Memorandum

MATERIALS AND GEOTECHNICAL BRANCH
GEOTECHNICAL PROGRAM
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DEPARTMENT OF TRANSPORTATION

IM 0251-334
I25 Ilex Retaining Wall
Pueblo, CO
Subaccount # 17666

To: Dan Groeneman, Bridge Design and Management

From: Ilyess Ksouri, Materials and Geotechnical Branch

Date: May 16, 2013

Subject: Final Foundation Report, MSE Retaining Wall

This report presents final geotechnical site exploration results and foundation recommendations for the proposed MSE retaining wall structure referenced above. The purpose of the geotechnical site exploration was to determine the geotechnical profile and to characterize the physical properties of the foundation materials at the site. This information was utilized to provide geotechnical recommendations related to foundation design.

The MSE wall will be a fill wall approximately 600 feet long with a height varying from 13 to 23 feet. The wall will be built at the toe of the existing embankment to support a 2H:1V embankment slope part of the new bridge alignment. The height of the original embankment slope varies from 30 to 45 feet along the wall.

The subsurface exploration was conducted the week of September 24, 2012 along the proposed MSE wall alignment. A total of three borings (B09, B10, and B11) were drilled for the proposed structure using a CME 550 ATV Mounted drill rig and hollow-stem augers.

Subsurface soil and bedrock samples were obtained using a standard split spoon in accordance with ASTM-D1586. Depths at which samples were taken and standard penetration resistance N-values are shown on the attached logs of the exploratory borings and the geology sheet.

GEOLOGY

The subsurface conditions encountered generally consisted of 32 to 39 feet of medium dense to very dense silty to gravelly sand material with some cobbles underlain by very hard shale bedrock. The bedrock was encountered at depths of 32 to 39 feet below the existing ground surface, corresponding to approximate elevations of 4616.3 feet to 4619.8 feet above mean sea level (amsl). Groundwater was encountered in all drilled borings. It was measured at 9 to 19 feet below ground surface corresponding to approximate elevations of 4639.3 feet to 4642.9 feet amsl immediately after drilling.

Based on the sulfate analysis results, the potential for sulfate attack on Portland cement concrete in direct contact with the ground would be classified as a Class 0 exposure per Table 601-2 *CDOT Standard Specifications for Road and Bridge Construction 2011.* Based on current information regarding corrosion of steel relative to soil sulfate content, the soil at this site would be considered strong corrosion potential/aggressive per Table 3.9 *Geotechnical Engineering Circular No.7 Soil Nail Walls. FHWA0-IF-03-01*

FOUNDATION RECOMMENDATIONS

The native materials encountered in the exploratory borings will be suitable to provide support for the bearing pressures imposed by the proposed MSE wall. For retaining walls, it is assumed new fill will consist of Class 1 Structure Backfill. Class 1 Structure Backfill should be compacted to at least 95 percent of the maximum dry density and within 2 percent of optimum moisture content as determined by AASHTO T180 (ASTM D 1557) and as described in Section 206 of the 2011 CDOT *Standard Specification for Road and Bridge Construction*. The parameters used for the design of the MSE wall are presented in Table 1. The coefficient of active earth pressure, K_a, presented in the table corresponds to approximately 51 pcf of equivalent fluid unit weight for the Class 1 structure backfill. The parameters for the embankment material are assumed.

Table 1. Design Parameters for MSE Wall

Material	Total Unit Weight, γ_T (pcf)	Internal Friction Angle, ϕ (degrees)	Cohesion, c (psf)	Coefficient of Active Earth Pressure, K_a	Coefficient of Base Sliding Resistance, μ	Nominal Bearing Pressure, q_a (ksf)
Class 1 Structure Backfill*	125	34	0	0.406	0.53	---
Native Sand Material**	125	34	0	0.28	0.45	16.00
Embankment Fill Material*	125	32	300	0.463	0.5	----

Using $\mathbf{K_a}$ for Class 1 assumes that a construction cut no greater than 1.0 H: 1.0 V is used (i.e., no temporary excavation support). If temporary shoring is required, $\mathbf{K_a}$ for native material should be used. * Backfill slope of 2H:1V. ** Leveled with no backfill slope and undisturbed.

The bearing material will be medium dense sand material. The nominal bearing capacity value was calculated based on current groundwater conditions, an assumed maximum wall height of approximately 23 feet, a reinforcement length of 16.1 feet, a 2H:1V backfill slope,

and a minimum 3 feet of embedment for frost protection. The nominal bearing capacity value was conservatively estimated to be 16,000 pounds per square foot as presented in Table 1. The coefficient of sliding resistance (μ) that may be used between mass concrete and undisturbed foundation material per Table 3.11.5.3-1 of AASHTO 2012 LRFD Bridge Design Specification is presented in Table 1. A bearing resistance factor of 0.65 for MSE walls per table 11.5.7-1 of AASHTO 2012 LRFD Design Specification may be applied when using the Load Resistance Factor Design (LRFD) method. The global stability of the wall should be verified after final design is completed.

REVIEW: Thomas

COPY: Wrona/Wieden
Groeneman
DeHeart/Garcia
Cress
Schiebel/Hernandez/Ortiz

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # **B09**

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM 0251-334	17666	I25 Ilex Retaining Wall	9/27/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I25	Pueblo	R.W./S. End	Pueblo South

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
4,648.3ft	32.5ft	N:1582322.8095, E:3257873.1474	I. Ksouri/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
4645			Gravelly sand, some cobbles, medium dense, moist to wet, brown. No visible petroleum contamination or odor.						
					4.5	A 7-12-7	19		
4640									
					9.5	B 7-11-8	19		
4635									
4630									
4625									
4620									
	32.0				32.0	C 50/1"	50/1"	>>	
4615	32.5		Shale bedrock, very hard, dark gray. Total Boring Depth 32.5ft						

SPT | CON'T | GRAB | SHELBY | CORE

H_2O DEPTH	▽ 9.0				
DATE	9/27/12				
TIME	10:00 AM				

NOTES: CME 550, Hollow Stem Auger

GEOLOGIC BORING LOG I25 ILEX BRIDGES AND RETAINING WALL.GPJ CO_DOT.GDT 5/16/13

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # **B10**

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM 0251-334	17666	I25 Ilex Retaining Wall	9/25/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I25	Pueblo	R.W./Middle	Pueblo South

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
4,651.9ft	34.5ft	N:1582605.6825, E:3257871.3687	I. Ksouri/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%	SPT DATA (5 10 20 40 70)	WELL DIAGRAM
4650			Silty sand to gravelly sand, some cobbles, medium dense to very dense, moist to wet, light brown. No visible petroleum contamination or odor.						
4645					9.0	A 19-26-25	51		
4640									
4635					19.0	B 28-15-10	25		
4630									
4625					29.0	C 17-25-18	43		
4620									
	34.0		Shale bedrock, very hard, dark gray.		34.0	D 50/1"	50/1"	>>	
	34.5		Total Boring Depth 34.5ft						

SPT | CON'T | GRAB | SHELBY | CORE

H_2O DEPTH	▽ 9.0
DATE	9/25/12
TIME	2:00 PM

NOTES: CME 550, Hollow Stem Auger

GEOLOGIC BORING LOG I25 ILEX BRIDGES AND RETAINING WALL.GPJ CO_DOT.GDT 5/16/13

GEOLOGICAL BORING LOG

DEPARTMENT OF TRANSPORTATION

BORING # **B11**

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
IM 0251-334	17666	I25 Ilex Retaining Wall	9/26/12

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I25	Pueblo	R.W./N. End	Pueblo South

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
4,658.8ft	39.5ft	N:1582904.2337, E:3257890.9877	I. Ksouri/A. Moreno

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
4655	0.0		Gravelly sand, some cobbles, medium dense, moist to wet, brown. No visible petroleum contamination or odor.		4.5	A 11-26-23	49
	5.0		Black sandy material, possibility of a coal layer, dense, moist.				
4650	9.0		Sandy gravel, medium dense to very dense, moist to wet, brown. No visible petroleum contamination or odor.		9.5	B 9-5-6	11
4645					14.5	C 26-36-30	66
4640					19.5	D 3-9-10	19
4635							
4630					29.5	E 8-18-10	28
4625							
4620	39.0		Shale bedrock, very hard, dark gray.		39.0	F 50/1"	50/1"
	39.5		Total Boring Depth 39.5ft				

SPT DATA: 5 10 20 40 70 (>>)

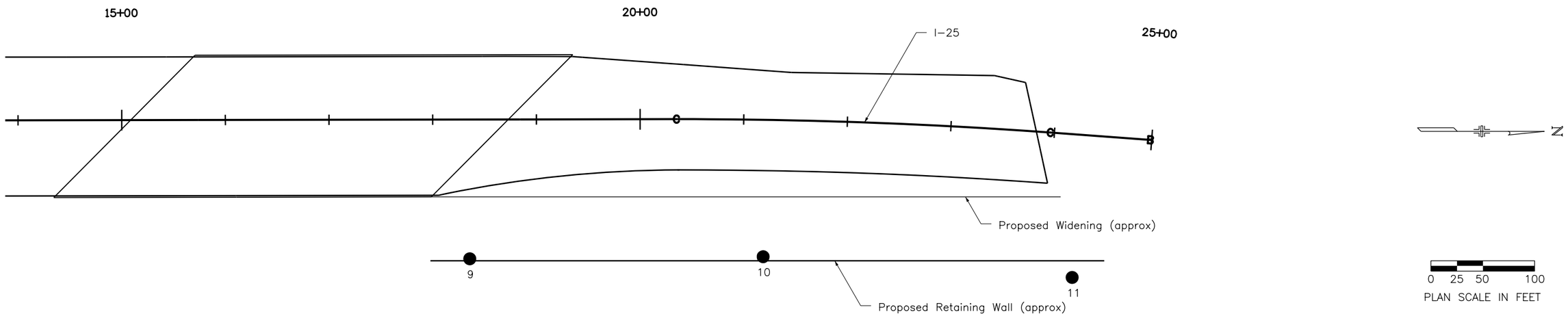
WELL DIAGRAM

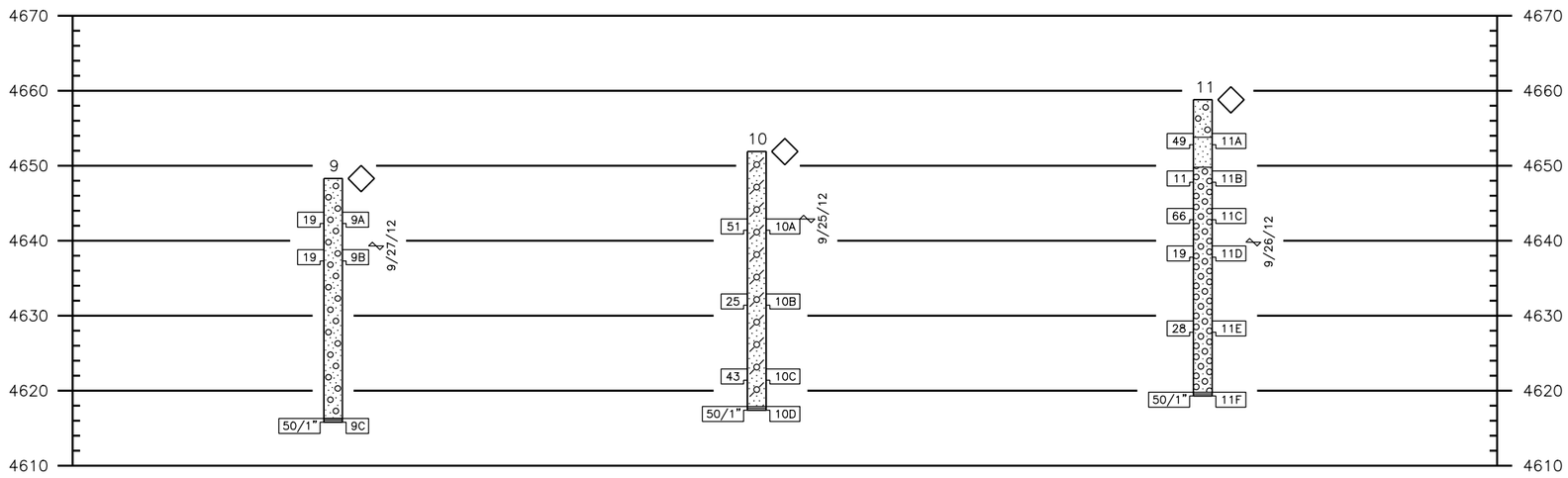
SPT | CON'T | GRAB | SHELBY | CORE

H_2O DEPTH	▽ 19.0
DATE	9/26/12
TIME	11:00 AM

NOTES: CME 550, Hollow Stem Auger

GEOLOGIC BORING LOG I25 ILEX BRIDGES AND RETAINING WALL.GPJ CO_DOT.GDT 5/16/13





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 %	Dry Density (lb/ft^3)	Uniaxial Compressive Strength (psf)	Chlorides (% mass)	Water Soluble Sulfates (% mass)	Soil pH ($H_2O/CaCl_2$)	Resistivity ohm–cm Saturated
11A	4–4.5	Gravelly Sand	SM–SC	A–1–b(0)	28.2	27.5	20.5	23.8	23	18	5	4.9	–	–	–	–	–	–
11B	9.0	Gravelly Sand	–	–	–	–	–	–	–	–	–	–	–	–	0.008	0.072	8.47	2350
11D	19–20.5	Sandy Gravel	GP	A–1–a(0)	51.3	27.4	18.6	2.7	NV	NP	NP	2.6	–	–	–	–	–	–

TYPE OF MATERIAL

- Silty Sand to Gravelly Sand, some Cobbles
- Gravelly Sand, some Cobbles
- Black Sandy Material, possible Coal
- Sandy Gravel
- Shale Bedrock

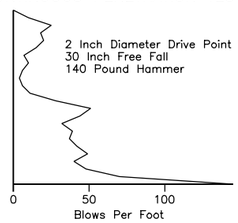
Note: Boulders may be encountered at any depth

LEGEND

TEST BORING

Blows per foot* 30 — 3" Hole Size; 1A Sample Number
R = Refusal on SPT
C = California Sample
50/0.1
50 Blows in 0.1 ft
Water Level
Core Recovery 50
R.Q.D. 25
*Standard Penetration Test (AASHTO T 206–87(2000))

CONTINUOUS PENETRATION TEST



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

Print Date: 5/16/2013
Drawing File Name: 17666geosheet03.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Staff Geotechnical Program LAC

R-X

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
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Denver, CO 80216
Phone: 303-398-6601 FAX: 303-398-6504
Staff Geotechnical Program LAC

As Constructed
No Revisions:
Revised:
Void:

ENGINEERING GEOLOGY

Designer: I. Ksouri
Detailer: T. McNulty
Sheet Subset: Geology
Structure Numbers: (retaining wall)
Subset Sheets: XXX of XXX

Project No./Code
IM 0251-334
17666
Sheet Number XXX