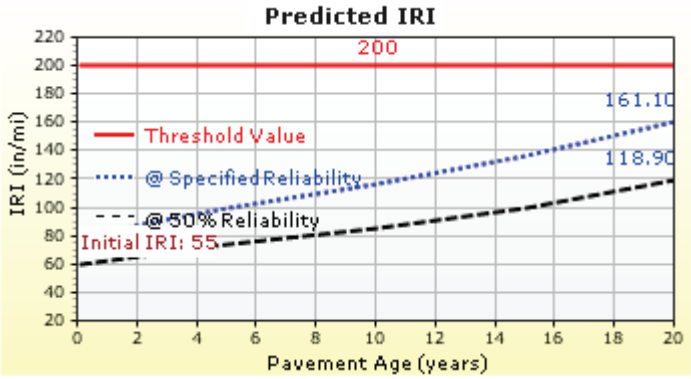
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	2,603
2025 (10 years)	4,528,640
2035 (20 years)	9,613,470

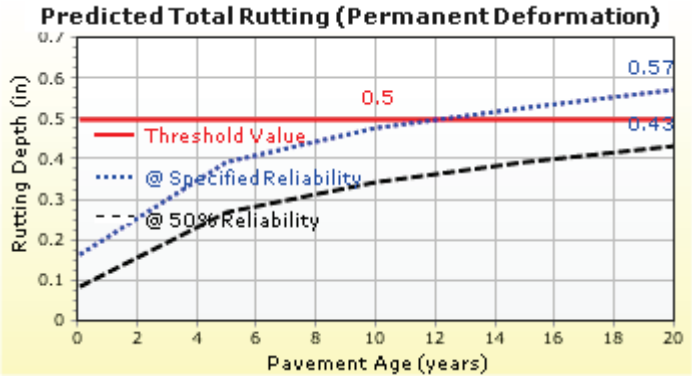
Design Outputs

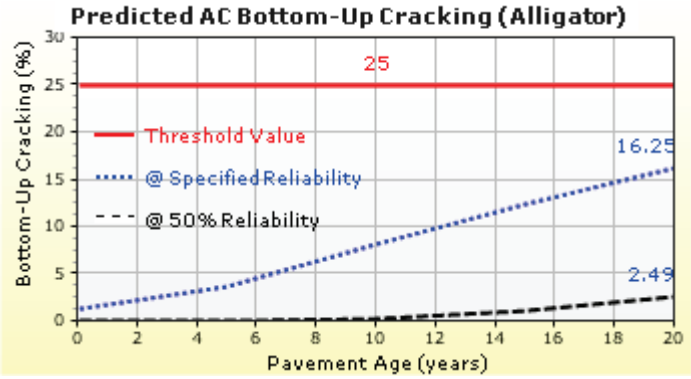
Distress Prediction Summary

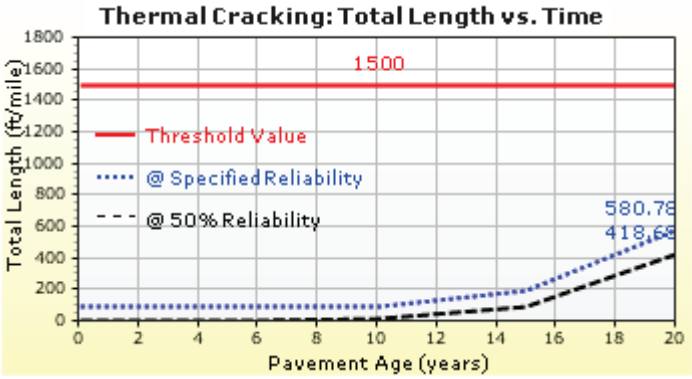
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	161.06	90.00	99.32	Pass
Permanent deformation - total pavement (in.)	0.50	0.57	90.00	73.05	Fail
AC bottom-up fatigue cracking (percent)	25.00	16.25	90.00	98.20	Pass
AC thermal cracking (ft/mile)	1500.00	580.78	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	453.73	90.00	100.00	Pass
Permanent deformation - AC only (in.)	0.35	0.44	90.00	66.29	Fail

Distress Charts









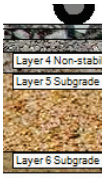
I-25 at Cim US 24 EO I-25 clay 2 5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim US 24 EO I-25 clay 2 5 (01312014).dgpx

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	5.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

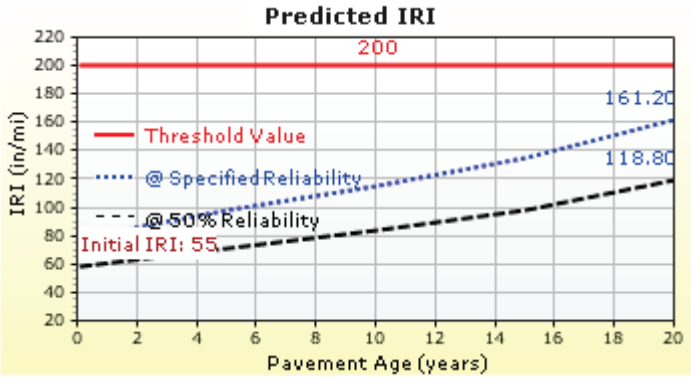
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,230
2025 (10 years)	2,139,930
2035 (20 years)	4,542,670

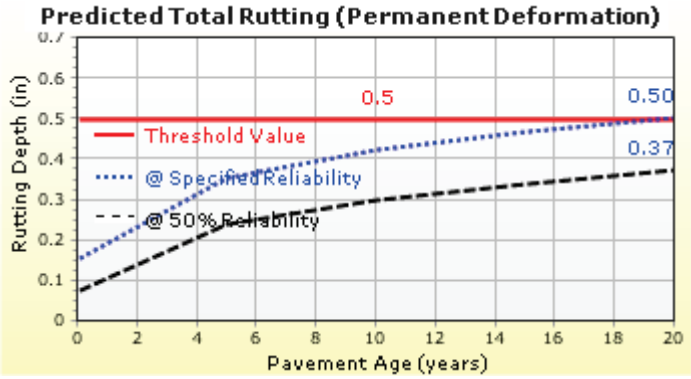
Design Outputs

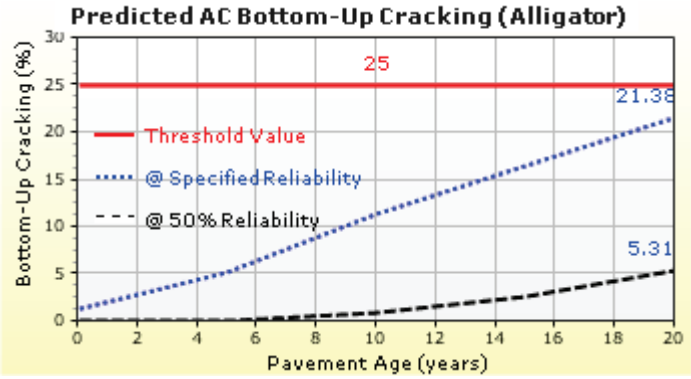
Distress Prediction Summary

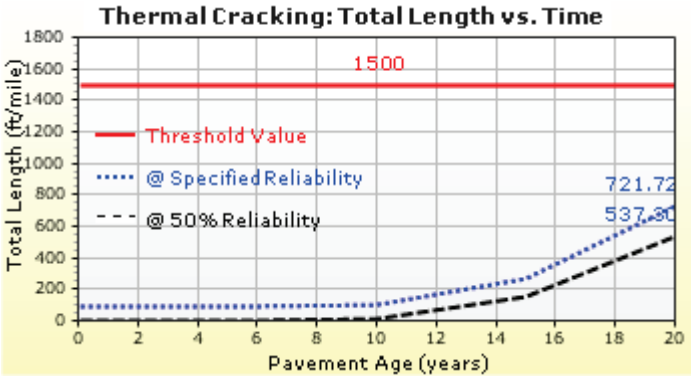
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	161.21	90.00	99.29	Pass
Permanent deformation - total pavement (in.)	0.50	0.50	90.00	89.22	Fail
AC bottom-up fatigue cracking (percent)	25.00	21.38	90.00	94.18	Pass
AC thermal cracking (ft/mile)	1500.00	721.72	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	970.66	90.00	99.60	Pass
Permanent deformation - AC only (in.)	0.35	0.37	90.00	86.68	Fail

Distress Charts









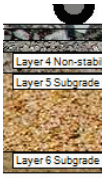
I-25 at Cim US 24 under I-25 clay 2 5.5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim US 24 under I-25 clay 2 5.5.dmc

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	5.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

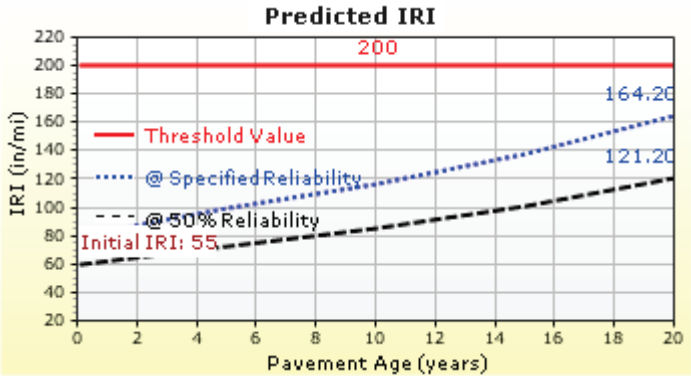
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,995
2025 (10 years)	3,470,860
2035 (20 years)	7,367,980

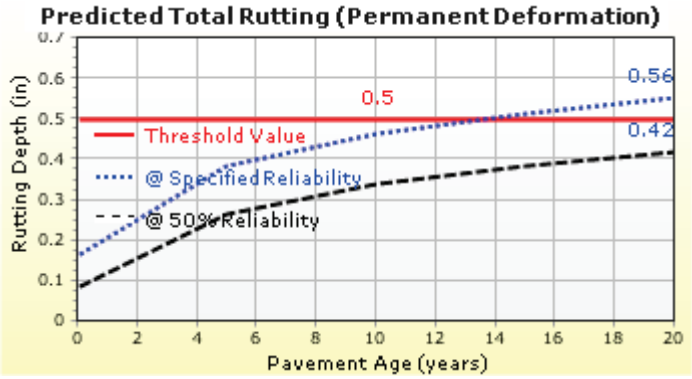
Design Outputs

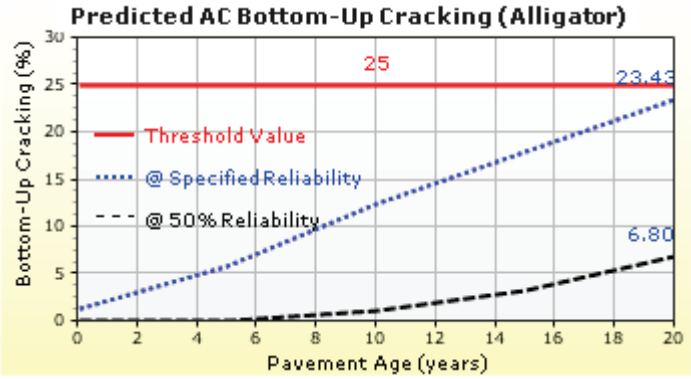
Distress Prediction Summary

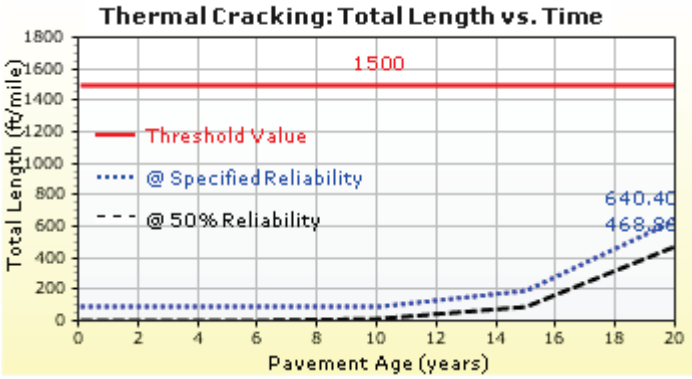
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	164.18	90.00	99.06	Pass
Permanent deformation - total pavement (in.)	0.50	0.56	90.00	77.59	Fail
AC bottom-up fatigue cracking (percent)	25.00	23.43	90.00	91.96	Pass
AC thermal cracking (ft/mile)	1500.00	640.40	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	850.46	90.00	99.88	Pass
Permanent deformation - AC only (in.)	0.35	0.42	90.00	74.00	Fail

Distress Charts









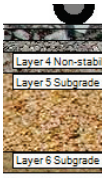
I-25 at Cim SB Exit Ramp clay 2 5.5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim SB Exit Ramp clay 2 5.5 (01312014).dgpx

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	5.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

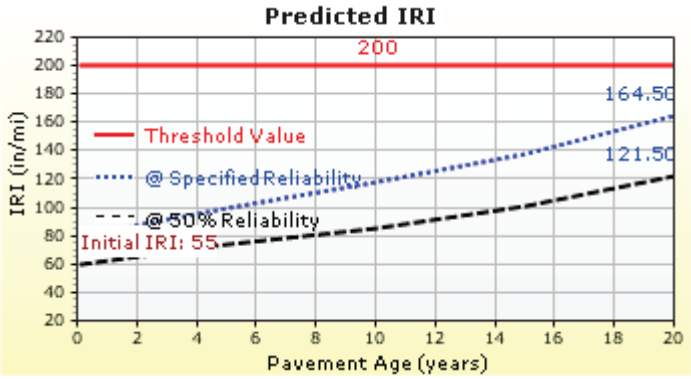
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,406
2025 (10 years)	2,732,940
2035 (20 years)	5,833,060

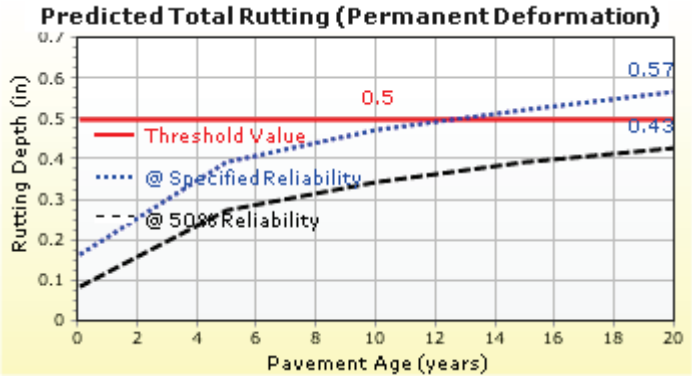
Design Outputs

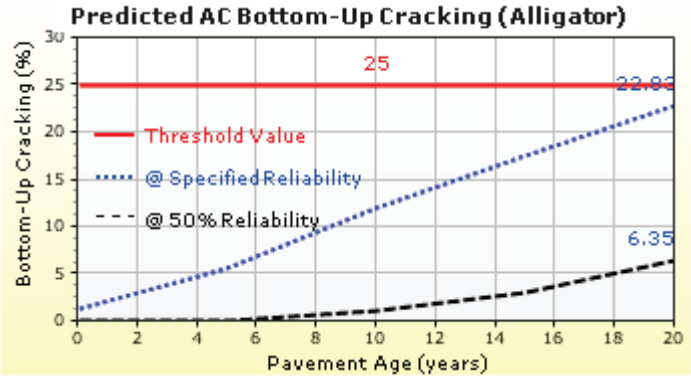
Distress Prediction Summary

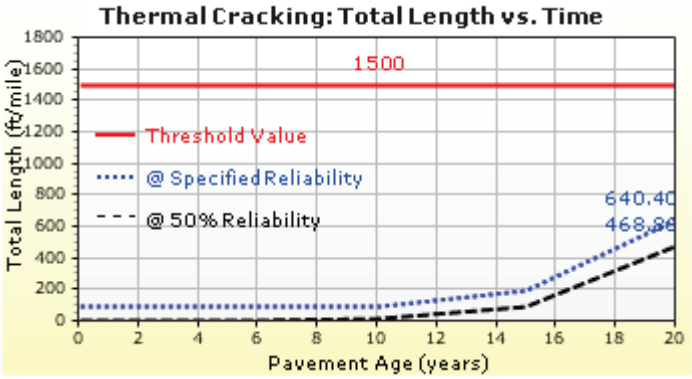
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	164.52	90.00	99.03	Pass
Permanent deformation - total pavement (in.)	0.50	0.57	90.00	74.24	Fail
AC bottom-up fatigue cracking (percent)	25.00	22.83	90.00	92.65	Pass
AC thermal cracking (ft/mile)	1500.00	640.40	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	1017.68	90.00	99.43	Pass
Permanent deformation - AC only (in.)	0.35	0.43	90.00	70.22	Fail

Distress Charts









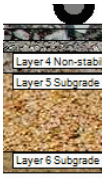
I-25 at Cim SB Entrance Ramp clay 2 5.5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim SB Entrance Ramp clay 2 5.5

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	5.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

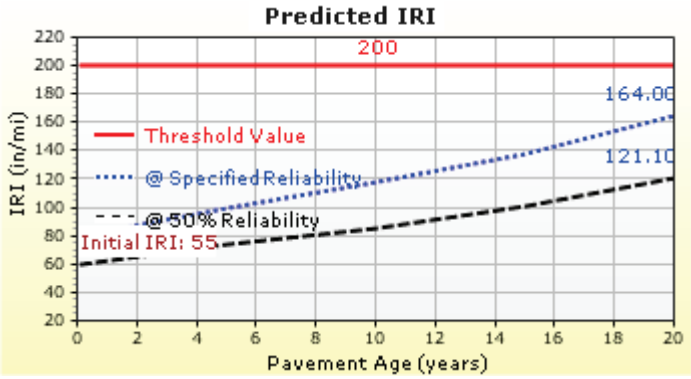
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,366
2025 (10 years)	2,655,190
2035 (20 years)	5,667,110

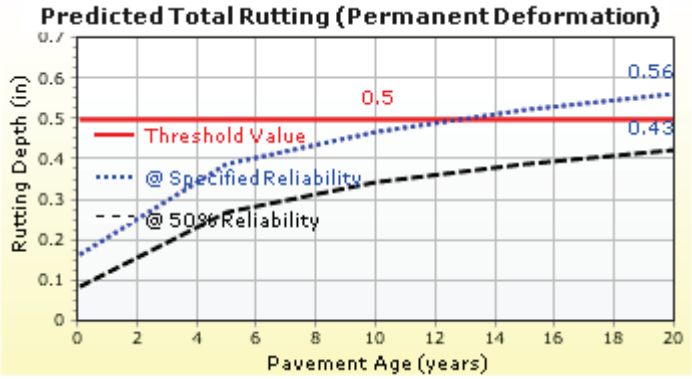
Design Outputs

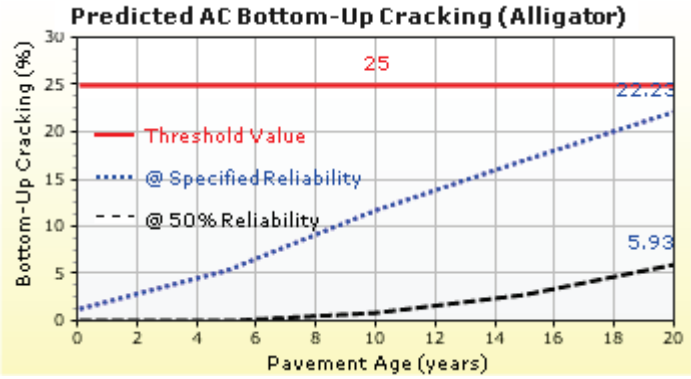
Distress Prediction Summary

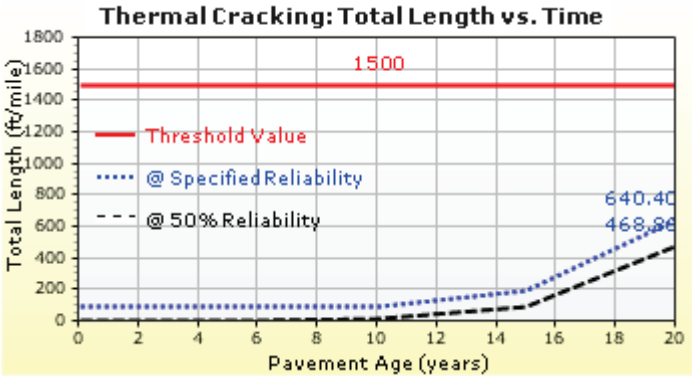
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	163.98	90.00	99.08	Pass
Permanent deformation - total pavement (in.)	0.50	0.56	90.00	75.40	Fail
AC bottom-up fatigue cracking (percent)	25.00	22.23	90.00	93.31	Pass
AC thermal cracking (ft/mile)	1500.00	640.40	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	1002.41	90.00	99.49	Pass
Permanent deformation - AC only (in.)	0.35	0.43	90.00	71.28	Fail

Distress Charts









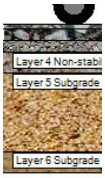
I-25 at Cim NB Exit Ramp clay 2 5.5 (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cim NB Exit Ramp clay 2 5.5 (01312014).dgpx

Design Inputs

Design Life:	20 years	Base construction:	May, 2015	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Flexible Pavement	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	R2 SMA	2.0
Flexible	R2 SX(100) PG 64-22	5.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	10.0
Subgrade	A-2-4	38.0
Subgrade	A-7-6	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	12.2
Air voids (%)	4.7

Traffic

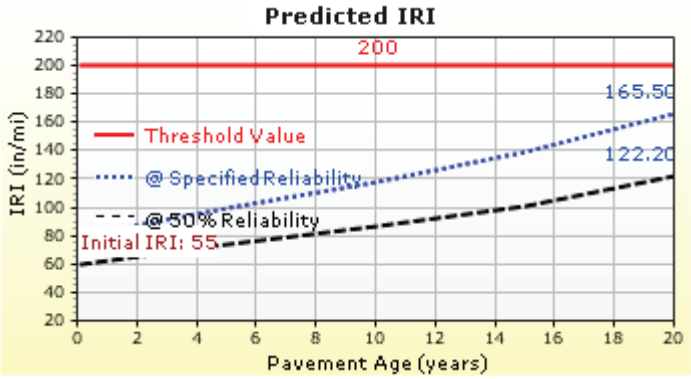
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,475
2025 (10 years)	2,867,060
2035 (20 years)	6,119,320

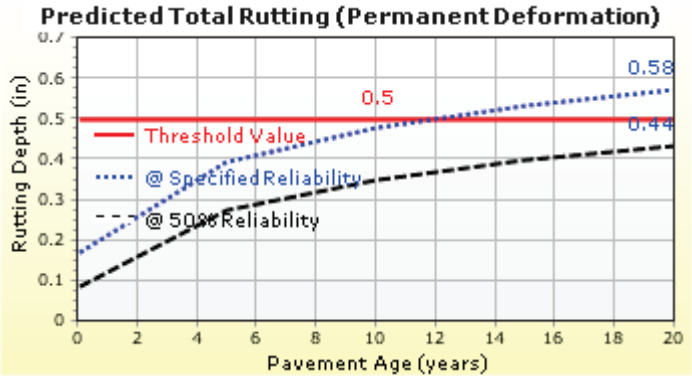
Design Outputs

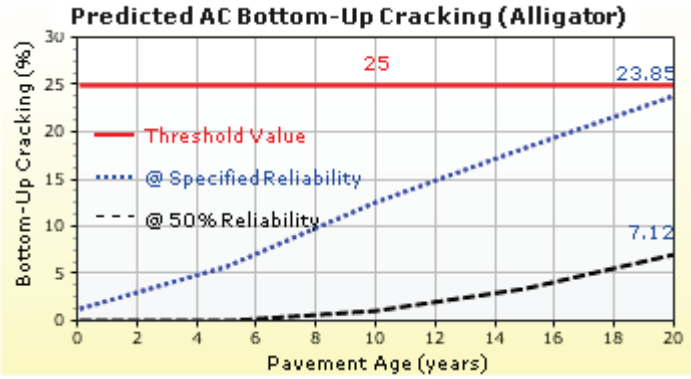
Distress Prediction Summary

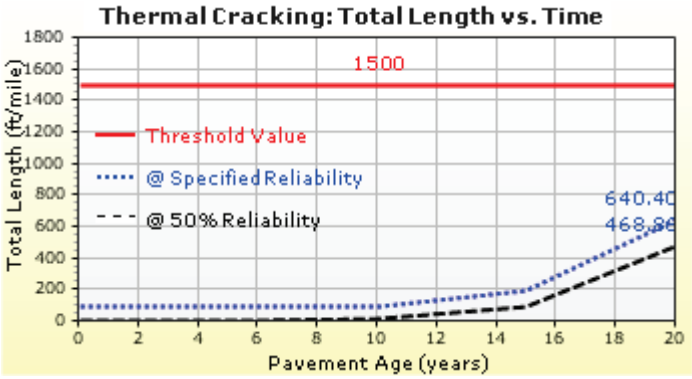
Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	165.47	90.00	98.94	Pass
Permanent deformation - total pavement (in.)	0.50	0.57	90.00	72.22	Fail
AC bottom-up fatigue cracking (percent)	25.00	23.85	90.00	91.46	Pass
AC thermal cracking (ft/mile)	1500.00	640.40	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	1044.34	90.00	99.32	Pass
Permanent deformation - AC only (in.)	0.35	0.44	90.00	68.30	Fail

Distress Charts









I-25 at Cimarron I-25 NB and SB PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cimarron I-25 NB and SB PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	9.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

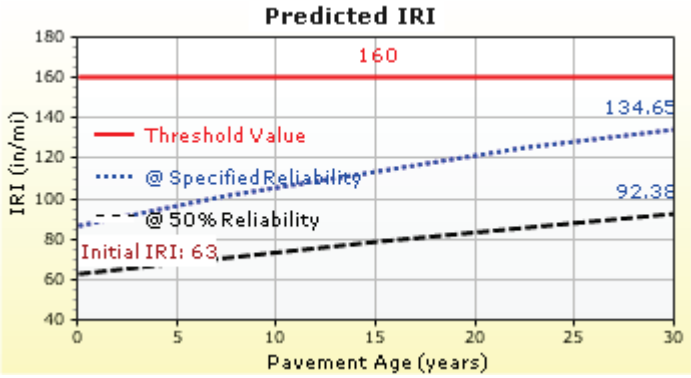
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	11,975
2030 (15 years)	21,652,600
2045 (30 years)	47,527,100

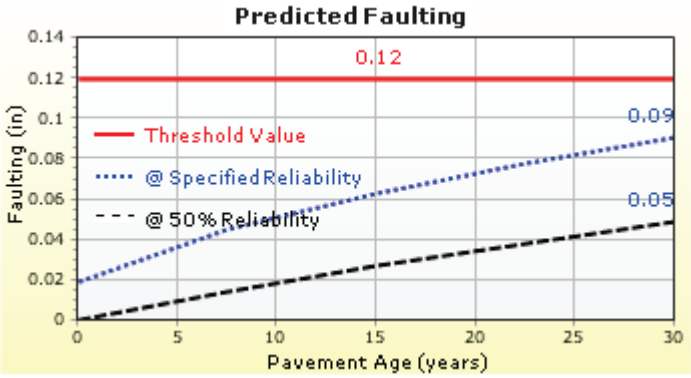
Design Outputs

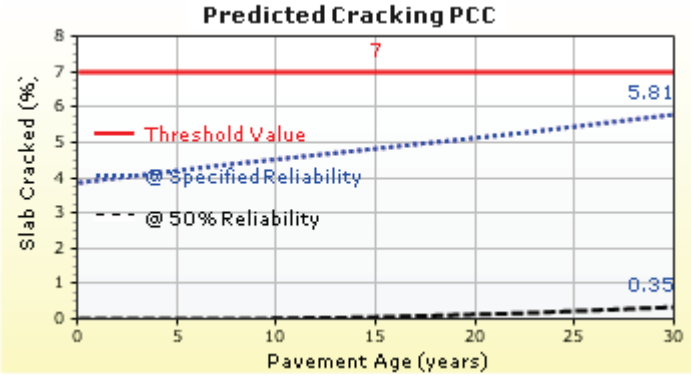
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	160.00	134.65	90.00	97.98	Pass
Mean joint faulting (in.)	0.12	0.09	90.00	98.47	Pass
JPCP transverse cracking (percent slabs)	7.00	5.81	90.00	94.06	Pass

Distress Charts







I-25 NB and SB PCC 20yr 7.5 1 DOW White top (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Asphalt_XML_Files\I-25 NB and SB PCC 20yr 7.5 1 DOW White top

Design Inputs

Design Life:	20 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	7.5
Flexible	Default asphalt concrete	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.00
Slab width (ft)	12.0

Traffic

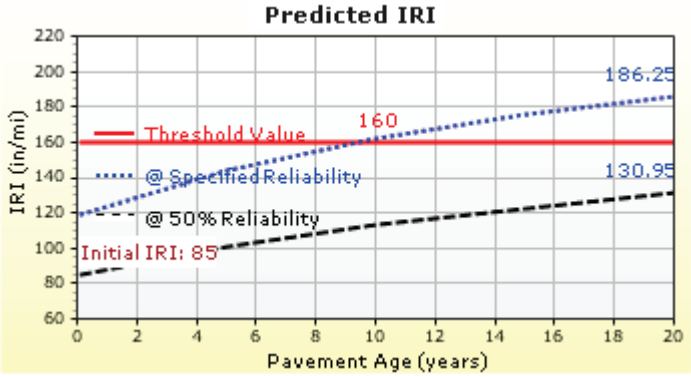
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	11,975
2025 (10 years)	13,966,000
2035 (20 years)	29,808,400

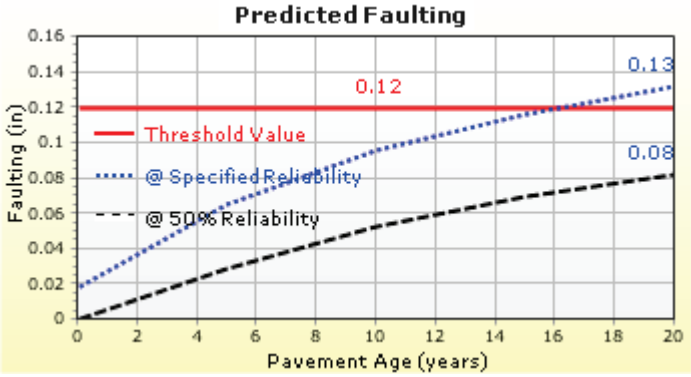
Design Outputs

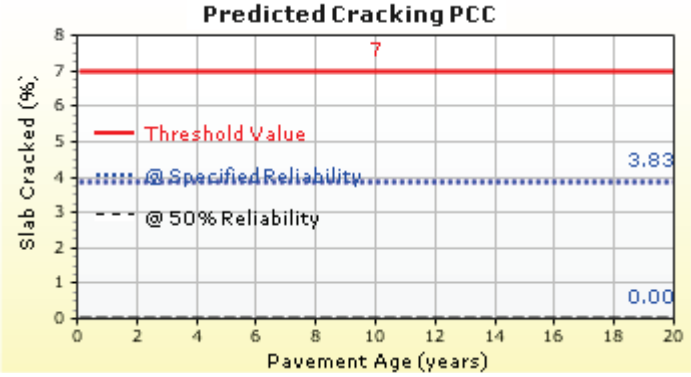
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	160.00	186.25	90.00	74.96	Fail
Mean joint faulting (in.)	0.12	0.13	90.00	83.01	Fail
JPCP transverse cracking (percent slabs)	7.00	3.83	90.00	99.04	Pass

Distress Charts







I-25 at Cimarron SB Exit Ramp PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\Traffic_XML_Files\I-25 at Cimarron SB Exit Ramp PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

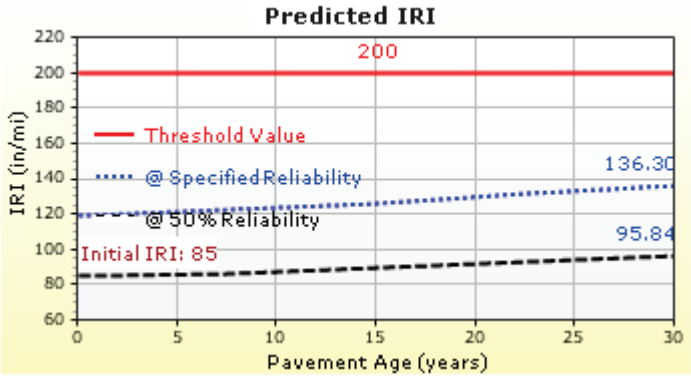
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,406
2030 (15 years)	4,237,100
2045 (30 years)	9,300,360

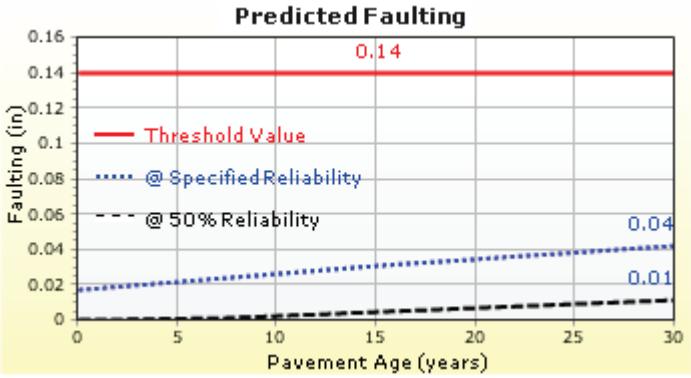
Design Outputs

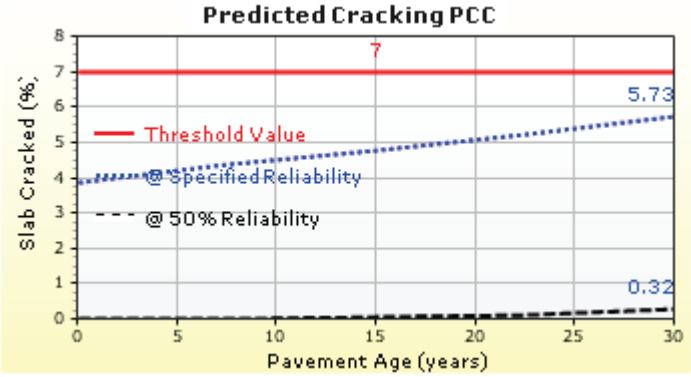
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	136.30	90.00	99.95	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.73	90.00	94.33	Pass

Distress Charts







I-25 at Cimarron SB Entrance Ramp PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron SB Entrance Ramp PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

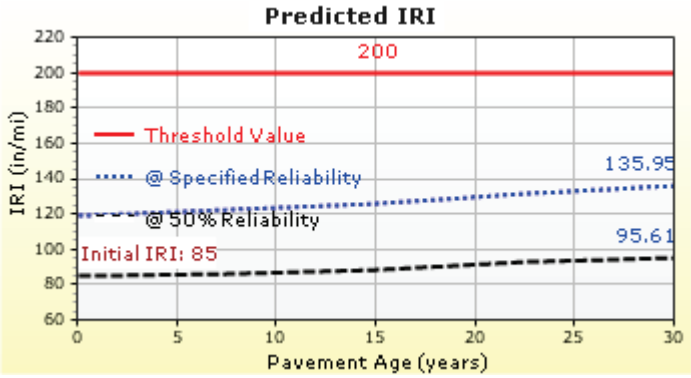
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,366
2030 (15 years)	4,116,560
2045 (30 years)	9,035,770

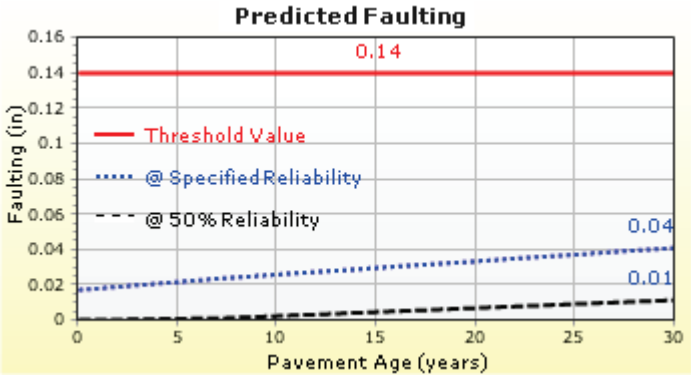
Design Outputs

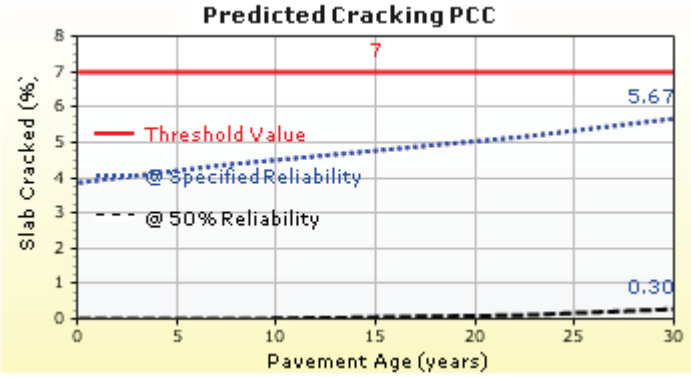
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	135.95	90.00	99.95	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.67	90.00	94.51	Pass

Distress Charts







I-25 at Cimarron NB Entrance Ramp PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron NB Entrance Ramp PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

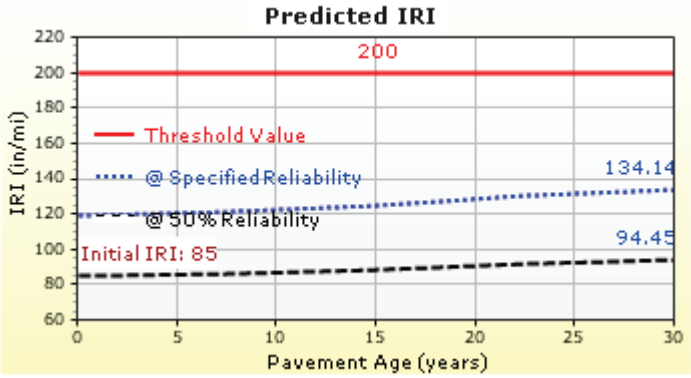
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,404
2030 (15 years)	4,231,080
2045 (30 years)	9,287,140

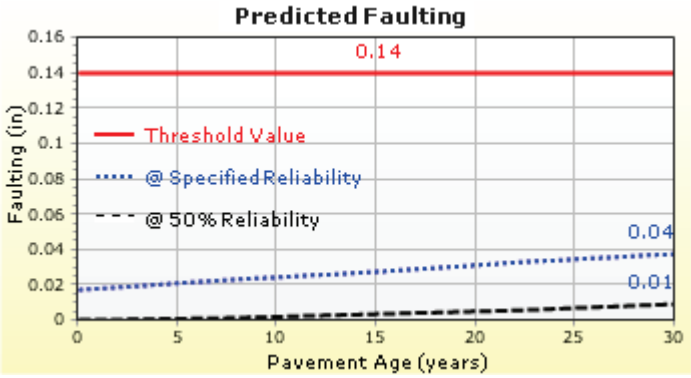
Design Outputs

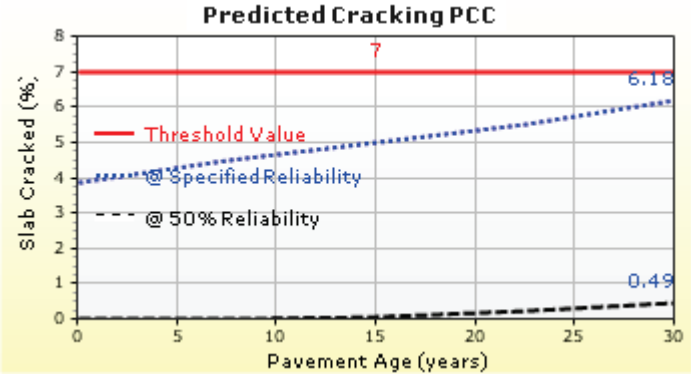
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	134.14	90.00	99.97	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	6.18	90.00	92.86	Pass

Distress Charts







I-25 at Cimarron NB Entrance Ramp PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron NB Entrance Ramp PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

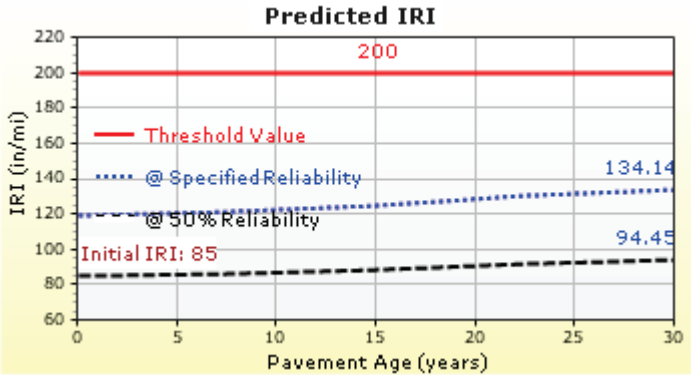
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,404
2030 (15 years)	4,231,080
2045 (30 years)	9,287,140

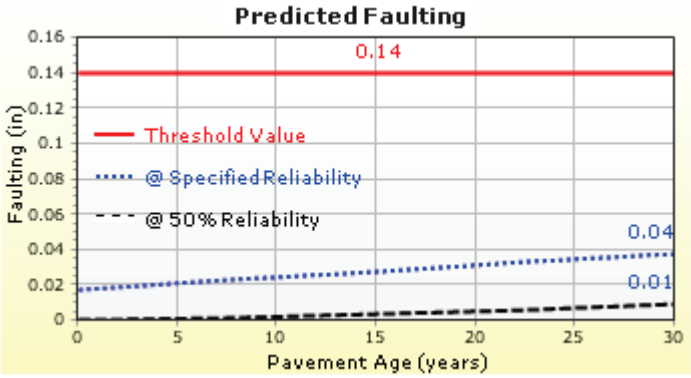
Design Outputs

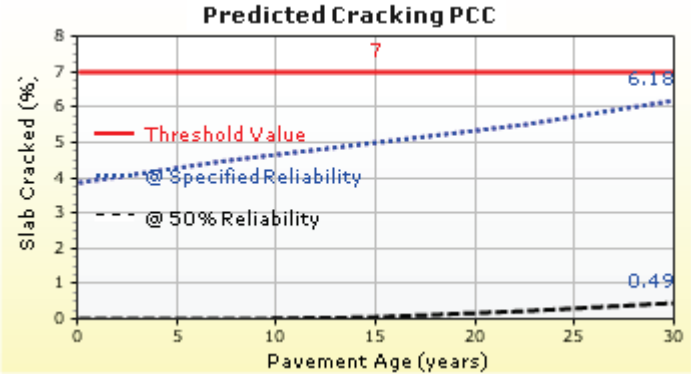
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	134.14	90.00	99.97	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	6.18	90.00	92.86	Pass

Distress Charts







I-25 at Cimarron NB Exit Ramp PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron NB Exit Ramp PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

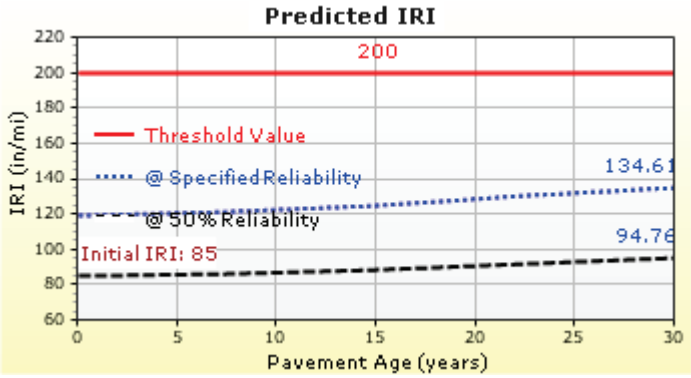
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,475
2030 (15 years)	4,445,040
2045 (30 years)	9,756,780

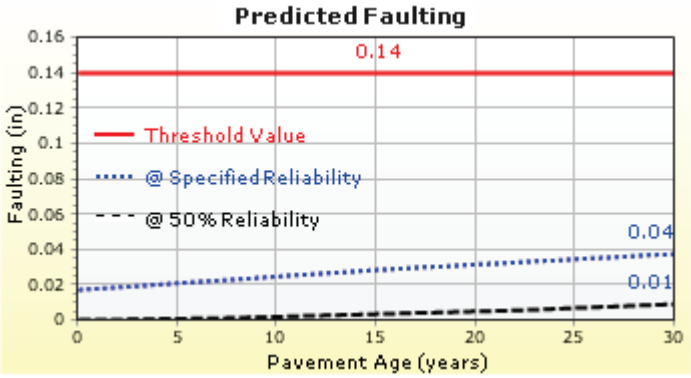
Design Outputs

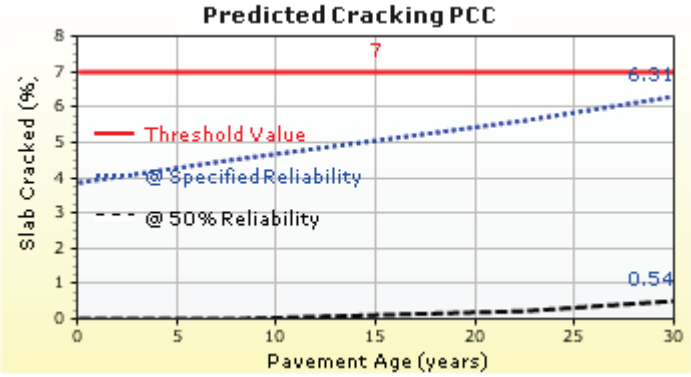
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	134.61	90.00	99.96	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	6.31	90.00	92.45	Pass

Distress Charts







I-25 at Cimarron US 24 East of I25 PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron US 24 East of I25 PCC (01312014).mdpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

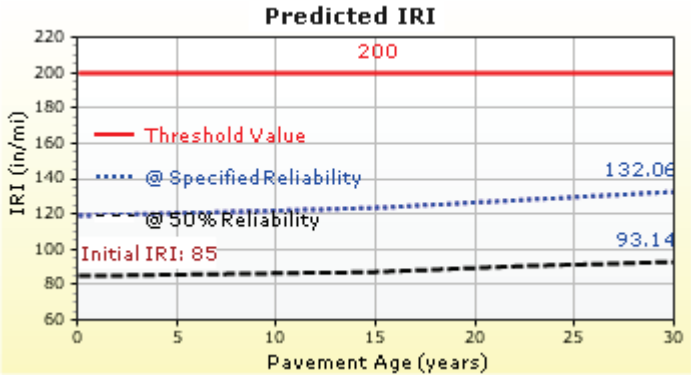
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,230
2030 (15 years)	3,308,440
2045 (30 years)	7,208,220

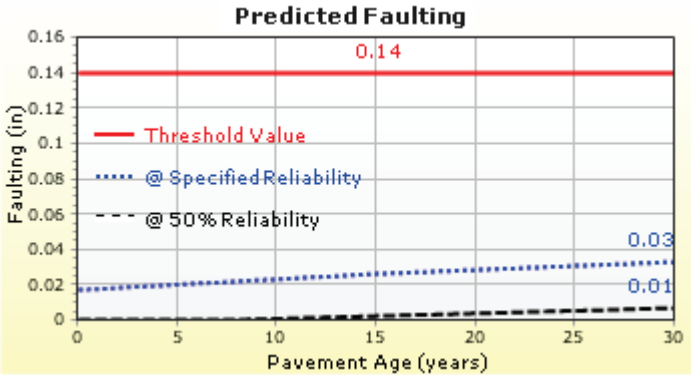
Design Outputs

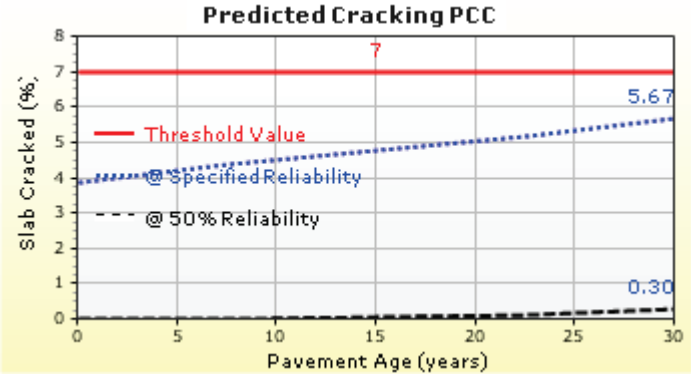
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	132.06	90.00	99.98	Pass
Mean joint faulting (in.)	0.14	0.03	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.67	90.00	94.51	Pass

Distress Charts







I-25 at Cimarron US 24 under I25 PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron US 24 under I25 PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.0
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

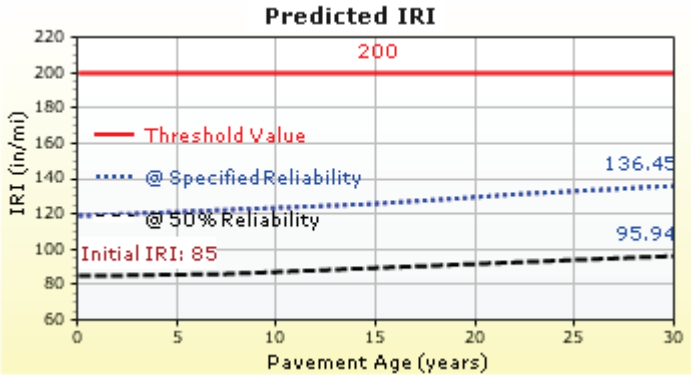
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	1,995
2030 (15 years)	5,366,140
2045 (30 years)	11,691,400

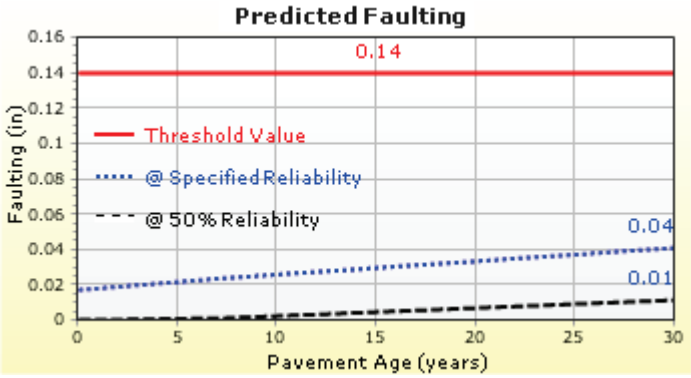
Design Outputs

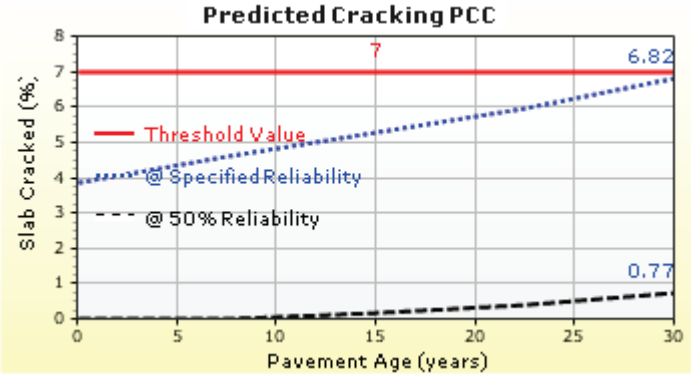
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	136.45	90.00	99.95	Pass
Mean joint faulting (in.)	0.14	0.04	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	6.82	90.00	90.64	Pass

Distress Charts







I-25 at Cimarron US 24 WO I25 PCC (01312014)

File Name: C:\Users\Bob\Documents\DARWin ME\USB DISK\CDOT ME Design Training\CDOT_XML_FILES\PCC_XML_Files\I-25 at Cimarron US 24 WO I25 PCC (01312014).dgpx

Design Inputs

Design Life:	30 years	Existing construction:	-	Climate Data Sources (Lat/Lon)	38.812, -104.711
Design Type:	Jointed Plain Concrete Pavement (JPCP)	Pavement construction:	June, 2015		
		Traffic opening:	September, 2015		

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	R4 Level 1 Lawson	8.5
NonStabilized	Aggregate Base	6.0
NonStabilized	A-2-4	48.0
Subgrade	A-7-6	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

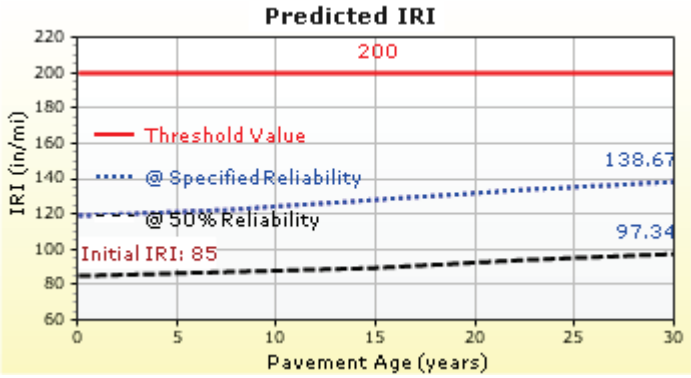
Age (year)	Heavy Trucks (cumulative)
2015 (initial)	2,603
2030 (15 years)	7,001,530
2045 (30 years)	15,254,500

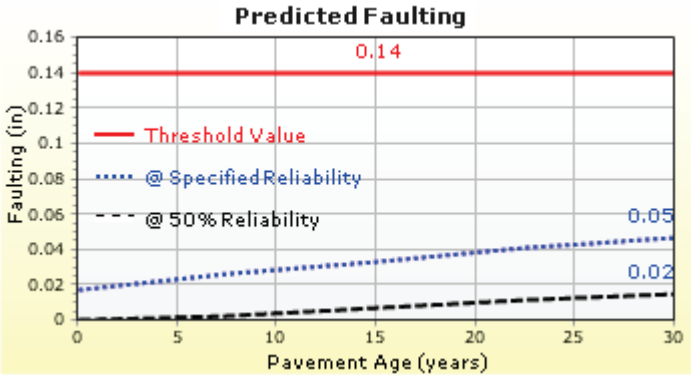
Design Outputs

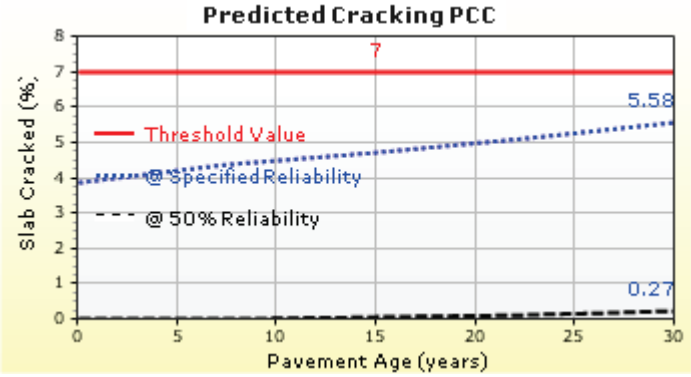
Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	200.00	138.67	90.00	99.93	Pass
Mean joint faulting (in.)	0.14	0.05	90.00	100.00	Pass
JPCP transverse cracking (percent slabs)	7.00	5.58	90.00	94.79	Pass

Distress Charts







Appendix f

LIFE CYCLE COST ANALYSIS DATA

I/25 & Cimarron Pavement Option Costs - per 2/26/12 Yeh Draft Pavement Thickness Designs
By: RFL

PAVEMENT QUANTITIES		Asphalt Section				Concrete	Agg. Base Course	
		Surface		Base				
Segment	Pavement Areas (SY)	SMA Thickness (in)	SMA Quantity (TON)	HMA Thickness (in)	HMA Quantity (TON)	Thickness (in.)	ABC Depth (in)	ABC Quantity (CY)
US24 e/o I-25	4105	2	452	5	1129	8.5	6	684
US24 under I-25	10140	2	1115	5.5	3067	8.5	6	1690
US24 w/o I-25	4415	2	486	6.5	1578	9.0	6	736
I-25 Mainline	77605	2	8537	12	51219	9.5	6	12934
I-25 Ramps	17500	2	1925	5.5	5294	8.5	6	2917
TOTALS	**113765**		**12514**		**62288**			**18961**

PAVEMENT OPTION COSTS

ASPHALT

		Surface	Base	SMA	HMA	Asphalt	ABC	Total Segment	
Segment	Pavement Area (SY)	SMA Quantity (TON)	HMA Quantity (TON)	Unit Cost	Unit Cost	Cost	Cost ($25/CY)	Cost	
US24 e/o I-25	4105	452	1129	$95.00	$78.00	$130,949.50	$17,104.17	$148,053.67	
US24 under I-25	10140	1115	3067	$95.00	$78.00	$345,216.30	$42,250.00	$387,466.30	$723,164.83
US24 w/o I-25	4415	486	1578	$95.00	$78.00	$169,249.03	$18,395.83	$187,644.86	
I-25 Mainline	77605	8537	51219	$95.00	$78.00	$4,806,077.65	$323,354.17	$5,129,431.82	
I-25 Ramps	17500	1925	5294	$95.00	$78.00	$595,787.50	$72,916.67	$668,704.17	
					Totals	**$6,047,279.98**	**$474,020.83**	**$6,521,300.81**	

CONCRETE

		Concrete	Concrete	Concrete	ABC	Total Segment	
Segment	Pavement Area (SY)	Depth (in)	Unit Cost	Cost	Cost ($25/CY)	Cost	
US24 e/o I-25	4105	8.5	$40.00	$164,200.00	$17,104.17	$181,304.17	
US24 under I-25	10140	8.5	$40.00	$405,600.00	$42,250.00	$447,850.00	$832,980.00
US24 w/o I-25	4415	9.0	$42.00	$185,430.00	$18,395.83	$203,825.83	
I-25 Mainline	77605	9.5	$45.00	$3,492,225.00	$323,354.17	$3,815,579.17	
I-25 Ramps	17500	8.5	$40.00	$700,000.00	$72,916.67	$772,916.67	
			Totals	**$4,947,455.00**	**$474,020.83**	**$5,421,475.83**	

I/25 & Cimarron Pavement Option Costs - per 2/26/12 Yeh Draft Pavement Thickness Designs
By: RFL

Life Cycle Cost Analysis Cost Inputs

ASPHALT

Segment	Total Segment Cost		Cost - 10%	Most Likely Cost	Cost + 10%		Cost - 10%	Most Likely Cost	Cost + 10%
								X1.431	
US24 e/o I-25	$148,053.67		$133,248.30	$148,053.67	$162,859.03				
US24 under I-25	$387,466.30	$723,164.83	$348,719.67	$387,466.30	$426,212.93	US 24	$931,363.98	$1,034,848.86	$1,138,333.75
US24 w/o I-25	$187,644.86		$168,880.37	$187,644.86	$206,409.34				
I-25 Mainline	$5,129,431.82		$4,616,488.64	$5,129,431.82	$5,642,375.00	I-25	$6,606,195.24	$7,340,216.93	$8,074,238.62
I-25 Ramps	$668,704.17		$601,833.75	$668,704.17	$735,574.58	Ramps	$662,017.13	$668,704.17	$809,132.04

CONCRETE

Segment	Total Segment Cost		Cost - 10%	Most Likely Cost	Cost + 10%		Cost - 10%	Most Likely Cost	Cost + 10%
US24 e/o I-25	$181,304.17		$163,173.75	$181,304.17	$199,434.58				
US24 under I-25	$447,850.00	$832,980.00	$403,065.00	$447,850.00	$492,635.00	US 24	$749,682.00	$832,980.00	$916,278.00
US24 w/o I-25	$203,825.83		$183,443.25	$203,825.83	$224,208.42				
I-25 Mainline	$3,815,579.17		$3,434,021.25	$3,815,579.17	$4,197,137.08	I-25	$4,914,084.41	$5,460,093.79	$6,006,103.17
I-25 Ramps	$772,916.67		$695,625.00	$772,916.67	$850,208.33	Ramps	$995,439.38	$1,106,043.75	$1,216,648.13

PAVEMENT QUANTITIES

Lane Mile Calcs and Maintenance Costs

Segment	Pavement Areas (SY)	No. of Lane Miles	HMA Annual Maintenance Cost	PCCP Annual Maintenance Cost	HMA Annual Maintenance Cost	PCCP Annual Maintenance Cost	
US24 e/o I-25	4105	0.6	$473	$262			
US24 under I-25	10140	1.4	$1,170	$647	$2,152	$1,190	US 24
US24 w/o I-25	4415	0.6	$509	$282			
I-25 Mainline	77605	11.0	$8,951	$4,950			
I-25 Ramps	17500	2.5	$2,018	$1,116			

1 Lane Mile = 4 yd X 1760 yd = 7,040 yd2

Region 2 Maintenance Costs - HMA	$812	/lane mile
Region 2 Maintenance Costs - PCCP	$449	/lane mile

Rehabilitation Quantities and Costs

HMA Rehabilitation Quantities and Costs

Typical Rehabilitation of HMA is 2 inches of milling followed by placement of 2 inches of new SMA
In addition, design, construction, and traffic control costs are also added to the pavement construction cost at the rate of
Design Costs = 10%, Construction Engineering = 18.1%, Traffic Control Costs = 15%, A total addition of 43.1% of the constructions costs
Milling Costs taken from the CDOT Cost Data Book for 2013 = $1.65/yd. The range used for this analysis will be $1.65 +/- $0.35
SMA Costs from above = $95/ton for the most likely cost, and the same +/- 10% will be used for the cost variatin

These values are also normally entered into the life cycle cost program with a high
most likely, and low cost estimate. The current price is used, because the future cost is brought back to current costs using the discount rate by the LCCA program.

	Pavement Areas (SY)		SMA		
			Cost - 10%	Most Likely Cost	Cost + 10%
US24 e/o I-25	4105		$38,607.53	$42,897.25	$47,186.98
US24 under I-25	10140	18,660	$95,366.70	$105,963.00	$116,559.30
US24 w/o I-25	4415		$41,523.08	$46,136.75	$50,750.43
I-25 Mainline	77605		$729,875.03	$810,972.25	$892,069.48
I-25 Ramps	17500		$164,587.50	$182,875.00	$201,162.50

Milling		
Cost - 10%	Most Likely Cost	Cost + 10%
$6,095.93	$6,773.25	$7,450.58
$15,057.90	$16,731.00	$18,404.10
$6,556.28	$7,284.75	$8,013.23
$115,243.43	$128,048.25	$140,853.08
$25,987.50	$28,875.00	$31,762.50

SMA = $95/ton X 220 lbs/yd2-in / 2000/ton = $10.45 /yd2 +/- 10%

Composite Table for RealCost Program Input

SMA and Milling		
Cost - 10%	Most Likely Cost	Cost + 10%
$44,703.45	$49,670.50	$54,637.55
$110,424.60	$122,694.00	$134,963.40
$48,079.35	$53,421.50	$58,763.65
$845,118.45	$939,020.50	$1,032,922.55
$190,575.00	$211,750.00	$232,925.00

RealCost Program Input		
SMA and Milling with Design, Const. and Traffic +43.1%		
Cost - 10%	Most Likely Cost	Cost + 10%
$63,970.64	$71,078.49	$78,186.33
$158,017.60	$175,575.11	$193,132.63
$68,801.55	$76,446.17	$84,090.78
$1,209,364.50	$1,343,738.34	$1,478,112.17
$272,712.83	$303,014.25	$333,315.68

User Costs:

US 24	$290,790	$323,100	$355,410

Mainline I-25 - most of the new section will be constructed on new alignment outside of existing traffic and the tie in at the south end will be constructed using HMA for either material, so the user costs for initial construction are anticipated to be the same for either HMA or PCCP, so no user costs are included for initial construction.
For rehabilitation using HMA, all work will be required to be completed between 8 PM and 5 AM with a minimum of two lanes open in each direction.
To address the predicted rutting from the DARWin ME design, a rehabilitation will be required at 12 year intervals.

Ramps - Most Ramps will also be constructed off the mainline, so only minimal differnce user costs are considered for initial construction.

US 24 - Initial construction on US 24 will have a large impact on traffic, so extensive user costs will be considered for initial construction.

User Costs from User Cost Program

	I-25 Mainline	Ramps	Total US 24 User Costs	US 24 W/O I-25	US 24 under I-25	US 24 E/O I-25
2015 Initial Const.	$0	0	713070	222088	490982	0
2027 Rehabilitation	55789	3083	32216	18721	13495	0
2039 Rehabilitation	72693	6579	43399	25296	18103	0
2051 Rehabilitation	158068	182994	60786	35769	25017	0
Salvage Value 2055						

Rehabilitation Quantities and Costs

	SB Entrance	SB Exit	NB Entrance	NB Exit
2027	716	751	776	840
2039	973	2623	1435	1548
2051	1385	169950	5047	6612

PCCP Rehabilitation Quantities and Costs

Typical rehabilitation for PCCP wll be 1/2% slab replacement in travel lanes, full width diamond grinding, and longitudinal and transverse joint resealing
In addition, design, construction, and traffic control costs are also added to the pavement construction cost at the rate of
Design Costs = 10%, Construction Engineering = 18.1%, Traffic Control Costs = 15%, A total addition of 43.1% of the constructions costs

	Pavement Areas (SY)	Approx. Section length (ft)	Assumed Section width (ft)	Assumed Section length (yd)	Assumed Section width (yd)	Assumed yd2	# of long. joints	# transverse joints	Total Joint length ft
US24 e/o I-25	4105	385	96	128	32	4107	7	26	5159
US24 under I-25	10140	815	112	272	37	10142	8	54	12605
US24 w/o I-25	4415	500	80	167	27	4444	5	33	5167
I-25 Mainline	77605	5820	120	1940	40	77600	8	388	93120
I-25 Ramps (each)	17500	1100	36	367	12	17600	2	73	19360
Total Squre Yards =	113765				Total Squre Yards =	113893		Total Lineal ft of joints =	135411

	Pavement Areas (SY)	0.5% of slab area SY	Replacement Cost	Slab Replacement		Grinding		Saw and Seal Joints	Total Rehab PCCP Cost
US24 e/o I-25	4105	21	$1,273						
US24 under I-25	10140	51	$3,143	$5,785	US 24	$93,300	US 24	$91,724	$190,809
US24 w/o I-25	4415	22	$1,369						
I-25 Mainline	77605	388	$24,058	I-25	I-25	$388,025	I-25	$372,480	$784,563
I-25 Ramps (each)	17500	88	$5,425	Ramps	Ramps	$87,500	Ramps	$77,440	$170,365
	Total Squre Yards =	569	$35,267						
						$481,325		$464,204	$975,371

Data from CDOT Cost Data Book

Remove Concrete Pavement	$12	/yd2
Concrete Pavement	$50	/yd2
Total Replace PCCP =	$62	/yd2

Total Rehabilitation Costs

						Mainline	US 24	Ramps
						Pro-rated based on area		
Remove and Replace 0.5% of Slabs =	569	yd2 X	$62	/yd2 =	$35,267.15			
Grind surface	113765	yd2 X	$5	/yd2 =	$568,825.00	0.68	0.16	0.15
Saw and Seal Concrete Joints	135411	lin ft X	$4	/lin ft =	$541,644.00			
				Total PCCP Rehab =	$1,145,736.15	$781,566	$187,926	$176,244

PCCP Rehabilitation

The only rehabilitation for PCCP will occur at 27 years in the year 2042.

2015 Initial Const.	$0
2042 Rehabilitation	$1,145,736

Mainline I-25 - most of the new section will be constructed on new alignment outside of existing traffic and the tie in at the south end will be constructed using HMA for either material, so the user costs for initial construction are anticipated to be the same for either HMA or PCCP, so no user costs are included for initial construction.
For rehabilitation using HMA, all work will be required to be completed between 8 PM and 5 AM with a minimum of two lanes open in each direction.
To address the predicted rutting from the DARWin ME design, a rehabilitation will be required at 12 year intervals.

Ramps - Most Ramps will also be constructed off the mainline, so only minimal differnce user costs are considered for initial construction.

US 24 - Initial construction on US 24 will have a large impact on traffic, so extensive user costs will be considered for initial construction.

	I-25 Mainline	Ramps	Total US 24 User Costs	US 24 W/O I-25	US 24 under I-25	US 24 E/O I-25
2015 Initial Const.	$0	0	1211337	811090	400247	0
2042 Rehabilitation	206382	106221				

	SB Entrance	SB Exit	NB Entrance	NB Exit	HMA Totals	
2027	1013	1063	1100	1193	$4,369	2027
2039	1386	4475	2068	2235	$10,164	2039
2051	1992	225523	11717	15269	$254,501	2051
PCCP 2042	6001	79553	9935	10732	$106,221	

RealCost Input Data

1. Economic Variables	
Value of Time for Passenger Cars ($/hour)	$17.00
Value of Time for Single Unit Trucks ($/hour)	$35.00
Value of Time for Combination Trucks ($/hour)	$36.50

2. Analysis Options	
Include User Costs in Analysis	Yes
Include User Cost Remaining Life Value	Yes
Use Differential User Costs	Yes
User Cost Computation Method	Specified
Include Agency Cost Remaining Life Value	Yes
Traffic Direction	Both
Analysis Period (Years)	40
Beginning of Analysis Period	2015
Discount Rate (%)	2.6
	LCCALOGNORMAL(2.6,0.25)
Number of Alternatives	2

3. Project Details	
State Route	I-25 at US 24 (Cimarron St in Colo Spgs)
Project Name	I-25 Mainline
Region	2
County	El Paso
Analyzed By	Robert LaForce
Mileposts	
Begin	140.50
End	141.50
Length of Project (miles)	1.00
Comments	Mainline I-25 Reconstruction comparing 9.5 inches PCCP with 14 inches HMA Both PCCP and HMA will be placed over 6 inches of ACB Class 6

4. Traffic Data	
AADT Construction Year (total for both directions)	124,644
Cars as Percentage of AADT (%)	91.2
Single Unit Trucks as Percentage of AADT (%)	4.1
Combination Trucks as Percentage of AADT (%)	4.7
Annual Growth Rate of Traffic (%)	1.3
Speed Limit Under Normal Operating Conditions (mph)	55
No of Lanes in Each Direction During Normal Conditions	3
Free Flow Capacity (vphpl)	2157
Rural or Urban Hourly Traffic Distribution	Urban
Queue Dissipation Capacity (vphpl)	1482
Maximum AADT (total for both directions)	310,000
Maximum Queue Length (miles)	1.0

Alternative 1	HMA Construction	
Number of Activities	4	

Activity 1	Initial Construction 12" SX(100) & 2" SMA	
Agency Construction Cost ($1000)	$5,129.43 **LCCATRIANG(4616.489,5129.432,5642.375)**	
User Work Zone Costs ($1000)	$0.00	
Work Zone Duration (days)	48	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(9,12,15)**	
Activity Structural Life (years)	20.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	8.951	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	55	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 12 years (2027) Mill 2" and replace SMA at 2"	
Agency Construction Cost ($1000)	$1,343.74 **LCCATRIANG(1209.365,1343.738,1478.112)**	
User Work Zone Costs ($1000)	$55.79	
Work Zone Duration (days)	9	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(9,12,15)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	8.951	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	45	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 3	Rehabilitation at 12 years (2027) Mill 2" and replace SMA at 2"	
Agency Construction Cost ($1000)	$1,343.74	
	LCCATRIANG(1209.365,1343.738,1478.112)	
User Work Zone Costs ($1000)	$72.67	
Work Zone Duration (days)	9	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0	
	LCCATRIANG(9,12,15)	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	8.951	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	45	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 4	Rehabilitation at 12 years (2027) Mill 2" and replace SMA at 2"	
Agency Construction Cost ($1000)	$1,343.74	
	LCCATRIANG(1209.365,1343.738,1478.112)	
User Work Zone Costs ($1000)	$158.07	
Work Zone Duration (days)	9	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0	
	LCCATRIANG(9,12,15)	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	8.951	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	45	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

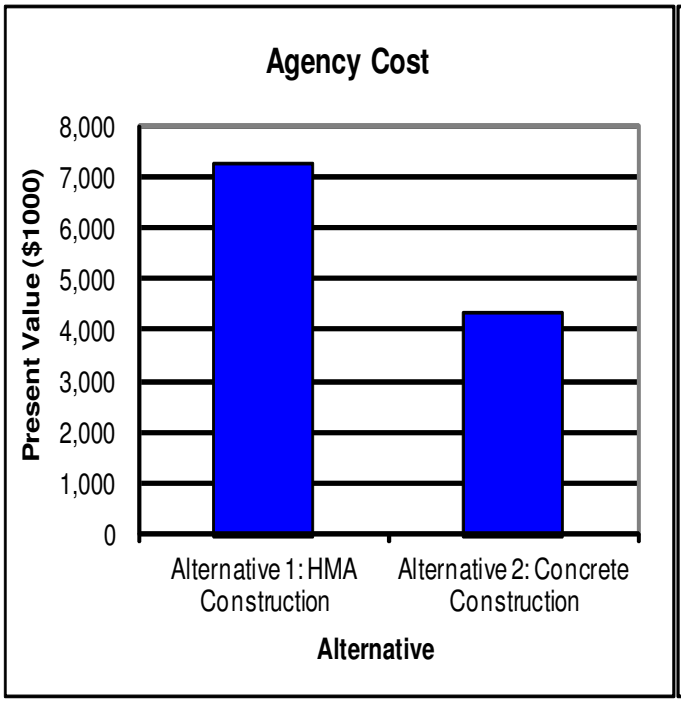
Alternative 2	Concrete Construction	
Number of Activities	2	

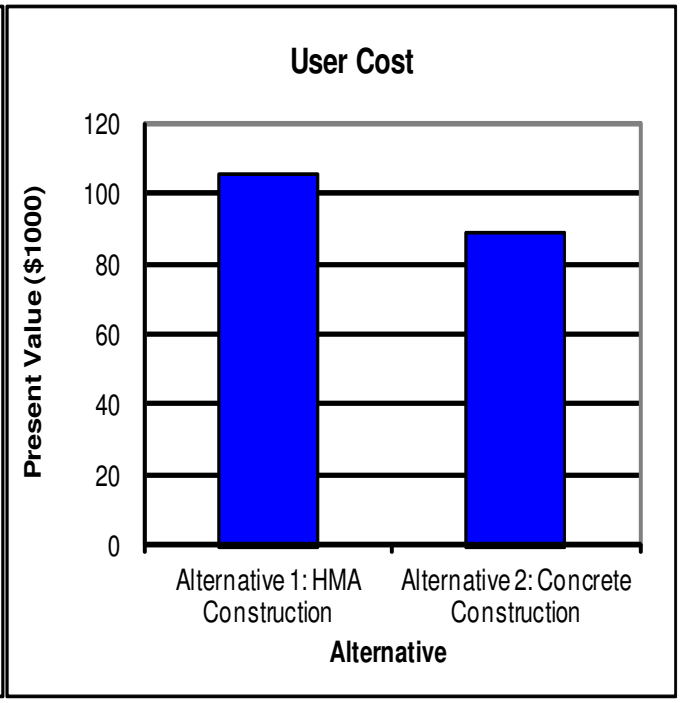
Activity 1	Initial Construction with 9.5" PCCP over 6" ABC	
Agency Construction Cost ($1000)	$3,815.58 **LCCATRIANG(3434.021,3815.579,4197.137)**	
User Work Zone Costs ($1000)	$0.00	
Work Zone Duration (days)	48	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	28.7 **LCCATRIANG(16,27,43)**	
Activity Structural Life (years)	30.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	4.95	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	55	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 27 years Year 2042	
Agency Construction Cost ($1000)	$1,145.74 **LCCATRIANG(1031.163,1145.736,1260.311)**	
User Work Zone Costs ($1000)	$259.52	
Work Zone Duration (days)	48	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	18.0 **LCCATRIANG(12,18,24)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	4.95	
Work Zone Length (miles)	1.20	
Work Zone Speed Limit (mph)	55	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Deterministic Results

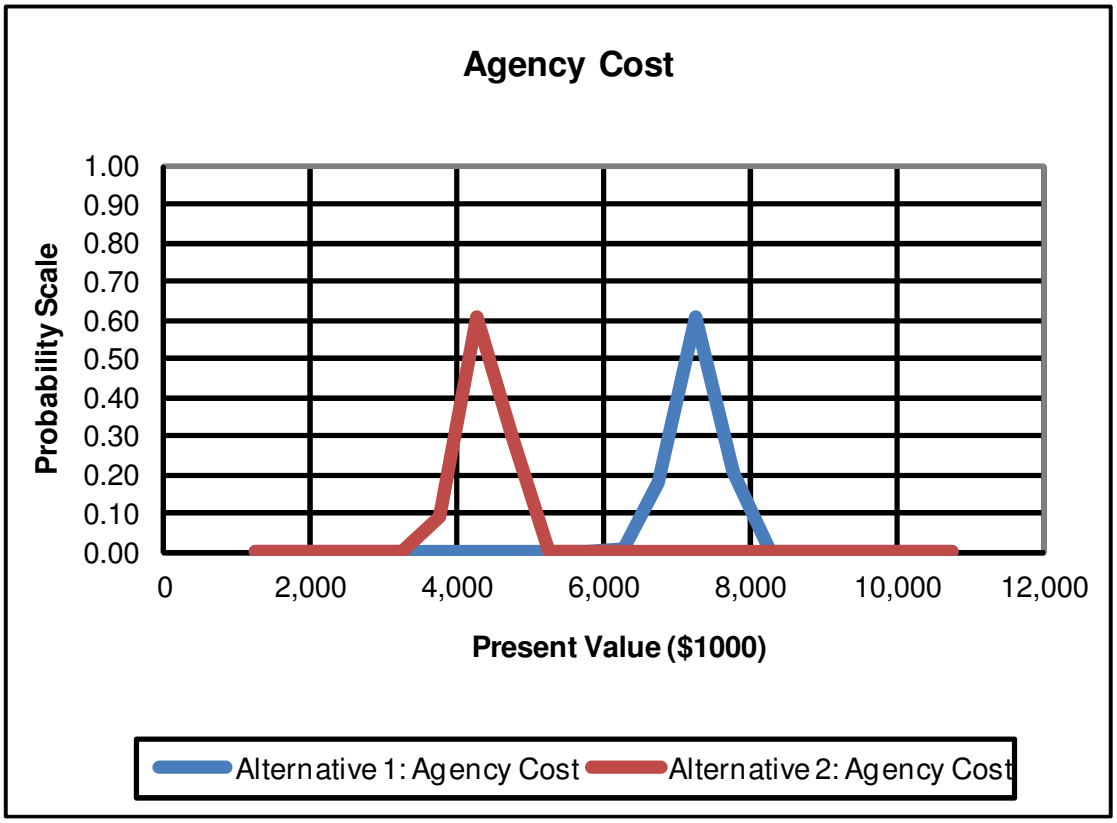
Total Cost	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Undiscounted Sum	$8,587.06	$181.15	$4,725.07	$163.40
Present Value	$7,257.95	$105.24	$4,325.92	$88.85
EUAC	$294.02	$4.26	$175.24	$3.60

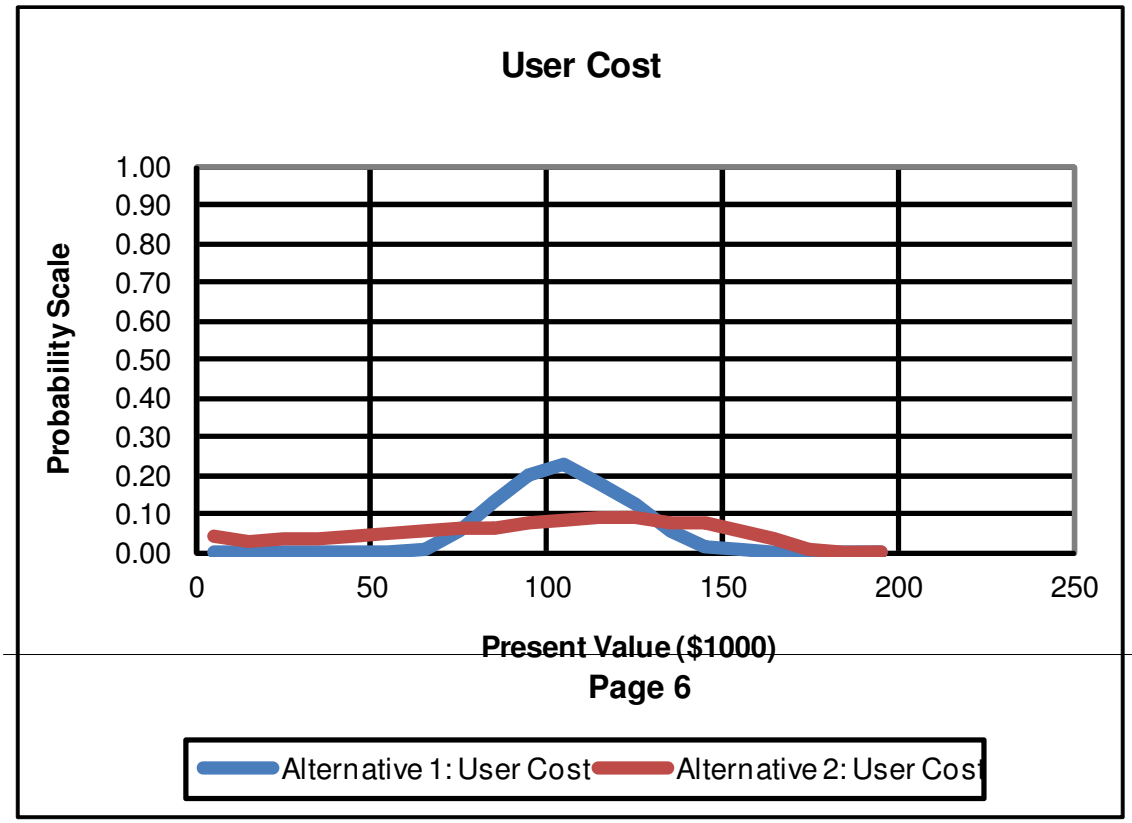


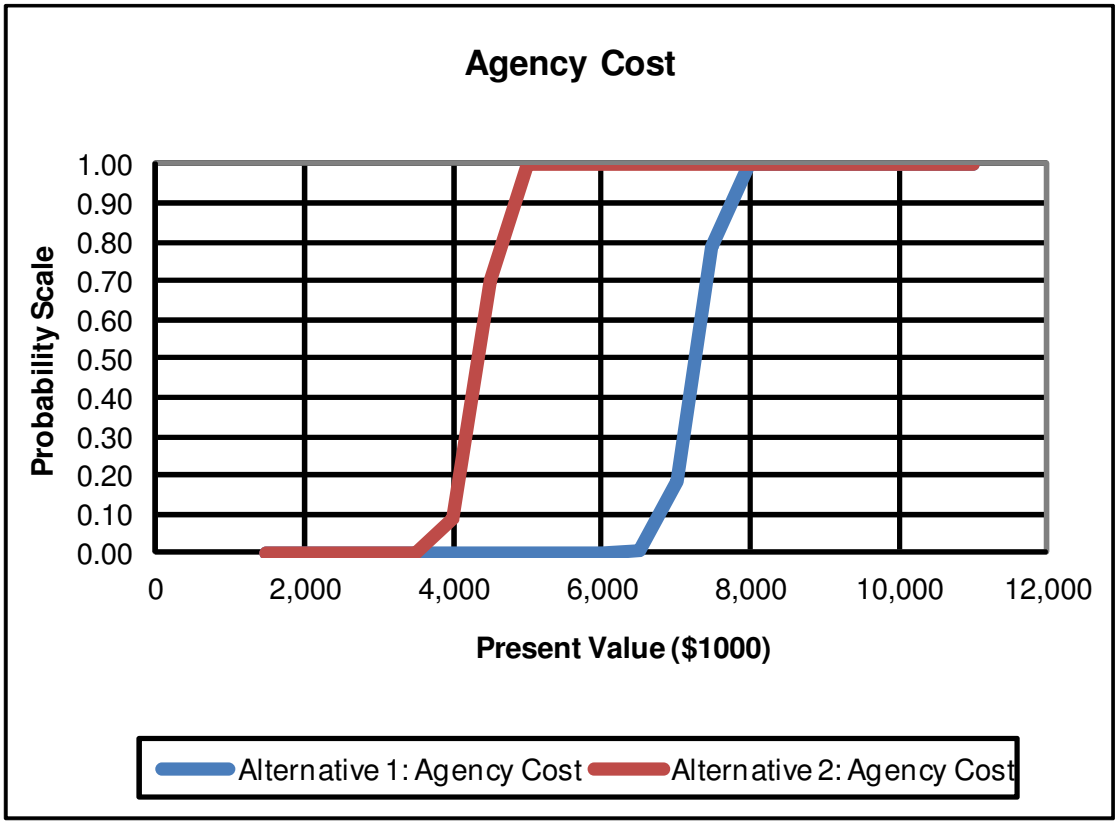


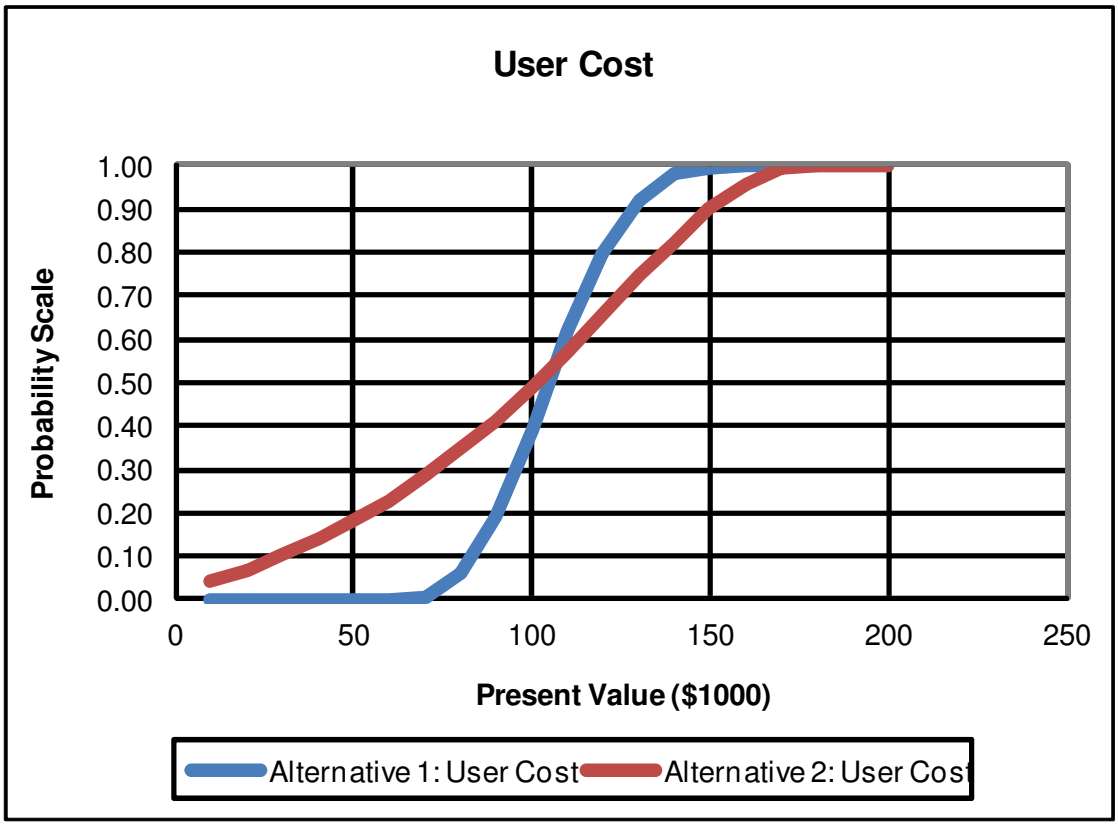
Probabilistic Results

Total Cost (Present Value)	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Mean	$7,262.81	$105.29	$4,352.76	$95.37
Standard Deviation	$291.42	$16.55	$249.41	$44.09
Minimum	$6,270.34	$62.54	$3,592.48	$0.00
Maximum	$8,123.35	$156.47	$4,991.00	$181.64

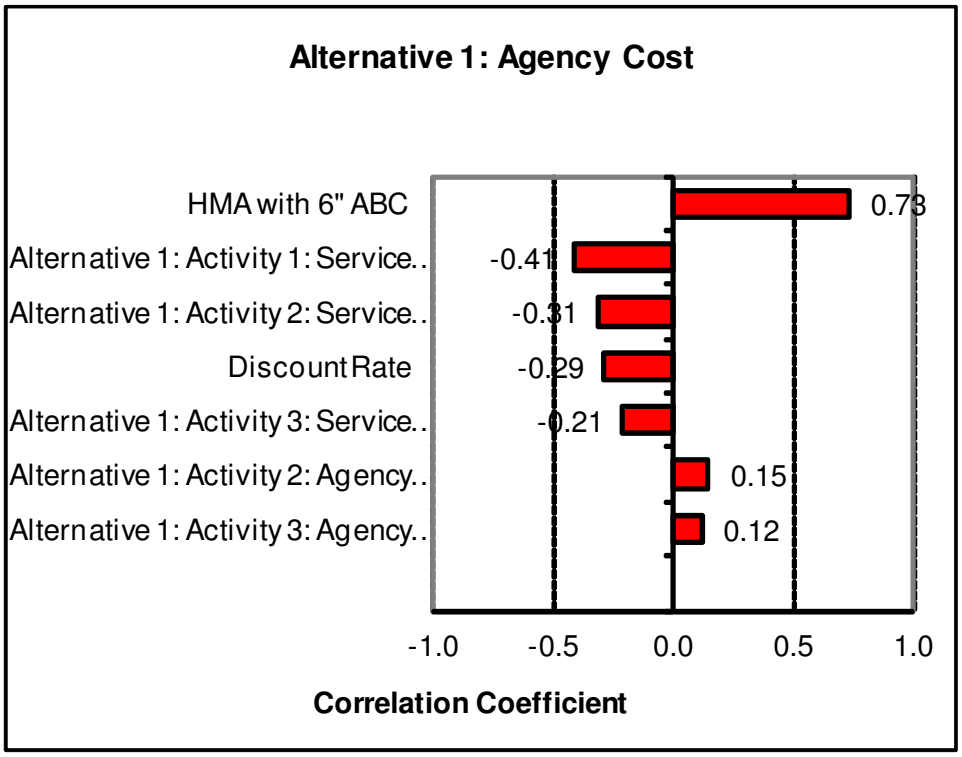


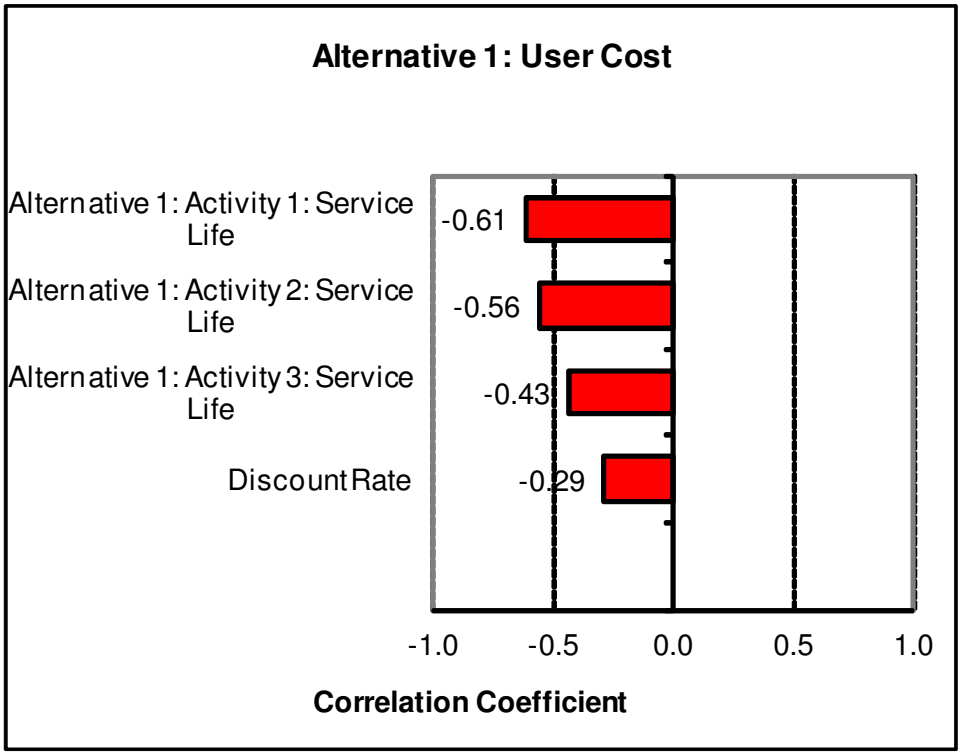


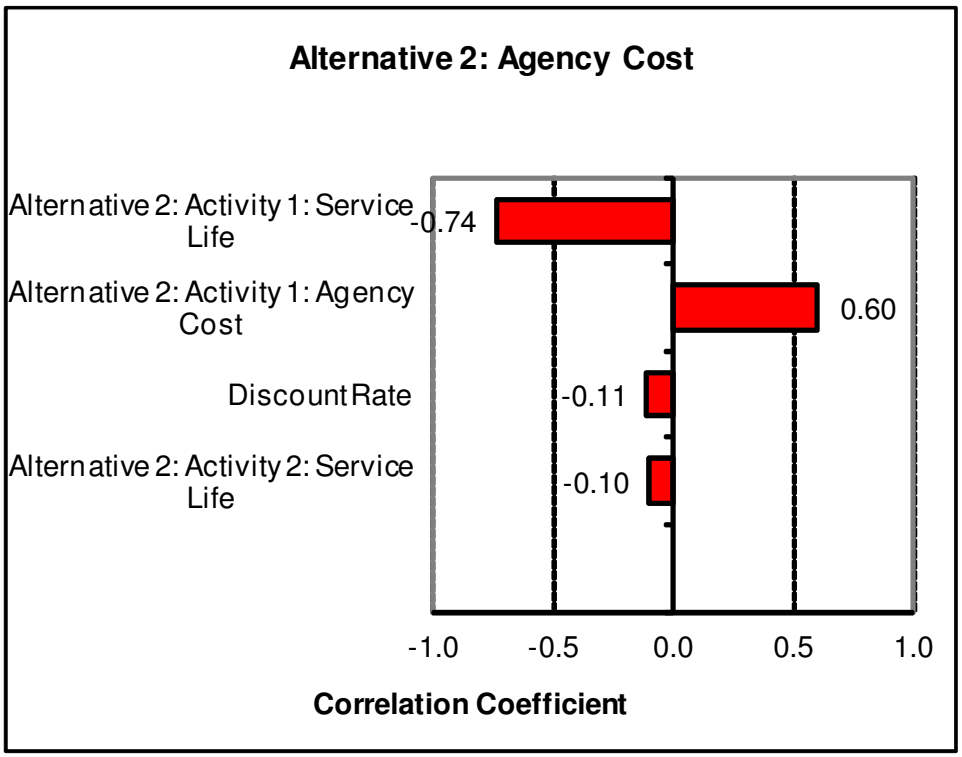

Agency Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
Present Value ($1000)
Alternative 1: Agency Cost
Alternative 2: Agency Cost

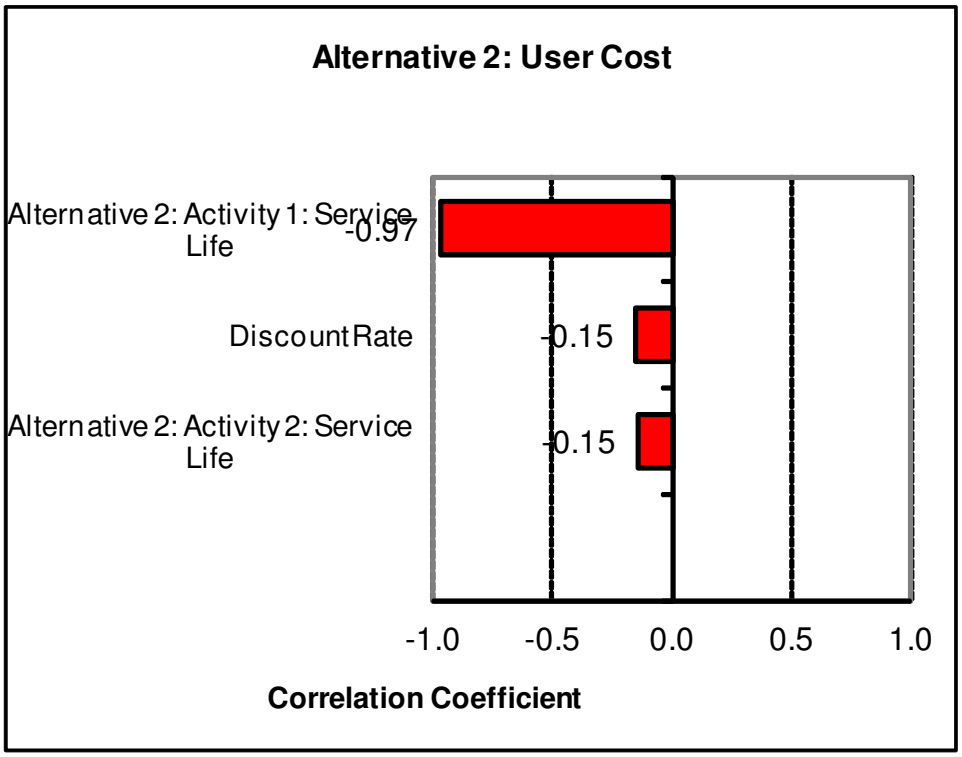

User Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
Present Value ($1000)
Alternative 1: User Cost
Alternative 2: User Cost

Tornado Graphs






Alternative 2: Agency Cost
Alternative 2: Activity 1: Service Life
Alternative 2: Activity 1: Agency Cost
Discount Rate
Alternative 2: Activity 2: Service Life
-0.74
0.60
-0.11
-0.10
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient


Alternative 2: User Cost
Alternative 2: Activity 1: Service Life
Discount Rate
Alternative 2: Activity 2: Service Life
-0.97
-0.15
-0.15
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	144399	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$36,167.48	6
403-Stone Mastic Asphalt	$37,704.80	6
TOTAL ADDL. USER COST	$73,872.28	12
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 12 DAYS = $255,863.73		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	144399	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$18,083.74	3
403-Stone Mastic Asphalt	$37,704.80	6
TOTAL ADDL. USER COST	$55,788.54	9
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 9 DAYS = $191,897.80		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	167284	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$23,373.87	3
403-Stone Mastic Asphalt	$49,299.33	6
TOTAL ADDL. USER COST	$72,673.20	9
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 9 DAYS = $222,613.06		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	167284	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$46,747.74	6
403-Stone Mastic Asphalt	$49,299.33	6
TOTAL ADDL. USER COST	$96,047.07	12
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 12 DAYS = $296,817.42		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	193681	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$70,162.41	6
403-Stone Mastic Asphalt	$122,986.68	6
TOTAL ADDL. USER COST	$193,149.09	12
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 12 DAYS = $344,204.11		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron HMA Year 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	193681	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$35,081.20	3
403-Stone Mastic Asphalt	$122,986.68	6
TOTAL ADDL. USER COST	$158,067.89	9
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 9 DAYS = $258,153.08		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron PCCP Year 2042	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	173551	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
210-Replace Concrete Pavement	$106,321.26	12
202-Removal of Concrete (Diamond Grind	$100,186.64	12
412-Routing & Sealing PCCP Cracks	$53,013.18	6
TOTAL ADDL. USER COST	$259,521.07	30
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 30 DAYS = $770,132.82		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	I-25 at Cimarron PCCP Year 2042	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	55 mph	
Workzone Speed Limit	45 mph	
Grade	2.0 %	
Work Zone Length	1.00 miles	
Total Number of Lanes	6	
Number of Open Lanes	5	
Number of Temporary Lanes	1	
AADT, Directional	173551	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Rural Interstate (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
210-Replace Concrete Pavement	$106,321.26	12
202-Removal of Concrete (Diamond Grind	$47,047.65	6
412-Routing & Sealing PCCP Cracks	$53,013.18	6
TOTAL ADDL. USER COST	$206,382.08	24
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 24 DAYS = $616,106.25		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

RealCost Input Data

1. Economic Variables	
Value of Time for Passenger Cars ($/hour)	$17.00
Value of Time for Single Unit Trucks ($/hour)	$35.00
Value of Time for Combination Trucks ($/hour)	$36.50

2. Analysis Options	
Include User Costs in Analysis	Yes
Include User Cost Remaining Life Value	Yes
Use Differential User Costs	Yes
User Cost Computation Method	Specified
Include Agency Cost Remaining Life Value	Yes
Traffic Direction	Both
Analysis Period (Years)	40
Beginning of Analysis Period	2015
Discount Rate (%)	2.6
	LCCALOGNORMAL(2.6,0.25)
Number of Alternatives	2

3. Project Details	
State Route	I-25 at US 24 (Cimarron St in Colo Spgs)
Project Name	I-25 Ramps
Region	2
County	El Paso
Analyzed By	Robert LaForce
Mileposts	
Begin	1.00
End	2.00
Length of Project (miles)	1.00
Comments	I-25 Ramps 8.5 inches PCCP with 7.5 inches HMA Both PCCP and HMA will be placed over 6 inches of ACB Class 6. The HMA layer is 2" SMA over SX(100) PG 64-22

4. Traffic Data	
AADT Construction Year (total for both directions)	9,772
Cars as Percentage of AADT (%)	91.2
Single Unit Trucks as Percentage of AADT (%)	4.1
Combination Trucks as Percentage of AADT (%)	4.7
Annual Growth Rate of Traffic (%)	1.3
Speed Limit Under Normal Operating Conditions (mph)	40
No of Lanes in Each Direction During Normal Conditions	2
Free Flow Capacity (vphpl)	2157
Rural or Urban Hourly Traffic Distribution	Urban
Queue Dissipation Capacity (vphpl)	1482
Maximum AADT (total for both directions)	310,000
Maximum Queue Length (miles)	1.0

Alternative 1	HMA Construction	
Number of Activities	4	

Activity 1	Initial Construction 7.5" S(100) & 2" SMA	
Agency Construction Cost ($1000)	$713.28 **LCCATRIANG(662.017,668.704, 809.132)**	
User Work Zone Costs ($1000)	$0.00	
Work Zone Duration (days)	24	
No of Lanes Open in Each Direction During Work Zone	2	
Activity Service Life (years)	12.0 **LCCATRIANG(9,12,15)**	
Activity Structural Life (years)	20.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$303.01 **LCCATRIANG(272.713,303.014, 333.315)**	
User Work Zone Costs ($1000)	$4.37	
Work Zone Duration (days)	3	
No of Lanes Open in Each Direction During Work Zone	1	
Activity Service Life (years)	11.3 **LCCATRIANG(8,12,14)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	30	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 3	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$303.01 **LCCATRIANG(272.713,303.014, 333.315)**	
User Work Zone Costs ($1000)	$10.16	
Work Zone Duration (days)	3	
No of Lanes Open in Each Direction During Work Zone	1	
Activity Service Life (years)	11.3 **LCCATRIANG(8,12,14)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	30	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 4	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$303.01 **LCCATRIANG(272.713,303.014, 333.315)**	
User Work Zone Costs ($1000)	$254.50	
Work Zone Duration (days)	3	
No of Lanes Open in Each Direction During Work Zone	1	
Activity Service Life (years)	11.3 **LCCATRIANG(8,12,14)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	30	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

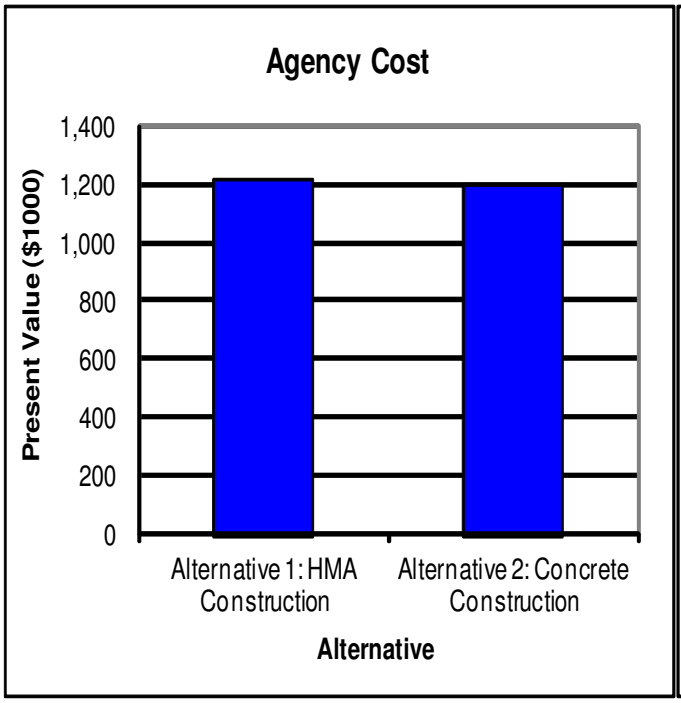
Alternative 2	Concrete Construction	
Number of Activities	2	

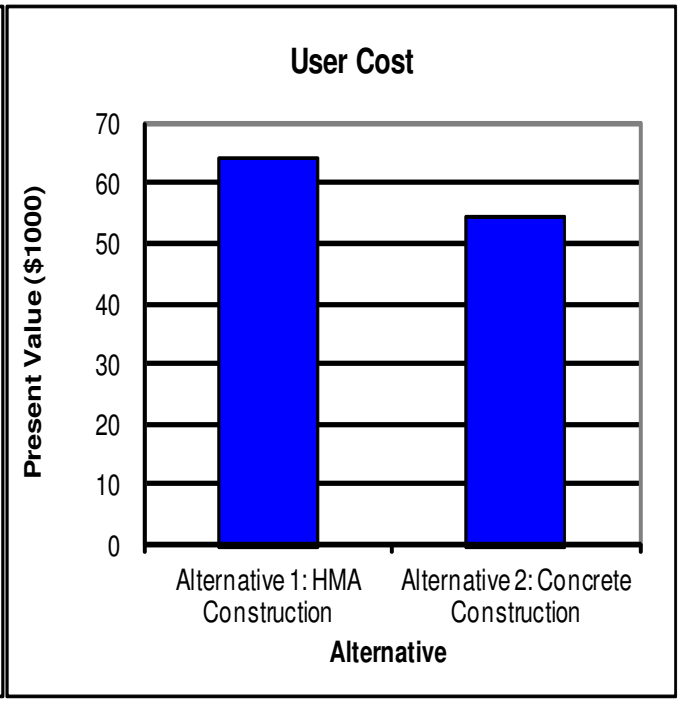
Activity 1	Initial Construction with 8.5" PCCP	
Agency Construction Cost ($1000)	$772.92 **LCCATRIANG(695.625,772.917, 850.208)**	
User Work Zone Costs ($1000)	$0.00	
Work Zone Duration (days)	36	
No of Lanes Open in Each Direction During Work Zone	2	
Activity Service Life (years)	28.7 **LCCATRIANG(16,27,43)**	
Activity Structural Life (years)	30.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	1.116	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 27 years	
Agency Construction Cost ($1000)	$1,145.88 **LCCATRIANG(1031.162,1145.736,1260.736)**	
User Work Zone Costs ($1000)	$159.20	
Work Zone Duration (days)	12	
No of Lanes Open in Each Direction During Work Zone	1	
Activity Service Life (years)	18.0 **LCCATRIANG(12,18,24)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	1.116	
Work Zone Length (miles)	1.00	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Deterministic Results

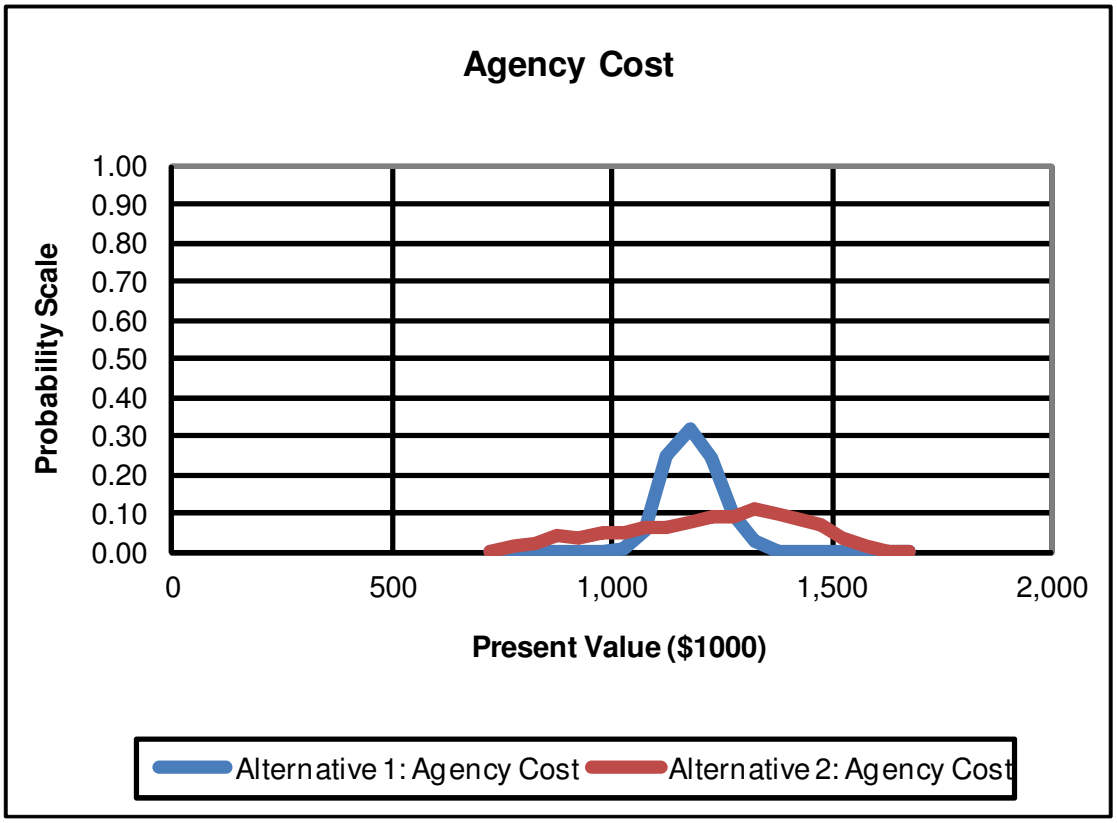
Total Cost	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Undiscounted Sum	$1,534.55	$134.30	$1,536.80	$100.24
Present Value	$1,215.49	$64.22	$1,191.86	$54.51
EUAC	$49.24	$2.60	$48.28	$2.21

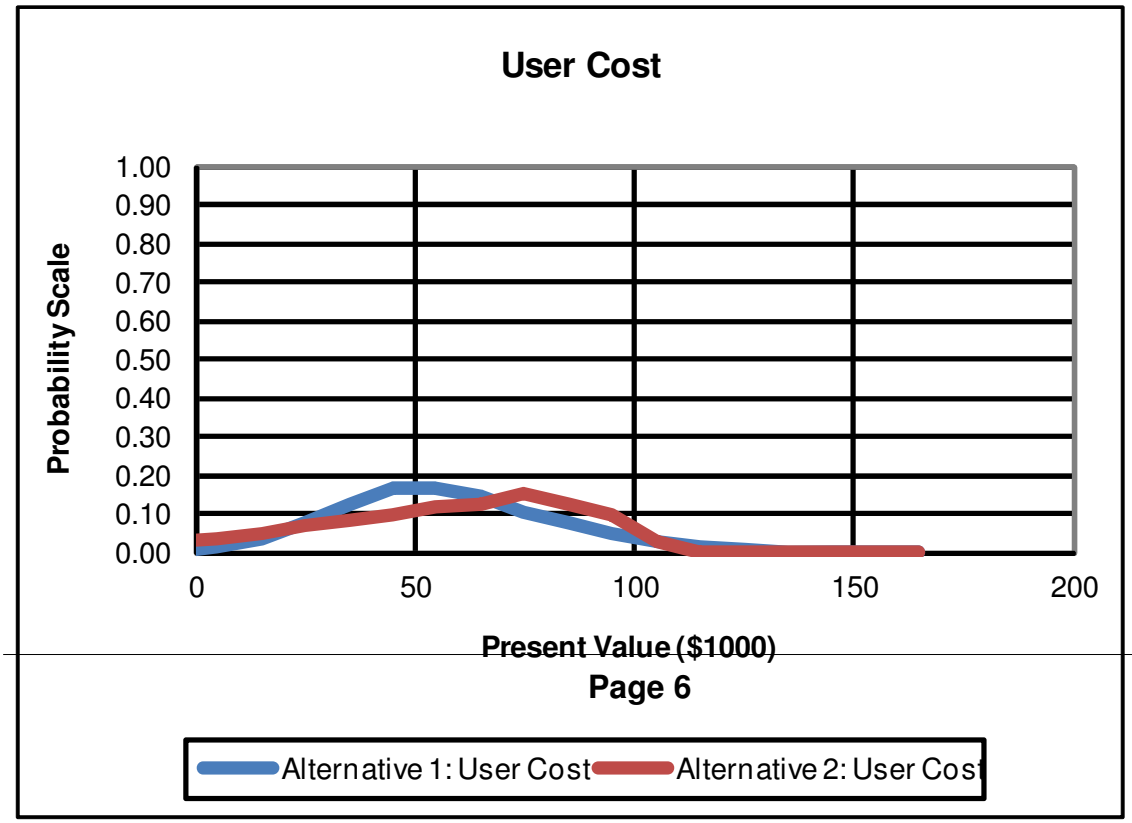


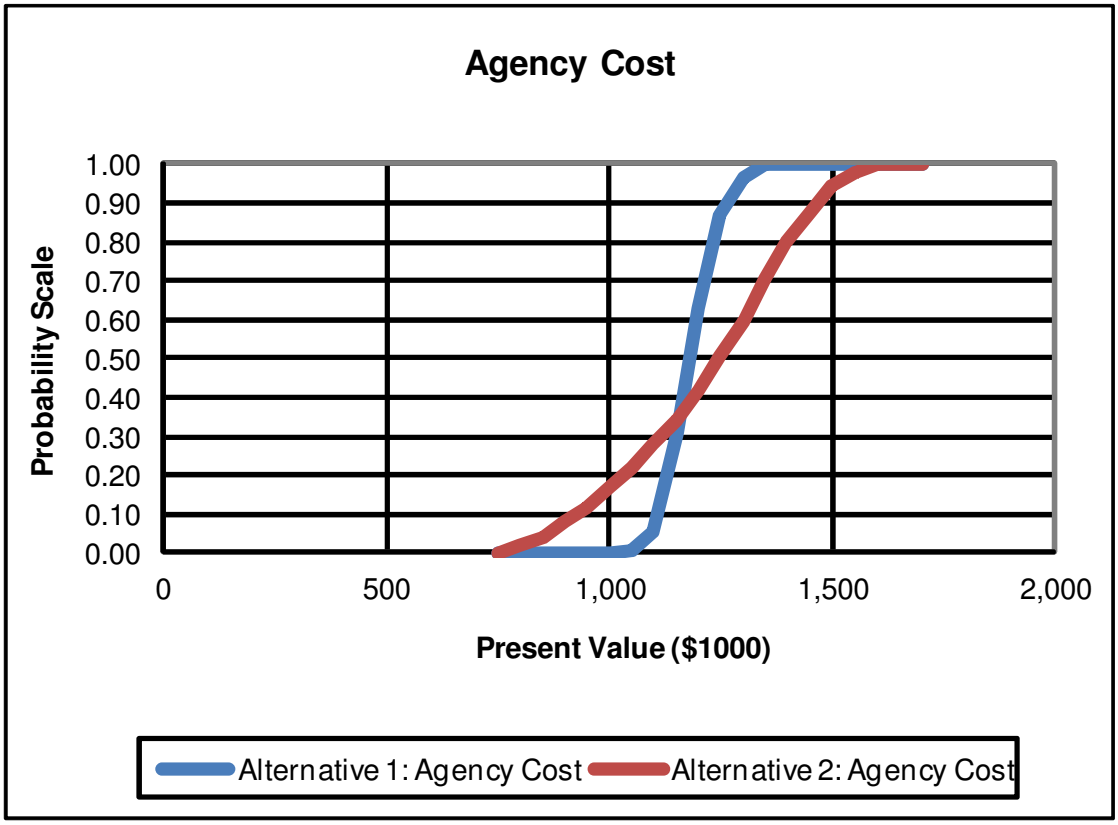


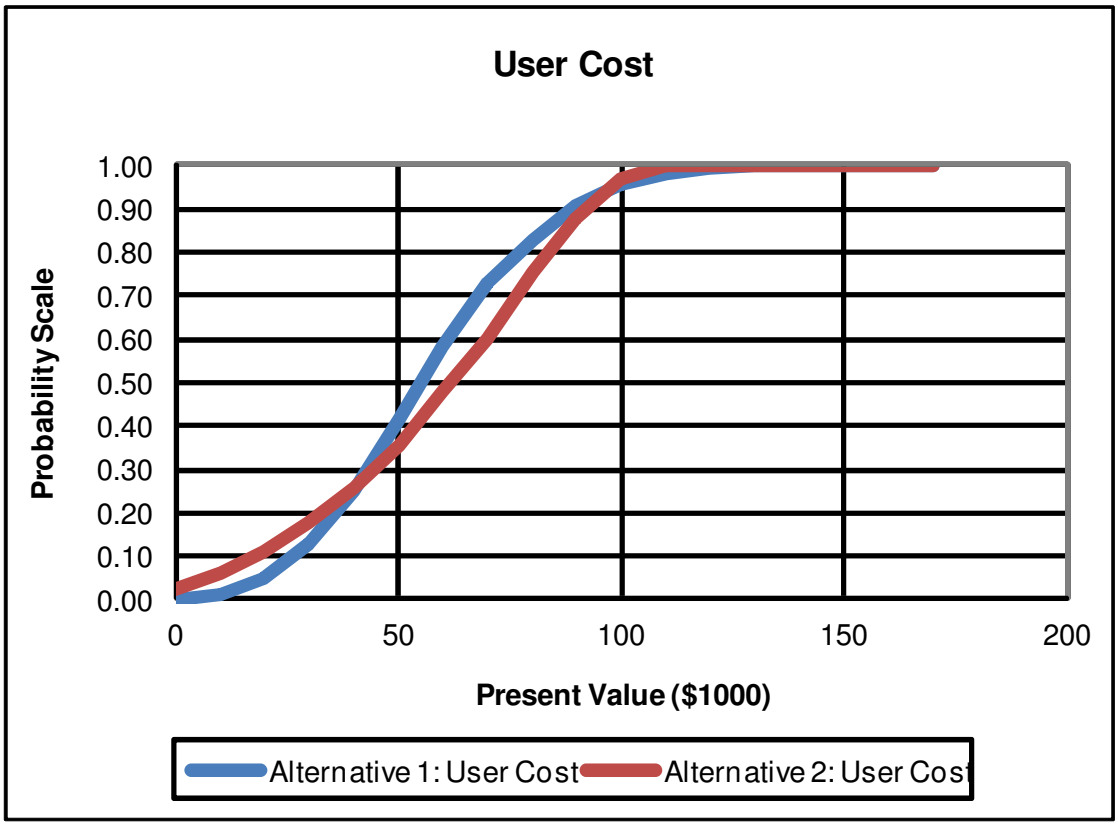
Probabilistic Results

Total Cost (Present Value)	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Mean	$1,183.14	$56.71	$1,220.23	$58.51
Standard Deviation	$57.22	$23.52	$198.12	$27.05
Minimum	$1,007.73	$6.78	$739.72	$0.00
Maximum	$1,373.47	$135.30	$1,642.15	$111.43

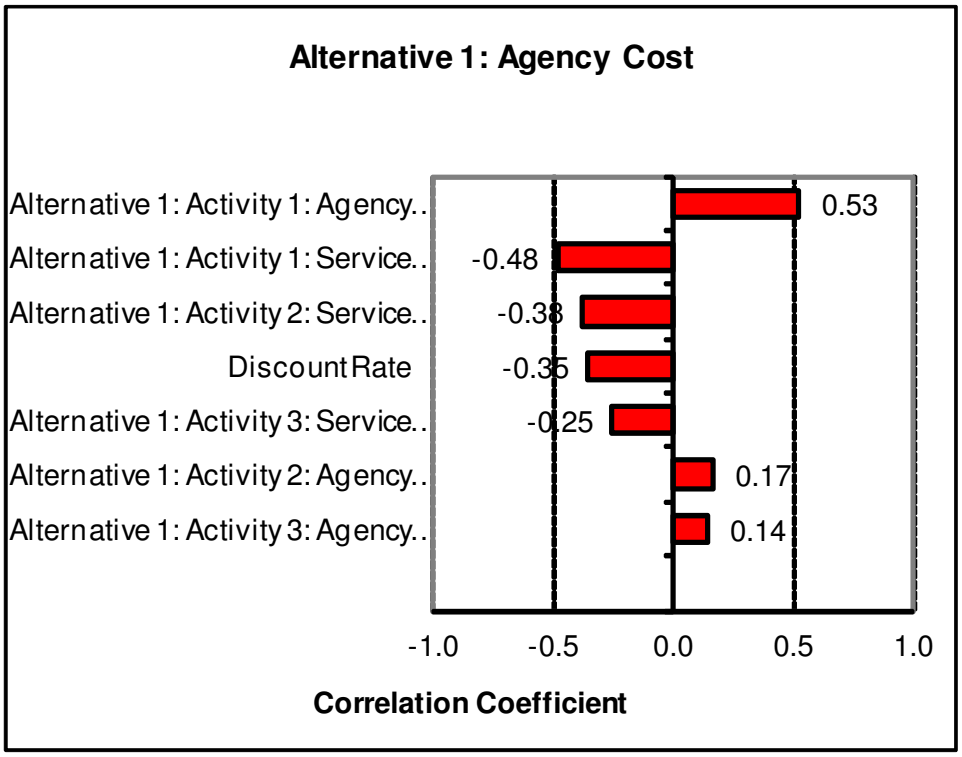


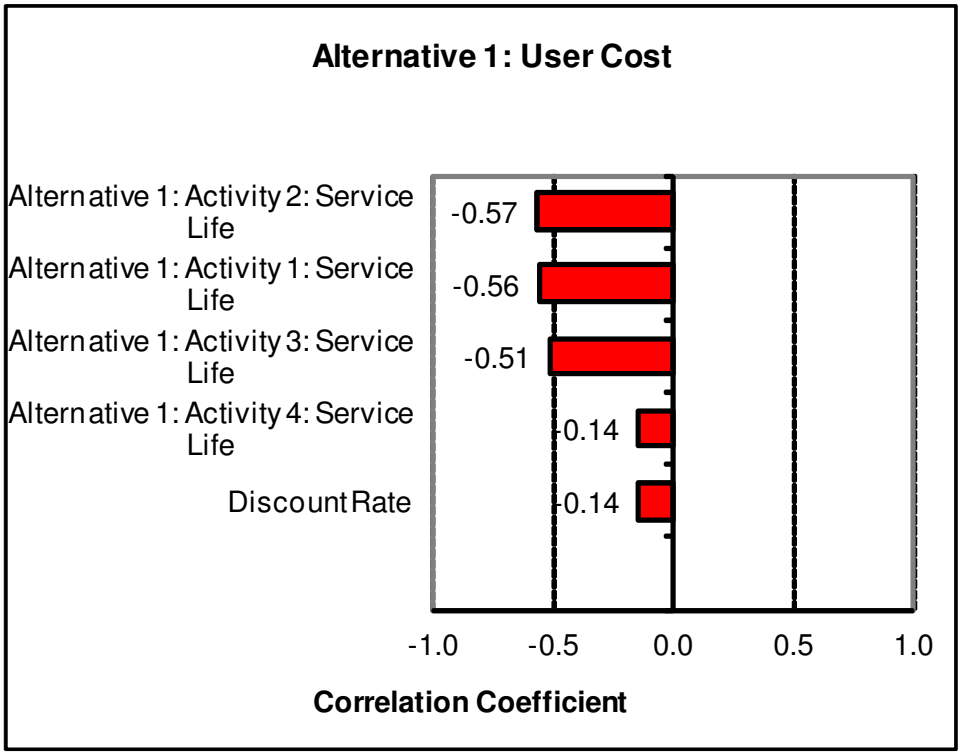


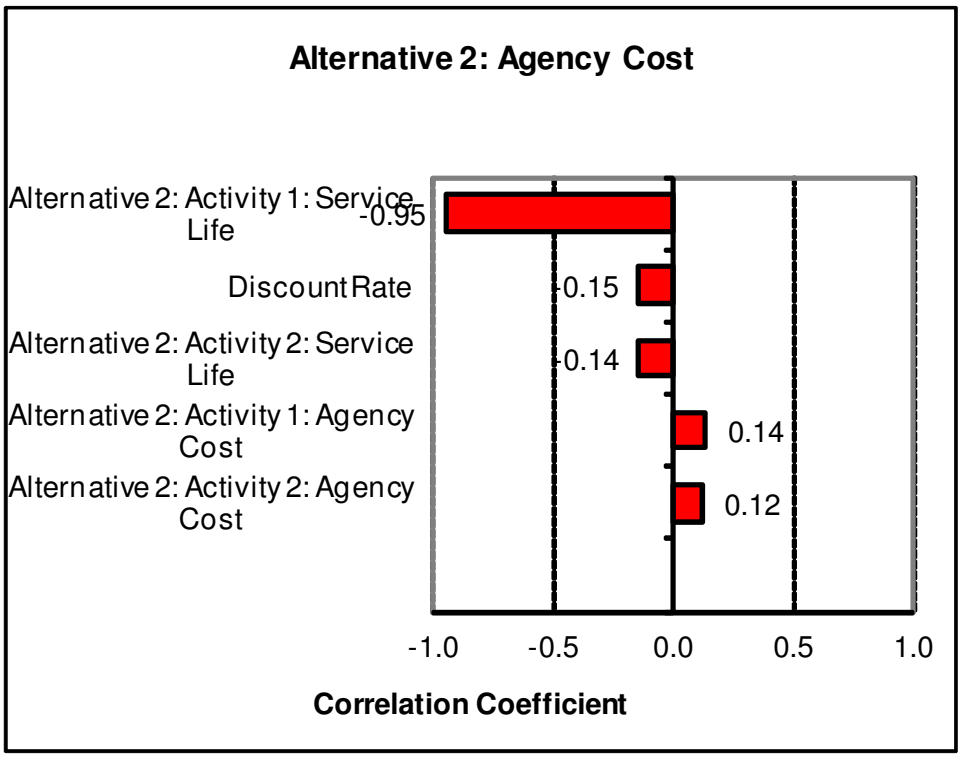

Agency Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
500
1,000
1,500
2,000
Present Value ($1000)
Alternative 1: Agency Cost
Alternative 2: Agency Cost

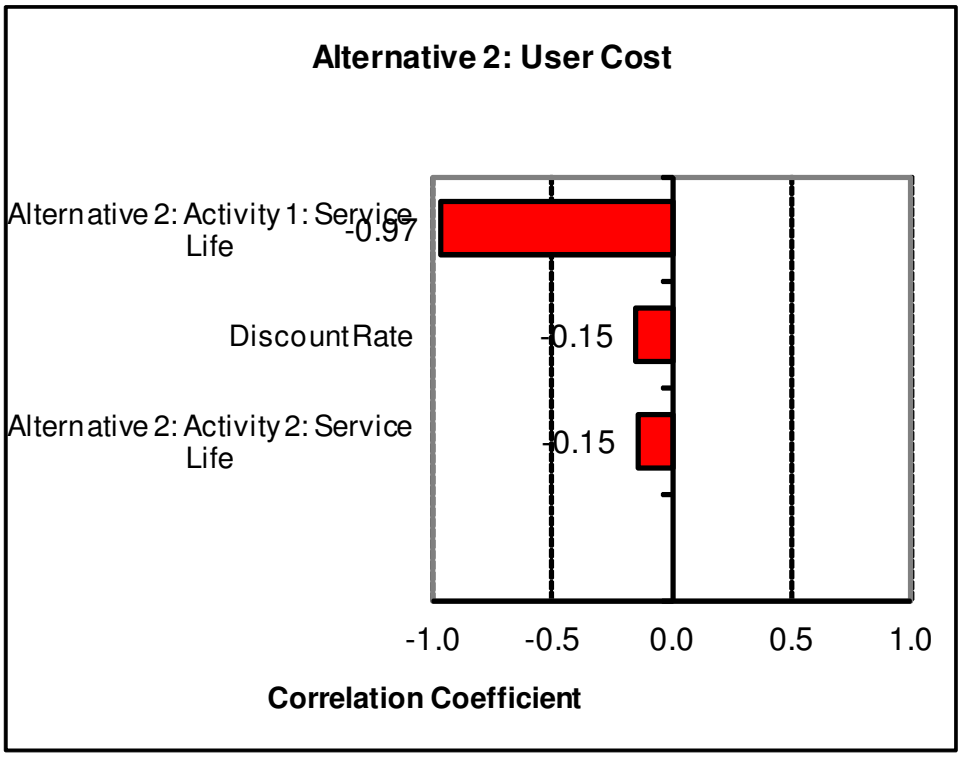

User Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
Present Value ($1000)
Alternative 1: User Cost
Alternative 2: User Cost

Tornado Graphs






Alternative 2: Agency Cost
Alternative 2: Activity 1: Service Life
-0.95
Discount Rate
-0.15
Alternative 2: Activity 2: Service Life
-0.14
Alternative 2: Activity 1: Agency Cost
0.14
Alternative 2: Activity 2: Agency Cost
0.12
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient


Alternative 2: User Cost
Alternative 2: Activity 1: Service Life
-0.97
Discount Rate
-0.15
Alternative 2: Activity 2: Service Life
-0.15
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Exit Ramp PCCP	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	36747	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
210-Replace Concrete Pavement	$45,604.23	4
412-Routing & Sealing PCCP Cracks	$22,316.23	2
202-Removal of Concrete (Diamond Grind	$11,632.19	2
TOTAL ADDL. USER COST	$79,552.65	8
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 8 DAYS = $13,126.47		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Entrance Ramp PCCP	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	21010	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
210-Replace Concrete Pavement	$3,045.90	4
412-Routing & Sealing PCCP Cracks	$1,518.71	2
202-Removal of Concrete (Diamond Grind	$1,436.05	2
TOTAL ADDL. USER COST	$6,000.66	8
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 8 DAYS = $7,456.54		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Exit Ramp PCCP	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	27625	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
210-Replace Concrete Pavement	$5,498.97	4
412-Routing & Sealing PCCP Cracks	$2,736.80	2
202-Removal of Concrete (Diamond Grind	$2,496.42	2
TOTAL ADDL. USER COST	$10,732.18	8
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 8 DAYS = $9,830.76		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Entrance Ramp PCCP	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	26752	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
210-Replace Concrete Pavement	$5,082.91	4
412-Routing & Sealing PCCP Cracks	$2,530.47	2
202-Removal of Concrete (Diamond Grind	$2,321.25	2
TOTAL ADDL. USER COST	$9,934.63	8
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 8 DAYS = $9,516.68		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Exit Ramp HMA 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	18398	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$572.58	1
403-Stone Mastic Asphalt	$267.84	0
TOTAL ADDL. USER COST	$840.42	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $815.33		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Exit Ramp HMA 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	25468	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$1,043.13	1
403-Stone Mastic Asphalt	$504.68	0
TOTAL ADDL. USER COST	$1,547.82	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,131.89		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Exit Ramp HMA 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	35255	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$3,257.77	1
403-Stone Mastic Asphalt	$3,354.26	0
TOTAL ADDL. USER COST	$6,612.03	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,573.21		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Entrance Ramp HMA 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	17520	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$529.39	1
403-Stone Mastic Asphalt	$246.79	0
TOTAL ADDL. USER COST	$776.18	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $776.14		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Entrance Ramp HMA 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	24581	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$968.98	1
403-Stone Mastic Asphalt	$466.49	0
TOTAL ADDL. USER COST	$1,435.47	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,092.08		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	NB Entrance Ramp HMA 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	34487	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$2,534.36	1
403-Stone Mastic Asphalt	$2,512.58	0
TOTAL ADDL. USER COST	$5,046.94	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,538.45		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Entrance Ramp HMA 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	16648	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$488.97	1
403-Stone Mastic Asphalt	$227.21	0
TOTAL ADDL. USER COST	$716.17	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $737.25		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Entrance Ramp HMA 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	20055	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
202-Removal of Asphalt (Planing)	$661.66	1
403-Stone Mastic Asphalt	$311.63	0
TOTAL ADDL. USER COST	$973.29	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $889.36		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Entrance Ramp HMA 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	24158	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
202-Removal of Asphalt (Planing)	$935.45	1
403-Stone Mastic Asphalt	$449.33	0
TOTAL ADDL. USER COST	$1,384.79	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,073.10		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Exit Ramp HMA 2027	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	17157	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$512.27	1
403-Stone Mastic Asphalt	$238.49	0
TOTAL ADDL. USER COST	$750.76	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $759.95		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Exit Ramp HMA 2039	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	31555	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt (Planing)	$1,742.12	1
403-Stone Mastic Asphalt	$881.16	0
TOTAL ADDL. USER COST	$2,623.28	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $1,405.94		
Disclaimer:		
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CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	SB Exit Ramp HMA 2051	
Freeway Name	I-25	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	50 mph	
Speed Limit	40 mph	
Workzone Speed Limit	30 mph	
Grade	2.0 %	
Work Zone Length	0.20 miles	
Total Number of Lanes	2	
Number of Open Lanes	1	
Number of Temporary Lanes	0	
AADT, Directional	58036	
Percentage of Single Unit Trucks	4.1 %	
Percentage of Combination Trucks	4.7 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST	DURATION
	DUE TO WORKZONE	
202-Removal of Asphalt (Planing)	$113,064.60	1
403-Stone Mastic Asphalt	$56,884.77	0
TOTAL ADDL. USER COST	$169,949.38	1
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 1 DAYS = $2,615.01		
Disclaimer:		
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RealCost Input Data

1. Economic Variables	
Value of Time for Passenger Cars ($/hour)	$17.00
Value of Time for Single Unit Trucks ($/hour)	$35.00
Value of Time for Combination Trucks ($/hour)	$36.50

2. Analysis Options	
Include User Costs in Analysis	Yes
Include User Cost Remaining Life Value	Yes
Use Differential User Costs	Yes
User Cost Computation Method	Specified
Include Agency Cost Remaining Life Value	Yes
Traffic Direction	Both
Analysis Period (Years)	40
Beginning of Analysis Period	2015
Discount Rate (%)	2.6
	LCCALOGNORMAL(2.6,0.25)
Number of Alternatives	2

3. Project Details	
State Route	US 24 Cimarron St at I-25 in Colo Spgs
Project Name	I-25 and Cimarron Interchange
Region	2
County	El Paso
Analyzed By	Robert LaForce
Mileposts	
Begin	140.50
End	141.50
Length of Project (miles)	1.00
Comments	US 24 at I-25 in Colorado Springs Three segments combined to cover west of I-25, under I-25 and east of I-25. Pavement thicknesses vary from 7.0 to 8.5 inches of HMA versus 8.5 to 9.0 inches of PCCP

4. Traffic Data	
AADT Construction Year (total for both directions)	37,541
Cars as Percentage of AADT (%)	96.1
Single Unit Trucks as Percentage of AADT (%)	3.7
Combination Trucks as Percentage of AADT (%)	0.2
Annual Growth Rate of Traffic (%)	1.3
Speed Limit Under Normal Operating Conditions (mph)	40
No of Lanes in Each Direction During Normal Conditions	2
Free Flow Capacity (vphpl)	2157
Rural or Urban Hourly Traffic Distribution	Urban
Queue Dissipation Capacity (vphpl)	1482
Maximum AADT (total for both directions)	310,000
Maximum Queue Length (miles)	1.0

Alternative 1	HMA Construction	
Number of Activities	4	

Activity 1	Initial Construction 5 to 6.5" S(100) & 2" SMA	
Agency Construction Cost ($1000)	$723.16 **LCCATRIANG(650.848,723.165, 795.481)**	
User Work Zone Costs ($1000)	$713.07	
Work Zone Duration (days)	48	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(9,12,15)**	
Activity Structural Life (years)	20.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$323.10 **LCCATRIANG(290.79,323.099,355.41)**	
User Work Zone Costs ($1000)	$32.22	
Work Zone Duration (days)	6	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(8,12,16)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 3	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$323.10 **LCCATRIANG(290.79,323.099,355.41)**	
User Work Zone Costs ($1000)	$43.40	
Work Zone Duration (days)	6	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(8,12,16)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Activity 4	Rehabilitation at 12 years (2027)	
Agency Construction Cost ($1000)	$323.10 **LCCATRIANG(290.79,323.099,355.41)**	
User Work Zone Costs ($1000)	$60.79	
Work Zone Duration (days)	6	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	12.0 **LCCATRIANG(8,12,16)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	2.018	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

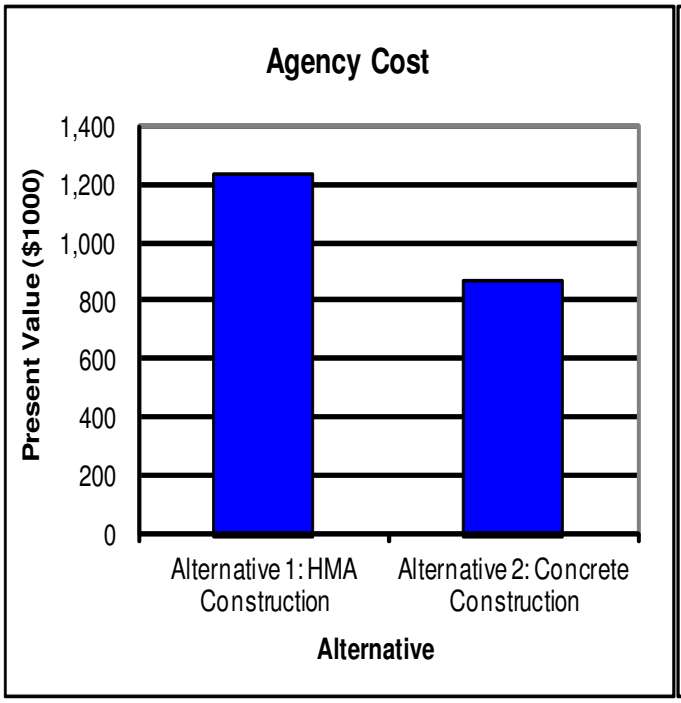
Alternative 2	Concrete Construction	
Number of Activities	2	

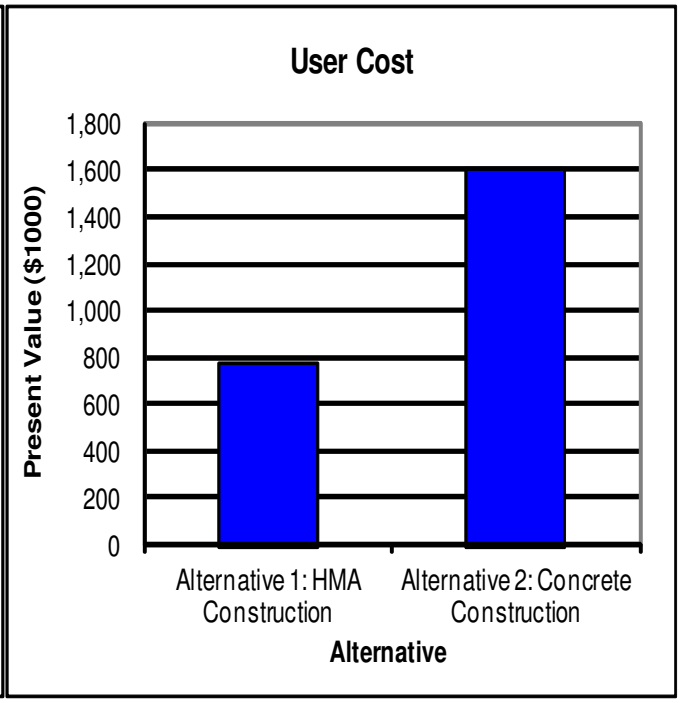
Activity 1	Initial Construction with 8.5" to 9.0" PCCP	
Agency Construction Cost ($1000)	$832.98 **LCCATRIANG(749.682,832.98,916.278)**	
User Work Zone Costs ($1000)	$1,211.34	
Work Zone Duration (days)	25	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	28.7 **LCCATRIANG(16,27,43)**	
Activity Structural Life (years)	30.0	
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	1.191	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24
Outbound	Start	End
First period of lane closure	0	24
Second period of lane closure	0	24
Third period of lane closure	0	24

Activity 2	Rehabilitation at 27 years	
Agency Construction Cost ($1000)	$21.70 **LCCATRIANG(19.53,21.7,23.87)**	
User Work Zone Costs ($1000)	$1,145.74	
Work Zone Duration (days)	12	
No of Lanes Open in Each Direction During Work Zone	3	
Activity Service Life (years)	18.0 **LCCATRIANG(12,18,24)**	
Activity Structural Life (years)		
Maintenance Frequency (years)	1	
Agency Maintenance Cost ($1000)	1.191	
Work Zone Length (miles)	0.70	
Work Zone Speed Limit (mph)	40	
Work Zone Capacity (vphpl)	1450	
Traffic Hourly Distribution	Week Day 1	
Time of Day of Lane Closures (use whole numbers based on a 24-hour clock)		
Inbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5
Outbound	Start	End
First period of lane closure	21	5
Second period of lane closure	21	5
Third period of lane closure	21	5

Deterministic Results

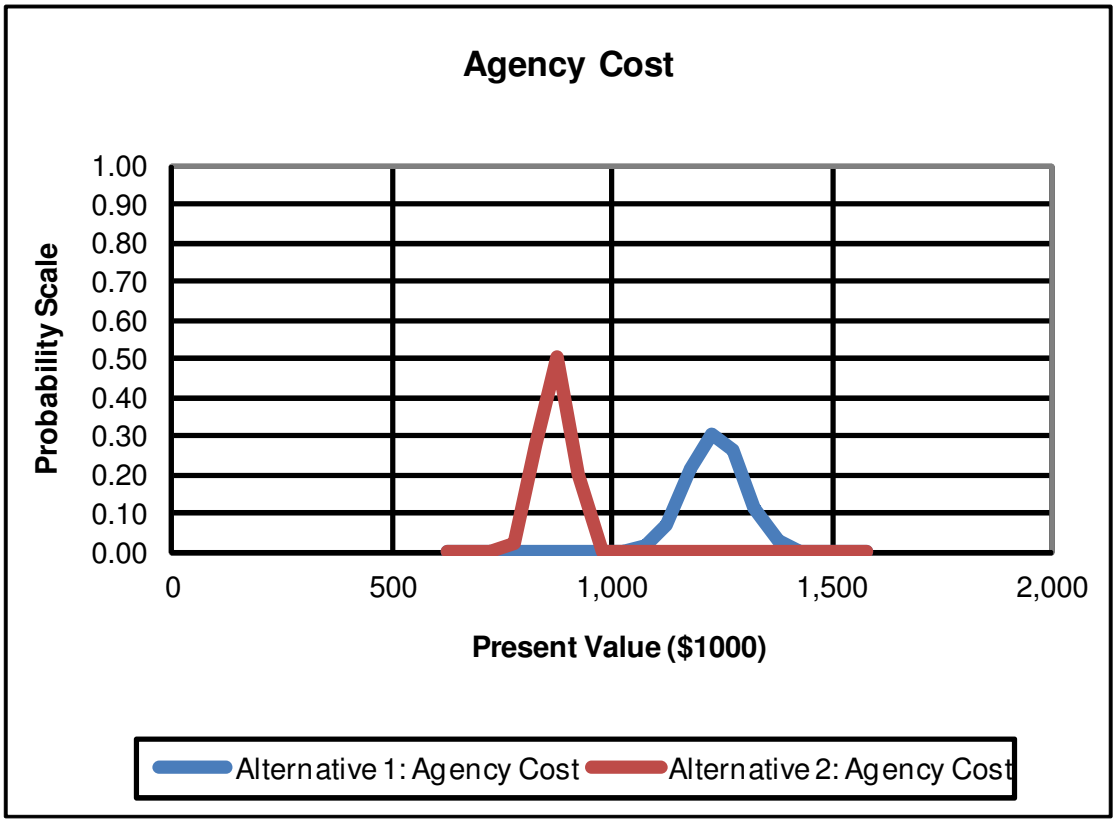
Total Cost	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Undiscounted Sum	$1,549.71	$808.95	$891.90	$1,932.73
Present Value	$1,231.92	$769.80	$868.82	$1,603.61
EUAC	$49.91	$31.18	$35.20	$64.96

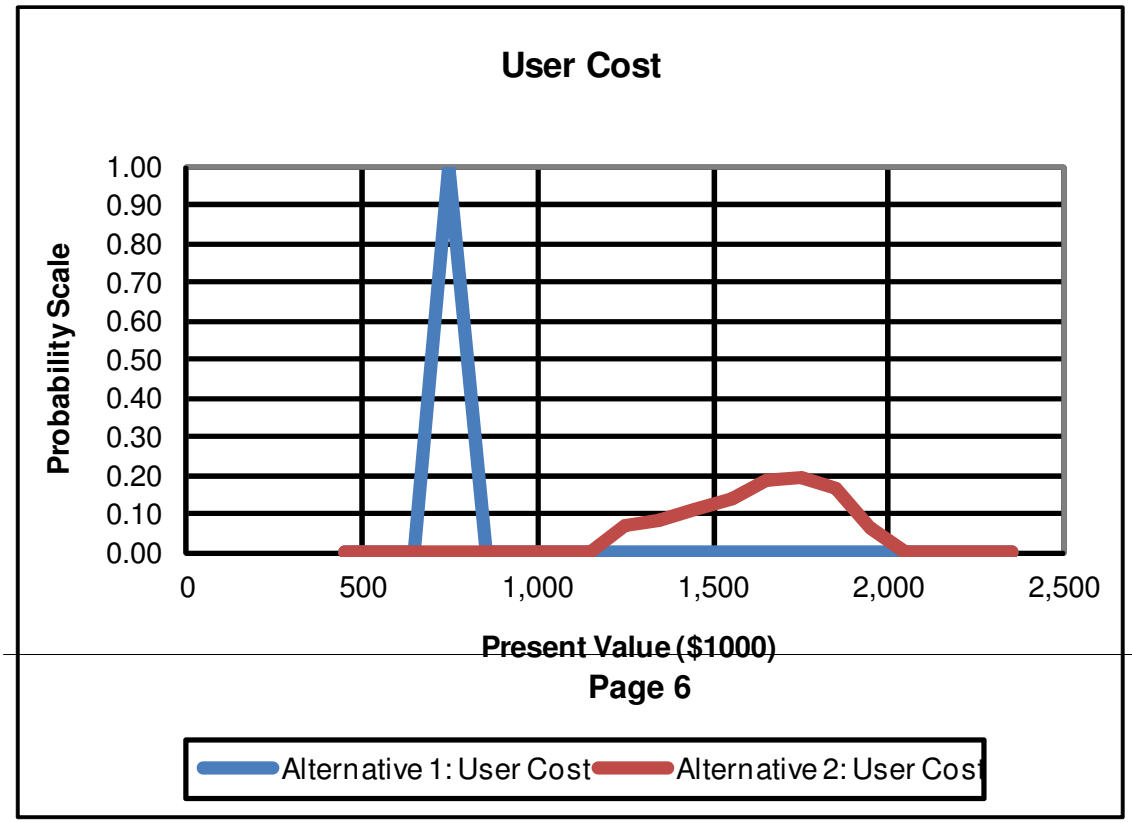


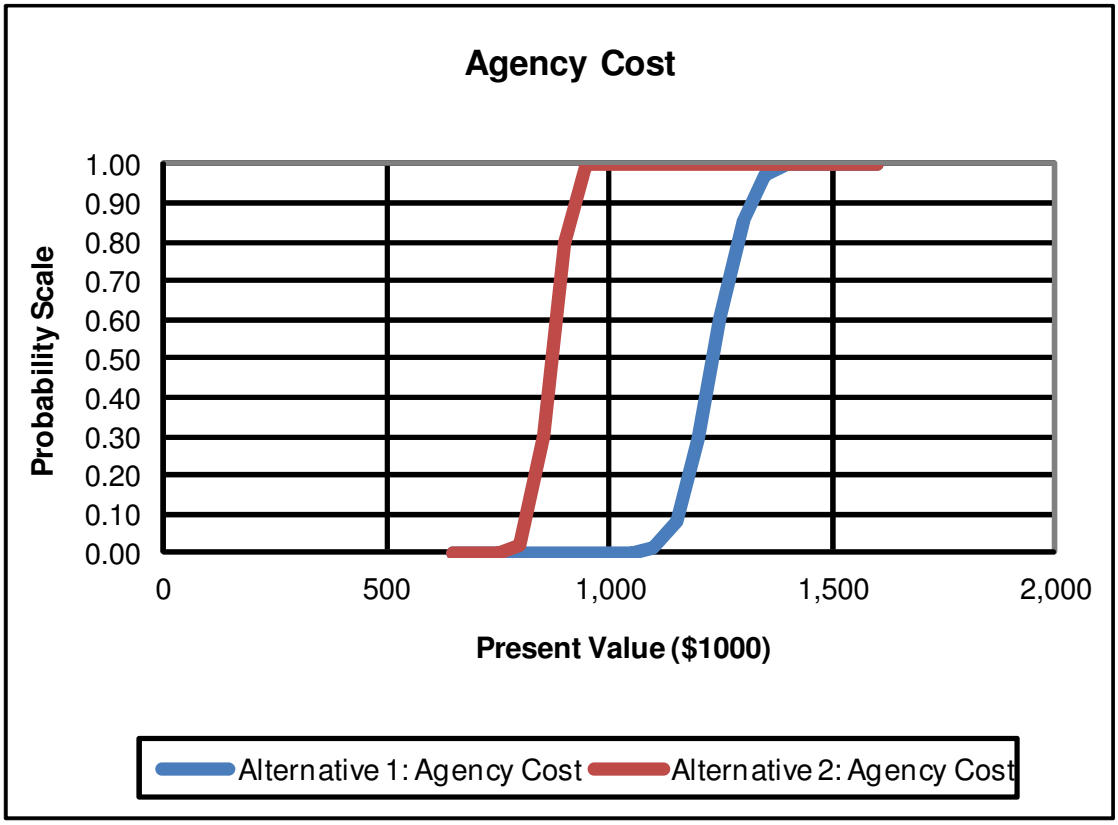


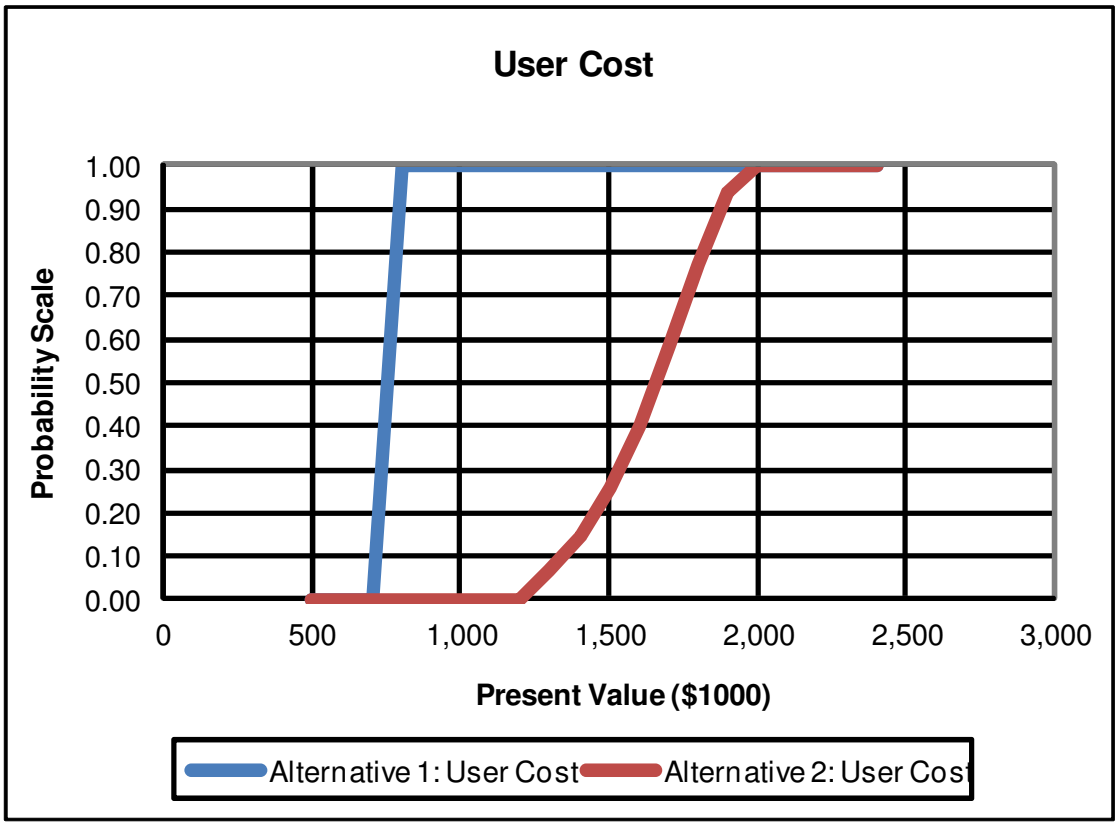
Probabilistic Results

Total Cost (Present Value)	Alternative 1: HMA Construction		Alternative 2: Concrete Construction	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Mean	$1,233.39	$769.96	$868.93	$1,632.39
Standard Deviation	$60.83	$8.20	$34.60	$194.64
Minimum	$1,027.38	$748.32	$784.44	$1,211.34
Maximum	$1,417.80	$796.29	$950.16	$2,013.27

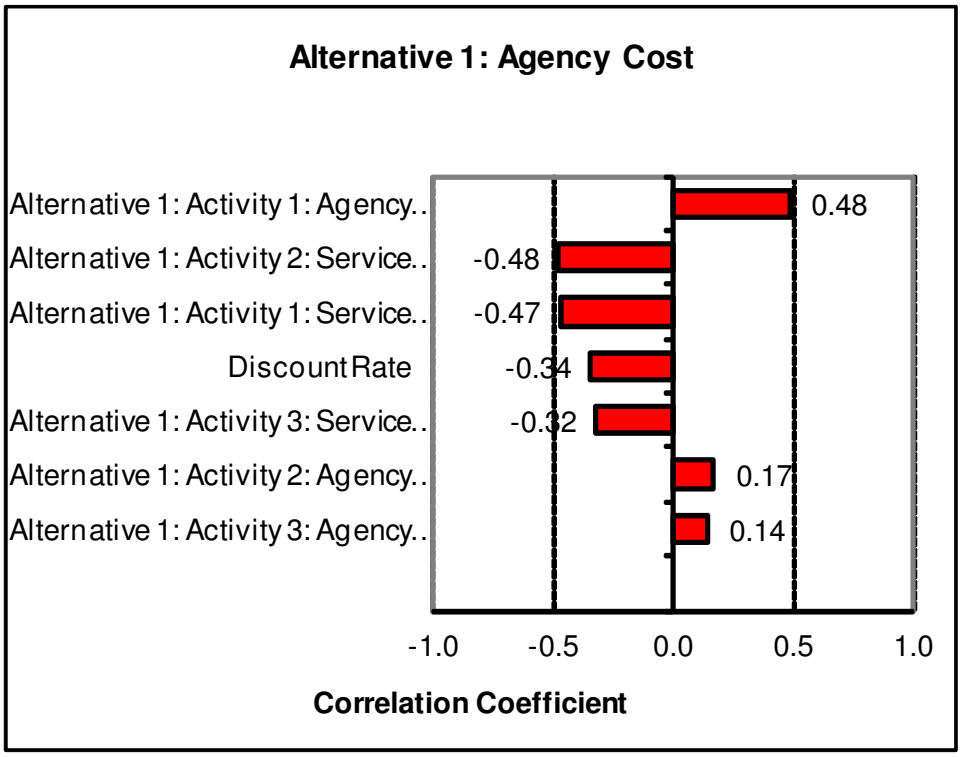


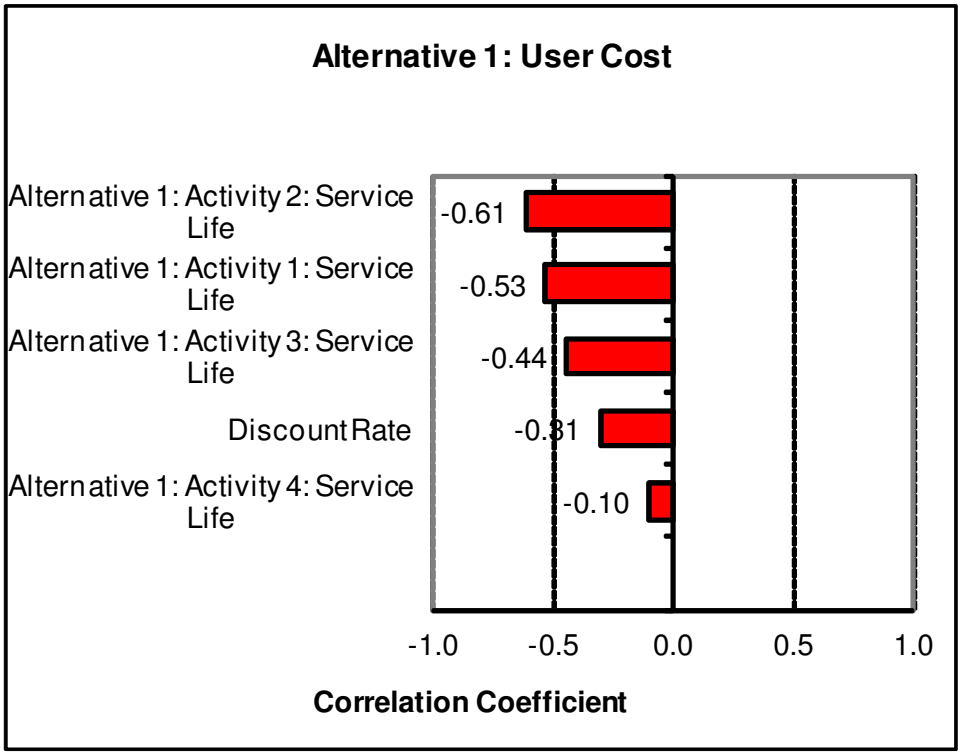


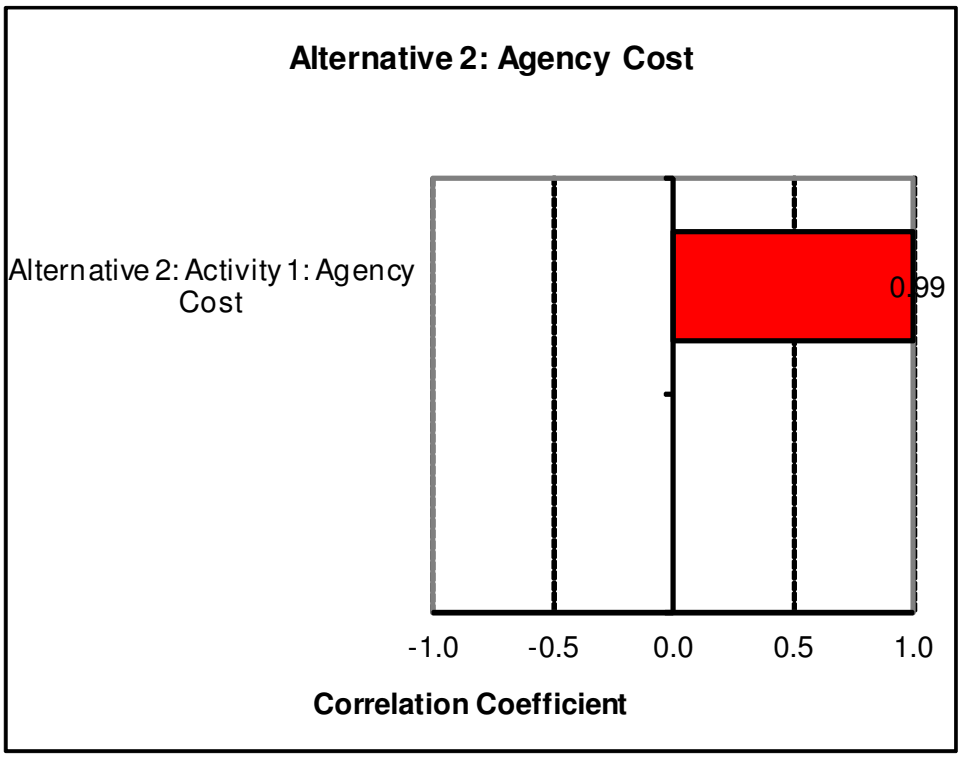

Agency Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
500
1,000
1,500
2,000
Present Value ($1000)
Alternative 1: Agency Cost
Alternative 2: Agency Cost

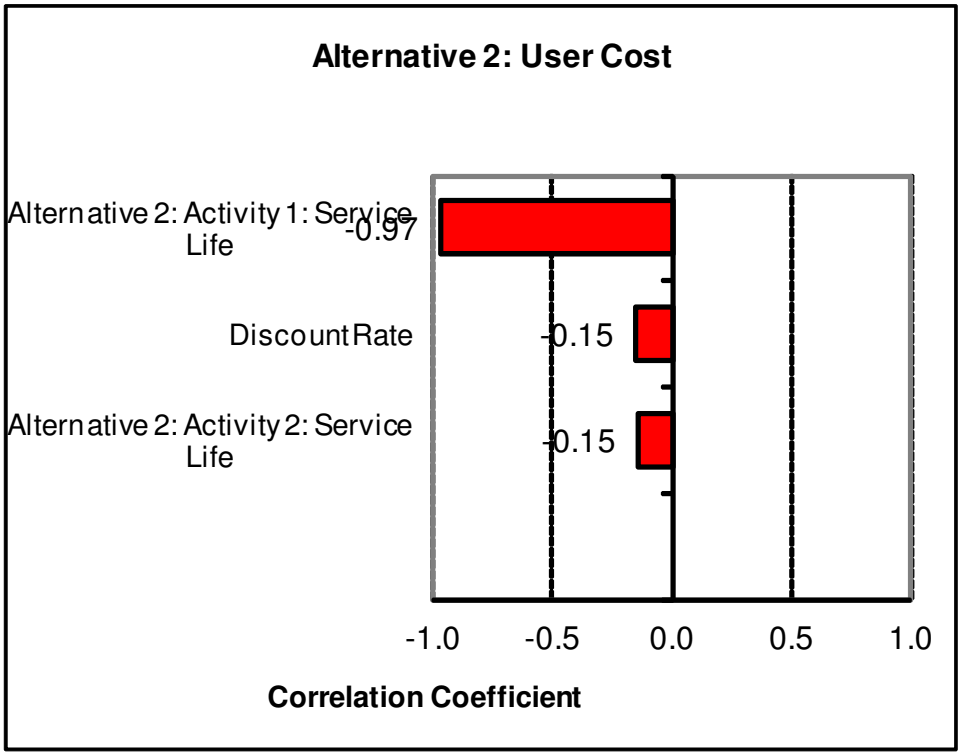

User Cost
Probability Scale
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
500
1,000
1,500
2,000
2,500
3,000
Present Value ($1000)
Alternative 1: User Cost
Alternative 2: User Cost

Tornado Graphs






Alternative 2: Agency Cost
Alternative 2: Activity 1: Agency Cost
0.99
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient


Alternative 2: User Cost
Alternative 2: Activity 1: Service Life
-0.97
Discount Rate
-0.15
Alternative 2: Activity 2: Service Life
-0.15
-1.0
-0.5
0.0
0.5
1.0
Correlation Coefficient

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	US 24 Under I-25 Initial Construction PCCP	
Freeway Name	US 24	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	45 mph	
Workzone Speed Limit	25 mph	
Grade	2.0 %	
Work Zone Length	0.50 miles	
Total Number of Lanes	4	
Number of Open Lanes	2	
Number of Temporary Lanes	1	
AADT, Directional	37541	
Percentage of Single Unit Trucks	3.7 %	
Percentage of Combination Trucks	0.2 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt	$41,522.57	2
203-Unclassified Excavation (C.I.P.)	$40,539.95	2
203-Embankment Material (C.I.P.)	$20,269.97	1
304-Aggregate Base Course	$59,582.89	3
412-Concrete Pavement <= 6.0 inch	$238,331.57	12
TOTAL ADDL. USER COST	$400,246.96	20
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 20 DAYS = $350,994.90		
Disclaimer:		
The values presented in this program are intended to provide guidelines only.		
Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	US 24 Under I-25 Initial Construction PCCP	
Freeway Name	US 24	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	45 mph	
Workzone Speed Limit	25 mph	
Grade	2.0 %	
Work Zone Length	0.50 miles	
Total Number of Lanes	4	
Number of Open Lanes	2	
Number of Temporary Lanes	1	
AADT, Directional	50300	
Percentage of Single Unit Trucks	3.7 %	
Percentage of Combination Trucks	0.2 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt	$123,311.26	2
203-Unclassified Excavation (C.I.P.)	$90,096.69	2
203-Embankment Material (C.I.P.)	$45,048.35	1
304-Aggregate Base Course	$110,526.74	3
412-Concrete Pavement <= 6.0 inch	$442,106.94	12
TOTAL ADDL. USER COST	$811,089.98	20
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 20 DAYS = $472,261.89		
Disclaimer:		
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Engineering judgement must be applied to use these values.		
No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	US 24 Under I-25 Initial Construction HMA	
Freeway Name	US 24	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	45 mph	
Workzone Speed Limit	25 mph	
Grade	2.0 %	
Work Zone Length	0.50 miles	
Total Number of Lanes	4	
Number of Open Lanes	2	
Number of Temporary Lanes	1	
AADT, Directional	37541	
Percentage of Single Unit Trucks	3.7 %	
Percentage of Combination Trucks	0.2 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt	$41,522.57	2
203-Unclassified Excavation (C.I.P.)	$40,539.95	2
203-Embankment Material (C.I.P.)	$20,269.97	1
304-Aggregate Base Course	$59,582.89	3
403-HBP (Asphalt) <= 3.0 inch	$39,931.27	2
403-Stone Mastic Asphalt	$20,241.25	1
TOTAL ADDL. USER COST	$222,087.91	11
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 11 DAYS = $193,047.20		
Disclaimer:		
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No one but the user can assure that these results are properly applied.		

CDOT REPORT - Summary Input and Output for the Single Lane Closure Strategy

	INPUT DATA	
Project Name	US 24 Under I-25 Initial Construction HMA	
Freeway Name	US 24	
Input Filename		
Project Start Date		
Project End Date		
Design Speed	65 mph	
Speed Limit	45 mph	
Workzone Speed Limit	25 mph	
Grade	2.0 %	
Work Zone Length	0.50 miles	
Total Number of Lanes	4	
Number of Open Lanes	2	
Number of Temporary Lanes	1	
AADT, Directional	50300	
Percentage of Single Unit Trucks	3.7 %	
Percentage of Combination Trucks	0.2 %	
Functional Class	Urban Principal Arterial (Weekday)	
	OUTPUT SUMMARY	
TYPE OF WORK	ADDITIONAL USER COST DUE TO WORKZONE	DURATION
202-Removal of Asphalt	$123,311.26	2
203-Unclassified Excavation (C.I.P.)	$90,096.69	2
203-Embankment Material (C.I.P.)	$45,048.35	1
304-Aggregate Base Course	$110,526.74	3
403-HBP (Asphalt) <= 3.0 inch	$77,950.41	2
403-Stone Mastic Asphalt	$44,048.47	1
TOTAL ADDL. USER COST	$490,981.92	11
TOTAL USER COST FOR NORMAL CONDITION (WITH NO WORKZONE)		
FOR A DURATION OF 11 DAYS = $259,744.04		
Disclaimer:		
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