MEMORANDUM

MATERIALS AND GEOTECHNICAL BRANCH
GEOTECHNICAL PROGRAM
4670 HOLLY STREET, UNIT A, DENVER, COLORADO 80216 303-398-6512 FAX 303-398-6504

IM C040-029
I-25 over Black Squirrel Creek / MP 153.95
SA 17354

TO: An Tran, Staff Bridge

FROM: Richard M. Wenzel III, Geotechnical Program

DATE: September 04, 2012

SUBJECT: **FINAL GEOTECHNICAL RECOMMENDATIONS FOR WIDENING OR REPLACEMENT OF BRIDGE STRUCTURES H-17-J AND H-17-L, I-25 OVER BLACK SQUIRREL CREEK, MP 153.9**

1.0 INTRODUCTION

This report presents the final geotechnical exploration observations and foundation recommendations for the widening or replacement of bridge structures H-17-J and H-17-L, which carry both I-25 northbound and southbound over Black Squirrel Creek approximately 12 miles north of Colorado Springs, Colorado. Preliminary geotechnical recommendations were provided in our memorandum titled "*Preliminary Geotechnical Recommendations for Bridge Structures H-17-J and H-17-L, I-25 over Black Squirrel Creek / MP 153.9*" submitted on March 01, 2012. The purpose of the geotechnical exploration was to determine the geotechnical profile and characterize the physical properties of the foundation materials at the proposed structure location. The scope of work was based on information obtained from John Deland of Staff Bridge in his foundation investigation request dated February 06, 2012, and subsequent conversations regarding this project.

1.1 PROJECT DESCRIPTION

This project will consist of either widening or replacing existing bridge structures H-17-J and H-17-L. At the time this report was prepared new structure numbers were not available. Both existing structures are located at Mile Post 153.9 on I-25. Structure H-17-J carries northbound I-25 over Black Squirrel Creek while structure H-17-L carries southbound I-25 over the same feature. Both structures were built in 1954 and consist of two-lane, three-span, steel girder bridges supported on HP 10 x 42 steel H piles at the abutments and concrete columns on spread footings at the piers. In 1976 each structure was widened; H-17-J to the east and H-17-L to the west, with the piers and abutments supported on HP 10 x 42 steel H piles. Structure H-17-J is 103.7 feet long and 45.2 feet wide out to out. Structure H-17-L is 103.8 feet long and 45.2 feet wide out to out. Both structures have a concrete deck overlain with asphalt. The type of replacement structure, if replacement is chosen, was not determined at the time this report was prepared but we understand the widening or replacement of the existing structures will be completed using the design-build process.

1.2 SITE DESCRIPTION

The site is located in a perennial drainage with alluvial materials encountered above sedimentary bedrock. The topography of the site is relatively flat but drains to the west. Water was observed in the main channel at the time of drilling. Native grasses and other low-lying vegetation line the drainage channel.

2.0 GEOTECHNICAL INVESTIGATION

Geotechnical field activities were completed between February 14, 2012 and February 16, 2012. Six borings were advanced with a CME 55/300 all-terrain tracked drill rig using hollow stem auger techniques at or near locations recommended by John Deland of Staff Bridge. Three borings were drilled on the east side of existing structure H-17-J; one east of each abutment and one east of pier 2. Three borings were also drilled on the west side of existing structure H-17-L; one west of each abutment and one west of pier 3. Boring locations and elevations were then surveyed by a representative of the Farnsworth Group, Inc. Boring locations are shown in Attachment 1, Engineering Geology sheet. Standard penetration tests using a split spoon sampler were performed in each boring at select intervals in general accordance with ASTM D-l586. Piezometers were installed in borings B2, B3, B5 and B6 to obtain future groundwater measurements.

All soil and bedrock samples collected were visually classified and the subsurface conditions documented on field boring logs. Final Boring logs are presented in Attachment 2, Boring Logs. Representative soil and bedrock samples were submitted for laboratory testing to include gradation analysis, Atterberg Limits, moisture content, water soluble sulfates, pH, and resistivity. A summary of the laboratory test results is provided in the Summary of Test Results table in Attachment 1, Engineering Geology sheet.

2.1 GEOLOGY

Subsurface materials encountered at this site generally consisted of very loose to medium dense native sand and loose to medium dense sand fill with concrete fragments overlying medium hard to very hard, interbedded sandstone and claystone bedrock. Bedrock was encountered at a depth of 14.5 feet below ground surface (bgs) (EL. 6551.8 feet) in boring B1, 12.0 feet (EL. 6572.4 feet) in boring B2, 29.5 feet in boring B3 (EL. 6550.1 feet) in boring B3, 8.0 feet (EL. 6575.3 feet) in boring B4, 15.0 feet (EL. 6551.3 feet) in boring B5, and 22.0 feet (EL. 6559.1) feet in boring B6. Boring logs are presented in Attachment 2, Boring Logs.

2.2 GROUNDWATER

Groundwater was encountered during drilling in each boring except boring B4 at depths varying between 1.3 feet bgs and 19 feet bgs. Groundwater measurements taken on February 16, 2012 indicate groundwater to be at a depth of 1.3 feet bgs (EL. 6565.0 feet) in boring B1, 18.8 feet bgs (EL. 6565.6 feet) in boring B2, 14.7 feet bgs (EL. 6564.9 feet) in boring B3, 3.0 feet bgs (EL. 6563.3 feet) in boring B5, and 13.5 feet bgs (EL. 6567.6) feet in boring B6.

2.3 PHYSICAL PROPERTIES

Laboratory testing of selected soil samples indicate the granular subsurface soils classify as A-1-b (0) and A-2-4 (0) in accordance with AASHTO classifications. The bedrock classified as A-1-b, A-2-4, A-4, and A-6 with group indices varying between 0 and 8. A summary of the laboratory test results is presented in the Summary of Test Results table on Attachment 1, Engineering Geology sheet.

2.4 GEOCHEMICAL PROPERTIES

Five bedrock samples were analyzed for percent sulfate, pH and resistivity. Based on the results of water soluble sulfate testing performed in accordance with CP-L 2103, the potential for sulfate attack on Portland cement concrete in direct contact with the bedrock is classified as a Class 0 exposure per Table 601-2 of the *CDOT Standard Specifications for Road and Bridge Construction, 2011*.

Results of the resistivity testing suggest strong corrosion potential/aggressive behavior based on values per Table 3.9 of FHWA report FHWA0-IF-03-017, Geotechnical Engineering Circular No. 7 - Soil Nail Walls. A summary of the laboratory test results is presented in the Summary of Test Results table on Attachment 1, Engineering Geology sheet.

3.0 FOUNDATION RECOMMENDATIONS

Based on the subsurface conditions encountered at this site, the proposed bridge structures may be supported on deep foundations consisting of either drilled shafts or driven piles bearing in the interbedded sandstone and claystone bedrock. The following sections provide geotechnical parameters for the design of the various foundation alternatives.

3.1 DRIVEN PILES

Steel H-piles bearing in unweathered sandstone/claystone bedrock may be used to support the bridge superstructure. Section 6 of AASHTO LRFD specifications should be followed for the design of end bearing driven piles. A structural resistance factor of 0.60 is recommended. For driven piles with Grade 50 steel, a combined nominal skin friction and nominal end bearing capacity of 36 ksi times the cross sectional area of the pile is recommended.

Per Section 502 of *CDOT Standard Specifications for Road and Bridge Construction, 2011,* a pile driving analyzer should be used to establish pile deriving criteria. A resistance factor of 0.65 may be used in accordance with AASHTO LRFD specifications. Estimated pile penetration into unweathered bedrock is 5 to 8 feet for Grade 50 steel. However, actual pile tip elevation will depend on PDA results. The estimated driven steel H-pile tip elevations for the proposed bridge are shown in Table 1.

TABLE 1
ESTIMATED TIP ELEVATIONS FOR DRIVEN H-PILES

Location / Boring	Steel Grade	Estimated Pile Tip Elevation (feet amsl)
Abutment 1 East Side (Boring B3)	50	6542
Abutment 1 West Side (Boring B6)	50	6548
Piers 2 and 3 (Borings B1 and B5)	50	6541
Abutment 4 East Side (Boring B2)	50	6562
Abutment 4 West Side (Boring B4)	50	6570

Battered piles not exceeding 1H:4V batter may be used to provide lateral support. Center-center pile spacing should not be less than the greater of 30 inches or 2.5 pile widths unless a group analysis is performed and approved by the CDOT engineer. For lateral loading, the horizontal pile group analysis should be performed in accordance with Section 10 of AASHTO LRFD Bridge Design Specifications. Material properties presented in Table 3 should be utilized when performing lateral load analysis of the driven piles using LPILE or similar software. For steel H-piles, the minimum manufacturer's rated energy for the hammer should be as recommended in Table 502-1, *CDOT Standard Specifications for Road and Bridge Construction, 2011*. The pile caps for the abutments should be located outside the zone of potential scour or beneath the design scour elevation as determined by the hydraulic engineer.

3.2 DRILLED SHAFTS

For drilled shafts, the recommended geotechnical resistance utilizes side shear and end bearing for the portion of the shaft embedded in unweathered bedrock. A summary of recommended axial resistance values is presented in Table 2. This table also contains information on the anticipated elevation of unweathered bedrock at each drilling location. The information provided in Table 2 is based on the recommendation that the drilled shafts be socketed into unweathered bedrock a minimum depth of 10 feet.

The nominal end bearing, q_p, and nominal side shear resistance, q_s, for LRFD were determined using allowable values from the Denver method, which is based on the results of the Standard Penetration Test (SPT), and assumes a resistance factor of 0.5 and a weighted load factor of 1.5.

TABLE 2
RECOMMENDED DRILLED SHAFT RESISTANCE VALUES FOR BEDROCK

Location / Boring	Estimated Unweathered Bedrock Elevation (feet amsl)	LRFD	
		q_p (ksf)	q_s (ksf)
Abutment 1 East Side (Boring B3)	6547	120	9.0
Abutment 1 West Side (Boring B6)	6553	90	6.0
Pier 2 East Side (Boring B1)	6548	75	4.5
Piers 2 West Side (Boring B5)	6548	150	12.0
Pier 3 East Side (Boring B1)	6548	75	4.5
Pier 3 West Side (Boring B5)	6548	150	12.0
Abutment 4 East Side (Boring B2)	6567	120	9.0
Abutment 4 West Side (Boring B4)	6575	120	9.0

Resistance to axial loading provided by the overburden is not considered in these recommendations due to the difference in the strain limits between materials and the potential for scour. The native soils can be considered for the lateral resistance. However, the materials encountered in the top 5 feet of the shaft should be neglected when calculating the lateral resistance of the drilled shaft foundation. Material properties presented in Table 3 should be utilized when performing the lateral load analysis of the drilled shafts using LPILE or similar software.

TABLE 3
RECOMMENDED MATERIAL PROPERTIES FOR LATERAL LOAD ANALYSIS USING LPILE

Material	Internal Friction Angle φ (degrees)	Cohesion C (lb/ft²)	Horizontal Subgrade Reaction k_h (lb/in³)	Strain at ½ the max principle stress difference ε_{50} (in/in)	Total Unit Weight γ_T (lb/ft³)	Saturated Unit Weight γ_T (lb/ft³)
Existing Embankment Fill	32	0	25	--	125	135
Sand (above EL. 6567)	30	0	25	--	115	125
Sand and Clayey Sand (below EL. 6567)	28	0	20	--	115	125
Claystone/Sandstone Bedrock	0	3,000	1,500	0.005	128	138

Caving soil may be encountered above the bedrock elevation when installing drilled shafts. Therefore, slurry and/or casing may be needed to support the soils overlying the bedrock during drilled shaft excavation if caving occurs. Dewatering of the drilled holes also may be required prior to placement of the concrete. The potential for dewatering may increase with the amount of time the drill holes remain open. Alternatively, the concrete may be placed by tremie or other methods to avoid placement of concrete into water.

4.0 LATERAL EARTH PRESSURES

For lateral earth pressure on retaining walls and wingwalls, the parameters for design are presented in Table 4. The coefficients of earth pressure correspond to an active pressure equivalent fluid unit weight of 35 pounds per cubic foot (lb/ft^3) for Class 1 Structure Backfill. Lateral pressures must be reevaluated when sloping backfill or surcharge loads exist. Temporary excavation support may be required where slopes are steeper than 1H:1V. Bearing capacity for retaining wall foundations cannot be accurately determined without information on the wall type and foundation configuration. Typical nominal bearing capacity values for undisturbed or recompacted sandy soils like those present at the project site are 6 ksf for LFRD, assuming a minimum foundation width of 3 feet and a minimum embedment of 3 feet below the ground surface. We recommend that all wingwall foundations be constructed on the natural sand encountered in borings B3 and B6 and the bedrock encountered in borings B2 and B4. A coefficient of sliding resistance (μ) of 0.40 may be used between concrete and the undisturbed or recompacted sandy soils or unsaturated bedrock at the project site.

TABLE 4
RECOMMENDED PARAMETERS FOR RETAINING WALLS AND TEMPORARY EXCAVATIONS

Material	Typical Total Unit Weight, γ_T (pcf)	Internal Friction Angle, ϕ (degrees)	Cohesion c (psf)	Earth Pressure Coefficients		
				Active (K_a)	At Rest (K_o)	Passive (K_p)
Class 1 Structural Backfill	125	34	0	0.28	0.44	3.5
Existing Embankment Fill	125	32	0	0.31	0.47	3.3
Sand and Clayey Sand	115	30	0	0.33	0.50	3.0

5.0 SEISMIC DESIGN PARAMETERS

A shear wave velocity (V_s) survey was conducted by the Geotechnical Program on June 06, 2012. The survey consisted of performing an active and passive multichannel analysis of surface waves. The average V_s for the upper 100 feet was determined to be 1,485 feet per second as shown in Figure 1 in Attachment 3. According to the AASHTO Specifications for LRFD Seismic Bridge Design, this classifies the site as “C” and the seismic zone as “1” using Tables 3.10.3.1-1 and 3.10.6-1, respectively. Using the USGS AASHTO Earthquake Motion Parameters program, a seismic design spectrum plot was created for Spectral Acceleration vs. Time and is presented in Figure 2. Additional data from the program is included in Attachment 3 as well.

Please contact the Geotechnical Program at 303-398-6603 with questions.

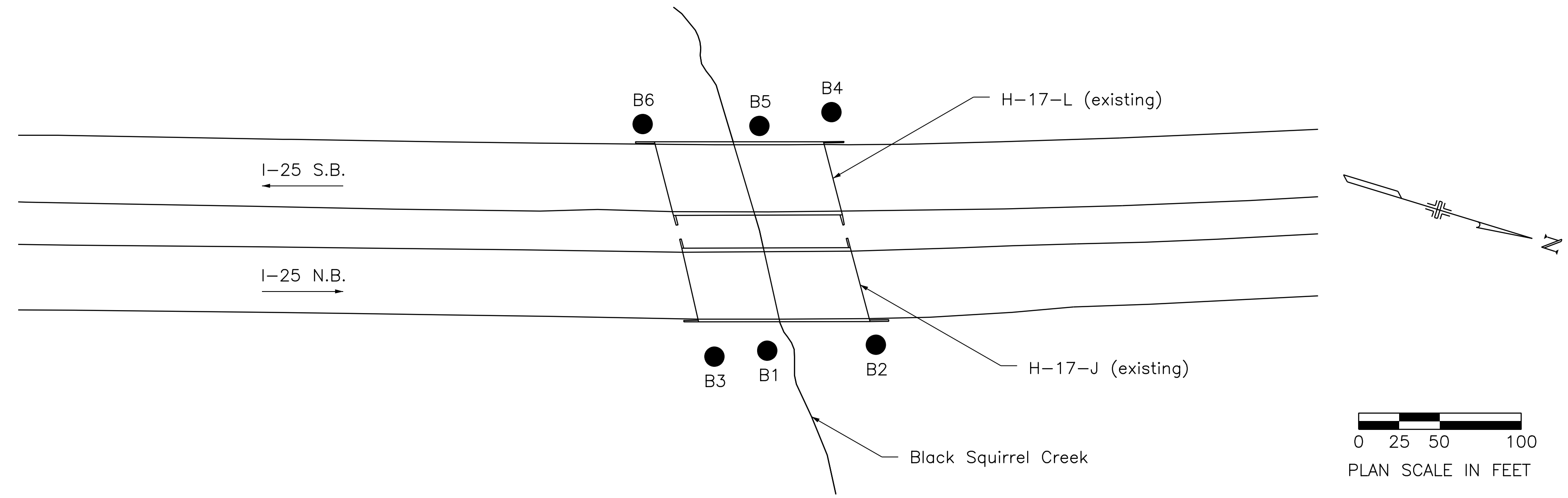
REVIEW: Conroy

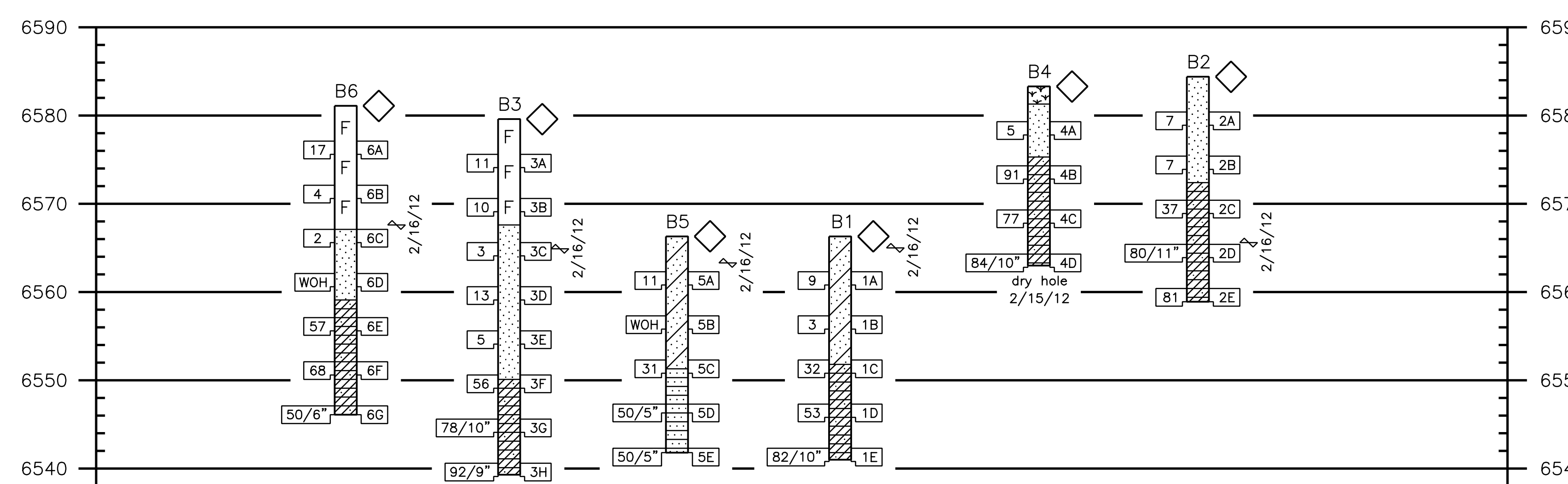
COPY: Wrona – Region 2 RTD
Lollar – Region 2 North Program Engineer
Hunt – Region 2 Resident Engineer
Wieden – Region 2 Materials Engineer
Cress – Region 2 Hydraulic Engineer
Conroy / Hotchkiss / Hernandez – Materials and Geotechnical Branch

ATTACHMENT 1

ENGINEERING GEOLOGY

IM C040-029
SA 17354
I-25 over BLACK SQUIRREL CREEK





The boring logs of the above test holes and geotechnical report are on file in the Geotechnical Program Office, Staff Materials and Geotechnical Branch, (303)398-6601

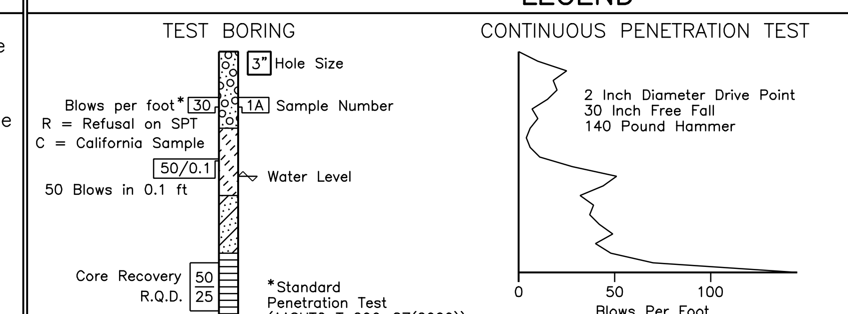
SUMMARY OF TEST RESULTS

Sample Number	Depth (feet)	Classification: Corps of Engrs. or Visual	Classification: USCS	Classification: AASHTO	Grading Analysis (AASHTO) Percent: Gravel	Coarse Sand	Fine Sand	Silt and Clay	Atterberg Limits: L.L. L_W	P.L. P_W	P.I. I_W	Water Content W %	Water Soluble Sulfates (%)	Soil pH ($H_2O/CaCl_2$)	Resistivity ohm-cm Saturated
1A	4	Sand	SW-SC	A-1-b(0)	35.0	37.7	17.3	10.0	25	21	4	16.2	–	–	–
1C	14	Sandstone	SM-SC	A-2-4(0)	7.4	28.2	37.6	26.7	24	20	4	15.4	–	–	–
1D	19	Claystone	–	–	–	–	–	–	–	–	–	–	0.02	6.52	1900
1E	24	Claystone	CL	A-6(5)	0.4	8.6	29.4	61.6	32	20	12	14.4	–	–	–
2B	9	Sand	SM	A-2-4(0)	11.4	34.6	36.1	18.0	NV	NP	NP	4.1	–	–	–
2D	19	Claystone	–	–	–	–	–	–	–	–	–	–	0.02	6.75	2400
2E	24	Claystone	CL	A-6(8)	0.0	0.6	22.0	77.3	33	21	12	17.7	–	–	–
3B	9	Fill, Sand	SC	A-2-4(0)	19.1	27.0	24.3	29.7	26	18	8	9.5	–	–	–
3D	19	Sand	SW-SM	A-1-b(0)	26.1	50.5	16.3	7.0	NV	NP	NP	16.4	–	–	–
3F	29	Claystone	–	–	–	–	–	–	–	0	–	–	0.04	7.05	2800
3G	34	Claystone	CL	A-6(6)	1.4	1.5	32.6	64.5	34	21	13	14.5	–	–	–
3H	39	Sandstone	SM	A-2-4(0)	13.7	34.4	33.8	18.1	NV	NP	NP	14.9	–	–	–
4A	4	Sand	SW-SM	A-1-b(0)	42.5	41.5	9.6	6.5	22	20	2	4	–	–	–
4B	9	Sandstone	SW-SM	A-1-b(0)	21.6	41.3	25.8	11.3	NV	NP	NP	5.5	–	–	–
4D	19	Sandstone	SC	A-6(3)	6.0	8.3	39.7	45.9	29	16	13	11.2	–	–	–
5B	9	Sand	SM-SC	A-2-4(0)	16.3	27.1	30.7	25.8	25	19	6	16.3	–	–	–
5C	14	Sandstone	SC	A-4(1)	6.9	21.0	26.6	45.5	29	20	9	13.8	–	–	–
5D	19	Sandstone	–	–	–	–	–	–	–	0	–	–	0.02	7.31	2450
6D	19	Sand	SM-SC	A-1-b(0)	23.3	36.0	25.1	15.7	24	19	5	20.9	–	–	–
6E	24	Sandstone	SP-SM	A-1-b(0)	26.5	40.6	21.5	11.4	NV	NP	NP	13.4	–	–	–
6F	29	Claystone	–	–	–	–	–	–	–	0	–	–	0	6.01	3150

TYPE OF MATERIAL

- Topsoil/Sand
- Sand, Clayey
- Sand
- F Fill – Sand, Clayey, Silty, some concrete fragments
- Bedrock, Interbedded Sandstone/Claystone
- Bedrock, Sandstone, Clayey

LEGEND



- Location of Test Boring
- Location of Continuous Penetration Test
- W 3 Inch Wireline Boring
- Rotary Boring
- Auger Boring

Print Date: 9/4/2012	
Drawing File Name: 17354geosheet01.dgn	
Horiz. Scale: 1:100	Vert. Scale: As Noted
Staff Geotechnical Program	HCL

R-X

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
DOT
4670 Holly Street, Unit A
Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program HCL

As Constructed
No Revisions:
Revised:
Void:

ENGINEERING GEOLOGY

Designer:	R. Wenzel	Structure Numbers	H-17-J
Detailer:	T. McNulty		H-17-L
Sheet Subset:	Geology	Subset Sheets: XXX of XXX	

Project No./Code
IM C040-029
17354
Sheet Number XXX

ATTACHMENT 2

BORING LOGS

IM C040-029
SA 17354
I-25 over BLACK SQUIRREL CREEK

DEPARTMENT OF TRANSPORTATION

GEOLOGICAL BORING LOG

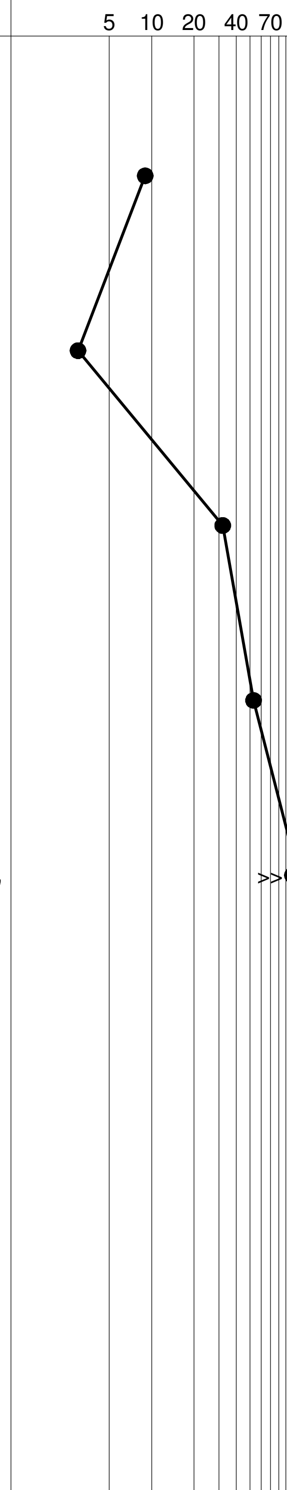
BORING #	
	B1

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM C040-029	17354	I 25 & Black Squirrel Creek	2/14/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I 25	El Paso	H-17-J/E. of Pier 2	MP 153.95

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
6,566.3ft	25.3ft	N: 426,536 E: 195,000	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%	SPT DATA	WELL DIAGRAM
6565 ▼			**Sand, Clayey,** loose, wet, gray						
	4.0		sand, clayey, loose, wet, gray	SPT	4.0	1A 3-5-4	9		
6560									
	9.0		same as above, but very loose and clay in tip	SPT	9.0	1B 2-2-1	3		
6555									
				SPT	14.0	1C 3-14-18	32		
	14.5		sandstone, medium hard, moist, gray, yellow						
6550			**Bedrock, Interbedded Sandstone and Claystone,** medium hard to very hard, slightly moist to moist, gray, brown						
	19.0		claystone, hard, slightly moist, brown	SPT	19.0	1D 8-15-38	53		
6545									
	24.0		claystone, sandy, very hard, moist, gray, brown	SPT	24.0	1E 18-32-50/4"	82/10"		
	25.3		Total Boring Depth 25.3ft						
6540									
6535									
6530									
6525									



SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH (ft)	▼ 1.3	▽ 1.3			
DATE	2/14/12	2/16/12			
TIME					

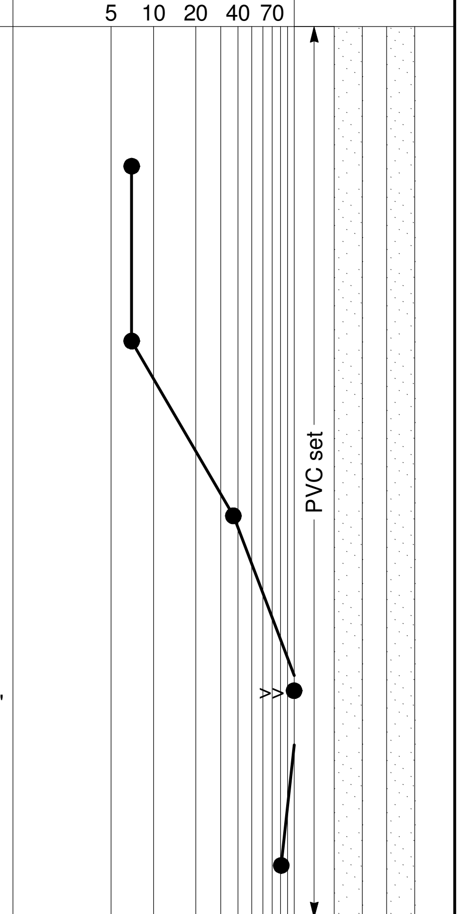
NOTES: CME 55/300, Auger

GEOLOGICAL BORING LOG

BORING #	B2
PROJECT ID	IM C040-029
SA	17354
PROJECT NAME	I 25 & Black Squirrel Creek
DATE DRILLED	2/14/12
ROUTE	I 25
COUNTY	El Paso
STRUCTURE/BENT	H-17-J/E. of Abut. 4
LOCATION	MP 153.95
TOP HOLE ELEV	6,584.4ft
TOTAL DEPTH	25.5ft
SURVEY INFO	N: 426,599 E: 194,977
GEOLOGIST/FOREMAN	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%
		Sand, fine to coarse, loose, slightly moist, tan				
6580	4.0	sand, fine to coarse, loose, slightly moist, tan	SPT	4.0	2A 3-3-4	7
6575	9.0	same as above	SPT	9.0	2B 4-4-3	7
	12.0	*stiff drilling* **Bedrock, Interbedded Sandstone and Claystone,** medium hard to very hard, dry to slightly moist, gray, tan, orange				
6570	14.0	claystone with lenses of sandstone, medium hard, slightly moist, gray, tan	SPT	14.0	2C 15-19-18	37
6565	19.0	claystone, very hard, dry, gray with orange, sandstone at top of drive, spoon wet at 19'	SPT	19.0	2D 16-30-50/5"	80/11"
6560	24.0	claystone, very hard, slightly moist, gray	SPT	24.0	2E 24-37-44	81
	25.5	Total Boring Depth 25.5ft				
6555						
6550						
6545						

SPT DATA / WELL DIAGRAM



SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H2O DEPTH (ft)	18.8
DATE	2/16/12
TIME	

NOTES: CME 55/300, Auger

GEOLOGICAL BORING LOG

CDOT — DEPARTMENT OF TRANSPORTATION

BORING # **B3**

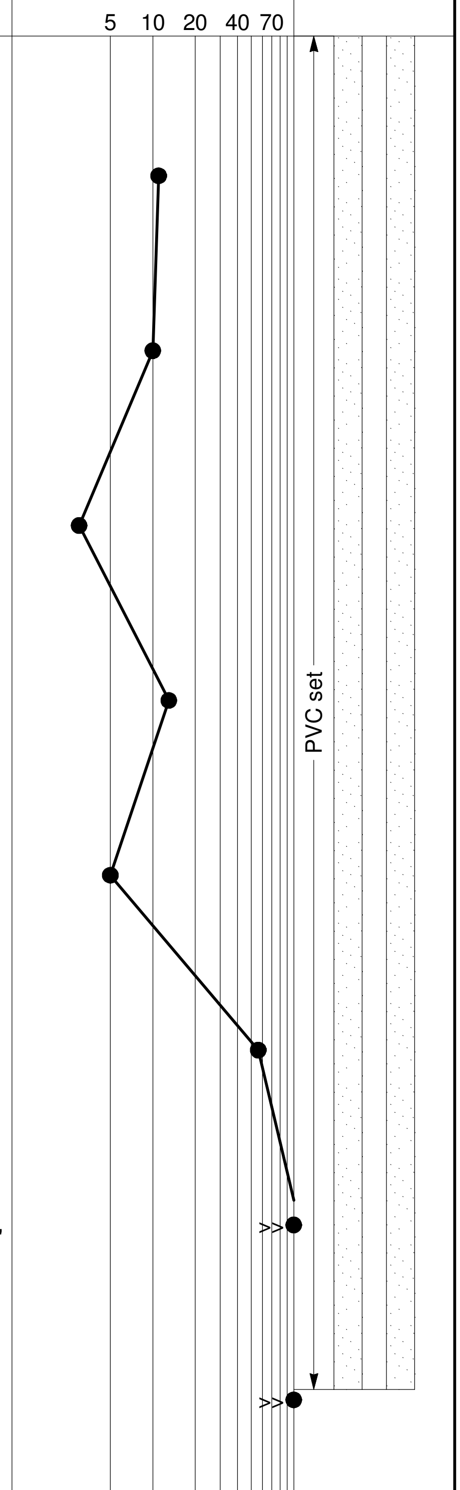
PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM C040-029	17354	I 25 & Black Squirrel Creek	2/15/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I 25	El Paso	H-17-J/E. of Abut. 1	MP 153.95

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
6,579.6ft	40.3ft	N: 426,506 E: 195,013	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%
		F	**Fill, Sand, Clayey,** with concrete fragments, loose to medium dense, moist, gray, brown				
6575	4.0	F	little recovery, concrete in tip, fill, sand, clayey with concrete blocks	SPT	4.0	3A 4-5-6	11
6570	9.0	F	fill, sand, clayey, loose, moist, gray, brown	SPT	9.0	3B 3-4-6	10
	12.0		**Sand,** fine to coarse, very loose to medium dense, wet, brown, gray				
	13.5		wet at 13.5'				
6565	14.0		sand, fine to coarse, very loose, wet, brown	SPT	14.0	3C 1-1-2	3
6560	19.0		sand, fine to coarse, medium dense, wet, gray	SPT	19.0	3D 3-6-7	13
6555	24.0		sand, fine to medium, loose, wet, gray	SPT	24.0	3E 1-3-2	5
6550	29.5		**Bedrock, Interbedded Sandstone and Claystone,** hard to very hard, miost, gray, brown	SPT	29.0	3F 6-18-38	56
6545				SPT	34.0	3G 22-28-50/4"	78/10"
6540				SPT	39.0	3H 47-42-50/3"	92/9"
	40.3		Total Boring Depth 40.3ft				

SPT DATA / WELL DIAGRAM



SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH (ft)	14.7				
DATE	2/16/12				
TIME					

NOTES: CME 55/300, Auger

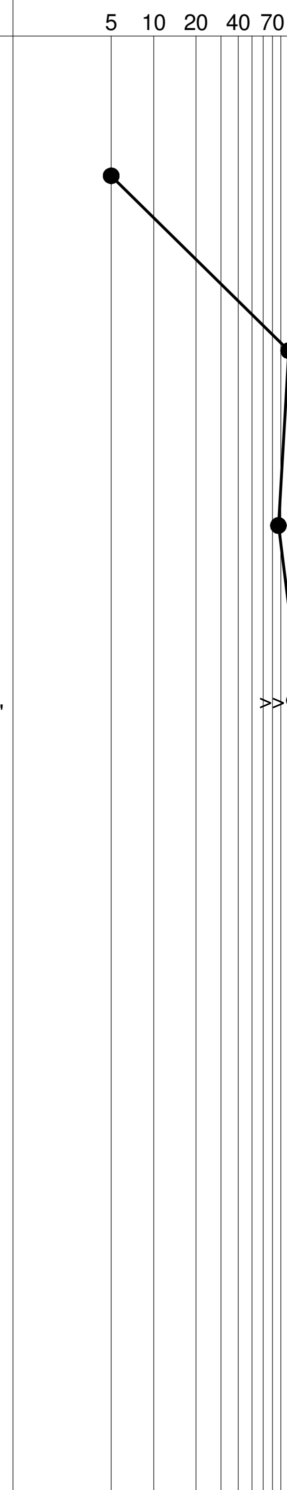
GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING #	B4
PROJECT ID	IM C040-029
SA	17354
PROJECT NAME	I 25 & Black Squirrel Creek
DATE DRILLED	2/15/12
ROUTE	I 25
COUNTY	El Paso
STRUCTURE/BENT	H-17-L/W. of Abut. 4
LOCATION	MP 153.95
TOP HOLE ELEV	6,583.3ft
TOTAL DEPTH	20.3ft
SURVEY INFO	N: 426,531 E: 194,848
GEOLOGIST/FOREMAN	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%
		Topsoil/Sand				
	2.0	**Sand,** fine to coarse, loose, moist, light gray				
6580						
	4.0	sand, fine to coarse, loose, moist, light gray	SPT	4.0	4A 3-3-2	5
6575	8.0	**Interbedded weakly cemented Sandstone and Claystone,** hard to very hard, slightly miost to moist, tan, olive, gray, red-brown				
	9.0	sandstone, fine to coarse, weakly cemented, very hard, slightly moist, tan	SPT	9.0	4B 29-43-48	91
6570						
	14.0	same as above, but moist, with some clay	SPT	14.0	4C 22-31-46	77
6565						
	19.0	sandstone, clayey, very hard, moist, olive, gray, red-brown	SPT	19.0	4D 23-34-50/4"	84/10"
	20.3	Total Boring Depth 20.3ft				
6560						
6555						
6550						
6545						

SPT DATA



WELL DIAGRAM

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH (ft)	dry
DATE	2/15/12
TIME	0955

NOTES: CME 55/300, Auger

GEOLOGIC BORING LOG I25 BLACK SQUIRREL CREEK.GPJ CO_DOT.GDT 9/4/12

GEOLOGICAL BORING LOG

BORING # **B5**

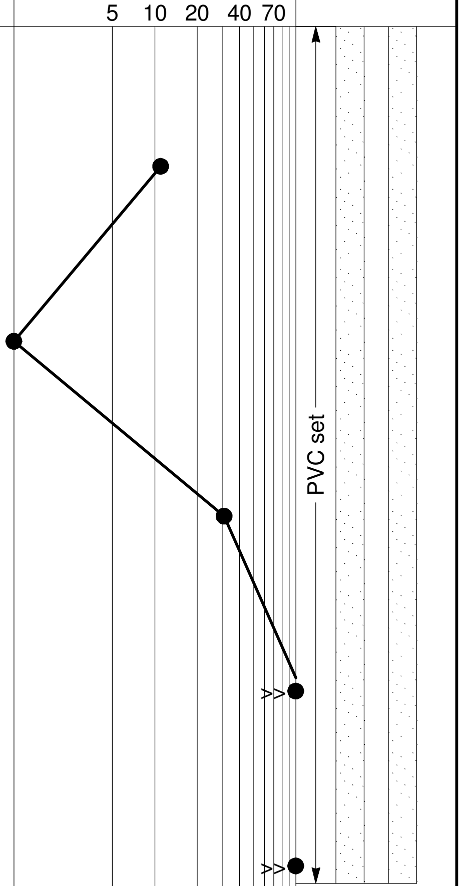
PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM C040-029	17354	I 25 & Black Squirrel Creek	2/14/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I 25	El Paso	H-17-L/W. of Pier 3	MP 153.95

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
6,566.3ft	24.5ft	N: 426,491 E: 194,869	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%
6565		**Sand, Clayey,** medium dense, wet, brown				
	4.0	sand, clayey, medium dense, wet, brown	SPT	4.0	5A 4-4-7	11
6560						
	9.0	sand, clayey, very loose, wet, gray	SPT	9.0	5B WOH	WOH
6555						
			SPT	14.0	5C 4-4-27	31
	15.0	**Bedrock, Sandstone, Clayey,** medium hard to very hard, slightly moist, gray, brown				
6550						
	19.0	same as above	SPT	19.0	5D 33-50/5"	50/5"
6545						
	24.0	same as above	SPT	24.0	5E	50/5"
	24.5	Total Boring Depth 24.5ft				
6540						
6535						
6530						
6525						

SPT DATA / WELL DIAGRAM



SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH (ft)	▼ 3.0			
DATE	2/16/12			
TIME				

NOTES: CME 55/300, Auger

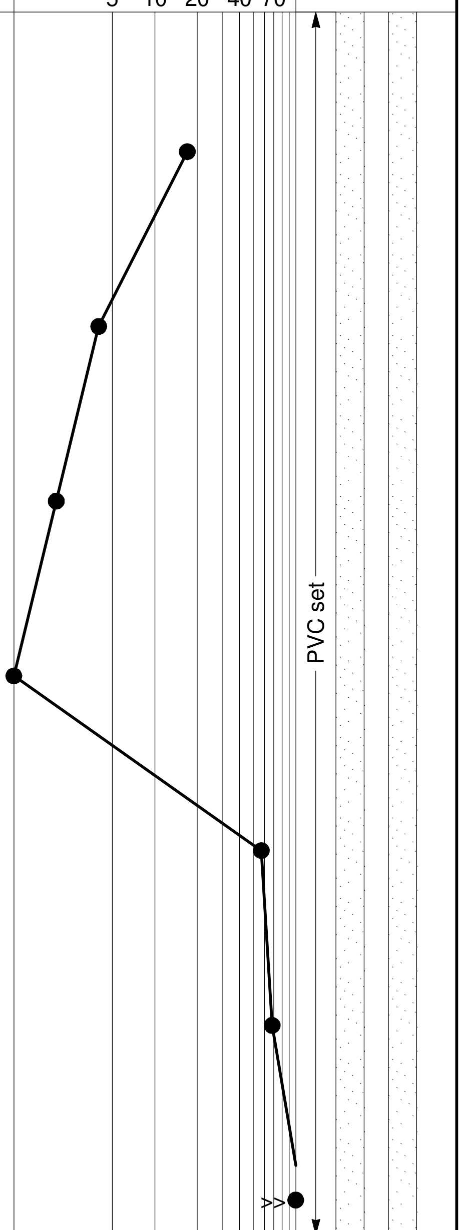
GEOLOGICAL BORING LOG

CDOT DEPARTMENT OF TRANSPORTATION

BORING #	B6
PROJECT ID	IM C040-029
SA	17354
PROJECT NAME	I 25 & Black Squirrel Creek
DATE DRILLED	2/16/12
ROUTE	I 25
COUNTY	El Paso
STRUCTURE/BENT	H-17-L/W. of Abut. 1
LOCATION	MP 153.95
TOP HOLE ELEV	6,581.1ft
TOTAL DEPTH	35.0ft
SURVEY INFO	N: 426,422 E: 194,889
GEOLOGIST/FOREMAN	R. Wenzel/H. Blailes/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID BLOWS	N-VALUE REC%/RQD%
6580		F	**Fill, Sand to Silty Sand,** fine to coarse, loose to medium dense, slightly moist to moist, tan, brown, dark brown				
	4.0	F	fill, sand, fine to coarse, medium dense, slightly moist, tan, brown	SPT	4.0	6A 4-6-11	17
6575		F					
	9.0	F	fill, silt, sandy, loose, moist, dark brown	SPT	9.0	6B 3-2-2	4
6570		F					
	14.0		**Sand,** fine to coarse, clean to clayey, very loose, moist to wet, tan, brown, gray	SPT	14.0	6C 2-1-1	2
6565							
	17.0		spoon wet at 17'				
	19.0		sand, fine to coarse, very loose, wet, gray	SPT	19.0	6D WOH	WOH
6560							
	22.0		**Bedrock, Interbedded weakly cemented Sandstone and Claystone,** hard to very hard, wet to moist, gray, brown, light brown, olive				
	24.0		sandstone, weakly cemented, fine to coarse, hard, wet, gray	SPT	24.0	6E 28-34-23	57
6555							
	29.0		claystone, sandy, hard, moist, gray, brown, olive	SPT	29.0	6F 12-23-45	68
6550							
	34.0		sandstone, fine to medium, weakly cemented, very hard, wet, light brown	SPT	34.0	6G 37-50/6"	50/6"
	35.0		Total Boring Depth 35.0ft				
6545							
6540							

SPT DATA — WELL DIAGRAM



SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH (ft)	13.5				
DATE	2/16/12				
TIME					

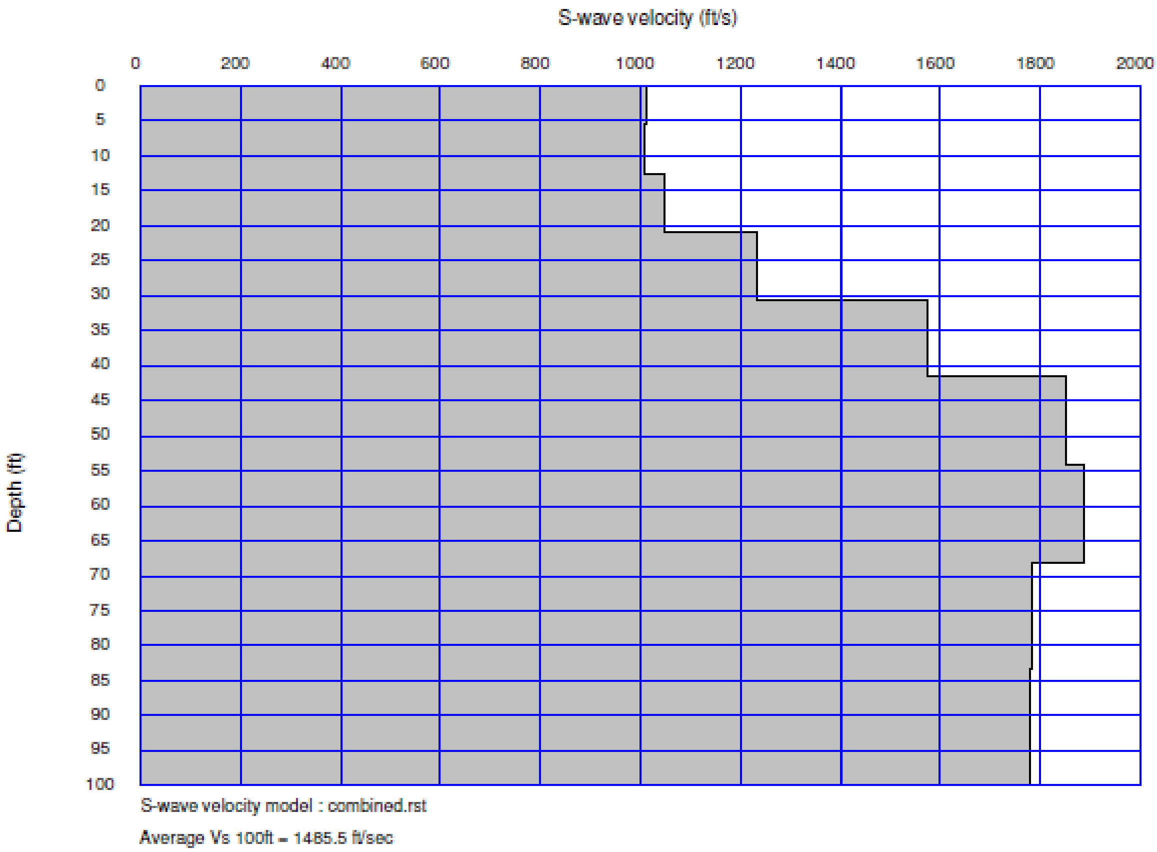
NOTES: CME 55/300, Auger

ATTACHMENT 3

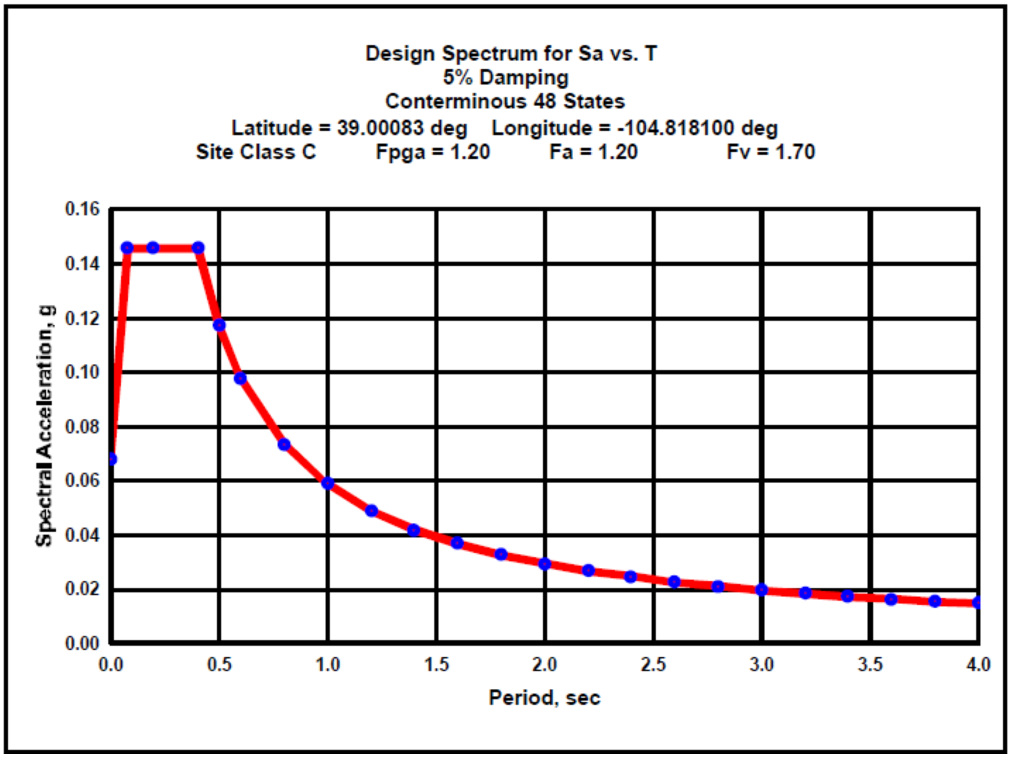
SEISMIC DESIGN PARAMETERS

IM C040-029
SA 17354
I-25 over BLACK SQUIRREL CREEK

IM C040-029
FIGURE 1
AVERAGE SHEAR WAVE VELOCITY TO 100 FEET



IM C040-029
FIGURE 2
DESIGN SPECTRAL ACCELERATION VS. TIME



Graph Data	
Period, sec	Sa, g
0.00	0.0678
0.08	0.1457
0.20	0.1457
0.40	0.1457
0.50	0.1177
0.60	0.0981
0.80	0.0735
1.00	0.0588
1.20	0.0490
1.40	0.0420
1.60	0.0368
1.80	0.0327
2.00	0.0294
2.20	0.0267
2.40	0.0245
2.60	0.0226
2.80	0.0210
3.00	0.0196
3.20	0.0184
3.40	0.0173
3.60	0.0163
3.80	0.0155
4.00	0.0147

IM C040-029
2007 AASHTO Bridge Design Guidelines

AASHTO Spectrum for 7% PE in 75 years
Latitude = 39.000830
Longitude = -104.818056
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.056	PGA - Site Class B
0.2	0.121	Ss - Site Class B
1.0	0.035	S1 - Site Class B

Spectral Response Accelerations SDs and SD1
Latitude = 39.000830
Longitude = -104.818056
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class C - Fpga = 1.20, Fa = 1.20, Fv = 1.70
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.068	As - Site Class C
0.2	0.146	SDs - Site Class C
1.0	0.059	SD1 - Site Class C

Map Response Spectra for Site Class B
Latitude = 39.000830
Longitude = -104.818056
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	Sd in.	
0.000	0.056	0.000	T = 0.0, Sa = PGA
0.057	0.121	0.004	T = To, Sa = Ss
0.200	0.121	0.047	T = 0.2, Sa = Ss
0.285	0.121	0.096	T = Ts, Sa = Ss
0.300	0.115	0.101	
0.400	0.087	0.135	
0.600	0.058	0.203	
0.800	0.043	0.270	
1.000	0.035	0.338	T = 1.0, Sa = S1
1.200	0.029	0.406	
1.400	0.025	0.473	
1.600	0.022	0.541	
1.800	0.019	0.609	
2.000	0.017	0.676	
2.200	0.016	0.744	
2.400	0.014	0.811	
2.600	0.013	0.879	
2.800	0.012	0.947	
3.000	0.012	1.014	
3.200	0.011	1.082	
3.400	0.010	1.150	
3.600	0.010	1.217	
3.800	0.009	1.285	
4.000	0.009	1.352	

Design Response Spectra for Site Class C
Latitude = 39.000830
Longitude = -104.818056
As = FpgaPGA, SDs = FaSs, SD1 = FvS1
Site Class C - Fpga = 1.20, Fa = 1.20, Fv = 1.70
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	Sd in.	
0.000	0.068	0.000	T = 0.0, Sa = As
0.081	0.146	0.009	
0.200	0.146	0.057	T = 0.2, Sa = SDs
0.404	0.146	0.232	T = Ts, Sa = SDs
0.500	0.118	0.287	
0.600	0.098	0.345	
0.800	0.074	0.460	
1.000	0.059	0.575	T = 1.0, Sa = SD1
1.200	0.049	0.690	
1.400	0.042	0.805	
1.600	0.037	0.920	
1.800	0.033	1.035	
2.000	0.029	1.150	
2.200	0.027	1.265	
2.400	0.025	1.379	
2.600	0.023	1.494	
2.800	0.021	1.609	
3.000	0.020	1.724	
3.200	0.018	1.839	
3.400	0.017	1.954	
3.600	0.016	2.069	
3.800	0.015	2.184	
4.000	0.015	2.299	